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NUMBER, BIOMASS, AND DISTRIBUTION OF FISH SPECIES IN THE LITTORAL ZONE OF THE UPPER ST. LAWRENCE RIVER--QUANTITATIVE ELECTROFISHING, JOHNSTOWN BAY, JUNE TO OCTOBER 1995: AN ASSESSMENT BY TYPE OF HABITAT

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NUMBER, BIOMASS, AND DISTRIBUTION OF FISH SPECIES IN THE LITTORAL ZONE OF THE UPPER ST. LAWRENCE RIVER--QUANTITATIVE ELECTROFISHING, JOHNSTOWN BAY, JUNE TO OCTOBER 1995: An assessment by type of habitat[1]

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ABSTRACT

The fish community of Johnstown Bay, a shallow, mesotrophic embayment in the upper St. Lawrence River, was studied, using quantitative electrofishing techniques that sampled on an area basis. A total of 168 transects, with a total area of 25,995 m^2, were used to examine species and assemblages on a monthly basis (June-October 1995) in various types of shallow-water habitats in nine different areas. Replicate sampling was conducted, and geometric mean density (both numbers $\cdot 100\ m^{-2}$ and biomass $g \cdot 100\ m^{-2}$), sampling variability, and species distribution were described. Over the summer, in the shallow littoral zone ($\bar{x}$ = 1.43 m, 0.50-2.21 m), the vegetative cover was moderately dense (57.7%) and filled approximately half of the water column (46.8%). The main vegetation species were wild celery (*Vallisneria americana*)--29.6% and common elodea (*Elodea canadensis*)--26.6%.

The total electrofishing catch (34 species), corrected for the size of the individuals that escaped capture, was 3784. Overall capture efficiency was 50.2% but 73.3% by species. Vegetative cover and height, and occasionally turbidity created by unstable soft substrate (recently altered habitat), affected capturability, but the effect was minimized by correcting for missed individuals and replication. Bluntnose minnows (*Pimephales notatus*) were 47% of the total catch; 35% of the species accounted for 95% of the overall catch. Catch was most abundant in August and September. Specific density data (numbers and biomass), with confidence limits where appropriate, along with sampling variability, were calculated for 34 species by month and area, along with monthly, area, and overall means combined.

Species assemblages are described for several types of shallow, natural, littoral-zone habitats: offshore, lower bay, outer bay, and inner bay, along with recently altered quarry shot-rock infill and closely related and disturbed areas. The relative importance of the species in these assemblages was ranked on the basis of density (numbers and biomass) and relative distribution (CV). In natural littoral habitats, pumpkinseeds (*Lepomis gibbosus*) were the most important species, followed by white suckers (*Catostomus commersoni*), yellow perch (*Perca*

flavescens), brown bullheads (*Ictalurus nebulosus*), golden shiners (*Notemigonus crysoleucas*), rock bass (*Ambloplites rupestris*), and northern pike (*Esox lucius*); 23 species were statistically important, with a density of 7.23·100 m^{-2} and 682.47 g·100 m^{-2}. The rock infill deposited the previous autumn in shallow water (0.91 m) had a strikingly different fish community; bluntnose minnows (*Pimephales notatus*) were the most important species, followed by rock bass, white suckers, pumpkinseeds, spottail shiners (*Notropis hudsonius*), yellow perch, and American eels (*Anguilla rostrata*). Compared with natural habitats, this community was much less diverse, containing only nine species, with an overall density of 48.61·100 m^{-2} and 721.83 g·100 m^{-2}. In this altered habitat, six species showed increased relative abundance: bluntnose minnows--71.0×, American eels--8.1×; rockbass--7.6×, spottail shiners--7.0×, darters (*Etheostoma* sp.)--2.7×, white suckers--1.1×, whereas decreased relative abundance was shown by pumpkinseeds--0.9× and yellow perch--0.6×. In the adjacent area, where the soft substrate was disturbed by the infill, overall biomass was considerably less (206.91 g·100 m^{-2}).

Although the overall density of species associated with the edge of the rock infill was greater than in natural habitats, the species composition was considerably different and was atypical for the vegetated littoral-zone habitat of the bay. Bluntnose minnows, rock bass, and American eels appear to have been attracted in large numbers to the rock, either to spawn or for cover.

The loss of vegetation associated with this infill would directly affect overall fish production. Quite specifically, optimal muskellunge nursery habitat was lost as a result of infilling. Also, juvenile muskellunge in nearby nursery habitat would be affected either directly by the associated density of potential predators or indirectly through decreased growth and production because rock bass, by virtue of sheer numbers, would successfully out-compete muskellunge for golden shiners, a mutually important and preferred prey.

By detailed and systematic observations, with replication and appropriate habitat

comparisons, we conclude that the rock infill has negatively affected the natural fish community in the shallow vegetated littoral zone of Johnstown Bay.

Key words: upper St. Lawrence River, fish community, embayment, cool- and warm-water fishes, density, numbers, biomass, community structure, species associations, interactions, predator-prey, littoral zone, quantitative electrofishing, sampling variability, vegetation, habitat alteration, rock infill, muskellunge

SOMMAIRE

Nous avons étudié la communauté ichtyenne de la baie Johnstown, une baie mésotrophe peu profonde du cours supérieur du fleuve Saint-Laurent, au moyen de techniques quantitatives de pêche électrique permettant d'échantillonner des superficies déterminées. En tout, nous avons délimité 168 transects, représentant ensemble 25 995 m^2, et nous avons examiné chaque mois (de juin à octobre 1995) les assemblages et les espèces des habitats d'eau peu profonde de neuf secteurs différents. Nous avons fait des échantillonnages répétés et nous avons déterminé la moyenne géométrique (effectifs et biomasse·100 m^{-2}), la variabilité d'échantillonnage et la distribution des espèces. Au cours de l'été, dans la zone littorale peu profonde ($\bar{x}$ = 1,43 m, 0,50 - 2,21 m), la végétation était moyennement dense (57,7%) et occupait à peu près la moitié de la colonne d'eau (46,8%). La vallisnérie américaine (*Vallisneria americana*) et l'élodée du Canada (*Elodea canadensis*), les deux espèces les plus communes, représentaient respectivement 29,6% et 26,6% de la végétation.

En tout, après correction pour la taille des sujets échappés, nous avons fait 3 784 captures (34 espèces) à la pêche électrique. L'efficacité de capture globale a atteint 50,2%, mais sa valeur par espèce était de 73,3%. L'étendue et la hauteur de la couverture végétale, ainsi que la turbidité occasionnelle due à la présence d'un substrat mou et instable (habitat récemment modifié), ont influé sur la capturabilité, mais nous avons atténué l'effet de ces facteurs par une correction, pour tenir compte des sujets échappés, et par des échantillonnages répétés. Le ventre-pourri (*Pimephales notatus*) représentait 47% du total des captures; 95% des captures globales étaient constitués de 35% des espèces recensées. Les plus fortes captures ont été faites aux mois d'août et septembre. Nous avons déterminé la densité (effectifs et biomasse) en fonction de l'espèce, avec intervalles de confiance lorsqu'il y avait lieu, et la variabilité d'échantillonnage pour 34 espèces par mois par secteur; nous avons aussi calculé les moyennes mensuelles, les moyennes par secteur et les moyennes globales.

Nous décrivons les assemblages d'espèces observés dans divers habitats naturels de la zone littorale peu profonde, soit la zone du large, l'entrée de la baie, la zone intermédiaire et

le fond de la baie, ainsi que dans des secteurs récemment modifiés par remblayage avec des déblais de carrière et dans les zones avoisinantes perturbées. Nous avons établi l'importance relative des espèces représentées dans ces assemblages d'après les paramètres de densité (effectifs et biomasse) et leur distribution relative (CV). Dans les habitats de la zone littorale, le crapet-soleil (*Lepomis gibbosus*) était l'espèce la plus importante; venaient ensuite le meunier noir (*Catostomus commersoni*), la perchaude (*Perca flavescens*), la barbotte brune (*Ictalurus nebulosus*), la chatte de l'est (*Notemigonus crysoleucas*), le crapet de roche (*Amploplites rupestris*) et le grand brochet (*Esox lucius*); 23 espèces étaient statistiquement importantes, leur densité atteignant 7,23·100 m^{-2} et 682,47 g·100 m^{-2}. Dans la zone d'eau peu profonde (0,91 m) où des déblais de carrière avaient été déposés l'automne précédent, la communauté ichtyenne était remarquablement différente : le ventre-pourri était l'espèce la plus commune, puis venaient le crapet de roche, le meunier noir, le crapet-soleil, la queue à tache noire (*Notropis hudsonius*), la perchaude et l'anguille d'Amérique (*Anguilla rostrata*). Cette communauté était beaucoup moins riche que celles des habitats naturels, car elle ne comprenait que neuf espèces; les paramètres de densité globale étaient de 48,61·100 m^{-2} et de 721,83 g·100 m^{-2}. Dans cet habitat modifié, six espèces présentaient une abondance relative accrue : le ventre-pourri (71,0×), l'anguille d'Amérique (8,1×), le crapet de roche (7,6×), la queue à tache noire (7,0×), le dard (*Etheostoma* sp., 2,7×) et le meunier noir (1,1×); quant au crapet-soleil (0,9×) et à la perchaude (0,6×), leur abondance relative avait diminué. Dans la zone adjacente, où le substrat mou avait été remué par le remblayage, la biomasse globale était considérablement moindre (206,91 g·100 m^{-2}).

La densité globale des espèces trouvées à la périphérie de la zone remblayée était plus élevée que ce que nous avons observé dans les habitats naturels, mais la composition spécifique de la communauté de cette zone présentait des différences considérables et n'était pas caractéristique de l'habitat à végétation de la zone littorale de la baie. Les déblais rocheux semblent avoir attiré le ventre-pourri, le crapet de roche et l'anguille d'Amérique, ceux-ci y venant en grand nombre, soit pour frayer, soit pour s'abriter.

La disparition de la végétation dans la zone remblayée a vraisemblablement influé sur la production globale des poissons. Plus précisément, le remblayage a détruit une zone où l'habitat était optimal, comme nourricerie, pour le maskinongé. En outre, le maskinongé juvénile des nourriceries environnantes a vraisemblablement été touché, soit directement, par suite du changement de la densité des prédateurs potentiels, soit indirectement, à cause d'une baisse de croissance et de production, le crapet de roche, du simple fait de sa supériorité numérique, surpassant le maskinongé dans sa prédation de la chatte de l'est, une espèce proie importante et préférée tant par le crapet de roche que par le maskinongé.

Au terme de cette étude où nous avons fait des observations approfondies et systématiques, avec répétitions et, lorsqu'il y avait lieu, comparaisons entre habitats, nous avons conclu que le remblayage a eu un effet négatif sur la communauté ichtyenne naturelle de la zone littorale peu profonde à végétation de la baie Johnstown.

Mots clés: cours supérieur du Saint-Laurent, communauté ichtyenne, baie, poissons d'eau froide et poissons d'eau chaude, densité, effectifs, biomasse, structure des communautés, associations d'espèces, interactions, prédation, zone littorale, pêche électrique quantitative, variabilité d'échantillonnage, végétation, modification de l'habitat, remblayage, maskinongé

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INTRODUCTION

Studies of fish communities are legion; fish assemblages and the multitude of factors that affect them have been variously reviewed (e.g., Great Lakes--Regier 1979) and compared (e.g., stream fishes--Matthews and Heins 1987; lake fishes--Tonn et al. 1990). Relative abundance is usually used to assess fish populations because many factors affect the ability to sample them in an unbiased and absolute fashion. Size selectivity, influenced by gear type, is a primary problem in comparing among species with a broad range of sizes and habitat requirements. Sampling variability and its effect on documenting relative occurrence and detecting significant change in abundance pose a very fundamental and difficult problem in fisheries science (Casselman et al. 1986; Lester et al. 1996). Some studies have emphasized the quite specific environmental and microhabitat requirements of various fish species and assemblages (e.g., Keast 1978; Keast et al. 1978; Killgore et al. 1989; Matuszek et al. 1990; Casselman and Lewis 1996; Randall et al. 1996).

Some comprehensive fish community studies have been conducted on the structure and occurrence of various species in the confines of small lakes (e.g., Kelso 1988; Kelso and Johnson 1991) and small streams and rivers (e.g., Hallam 1959; Bowlby and Roff 1986). Fish communities in large, open lakes and rivers present some very complicated sampling problems (Casselman et al. 1990). Various types of sampling methods and techniques have been assessed in considerable detail (e.g., Hubert 1983; Reynolds 1983; Casselman et al. 1986). Sampling that provides absolute abundance estimates of the species assemblages of fish communities has been sought but rarely realized. Although mark-recapture studies are routinely conducted, they are usually limited to one or a few species and have considerable bias and limitations; rarely are species recaptured in numbers adequate to calculate statistically appropriate, useful estimates. Small species, which are difficult to handle and mark, pose very specific difficulties.

Electrofishing has proved to be practical in confined environments (e.g., Wiley and Tsai 1983; Bowlby and Roff 1986) and is proving useful in the littoral zone of relatively

large, open systems (e.g., Casselman et al. 1990; Minns et al. 1994). It is, however, restricted to relatively shallow-water habitats (< 3 m). Unfortunately, open-water estimates are often described in terms of shocker time or distance and in relative rather than absolute terms and without strict reference to volume or area sampled.

In the early 1980s, the Ontario Ministry of Natural Resources (OMNR) acquired, and has since used, several large electrofishing boats. The Research Section has experimented with and applied various open-water quantitative electrofishing sampling techniques (Casselman, unpubl. data). Open-water electrofishing has low variability when compared with other routine fish-sampling techniques (Casselman et al. 1986), and specific practical techniques have been developed that permit quantification on an area-effort basis, which provides absolute and comparable abundance estimates. With some modification of technique, appropriate care, and replication, the technique can provide valuable shallow-water fish community data. If habitat is thoroughly described and sampled, it is possible to understand and explain fish patchiness on the basis of microhabitat association and preference. In a preliminary study conducted on Dalrymple Lake, Ontario, in 1983, quantitative electrofishing showed a statistically significant change in the absolute abundance and biomass of several small fish species associated with shoreline alteration and infill (Casselman, unpubl. data). Electrofishing catches a broad range of sizes, hence is less size selective than most other sampling techniques used in fisheries science.

The technique that was developed and is subsequently described here not only standardizes effort on an area basis but also incorporates replication, permitting more rigorous statistical analysis. Research has used this method in several littoral-zone fish community studies (Lake Ecosystem Working Group--9 lakes; Haliburton Highlands acid precipitation research studies--12 lakes; Eastern Region walleye stocking study, Rideau Lakes Fisheries Assessment Unit--18 lakes). The versatility of this specific technique has been demonstrated in a number of studies: fish and plankton abundance (Sprules et al. 1983); low sampling variability (Casselman et al. 1986); walleye (*Stizostedion vitreum*) stocking success and fish community interaction (Seip 1995).

Habitat alterations involving the infilling of an estimated 10,500 tonnes of quarry rock (5346 m^2) in Johnstown Bay, upper St. Lawrence River (Grant 1995), in November 1994 posed some very specific questions concerning the fish community and habitat associations in the littoral zone of this embayment. Although there are very powerful statistical techniques for examining habitat changes and ecosystem health (Hildén and Rapport 1993; Osenberg et al. 1994; Underwood 1994; W. F. Baird & Associates 1996; Minns et al. 1996), sampling variability is a major and overriding factor affecting the ability to detect real and significant change (Casselman et al. 1986). Limited quantitative data existed concerning the diverse assemblage of species, especially small species, present in the embayment (Jacques Whitford Environment Limited 1992; Grant 1995). Time-series analysis was not possible. However, an "after-only" spatial-analysis study (Osenberg et al. 1994) could provide data to determine changes in the fish community and thereby help assess the impact of the alteration. Of primary importance was that if a study were conducted, it would provide general insights and quantitative data on absolute abundance for the species assemblage of the fish community of a shallow littoral zone of a large river system. It would also help assess the impact of the infill of quarry rock in the upper backwater area of Johnstown Bay and specifically determine the significance of this alteration on the nursery requirements and habitat of muskellunge (*Esox masquinongy*), a locally important sports species (Grant 1995).

We decided to conduct a quantitative electrofishing survey throughout Johnstown Bay during the summer of 1995 and to look at different habitat types by location, including the edge of the rock infill. The specific objectives of the study were to (1) apply the quantitative open-water electrofishing technique with replication to describe the abundance, biomass, and distribution of littoral-zone fishes in a shallow embayment (< 3 m) in the upper St. Lawrence River; (2) examine the occurrence of various species in relation to locally different types of microhabitat, including the recent rock infill; (3) assess and compare the importance of this habitat alteration on species that can be shown to be statistically present and abundant, including juvenile muskellunge.

METHODS

The fish community study of the littoral zone of the upper St. Lawrence River was conducted in a large, shallow bay (44°44'N, 75°28'W) on the Canadian side of the international section of the St. Lawrence River approximately 100 km downriver from Lake Ontario at Johnstown, Ontario, and just downstream from the Canada Ports Corporation (CPC) elevator and dock facilities (Fig. 1).

General study area

Johnstown Bay is bordered upstream by CPC dock B and downstream by a group of islands and a peninsula channelized for the original St. Lawrence River canal system (Fig. 1). One large tributary, Johnstown Creek, flows into the bay just west of Johnstown (Fig. 1, also I upper outer bay). The Prescott-Ogdensburg International Bridge crosses the river over the middle of the bay.

The habitat associated with the upper inner portion of the bay was described in the early 1990s by Jacques Whitford Environment Limited (1991) in relation to a proposed expansion to dock B (Fig. 1--II upper inner bay). Although certain parts of the upper bay may have been altered over the years by some dredging and filling, aquatic plants in the shallow near-shore section (< 2 m) are now typical of most natural shallow backwater habitats in the area. Most of the bay is shallow (< 3 m) and moderately heavily vegetated in midsummer, providing a productive littoral-zone habitat uncommon in this fast-flowing section of the river (Grant 1995). Vertical wood shoring, deteriorated to the water level, and piling, backfilled with rock rubble, skirt the upper and inner portions of the bay around to the Bridgeview Marina (Fig. 1--II upper inner bay), providing a distinct retaining wall bordering deeper water (0.8-2.0 m). The lower bay is shallower, with more sand and gravel and some channelization (Fig. 1, also III lower bay), but appears to be less affected by man-made shoreline alterations.

