ATLANTIC SALMON AND BROOK TROUT POPULATION AND HABITAT CHARACTERISTICS OF NORTHEAST BROOK, TREPASSEY, NEWFOUNDLAND AND LABRADOR, 1984-96.

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2005

Canadian Technical Report of
Fisheries and Aquatic Sciences No. 2596

Fisheries and Oceans   Pêches et Océans

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

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by

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Cat No. Fs 97-6/2596E ISSN 0706-6457

Correct citation for this publication:

Mitchell, S.C., Scruton, D.A., Cunjak, R.A., and Gibson, R.J. 2005. Atlantic salmon and brook trout population and habitat characteristics of Northeast Brook, Trepassey, Newfoundland and Labrador, 1984-96. Can. Tech. Rep. Fish. Aquat. Sci. 2596: ix + 73 p.

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ABSTRACT

Mitchell, S.C., Scruton, D.A., Cunjak, R.A., and Gibson, R.J. 2005. Atlantic salmon and brook trout population and habitat characteristics of Northeast Brook, Trepassey, Newfoundland and Labrador, 1984-96. Can. Tech. Rep. Fish. Aquat. Sci. 2596: ix + 73 p.

Physical habitat, fish, and water quality sampling in Northeast Brook, Trepassey, on the island of Newfoundland, was conducted as part of the Atlantic Salmon Experimental Rivers Program between 1984 and 1996. The stream drains a small catchment (21.2 km^2) dominated by heathlands with patches of stunted trees, and punctuated by a number of ponds. The hydrology of the system is typical of rain dominated maritime coastal systems. Sampling took place at a variety of spatial and temporal scales over the period of study and included annual physical habitat surveys and fish sampling at established sites, as well as water quality sampling near the mouth of the brook.. Measured physical habitat characteristics of riffles, flats and pools showed that there was considerable variability among replicates within a habitat type. Despite this, Discriminant Function Analysis determined that habitat types, for this brook, may be defined objectively. The water was slightly acidic (mean pH of 5.8-6.8), soft and of low buffering capacity (mean hardness 4.3-8.0 mg/L $CaCO_3$). In general, the stream water peaks at relatively high colour values but low turbidity (max >100 color units; <1 NTU). Nutrient concentrations are low (P or N generally <0.05 mg/L). The fish community is depauperate, consisting of only four species (Atlantic salmon, brook trout, American eel, and three spine stickleback). Juvenile density, weight, growth and biomass of Atlantic salmon and brook trout are described and compared in detail among habitat types and over time. The value of this data set lies in the long term nature of the monitoring and the spatial scale over which it was conducted. This information will be very valuable for applied and academic facets of fisheries management, and understanding biotic/abiotic influences on salmonid production dynamics.

RÉSUMÉ

Mitchell, S.C., Scruton, D.A., Cunjak, R.A., and Gibson, R.J. 2005. Atlantic salmon and brook trout population and habitat characteristics of Northeast Brook, Trepassey, Newfoundland and Labrador, 1984-96. Can. Tech. Rep. Fish. Aquat. Sci. 2596: ix + 73 p.

L'habitat physique, les populations de poissons et l'eau ont été échantillonnés dans le ruisseau Northeast, à Trepassey, sur l'île de Terre-Neuve, dans le cadre du programme de rivières expérimentales à saumon atlantique entre 1984 et 1996. Ce ruisseau alimente un petit bassin versant (21,2 km^2) dominé par des landes comptant des îlots d'arbres rabougris et un certain nombre d'étangs. Le régime hydrologique du ruisseau est typique des écosystèmes côtiers dominés par les pluies. L'échantillonnage a été mené à diverses échelles spatio-temporelles au cours de la période d'étude et a consisté en des relevés annuels de l'habitat physique, en un échantillonnage de poissons à des sites établis et en un échantillonnage de l'eau afin d'en déterminer la qualité près de l'embouchure du ruisseau. Les caractéristiques physiques mesurées des rapides, des fosses et des tronçons d'eau calme (habitat) montrent qu'il existe une variation considérable entre les réplicats au sein d'un même type d'habitats. Malgré cela, une analyse discriminante nous a permis d'établir que les types d'habitats pour ce ruisseau peuvent être définis avec objectivité. L'eau est douce, légèrement acide (pH moyen de 5,8 à 6,8) et caractérisée par un faible pouvoir tampon (dureté moyenne de 4,3 à 8,0 mg/l $CaCO_3$). En général, l'eau du ruisseau peut atteindre des valeurs de couleur relativement élevées, mais elle est caractérisée par une faible turbidité (maximum > 100 unités de couleur; < 1 uTN). La teneur en éléments nutritifs est faible (concentrations de P ou de N généralement < 0,05 mg/l). L'ichtyofaune est pauvre et est constituée de seulement quatre espèces (saumon atlantique, omble de fontaine, anguille d'Amérique et épinoche à trois épines). La densité, le poids, la croissance et la biomasse des saumons atlantiques et des ombles de fontaine juvéniles sont décrits et analysés en détail en fonction du type d'habitats et au fil du temps. La valeur de ce jeu de données réside dans la nature à long terme de la surveillance et l'échelle spatiale de l'étude. Ces données seront très utiles pour les aspects appliqués et académiques de la gestion des pêches et pour comprendre les effets biotiques et abiotiques sur la dynamique de la production de salmonidés.

INTRODUCTION

Intensive fish and habitat sampling was conducted within Northeast Brook, Trepassey, a catchment in insular Newfoundland between 1984 and 1996 as part of the large scale Atlantic Salmon Experimental Rivers Program (ASERP). This program was initiated in 1984 with the objectives to: (1) determine the egg deposition required by a spawning stock of Atlantic salmon (*Salmo salar*) to optimize smolt production; (2) develop a model to estimate the Atlantic salmon and brook trout production capacity of streams; and, (3) develop a stock-recruitment relationship from egg to smolts (Porter et al. 1984). Northeast Brook served as the control stream for experimental manipulation of nearby Freshwater Brook between 1984 and 1996. This manipulation involved experimentally altering the spawner escapement, and so also egg deposition, to address the goals of ASERP (Gibson and O'Connell 1995).

Sampling was completed in 1996, with the amassed data having not been fully exploited. Several in-house analyses and reports have been generated (e.g., Talbot undated; Talbot and Gibson 1990; Talbot et al. 1990), and parts of the available data presented in secondary publications (e.g., Gibson 1990; 1991; Dempson et al. 1994; O'Connell et al. 2001) and two primary publications (Scruton and Gibson 1993; Gibson et al. 1993). The data, however, have not yet been analyzed with the intent of meeting Objective 2 of the ASERP. The purpose of preparing this technical report is two-fold: (*i*) to carefully summarize, examine and prepare the data prior to modelling, and (*ii*) to encourage other researchers/users to take advantage of this largely untapped, extensive data set.

This report summarizes physical habitat and water chemistry data of Northeast Brook, Trepassey, and the attributes (i.e. abundance, size-at-age, weight, growth and biomass) of the Atlantic salmon and brook trout (*Salvelinus fontinalis*) populations of the stream over the period 1984-96.

STUDY AREA

Northeast Brook, Trepassey, drains a small catchment (area 21.2 km^2; Dempson et al. 1994) located on the southern tip of the Avalon Peninsula, of insular Newfoundland (Fig. 1). The brook is a third order stream with a mainstem length of approximately 9.4 km, of which the upper 4.0 km are identified as intermittent at the 1:50,000 scale.[1] The stream drains in a south-southwest direction directly into Northeast Arm of Trepassey Bay at 46°46'N, 53°21'W (Gibson et al. 1993; Hiscock et al. 2002), and includes nine tributaries, several which are intermittent, resulting in a drainage density of 1.72 km/km^2. Several ponds punctuate the drainage, of which the largest are Millers, Three Corner, Beaver, Gall, Doctors, and an unnamed pond in the western part of the drainage (Fig. 1). Millers Pond is likely to be the most significant in terms of buffering extreme flows and sediment transport as it sits directly on the mainstem, while the others are associated with the tributaries. The surrounding terrain is relatively low relief with the steepest slopes on

[1] National Topographic Survey Map # 1 K/14. Biscay Bay River.

the order of 15% and the highest points in the basin reaching about 170 m. The brook drops from an elevation of approximately 150 m in the headwaters to 0 m at the mouth (Fig. 2). Based on the gradient breaks evident in Figure 2, and the presence of Millers Pond, three reaches of the mainstem have been delineated for this stream (Fig. 2 and 3, Table 1).

Two of the numerous ponds – Millers and Three Corner – have been briefly described by Erkinaro and Gibson (1997). Millers Pond, at an elevation of ~20 m asl, has a surface area of 7.6 ha, mean depth of 3.8 m, maximum depth of 9.5 m, and total shoreline length of 1,120 m. Three Corner Pond (elevation ~30 m asl), with a surface area of 5.0 ha, has a mean depth of 3.0 m, maximum depth of 6.6 m and total shoreline length of 970 m.

The bedrock geology of the drainage basin is composed of two formations of Hadrynian age (i.e. late Precambrian, about 600 to 900 million years before present) – the Briscal Formation and the Drook Formation (Williams and King 1979). These formations contain rock of volcanic and sedimentary origin. The Briscal Formation, lying along the eastern side and extending across the southern portion of the basin, is composed of sandstone, siltstone, shale and argillite. The Drook Formation, within the west and northwest portion of the basin, is also composed of sandstone, siltstone, and argillite, but additionally contains chert and tuff (Williams and King 1979). There are no economic mineral deposits within the basin. The soils are classified under five series, three of which are Ferro-Humic Podzols (Biscay Bay, St. Stephens, and Bauline), one Humo-Ferric Podzol (Pouch Cove), and one Organic soil (Heringa 1981). Soil drainage varies from poor (Organic and Biscay Bay soils), through moderate (Pouch Cove and St. Stephens soils). The Bauline soils are well- to rapidly-drained (Heringa 1981).

The climate of the area is dominated by cool summers and mild winters (Fig. 4a), and relatively constant rainfall throughout the year (Fig. 4b). Winters are characterized by relatively little snow accumulation, with most of this occurring in December and January. The mean annual daily air temperature is 4.5°C and mean annual precipitation is 1,401.4 mm (as rain) and 111.5 cm (as snow) (Anonymous 2005). There are, on average, 150.7 days with rain in a year, and 16.8 with snow. The area is classified as Oceanic Low Boreal Ecoclimatic Region of the Boreal Ecoclimatic Province (Anonymous 1989).

In terms of forest type, the basin lies within the Southeastern Barrens Subregion of the Maritimes Barren Ecoregion nested in the Boreal Shield Ecozone (Anonymous 2004). In this forest type, the landscape is dominated by heathlands with forested areas only occurring in those areas that have escaped fire in the past. The forest is primarily of balsam fir (*Abies balsamea*), but also with isolated stands of black spruce (*Picea mariana*), tamarack (*Larix laricina*) and yellow birch (*Betula alleghaniensis* = *B. lutea*). The heathland is composed principally of sheep laurel (*Kalmia angustifolia*), crowberry (*Empetrum nigrum)*, ericaceous shrubs and sphagnum moss, and occupies large tracts of flat bogs (Anonymous 2003, 2004).

The hydrological regime of Northeast Brook is typical of rain dominated coastal systems with the occurrence of frequent short duration rainfall events throughout the year. Unfortunately, a stage-discharge relationship has not been determined for Northeast Brook and so discharge in terms of m^3/s remains undocumented. Figure 5 illustrates three representative hydrographs (using water level rather than discharge) of Northeast Brook between April and October. Figure 6 provides an approximate annual hydrograph of discharge. This latter figure is constructed by pro-rating the recorded discharge of the nearby St. Shotts River in order to estimate the hydrology of Northeast Brook. There appears to be a spring freshet peak(s) that is not revealed in the water level data from Northeast Brook; this is suggestive that there are likely significant winter and spring events that remain unrecorded in the Northeast Brook hydrology data. Future work should include comparing the truncated annual Northeast Brook data with the more complete discharge data from nearby St. Shotts station.

Northeast Brook is the water supply for the town of Trepassey, and thus disturbance within the basin has been very limited. The existing road/trail density is estimated at 0.40 km/km^2 (i.e. ~8.2 km of road/trail within the basin). The brook has been closed to recreational angling since ASERP sampling was initiated in 1984 (O'Connell et al. 2001).

Intensive fish sampling within Northeast Brook has yielded only four fish species – Atlantic salmon, brook trout, American eel (*Anguilla rostrata*), and three spine stickleback (*Gasterosteus aculeatus*). There are no obvious obstructions to fish movement within the system, though there is a small falls at the stream mouth which can be an impediment during very high or low flows. This falls may prevent access by brown trout (*Salmo trutta*) into Northeast Brook; this is a species known to occur in adjacent drainages (Northwest Trepassey and Stoney Brook) as well as with the estuary of Northeast brook (K. Clarke, Habitat Research Biologist, Department of Fisheries and Oceans, St. John's, Newfoundland, personal communication). A fish counting fence has been in operation near the mouth of the brook since 1984 (Fig. 3).