In November 1994, an estimated 10,500 tonnes of shot-rock and coarse granular

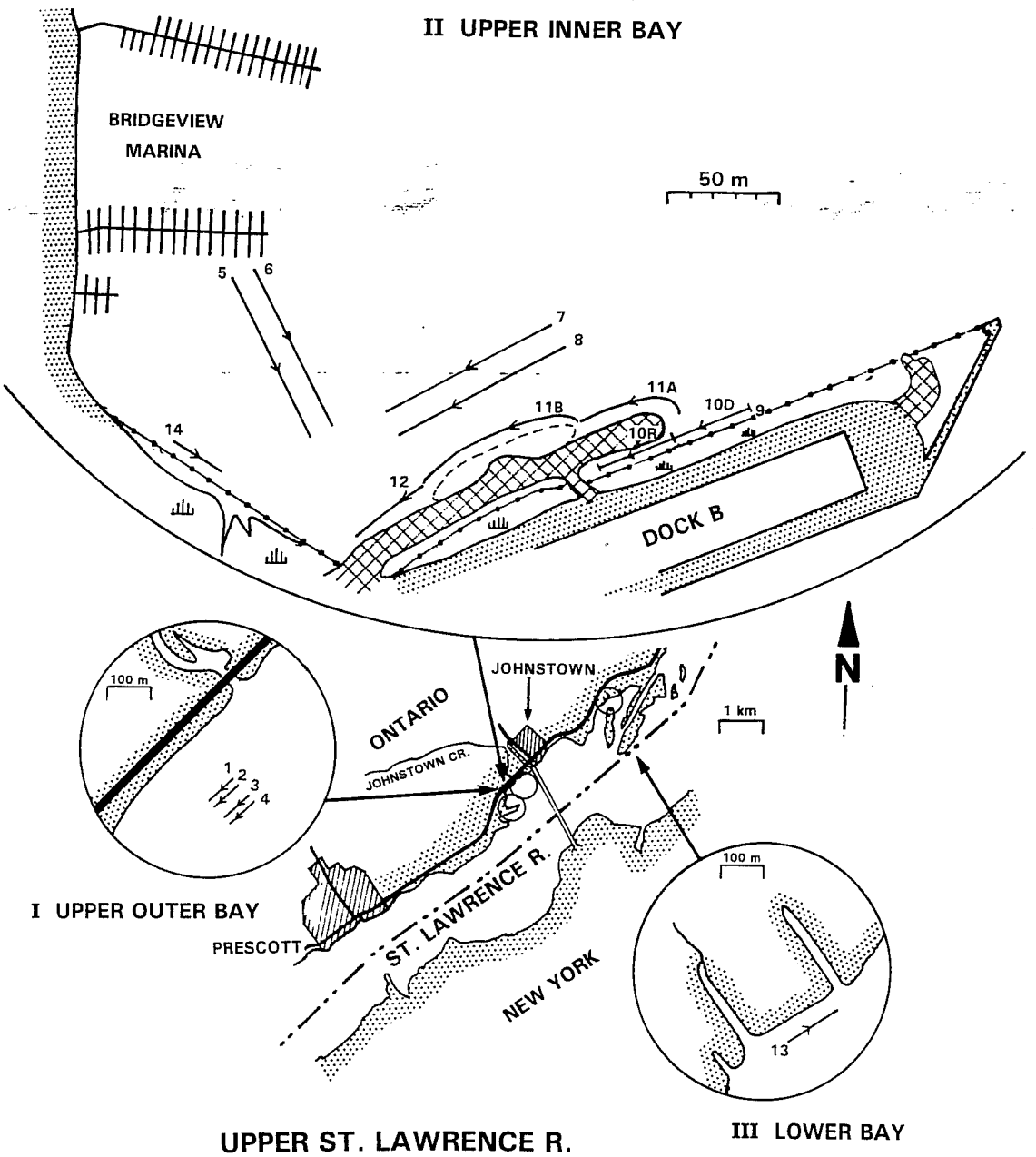

Fig. 1. Map of upper St. Lawrence River illustrating the areas and transects that were sampled during the quantitative electrofishing survey of the littoral-zone habitat of Johnstown Bay, June to October 1995. Detail I indicates the location of 4 transects (Area A) in the upper outer bay near the mouth of Johnstown Creek. Detail II indicates the location of 10 transects (Areas A-H) in the upper inner bay, including Dock B, Canada Ports Corporation. Detail III indicates the location of 1 transect (Area I) in the lower bay. Recent rock infill (coarse crosshatch) and the remains of the bottom of an old scuttled vessel (partially outlined) are also indicated. Electrofishing transects are shown and labelled, along with the direction of travel during the survey. Details drawn to scale as indicated.

quarry rock was deposited along the inner northeast side of dock B (Fig. 1) (Grant 1995). This rock varies in size but is coarse, up to 60 cm. Some of it was deposited over the inner side of the wood and steel debris of a sunken vessel scuttled in the inner bay. Only a small portion of this deteriorated wreck is above water; most of it has disintegrated to just above the bottom.

To describe the habitat and fish community of Johnstown Bay and to assess the habitat alteration associated with the rock infill, three general sections of the bay were studied: the upper outer bay (Fig. 1--Detail I), the upper inner bay (Fig. 1--Detail II), and the lower bay (Fig. 1--Detail III). Most of the off-shore habitat of the bay, except for that altered by the rock infill, is typical of shallow backwater embayments of the upper St. Lawrence River.

Quantitative electrofishing techniques--catch per area estimates

The open-water electrofishing techniques used in this study have been designed to be quantitative and to sample fish on an area basis. The boat-mounted electroshocker used in the study belonged to the Rideau Lakes Fisheries Assessment Unit, White Lake, Ontario, and consisted of a Smith-Root type 6A electrofisher (Smith-Root Corp., Vancouver, WA) powered by a 5000-watt generator mounted on a 5.2-m boat. The anode array was mounted on two booms, one on each side at the front of the boat, and each consisted of four stainless-steel cable "rat-tail' droppers (Smith-Root Corp., Vancouver, WA), while the hull acted as the cathode. DC voltage was used, set at a constant output of 168 volts, 120 pulses per sec, and the pulse width was varied between 1.0 and 5.0 ms to provide a current of 6 to 7 amps. The pulse width was adjusted such that throughout the survey, the current stunned the fish on the bottom and in the water column so that they could be dip-netted with no significant attraction or repulsion of the fish about the anodes and the associated 1.50-m-wide transect subsequently described. In order to assess area fished, two trailers, in this study 1.50 m apart and half the length of the boat, were dragged on each side from an additional boom mounted behind the anode array, marking the width of a transect centred about the array.

The factors that affect the width of the transect used in a study vary with species abundance, conductivity, and length of transect (Casselman, unpubl. data). The width of the transect is determined from a preliminary survey conducted at the beginning of a study. The trailers are long enough to permit dip-netting over a considerable distance (Casselman, unpubl. data) and can be either brightly coloured fine lead-core rope or orange electrical extension cord. These trail along the bottom, marking the width of the transect to be dip-netted and observed. All fish outside this transect are excluded and ignored.

Electrofishing was done at night, commencing at least one hour after dusk, and was usually complete by 0100 h. The shocked fish in the delineated transect that could be captured were dip-netted into live tanks in the boat, where they began to recover. The catch from each side of the boat was kept separate. In this study, each dip netter kept track of the species and size of every fish in the transect that was missed. When numerous fish were missed, percentages were used. The crew consisted of a recorder, an experienced and certified boat operator, and two experienced dip netters. To ensure consistency, the same dip netters were used throughout the study. A separate crew of three or more individuals on the shore processed the live fish.

Electrofishing was scheduled at approximately the same time on two successive nights each month from June to October. The survey was cancelled one night in June because of heavy rains and an electrical storm.

Electrofishing logs and catch-record forms were kept for each transect (distinct by port and starboard) throughout the study, including the start and stop times for each transect, number of shocking seconds, and weather and environmental conditions. Throughout the study, water conditions were generally calm with high transparency; intense lighting provided good visibility and very good dip-netting conditions, and the boat was operated at a constant and slow speed ($m \cdot s^{-1}$, $\bar{x} \pm 95\%$ C.I. $= 0.46 \pm 0.041$, calculated from 93 transects) not inhibiting the collection or survival of the fish.

Survey transects and areas

Transect locations were chosen from a preliminary survey and selected to sample the various types of habitats with replication in conditions that were consistent and typical of the habitat of the bay. Nine general areas were surveyed (Table 1). Some habitat types were consistent and abundant enough to permit replication, yet others were very restricted, providing only one transect (Table 1). Catches were separated by side of the boat but in subsequent analyses were combined where necessary to increase effort. The transects are defined and described in Table 1 and Table A-1 and are illustrated in Fig. 1.

In the upper outer bay (Fig. 1--Detail I), four parallel transects were established, 75 m long, with 10 m between 1-2 and 3-4, and 20 m between the two pairs. In the upper inner bay (Fig. 1--Detail II), another four off-shore 75-m-long transects were established; 5 and 6 were parallel, running generally north-south, and 7 and 8 were parallel, running generally east-west, with each pair being 10 m apart. A transect was established near shore that ran parallel to the shoring, started outside the rock infill, and extended behind it up to the connecting rock causeway. The port side of the boat sampled transect 9 in Area C along the shoring, whereas the starboard was subdivided into two shorter transects--10D (40 m) in relatively deep water (Area D) and 10R (35 m) behind and along the edge of the rock infill. The latter transect is one of a total of three sampling Area E, along the edge of the quarry rock.

Three transects were also set up along the outside edge of the rock infill and the submerged vessel--11A (50 m), 11B (75 m), and 12 (35m) (Fig. 1--Detail II). The port side of 11A and 12 sampled the edge of the rock infill (Area E). The starboard side of 11A, 11B, and 12, which ran parallel to the rock infill approximately 3.5 to 6.0 m from the edge, sampled a relatively less vegetated area (Area F) of silt, clay, and sand that was shallower as a result of displacement and uplift of the soft bottom by the adjacent rock infill. The port side of transect 11B sampled the edge of the steel and wood debris of the submerged vessel (Area B).

A longer transect, 13 (125 m), was chosen as typical offshore habitat in the lower bay.

Table 1. General description of the study areas, sites, and electrofishing effort by transect and area surveyed in littoral habitats of Johnstown Bay, upper St. Lawrence River, June to October 1995. Effort refers to one night of electrofishing, with two duplicate and consecutive nights' effort each month except June. The three transects treated as replicates in Areas E and F varied in area, with an average area surveyed in Area E—60 m^2 and Area F—80 m^2. Substrate and cover and structure are described only very generally. Although catches were separated by port and starboard initially during the survey, in some areas, they were combined to provide more comparable effort (i.e., A, B, and H).

Area	Site	General substrate	Structure and cover	Transect N	Transect No. and description	Transect Length (m)	Area surveyed (m^2)
A	upper outer bay	sand-silt	vegetation	4			
					1--port and starboard	75	225.0
					2--port and starboard	75	225.0
					3--port and starboard	75	225.0
					4--port and starboard	75	225.0
B	upper inner bay (north-south)	sand-silt	vegetation	4			
					5--port and starboard	75	225.0
					6--port and starboard	75	225.0
	upper inner bay (east-west)				7--port and starboard	75	225.0
					8--port and starboard	75	225.0
C	shoring--upper inner bay	sand-silt	wood-steel pilings and vegetation	1	9--starboard	75	112.5
D	deep water--upper inner bay	sand-silt	vegetation	1	10D--starboard	40	60.0
E	rock infill--upper inner bay	rock and sand-silt	quarry rock--irregular coarse rubble <60 cm diam.	3	10R--starboard	35	52.5
					11A--port	50	75.0
					12--port	35	52.5
F	silt-sand uplift--outside rock infill upper inner bay	silt-sand	sparse vegetation	3	11A--starboard	50	75.0
					11B--starboard	75	112.5
					12--starboard	35	52.5
G	sunken vessel--upper inner bay	silt-sand	wreck debris--steel and wood and vegetation	1	11B--port	75	112.5
H	shallow water--upper inner bay	silt-sand	vegetation	1	14--port and starboard		25 75.0
I	lower bay	gravel and sand-silt	vegetation	2	13--port	125	187.5
					13--starboard	125	187.5
Total				20	29		2955.0

(Fig. 1--Detail III) (Area I). In September, a short transect, 25 m long (transect 14), was electrofished in the shallow inner bay just out from and parallel to the shoring (Area H). The general type of substrate structure and cover associated with these areas, as well as the length and area surveyed in each transect, are summarized in Table 1. Transects ranged in depth from approximately 1 to 2 m. The measured length of the transect was specifically marked in daylight with lit flashing buoys so that its length could be easily followed at night. Usually transects were sampled in the same direction throughout the study.

Specific environmental and habitat conditions

Although the general environmental and habitat conditions in the upper inner bay were described in considerable detail in the early 1990s (Jacques Whitford Environment Limited 1991), specific environmental and habitat information was collected in conjunction with the survey.

Surface water temperatures were measured each night. Water depths, vegetative cover and height in the water column, and species composition were collected each month when the transect markers were laid out on the first day of the 2-day sampling period (June 7, July 10, August 8, September 21, October 11). Vegetative conditions and water depth were measured at the same time. For the vegetation survey, two individuals studied the vegetation along the full length of the transect, estimated percent cover and height, and recorded the average. Specific vegetation and depth measurements were made either at a single location in the middle of short transects or occasionally at two locations--the beginning and end. Multiple measurements were made for long transects--usually three and occasionally two.

Because of their proximity to each other, depth and vegetative information were collected on transect 1 for 1 and 2, transect 3 for 3 and 4, transect 5 for 5 and 6, and transect 7 for 7 and 8. Environmental data were collected separately on all other transects. No similar data were collected for transect 13 in June or transect 14 in September.

Vegetation samples were collected by grab-sampling with a garden rake with an extended handle. The rake was dragged and twisted along the substrate. Each species was identified (Hotchkiss 1970), and its percent of the total sample was estimated and averaged for the transect.

Water depth was measured with the rake handle when the vegetation was sampled. Water depths within a transect were often quite consistent. However, when more than one depth was measured, the average was used. With some exceptions, as with the vegetation, depths were usually measured in the middle of the transect but occasionally at the ends. Multiple measurements were made on longer transects--usually at the beginning, middle, and end. Water depth was not measured in transect 13 in June or in transect 14 in September; however, the latter was estimated.

Processing fish and collecting biological data

The electrofishing transect catch-record forms, which also recorded the numbers or percentages and size of species missed, were used to record individual biological information on the fish caught. At the shore, the fish were kept alive, processed, and usually released. The fish were identified, described by life stage (young-of-the-year, juvenile, or adult), measured (total length in mm), weighed (usually to the nearest 0.01 or 0.1 g, depending upon size), and released, except for large piscivores and esocids. Otoliths, cleithra, or scales were taken from the latter and stored; stomach contents were identified and weighed. All fish were processed live or fresh on the night they were collected.

The fisheries personnel working on this study came from various OMNR units--Rideau Lakes Fisheries Assessment Unit, St. Lawrence Fisheries Management Unit, Kemptville District, Lake Ontario Fisheries Unit, and Lake Ontario Research Unit.

Analysis of data and presentation of results

The environmental and habitat data collected during the survey were entered and analyzed in Statistix (Analytical Software 1994). When replicate values were obtained, means were calculated. In addition to means, where possible, extremes were determined by area. Since water depth was measured and the vegetation survey was conducted only one day each month, Areas A and B are described by four among-transect replicates, Areas E and F by three among-transect replicates, Area I by within-transect replicates, and Areas C, D, and G by single values from either within-transect replicates or single observations (Table 1). The level of precision presented indicates the degree of replication.

Fish data were entered and analyzed in Statistix (Analytical Software 1994). The data on captured fish were entered separately, along with the catch-record information documenting specific location of capture--transect and side. Another set of data was created to record individual fish (species and size) that were observed within the transect markers but not captured. A preliminary analysis was conducted on the captured fish to estimate the length and weight of the missed individuals. In some cases, no individuals of that size or species were captured within the transect, so the size had to be estimated from other transects, other months, or very rarely, other studies (e.g., American eels, *Anguilla rostrata*). In all cases, length estimates were related to frequency distributions, and weight estimates were predicted from calculations from a sample that was most closely related to the fish that were missed in both space and time. For 98% of the estimates, calculations could be made from fish of similar size caught within the transect, area, or general section of the bay for that particular month.

The two sets of fish data, both captured and estimated, were combined to provide the corrected electrofishing "catch." The catches for the same transects on successive days were treated as replicates, and replicates within an area were used to describe that area within a month. Within each transect, the number and biomass of each species was calculated on a m^2 basis, using the area surveyed (Table 1). In Areas A, B, and H, the catches on the two sides

of the boat were combined to obtain more comparable effort for within-area comparisons (Areas A and B with Area I). Within areas (E and F), some transects treated as replicates covered quite different areas (Table 1); however, catches within these transects were usually high, tending to minimize the variance in effort. Also among areas (A, B, and I compared with C to G), transects covered different areas; however, catches in the transects with larger areas were usually lower than in transects with small areas, making the catch statistics more comparable.

Various procedures exist for describing average fish-catch statistics and variance (e.g., Moyle and Lound 1960). We chose to log-transform the catch statistics to describe means and assess statistical significance. Geometric mean abundance, both number and biomass, was calculated following a procedure outlined by Elliott (1971), which involved adding 1 for each species (in the combined catch) in each transect to eliminate 0 values, $\log_{10}$ transforming the data, calculating the mean and 95% confidence interval (divisive and multiplicative), anti-logging the values, and subtracting 1 from the resulting values for each species. Mean numbers, biomass, and confidence limits are presented by species on a 100 m^{-2} basis. Observational sampling variability for each species, expressed as the coefficient of variation of numerical catch (Casselman et al. 1986), is also presented to describe relative distribution.

The results are provided by species for each month and area, as well as combined months, areas, and overall. In the results, presentation of confidence limits and means is used to signify significance and denote replication. Results from all areas (except H) were combined to describe the overall fish community of Johnstown Bay. The number, biomass, and general distribution (as indicated by sampling variability--CV) for all areas combined were summarized and ranked by species for those that were shown to be present in statistically significant quantities. To describe littoral habitats that were not recently structurally altered, similar combined results were summarized for Areas A, B, and I, whereas similar summaries for Areas E and F described the species assemblages associated with these recently structurally altered habitats--rock infill in the former and associated relatively less vegetated and displaced, uplifted silt and clay, and sand in the latter. The fish assemblages in

the recently altered and unaltered habitats were then compared to assess the impact of the infill on the fish community of Johnstown Bay.

RESULTS AND DISCUSSION

Johnstown Bay is shallow and mesotrophic, a typical embayment of the upper St. Lawrence River. The upstream, backwater portions of the upper inner bay are more eutrophic, with considerable development along the shoreline. The lower bay is shallower, with more current and sand-gravel substrate. Throughout the bay, macrophyte cover is moderately dense, and there is a good assemblage of warm- and cool-water fish species (Jacques Whitford Environment Limited 1992). The bay has been renowned among eastern Ontario anglers for open-water and ice fishing (Jacques Whitford Environment Limited 1991) for northern pike (*Esox lucius*) and yellow perch (*Perca flavescens*), and the catches of trophy-size muskellunge in the area are legendary (Grant 1995).

Environmental and habitat conditions

Summer water temperatures are ideal for mesothermal fishes (Table 2). During the June survey, the open-water surface temperature was 16.0 C. Temperatures were highest in August (23.5 C) and lowest in October (15.0 C). Seasonal temperatures increased more rapidly than they decreased, because July (21.3 C) was considerably warmer than September (15.8 C).

Water depths were greatest in June and July, decreased in August and September, and increased slightly in October (Table 3). The trend of decreasing water levels from June to September follows the natural water elevation cycle in this portion of the upper St. Lawrence River. Over the sampling period, water depth decreased by approximately 40 cm. The increase in October was atypical and probably resulted from an abnormal increase in late summer and fall precipitation. Water depths were ideal for dip-netting shocked fish, averaging 1.43 m,

Table 2. Surface water temperatures measured during electro-fishing survey conducted on the fish community in the littoral zone of Johnstown Bay, upper St. Lawrence River, June to October 1995. Mean temperatures provided for the two consecutive survey days except for June, when survey on June 7 had to be cancelled because of rain.

		Water temperature (°C)	
Month	Day	Mean	Actual
June		16.0	
	7		
	8		16.0
July		21.3	
	10		21.0
	11		21.5
August		23.5	
	8		23.0
	9		24.0
September		15.8	
	21		16.0
	22		15.5
October		15.0	
	11		15.0
	12		15.0

Table 3. Water depth (m) in the transects used to survey the littoral zone of Johnstown Bay, upper St. Lawrence River, during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Mean depth in Area H in September was estimated. Mean and extremes indicate among- and within-transect replication, whereas a mean alone indicates a single transect value. Area H was not used in the combined summary.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	1.50	1.65	1.80	1.43	1.73	1.92	1.23	1.35	1.50	1.10	1.40	1.70	0.90	1.13	1.50	0.90	1.45	1.92
B	1.60	1.75	1.90	1.48	1.77	2.05	1.38	1.58	1.72	1.20	1.37	1.60	1.30	1.46	1.70	1.20	1.59	2.05
C	0.90	1.50	2.10	0.90	1.56	2.21	0.68	1.31	2.20	0.50	1.16	2.05	0.80	1.45	2.10	0.50	1.40	2.21
D		2.10			2.21		1.05	1.63	2.20	0.80	1.38	2.05		2.10		0.80	1.88	2.21
E	0.90	0.97	1.00	0.79	1.10	1.44	0.68	0.81	0.93	0.50	0.70	0.80	0.70	0.98	1.30	0.50	0.91	1.44
F	1.00	1.30	1.90	0.79	1.39	2.06	0.81	1.21	1.90	0.80	1.18	1.60	0.70	1.23	1.80	0.79	1.26	2.06
G		1.90			2.06			1.90			1.55			1.80		1.55	1.84	2.06
H		na			na			na			0.80			na				
I					1.32			1.08			0.90			0.90		0.90	1.05	1.32
Combined	0.90	1.60	2.10	0.79	1.64	2.21	0.68	1.36	2.20	0.50	1.21	2.05	0.70	1.38	2.10	0.50	1.43	2.21

with extremes of 0.50 m and 2.21 m (Table 3).

Water depth varied somewhat among areas, the deepest being Area D (1.88 m) and the shallowest routinely sampled area, Area E, associated with the edge of the rock infill (0.91 m), an overall mean difference of approximately 1 m (Table 3). The transect at Area H was shallower (0.80 m) but was sampled only once (in September) to assess the fish assemblage in shallower habitat closer to shore in the upper inner bay. The depths measured in the various transects documented that the study area is a shallow littoral zone (0.50-2.21 m).

Throughout the summer period (June to October), vegetative cover was moderately dense (Table 4--A). The percent of vegetation covering the bottom, all species combined, was lowest in June (32.6%) and increased to a maximum in September (72.9%). Over the period, the density of vegetation covering the bottom doubled. Independent of month and area, slightly more than half (57.7%) of the bottom was covered with vegetation. However, some transects contained no vegetation, whereas in others, the bottom was fully covered. Among areas, the densest vegetation was in the lower bay (Area I--88.8%), offshore in the upper inner bay (Area B--81.7%), and the upper outer bay (Area A--74.0%) (Table 4A). Vegetation was least dense in the recently altered habitats on the edge of the rock infill (Area E--19.0%) and the impacted silt-clay and sand 3.5 to 6.0 m out from the perimeter of the rock infill (Area F--33.0%). Some transects in these recently altered areas were unvegetated during the first part of the summer, probably because vegetation had not yet re-established after the perturbation of the infilling the previous autumn. Although the vegetative cover in Area H was not measured, it appeared to be similar to Area B.

Although the macrophyte cover in the bay was moderately dense, it usually didn't completely fill the water column (Table 4--B). The height in the water column increased progressively from a low in June (6.6%) to a high in September (71.5%). Although most of the increase was probably related to vegetative growth and subsequent senescence, the water level also decreased during the period, probably in part accounting for the difference up to September. The height of the vegetation decreased appreciably in October (46.7%), similar to

Table 4. Percent vegetative cover (A) and relative height (B) in the water column in the transects in the littoral zone of Johnstown Bay, upper St. Lawrence River, during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analysis.

A--Cover

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	40	52.5	65	65	80.0	95	75	82.5	90	70	80.0	90	60	75.0	90	40	74.0	95
B	70	72.5	75	77	81.0	85	85	90.0	95	65	80.0	95	75	85.0	95	65	81.7	95
C		50			30			90			70			55.0		30	59.0	90
D		50			30			90			70			95		30	67.0	95
E	0	1.7	5	5	15.0	30	0	1.7	5	40	50.0	60	15	26.7	40	0	19.0	50
F	0	1.7	5	5	23.3	35	30	33.3	40	40	58.3	75	25	48.3	80	0	33.0	80
G		0			35			40			75			80		0	46.0	80
H		na			na			na						na				
I					80			95			100			80		80	88.8	100
Combined	0	32.6	75	5	46.8	95	0	65.3	95	40	72.9	95	15	68.1	95	0	57.7	100

B--Height

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	15	16.5	18	25	60.0	95	60	67.5	75	60	62.5	65	35	60.0	85	15	53.3	95
B	15	15.0	15	75	80.0	85	85	87.5	90	65	67.5	70	70	72.5	75	15	64.5	90
C		5			20			50			65			38.0		5	35.6	65
D		5			20			50			65			38.0		5	35.6	65
E	0	3.3	5	5	30.0	80	30	40.0	60	55	75.0	90	10	25.0	40	0	34.7	60
F	0	1.7	5	5	53.3	80	30	33.3	40	75	81.7	90	20	30.0	40	0	40.0	90
G		0			75			40			75			30		0	44.0	75
H		na			na			na						na				
I					55			70			80			80		55	71.3	80
Combined	0	6.6	18	5	49.2	95	30	54.8	90	55	71.5	90	10	46.7	85	0	46.8	95

the overall average for the study period and areas (46.8%), although in some transects, vegetation was not present, while in others, it extended almost to the surface (95.0%). The height of the vegetation in the water column varied slightly among areas and was directly related to the amount of cover. It was highest in areas in the lower bay (Area I--71.3%), offshore in the upper inner bay (Area B--64.5%), and in the upper outer bay (Area A--53.3%).

During the study, almost 60% of the shallow littoral zone was covered with vegetation, and it extended through slightly less than 50% of the water column. This intermediate density is associated with very productive fish habitat, and it is well documented that submergent macrophyte cover directly influences fish biomass (Killgore et al. 1989) and production (Randall et al. 1996). The largest catches of piscivores such as northern pike are associated with similar intermediate vegetative cover--35 to 80% (Casselman and Lewis 1996). When the vegetative cover in Johnstown Bay in August and September was compared with Great Lakes embayments reported by Randall et al. (1996), it was almost identical to Severn Sound, Lake Huron; three times denser than in the Bay of Quinte; and six times denser than in Hamilton Harbour, both in Lake Ontario.

Two macrophytes were most abundant in the vegetative cover--wild celery (*Vallisneria americana*) and common elodea (*Elodea canadensis*). Wild celery increased in abundance through the summer (Table 5); it was not present in June but constituted more than half (56.1%) of the vegetative cover in October. Overall, its relative density was slightly less than one-third (29.6%). It was densest in Areas E and F, associated with the rock infill, and least dense in deeper areas and habitats (Table 5). According to the environmental assessment survey conducted by Jacques Whitford Environment Limited (1991) prior to the infilling, this macrophyte also previously dominated these specific areas. The second most abundant species, common elodea, showed the opposite seasonal trend: decreasing abundance from June (37.2%) to October (20.1%) (Table 6). It constituted slightly more than one-quarter of the overall vegetative density (26.6%). The relative abundance of this species varied across the areas: most abundant in the lower bay (Area I--57.4%) and least abundant along the edge of the submerged vessel (Area G--2.4%) and outside the rock infill (Area F--12.8%).

Table 5. Relative density (%) of wild celery (*Vallisneria americana*) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses. *Vallisneria* was present in Area I in August but was not sampled.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	0.0	0	0	11.7	70	0	24.2	80	0	13.5	40	0	42.5	95	0	18.4	95
B	0	0.0	0	0	23.3	60	0	60.8	100	0	44.8	100	0	68.2	100	0	39.4	100
C		0			0			0.0			15.0			55.0		0	14.0	55
D		0			0			50			15.0			10		0	15.0	50
E	0	0.0	0	5	11.7	25	5	58.3	100	70	90.0	100	50	73.3	100	0	46.7	100
F	0	0.0	0	0	3.3	5	5	58.3	100	70	83.3	100	50	73.3	100	0	54.6	100
G		0			0			5			80			100		0	37.0	100
H		na			na			na						na				
I					11.0			0.0			45.0			26.7		0	20.7	45
Combined	0	0.0	0	0	7.6	70	0	32.1	100	0	48.3	100	0	56.1	100	0	29.6	100

Table 6. Relative density (%) of common elodea (*Elodea canadensis*) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	7.5	10	0	27.2	75	0	31.7	80	0	25.0	70	0	14.3	45	0	21.1	80
B	0	3.0	10	0	25.8	100	0	25.8	85	0	31.5	99	0	27.7	90	0	22.8	100
C		100			5			27.5			35.0			15.0			36.5	100
D		100			5			0			35.0			30		0	34.0	100
E	0	50.0	100	25	71.7	95	0	13.8	45	0	3.3	10	0	21.7	50	0	32.1	100
F	0	0.0	0	0	37.7	95	0	6.7	10	0	4.0	10	0	21.7	50	0	12.8	95
G		0			0			10			2			0		0	2.4	10
H		na			na			na						na				
I					78.3			91.3			30.0			30.0		30	57.4	91
Combined	0	37.2	100	0	30.6	100	0	25.9	85	0	20.7	99	0	20.1	90	0	26.6	100

Four other macrophytes were abundant throughout the study areas: curly pondweed (*Potamogeton crispus*)--13.2% (Table B-1), milfoil (*Myriophyllum* sp.)--9.0% (Table B-2), coontail (*Ceratophyllum demersum*)--7.4% (Table B-3), and white water buttercup (*Ranunculus aquatilis*)--4.5% (Table B-4). These four species, along with the other two more abundant ones, constituted 90.3% of the overall density of vegetation. An additional six types of vegetation made up the remainder of the vegetative cover. They were, in decreasing abundance: *Chara* sp. (Table B-5), *Zannichellia palustris* (Table B-6), *Potamogeton pusillus* (Table B-7), *Alisma plantago-aquatica* (Table B-8), *Utricularia* sp. (Table B-9), and *Potamogeton* sp. (Table B-10). Curly pondweed was disproportionately more abundant in the moderately deep waters of Areas A and B (Table B-1), whereas common elodea was extremely abundant in Area I. These three areas were offshore and appeared to be natural undisturbed vegetated littoral habitat.

Fish community

Catch

When the actual catch of fish was corrected for those that were within the transect but were not captured, the total electrofishing catch was 3784 individuals (Table 7). A total of 1900 of the fish were captured (50.2%); however, on a species basis, this was considerably higher (73.3% ± 11.0%). A total of 32 species were captured, another 2 were observed in the transects but were never caught: longnose gar (*Lepisosteus osseus*) was seen only once, and American eels (*Anguilla rostrata*) were observed frequently. Carp (*Cyprinus carpio*) were captured only infrequently (22%), and as would be expected, some of the poorest capture rates were for the smallest cyprinids: sand shiners *(Notropis stramineus*)--25%, bluntnose minnows (*Pimephales notatus*)--35%. Capture efficiency for most other species was high (Table 7).

Catches varied among months and areas (Tables 7 and 8). The largest catches were in

Table 7. Number of fish by species and month in the electrofishing transects in the littoral zone of Johnstown Bay, upper St. Lawrence River, June to October 1995. Species number refers to a standard serial number used by the Ontario Ministry of Natural Resources to provide a numerical species-specific code. Darters are of two species--johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi*). Total area surveyed is 25,995 m^2.

			Month											
			June		July		Aug.		Sep.		Oct.		Combined	
				Caught		Caught		Caught		Caught		Caught		Caught
Common name	Scientific Name	Sp. No.	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)
Longnose gar	*Lepisosteus osseus*	41	1	0	0		0		0		0		1	0
Bowfin	*Amia calva*	51	0		0		1	100	1	0	2	50	4	50
Alewife	*Alosa pseudoharengus*	61	0		0		2	100	3	100	3	100	8	100
Northern pike	*Esox lucius*	131	5	80	4	50	8	63	12	67	6	50	35	63
Muskellunge	*Esox masquinongy*	132	0		0		0		7	100	5	100	12	100
Central mudminnow	*Umbra limi*	141	0		3	100	0		4	100	3	100	10	100
White sucker	*Catostomus commersoni*	163	8	88	34	79	22	73	57	75	53	89	174	80
Silver redhorse	*Moxostoma anisurum*	168	0		0		1	100	0		1	0	2	50
Carp	*Cyprinus carpio*	186	0		1	0	2	0	2	50	4	25	9	22
Golden shiner	*Notemigonus crysoleucas*	194	1	100	31	71	30	57	72	58	38	63	172	62
Emerald shiner	*Notropis atherinoides*	196	1	100	0		0		0		0		1	100
Common shiner	*Notropis cornutus*	198	0		1	0	2	0	0		11	73	14	57
Blacknose shiner	*Notropis heterolepis*	200	0		0		0		0		1	100	1	100
Spottail shiner	*Notropis hudsonius*	201	29	69	53	49	5	60	0		0		87	56
Rosyface shiner	*Notropis rubellus*	202	5	100	0		0		2	50	0		7	86
Sand shiner	*Notropis stramineus*	204	0		0		0		122	17	27	59	149	25
Bluntnose minnow	*Pimephalus notatus*	208	85	91	158	52	510	28	540	21	498	43	1791	35
Fathead minnow	*Pimephalus promelas*	209	0		0		0		1	100	0		1	100
Fallfish	*Semotilus corporalis*	213	0		0		1	100	0		0		1	100
Brown bullhead	*Ictalurus nebulosus*	233	28	36	43	63	22	59	40	50	60	68	193	58
American eel	*Anguilla rostrata*	251	2	0	17	0	6	0	3	0	1	0	29	0
Banded killifish	*Fundulus diaphanus*	261	1	100	0		2	100	2	100	1	100	6	100
Rockbass	*Ambloplites rupestris*	311	16	81	80	74	26	73	80	63	48	77	250	71
Pumpkinseed	*Lepomis gibbosus*	313	23	52	87	63	61	44	74	54	91	53	336	54
Bluegill	*Lepomis macrochirus*	314	0		0		1	100	1	100	6	100	8	100
Smallmouth bass	*Micropterus dolomieu*	316	4	100	2	100	0		3	100	12	92	21	95
Largemouth bass	*Micropterus salmoides*	317	0		0		1	100	15	93	23	100	39	97
Black crappie	*Pomoxis nigromaculatus*	319	2	100	1	100	3	100	8	88	4	100	18	94
Yellow perch	*Perca flavescens*	331	31	71	37	68	43	53	98	54	98	81	307	66
Logperch	*Percina caproides*	342	0		0		0		3	100	0		3	100
Darters	*Etheostoma* spp.	347	5	100	8	100	5	100	27	100	30	97	75	99
Brook silversides	*Labidesthes sicculus*	361	1	100	0		0		8	100	5	100	14	100
Mottled sculpin	*Cottus bairdi*	380	0		0		0		3	100	3	100	6	100
Combined			248	75	560	61	754	38	1188	40	1034	59	3784	50

Table 8. Number of fish by species and area in the electrofishing transects in the littoral zone of Johnstown Bay, upper St. Lawrence River, June to October 1995. Species number refers to a standard serial number used by the Ontario Ministry of Natural Resources to provide a numerical species-specific code. Darters are of two species--johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi*). Total area electrofished is 25,995 m^2.

			Area																					
			A		B		C		D		E		F		G		H		I		Combined	
			Caught		Caught		Caught		Caught		Caught		Caught		Caught		Caught		Caught		Caught	
Common name	Scientific Name	Sp. No.	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)
Longnose gar	*Lepisosteus osseus*	41	0		0		0		0		0		0		0		0		1	0	1	0
Bowfin	*Amia calva*	51	1	100	2	50	0		0		1	0	0		0		0		0		4	50
Alewife	*Alosa pseudoharengus*	61	6	100	0		0		0		0		0		0		0		2	100	8	100
Northern pike	*Esox lucius*	131	7	71	9	56	4	50	0		4	50	5	60	1	0	0		5	100	35	63
Muskellunge	*Esox masquinongy*	132	0		2	100	0		0		0		0		0		0		10	100	12	100
Central mudminnow	*Umbra limi*	141	0		5	100	0		0		1	100	0		0		1	100	3	100	10	100
White sucker	*Catostomus commersoni*	163	75	79	44	86	4	75	5	100	16	63	10	70	3	100	0		17	88	174	80
Silver redhorse	*Moxostoma anisurum*	168	0		1	0	0		0		0		1	100	0		0		0		2	50
Carp	*Cyprinus carpio*	186	0		1	0	1	0	0		0		0		3	0	0		4	50	9	22
Golden shiner	*Notemigonus crysoleucas*	194	41	56	81	68	8	25	0		11	55	2	50	2	50	2	100	25	64	172	62
Emerald shiner	*Notropis atherinoides*	196	0		0		0		0		0		1	100	0		0		0		1	100
Common shiner	*Notropis cornutus*	198	6	50	7	57	0		0		1	100	0		0		0		0		14	57
Blacknose shiner	*Notropis heterolepis*	200	0		0		0		0		1	100	0		0		0		0		1	100
Spottail shiner	*Notropis hudsonius*	201	17	65	8	38	0		0		18	56	43	56	0		0		1	100	87	56
Rosyface shiner	*Notropis rubellus*	202	0		2	100	0		0		4	75	1	100	0		0		0		7	86
Sand shiner	*Notropis stramineus*	204	12	33	0		0		0		45	49	91	11	0		1	100	0		149	25
Bluntnose minnow	*Pimephalus notatus*	208	40	58	11	91	86	60	1	0	702	44	884	23	26	38	0		41	76	1791	35
Fathead minnow	*Pimephalus promelas*	209	0		1	100	0		0		0		0		0		0		0		1	100
Fallfish	*Semotilus corporalis*	213	0		0		0		0		1	100	0		0		0		0		1	100
Brown bullhead	*Ictalurus nebulosus*	233	70	64	45	58	4	50	5	40	2	100	40	8	2	50	0		55	55	193	58
American eel	*Anguilla rostrata*	251	6	0	4	0	1	0	2	0	11	0	2	0	2	0	0		1	0	29	0
Banded killifish	*Fundulus diaphanus*	261	0		2	100	0		0		1	100	0		0		0		3	100	6	100
Rockbass	*Ambloplites rupestris*	311	29	66	23	74	11	82	0		98	77	21	86	28	54	1	100	39	62	250	71
Pumpkinseed	*Lepomis gibbosus*	313	80	55	90	40	8	63	0		24	50	23	57	6	100	5	60	100	63	336	54
Bluegill	*Lepomis macrochirus*	314	2	100	0		0		0		3	100	0		0		0		3	100	8	100
Smallmouth bass	*Micropterus dolomieu*	316	1	100	1	100	1	100	0		9	89	2	100	2	100	0		5	100	21	95
Largemouth bass	*Micropterus salmoides*	317	15	93	19	100	0		0		1	100	0		3	100	0		1	100	39	97
Black crappie	*Pomoxis nigromaculatus*	319	1	100	2	100	1	100	0		1	100	1	100	2	100	1	100	9	89	18	94
Yellow perch	*Perca flavescens*	331	121	64	39	74	2	50	0		17	35	22	59	15	67	0		91	73	307	66
Logperch	*Percina caproides*	342	2	100	0		0		0		0		0		0		0		1	100	3	100
Darters	*Etheostoma* spp.	347	13	100	7	100	7	100	0		14	100	4	100	1	100	2	100	27	96	75	99
Brook silversides	*Labidesthes sicculus*	361	3	100	3	100	0		1	100	2	100	1	100	2	100	2	100	0		14	100
Mottled sculpin	*Cottus bairdi*	380	1	100	0		0		0		1	100	0		0		0		4	100	6	100
Combined			549	65	409	66	138	62	14	57	989	49	1124	27	98	57	15	87	448	71	3784	50

August (31.4%) and September (27.3%), mid- to late summer (Table 7). Among areas, the greatest number of individuals were caught outside the rock infill (Area F--29.7%) and along its edge (Area E--26.1%) (Table 8). However, overall catches were quite high in the upper outer bay (Area A--14.5%), in the lower bay (Area I--11.8%), and offshore in the upper inner bay (Area B--10.8%). In Area D, which was the deepest, catches were quite low (Table 8), not because fish were missed but because they simply were not abundant in the deeper water.