MATERIALS AND METHODS

SAMPLING REGIME AND METHODOLOGY

For the purposes of this document, the watercourse of Northeast Brook has been divided into six 'segments' based on gradient (from Fig 2), presence of ponds, and sampling of tributaries. These segments are: three reaches on the mainstem (Lower, Middle, Upper; see Table 1; Fig 3), two principal tributaries, and Millers Pond. These divisions, though somewhat arbitrary, are characterized and described in Table 1. The number of sample sites ranged from one to ten sites per segment with the Lower Reach receiving the most intense sampling (six riffles, two flats, and one each of run and pool;[2] Table 2). The Middle Reach included seven sample sites (three riffles, three flats and a pool). The Upper Reach and two tributaries shared six sample sites (four riffles, a flat and a pool) among them. Summing the lengths of these sample sites indicates that collectively these sites represent approximately 5% of the mainstem length and 1% of the length of the two tributaries.

Physical Habitat Sampling

Physical habitat surveys at each site (from Table 2) were conducted at various levels of temporal intensity among the different sites. Annual surveys in each of the 13 years of record were conducted at five sites (LRI1, LFL2, LP1, MRI1, Trib1RI1) while all other sites were evaluated between one and eleven times over the 13 years (Table 3). Habitat surveys occurred within the month of June (2 years) or July (5 years) or took place over more protracted two month (July and August; 5 years) or three month (June-August; 1 year) periods. Physical habitat variables sampled were water velocity, cover, and substrate. The following description is from Gibson (1990): mean water velocity (at 0.6 of the depth) was measured at distances 0.25, 0.5, and 0.75 of distance along transects used for measuring stream width. Cover (instream, overhanging, and canopy) was estimated visually and recorded as percentage of total area. The substrate of each site and sampling period was classified by visually estimating the proportion of seven substrate classes.[3] A system of rating the substrate was used to summarize these proportional estimates into a single value to characterize the substrate. This was done by multiplying the estimated proportion by the following rating scores: flat bedrock and fines = 1, gravel = 2, pebble = 3, cobble = 4, rubble = 5, boulder = 6, irregular convoluted bedrock = 7, and summing the derived scores.

Water level (cm) was continuously recorded near the mouth of the brook from April to October between 1984 and 2000 (only 1984 to 1996 reported here). The dates of initiating and terminating recording water levels varied among years with recording beginning between April 13 (1987) and June 19 (1984) and ending between August 30 (1995) and October 14 (1987).

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[2] Cunjak et al. (1993) defines: *Flats are typically long, wide, slow-flowing sections of the stream with a nearly homogenous substrate of small-medium particle sizes throughout the area; they have a very gentle slope with an unbroken (smooth) water surface. Riffles are shallow, fast-flowing sections of stream with a relatively shallow depth, marked gradient, a broken (turbulent) water surface and heterogenous substrate often with significant amounts of rubble and boulder. The runs are intermediate to flats and riffles and are characterized by heterogenous flow patterns and substrate sizes, are usually deeper than riffles and shallower than flats.... Pools, like flats, are slow-flowing stream section, but unlike the former are more depositional in character with an obvious reduction in mean water velocity relative to adjacent habitat types; this is reflected in the predominant particle sizes of the substrate which include significant amount of sands and fines (silt). In general, pools have negligible slopes and the greatest average depth of all habitat-types* (p2).

[3] Substrate classes are Flat Bedrock and Fines (material <2.0 mm), Gravel (2.0-16.0 mm), Pebble (1.6-6.0 cm), Cobble (6.5-15.0 cm), Rubble (15.0-25.0 cm), Boulder (>25.0 cm), and Irregular Convoluted Bedrock.

Water Quality Sampling

Water quality was sampled less frequently than physical habitat. At most sites sampling was intermittent between 1984 and 1992 (Table 4) and predominately during the months of July and August. Sampling did not take place from 1993-95 and was limited in 1996. Two sites (LRI1, Trib1RI1), however, have been sampled quite consistently over time (10 of 13 years). Site LRI1 and a water quality sampling site established at the site of the fish counting fence (Site 1) were sampled intensively within selected years (e.g., 3-9 months within a year) as well as among years. Water quality variables monitored via these point samples were pH (lab and field, only lab reported here as relatively few field measurements made), specific conductance, total alkalinity, total hardness, chloride, magnesium, calcium, total phosphate (organic fraction not filtered out), nitrates, sulphates, turbidity and colour. Analyses were performed by laboratories of Environment Canada on fresh unfiltered samples. Water temperature was monitored using a continuously recording thermograph. However, problems with thermograph operation resulting in only intermittent recording, and that this data is not yet amenable to analysis (still in chart form), precludes its use here. Instead, the daily minimum and maximum water temperatures (as presented in O'Connell et al. 2001), with mean temperature approximated as the midpoint between these extremes, are utilized in this document.

Fish Sampling

During the period of 1984 to 1996, the sites listed in Table 2 were sampled. Not all sites were sampled equally over time (Table 5). The most consistently sampled sites were eight riffles (Sites LRI1, LRI5, MRI1, MRI2, MRI3, URI2, Trib1RI1, Trib2RI1,), one pool (Site LP1), three flats (Sites LFL2, MFL1, MFL2), and Millers Pond. Sampling took place in each year between the months of May and September, most commonly during July and August (Table 5). Sampling methodology is detailed in Gibson et al. (1993), but in brief, electrofishing was conducted using upstream and downstream barrier nets, at least four passes being made in an upstream direction through the site, and population estimates calculated using the depletion (removal) method of Zippin (1958). In deeper water (i.e. pools), where the electrofisher was not effective, sampling was also done using a beach seine in addition to the electrofisher. In Millers Pond sampling was via fyke nets and beach seine. In these deeper waters population estimates were made using the Petersen mark-recapture method (pools), or Schnabels multiple mark-recapture method (Millers Pond). Fish were anaesthetized and measured for length (fork length for salmonids; total length for eel and sticklebacks). A subsample of about 10 salmonids from each year class for each site/sampling period were killed for age and sex analysis.

Length-at-age (Appendix 1) was estimated via length frequency analysis (LFA) for each year by pooling the sampled habitat replicates within a stream reach/tributary. Ages of salmon could be discriminated by LFA to age 0+, 1+ and $\geq$2+ and for brook trout as ages 0+, 1+, 2+ and $\geq$3+. Growth was calculated as mean weight for age *i* in year *x* minus age *i-1* in year *x-1* (e.g., age 2+ mean weight in 1994 minus age 1+ in 1993). Biomass was calculated for each age class by multiplying mean weight by estimated density (or abundance for Millers Pond as area not measured precluding calculation of density).

RESULTS AND DISCUSSION

PHYSICAL HABITAT AND WATER QUALITY

Physical Habitat

Within Northeast Brook there were three habitat types recognized by this sampling – riffles, flats, and pools (Millers Pond not sampled for physical habitat). There was a single run (LRU1) but it was only sampled in one year (1984) and so is not considered in this summary. The riffles in Northeast Brook are characterized by relatively rapid water velocity (mean velocity generally > 0.2 m/s), substrate composed of larger material (cobble, rubble, boulder), though this is quite variable, and roughly equal distributions of cover among instream, overhanging and canopy (Table 6; Appendix 2). The variability in mean water velocity for a given site among years (as indicated by standard deviations in Appendix 2) is relatively low, suggesting stability among years. It must be remembered, however, that sampling occurred within a narrow window of time in each year (i.e. July and August) which would represent similar hydrologic conditions. The mean substrate rating for the riffles ranged from 3.9 to 5.3. The riffles LRI1, LRI2 and LRI3 appear to have higher substrate rating (>5.0) than the others (Appendix 2), reflecting the steeper gradient of the Lower Reach in which they are located. Exclusion of these sites yields a lower range of ratings among the remaining ten riffle sites of 3.9 (MRI2) to 4.8 (LRI6). These higher ratings for Sites LRI1 to LRI3 represent greater proportions of boulder (>40%) relative to the other sites (<31%). Mean estimates of cobble and rubble are consistent among riffle sites (cobble 12-35.6%; rubble 21-39.5%). The range of pebble representation among sites is relatively large, due to low values for the sites LRI1 to LRI3 and LRI6 (<6%) compared with the other locations (>10%). Variation in the proportion of the category flat bedrock and fines, and of gravel, is quite low among sites. Irregular convoluted bedrock was not found in any of the sampled sites.

The percent cover is variable among riffle sites with mean instream cover ranging from 1.5 to 36.25%. Eleven of the thirteen sites indicate instream cover of <15%; Sites LRI4 and LRI5 differ from the others in having high estimates of instream cover (>20%; Appendix 2). Overhanging cover ranges from 3.1-27.5% with a more even distribution of cover among sites than the instream class. That is, seven of the 13 sites have overhanging cover of <10%, four sites between 10 and 20% and one site in excess of 20% (Appendix 2). Finally, canopy cover shows a range in estimates similar to instream cover (Table 6). The Middle and Upper reaches generally have a greater preponderance of canopy cover (>15% in four of six sites) while the Lower Reach has consistently <10%. Tributary 1 riffle is intermediate with a canopy cover of 15%.

These data suggest that the riffles LRI1, LRI2 and LRI3 are of different character (larger substrate; trend toward higher water velocity) than the other riffles sampled in the system. Cover estimates suggest that there is a difference between the Lower and

Middle/Upper reaches in term of canopy cover, with the latter having a greater abundance of this cover class. Thus, in the following analyses, these differences in Lower Reach riffles must be borne in mind.

The five flats sampled in Northeast Brook indicate a lower water velocity than the riffles (mean velocity 0.15-0.22 m/s; Table 6), substrate with a greater percentage of gravel, pebble and cobble, and less instream cover. For the three flats with repeated sampling over time (Table 3), Site LFL2 appears to have a greater mean velocity than sites MFL1 and MFL2 (Appendix 2). This suggests that the velocities are quite constant over the years but differ spatially among these three sites. This is further supported by the substrate rating which scores LFL2 as having a rating of 4.6, while the other four sites range from 3.2 to 3.6 (Appendix 2). This difference is due to the greater proportion of rubble and boulder (35.6% and 28.9%, respectively) at Site LFL2 compared with all other flats (rubble <18%, boulder <7%). LFL2 also has less gravel, pebble and cobble (7.2%, 11.2% and 16.5%, respectively) than the other sites which are quite similar (gravel 13.2-15.4%; pebble 30-50%; cobble 25.5-40%). Percent of instream cover is similar among the five sampled flats (5.8%-15.8%; Appendix 2) as is overhanging cover (10.4-23.8%). Canopy cover provides a greater proportion of total cover in the two Middle flats (19.7-40.3%) relative to the Lower and Tributary 2 sites (5-6%), though the small numbers of sampled flats preclude strong conclusions on these habitat measures. This is, however, consistent with the canopy cover for riffles also being greater in the Middle Reach than the Lower Reach.

Site LFL2 appears to be different from the other sampled flats in terms of velocity and substrate, though lack of replication of flats in the Lower Reach prevents meaningful conclusions of whether all flats in the Lower Reach are different in character from elsewhere in the system.

Pools were sampled for physical habitat measures in two locations only – the Lower Reach and Tributary 2. Water velocity is, by definition of a pool, very low (mean < 0.07 m/s in the single pool for which this was measured). Substrate rating is quite high for the pools (4.2 and 4.6) due to abundance (>20%) of each of cobble, rubble and boulder. Material of pebble size and smaller is present at very low proportions (<15% each). Cover, in general, is low in the classes used here; instream cover from 8.75-30%, overhanging and canopy cover <5%. However, in pools another class of cover not considered here exists – water depth – and thus these other cover classifications are less meaningful. There are insufficient replicates of pools to draw conclusions about variability among reaches.

In comparing characteristics among fluvial habitat types (excluding Millers Pond), the three habitat types may be well discriminated based on mean water velocity (riffles>flats>pools). Substrate is quite similar among habitat types due to the preponderance of large materials (rubble and boulder), though there is considerable variation among replicates within a habitat type. Flats, in general, appear to have less instream cover than overhanging and canopy cover while pools show the opposite pattern with greater instream than overhanging and canopy cover. Riffles have a more even distribution of the three classes of cover. The range of estimates within a habitat type and cover class is quite broad suggesting a high degree of variability among replicates of habitat types; this is to be expected as the different geographically separated sites have differing micro-environments and growing conditions for the plants forming the cover.