Bluntnose minnows were by far the most common species in the total estimated catch (47.3%) (Table 7). Several other species were quite abundant: pumpkinseed (*Lepomis gibbosus*)--8.9%; yellow perch--8.1%; rock bass (*Ambloplites rupestris*)--6.6%; brown bullhead (*Ictalurus nebulosus*)--5.1%; white sucker (*Catostomus commersoni*)--4.6%; golden shiner (*Notemigonus crysoleucas*)--4.5%; sand shiner--3.9%; spottail shiner (*Notropis hudsonius*)--2.3%; darters (*Etheostoma* sp.)--2.0%; largemouth bass (*Micropterus salmoides*)--1.0%; and northern pike (*Esox lucius*)--0.9%. These 12 species constituted 95.2% of the overall catch.

Capture efficiency for all species combined was not correlated with the number of fish caught on either a monthly or an area basis. However, for very abundant small species, such as bluntnose minnows, capture efficiency over the period was negatively correlated with abundance ($P = 0.05$); differences in seasonal abundance explained 71% of the variance in the capture of bluntnose minnows. This result may, however, be explained by the fact that vegetative cover and height increased over the period (Table 4).

For all species combined, capture efficiency on a seasonal basis was negatively correlated with the height of the vegetation ($P = 0.05$); seasonal vegetative height explained 77% of the variance in capture. The capture of bluntnose minnows, the most common species, yet one of the smallest, was more negatively affected than most by seasonal change in vegetative cover ($P = 0.02$, explaining 84% of the variance in capture efficiency) and the relative increase in the height of the vegetation ($P = 0.01$, explaining 92% of the variance in

capture efficiency). Overall among areas, there was not a negative but a positive relationship between capture efficiency and vegetation. The unexpected correlation probably existed because, in the absence of vegetation, dip netting created turbidity, which under certain conditions interfered with visibility, especially in the recently altered, less vegetated habitats of Areas E and F (Table 4A).

Electrofishing efficiency and variance have been variously evaluated and described (Penczak and Zalewski 1981; Zalewski 1983; Mann and Penczak 1984; Casselman et al. 1986; Casselman et al. 1990). However, it is virtually impossible to make direct comparisons among studies because of differences in methods and environmental conditions. But very generally, extremely dense vegetation, increased turbidity, and any water conditions that affect visibility will have a negative effect on capture efficiency. Even though electrofishing conditions in Johnstown Bay were usually ideal, in the very densest vegetation and over the most easily disturbed bottom, capture efficiency may have been affected. The absolute magnitude of this effect remains unmeasured; however, we have included estimates of the fish that were missed, and replication was conducted to minimize and assess these effects.

Since effort was carefully controlled and replicated where habitat permitted, catches were adequate both over time and among areas to examine density, both numbers and biomass, of the fish community more quantitatively.

Numbers, biomass, and sampling variability

Absolute density estimates of fish abundance based on area or volume, with some exceptions, are rarely available from routine sampling because only a few techniques allow this type of area or volume sampling effort (e.g., pop-up nets--Serafy et al. 1988; Killgore et al. 1989; purse seines--Evans and Johannes 1988; electrofishing in confined or blocked-off areas--Reynolds 1983; Casselman et al. 1990). The open-water electrofishing techniques used here permitted us to control effort by standardizing electrofishing operating conditions in relation to fish response and to mark off a transect of known area. By trailing transect

markers along with the anode arrays to delineate the width of the transect, it is possible to sample microhabitats such as the edge of the rock infill (Area E) quite precisely and to relate abundance, both numbers and biomass, to specific habitat types and conditions.

Although a large number of species were caught, only 35% of the species accounted for 95% of the catch (Tables 7 and 8). Even though the remaining 22 species were not caught consistently, we analyzed number, biomass, and sampling variability of all species, separated by month and area as well as combined, to provide a full description of the fish community in this important upper St. Lawrence River embayment (Grant 1995).

Bluntnose minnows

Bluntnose minnows varied widely in abundance throughout the bay. In some areas and during some months, replication was inadequate to indicate whether they were present in statistically significant quantities (>0), both number and biomass (e.g., Areas C and G, Table 9A and 9B--means underlined). Considerable effort was applied in this study, a total of 168 transects were sampled (Table 10), and some areas within months were sampled intensively, with multiple replicates (up to 8). In Area F, where application was adequate ($N = 6$, except in June), bluntnose minnows were caught in fairly large numbers but not consistently enough to be considered statistically present (e.g., Table 9A and 9B--means not underlined). However, in Area E, their numbers and biomass were dense enough to be statistically significant (Table 9A and 9B--means and 95% confidence limits).

When all months and areas were combined to describe overall densities, bluntnose minnows were dense in Johnstown Bay (numbers 10.59·100 m^{-2}, biomass 18.73 g·100 m^{-2}) (Table 9). When results were combined by month, in Areas E and F, associated with rock infill, bluntnose minnows were significantly more abundant (Area E--36.88·100 m^{-2}, 76.66 g·100 m^{-2} and Area F--28.09·100 m^{-2}, 42.10 g·100 m^{-2}) than in most other areas, with the possible exception of Area C, which was nearby. Bluntnose minnows were approximately 3.1 times denser in numbers and biomass around the recent rock infill than in all habitats

Table 9. Number (A) and biomass (B) of bluntnose minnow (*Pimephales notatus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence intervals are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates electrofishing survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0.06			0			1.32			0.83		0.14	0.49	0.83
B		0.26			0			0.11			0.17			0.28		0.04	0.14	0.24
C		4.44			5.33			12.44			0			18.03		2.55	8.25	14.27
D		0			0			0			0			0.83			0.18	
E		12.35		7.68	18.93	31.36	19.83	51.61	91.82	1.61	42.73	100.49	32.21	58.36	89.69	24.26	36.88	50.79
F		6.67			13.33			40.20			41.31			35.71		10.15	28.09	48.96
G		na			0.89			6.55			3.09			0.89			2.51	
H		na			na			na			0			na				
I		6.88			0			0.80			0			1.20		0.00	1.19	2.39
Combined		4.27			4.60			12.52			9.78			12.90		6.90	10.59	14.40

B--Biomass

	Month																
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0.23			0			2.96			2.08		0.22	1.16	2.12
B		0.85			0			0.30			0.23			0.50		0.07	0.28	0.49
C		16.43			9.71			19.87			0			41.15		4.80	16.69	29.94
D		0			0			0			0			4.59			1.00	
E		42.13		17.88	41.66	70.24	40.43	98.93	181.81	6.42	86.81	227.92	98.51	141.55	193.93	50.80	76.66	106.95
F		19.84			24.86			68.05			46.07			58.56		17.37	42.10	72.03
G		na			2.73			12.85			9.26			3.06		0.22	6.10	12.32
H		na			na			na			0			na				
I		19.37			0			1.07			0			3.04			2.91	
Combined		13.21			9.04			20.97			15.08			25.52		12.84	18.73	24.93

Table 10. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of bluntnose minnow (*Pimephales notatus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates electrofishing survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8	282.8	8		8	81.8	8	114.0	36	208.3
B	4	200.0	8		8	185.2	8	191.4	8	151.2	36	218.5
C	1		2	0.0	2	3.5	2		2	17.1	9	88.9
D	1		2		2		2		2	141.4	9	300.0
E	2	34.7	6	26.5	6	21.1	6	47.1	6	13.4	26	77.9
F	1		6	128.3	6	38.9	6	101.9	6	84.1	25	154.0
G	na		2	0.0	2	58.3	2	67.1	2	141.4	8	142.5
H	na		na		na		1		na			
I	2	25.5	4		4	88.2	4		4	74.3	18	201.0
Combined	15	106.5	38	151.0	38	141.0	39	170.6	38	144.3	167	220.0

combined (Table 9).

The overall combined sampling variability was high for bluntnose minnows (CV = 220%) (Table 10). By area, they were taken most consistently at the edge of the rock infill, Area E (78%), but were also caught quite consistently (89%) in Area C, along the shoring in close proximity to the rock infill.

Even though this species was the most numerous in the overall catch and the effort was intensive, involving a total of 168 transects (including Area H, Table 10) and surveying a total of 25,995 m^{-2} of bottom, sampling variability was high. Overall, effort was quite consistent for all months except June, when sampling was conducted only one night (Table 10). Comparable effort was applied across Areas A, B, E, F, and possibly I. In other areas, effort was three-to fourfold less, but these types of habitats were much more restricted and difficult to replicate (Table 10). Sampling variability could have been reduced, but it would have required a disproportionate and impractical increase in effort because the reduction in variability is roughly proportional to the square root of the effort or number of samples obtained (Casselman et al. 1986).

Rock bass

Overall, rock bass were the second numerically densest species in the littoral zone of Johnstown Bay (1.49·100 m^{-2}, 50.45 g·100 m^{-2}) (Table 11A and 11B). Over the period of the study, the greatest densities in both numbers and biomass (5.48·100 m^{-2}, 186.24 g·100 m^{-2}) were taken in Area E. Rock bass were, however, present in other areas during specific months (e.g., Area A in July and September and numerically abundant in Area I during the same months). When all sampling periods were combined, rock bass were more abundant on the edge of the rock infill in Area E than in any other area with the possible exception of Area G the biomass in Area C, which were both close to the infill. Around the rock infill, rock bass were approximately 3.7 times denser than in all habitats combined (Table 11).

Table 11. Number (A) and biomass (B) of rock bass (*Ambloplites rupestris*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence intervals are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates electrofishing survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0.11		0.05	0.44	0.84		0.17		0.04	0.66	1.29		0.28		0.18	0.36	0.53
B		0			0.22			0.22		0.11	0.67	1.23		0.17		0.13	0.28	0.44
C		0.89			1.33			0.89			1.32			0.89		0.52	1.08	1.65
D		0			0			0			0			0			0	
E		3.07		3.07	9.80	16.97	2.45	3.87	5.31	0.62	3.57	6.60	0.98	7.06	13.50	3.52	5.48	7.49
F		1.25			0.21			0.21			2.63			0.61			0.81	
G		na			8.00			0.44			0.89			3.11		0.29	2.72	5.21
H		na			na			na			1.33			na				
I		0.53		0.24	1.33	2.42		0.13		2.52	3.20	3.90		0.27		0.52	1.15	1.79
Combined		0.83			2.60			0.73		0.51	1.61	2.72		1.52		1.04	1.49	1.94

B--Biomass

	Month																
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		8.20		0.96	37.26	86.60		5.89		3.96	56.60	135.89		13.47		10.89	24.56	39.92
B		0			6.06			12.22		3.33	52.73	125.74		10.40		6.06	16.74	28.50
C		82.31			64.24			57.45			86.53			4.87		5.03	53.26	123.62
D		0			0			0			0			0			0	
E		476.50		322.9	733.0	1540.9	29.54	111.66	245.85	1.41	102.13	302.87	3.3	129.1	408.1	102.82	186.24	303.97
F		110.53			24.78			0.85			76.18			18.95		0.48	24.05	53.15
G		na			723.21			2.74			102.23			345.90		27.60	162.00	437.96
H		na			na			na			2.72			na				
I		82.64			136.16			0.06			31.10			0.27		7.38	37.55	76.19
Combined		75.81		4.86	117.13	349.63		19.31		30.52	59.61	95.16		41.43		36.43	50.45	65.91

Rock bass were caught consistently where they were most abundant, around the rock infill in Area E (CV = 89%) (Table 12), but were caught even more consistently in adjacent Area C, along the edge of the shoring (68%). Overall, they were collected only slightly more consistently (195%) than bluntnose minnows.

Yellow perch

Although some species did reach the numerical density that was observed for bluntnose minnows and rock bass in some areas (e.g., Areas E and F), they were moderately dense, but these densities were much more uniform throughout the study period and the various habitats of the bay. When replication was adequate, one of these species, yellow perch, showed significant numbers and biomass in most areas and months and had overall numerical densities and biomass of 1.11·100 m^{-2} and 55.57 g·100 m^{-2} (Table 13A and 13B). For the overall bay, both numbers and biomass were not significantly different than those of rock bass (Table 11). Throughout the period and habitats sampled, their densities were quite consistent (CV = 132%) (Table 14) but occurred most consistently in Area I, offshore in the lower bay (CV = 62%).

Pumpkinseeds

Pumpkinseeds had overall densities of 1.24·100 m^{-2} and 64.52 g·100 m^{-2} (Table 15A and 15B), higher but not significantly different from yellow perch (Table 13), and they were almost uniformly distributed, in both numbers and biomass, throughout the summer period in the various habitats in Johnstown Bay but not as uniform as yellow perch. As with yellow perch, significant densities of this species usually were observed in the unaltered habitats of the lower bay (Area I), the upper outer bay (Area A), and the upper inner bay (Area B). Overall, their densities were quite consistent (CV = 140%) (Table 16) but were most consistently distributed over the summer in Area B, offshore in the upper inner bay (CV = 89%), and offshore in the lower bay (CV = 98%).

Table 12. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of rock bass (*Ambloplites rupestris*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates electrofishing survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4	200.0	8	92.9	8	282.8	8	108.8	8	112.0	36	144.6
B	4		8	143.8	8	143.8	8	90.1	8	191.4	36	159.2
C	1		2	32.0	2	0.0	2	147.4	2	0.0	9	67.7
D	1		2		2		2		2		9	
E	2	7.6	6	31.7	6	23.4	6	60.8	6	63.2	26	89.1
F	1		6	244.9	6	244.9	6	156.1	6	244.9	25	273.9
G	na		2	6.2	2	141.4	2	141.4	2	10.6	8	116.2
H	na		na		na		1		na			
I	2	141.4	4	33.1	4	200.0	4	6.1	4	115.5	18	110.7
Combined	15	130.2	38	145.2	38	173.3	39	81.8	38	156.1	167	194.5

Table 13. Number (A) and biomass (B) of yellow perch (*Perca flavescens*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence intervals are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates electrofishing survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A	0.23	1.00	1.78	0.09	0.28	0.47		0.39		1.31	2.27	3.24	1.75	3.26	4.80	0.95	1.48	2.02
B	0.45	1.03	1.61		0.39			0.06		0.01	0.72	1.43	0.35	0.78	1.21	0.28	0.48	0.68
C		0			0.44			0			0.44			0			0.20	
D		0			0			0			0			0			0	
E		1.02			0.55			1.92			1.10			0.28		0.27	0.85	1.43
F		0.42			0.62			2.26			0.82			0.62		0.36	1.00	1.55
G		na			0.44			0.44			2.22			3.56		0.35	1.47	2.61
H		na			na			na			0			na				
I		3.73			2.38		0.59	2.13	3.68	0.26	3.97	7.85		1.73		1.85	2.68	3.53
Combined		0.94		0.03	0.64	1.25	0.05	0.90	1.75	0.36	1.44	2.53	0.09	1.27	2.47	0.88	1.11	1.33

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A	16.04	55.69	108.90	4.12	17.61	32.86		27.50		60.6	134.6	242.7	124.4	210.9	330.6	50.93	78.74	111.68
B		18.83		1.82	29.46	64.59		1.07			48.84		13.26	42.04	78.14	15.37	28.45	43.01
C		0			19.39			0			60.83			0			45.60	
D		0			0			0			0			0			0	
E		51.38			2.25			111.94			112.80			7.17		10.36	42.60	84.24
F		15.89			30.13			89.49			48.13			47.30		17.64	45.35	79.58
G		na			23.00			24.26			216.29			257.74		17.56	88.40	201.93
H		na			na			na			0			na				
I		220.33		25.95	153.05	408.39	69.5	180.8	365.3	108.3	196.9	323.3		52.72		103.0	146.2	198.6
Combined		40.74		0.10	29.57	67.70	3.07	43.62	100.11	36.5	89.8	163.8	4.56	58.10	139.04	43.63	55.57	68.49

Table 14. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of yellow perch (*Perca flavescens*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates electrofishing survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4	33.4	8	82.8	8	116.3	8	43.2	8	23.2	36	105.7
B	4	73.4	8	116.3	8	282.8	8	110.1	8	53.5	36	121.4
C	1		2	141.4	2		2	141.4	2		9	198.4
D	1		2		2		2		2		9	
E	2	141.4	6	244.9	6	111.0	6	115.2	6	244.9	26	171.9
F	1		6	109.5	6	88.8	6	154.9	6	160.8	25	155.7
G	na		2	141.4	2	141.4	2	16.4	2	0.0	8	99.1
H	na		na		na		1		na			
I	2	8.6	4	44.0	4	24.8	4	23.5	4	67.0	18	62.1
Combined	15	136.4	38	114.2	38	112.6	39	89.4	38	111.4	167	132.0

Table 15. Number (A) and biomass (B) of pumpkinseed (*Lepomis gibbosus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence intervals are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the mean underlined is provided. 0 indicates no catch, na indicates electrofishing survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0		0.23	0.55	0.88		0.88		0.17	0.72	1.28	1.32	2.27	3.24	0.06	0.98	1.36
B	2.18	2.59	3.01	0.05	0.44	0.84	0.01	0.66	1.32	0.73	1.94	3.16	0.89	1.39	1.89	0.77	1.11	1.44
C		0			1.33			1.77			1.32			0		0.07	0.79	1.51
D		0			0			0			0			0			0	
E		0			0.82		0.11	2.20	4.33	0.21	1.10	2.01	0.37	2.48	4.63	0.80	1.46	2.13
F		0			1.44			1.79			0.82			0.62		0.14	1.04	1.94
G		na			0.44			1.33			0.89			0		0.11	0.59	1.07
H		na			na			na			6.67			na				
I		3.44		3.30	7.30	11.48		1.20			1.33			1.72		1.48	2.92	4.39
Combined		0.65			1.52		0.64	1.23	1.82	0.42	0.90	1.39	0.19	1.06	1.93	0.98	1.24	1.51

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0		16.91	61.76	123.82		49.60		12.09	74.42	171.41	99.6	160.0	238.75	44.19	70.30	101.13
B	42.59	28.35	215.46		25.75			30.37		107.8	206.0	350.6	109.2	161.0	225.76	62.47	92.54	128.19
C		0			21.41			41.36			86.53			0		2.74	17.20	33.69
D		0			0			0			0			0			0	
E		0			20.87			55.44		8.58	155.16	499.60		87.31		26.77	62.87	109.24
F		0			49.09			30.44			40.03			40.11		7.78	34.66	68.25
G		na			69.30			45.62			38.53			0		0.43	31.38	71.88
H		na			na			na			617.27			na				
I		15.05		84.16	339.64	949.54		51.43			69.39			99.48		65.02	33.96	231.69
Combined		37.85		4.90	55.99	131.97	21.64	38.26	57.15	21.65	67.30	130.07	10.79	59.41	129.35	50.94	64.52	79.31

Table 16. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of pumpkinseed (*Lepomis gibbosus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates electrofishing survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8	53.4	8	119.3	8	60.5	8	24.4	36	111.7
B	4	13.4	8	92.9	8	96.9	8	38.1	8	23.2	36	89.1
C	1		2	32.0	2	47.1	2	141.4	2		9	118.2
D	1		2		2		2		2		9	
E	2		6	160.8	6	83.4	6	77.5	6	64.5	26	113.3
F	1		6	118.0	6	244.9	6	167.5	6	109.5	25	218.9
G	na		2	141.4	2	32.0	2	0.0	2		8	105.9
H	na		na	14.6	na		1		na			
I	2	37.8	4		4	69.6	4	53.3	4	57.6	18	98.4
Combined	15	19.95	38	152.1	38	57.4	39	63.8	38	98.0	167	139.6

Other species

The biomass of some species was extremely high, although they were not distributed as consistently or in such great numbers as the above specifically detailed species. Overall, white suckers in Johnstown Bay had a significantly higher biomass (214.5 g·100 m^{-2}) (Table C-11B) than any other species, even though suckers were significantly less dense (0.68·100 m^{-2}) (Table C-11A) than yellow perch and pumpkinseeds. Likewise, brown bullhead biomass was quite high (98.62 g·100 m^{-2}) (Table C-35B) but less than half that of white suckers, although their numerical densities (0.65·100 m^{-2}) (Table C-35A) were virtually identical to those of white suckers.

Although there are many species-specific results (provided in Appendix C) other than the most dense, the greatest biomass, and the most consistent distribution, particulars for two other species should be highlighted.

American eels, although they were never captured, were detected in significant numbers in association with the rock infill in Area E (0.63·100 m^{-2}) (Table 17A). There, their estimated biomass was very high (142.84 g·100 m^{-2}) (Table 17B). Around this rock infill, they were 3.5 times more numerous and had 2.9 times greater biomass than in all habitats combined in Johnstown Bay. This is not surprising, given the increased cover created by the large interstitial spaces in the coarse shot-rock infill. Eels were taken most consistently around the rock infill and the adjacent debris and vegetation associated with the sunken vessel (Table 18).

Juvenile muskellunge were taken during the survey (Tables 7 and 8) (Areas I, lower bay, and B, upper inner bay). They were not abundant (Table 19) and were taken only several times in two areas (Table 20), but their presence was important in assessing habitat alteration associated with the rock infill. However, when all periods and habitats were combined, they were numerous enough throughout Johnstown Bay to be considered statistically present (0.04·100 m^{-2}) but at a low biomass (0.71 g·100 m^{-2}) because all the fish

Table 17. Number (A) and biomass (B) of American eel (*Anguilla rostrata*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence intervals are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates electrofishing survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0.11			0.22			0			0			0.06			0.07	
B		0		0.02	0.22	0.42		0			0			0		0.00	0.05	0.10
C		0			0			0			0			0			0	
D		0			0			0			<u>0.83</u>			0			0.10	
E		0.34		0.08	1.38	2.70		1.36			0			0		0.12	0.63	1.15
F		0			0.21			0			0.21			0			0.09	
G		na			<u>0.44</u>			0			0.44			0			0.20	
H		na			na			na			0			na				
I		0			0.13			0			0			0			0.13	
Combined		0.06		0.05	0.43	0.81		0.23			0.19			0.01		0.09	0.18	0.28

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		66.40			83.21			0			0			34.61		0.50	29.33	66.42
B		0		11.62	210.42	763.27		0			0			0		0.60	28.62	64.45
C		0			0			0			0			0			0	
D		0			0			0			<u>553.20</u>			0			41.83	
E		235.24		46.97	791.81	5311.61		306.02			0			0		30.88	142.84	350.58
F		0			64.34			0			78.34			0			26.99	
G		na			<u>278.59</u>			0			381.89			0			90.66	
H		na			na			na			0			na				
I		0			73.22			0			0			0			12.98	
Combined		27.83		55.70	178.30	397.44		45.02			6.54			3.79		27.38	49.26	74.90

Table 18. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of American eel (*Anguilla rostrata*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates electrofishing survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4	200.0	8	198.4	8		8		8	282.8	36	336.0
B	4		8	106.9	8		8		8		36	286.9
C	1		2		2		2		2		9	
D	1		2		2		2	141.4	2		9	300.0
E	2	141.4	6	82.9	6	156.5	6		6		26	198.4
F	1		6	244.9	6		6	244.9	6		25	360.3
G	na		2	141.4	2		2	141.4	2		8	198.4
H	na		na		na		1		na			
I	2		4	200.0	4		4		4		18	424.3
Combined	15	199.3	38	106.4	38	214.6	39	165.1	38	282.8	167	336.5

Table 19. Number (A) and biomass (B) of muskellunge (*Esox masquinongy*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence intervals are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates electrofishing survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0.06			0.06			0.02	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na			0	
I		0			0			0			0.80			0.53		0.04	0.30	0.56
Combined		0			0			0			0.11			0.07		0.01	0.04	0.07

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0			0	
C		0			0			0			1.05			1.33			0.53	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na			0	
I		0			0			0			13.71			12.54		0.66	5.63	10.84
Combined		0			0			0			1.80			1.74		0.14	0.71	1.27

Table 20. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of muskellunge (*Esox masquinongy*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates electrofishing survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8		8		8	282.8	8	282.8	36	418.2
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6		26	
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4	75.7	4	115.5	18	176.9
Combined	15		38		38		39	262.4	38	253.7	167	527.5

caught were young-of-the-year (Table 19). What is important here is not that the densities seem extremely low but that juvenile muskellunge were actually caught with any consistency.

Habitat associations and species assemblages

We combined the results by area to describe the various types of habitat and to examine the relative importance of habitat associations and the fish community. To provide a general description of the community to examine the relative importance of various species, we used their relative occurrence, on the basis of density (both numbers and biomass) and consistency of distribution. For species that were abundant enough (both numbers and biomass) to be considered present in statistically significant quantities, we ordered and ranked these three measures of occurrence. We considered that each of the three community descriptors was equally important, so we averaged them to provide an overall rank of community importance.

Pumpkinseeds were the most important species in all areas, followed by yellow perch, white suckers, rock bass, brown bullheads, bluntnose minnows, and golden shiners (Table 21). The fish community contained a large number of species (22 or 24) with an overall numerical abundance of 19.08·100 m^{-2} and a biomass of 607.67 g·100 m^{-2} (Table 21).

Since two of the seven most important species were dominant around the infilled rock rubble in the inner bay (Area E), an atypical habitat for a shallow backwater littoral-zone bay in the upper St. Lawrence River, we combined the results for Areas A, B, and I to obtain a better description of a more natural unaltered and typical littoral-zone habitat. In the fish community of this habitat, pumpkinseeds remained the most important species, followed by white suckers, yellow perch, brown bullheads, golden shiners, rock bass, and northern pike (Table 22). In these naturally vegetated areas, rock bass (sixth compared with fourth) and bluntnose minnows (eighth compared with sixth) were less important. This fish community had approximately the same number of important species (23), with only one-third the overall density (7.23·100 m^{-2}) but slightly higher biomass (682.47 g·100 m^{-2}) (Table 22).

Table 21. Occurrence of species electrofished in statistically significant quantities ($\bar{x}$ >0) in both recently altered and unaltered littoral habitats of Johnstown Bay, upper St. Lawrence River, June to October 1995. Numerical rank orders the variables by decreasing magnitude. Includes 167 transects at 10 different sites in 8 general areas (A-G and I) sampled on 2 consecutive days each month (once in June). Relative distribution is described by the coefficient of variation (CV) including all transects. Overall rank indicates order of importance, based on equally weighted ranks of numerical abundance, biomass, and distribution. Darters are of two species--johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi*). Additional species are those that were taken in statistically insignificant quantities. Number of species is in parentheses. A relative biomass of 0.0 indicates a value <0.05. Mean weight was calculated from the geometric mean biomass and number.

Species	Number			Distribution		Biomass			Mean weight (g)	Overall rank
	Rank	$N \cdot 100^{-2}$	%	Rank	CV	Rank	$g \cdot 100^{-2}$	%		
bluntnose minnow	1	10.59	55.5	6	220.0	8	18.73	3.1	1.8	6
rockbass	2	1.49	7.8	5	194.5	6	50.45	8.3	33.9	4
pumpkinseed	3	1.24	6.5	2	139.6	3	64.52	10.6	52.0	1
yellow perch	4	1.11	5.8	1	132.0	4	55.57	9.1	50.1	2
sand shiner	5	0.98	5.1	20	568.8	13	1.51	0.2	1.6	13
white sucker	6	0.68	3.6	3	142.6	1	214.78	35.3	315.9	3
brown bullhead	7	0.65	3.4	4	167.6	2	98.62	16.2	151.7	5
golden shiner	8	0.57	3.0	7	223.9	11	1.84	0.3	3.2	7
spottail shiner	9	0.49	3.0	21	547.1	14	0.95	0.2	1.9	15
darters	10	0.34	2.0	8	270.4	16	0.65	0.1	1.9	10
American eel	11	0.18	0.9	11	336.5	5	49.26	8.1	273.7	8
northern pike	12	0.16	0.8	9	280.6	7	41.84	6.9	261.5	9
smallmouth bass	13	0.13	0.7	14	423.3	9	3.62	0.6	27.9	12
largemouth bass	14	0.12	0.6	10	303.9	10	1.85	0.3	15.4	11
black crappie	15	0.07	0.4	12	371.8	12	1.74	0.3	24.9	14
brook silversides	16	0.06	0.3	13	418.8	20	0.10	0.0	1.7	16
common shiner	17	0.04	0.2	19	532.1				5.0	
muskellunge	18	0.04	0.2	18	527.5	15	0.71	0.1	17.8	19
carp	19	0.04	0.2	15	436.6	17	0.47	0.1	11.8	18
central mudminnow	20	0.03	0.2	16	517.9	18	0.21	0.0	7.0	20
sculpins	21	0.03	0.2	22	609.6	21	0.07	0.0	2.3	22
banded killifish	22	0.02	0.1	23	616.6				3.0	
alewife	23	0.02	0.1	17	519.2	22	0.06	0.0	3.0	21
bluegill						19	0.12	0.0	3.0	
Combined		19.08 (23)					607.67 (22)		31.9	
Additional species		0.14 (10)					11.06 (11)		79.0	

Table 22. Occurrence of species electrofished in statistically significant quantities ($\bar{x}$ >0) in structurally unaltered littoral habitats in Johnstown Bay, upper St. Lawrence River, June to October 1995. Numerical rank orders the variables by decreasing magnitude. Includes 90 transects at 5 different sites in 3 general areas (A, B, and I), sampled over 2 consecutive days each month (once in June). Relative distribution is described by the coefficient of variation (CV) including all transects. Overall rank indicates order of importance, based on equally weighted ranks of numerical abundance, biomass, and distribution. Darters are of two species--johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi*). Additional species are those that were taken in statistically insignificant quantities. Number of species is in parentheses. A relative biomass of 0.0 indicates a value <0.05.

Species	Number			Distribution		Biomass			Mean weight (g)	Overall rank
	Rank	$N \cdot 100^{-2}$	%	Rank	CV	Rank	$g \cdot 100^{-2}$	%		
pumpkinseed	1	1.42	19.6	3	121.7	3	90.60	13.3	63.8	1
yellow perch	2	1.32	18.3	2	114.6	4	66.97	9.8	50.7	3
brown bullhead	3	0.89	12.3	4	129.6	2	164.77	24.1	185.1	4
golden shiner	4	0.74	10.2	5	158.3	8	2.73	0.4	3.7	5
white sucker	5	0.69	9.5	1	111.8	1	260.23	38.1	377.1	2
bluntnose minnow	6	0.49	6.8	9	265.8	11	1.15	0.2	2.4	8
rockbass	7	0.48	6.6	6	160.0	7	23.80	3.5	49.6	6
darters	8	0.26	3.6	10	286.5	12	0.62	0.1	2.4	10
largemouth bass	9	0.17	2.4	8	235.4	9	2.52	0.4	14.8	9
spottail shiner	10	0.13	1.8	11	301.8	14	0.28	0.0	2.2	12
northern pike	11	0.11	1.5	7	193.0	5	41.10	6.0	373.6	7
black crappie	12	0.07	1.0	13	348.0				31.0	
muskellunge	13	0.07	1.0	17	382.2	10	1.31	0.2	18.7	13
American eel	14	0.06	0.8	12	340.8	6	25.60	3.8	426.7	11
common shiner	15	0.06	0.8	22	421.9	15	0.19	0.0	3.2	16
central mudminnow	16	0.04	0.6	14	359.3	13	0.32	0.0	8.0	14
alewife	17	0.04	0.6	15	376.0	16	0.11	0.0	2.8	15
smallmouth bass	18	0.04	0.6	23	449.9				81.0	
brook silversides	19	0.03	0.4	16	376.3	19	0.03	0.0	1.0	18
sculpin	20	0.03	0.4	18	415.7	17	0.10	0.0	3.3	17
carp	21	0.03	0.4	19	415.7				14.0	
banded killifish	22	0.03	0.4	20	416.3	18	0.04	0.0	1.3	19
bluegill	23	0.03	0.4	21	416.3				4.0	
Combined		7.23 (23)					682.47 (19)		94.4	
Additional species		0.12 (7)					17.56 (11)		146.3	

Since the fish community associated with the rock infill appeared to be different, we compared it separately. As expected, along the edge of the rock infill (Area E), bluntnose minnows were singularly important, followed by rock bass, white suckers, pumpkinseeds, spottail shiners, yellow perch, and American eels (Table 23). Darters also formed an important part of the fish community. Rank importance was considerably different than in the more natural habitats of Johnstown Bay. The species assemblage was very much smaller, containing only nine species, fewer than half as many species. Compared with the community of more natural and typical vegetated habitats (Table 22), the numerical density was very high (48.61·100 m^{-2}), 6.7 times, whereas the biomass was slightly higher (721.83 g·100 m^{-2}) (Table 23), 1.1 times.

The habitat around the perimeter of the rock was affected by the infilling. It was less vegetated (Table 4) and the substrate was less stable. The fish community in this habitat (approximately 3.5 to 6.0 m out from the edge of the infill) was much less diverse, containing very few species (5 or 6) (Table 24). Bluntnose minnows were singly most important, followed by yellow perch, white suckers, pumpkinseeds, brown bullheads, and rock bass. Excluding bluntnose minnows, most of these species were important members of the natural littoral habitats of Johnstown Bay. For all species combined, densities (30.91·100 m^{-2}) (Table 24) were higher (4.3×) than in natural habitats but lower (0.6×) than around the immediate edge of the rock infill. This was mainly related to the disproportionate abundance of bluntnose minnows. The overall biomass of species in this assemblage (279.91 g·100 m^{-2}) (Table 24) was very much lower than in more natural, heavily vegetated habitats. Although the important species were present, their numbers and biomass were much lower and were greatly affected by the altered habitat.

The rock infill and associated habitat contained an appreciably different fish assemblage. It was much simpler, and although numbers of individuals were high, this was attributed to the disproportionate abundance of bluntnose minnows and rock bass associated

Table 23. Occurrence of species electrofished in statistically significant quantities ($\bar{x} > 0$) along the recently structurally altered habitat at the edge of rock infill (size up to 80 cm) in Johnstown Bay, upper St. Lawrence River, June to October 1995. Numerical rank orders the variables by decreasing magnitude. Includes 27 transects at one site in one general area (E) sampled on 2 consecutive days each month (once in June). Relative distribution is described by the coefficient of variation (CV) including all transects. Overall rank indicates order of importance, based on equally weighted ranks of numerical abundance, biomass, and distribution. Darters are of two species--johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi*). Additional species are those that were take in statistically insignificant quantities. Number of species is in parentheses. Mean weight was calculated from the geometric mean biomass and number.

Species	Number			Distribution		Biomass			Mean weight (g)	Overall rank
	Rank	$N \cdot 100^{-2}$	%	Rank	CV	Rank	$g \cdot 100^{-2}$	%		
bluntnose minnow	1	36.88	75.9	1	77.9	4	76.66	10.6	2.1	1
rockbass	2	3.52	7.2	2	89.1	2	186.24	25.8	52.9	2
sand shiner	3	2.58	5.3	9	237.4				2.1	
pumpkinseed	4	1.46	3.0	3	113.3	5	62.87	8.7	43.1	4
white sucker	5	0.94	1.9	5	175.1	1	207.34	27.7	220.6	3
spottail shiner	6	0.90	1.9	8	240.2	7	1.99	0.3	2.2	5
yellow perch	7	0.85	1.7	4	171.9	6	42.60	5.9	50.1	6
darters	8	0.85	1.7	6	186.6	8	1.29	0.2	1.5	8
American eel	9	0.63	1.3	7	203.7	3	142.84	19.8	226.7	7
Combined		48.61 (9)					721.83 (8)		14.9	
Additional species		3.52 (16)					66.85 (17)		19.0	

Table 24. Occurrence of species electrofished in statistically significant quantities ($\bar{x}$ >0) over the rather sparsely vegetated uplifted silt and sand in close proximity to the recently structurally altered habitat associated with the rock infill in Johnstown Bay, upper St. Lawrence River, June to October 1995. Transects ran parallel to the rock fill, approximately 3.5-6.0 m from the edge. Numerical rank orders the variables by decreasing magnitude. Includes 27 transects at one site in one general area (F) sampled on 2 consecutive days each month (once in June). Relative distribution is described by the coefficient of variation (CV) including all transects. Overall rank indicates order of importance, based on equally weighted ranks of numerical abundance, biomass, and distribution. Additional species are those that were taken in statistically insignificant quantities. Number of species is in parentheses. Mean weight was calculated from the geometric mean biomass and number.