To further explore the physical habitat distinctions among riffles, flats and pools, Discriminant Function Analysis was conducted using all of the physical habitat variables to assess how well habitat types could be statistically discriminated. Seven variables (mean width, mean depth, mean velocity, % overhanging cover, deepest point, % fines, and % gravels) were found to be statistically significant but exclusion of four of these to leave only mean depth, mean width, and mean velocity did not reduce the discriminatory ability of the function. The function $Y = -7.897 * \textit{mean velocity} + 2.036 * \textit{mean depth} + 0.148 * \textit{mean width} + 0.424$ was found to correctly assign riffles 84.3% of the time, flats 62.1% and pools 60.0% of the time. Errors in classification resulted in flats being classified as riffles and pools classified as flats. This analysis suggests that these habitats may be objectively discriminated.

Water Quality

The water of Northeast Brook has a median pH value of 6.4 and 90th percentile of 6.9 for 204 pH measurements (Table 7; Appendix 3). The reported range is 5.0-8.3 but the central 80% of the values (90th percentile – 10th percentile; i.e. the trimmed data) is 5.7-6.9. The slightly acidic nature of the water is not surprising given that the drainage includes a large amount of bog and heathland. Specific conductance ranged from 14 to 106 μS/cm with the trimmed data indicating the central 80% of these measurements had a much smaller range, from 33.7 to 49.3 μS/cm. There have been two measured peaks in specific conductance; January-February, 1988 and May 1989, when conductance exceeded 60 μS/cm (Fig. 7). Total alkalinity and total hardness are both low, alkalinity ranging from 0.2 to 28.5 mg/L $CaCO_3$, and hardness from 3.0 to 15.4 mg/L. The majority of the values (the trimmed data) for these variables fall within 1.3 and 5.0 mg/L $CaCO_3$ and 4.3 to 9.2 mg/L, respectively. Similar to conductance hardness showed a peak in January-February, 1988 (Fig. 8). Hardness appears to generally increase seasonally to maximal values in July-September of each year. The alkalinity measurements show two peaks, the first through July-September, 1987 and then a very high value of 15.25 mg/L $CaCO_3$ in May 1989 (Fig. 8).

Ionic components (chloride, magnesium, calcium, and sulphate) and nutrients (phosphate and nitrates) are all present at low concentrations. Chloride, though varying as high as 66.3 mg/L is most commonly (i.e. 90th percentile) <9.7 mg/L (Table 7; Appendix 3). The concentration of chloride increased dramatically in January-February, 1988 (>20 mg/L), similar to specific conductance and hardness. Elevated levels of chloride may be a function of sea salt deposition as the water quality sampling station is quite close to the interface of the brook and the marine environment. Magnesium concentration is also low, almost always <1.0 mg/L and calcium too is present at low concentrations; with the 90th percentile of 1.8 mg/L. Magnesium showed a peak in concentration in January-February, 1988 at >1.5 mg/L (Fig. 9). Calcium did not show this but instead had an elevated concentration in May, 1989 (Fig. 9). Calcium also showed an intriguing double peak from May-October, 1987 and then again December-March, 1988. Sulphates are present at concentrations up to 4.4 mg/L with a median of 2.4 mg/L and 90th percentile of 3.2 mg/L. Sulphate concentration appears to be quite sTable over the period of record, though there is a suggestion of a peak in January-February, 1988 (Fig. 9). Phosphates and nitrates are present at low concentrations, each <0.06 mg/L in 90 percent of samples though occasionally rising as high as 0.23 mg/L. Phosphate concentrations were elevated relative to the usual concentrations in July and October, 1987, (Fig. 10) while nitrates showed an unusually high peak only once – during July, 1989.

Neither turbidity nor colour indicated great variability among samples. The median turbidity value was 0.52 NTU and 90th percentile was 0.99 NTU (Table 7; Appendix 3). Colour had a median value of 50 colour units with 90th percentile of 120 units. Mean turbidity of samples by month indicates the highest values occurring in December, 1987, August, 1989, June and October, 1990 (Fig. 11), only one of which would correspond with spring snowmelt. Peak colour values occurred in July, 1984, August 1985, July, 1988, July, 1989 and August, 1992. There is no obvious or consistent correlation between these high turbidity and colour events and water level; that is, during some of these periods (July, 1984, 1988 and 1989; June, 1990) the stream was at a relatively high level, while at others it was at "baseflow" (August, 1985, 1989 and 1992). The water level was not measured during the months of December, 1987 and October, 1990.

Northeast Brook maintains a cool water temperature through much of the summer season. Between 1984 and 1996 the maximum temperature recorded each year averaged 22.6°C (±SD 1.6°C) with the greatest temperature recorded on August 10, 1995 (26.3°C). The year 1989 possesses the longest record of water temperatures (April 5 to October 24) and is illustrated in Fig. 12 on the assumption that it is representative. The minimum mean temperature in this year was 0.2°C and the overall maximum was 23.1°C. The diel range of temperature (maximum–minimum) averaged 2.7°C with a range from 0 to 7.4°C.

The results of eight years of water chemistry sampling allow a relatively detailed characterization of the water chemistry of Northeast Brook. The water is slightly acidic, soft, of low buffering capacity (i.e. low hardness and calcium ion concentration). Nutrient (phosphates and nitrates) concentrations are low which may have implications for primary and secondary (invertebrate) production. The water has relatively high colour values but very low turbidity suggesting it is carrying a high dissolved organic matter load but not a great deal of suspended material. This is not surprising given the preponderance of bogs in the surrounding landscape. The water quality characteristics appear to be quite stable, fluctuating relatively little, at least during the years 1984–92. Two exceptions to this stability appear to have occurred. The first in January-February, 1988, when specific conductance, hardness, chloride, magnesium, and sulphate all increased dramatically relative to other periods. At this point it remains unclear what this represented. It is unfortunate that this is the only year in which sampling was undertaken during the winter months and so it is impossible to infer whether this is a natural, annually occurring event, or was significant for this winter only. The second appreciable fluctuation occurred in May 1989 when specific conductance and calcium both increased. Stream discharge, as represented by water level, was declining from a high flood event to baseflow conditions through this period. As with the previous increase, this remains unexplained to date. Of course, as specific conductance is a reflection of free ions, the observation that both it and calcium (or that conductance, chloride and magnesium all increased during January-February, 1988) is redundant: both measures are recording the same process – the increase in calcium (May, 1989) or chloride and magnesium (January-February, 1988). This same argument applies to hardness and its correlated variables. Hardness is well correlated with pH (r=0.83), specific conductance (r=0.92), alkalinity (r=0.87), calcium (r=0.93) and magnesium (r=0.92). Therefore, these individual variables are tightly coupled and behave in similar manners.

FISH COMMUNITY COMPOSITION

Northeast Brook has a depauperate fish fauna, with only four species present. Atlantic salmon and brook trout form the vast majority (i.e. >98%; Table 8) of the fish sampled within the system. American eel and three-spine stickleback form a very small component of the community. All four of the species in this brook are sea water tolerant, or at least have the ability to be so during some period in their life history. Given the short stream length of Northeast Brook, it is likely that post-glacial invasion from adjacent streams had to occur through the marine environment, and so only sea water tolerant species could successfully immigrate. The low species richness is not unique to Northeast Brook. Nearby systems (Freshwater and Drook rivers) also have only these four species (Gibson et al. 1993; Erkinaro and Gibson, 1997) and Scott and Crossman (1973) list only 20 fish species for the entire insular portion of the province of Newfoundland and Labrador.

THE ATLANTIC SALMON OF NORTHEAST BROOK

General Description

The following general description is drawn from data provided by O'Connell et al. (2001).

Based on analysis of scales from smolts, juvenile Atlantic salmon rear in Northeast Brook for between two and six years before smolting, with the most common smolt ages being 3+ and 4+ (i.e. together forming 76-98% of all smolts; Table 9). Age 5+ smolts are quite rare (mean proportion <10%). Age 2+ smolts were only found in 1989 and 1995, and age 6+ only in 1987. Between 1985 and 1996 the mean proportion of age 3+, 4+, and 5+ smolts have been 36.6%, 53.8% and 8.8% respectively. The proportion of age 3+ and 4+ have remained relatively sTable over these 12 years of record. The Coefficient of Variation (CV = s^2/mean*100) for these age classes were 29.1% and 14.9% , respectively, while the age 5+ CV is considerably greater, 61.7%, indicating greater variability among years than the other ages. The smolts emigrate from Northeast Brook generally in May and June, with a mean date of passage (i.e. 50th percentile column in Table 10) through the fence between 1985 and 1996 of May 21 (± SD of 7.7 days), and the majority (90th percentile) of the run through by June 4 (± SD of 6.8 days; Table 10). The range of timing over the 12 years of record indicates the median (50th percentile) of the run has been completed between May 10 and June 4 and the 90th percentile between May 25 and June 14. The duration of the smolt passage (number of days between dates of 10th and 90th percentiles; Table 10) has ranged from 9 days (1993) to 34 days (1987) with a mean of 21 days. The number of smolts estimated leaving Northeast Brook between 1986 and 1996 has ranged between 792 (1995) and 1,911 (1991), with a mean of 1,522 per annum (SD=398.2; Table 9).

The majority of the salmon from Northeast Brook are virgin grilse; that is, spend only a single year at sea before returning to the river. Virgin grilse constitute the bulk of small salmon (<63 cm in length) reported in Table 11, with the remainder being repeat spawning grilse. Small salmon represent, on average, 82% (±SD 5%) of the total adult run (Table 11). The estimated rates of smolt-to-adult survival for virgin grilse ranged from 2.2% to 8.1% between 1986 and 1996 (Table 12). The number of returning grilse between 1984 and 1996 ranged from 49 to 158 fish per year (mean of 90 ± 28 fish). When all salmon are included (including large salmon which are all repeat spawning grilse) the total number of returning fish ranged from 59 to 188 (mean 110 ± 35 fish) over this same period. The timing of adult returns occurs generally through July and August. Median dates of passage past the counting fence for the years 1992-96 ranged from July 28 to August 18, with 90% of the run in by the middle of August (i.e. generally after August 18, except 1994 when 90% were in by August 8). O'Connell et al. (2001) do not provide data on fish passage in Northeast Brook prior to 1992. Spawning by adult fish generally occurs through the last two weeks of October into the first week of November, though it is water temperature dependant.

Upstream migrating adults have not been sampled in Northeast Brook for biological characteristics (length, sex, etc.) due to concerns that handling of the fish may result in detrimental consequences for this small run. Instead, the biological characteristics of the adults were sampled from downstream moving kelts the spring following spawning. From these samples the annual mean fork length of the female fish (males not reported in O'Connell et al. 2001) has fluctuated over a small range of 52.3 to 57.6 cm (Table 13). The female to male ratio using this sampling regime is highly skewed, commonly in excess of 4:1. This sampling also resulted in estimates of repeat spawners, based on scale analysis, between 0 and 14.8%, with a mean repeat spawner rate of 7.3%.

Based on a relative fecundity of 65.6 eggs/cm of female, measured fork lengths and counts of females, egg deposition rates (#/100 m^2) have been calculated for each year from 1984-96 by O'Connell et al. (2001). Rates have ranged between 328 and 953 eggs/100 m^2 (Table 11) with a mean rate of 573 eggs/100m^2 (± SD of 165). Egg-to-smolt survival between 1984 and 1995, as determined by dividing production of smolts by estimated egg deposition for that cohort, ranged between 0.34% and 1.09% (Table 12).

In summary, the salmon of Northeast Brook are a small population of predominately virgin grilse returns. The number of returning large salmon are relatively low, though with their larger body size they may be expected to contribute disproportionately to the egg deposition. Adults return through late July and August. The juveniles rear generally for three or four years prior to smolting and emigrating out to sea, with the emigration occurring through May and June of each year. Attributes of these rearing juveniles are described below.

Juvenile Salmon Density, Weight, Growth and Biomass

Density of juvenile salmon in Northeast Brook was generally greatest in riffles (grand mean for all ages combined 79.7 fish/100 m^2; range of annual means 48.7–129.3; Table 14) followed by flats and then pools (grand means 50.4 and 34.2 fish/100 m^2, respectively). It may be seen from Figure 13 that for a given sampling percentile, riffles returned the highest density. For example, the 50th percentile (i.e. the median) density for riffles is 70.0, flats 41.7 and pools 30.2 fish/100m^2. The unusually high mean density value in flats for 1988 (Table 14) was due to a very high estimate of 267 fish/100m^2 for site LFL2 (see also error bars associated with this estimate in Fig. 14). Over the 13 years of record, total salmon density fluctuated (Fig. 14), with riffles consistently having greater density than flats or pools with the exception of the previously mentioned anomalous flat value in 1988. The variation about the long-term grand means, as indicated by the Coefficient of Variation (CV) in Table 14 was greatest for the flats (98.2%; likely most attribuTable to the anomalous 1988 peak), followed by riffles (70.6%) and least for pools (46.2%). The relatively large standard deviations associated with the annual means for riffles and flats in Table 14 imply considerable variance among replicates of a habitat type within a year, and this is also reflected in the standard error bars of Fig. 14 for many of the years. This conclusion is not surprising given the earlier inferences that LRI1, LRI2, and LRI3 appear to be different from the other riffles. Millers Pond is not included in this discussion as estimates there are of fish abundance rather than density (see below).

As may be seen from Table 14, age 0+ salmon were conspicuously absent from the single pool sampled (grand mean 0.10 fry/100 m^2). This age class then appears to be present in approximately equal densities in flats and riffles (grand means 19.2, and 25.3 fish/100 m^2, respectively; Table 14, Fig. 15). The density of this age class is quite variable from year-to-year, with a CV of the grand mean of 115% for the riffles and 92% for the flats (Table 14; see also Fig. 15). The years 1986, 1990 and 1993 are conspicuous for their low mean density of 0+ fish (<20 fish/100m^2) in the riffles and flats, and these years may generate the very low mean values, relative to the age 1+ fish, in all habitat types shown in Fig. 16. The adult returns giving rise to these cohorts were 165, 80, and 59 fish, respectively (see Table 11). The value of 59 adults in 1992 would be expected to give rise to the low 1993 cohort, but adult returns in the other two years of interest were of larger magnitude; indeed the 165 adult return in 1985 was the second largest in this time series. Therefore, it is difficult to contribute these low densities to poor adult returns.

The importance of the pool habitat, in terms of density, relative to flats and riffles, increases for the age 1+ and 2+ salmon (Fig. 16). Riffles still appear to have a greater density than pools or flats, on average, for the 1+ fish. The pool and riffle support equal density of 2+ fish, while the flats have considerably lower density (Table 14; Fig. 16). Thus, as the fish get older there seems to be a move from flats (used by 0+ and 1+ fish) into the pools; the riffles appear to be used to a large degree by all age classes. The maximum recorded density for each age class was found in the riffles (Table 14).

Millers Pond is treated separately as true densities could not be calculated due to the area actually sampled not being recorded. Instead, population values (Schnabel estimates) are included in Table 14. Little useful information can be drawn from these population estimates without being able to standardize to a unit sampling area. The distribution of age classes in these samples, however, is revealing – the age 0+ fish comprise a very small component of the population in Millers Pond (i.e. <10%), while the age 1+ and 2+ form approximately similar contributions (grand mean of 1+ is 57%, 2+ is 41%). This is consistent with the foregoing which indicated that age 0+ fish do not use pool habitats. This absence of age 0+ salmon may, however, be a function of the sampling methodology (beach seine which may not have captured 0+ fish) and so the interpretation should only be considered tentative. Difficulty in discriminating age groups in Millers Pond, despite very large number of fish captured per sampling period, further confounds interpretation of age class estimates in the pond (see Growth below).

The mean weight of each age class of salmon by habitat type is presented in Table 15 and Fig. 17. For age 0+ fish the mean weight is greater in Millers Pond and pools (0.92 and 0.95 g, respectively; though note very small sample sizes), followed by riffles (0.55 g) and finally flats (0.44 g). Age 1+ fish show a similar pattern, while the age 2+ fish show weight in the flats increasing relative to the riffles, though pools and Millers Pond still provide the maximum values. In all habitat types the variance associated with the mean (as reflected by the CV) is low. Age 0+ fish have a CV of 54-61% for the four habitat types, age 1+ salmon 29-52% and age 2+ fish 9-31% (Table 15). These low values for CV, and decreasing with age, imply that the variability among sites and among years (all data pooled within each habitat type) is quite low for weight.

The growth of salmon between age classes each year for the period 1984-96 (habitat types pooled) is illustrated in Fig. 18. Growth from 0+ to 1+ fish ranged between 2.0 (1993) and 6.9 g (1990), and ages 1+ to 2+ from 6.1 (1993) to 15.2 g (1992). The overall mean growth rate (all years combined) was 4.12 g (SD $\pm$ 4.22) for age 0+ to 1+ and 11.6 g (SD $\pm$ 11.2) for age 1+ to 2+. The relatively large CV associated with these mean estimates (i.e. CV approaching or exceeding 100%) imply considerable year-to-year variability in growth – a feature confirmed by Fig. 18. The year 1993 stands out as being one of very low growth for all age groups, and no obvious explanation is apparent.

Data from Millers Pond indicate different growing conditions than those just described. Fig.19 illustrates a length-frequency plot from this pond and it is apparent that, despite a very large sample size (>800 fish), the individual size (=age) classes cannot be discriminated. It appears that in this habitat type the growth is such as to cause an overlap of the size classes so that age 1+ fish may resemble 2+. Of course, this inability to discriminate age classes in Millers Pond could be due also to movement of fish between the ponds and the brook, which has been well documented (Erkinaro and Gibson, 1997). Such movements may tend to obscure the individual peaks of a length frequency plot by introducing individuals which had experienced different growing conditions from lotic habitats and so fall between the peaks of pond-resident fish. This may act to create the relatively uniform distribution seen.

In terms of biomass, total salmon weight is greatest in the pools and riffles (Table 16). Biomass of age 0+ fish is greatest in riffles (17.3 g/100 m^2) followed by flats (9.9 g/100 m^2); in pools 0+ fish form a very small component of the biomass in Northeast Brook. This is in keeping with the low density of 0+ fish in pools. Age 1+ fish biomass is greatest in riffles (grand mean 150 g/100 m^2) followed by flats and pools, with the latter two habitats supporting approximately equal biomass (96.9 and 89.9 g/100 m^2, respectively). This may be explained as the density of this age class is considerably greater in riffles than flats and pools (Fig. 16) yet the greater mean weight in pools (Fig. 17) compensates, so bringing pool biomass up to be more equal with that of flats. For the age 2+ fish, the pools gain increasing contribution of biomass, equaling or exceeding riffles and followed by flats (Table 16). This may be primarily explained as a shift in density between these habitats as 2+ fish are in equal densities in pools and riffles (Fig. 16). Weight of age 2+ salmon is also greater in pools than riffles or flats, and so combined with changing density results in greater biomass for the pools. The biomass estimates for Millers Pond in Table 16 are based on absolute abundance, not density, and so are not comparable with the fluvial density estimates. What is clear however, is that age 0+ salmon maintain very little biomass in Millers Pond and the biomass is dominated by age 2+ fish.

In summary, within Northeast Brook, density of juvenile salmon tends to be highest in riffles, with some indication of habitat shifts with age, i.e. the older fish moving into pools and Millers Pond. Age 0+ fish are present in pools at very low abundance. Variation in density among years is considerable within a habitat type, and also among replicates of a habitat type at a single sampling interval. The mean weight of fish by age class is greatest in pools and Millers Pond, with smaller-sized fish within an age class occupying riffles and flats. Variation in weight over time is quite low. Growth from one age class to another is highly variable among years, with 1993 being a conspicuously poor year affecting all age classes. It is likely that Millers Pond is fundamentally different from the stream environment with respect to utilization by age classes, weight and growth, and so is likely not comparable with the stream habitat. This is significant in that in Newfoundland salmon parr rear extensively in lakes (e.g., Chadwick and Green 1985; Ryan, 1986; Scruton et al. 2000). Within the stream, biomass is greatest in pools and riffles, likely reflecting the use of these habitats by the larger, older fish.

THE BROOK TROUT OF NORTHEAST BROOK

General Description

Unfortunately, no data set comparable to that of O'Connell et al. (2001) for salmon exists describing the brook trout of this system. Therefore, this document includes only information on juvenile density, weight, growth and biomass. The anadromous component of the brook trout population is also not considered here.

Juvenile Trout Density, Weight, Growth and Biomass

Total density of brook trout, all age classes combined, were quite similar among riffles, flats and pools (grand mean ~10-12.5 trout/100m^2; Table 17). These observed densities were considerably less than the salmon (mean trout densities ranged from 10.1 trout/100m^2 (pool) to 12.5 trout/100 m^2 (riffles) compared with 34.2-79.7 salmon/100 m^2; Table 14). The variability, as indicated by the CV (86-115%; Table 17), was also greater for trout than the salmon. Total trout abundance (not density) in Millers Pond averaged approximately one-half the abundance of salmon but indicated the same degree of relative variability (CV 72-74%). It may be seen from Fig. 20 that the frequency distribution of densities among the three habitat types are quite similar, at least up to the 75th to 90th percentiles. The median density is very similar (8 trout/100m^2) among the riffles, flats and pools and is between four and nine times less than the density of salmon. This similarity in density among habitat types for total trout is shown to apply over time as well (Fig. 21) with a lack of consistently greater density for any single habitat type (contrast with Fig. 14 of salmon density) and large standard error bars indicating considerable variability within a habitat type.

In contrast to the equal distribution of total trout among habitat types, the age 0+ brook trout show a marked preference for riffles and flats over pools in terms of density, though there does not appear to be a consistent difference between riffles and flats themselves (Table 17; Fig. 22 and 23). The variability is quite high (CV > 100% for each habitat type) indicating a very high fluctuation in use of habitat among replicates and years. The density of the age 0+ trout was considerably less than age 0+ salmon (mean salmon density 19.2-25.3/100 m^2 in riffles and flats), and the years 1986, 1990 and 1993, so noticeable for poor salmon 0+ density, showed much less effect for the trout. These were low years for the trout, but not conspicuously lower than some of the other years.

In terms of the various age classes, the riffle and flat habitats appear to have the highest age 0+ density, all three habitat types have approximately equal density of age 1+, and then pools have higher densities than flats and riffles for ages 2+ and 3+ (Table 17; Fig. 23). This is suggestive of a habitat shift similar to that for salmon with older fish moving into the pool habitats while the younger fish utilize the riffles and flats. The maximum density found was in the riffles for ages 0+, 1+ and 2+, and in the flats for the age 3+ trout.

As with the salmon, only abundance, not density, could be calculated for Millers Pond. Results by age class presented in Table 17 are the proportion of total abundance by age class. From this Table it appears that the brook trout of Millers Pond are primarily age 1+ and 2+ (grand means of 40% and 34%, respectively of fish captured), with ages 0+ and 3+ forming much smaller components of this population. This result is inconsistent with the previous inference that trout move into slower water (e.g., pools) as they age. The entire pond was not sampled however, but only the shoreline margins, the larger (=older) fish may be in the deeper water outside of the sampled area.

The mean weight of trout in the various habitat types are presented in Table 18 and Fig. 24. Age 0+ trout averaged less than 1.0 g in the riffles, but equalled or exceeded this value in flats, pools and Millers Pond. The variation (i.e. CV) is relatively small, ranging from 32.3-58.55%, compared with the variation associated with the density. The mean weight of these age 0+ fish was considerably greater than the weight of 0+ salmon (compare Tables 15 and 18; Fig. 17 and 24). The mean weight of age 1+ trout was very similar among riffles, flats and pools, and appeared to be slightly greater than the mean weight of this age class in Millers Pond. The CV of these estimates was less even than that of the age 0+ fish, ranging from 30.8 to 34.1%. Again, in comparison with age 1+ salmon, the trout are considerably larger at age. The age 2+ trout show similar weight among the habitat types, still greater than the same age Atlantic salmon, and the age 3+ trout follow this pattern.

Mean growth between age classes for brook trout in Northeast Brook (Fig. 25) ranged between 2.5 and 8.1 g/year (ages 0+ to 1+), 1.6 to 36.8 g/year (ages 1+ to 2+), and 4.7 to 53.2 g/year (ages 2+ to 3+). Over all years of record the mean growth was 5.52 g/year (SD $\pm$ 1.8) for age 0+ to 1+, 18.5 g/year (10.4) for ages 1+ to 2+, and 24.4 g/year (16.8) for ages 2+ to 3+. The year 1988 appears to have been a poor year of growth for all age classes. The years 1992 and 1993 were poorer than the immediately preceding years for ages 1+ and 2+ trout, then 1996 was a catastrophically poor year for the age 1+ to 2+ age group. It is worth noting that the year 1993, so poor for salmon growth (Fig. 18), was also poor for age 1+ and 2+ trout (though not for the age 0+ trout); the relative decline in growth for the trout appeared to be much less than for the salmon (compare Fig. 18 and 25).