Species	Number			Distribution		Biomass			Mean weight (g)	Overall rank
	Rank	$N \cdot 100^{-2}$	%	Rank	CV	Rank	$g \cdot 100^{-2}$	%		
bluntnose minnow	1	28.09	90.9	1	154.0	4	42.10	15.0	1.5	1
pumpkinseed	2	1.04	3.4	5	218.9	5	34.66	12.4	33.3	4
yellow perch	3	0.96	3.2	2	155.7	3	45.35	16.2	47.2	2
white sucker	4	0.41	1.3	3	166.2	1	83.50	29.8	203.7	3
brown bullhead	5	0.41	1.3	4	234.9	2	50.25	18.0	122.6	5
rockbass						6	24.05	8.6	29.7	6
Combined		30.91 (5)					279.91 (6)		9.1	
Additional species		6.48 (11)					90.36 (10)		13.9	

with the rock infill.

Relative significance of recent habitat alterations

To quantify the relative significance of the rock infill on the fish community of the upper bay, we compared the relative occurrence, both numbers and biomass equally weighted, for each member of the fish community associated with the infill (Area E) (Table 23) with a natural vegetated habitat considered to be more typical of the shallow littoral zone of Johnstown Bay (Table 22). Six species were positively associated with the rock infill and showed overall increased relative occurrence and importance (Table 25). Ranked in order of relative occurrence, bluntnose minnows showed the greatest increase (71.0×), followed by rock bass (7.6×), American eels (8.1×), spottail shiners (7.0×), darters (2.7×), white suckers (1.1×). The remaining two species that were caught in significant numbers around the rock infill were negatively associated with it--pumpkinseeds (0.9×) and yellow perch (0.6×). When the species assemblage associated with the edge of the rock infill was combined, fish were, overall, 9.5 times denser and their biomass was 1.5 times greater than in the natural habitat of the vegetated littoral zone (Table 25). If the adjacent areas around the infill were included (especially Area E), the direct alteration of the fish community of the inner bay would be more extensive.

Increased fish abundance and biomass have also been reported for other artificial structures such as breakwaters (Portt and King 1991) and artificial reefs (Prince et al. 1982). Although these studies report different species, it appears that such structures can not only increase the abundance of fish but also alter the community assemblage and structure (Portt and King 1991). Nevertheless, the community assemblage either attracted to or produced by this rock infill is atypical of the natural habitat of Johnstown Bay. Without detailed analyses, it is difficult to know whether these species were attracted to the rock or were produced there; the former seems more likely, since the rock was deposited only the previous autumn and most of the fish captured were older than young-of-the-year (Casselman and Grant, unpubl.

Table 25. Comparative occurrence in decreasing order of relative quantities (number and biomass) of species that were electrofished in statistically significant quantities ($\bar{x} > 0$) associated with the edge of the rock infill (area E) relative to recently structurally unaltered areas (areas A, B, and I) in the littoral zone of Johnstown Bay, upper St. Lawrence River, June to October 1995. Darters are of two species--johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi*).

Species	Number		Biomass		Overall occurrence	
	Rank	Relative difference (×)	Rank	Relative difference (×)	Rank	Relative difference (×)
bluntnose minnow	1	75.3	1	66.7	1	71.0
American eel	2	10.5	4	5.6	3	8.1
rock bass	3	7.3	2	7.8	2	7.6
spottail shiner	4	7.1	3	6.9	4	7.0
darters	5	2.1	5	3.3	5	2.7
white sucker	6	0.8	6	1.4	6	1.1
pumpkinseed	7	0.7	7	1.0	7	0.9
yellow perch	8	0.6	8	0.6	8	0.6
Combined		9.5		1.5		5.5

data). We can only speculate on the reason why this lithophilic fish community became established so quickly. It is possible that prey abundance increased, but it seems more likely, given the short period of time, that the rock was more important for spawning or cover. Bluntnose minnows prefer gravel cobble in streams and spawn on the undersides of rocks and other objects (Aadland et al. 1991). The coarse rock would provide excellent spawning substrate for this species. Rock bass are strongly lithophilic and, although they are found in vegetative cover, they are most dense on rocky shorelines (Casselman and Brown, unpubl. data). It was surprising to see medium-sized eels so abundant along the rock infill. Indeed, commercial eel electrofishing operations in eastern Lake Ontario specifically target this type of large coarse rock habitat to collect eels; they are known to hide in this cover during the day (J. Rorabeck, commercial fisherman, Picton, Ontario, pers. comm.).

In considering the relative importance of the loss of the littoral zone because of this rock infill and the alteration of the fish community, we concur with Minns et al. (1996) that no single population or parameter should be used as a reference point for detecting change in response. We have emphasized the importance of detailed and systematic observations with replicates and appropriate habitat comparisons. The alteration of the habitat around the edge of the rock infill emphasizes the importance of vegetative cover and its loss (Killgore et al. 1989). Randall et al. (1996) have stressed the importance of conserving productive vegetated littoral habitats because of their direct effect on fish production, density, and species richness.

There is direct evidence that the fish community structure and density in the shallow littoral zone of Johnstown Bay are directly related to the abundance of macrophytes. Wetlands in the Great Lakes Basin have, since European colonization, shrunk dramatically (Casselman and Lewis 1996). The productivity of shallow embayments such as Johnstown Bay in part depends upon the associated wetlands and their inflows. The vegetation in the shallows and wetlands is especially important to the littoral-zone species associated with them (Jude and Pappas 1992). The structure of the fish community around the rock infill is atypical of a shallow, moderately vegetated, backwater littoral-zone bay; it is indicative of an altered habitat, one out of place. Fish community assemblages, if sampled thoroughly, are powerful

descriptors of environmental degradation (Fausch et al. 1990). Monitoring such critical habitats as the shallow littoral zone of Johnstown Bay and its recent infill can provide an early indicator of change in the aquatic ecosystem (Hildén and Rapport 1993), in this case, the upper St. Lawrence River.

Muskellunge and their nursery habitat requirements

Although northern pike and yellow perch are probably the most important sports species in the bay, this section of the upper St. Lawrence River is renowned for producing record-size trophy muskellunge (see review, Grant 1995). For this reason, a concern was expressed early on concerning the rock infill in the inner bay and its impact on the nursery habitat and productivity of this large, valuable sports species (Grant 1995).

Muskellunge must be long-lived (20-25 yr) to reach a large trophy size. With total mortality rates (natural and angling combined) of trophy muskellunge approaching 20 to 23% (Casselman et al. 1995), natural recruitment must be high to start with adequate numbers to produce trophy-age fish. Any loss of nursery habitat will directly affect recruitment, year-class strength, and the ability of muskellunge populations to maintain a high-quality trophy fishery (Casselman et al. 1995).

The upper inner bay is muskellunge nursery habitat. A young-of-the-year muskellunge was caught in September 1994 in the close vicinity of the area infilled during an electrofishing survey conducted by the St. Lawrence River Fisheries Management Unit (see review, Grant 1995). In the present study, young muskellunge were caught in similar habitats in the upper inner bay (Area B) (Table D-1), although their densities in that area were not significant enough to be considered to be statistically present with the effort applied (Table 19). Considerable electrofishing effort would be needed to conclusively demonstrate a significant presence. In spawning and nursery studies of Great Lakes populations, young-of-the-year muskellunge are rarely collected; any consistent presence indicates important nursery habitat. In this study, they were present in typical summer nursery habitat for juvenile Great

Lakes muskellunge (Craig and Black 1986). Our results confirm the contention of Casselman (1995) that the rock infill reduces the available juvenile habitat and negatively affects the survival, growth, and production of juvenile muskellunge in this embayment. During this study, it became apparent that some important potential predators on young muskellunge are associated with the rock infill. Besides rock bass, which are abundant, American eels are present. This species is strongly piscivorous and feeds in the water column on such species as alewife (*Alosa pseudoharengus*) (Casselman, unpubl. data). This behaviour makes juvenile muskellunge in the inner bay especially vulnerable, since during the night and at dawn, young muskellunge are found up in the water column above the vegetation (Osterberg 1985), near the surface of the water.

The fish community of the rock rubble could also have an indirect effect on juvenile muskellunge. Of the 12 young-of-the-year muskellunge that were caught during the survey (Table D-1), 86% had fish in their stomachs (Table D-2). Of these stomachs, 50% had young-of-the-year or yearling golden shiners, while 33% had darters. These two species were by far the most important prey items. Although darters were denser around the rock infill (Table 23), the most important prey item of muskellunge, golden shiners, would be negatively affected by the associated fish community. Rock bass were appreciably more abundant around the infill (7.6×). Rock bass are important predators on small littoral-zone species (Casselman and Brown unpubl. data). In lakes in the Haliburton Highlands of Ontario where rock bass have been introduced, not only has the inshore fish community been greatly reduced, but also some species, over a period of a few years, have disappeared. The first cyprinid to disappear when rock bass were introduced was golden shiners (D. Brown, Trent University, Peterborough, Ontario, pers. comm.). Therefore, this atypical fish community associated with the rock rubble, specifically the rock bass, will reduce the availability of golden shiners, thereby negatively affecting growth and production of juvenile muskellunge.

Although bluntnose minnows were abundant, in our survey, none of the piscivores we examined had this species in their stomachs.

Littoral-zone fish community of Johnstown Bay

Species composition in Johnstown Bay was similar to that reported for other Great Lakes inshore habitats (Randall et al. 1996). Although the principal species of the cool- and warm-water fish community associated with this embayment and this large river system were pumpkinseeds, white suckers, yellow perch, brown bullheads, and golden shiners, the community was diverse (23 species) and relatively dense (7.23·100 m^{-2}, 682.47 g·100 m^{-2}). This demonstrated the large biomass and high degree of productivity associated with large river systems and supports the contention of Randall et al. (1995) that the productivity of river habitats is usually greater than that of lake habitats.

The rock-infill habitat in Johnstown Bay is atypical and has produced a community that has a different species assemblage, is less diverse, and will negatively affect the productivity of important sports species such as muskellunge. The infill is in optimal muskellunge nursery habitat. The potential negative effects on this species are apparent. We have documented this by measuring the density of species on a number and biomass basis, using a practical open-water sampling technique that can be used in large rivers (Casselman et al. 1990). It has, however, required substantial fishing effort and replication. Describing the fish community more conclusively would require a major and destructive amount of sampling effort. Furthermore, it is unlikely that adequate sampling could be conducted over time to show any more significant trends or changes because of the inherent observational sampling variability (Casselman et al. 1986; Lester et al. 1996). In addition, the study has provided new quantitative information on fish community structure, abundance, biomass, and distribution in a productive, shallow littoral zone in an important embayment in the upper St. Lawrence River.

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Table A-1. Description of electrofishing transects used to survey the littoral zone of Johnstown Bay, upper St. Lawrence River, June to October 1995.

Transect No.	Area	Site	Length (m)	Specific location
1 and 2	A	upper outer bay	75	Starting point is line of utility poles N side Hwy. 2 Transect is on a line between point of land at international bridge and inside peak of roof at tallest building at Bridgeview Marina Transects 1 and 2 were parallel and separated by 10 m Bearing 250°
3 and 4	A	upper outer bay	75	Starting point approximately 20 m S of transect 2 Running parallel to transects 1 and 2 Transects 3 and 4 were parallel and separated by 10 m
5 and 6	B	upper inner bay (north-south)	75	Starting approximately 10 m from outer end of large W finger dock of Bridgeview Marina Running up toward cattail marsh Transects 5 and 6 were parallel and separated by 10 m Bearing 165°
7 and 8	B	upper inner bay (east-west)	75	Running parallel to sunken vessel, starting at outer edge and progressing inshore, ending opposite front of vessel Line up transect with middle light standard on shore with cement abutment of international bridge Transects 7 and 8 were parallel and separated by 10 m
9	C	shoring	75	Running alongside shoring and retaining wall on port side only Starting at end of horizontal steel beam on retaining wall and travelling along wall up to rock fill and behind rock fill up to connecting rock causeway

Table A-1 (cont'd)

Transect No.	Area	Site	Length (m)	Specific location
10D	D	deep water	40	Starboard side of transect 9 from end of horizontal steel beam to beginning of rock infill
10R	E	rock infill	35	Continuation of transect 9 on starboard side from start of rock infill along infill up to connecting rock causeway
11A	E, F	rock infill and silt-sand uplift	50	Starting approximately 1.9 m out from end (river end) of rock infill to outer end of submerged vessel Starboard and port involve different habitats Port side is associated with rock infill and Area E, while starboard side is associated with sand-silt uplift and Area F
11B	F, G	sunken vessel	75	Runs from end to end of submerged vessel Starboard and port involve different habitats Port side is associated with sunken vessel and rock debris and Area G, while starboard side is associated with sand-silt uplift and Area F
12	E, F	rock infill and silt-sand uplift	35	Starting at inshore end of sunken vessel and travelling inshore parallel to rock fill Starboard and port involve different habitats Port side is associated with rock infill and Area E, while starboard side is associated with sand-silt uplift and Area F
13	I	lower bay	125	Downstream from Grenville Park and opposite northern tip of Spencer Island, located between two man-made dredged channels
14	H	shallow water upper inner bay	25	Parallel to retaining wall in inner bay in centre of NW retaining wall

Table B-1. Relative density (%) of curly pondweed (*Potamogeton crispus*) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	40	75.0	100	10	43.8	95	0	0.0	0	0	10.0	35	0	2.5	10	0	26.3	100
B	80	90.0	100	0	29.2	50	0	1.7	10	0	7.5	40	0	0.0	0	0	25.7	100
C		0			0			45.0			0.0			0.0		0	9.0	80
D		0			0			50			0.0			0		0	10.0	50
E	0	0.0	0	0	8.3	25	0	16.7	50	0	0.0	0	0	0.0	0	0	5.0	100
F	0	0.0	0	0	33.3	100	0	0.0	0	0	0.0	0	0	0.0	0	0	8.3	100
G		0			100			0			0			0		0	20.0	100
H		na			na			na						na				
I					0.0			0.0			0.0			0.0		0	0.0	0
Combined	0	23.6	100	0	26.8	100	0	14.2	50	0	2.2	40	0	0.3	10	0	13.2	100

Table B-2. Relative density (%) of milfoil (*Myriophyllum* sp.) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	17.5	50	0	14.8	40	0	16.7	50	8	27.2	80	0	12.8	45	0	17.8	80
B	0	6.0	20	0	21.7	50	0	8.3	20	0	6.2	25	0	0.8	5	0	8.6	50
C		0			15			22.5			25.0			15.0		0	15.5	45
D		0			15			0			25.0			30		0	14.0	45
E	0	0.0	0	0	8.3	25	0	3.3	10	0	1.7	5	0	0.0	0	0	2.7	25
F	0	0.0	0	0	0.0	0	0	5.0	10	0	4.7	9	0	0.0	0	0	2.4	10
G		0			0			5			9			0		0	2.8	9
H		na			na			na						na				
I					10.0			2.3			7.5			15.0		2	8.7	15
Combined	0	3.4	50	0	10.6	50	0	7.9	50	0	13.3	80		9.2	45	0	9.0	80

Table B-3. Relation density (%) of coontail (*Ceratophyllum demersum*) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	0.0	0	0	0.8	5	0	0.0	0	0	2.7	9	0	0.0	0	0	0.7	9
B	0	1.0	5	0	0.0	0	0	0.0	0	0	0.0	0	0	0.2	1	0	0.2	5
C		0			80			0.0			25.0			0.0		0	21.0	80
D		0			80			0			25.0			0		0	21.0	80
E	0	0.0	0	0	0.0	0	0	3.3	10	0	1.7	5	0	5.0	15	0	2.0	15
F	0	0.0	0	0	0.0	0	0	3.3	10	0	4.7	9	0	5.0	15	0	4.1	15
G		0			0			0			9			0		0	1.8	9
H		na			na			na						na				
I					0.0			6.3			12.5			21.7		0	10.1	22
Combined	0	0.2	5	0	20.1	80	0	1.6	10	0	10.1	25	0	4.0	22	0	7.4	80

Table B-4. Relative density (%) of white water buttercup (*Ranunculus aquatilis*) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	0.0	0	0	0.0	0	0	26.7	80	0	14.7	30	0	8.7	40	0	10.0	80
B	0	0.0	0	0	0.0	0	0	3.3	10	0	6.7	40	0	0.0	0	0	2.0	40
C		0			0			7.5			0.0			0.0		0	1.5	8
D		0			0			0			0.0			0		0	0.0	0
E	0	0.0	0	0	0.0	0	0	0.0	0	0	3.3	10	0	0.0	0	0	0.7	10
F	0	0.0	0	0	0.0	0	0	23.3	70	0	3.3	10	0	0.0	0	0	6.7	70
G		0			0			70			0			0		0	14.0	70
H		na			na			na						na				
I					0.0		0	0.0			0.0			6.7		0	1.7	7
Combined	0	0.0	0	0	0.0	0	0	16.4	80	0	3.5	40	0	1.9	40	0	4.5	80

Table B-5. Relative density (%) of muskgrass (*Chara* sp.) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	0.0	0	0	1.7	10	0	0.0	0	0	6.7	40	0	18.3	90	0	5.3	90
B	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
C		0			0			0.0			0.0			15.0		0	3.0	15
D		0			0			0			0.0			30		0	6.0	30
E	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
F	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
G		0			0			0			0			0		0	0.0	0
H		na			na			na						na				
I					0.7			0.0			0.0			0.0		0	0.2	1
Combined	0	0.0	0	0	0.3	10	0	0.0	0	0	0.8	40	0	7.9	90	0	1.9	90

Table B-6. Relative density (%) of horned-pondweed (*Zannichellia palustris*) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. by area and combined overall include all transects. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
B	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
C		0			0			0.0			0.0			0.0		0	0.0	0
D		0			0			0			0.0			0		0	0.0	0
E	0	0.0	0	0	0.0	0	0	15	45	0	0.0	0	0	0.0	0	0	3.0	45
F	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
G		0			0			0			0			0		0	0.0	0
H		na			na			na						na				
I					0.0			0.0			0.0			0.0		0	0.0	0
Combined	0	0.0	0	0	0.0	0	0	1.9	45	0	0.0	0	0	0.0	0	0	0.4	45

Table B-7. Relative density (%) of slender pondweed (*Potamogeton pusillus*) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month															Combined		
	June			July			August			September			October					
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	0.0	0	0	0.0	0	0	0.0	0	0	0.8	5	0	0.0	0	0	0.2	5
B	0	0.0	0	0	0.0	0	0	0.0	0	0	3.3	20	0	0.0	0	0	0.7	20
C		0			0			0.0			0.0			0.0		0	0.0	0
D		0			0			0			0.0			0		0	0.0	0
E	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
F	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
G		na			0			0			0			0		0	0.0	0
H		na			na			na						na				
I					0.0			0.0			2.5			0.0		0	0.6	5
Combined	0	0.0	0	0	0.0	0	0	0.0	0	0	0.8	20	0	0.0	0	0	0.2	20

Table B-8. Relative density (%) of broad-leaf water plaintain (*Alisma plantago-aquatica*) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
B	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
C		0			0			0.0			0.0			0.0		0	0.0	0
D		0			0			0			0.0			0		0	0.0	0
E	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
F	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
G		na			0			0			0			0		0	0.0	0
H		na			na			na						na				
I					0.0			0.0			2.5			0.0		0	0.5	5
Combined	0	0.0	0	0	0.0	0	0	0.0	0	0	0.3	3	0	0.0	0	0	0.1	5

Table B-9. Relative density (%) of bladderwort (*Utricularia* sp.) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. A combined overall relative density of 0.0 indicates a value <0.05. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	0.0	0	0	0.0	0	0	0.8	5	0	0.0	0	0	0.0	0	0	0.2	5
B	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
C		0			0			0.0			0.0			0.0		0	0.0	0
D		0			0			0			0.0			0		0	0.0	0
E	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
F	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
G		0			0			0			0			0		0	0.0	0
H		na			na			na						na				
I					0.0			0.0			0.0			0.0		0	0.0	0
Combined	0	0.0	0	0	0.0	0	0	0.1	5	0	0.0	0	0	0.0	0	0	0.0	5

Table B-10. Relative density (%) of unidentified pondweed species (*Potamogeton* sp.) in the vegetative cover in the littoral zone of Johnstown Bay, upper St. Lawrence River during the electrofishing survey, June to October 1995. Means and extremes are presented by month and area. Blank indicates data not collected; na indicates electrofishing survey not conducted. A combined overall relative density of 0.0 indicates a value <0.05. Means and extremes indicate among-transect replication, whereas a mean alone indicates a single transect value, with within-transect replication if increased precision is indicated. Area H was not used in the combined analyses.