Total brook trout biomass was, on average, greatest in the pools (156 g/100 m^2) over riffles and flats (97.2 and 77.5 g/100 m^2, respectively; Table 19), though the maximum calculated individual biomass estimates were in the riffles and flats (>400 g/100 m^2). This predominance of biomass in the pools is likely a function of the older (=larger) fish preferentially inhabiting the pools. The greatest biomass of age 0+ trout was found in the flats, followed by the riffles than the pools. The greatest biomass of age 0+ trout was found, on average, in the flats, followed by the riffles than the pools. Age 1+ and 2+ biomass was similar in the three habitat types (mean biomass 27.0-35.2 g/100m^2 for age 1+; 49.2-59.9 g/100m^2 for age 2+). Age 3+ fish appeared to have the greatest biomass in flats, than pools and lastly riffles (Table 19). However, the estimate of age 3+ biomass in flats are based on small sample size and anomalously high value in 1989 (363.88 g/100 m^2) which inflates the mean. The biomass of the trout (ages 0+, 1+, 2+ and all ages combined) was considerably lower than that of the salmon (compare Tables 16 and 19). This is due to the much lower density of trout relative to the salmon; this difference is not entirely compensated by the increased weight of the trout and there results a considerable difference in biomass.

In summary, the brook trout of Northeast Brook are at a considerably lower density than the co-occurring juvenile salmon but are of larger size-at-age. This increased size, however, does not compensate for the lower density and so overall biomass in the brook is less for the trout than the salmon. Total brook trout density was similar among the habitat types of the riffles, flats, and pools, while age 0+ trout tended to prefer riffles and flats with a shift to pools by older fish. The density of the trout varies to a greater degree than the salmon among replicates and over the years. Mean weight was less for age 0+ trout in riffles compared with other habitat types, but was equal among habitats for the other age classes. Growth by trout appeared to be poor in 1993 (similar to salmon) and in 1998. In general, biomass of trout was similar in riffles and flats and less there than in the pool habitat; this is most likely due to older (larger) fish preferring the pool habitat over the other habitat types.

CONCLUSIONS

The intensive 13 years of fish, habitat and water quality sampling of Northeast Brook, Trepassey, between 1984 and 1996 has allowed a relatively detailed characterization of the drainage and the attributes of the Atlantic salmon and brook trout within it. These data are valuable in that they provide indications of the variation exhibited by fish populations in an unimpacted watershed. The long term nature of the record is instructive in providing researchers and managers with indications of population fluctuations, changes in weight and growth under natural conditions. This system represents one of the few long-term data sets representing "baseline" fish population dynamics and habitat conditions in eastern Canada, and as such will likely provide insights and productive information for academic purposes and for fisheries management. These data are fundamental to a present detailed analysis of fish production as a function of biotic and abiotic factors in an effort to model fish production in a relatively unimpacted watershed.

ACKNOWLEDGMENTS

The field crews over 13 years of sampling must be acknowledged for the intensive and consistent work carried out. Bob Whalen of DFO St. John's retrieved the information and provided guidance on interpretation and coding. Mike O'Connell provided valuable background information a review of the manuscript, and clarified terminology and salmon interpretation. Additional funding was provided by the Canada Research Chairs Program (via University of New Brunswick) and the Department of Fisheries and Oceans, Science Branch (Gulf Region and Newfoundland Region).

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Table 1. Description of reaches delineated for Northeast Brook, Trepassey.[1]

	Lower Reach[2]	Middle Reach[2]	Upper Reach	Tributary 1	Tributary 2
Length (km)	1.05	6.2	2.1	3.8	3.5
Stream order	3	3	2	2	2
Gradient (%)[3]	~2% for first 750 m; 0.8% for remainder	0.8-0.9	1.1-1.3	3.2	2.2
# sample sites	10	7	2	1	3
Description	Brook mouth to Millers Pond	Millers Pond to inflow from Doctors Pond	Ephemeral systems to headwaters	Tributary to Millers Pond	West tributary opposite Three Corner Pond

[1] = Millers Pond also sampled though not included in this table.
[2] = Lower and Middle reaches of similar gradient; distinction based on Millers Pond breaking the continuity between the two.
[3] = Gradient approximate only - determined from 1:50,000 scale map.

Table 2. Nomenclature for designating replicates of habitat types in Northeast Brook (adapted from system used in Catamaran Brook, New Brunswick; Cunjak et al. 1993). Stations arranged in order ascending upstream along the brook. See also Fig. 3.

Original Station #	Segment	Habitat type	Name	Code
5	Lower Reach	Riffle	Lower Riffle 1	LRI1
6	Lower Reach	Riffle	Lower Riffle 2	LRI2
7	Lower Reach	Riffle	Lower Riffle 3	LRI3
14	Lower Reach	Riffle	Lower Riffle 4	LRI4
15	Lower Reach	Pool	Lower Pool 1	LP1
18	Lower Reach	Flat	Lower Flat 2	LFL2
19	Lower Reach	Riffle	Lower Riffle 5	LRI5
25	Lower Reach	Riffle	Lower Riffle 6	LRI6
30	Lower Reach	Run	Lower Run 1	LRU1
33		Pond	Millers Pond	Millers Pd
37	Middle Reach	Riffle	Middle Riffle 1	MRI1
48	Middle Reach	Flat	Middle Flat 1	MFL1
53	Middle Reach	Flat	Middle Flat 2	MFL2
57/59	Middle Reach	Riffle	Middle Riffle 2	MRI2
65	Middle Reach	Pool	Middle Pool 1	MP1
75	Middle Reach	Flat	Middle Flat 3	MFL3
90	Middle Reach	Riffle	Middle Riffle 3	MRI3
12	Upper Reach	Riffle	Upper Riffle 2	URI2
20	Upper Reach	Riffle	Upper Riffle 3	URI3
8	Tributary 1	Riffle	Trib 1 Riffle 1	Trib1RI1
10	Tributary 2	Flat	Trib 2 Flat 1	Trib2FL1
16	Tributary 2	Pool	Trib 2 Pool 1	Trib2P1
80	Tributary 2	Riffle	Trib 2 Riffle 1	Trib2RI1

Table 3. Sampling schedule for physical habitat variables in Northeast Brook, 1984-96.

Site	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
LRI1	July	August	July	July	August	July	July	July	August	June	June	August	July
LRI2	July	August											
LRI3	July	August											
LRI4	May, June, September	May, July											
LRI5			July	July	August	July	July	July	August	June	June	July	June
LRI6	July												
LFL1	July												
LFL2	July	July	July	July	August	July	July	July	July	June	June	July	June
LRU1	July												
LP1	July	July	July	July	August	July	July	July	July	June	June	July	June
Millers Pond	September	July	July	July	July								
MRI1	July	July	July	July	July	July	August	July	August	June	June	August	June
MRI2	July	July	July		July	July	August	July	August	June	June		June
MRI3	July				July	July	August	July	August	June	June	August	August
MFL1	July						August	July	August	June	June		
MFL2	July				July	July	August	July	August	June	June		June
MFL3	July												
MP1	July											May	
URI2	July				July	July	August	July	August	June	June	August	July
URI3									August	June	June		July
Trib1RI1	July	July	July	July	July	July	August	July	July	June	July	August	July
Trib2RI1	July				August	July	August	July	August	June	June		
Trib2P1	July												

Table 4. Sampling schedule for water quality variables in Northeast Brook, 1984-96. *Note no samples for period 1993-95.*

Site	1984	1985	1986	1987	1988	1989	1990	1991	1992	1996
Site 1	July, August, September	5 months[1]	5 months[1]	7 months[2]		5 months[1]		4 months[5]		
LRI1	July	August	July	July, November, December	9 months[3]	July	7 months [4]	July	May, June, August	July
LRI2	July	August								
LRI3	July	August								
LRI4	May, June, September	May, July								
LRI5				July	August	July	July			
LRI6	July									
LFL1	July									
LFL2	July	July	July			July			July	June
LRU1	July									
LP1	July	July	July				July	July		
Millers Pond			July							
MRI1	July	July	July	July		July	August	July		June
MRI2	July	July	July		July				August	
MRI3	July				July	July	August	July	August	August
MFL1	July							July		
MFL2	July						August			
MFL3	July									
MP1	July									
URI2	July				July	July	August	July	August	July
URI3									August	
Trib1RI1	July	July	July	July	July	July	August	July	July	August
Trib2RI1	July				August	July	August	July	August	
Trib2P1	July									

[1]May- September.
[2]May- November.
[3]January- September.
[4]Apr.il-October.
[5]April-May, and July-August

Table 5. Sampling schedule for fish in Northeast Brook, 1984-96.

Site	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	# years sampled
LFL1	9-Jul													1
LFL2	6-Jul	15-Jul	2-Jul	8-Jul	4-Aug	24-Jul	24-Jul	10-Jul	30-Jul	15-Jun	26-Jun	27-Jul	14-Jun	13
LP1	5-Jul	14-Jul	2-Jul	8-Jul	3-Aug	6-Jul	24-Jul	10-Jul	30-Jul	(1)	25-Jun	27-Jul	14-Jun	13
LRI1	3-Jul	13-Aug	18-Jul	17-Jul	12-Aug	26-Jul	20-Jul	23-Jul	14-Aug	17-Jun	30-Jun	4-Aug	10-Jul	13
LRI2	4-Jul	13-Aug												2
LRI3	5-Jul	14-Aug												2
LRI4	(2)	12-Jul												2
LRI5			2-Jul	15-Jul	4-Aug	24-Jul	30-Jul	11-Jul	4-Aug	16-Jun	26-Jun	28-Jul	15-Jun	11
LRI6	7-Jul													1
LRU1	8-Jul													1
Millers Pond	12-Jul	23-Jul	10-Jul	3-Jul	15-Jul	16-Jul	10-Aug	23-Aug	4-Aug	5-Jul				10
MFL1	9-Jul						2-Aug	24-Jul	7-Aug	18-Jun	28-Jun			6
MFL2	10-Jul				7-Jul	25-Jul	21-Aug	24-Jul		18-Jun	27-Jun		17-Jun	8
MRI1	11-Jul	9-Jul	17-Jul	16-Jul	6-Jul	25-Jul	1-Aug	24-Jul	10-Aug	19-Jun	28-Jun	2-Aug	16-Jun	13
MRI2	11-Jul	10-Jul	5-Jul		6-Jul	26-Jul	22-Aug	25-Jul	5-Aug	19-Jun	27-Jun		18-Jun	11
MRI3	4-Jul				22-Jul	19-Jul	9-Aug	17-Jul	12-Aug	21-Jun	28-Jun	3-Aug		9
URI2	6-Jul				20-Jul	19-Jul	8-Aug	18-Jul	12-Aug	20-Jun	29-Jun	3-Aug	10-Jul	10
URI3									6-Aug	20-Jun	30-Jun		9-Jul	4
Trib1RI1	9-Jul	9-Jul	6-Jul	16-Jul	8-Jul	17-Jul	7-Aug	23-Jul	29-Jul	16-Jun	9-Jul	3-Aug	8-Jul	13
Trib2P1	7-Jul													1
Trib2RI1	5-Jul				2-Aug	20-Jul	9-Aug	18-Jul	13-Aug	21-Jun	28-Jun		28-Aug	9
# sites sampled	19	10	8	7	12	12	13	13	13	14	13	8	11	

(1) = This site was sampled three times this years April 21; June 15; and September 13.

(2) = This site was sampled three times this years May 16; July 19; and September 27.

Table 6. Range of mean estimates (adapted from Appendix 2) of physical habitat variables from Northeast Brook, Trepassey, 1984-96. Note: Millers Pond excluded as these variables not measured for that habitat type.

	Riffle	Flat	Pool
Stream velocity (m/s)	0.23-0.35	0.15-0.22	0.06
Substrate			
Rating	3.9-5.3	3.2-4.6	4.2-4.6
Flat Bedrock and Fines (%)	<1.0-2.2	<1.0-5.0	5.0-7.25
Gravel (%)	<1.0-8.4	7.0-15.5	0.0-10.0
Pebble (%)	1.5-26.1	11.5-50.0	10.0-14.0
Cobble (%)	12.0-35.6	16.5-45.0	20.0-22.0
Rubble (%)	21.0-39.5	3.0-35.8	27.5-40.0
Boulder (%)	5.1-52.5	0.0-28.0	20.0-25.0
Cover			
Instream (%)	1.5-36.2	5.8-15.8	8.75-30.0
Overhanging (%)	3.1-27.5	10.4-23.8	0.0-4.3
Canopy (%)	0-36.25	0.0-40.3	0-1.75
Number of sites sampled	13	5	2

Table 7. Summary of water quality results for Northeast Brook sampling, all sites combined, 1984-96. (Adapted from Appendix 3).

Variable	Range of Means [1]	Min	Max	10th pctle	25th pctle	50th pctle	75th pctle	90th pctle	n
pH (lab)	5.8-6.8	5.0	8.3	5.7	6.0	6.4	6.75	6.9	204
Specific Conductance (µS/cm)	34.2-46.9	14	106	33.7	37	41	45	49.3	198
Total alkalinity (mg/L $CaCO_3$)	1.6-4.6	0.2	28.5	1.3	1.9	2.9	4.0	5.0	202
Total hardness (mg/L $CaCO_3$)	4.3-8.0	3.0	15.4	4.3	5.2	6.4	7.6	9.2	125
Chloride (mg/L)	5.88-13.50	0.10	66.30	5.63	6.70	7.70	8.40	9.67	204
Magnesium (mg/L)	0.52-0.93	0.00	2.41	0.55	0.66	0.77	0.88	1.04	205
Calcium (mg/L)	0.82-1.55	0.63	15.00	0.80	0.97	1.22	1.42	1.82	204
Total Phosphate (mg/L PO_4)	0.02-0.04	0.00	0.23	0.01	0.02	0.04	0.04	0.06	190
Nitrates (mg/L NO_3-N)	0.01-0.07	0.002	0.23	0.00	0.01	0.01	0.01	0.04	203
Sulphates (mg/L SO_4)	2.10-3.06	0.91	4.40	1.99	2.17	2.40	2.72	3.20	204
Turbidity (NTU)	<1.0	0.2	1.9	0.3	0.4	0.5	0.7	1.0	204
Colour (Colour units)	36-97	2	150	20	31.25	50	90	120	122

[1]Range of means represent range of mean values over time per site from Appendix 3.

Table 8. Fish community composition. Values are number of individuals within each fish species captured in year with percent of total fish captured in brackets.

	Atlantic salmon	Brook trout	American eel	Three-spine stickleback
1984	3377 (75.0%)	900 (20.0%)	227 (5.0%)	1 (<0.1%)
1985	3158 (83.2%)	581 (15.3%)	52 (1.4%)	5 (<0.1%)
1986	1845 (73.2%)	658 (26.1%)	18 (0.7%)	0 (0.0%)
1987	2531 (76.9%)	733 (22.3%)	27 (0.8%)	0 (0.0%)
1988	4115 (82.7%)	824 (16.6%)	37 (0.7%)	0 (0.0%)
1989	1770 (69.5%)	737 (28.9%)	42 (1.6%)	0 (0.0%)
1990	1808 (66.5%)	874 (32.1%)	37 (1.4%)	0 (0.0%)
1991	2183 (62.5%)	1287 (36.8%)	25 (0.7%)	0 (0.0%)
1992	2223 (71.5%)	858 (27.6%)	29 (0.9%)	0 (0.0%)
1993	1153 (82.5%)	223 (15.9%)	22 (1.6%)	0 (0.0%)
1994	1817 (73.9%)	627 (25.5%)	13 (0.5%)	0 (0.0%)
1995	769 (84.3%)	134 (14.7%)	10 (1.1%)	0 (0.0%)
1996	1238 (84.3%)	212 (14.4%)	18 (1.2%)	0 (0.0%)
Mean	2153 (75.8)	665 (22.7)	42.8 (1.3)	0.46 (0.01)
SD	945.7 (7.2)	322.6 (7.3)	56.6 (1.2)	1.39 (0.04)

Table 9. Number and percentage representation by smolt age for each year in Northeast Brook, 1985-96. Data from O'Connell et al. (2001).

Year	No. smolts	Smolt Age					Ages
		2+	3+	4+	5+	6+	3+ and 4+
1985	[1]		51.76	40.00	8.24		91.76
1986	1117		24.07	62.96	12.96		87.04
1987	1404		26.15	50.77	20.00	3.08	76.92
1988	1692		32.26	54.84	12.90		87.10
1989	1708	1.67	33.33	60.00	5.00		93.33
1990	1902		53.33	45.00	1.67		98.33
1991	1911		22.03	67.80	10.17		89.83
1992	1674		42.19	51.56	6.25		93.75
1993	1849		36.21	53.45	10.34		89.66
1994	944		28.89	60.00	11.11		88.89
1995	792	5.88	41.18	52.94			94.12
1996	1749		47.46	45.76	6.78		93.22
Mean	1522	0.63	36.57	53.76	8.79	0.26	90.33
Median	1692	0.00	34.77	53.19	9.20		90.80
SD	398.21	1.72	10.65	8.01	5.42		5.34
n	11	2	12	12	11	1	12
CV (%)	26.2	274	29.1	14.9	61.7		5.9

[1]Smolts in 1985 not reported by O'Connell et al. (2001).

Table 10. Percentile of dates of smolt passage downstream for each year in Northeast Brook, 1985-96. Data from O'Connell et al. (2001).

	Percentile					# days between
Year	10th	25th	50th	75th	90th	10^{th} and 90^{th} pctl
1985	17-May	19-May	21-May	30-May	4-Jun	18
1986	20-May	21-May	24-May	2-Jun	7-Jun	18
1987	9-May	10-May	10-May	3-Jun	12-Jun	34
1988	8-May	10-May	12-May	3-Jun	8-Jun	31
1989	17-May	22-May	29-May	31-May	2-Jun	16
1990	21-May	29-May	4-Jun	4-Jun	4-Jun	14
1991	8-May	13-May	25-May	25-May	25-May	17
1992	16-May	18-May	21-May	14-Jun	14-Jun	29
1993	18-May	19-May	21-May	23-May	27-May	9
1994	13-May	15-May	25-May	29-May	2-Jun	20
1995	15-May	19-May	23-May	7-Jun	8-Jun	24
1996	5-May	6-May	10-May	12-May	27-May	22
Mean	14-May	17-May	21-May	31-May	4-Jun	21
SD (days)	5.13	6.24	7.72	8.66	6.81	7.36
n	12	12	12	12	12	12

Table 11. Number of returning adults and egg deposition for each year, 1984-96 in Northeast Brook. Data from O'Connell et al. (2001).

Year	Total salmon	Large salmon	Small salmon[1]	% small salmon	Egg deposition (#/100m^2)
1984	122	33	89	72.95	594
1985	165	41	124	75.15	809
1986	188	30	158	84.04	953
1987	121	30	91	75.21	589
1988	116	19	97	83.62	551
1989	80	18	62	77.50	449
1990	80	9	71	88.75	404
1991	112	13	99	88.39	644
1992	59	10	49	83.05	328
1993	96	17	79	82.29	501
1994	114	15	99	86.84	619
1995	92	12	80	86.96	503
1996	88	15	73	82.95	507
Mean	110.23	20.15	90.08	82.13	573.15
Median	112.00	17.00	89.00	83.05	551.00
SD	35.16	10.03	27.88	5.31	165.03
n	13	13	13	13	13
Min	59	9	49	72.95	328
Max	188	41	158	88.75	953

[1]Small salmon = grilse.

Table 12. Estimated survivals from egg-to-smolt and smolt-to-adult for each year, 1984-96 in Northeast Brook. Data from O'Connell et al. (2001).

	Survival (percent)	
Year	Egg-to-smolt	Smolt-to-maiden female
1984	0.49	
1985	0.36	
1986	0.46	8.10
1987	0.45	6.30
1988	0.58	3.70
1989	0.49	3.90
1990	0.36	4.80
1991	0.34	2.20
1992	1.09	4.50
1993	0.75	4.90
1994	0.43	7.80
1995	0.47	7.60
1996		2.60
Mean	0.53	5.13
Median	0.46	4.80
SD	0.22	2.06
n	11	11
Min	0.34	2.20
Max	1.09	8.10

Table 13. Estimates of female mean fork length (cm), percent repeat spawners, and female to male ratio of downstream migrating kelts sampled in Northeast Brook, 1985-96. Year refers to years of adult upstream migration. Data from O'Connell et al. (2001).

Year	# fish sampled	# females sampled	Mean fork length (females)	% repeat spawners	f:m ratio
1985	16	4	57.60	6.70	0.33
1986	86	68	52.60	7.20	3.78
1987	104	83	53.70	13.70	3.95
1988	23	13	53.40	0.00	1.30
1989	63	48	52.30	8.60	3.20
1990	21	19	54.90	0.00	9.50
1991	55	43	55.30	5.90	3.58
1992	41	36	57.40	7.70	7.20
1993	33	27	55.30	14.80	4.50
1994	42	31	54.80	5.70	2.82
1995	44	37	55.80	9.30	5.29
1996	65	54	56.80	7.50	4.91
Mean	49.42	38.58	54.99	7.26	4.20
Median	43.00	36.50	55.10	7.35	3.87
SD	26.67	22.60	1.76	4.42	2.44
n	12	12	12	12	12
Min	16	4	52.30	0.00	0.33
Max	104	83	57.60	14.80	9.50

Table 14. Estimated salmon density (#/100 m^2) for all ages combined and for age 0+ salmon for riffles, flats, and pools in Northeast Brook, 1984-96. Estimates for Millers Pond are abundance (all ages combined) or proportions of total abundance (age class), not density. Habitat replicates pooled within years. Notation is mean (Std. Dev.); sample size. Summary statistics based on all replicates of habitat type pooled over all years.

Year	Riffle	Flat	Pool	Millers Pond
All ages combined				
1984	101.69 (83.3); 10	83.3 (30.34); 4	30.20	872.80
1985	129.26 (109.36); 7	44.43 (0); 1	33.94	1241.25
1986	48.73 (31.28); 5	25.63 (0); 1	30.58	636.78
1987	77.01 (35.46); 4	41.74 (0); 1	34.70	826.30
1988	97.42 (60.07); 8	163.36 (146.45); 2	30.36	3195.00
1989	68.34 (44.67); 8	48.99 (6.48); 2	24.37	893.64
1990	66.34 (31.25); 8	24.77 (33.69); 2	28.32	638.84
1991	64.75 (24.44); 8	30.69 (4.28); 3	14.85	909.73
1992	97.15 (36.65); 9	25.79 (22.54); 2	26.05	2000.07
1993	58.76 (10.15); 9	33.53 (16.71); 3	46.11	
1994	57.48 (28.36); 9	58.57 (21.79); 3	33.66	395.31
1995	75.61 (46.45); 6	21.33 (0); 1	26.27	
1996	82.92 (79.73); 7	24.87 (26.93); 2	29.61	
Summary Statistics				
Grand Mean	79.66	50.38	34.18	1160.97
SD	56.28	49.48	15.79	837.40
min	0.00	0.00	14.85	395.31
max	322.89	266.93	85.52	3195.00
n	98	27	15	10
CV (%)	70.65	98.21	46.21	72.13
Age 0+				
1984	26.05 (27.39); 8	23.34 (15.83); 4	0.19	0.00
1985	41.88 (40.26); 7	12.87 (0); 1	0.27	0.01
1986	10.61 (8.04); 4	6.47 (0); 1	0.13	0.01
1987	44.91 (30.03); 4	22.99 (0); 1	0.00	0.00
1988	27.87 (30.72); 8	49.49 (50.54); 2	0.00	0.02
1989	8.39 (13.1); 6	23.12 (8.93); 2	0.00	0.01
1990	15.45 (22.34); 6	13.9 (20); 2	0.00	0.01
1991	28.77 (27.65); 8	17.55 (3.22); 3	0.35	0.08
1992	48.53 (34.27); 7	24.4 (8.55); 2	0.00	0.02
1993	5.85 (9.36); 8	2.24 (2.75); 2	0.16	
1994	9.12 (21.58); 5	25.92 (17.38); 3	0.00	0.01
1995	40.21 (37.23); 6	11.45 (0); 1	0.36	
1996	33.18 (28.79); 7	9 (10.48); 2	0.00	
Summary Statistics				
Grand Mean	25.26	19.22	0.10	0.02
SD	29.07	17.82	0.14	0.02
min	0.00	0.00	0.00	0.00
max	119.12	85.24	0.36	0.08
n	84	26	6	10
CV (%)	115.08	92.73	133.00	140.26

Table 14. (Cont'd.)