	Month																	
	June			July			August			September			October			Combined		
Area	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.	Min.	$\bar{x}$	Max.
A	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.8	5	0	0.2	5
B	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
C		0			0			0.0			0.0			0.0		0	0.0	0
D		0			0			0			0.0			0		0	0.0	0
E	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
F	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
G		0			0			0			0			0		0	0.0	0
H		na			na			na						na				
I					0.0			0.0			0.0			0.0		0	0.0	0
Combined	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.1	5	0	0.0	5

Table C-1. Number (A) and biomass (B) of longnose gar (*Lepisosteus osseus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0.27			0			0			0			0			0.03	
Combined		0.04			0			0			0			0			0.00	

B--Biomass

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		199.99			0			0			0			0			12.98	
Combined		25.85			0			0			0			0			1.32	

Table C-2. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of longnose gar (*Lepisosteus osseus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8		8		8		8		36	
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6		26	
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2	141.4	4		4		4		4		18	424.3
Combined	15	264.6	38		38		39		38		167	1292.3

Table C-3. Number (A) and biomass (B) of bowfin (*Amia calva*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0.06			0.01	
B		0			0			0.06			0			0.06			0.02	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0.28			0			0.06	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			0.01			0.03			0.01			0.02	

B--Biomass

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			4.78			1.04	
B		0			0			42.56			0			42.56			17.07	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			77.14			0			13.55	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			4.53			7.41			5.14			5.84	

Table C-4. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of bowfin (*Amia calva*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8	282.8	36	600.0
B	4		8		8	282.8	8		8	282.8	36	418.2
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6	244.9	6		26	519.2
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15		38		38	282.8	39	282.8	38	185.2	167	784.8

Table C-5. Number (A) and biomass (B) of alewife (*Alosa pseudoharengus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0.11			0.17			0.06		0.02	0.07	0.13
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0.27			0	
Combined		0			0			0.01			0.02			0.11		0.00	0.02	0.04

B--Biomass

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0.05			0.68			0.06			0.17	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0.92			0.20	
Combined		0			0			0.01			0.08			0.12		0.00	0.06	0.12

Table C-6. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of alewife (*Alosa pseudoharengus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8	185.1	8	138.0	8	282.8	36	226.8
B	4		8		8		8		8		36	
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6		26	
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4	200.0	18	424.3
Combined	15		38		38	282.8	39	282.8	38	232.2	167	519.2

Table C-7. Number (A) and biomass (B) of northern pike (*Esox lucius*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month												Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0.22			0			0.11			0.11			0.06		0.03	0.09	1.47
B		0.51			0.06			0.06			0.11			0.17		0.04	1.11	1.86
C		0			0			1.33			0.44			0			0.39	
D		0			0			0			0			0			0	
E		0.34			0.83			0			0			0			0.18	
F		0			0			0.21			0.82			0			0.23	
G		na			0			0			0			0.44			0.10	
H		na			na			na			0			na				
I		0			0			0.13			0.40			0.13		0.03	0.15	0.27
Combined		0.11			0.11			0.23			0.24			0.10		0.09	0.16	0.22

B--Biomass

	Month												Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		96.44			0			58.01			71.06			10.33		8.41	37.41	74.18
B		209.36			12.44			17.99			42.77			100.91		11.54	43.29	84.08
C		0			0			978.44			305.79			0			131.57	
D		0			0			0			0			0			0	
E		95.86			170.25			0			0			0			24.72	
F		0			0			68.26			181.76			0			41.32	
G		na			0			0			0			305.79			36.51	
H		na			na			na			0			na				
I		0			0			40.60			127.09			79.18		4.17	47.35	108.43
Combined		31.41			14.90			64.26		8.16	69.34	165.15		46.65		25.51	41.84	60.30

Table C-8. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of northern pike (*Esox lucius*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4	115.5	8		8	185.1	8	185.2	8	282.8	36	206.4
B	4	200.0	8	282.8	8	282.8	8	185.2	8	138.0	36	199.9
C	1		2		2	32.0	2	141.4	2		9	163.3
D	1		2		2		2		2		9	
E	2	141.4	6	109.5	6		6		6		26	288.2
F	1		6		6	244.9	6	176.3	6		25	335.2
G	na		2		2		2		2	141.4	8	300.0
H	na		na		na		1		na			
I	2		4		4	200.0	4	66.7	4	200.0	18	165.9
Combined	15	129.6	38	263.1	38	196.2	39	125.2	38	153.9	167	280.6

Table C-9. Number (A) and biomass (B) of central mudminnow (*Umbra limi*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0.11			0			0.06			0.06			0.06	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0.28			0			0			0			0.06	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			1.33			na				
I		0			0			0			0.27			0.13			0.09	
Combined		0			0.05			0			0.04			0.03		0.01	0.03	0.06

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0.91			0			0.60			1.33			0.53	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			1.09			0			0			0			0.24	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			6.52			na				
I		0			0			0			1.64			0.79			0.54	
Combined		0			0.25			0			0.28			0.21		0.06	0.21	0.36

Table C-10. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of mudminnow (*Umbra limi*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8	282.8	8		8	282.8	8	185.27	36	199.9
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6	244.9	6		6		6		26	519.6
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4	115.5	4	200.0	18	230.1
Combined	15		38	206.3	38		39	232.2	38	186.2	167	517.9

Table C-11. Number (A) and biomass (B) of white sucker (*Catostomus commersoni*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0		0.17	0.55	0.94	0.33	0.72	1.12	0.51	1.22	1.93	0.66	1.66	2.67	0.62	0.92	1.22
B	0.42	0.77	1.13	0.54	0.89	1.23	0.07	0.33	0.60		0.22		0.19	0.83	1.47	0.36	0.54	0.72
C		0			<u>0.44</u>			0			<u>0.89</u>			<u>0.44</u>			0.39	
D		0			0			0			<u>1.67</u>			<u>0.25</u>			0.91	
E		<u>0.34</u>			0.28			0.83			2.74			0.28		0.29	0.94	1.59
F		<u>0.42</u>		0.15	0.83	1.51		0			0.62			0.41		0.14	0.41	0.69
G		na			<u>0.44</u>			0			<u>0.89</u>			0			0.30	
H		na			na			na			0			na			0	
I		<u>0.80</u>			0.13			0		0.06	1.60	3.16		0.13		0.09	0.50	0.91
Combined		0.27		0.19	0.46	0.71		0.23		0.58	1.23	1.88	0.06	0.78	1.50	0.53	0.68	0.82

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0		109.8	395.6	1070.3	136.7	385.2	894.4	148.8	636.2	2078.6	125.0	513.0	1570.2	220.5	372.7	597.2
B		162.13		594.2	899.7	1339.6	40.5	218.4	621.7		5.00		41.1	185.8	479.0	127.7	221.7	354.5
C		0			<u>285.60</u>			0			<u>374.80</u>			<u>216.16</u>			142.48	
D		0			0			0			<u>1569.72</u>			<u>3131.28</u>			304.68	
E		<u>210.10</u>			62.18			273.68		48.3	1033.8	8570.3		56.11		66.7	207.3	466.8
F		<u>315.63</u>		37.5	507.1	2580.1		0			59.46			58.66		16.5	83.5	189.1
G		na			<u>242.84</u>			0			<u>1029.44</u>			0			125.36	
H		na			na			na			0			na			0	
I		257.60			68.27			0		283.2	1350.1	5387.8		66.42		37.2	162.4	402.0
Combined	2.1	131.8	426.3	74.6	225.9	508.2		66.02		154.6	505.9	1341.7	25.8	213.1	679.2	158.9	214.5	282.0

Table C-12. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of white sucker (*Catostomus commersoni*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8	71.0	8	52.3	8	52.0	8	52.6	36	96.4
B	4	66.7	8	27.1	8	87.5	8	143.8	8	74.4	36	97.7
C	1		2	141.4	2		2	141.4	2	141.4	9	163.3
D	1		2		2		2	0.0	2	32.0	9	130.5
E	2	141.4	6	244.9	6	109.5	6	86.5	6	244.9	26	175.1
F	1		6	77.5	6		6	106.8	6	154.9	25	166.2
G	na		2	141.4	2		2	0.0	2		8	150.0
H	na		na		na		1		na			
I	2	141.4	4	200.0	4		4	38.4	4	200.0	18	163.9
Combined	15	110.0	38	69.8	38	150.1	39	62.8	38	110.4	167	142.6

Table C-13. Number (A) and biomass (B) of silver redhorse (*Moxostoma anisurum*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0.06			0.01	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0.21			0			0			0.05	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			0.03			0			0.01			0.01	

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			24.93			5.07	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			80.70			0			0			14.05	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			7.68			0			2.82			3.24	

Table C-14. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of silver redhorse (*Moxostoma anisurum*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8		8		8		8	282.2	36	600.0
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6		26	
F	1		6		6	244.9	6		6		25	519.6
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15		38		38	282.8	39		38	282.8	167	1008.9

Table C-15. Number (A) and biomass (B) of carp (*Cyprinus carpio*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0.06			0.01	
C		0			0			<u>0.44</u>			0			0			0.10	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			<u>0.44</u>			<u>0.44</u>			<u>0.44</u>			0.30	
H		na			na			na			0			na				
I		0			0.13			0			0.13			0.27		0.01	0.12	0.23
Combined		0			0.02			0.11			0.07			0.10		0.01	0.04	0.06

B--Biomass

	Month																
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			1.33			0.29	
C		0			0			<u>3.37</u>			0			0			0.74	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			<u>3.37</u>			<u>3.37</u>			<u>10.55</u>			3.77	
H		na			na			na			0			na				
I		0			0.28			0			2.47			4.23			1.54	
Combined		0			0.04			0.83			0.73			1.97		0.11	0.47	0.82

Table C-16. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of carp (*Cyprinus carpio*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8		8		8		8	282.8	36	600.0
C	1		2		2	141.4	2		2		9	300.0
D	1		2		2		2		2		9	
E	2		6		6		6		6		26	
F	1		6		6		6		6		25	
G	na		2		2	141.4	2	141.4	2	141.4	8	150.0
H	na		na		na		1		na			
I	2		4	200.0	4		4	200.0	4	115.5	18	192.5
Combined	15		38	282.8	38	185.2	39	217.9	38	175.5	167	436.6

Table C-17. Number (A) and biomass (B) of golden shiner (*Notemigonus crysoleucas*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0		0.15	0.39	0.63		0.17			0.50			0.12		0.18	0.50	0.82
B		0			0.50		0.17	0.61	1.05	0.85	2.76	4.69	0.22	0.61	1.00	0.50	0.99	1.49
C		0			0			0			3.06			0.44			0.77	
D		0			0			0			0			0			0	
E		0			1.34			1.08			0			0.55			0.67	
F		0			0			0			0.41			0			0.09	
G		na			0			0			0.44			0.44			0.20	
H		na			na			na			2.67			na				
I		0.27			1.33		0.06	1.60	3.16		0.13			0.13		0.28	0.74	1.19
Combined		0.04			0.44			0.43			0.91		0.09	0.42	0.76	0.38	0.57	0.77

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0		0.18	3.19	6.29		1.03			3.33			2.30		0.91	2.18	3.47
B		0			5.03		0.57	3.10	5.69	0.90	5.18	9.64		4.27		2.07	3.89	5.75
C		0			0			0			5.01			0.89			1.29	
D		0			0			0			0			0			0	
E		0			2.52			2.10			0			0.82			1.20	
F		0			0			0			1.37			0			0.30	
G		na			0			0			1.50			3.49			1.10	
H		na			na			na			3.89			na				
I		2.61			3.99		0.29	1.33	2.38		0.17			0.13		0.48	1.53	2.59
Combined		0.37			1.83			0.94		0.26	2.05	3.87	0.10	1.48	2.87	1.26	1.84	2.42

Table C-18.—Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of golden shiner (*Notemigonus crysoleucas*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8	66.4	8	138.0	8	134.4	8	99.0	36	187.5
B	4		8	115.5	8	73.0	8	66.3	8	57.0	36	147.1
C	1		2		2		2	141.4	2	141.4	9	259.7
D	1		2		2		2		2		9	
E	2		6	244.9	6	244.9	6		6	154.9	26	297.3
F	1		6		6		6	244.9	6		25	519.6
G	na		2		2		2	141.4	2	141.4	8	198.4
H	na		na		na		1		na			
I	2	141.4	4	47.6	4	38.4	4	200.0	4	200.0	18	123.4
Combined	15	264.6	38	131.1	38	141.7	39	136.5	38	93.9	167	223.9

Table C-19. Number (A) and biomass (B) of emerald shiner (*Notropis atherinoides*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0.42			0			0			0			0			0.01	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0.06			0			0			0			0			0.00	

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0.30			0			0			0			0			0.04	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0.04			0			0			0			0			0.00	

Table C-20. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of emerald shiner (*Notropis atherinoides*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8		8		8		8		36	
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6		26	
F	1	-	6		6		6		6		25	600
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15	264.6	38		38		39		38		167	1292.3

Table C-21. Number (A) and biomass (B) of common shiner (*Notropis cornutus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0.06			0.11			0			0.17			0.07	
B		0			0			0			0			0.39			0.09	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0.28			0.06	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0.01			0.03			0			0.10		0.01	0.04	0.08

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0.03			0.67			0			0.88			0.35	
B		0			0			0			0			0.61			0.13	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			2.84			0.62	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0.00			0.08			0			0.54			0.20	

Table C-22. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of common shiner (*Notropis cornutus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8	282.8	8	282.8	8		8	191.4	36	304.2
B	4		8		8		8		8	185.8	36	422.6
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6	244.9	26	519.6
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15		38	282.8	38	282.8	39		38	149.3	167	532.1

Table C-23. Number (A) and biomass (B) of blacknose shiner (*Notropis heterolepis*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0.28			0.06	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			0			0			0.04			0.01	

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0.55			0.12	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			0			0			0.08			0.02	

Table C-24. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of blacknose shiner (*Notropis heterolepis*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8		8		8		8		36	
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6	244.9	26	519.6
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15		38		38		39		38	264.6	167	1292.3

Table C-25. Number (A) and biomass (B) of spottail shiner (*Notropis hudsonius*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A	0.83	1.33	1.84		0.28			0			0			0		0.04	0.21	0.38
B	1.25	2.07	2.90		0			0			0			0			0.09	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		1.02			3.55			0.55			0			0		0.04	0.90	1.76
F		2.08			6.51			0.62			0			0			1.55	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0.27			0			0			0			0			0.03	
Combined	0.03	0.80	1.57		1.27			0.15			0			0		0.08	0.49	0.90

B--Biomass

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		3.55			0.54			0			0			0		0.02	0.51	1.00
B	0.15	0.80	2.72		0			0			0			0			0.16	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		1.05			6.25			2.84			0			0		0.10	1.99	3.92
F		3.80			12.69			0.25			0			0			2.75	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0.54			0			0			0			0			0.06	
Combined		1.47			2.35			0.38			0			0		0.15	0.95	1.75

Table C-26. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of spottail shiner (*Notropis hudsonius*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4	15.3	8	203.8	8		8		8		36	245.2
B	4	38.5	8		8		8		8		36	324.5
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2	141.4	6	87.5	6	244.9	6		6		26	240.2
F	1		6	166.0	6	160.8	6		6		25	401.2
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2	141.4	4		4		4		4		18	424.3
Combined	15	96.1	38	188.3	38	185.6	39		38		167	547.1

Table C-27. Number (A) and biomass (B) of rosyface shiner (*Notropis rubellus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0.51			0			0			0			0			0.02	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		<u>0.68</u>			0			0			0.55			0			0.12	
F		0.42			0			0			0			0			0.02	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0.19			0			0			0.07			0			0.04	

B--Biomass

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0.50			0			0			0			0			0.03	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		<u>1.68</u>			0			0			1.71			0			0.38	
F		0.82			0			0			0			0			0.05	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0.39			0			0			0.21			0			0.09	

Table C-28. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of rosyface shiner (*Notropis rubellus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4	200.0	8		8		8		8		36	600.0
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2	141.4	6		6		6	244.9	6		26	519.6
F	1		6		6		6		6		25	600.0
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15	143.2	38		38		39	282.8	38		167	796.8

Table C-29. Number (A) and biomass (B) of sand shiner (*Notropis stramineus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.66			0			0.15	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			5.12			6.68		0.15	2.58	5.06
F		0			0			0			15.73			0.21			3.35	
G		na			0			0			0			0			0	
H		na			na			na			1.33			na				
I		0			0			0			0			0			0	
Combined		0			0			0			2.56			0.84		0.13	0.98	1.84

B--Biomass

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			1.30			0			0.29	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			7.82			18.12			5.52	
F		0			0			0			16.56			0.61			3.61	
G		na			0			0			0			0			0	
H		na			na			na			0.69			na				
I		0			0			0			0			0			0	
Combined		0			0			0			3.07			2.18		0.25	1.51	2.80

Table C-30. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of sand shiner (*Notropis stramineus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8	152.9	8		36	385.9
B	4		8		8		8		8		36	
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6	87.1	6	156.4	26	237.4
F	1		6		6		6	155.9	6	244.9	25	369.2
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15		38		38		39	204.4	38	273.0	167	568.8