	Year	Riffle	Flat	Pool	Millers Pond
Age 1+					
	1984	39.3 (51.59); 9	32.86 (8.91); 4	12.43	0.33
	1985	64.64 (53.72); 7	27.69 (0); 1	23.22	0.63
	1986	24.64 (19.48); 5	15.11 (0); 1	12.34	0.67
	1987	23.38 (11.14); 4	16.33 (0); 1	21.97	0.82
	1988	56.95 (33.27); 8	92.63 (75.18); 2	16.17	0.59
	1989	51.09 (51.76); 8	18.75 (4.03); 2	11.95	0.56
	1990	27.18 (24.18); 7	10.04 (12.87); 2	11.47	0.29
	1991	19.61 (15.77); 8	12.16 (6.88); 3	8.70	0.43
	1992	35.88 (13.07); 9	13.31 (4.24); 2	24.70	0.77
	1993	36.09 (14.69); 8	24.62 (10.04); 3	32.82	
	1994	22.97 (16.43); 9	19.98 (13.06); 3	12.91	0.63
	1995	24.19 (14.97); 6	7.9 (0); 1	12.87	
	1996	41.59 (46.47); 7	11.63 (12.71); 2	18.07	
Summary Statistics					
	Grand Mean	36.65	23.99	16.04	0.57
	SD	34.08	26.42	7.39	0.17
	min	0.00	0.00	4.89	0.29
	max	180.93	145.80	32.82	0.82
	n	95	27	14	10
	CV (%)	92.97	110.14	46.09	30.42
Age ≥2+[1]					
	1984	36.33 (31.59); 10	27.09 (10.8); 4	17.59	0.67
	1985	22.73 (26.21); 7	3.86 (0); 1	10.44	0.36
	1986	13.48 (7.21); 5	4.04 (0); 1	18.11	0.32
	1987	8.7 (3.56); 4	2.42 (0); 1	12.74	0.18
	1988	12.59 (6.25); 8	21.23 (20.72); 2	14.18	0.39
	1989	8.85 (7.78); 7	7.12 (1.58); 2	12.41	0.43
	1990	23.7 (34.05); 7	0.81 (0.88); 2	16.85	0.70
	1991	16.36 (12.54); 8	0.97 (0.85); 2	5.80	0.49
	1992	12.73 (8.81); 9	0.97 (0.05); 2	1.34	0.22
	1993	16.8 (7.87); 9	6.66 (6.57); 3	13.13	
	1994	25.39 (11.85); 9	12.67 (4.99); 3	20.75	0.37
	1995	11.2 (5.67); 6	1.97 (0); 1	13.05	
	1996	19.99 (25.94); 7	4.23 (3.73); 2	11.54	
Summary Statistics					
	Grand Mean	18.56	8.97	17.75	0.41
	SD	19.24	11.09	18.77	0.17
	min	0.00	0.00	1.34	0.18
	max	106.30	37.11	80.64	0.70
	n	96	26	14	10
	CV (%)	103.66	123.61	105.70	41.39

[1]Includes fish of 2 years and older; these are combined as they individually form very small components of juvenile community, and cannot be reliably discriminated by Length Frequency Analysis.

Table 15. Estimated salmon weight (g) for ages 0+ and 1+ salmon for riffles, flats, pools and Millers Pond in Northeast Brook, 1984-96. Habitat replicates pooled within years. Notation is mean (Std. Dev.); sample size. Summary statistics based on all replicates of habitat type pooled over all years.

	Year	Riffle	Flat	Pool	Millers Pond
Age 0+					
	1984	0.32 (0.13); 6	0.2 (0.15); 3	0.20	
	1985	0.67 (0.28); 6	0.32 (0); 1		0.43
	1986	0.51 (0.26); 4	0.38 (0); 1		
	1987	1.01 (0); 1	0.38 (0); 1		
	1988	0.59 (0.43); 7	0.85 (0); 1		1.06
	1989	0.44 (0.29); 3	0.81 (0); 1	0.44	
	1990	0.73 (0.21); 7	0.87 (0.07); 2	1.47	1.43
	1991	0.54 (0.15); 8	0.49 (0.04); 2		1.32
	1992	0.84 (0.36); 6	0.49 (0.11); 3	1.29	
	1993	0.31 (0.2); 7	0.42 (0.08); 2	1.34	
	1994	0.19 (0.01); 3	0.25 (0.02); 3		0.37
	1995	0.93 (0); 1	0 (0);		
	1996	0.44 (0.2); 6	0.34 (0); 1		
Summary Statistics					
	Grand Mean	0.55	0.44	0.95	0.92
	SD	0.31	0.24	0.58	0.50
	min	0.13	0.00	0.20	0.37
	max	1.51	0.93	1.47	1.43
	n	65	21	5	5
	CV (%)	56.24	53.02	61.40	53.90
Age 1+					
	1984	3.13 (1.03); 8	2.38 (0.9); 4	4.60	1.05
	1985	3.11 (1.31); 6	3.25 (0); 1	4.69	3.53
	1986	3.29 (1.46); 5	3.2 (0); 1	4.10	5.53
	1987	3.94 (1.52); 4	3.92 (0); 1		3.42
	1988	3.93 (1.13); 7	4.55 (1.09); 2	6.07	5.92
	1989	4.75 (1.45); 6	5.89 (0); 1	6.51	7.46
	1990	6.19 (1.78); 8	7.97 (0.15); 2	8.31	6.83
	1991	5.47 (1.83); 8	5.82 (2.31); 2	7.43	4.84
	1992	5.04 (1.85); 8	4.33 (1.98); 3	8.08	5.23
	1993	2.38 (0.43); 8	2.15 (0.71); 3	4.01	
	1994	3.26 (0.8); 7	2.37 (0.86); 3	3.58	5.50
	1995	5.35 (1.22); 2	0 (0);	7.66	
	1996	4.12 (1.88); 7	3.55 (0); 1	6.50	
Summary Statistics					
	Grand Mean	4.14	3.86	5.85	4.93
	SD	1.76	2.00	1.68	1.86
	min	1.63	1.20	3.58	1.05
	max	9.36	8.09	8.31	7.46
	n	84	24	13	10
	CV (%)	42.47	51.74	28.70	37.69

Table 15 (Cont'd.)

Year	Riffle	Flat	Pool	Millers Pond
Age ≥2+				
1984	12.78 (2.37); 9	12.84 (0.67); 3	23.60	16.04
1985	14.21 (5); 6	18.12 (0); 1	14.43	18.46
1986	10.52 (2.93); 5	11.12 (0); 1	12.55	18.35
1987	13.16 (4.37); 4	13.54 (0); 1		18.18
1988	13.16 (2.26); 6	16.25 (0); 1	16.61	19.53
1989	15.2 (5.81); 4	18.47 (0); 1	15.58	16.39
1990	14.51 (4.14); 6	18.62 (2.19); 2	18.69	18.40
1991	13.07 (3.08); 8	25.52 (0); 1	19.57	21.18
1992	16.62 (5.37); 8	20.61 (1.53); 3	27.25	20.03
1993	11.69 (4.48); 9	10.09 (3.71); 3	13.98	
1994	9.91 (2.5); 7	10.92 (1.76); 3	12.71	16.44
1995	18.33 (0.99); 2	0 (0);	16.20	
1996	13.72 (4.27); 7	13.63 (0); 1	18.41	
Summary Statistics				
Grand Mean	13.30	15.11	17.19	18.30
SD	4.13	4.76	4.34	1.67
min	6.35	7.37	12.55	16.04
max	23.69	25.52	27.25	21.18
n	81	21	13	10
CV (%)	31.07	31.53	25.26	9.12

Table 16. Estimated salmon biomass (g/100 m^2) for all ages combined and for age 0+ salmon for riffles, flats, and pools in Northeast Brook, 1984-96. Estimates for Millers Pond are based on abundance (g), not density. Habitat replicates pooled within years. Notation is mean (Std. Dev.); sample size. Summary statistics based on all replicates of habitat type pooled over all years.

	Year	Riffle	Flat	Pool	Millers Pond
All ages combined					
	1984	355.23 (72.63); 5	400.91 (164.55); 3	472.26 (0); 1	
	1985	577.03 (670.46); 6	164.38 (0); 1		11010.4
	1986	195.53 (58.1); 4	96.01 (0); 1		
	1987	272.49 (0); 1	105.69 (0); 1		
	1988	408.31 (229.61); 6			35790.5
	1989	367.15 (133.33); 3	270.1 (0); 1	271.2 (0); 1	
	1990	384.41 (195.79); 6	29.92 (42.31); 1	410.22 (0); 1	9508.97
	1991	303.32 (147.36); 8	178.84 (0); 1		11476.7
	1992	376.49 (171.22); 6	93.93 (20.24); 2	236.09 (0); 1	
	1993	274.45 (76.56); 6	94.19 (81.29); 2	315.47 (0); 1	
	1994	185.03 (23.82); 3	197.02 (98.03); 3		3761.28
	1995	484.76 (0); 1			
	1996	332.41 (176.57); 5	172.62 (0); 1		
Summary Statistics					
	Grand Mean	353.09	178.76	341.05	14309.57
	SD	254.43	138.27	98.17	12396.09
	min	94.93	0.00	236.09	3761.28
	max	1893.92	502.72	472.27	35790.51
	n	60	17	5	5
	CV (%)	72.06	77.35	28.79	86.63
Age 0+					
	1984	11.38 (6.38); 5	4.9 (5.62); 3	0.04	
	1985	23.07 (14.15); 6	4.12 (0); 1		3.84
	1986	5.78 (2.58); 4	2.51 (0); 1		
	1987	88.06 (0); 1	8.81 (0); 1		
	1988	14.23 (10.26); 7	72.45 (0); 1		63.44
	1989	2.54 (1.18); 3	24.07 (0); 1	0.00	
	1990	15.95 (23.61); 6	1.99 (2.81); 1	0.00	7.11
	1991	15.99 (16.74); 8	9.23 (2.65); 2		90.15
	1992	58.1 (31.11); 6	13.25 (8.23); 2	0.00	
	1993	1.86 (2.65); 7	1.3 (1.85); 1	0.21	
	1994	0.44 (0.49); 3	6.77 (5.19); 3		0.74
	1995	7.76 (0); 1	0 (0);		
	1996	13.75 (10.18); 5	5.7 (0); 1		
Summary Statistics					
	Grand Mean	17.35	9.96	0.05	33.06
	SD	22.63	15.62	0.09	41.09
	min	0.00	0.00	0.00	0.74
	max	97.74	72.45	0.21	90.15
	n	62	18	2	5
	CV (%)	130.42	156.80	183.61	124.31

Table 16 (Cont'd.)

	Year	Riffle	Flat	Pool	Millers Pond
Age 1+					
	1984	95.85 (66.24); 7	76.14 (34.48); 4	57.16	301.12
	1985	223.66 (235.52); 6	90.24 (0); 1	108.93	2774.93
	1986	67.84 (33.84); 5	48.49 (0); 1	50.59	2358.18
	1987	80.94 (7.77); 4	64.1 (0); 1		2311.83
	1988	235.24 (141.39); 7	463.41 (444.34); 2	98.24	11096.87
	1989	344.01 (363.68); 6	93.71 (0); 1	77.76	3767.83
	1990	164.29 (148.68); 7	21.96 (31.06); 1	95.36	1274.93
	1991	92.94 (64.57); 8	79.01 (83.19); 2	64.64	1906.34
	1992	180.36 (82.06); 8	59.83 (12.03); 2	199.51	8014.98
	1993	98.21 (29.43); 8	54.24 (31.93); 3	131.74	
	1994	62.2 (55.96); 7	47.46 (29.24); 3	46.25	1361.10
	1995	51.77 (30.19); 2	0 (0);	98.57	
	1996	187.11 (130.42); 6	73.21 (0); 1	117.34	
Summary Statistics					
	Grand Mean	150.43	96.87	89.87	3516.81
	SD	155.25	152.94	45.59	3394.54
	min	0.00	0.00	22.24	301.12
	max	1046.81	777.61	199.51	11096.87
	n	81	22	13	10
	CV (%)	103.20	157.89	50.73	96.52
Age ≥2+					
	1984	359.08 (191.25); 8	309.44 (144.57); 3	415.07	9371.84
	1985	330.29 (426.59); 6	70.01 (0); 1	150.70	8231.60
	1986	127.82 (26.25); 5	45 (0); 1	227.30	3748.02
	1987	108.96 (45.17); 4	32.77 (0); 1		2669.10
	1988	170.18 (96.35); 6	106.9 (0); 1	235.56	24630.20
	1989	213.22 (137.7); 4	152.32 (0); 1	193.45	6264.23
	1990	198.02 (80.76); 6	5.96 (8.43); 1	314.87	8226.94
	1991	194.38 (133); 8	33.64 (0); 1	113.49	9480.25
	1992	211.05 (169.98); 8	20.84 (0.02); 2	36.59	8632.98
	1993	191.62 (100.64); 9	64.72 (54.7); 3	183.52	
	1994	288.17 (169.68); 7	142.78 (67.64); 3	263.81	2399.44
	1995	245.06 (224.59); 2	0 (0);	211.33	
	1996	224.8 (168.35); 6	93.7 (0); 1	212.51	
Summary Statistics					
	Grand Mean	225.52	106.94	282.69	8365.46
	SD	177.77	113.04	266.83	6330.56
	min	31.68	0.00	36.59	2399.44
	max	1169.46	418.03	1116.80	24630.20
	n	79	19	13	10
	CV (%)	78.83	105.70	94.39	75.67

Table 17. Estimated brook trout density (#/100 m^2) for all ages combined and for age 0+ trout for riffles, flats, and pools in Northeast Brook, 1984-96. Estimates for Millers Pond are abundance (all ages combined) or proportions of total abundance (age class), not density. Habitat replicates pooled within years. Notation is mean (Std. Dev.); sample size. Summary statistics based on all replicates of habitat type pooled over all years.