Table C-31. Number (A) and biomass (B) of fathead minnow (*Pimephales promelas*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0.06			0			0.01	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			0			0.01			0			0.00	

B--Biomass

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0.01			0			0.01	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			0			0.00			0			0.00	

Table C-32. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of fathead minnow (*Pimephales promelas*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8		8		8	282.8	8		36	600.0
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6		26	
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15		38		38		39	282.8	38		167	1292.3

Table C-33. Number (A) and biomass (B) of fallfish (*Semotilus corporalis*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0.28			0			0			0.06	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			0.03			0			0			0.01	

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			2.08			0			0			0.46	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0			0			0	
Combined		0			0			0.26			0			0			0.07	

Table C-34. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of fallfish (*Semotilus corporalis*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8		8		8		8		36	
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6	244.9	6		6		26	519.6
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15		38		38	282.8	39		38		167	1292.3

Table C-35. Number (A) and biomass (B) of brown bullhead (*Ictalurus nebulosus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0.22		0.02	0.22	0.42	0.31	1.05	1.80	0.10	0.44	0.79	0.10	0.20	0.31	0.52	0.86	1.20
B	2.08	4.45	6.87	0.07	0.33	0.60		0.17		0.39	0.67	0.95		0.39		0.30	0.55	0.81
C		0			1.78			0			0			0			0.39	
D		0			0			0			4.16			0			0.91	
E		0			0			0			0.55			0			0.12	
F		0.42			0			0		0.08	1.65	3.25		0.21		0.03	0.41	0.79
G		na			0			0			0.44			0.44			0.20	
H		na			na			na			0			na				
I		2.13		1.08	3.85	6.71		0			0.53			1.86		0.77	1.62	2.47
Combined		0.66			0.77			0.15			1.05			0.62		0.48	0.65	0.81

B--Biomass

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		27.53		5.03	60.09	144.01	76.4	302.98	820.55	34.4	119.3	257.6	288.0	505.9	846.3	107.6	176.25	267.65
B	58.59	85.74	103.75	13.98	77.71	177.10		46.62		123.0	209.0	328.1		67.83		69.4	109.44	159.01
C		0			512.48			0			0			0			49.59	
D		0			0			0			1668.05			0			89.33	
E		0			0			0			73.25			0			12.99	
F		83.63			0			0		29.0	373.8	1640.4		31.84		5.76	50.25	113.46
G		na			0			0			381.89			79.26			34.98	
H		na			na			na			0			na				
I		493.20		383.01	116.8	2965.5		0			151.88		105.2	502.8	1671.3	131.8	288.70	551.68
Combined		79.20			97.08			24.86		44.45	194.57	500.68		89.72		73.74	98.62	127.06

Table C-36. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of brown bullhead (*Ictalurus nebulosus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4	200.0	8	106.9	8	69.9	8	73.2	8	29.2	36	117.7
B	4	47.6	8	87.5	8	138.0	8	31.1	8	125.1	36	134.8
C	1		2		2	0.0	2		2		9	198.4
D	1		2		2		2	16.4	2		9	203.3
E	2		6		6		6	154.9	6		26	360.3
F	1		6		6		6	83.4	6	244.9	25	234.9
G	na		2		2		2	141.4	2	141.4	8	198.4
H	na		na		na		1		na			
I	2	0.0	4	22.9	4		4	73.4	4	32.7	18	105.3
Combined	15	140.1	38	178.3	38	241.6	39	125.6	38	136.3	167	167.6

Table C-37. Number (A) and biomass (B) of banded killifish (*Fundulus diaphanus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0.11			0			0			0.02	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0.28			0.06	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0.27			0			0			0.27			0			0.09	
Combined		0.04			0			0.01			0.03			0.03		0.00	0.02	0.05

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0			0	
B		0			0			0.23			0			0			0.05	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			1.08			0.24	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0.30			0			0			0.20			0			0.08	
Combined		0.04			0			0.02			0.03			0.13			0.06	

Table C-38. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of banded killifish (*Fundulus diaphanus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8		36	
B	4		8		8	185.2	8		8		36	418.2
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6	244.9	26	519.6
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2	141.4	4		4		4	115.5	4		18	230.1
Combined	15	264.6	38		38	282.8	39	282.8	38	282.8	167	616.1

Table C-39. Number (A) and biomass (B) of bluegill (*Lepomis macrochirus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0.06			0			0.06			0.02	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0.82			0.18	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			1.33			0.27			0.09	
Combined		0			0			0.01			0.02			0.14			0.04	

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0.76			0			0.28			0.23	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			1.63			0.36	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0.32			0.40			0.16	
Combined		0			0			0.09			0.04			0.29		0.01	0.12	0.24

Table C-40. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of bluegill (*Lepomis macrochirus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8	282.8	8		8	282.8	36	418.2
B	4		8		8		8		8		36	
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6	160.8	26	380.0
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4	200.0	4	115.5	18	230.1
Combined	15		38		38	282.8	39	282.8	38	202.3	167	662.7

Table C-41. Number (A) and biomass (B) of smallmouth bass (*Micropterus dolomieui*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0.06			0.01	
B		0			0			0			0			0.07			0.01	
C		0			0			0			0			0.44			0.10	
D		0			0			0			0			0			0	
E		0			0			0			0.28			1.92			0.48	
F		0			0			0			0.21			0.21			0.09	
G		na			0			0			0.44			0.44			0.2-	
H		na			na			na			0			na				
I		0.80			0.27			0			0			0			0.15	
Combined		0.16			0.03			0			0.12			0.39		0.05	0.13	0.22

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0			0.55			0.12	
B		0			0			0			0			2.63			0.58	
C		0			0			0			0			0.89			0.20	
D		0			0			0			0			0			0	
E		0			0			0			1.32			15.60			3.58	
F		0			0			0			0.57			3.26			0.84	
G		na			0			0			1.53			1.76			0.73	
H		na			na			na			0			na				
I		105.87			34.34			0			0			0			15.70	
Combined		26.85			4.83			0			0.42			2.98		0.64	3.62	6.70

Table C-42. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of smallmouth bass (*Micropterus dolomieui*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8		8	282.8	36	600.0
B	4		8		8		8		8	282.8	36	600.0
C	1		2		2		2		2	141.4	9	300.0
D	1		2		2		2		2		9	
E	2		6		6		6	244.9	6	111.0	26	261.2
F	1		6		6		6	244.9	6	244.9	25	360.3
G	na		2		2		2	141.4	2	141.4	8	198.4
H	na		na		na		1		na			
I	2	32.0	4	200.0	4		4		4		18	240.8
Combined	15	189.1	38	282.8	38		39	149.0	38	164.5	167	423.3

Table C-43. Number (A) and biomass (B) of largemouth bass (*Micropterus salmoides*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.22		0.13	0.61	1.10	0.04	0.18	0.32
B		0			0			0.06			0.44		0.12	0.55	0.99	0.08	0.23	0.40
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0.28			0			0.06	
F		0			0			0			0			0			0	
G		na			0			0			<u>0.44</u>			<u>0.89</u>			0.29	
H		na			na			na			0			na				
I		0			0			0			0.13			0			0.03	
Combined		0			0			0.01		0.03	0.19	0.35		0.26		0.06	0.12	0.17

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			4.20			8.65		0.43	2.80	5.22
B		0			0			0.46			6.40		0.13	7.89	16.25	0.75	3.22	5.76
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			9.42			0			2.02	
F		0			0			0			0			0			0	
G		na			0			0			<u>5.01</u>			<u>9.95</u>			3.20	
H		na			na			na			0			na				
I		0			0			0			2.73			0			0.60	
Combined		0			0			0.06		0.60	3.43	6.34		3.20		0.84	1.85	2.87

Table C-44. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of largemouth bass (*Micropterus salmoides*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8	198.4	8	88.2	36	224.8
B	4		8		8	282.8	8	130.2	8	87.4	36	204.5
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6	244.9	6		26	519.6
F	1		6		6		6		6		25	
G	na		2		2		2	141.4	2	141.4	8	212.0
H	na		na		na		1		na			
I	2		4		4		4	200.0	4		18	424.3
Combined	15		38		38	282.8	39	99.3	38	142.8	167	303.9

Table C-45. Number (A) and biomass (B) of black crappie (*Pomoxis nigromaculatus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.06			0			0.12	
B		0.26			0			0.06			0			0			0.02	
C		0.89			0			0			0			0			0.10	
D		0			0			0			0			0			0	
E		0			0.28			0			0			0			0.06	
F		0			0			0			0			0.21			0.05	
G		na			0			<u>0.44</u>			0			<u>0.44</u>			0.20	
H		na			na			na			<u>1.33</u>			na				
I		0			0			1.33			0.80			0.27		0.04	0.27	0.49
Combined		0.14			0.03			0.08			0.11			0.11		0.03	0.07	0.11

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			10.54			0			2.25	
B		12.52			0			5.18			0			0			1.79	
C		<u>100.43</u>			0			0			0			0			8.03	
D		0			0			0			0			0			0	
E		0			2.25			0			0			0			0.50	
F		0			0			0			0			0.81			0.18	
G		na			0			<u>2.33</u>			0			<u>1.33</u>			0.81	
H		na			na			na			<u>3.20</u>			na				
I		0			0			0.91			11.25			0.79			2.78	
Combined		11.38			0.27			1.04			2.73			0.37		0.29	1.74	3.22

Table C-46. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of black crappie (*Pomoxis nigromaculatus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8	282.8	8		36	600.0
B	4	200.0	8		8	282.8	8		8		36	418.2
C	1		2		2		2		2		9	300.0
D	1		2		2		2		2		9	
E	2		6	244.9	6		6		6		26	519.6
F	1		6		6		6		6	244.9	25	519.6
G	na		2		2	141.4	2		2	141.4	8	198.4
H	na		na		na		1		na			
I	2		4		4	200.0	4	66.7	4	200.0	18	171.5
Combined	15	232.0	38	282.8	38	195.7	39	262.4	38	149.5	167	371.8

Table C-47. Number (A) and biomass (B) of logperch (*Percina caprodes*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.11			0			0.02	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0.13			0			0.03	
Combined		0			0			0			0.03			0			0.01	

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.34			0			0.07	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0			0	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0.32			0			0.07	
Combined		0			0			0			0.08			0			0.02	

Table C-48. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of logperch (*Percina caprodes*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8	185.2	8		36	418.2
B	4		8		8		8		8		36	
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6		26	
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4	200.0	4		18	424.3
Combined	15		38		38		39	186.2	38		167	744.5

Table C-49. Number (A) and biomass (B) of darters, composed of two species, johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi),* in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.06			0.44		0.01	0.16	0.31
B		0			0			0			0.06			0.22		0.01	0.09	0.16
C		3.56			0.89			0.44			0			0			0.69	
D		0			0			0			0			0			0	
E		0			0.28			0.11		0.21	1.10	2.01		1.36		0.22	0.85	1.48
F		0.42			0.62			0			0			0			0.13	
G		na			0.44			0			0			0			0.10	
H		na			na			na			2.67			na				
I		0			0.13			0			1.71			1.73		0.10	0.79	1.49
Combined		0.56		0.02	0.29	0.57		0.19			0.41			0.47		0.20	0.34	0.48

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.16			1.10		0.07	0.44	0.81
B		0			0			0			0.08			0.83		0.01	0.34	0.66
C		6.52			0.76			0.66			0			0			1.02	
D		0			0			0			0			0			0	
E		0			0.44			1.90		0.11	1.34	2.58		2.15		0.34	1.29	2.25
F		0.48			1.27			0			0			0			0.28	
G		na			0.26			0			0			0			0.06	
H		na			na			na			7.45			na				
I		0			0.27			0			4.11		0.60	2.66	4.76	0.05	1.55	3.07
Combined		0.98		0.00	0.37	0.75		0.32			0.88			0.84		0.39	0.65	0.91

Table C-50. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of darters, composed of two species, johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi*), in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8	151.2	8	130.2	36	273.5
B	4		8		8		8	191.4	8	143.8	36	269.8
C	1		2	0.0	2	141.4	2		2		9	166.5
D	1		2		2		2		2		9	
E	2		6	244.9	6	167.3	6	77.5	6	172.3	26	186.6
F	1		6	160.8	6		6		6		25	381.0
G	na		2	141.4	2		2		2		8	300.0
H	na		na		na		1		na			
I	2		4	200.0	4		4	96.3	4	37.9	18	176.3
Combined	15		38	112.1	38	205.9	39	158.8	38	146.7	167	270.4

Table C-51. Number (A) and biomass (B) of brook silversides (*Labidesthes sicculus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.11			0.06			0.04	
B		0.26			0			0			0.06			0.06			0.04	
C		0			0			0			0			0			0	
D		0			0			0			0.83			0			0.18	
E		0			0			0			0.28			0.28			0.12	
F		0			0			0			0			0.21			0.05	
G		na			0			0			0.44			0.44			0.20	
H		na			na			na			2.67			na				
I		0			0			0			0			0			0	
Combined		0.02			0			0			0.21			0.13		0.02	0.06	0.10

B--Biomass

	Month															Combined		
	June			July			August			September			October					
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.14			0.06			0.04	
B		0.21			0			0			0.08			0.06			0.04	
C		0			0			0			0			0			0	
D		0			0			0			1.56			0			0.34	
E		0			0			0			0.47			0.55			0.22	
F		0			0			0			0			0.21			0.05	
G		na			0			0			0.79			0.89			0.37	
H		na			na			na			2.97			na				
I		0			0			0			0			0			0	
Combined		0			0			0			0.38			0.22		0.03	0.10	0.17

Table C-52. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of brook silversides (*Labidesthes sicculus*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8	185.2	8	282.8	36	336.4
B	4	200.0	8		8		8	282.8	8	282.8	36	336.4
C	1		2		2		2		2		9	
D	1		2		2		2	141.4	2		9	300.0
E	2		6		6		6	241.9	6	244.9	26	360.3
F	1		6		6		6		6	244.9	25	519.6
G	na		2		2		2	141.4	2	141.4	8	198.4
H	na		na		na		1		na			
I	2		4		4		4		4		18	
Combined	15	264.6	38		38		39	137.5	38	126.1	167	418.8

Table C-53. Number (A) and biomass (B) of mottled sculpin (*Cottus bairdi*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. Geometric means and 95% confidence limits are provided where catches and biomass were significantly >0; if replication was adequate but catch and biomass were not significantly >0, then only the mean is provided; if replication was not adequate to provide confidence limits, only the underlined mean is provided. 0 indicates no catch, na indicates survey not conducted, and 0.00 indicates a value >0 but <0.01. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses. Number--$N \cdot 100m^{-2}$. Biomass--$g \cdot 100m^{-2}$.

A--Number

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.06			0			0.01	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0.28			0.06	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0.27			0.27		0.01	0.12	0.23
Combined		0			0			0			0.04			0.06		0.00	0.03	0.05

B--Biomass

	Month																	
	June			July			August			September			October			Combined		
Area	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%	L95%	$\bar{x}$	U95%
A		0			0			0			0.16			0			0.04	
B		0			0			0			0			0			0	
C		0			0			0			0			0			0	
D		0			0			0			0			0			0	
E		0			0			0			0			0.55			0.12	
F		0			0			0			0			0			0	
G		na			0			0			0			0			0	
H		na			na			na			0			na				
I		0			0			0			0.67			1.19			0.41	
Combined		0			0			0			0.10			0.19		0.01	0.07	0.13

Table C-54. Number of replicates (*N*) and sampling variability, expressed as the coefficient of variation (CV), of the catch of mottled sculpin (*Cottus bairdi*) in the littoral zone of the upper St. Lawrence River, Johnstown, Ontario, presented by area and month as determined during the 1995 electrofishing survey. The CV was calculated on the geometric mean catch. Combined by month is equally weighted by area. Combined by area and combined overall include all transects. Area H was not used in the combined analyses; na indicates survey not conducted. Blank indicates the species was not caught.

	Month											
	June		July		August		September		October		Combined	
Area	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV	*N*	CV
A	4		8		8		8	282.8	8		36	600.0
B	4		8		8		8		8		36	
C	1		2		2		2		2		9	
D	1		2		2		2		2		9	
E	2		6		6		6		6	244.9	26	519.6
F	1		6		6		6		6		25	
G	na		2		2		2		2		8	
H	na		na		na		1		na			
I	2		4		4		4	115.5	4	115.5	18	192.5
Combined	15		38		38		39	232.2	38	198.5	167	609.6

Table D-1. Catch statistics and biological data for the 12 muskellunge (*Esox maskinongy*) caught in September and October 1995 during the electrofishing survey of the littoral habitat of Johnstown Bay, upper St. Lawrence River. Young-of-the-year--y-o-y. Darters may be of two species--johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi*).

			Source					Stomach contents					
No.	Date	Fish no.	Area	Transect no.	Side	Total length (mm)	Weight (g)	Species	Life stage	Estimated length (mm)	Percent digested	Weight (g)	Comments
1	950921	26	I	13	starboard	177	20.82	johnny darter	yearling	32	60	0.12	
								johnny darter	y-o-y	32	40	0.14	
2	950921	27	I	13	starboard	159	15.35	golden shiner					ID by otolith
3	950921	154	B	8	port	174	19.56	golden shiner	yearling	56	90		
								golden shiner	yearling	56	90		
4	950922	11	I	13	port	156	17.14	golden shiner	yearling	60	0	2.37	
5	950922	41	I	13	starboard	167	18.96	mottled sculpin	juvenile	50	40	1.16	
6	950922	45	I	13	starboard	168	19.8	golden shiner	y-o-y		50	0.93	
								darter	yearling		50	0.93	
7	950922	46	I	13	starboard	158	14.43	golden shiner	y-o-y		30	0.17	
								darter	yearling		30	0.17	
8	951011	17	I	13	port	162	14	brook stickleback	juvenile	30	50	<1	
9	951011	18	I	13	port	204	31						empty
10	951012	37	I	13	starboard	202	33	brook stickleback	juvenile	33	60	<1	
11	951012	38	I	13	starboard	179	22						empty
12	951012	143	B	6	port	189	25	golden shiner	y-o-y	23	70	<1	ID by scales

Table D-2. Stomach contents of 12 young-of-the-year muskellunge (*Esox masquinongy*) caught in September and October during the electrofishing survey of the littoral-zone habitat of Johnstown Bay, upper St. Lawrence River, June to October 1995, indicating the relative occurrence and the average estimated live length and weight, as well as life stage of the prey. Numbers are in parentheses. Young-of-the-year--y-o-y. Darters are of two species--johnny darter (*Etheostoma nigrum*) and tessellated darter (*E. olmstedi*).

Stomach contents	Occurrence (%)		Percent digested	Live estimates		
	Total	Stomachs		Length (mm)	Weight (g)	Life stage
Golden shiner	50 (7)	50 (6)	41	49	1.59	yearling, y-o-y
Darters	29 (4)	33 (4)	55	32	0.75	yearling
Brook stickleback	14 (2)	17 (2)	55	32	1.84	subadult
Mottled sculpin	7 (1)	8 (1)	40	50	2.90	subadult
Empty		17 (2)				
Total	(14)	(12)				