	Year	Riffle	Flat	Pool	Millers Pond
All ages combined					
	1984	11.27 (10.77); 10	8.48 (2.98); 4	23.75 (21.29); 2	384.6
	1985	6.81 (8.9); 7	1.51 (); 1	7.3 (); 1	305.9
	1986	4.61 (6.95); 5	1.42 (); 1	2.29 (); 1	383.5
	1987	19.51 (26.51); 4	2.41 (); 1	8.43 (); 1	288.3
	1988	8.56 (7.93); 8	5.05 (6.15); 2	6.65 (); 1	781.4
	1989	10.5 (9.51); 8	33.95 (24.15); 2	6.4 (); 1	844.3
	1990	10.16 (7.97); 8	8.96 (8.99); 3	7.25 (); 1	555.6
	1991	19.7 (25.64); 8	19.27 (13.86); 3	12.92 (); 1	626.9
	1992	13.33 (10.47); 9	7.84 (12.95); 3	4.53 (); 1	1109.8
	1993	18.31 (19.67); 9	9.28 (3.84); 3	11.81 (); 1	
	1994	16.11 (17.36); 9	20.61 (14.91); 3	7.98 (); 1	251.9
	1995	12.29 (16.17); 6	0 (); 1	8.51 (); 1	
	1996	9.93 (9.79); 8	5.09 (0.94); 2	9.86 (); 1	
Summary Statistics					
	Grand Mean	12.49	11.22	10.11	553.23
	SD	14.34	12.15	8.68	285.09
	Min	0.00	0.00	2.30	251.92
	Max	80.61	51.04	38.81	1109.87
	n	99	29	14	10
	CV(%)	114.87	108.26	85.91	74.13
Age 0+					
	1984	7.99 (11.74); 8	3.28 (1.65); 3	0 (); 1	0.29
	1985	3.49 (6.18); 7	0.75 (); 1	0.31 (); 1	0.12
	1986	2.51 (4.22); 5	0.79 (); 1	0 (); 1	0.14
	1987	12.54 (18.68); 4	2.41 (); 1	0.58 (); 1	0.11
	1988	1.94 (1.98); 8	3.05 (3.99); 2	0.29 (); 1	0.11
	1989	3.19 (2.42); 8	28.29 (20.12); 2	0 (); 1	0.07
	1990	4.89 (4.84); 8	4.18 (3.89); 3	0.25 (); 1	0.01
	1991	14.54 (23.34); 8	14.93 (11.64); 3	0.34 (); 1	0.05
	1992	4.22 (3.81); 6	5.63 (7.44); 2	0.34 (); 1	<0.01
	1993	4.31 (4.39); 9	5.67 (4.23); 3	0 (); 1	
	1994	7.72 (11.7); 9	10.92 (8.24); 3	0 (); 1	0.23
	1995	6.31 (9.61); 6		0.19 (); 1	
	1996	3.53 (3.2); 7	2.79 (1.04); 2	0 (); 1	
Summary Statistics					
	Grand Mean	5.85	7.71	0.18	0.12
	SD	10.12	9.64	0.19	0.09
	Min	0.00	0.00	0.00	0.00
	Max	70.21	42.53	0.58	0.30
	n	93	26	13	10
	CV(%)	172.94	125.01	107.69	30.73

Table 17 (Cont'd.)

	Year	Riffle	Flat	Pool	Millers Pond
Age 1+					
	1984	0.81 (1.22); 8	2.44 (0.93); 3	4.62 (); 1	0.25
	1985	1.57 (2.39); 7	0.75 (); 1	3.73 (); 1	0.27
	1986	1.71 (2.42); 5	0.15 (); 1	1.85 (); 1	0.53
	1987	5.8 (7.07); 4	0 (); 1	4.07 (); 1	0.62
	1988	4.11 (4.42); 8	1.46 (2.07); 2	1.92 (); 1	0.16
	1989	5.56 (7.01); 8	1.4 (1.98); 2	2.23 (); 1	0.27
	1990	4.41 (5.41); 8	1.39 (1.29); 3	5.43 (); 1	0.34
	1991	3.95 (2.64); 8	3.49 (1.89); 3	9.29 (); 1	0.59
	1992	4.44 (4.31); 6	4.64 (6.04); 2	1.91 (); 1	0.50
	1993	9.92 (12.73); 9	2.16 (1.95); 3	4.43 (); 1	
	1994	3.66 (2.6); 9	7.26 (9.37); 3	4.43 (); 1	0.42
	1995	3.78 (4.49); 6		2.12 (); 1	
	1996	4.96 (6.32); 7	2.29 (1.99); 2	0.43 (); 1	
Summary Statistics					
	Grand Mean	4.30	2.73	3.58	0.40
	SD	5.93	3.73	2.26	0.16
	Min	0.00	0.00	0.44	0.16
	Max	42.55	17.95	9.30	0.63
	N	93	26	13	10
	CV(%)	137.88	136.72	63.11	63.38
Age 2+					
	1984	0.98 (1.36); 8	0.89 (0.79); 3	2.99 (); 1	0.32
	1985	1.7 (3.17); 7	0 (); 1	1.71 (); 1	0.27
	1986	0.19 (0.44); 5	0.31 (); 1	0.35 (); 1	0.24
	1987	0.9 (0.94); 4	0 (); 1	2.18 (); 1	0.25
	1988	1.74 (1.78); 8	0.29 (0.41); 2	1.92 (); 1	0.43
	1989	1.15 (0.98); 8	0 (0); 2	2.23 (); 1	0.38
	1990	0.73 (1.25); 8	0.96 (0.85); 3	1.55 (); 1	0.43
	1991	1.03 (1.31); 8	0.84 (0.73); 3	3.28 (); 1	0.23
	1992	1.14 (0.85); 6	1.48 (2.1); 2	2.26 (); 1	0.49
	1993	3.38 (4.13); 9	0.73 (0.64); 3	4.1 (); 1	
	1994	4.03 (4.66); 9	2.42 (3.47); 3	3.54 (); 1	0.35
	1995	2 (2.83); 6		3.29 (); 1	
	1996	1.48 (2.25); 7	0 (0); 2	2.74 (); 1	
Summary Statistics					
	Grand Mean	1.70	0.83	2.48	0.34
	SD	2.60	1.37	1.00	0.09
	Min	0.00	0.00	0.35	0.23
	Max	14.80	6.41	4.10	0.49
	N	93	26	13	10
	CV(%)	153.51	165.75	40.21	28.81

Table 17 (Cont'd.)

	Year	Riffle	Flat	Pool	Millers Pond
Age ≥3+					
	1984	0.48 (0.54); 8	0.44 (0.39); 3	1.08 (); 1	0.13
	1985	0.03 (0.1); 7	0 (); 1	1.55 (); 1	0.33
	1986	0.19 (0.42); 5	0.15 (); 1	0.08 (); 1	0.081
	1987	0.25 (0.51); 4	0 (); 1	1.6 (); 1	0.00
	1988	0.76 (0.71); 8	0.23 (0.32); 2	2.51 (); 1	0.29
	1989	0.58 (0.94); 8	4.25 (6.01); 2	1.93 (); 1	0.27
	1990	0.11 (0.32); 8	2.41 (3.49); 3	0 (); 1	0.20
	1991	0.17 (0.34); 8	0 (0); 3	0 (); 1	0.11
	1992	0.11 (0.28); 6	0 (0); 2	0 (); 1	<0.01
	1993	0.68 (1.03); 9	0.7 (1.21); 3	3.28 (); 1	
	1994	0.68 (1.13); 9	0 (0); 3	0 (); 1	0.00
	1995	0.18 (0.45); 6		2.9 (); 1	
	1996	1.36 (1.75); 7	0 (0); 2	6.68 (); 1	
Summary Statistics					
	Grand Mean	0.46	0.76	1.67	0.14
	SD	0.85	2.05	1.92	0.12
	Min	0.00	0.00	0.00	0.00
	Max	5.04	8.51	6.69	0.33
	n	93	26	13	8
	CV(%)	182.92	268.64	115.08	94.89

Table 18. Estimated brook trout weight (g) for ages 0+ and 1+ trout for riffles, flats, pools and Millers Pond in Northeast Brook, 1984-96. Habitat replicates pooled within years. Notation is mean (Std. Dev.); sample size. Summary statistics based on all replicates of habitat type pooled over all years.

	Year	Riffle	Flat	Pool	Millers Pond
Age 0+					
	1984	0.51 (0.31); 7	1.65 (0.63); 2	1.05 (0.07); 2	1.17
	1985	1.04 (0.59); 4	0.65 (); 1	0.6 (); 1	0.68
	1986	0.88 (0.03); 2	0.8 (); 1		1.54
	1987	0.66 (0.18); 4	1.15 (); 1		1.60
	1988	1.04 (0.5); 6	1.75 (); 1	1.64 (); 1	0.89
	1989	0.97 (0.71); 6	2.11 (); 1	1.11 (); 1	1.19
	1990	1.17 (0.55); 8	1.52 (); 1	1.9 (); 1	0.35
	1991	0.7 (0.22); 7	1.13 (0.42); 2		1.39
	1992	1.16 (0.39); 6	1.19 (); 1	1.5 (); 1	
	1993	0.63 (0.42); 6	0.32 (0.08); 3	1.54 (); 1	
	1994	0.43 (0.38); 6	0.31 (0.01); 2	0.81 (); 1	1.01
	1995			1.53 (); 1	
	1996	0.58 (0.22); 6	0.69 (); 1		
Summary Statistics					
Grand Mean		0.82	1.00	1.27	1.09
	SD	0.48	0.62	0.41	0.41
	Min	0.13	0.23	0.60	0.35
	Max	2.34	2.11	1.91	1.60
	n	68	17	10	9
	CV(%)	58.52	62.03	32.29	34.97
Age 1+					
	1984	8.42 (2.76); 7	4.4 (); 1	8.06 (3.15); 2	2.47
	1985	7.33 (2.07); 5	8.1 (); 1	10.6 (); 1	9.55
	1986	5.83 (1.84); 4	8.5 (); 1	9.46 (); 1	9.88
	1987	7.18 (1.15); 4			11.36
	1988	6.86 (2.06); 6		9.84 (); 1	1.99
	1989	7.31 (0.92); 6		7.33 (); 1	2.43
	1990	7.41 (3.38); 7	5.75 (); 1	12.27 (); 1	2.03
	1991	8.94 (3.39); 6	9.16 (); 1	9.89 (); 1	2.39
	1992	6.53 (2.17); 8	9.46 (1.75); 2	5.25 (); 1	1.13
	1993	6.11 (2.02); 8	4.79 (3.55); 2	7.46 (); 1	
	1994	6.66 (3.02); 7	7.11 (2.89); 3	8.63 (); 1	7.40
	1995			5.27 (); 1	
	1996	6.6 (1.34); 6	6.75 (); 1	4 (); 1	
Summary Statistics					
Grand Mean		7.11	7.12	8.17	5.06
	SD	2.37	2.43	2.51	3.99
	Min	0.87	2.28	4.00	1.13
	Max	14.86	10.70	12.27	11.36
	n	74	13	13	10
	CV(%)	33.30	34.09	30.78	161.82

Table 18 (Cont'd.)

	Year	Riffle	Flat	Pool	Millers Pond
Age 2+					
	1984	20.64 (2.81); 7	21.15 (6.36); 2	19.77 (3.14); 2	22.25
	1985	20.5 (2.78); 3		26.1 (); 1	45.44
	1986	27.7 (5.23); 2	27.3 (); 1	15.4 (); 1	40.92
	1987	35.58 (11.17); 4			53.71
	1988	19.26 (4.77); 5		20.63 (); 1	21.16
	1989	20.18 (2.43); 5		20.9 (); 1	20.15
	1990	18.98 (0.55); 2	20.66 (); 1	59.01 (); 1	18.95
	1991	45.2 (23.47); 4		48.77 (); 1	24.70
	1992	21.18 (3.79); 7	25.68 (); 1	18.65 (); 1	15.00
	1993	17.71 (4.98); 6	18.7 (2.11); 2	13.53 (); 1	
	1994	21.65 (4.82); 6	44.4 (25.59); 2	23.61 (); 1	46.60
	1995			19.53 (); 1	
	1996	20.46 (4.58); 5		6.86 (); 1	
Summary Statistics					
	Grand Mean	23.33	26.91	24.04	30.89
	SD	10.20	13.94	14.25	14.13
	Min	13.70	16.65	6.86	15.00
	Max	65.82	62.51	59.02	53.71
	n	56	9	13	10
	CV(%)	43.71	51.80	59.26	63.53
Age ≥3+					
	1984	36.66 (4.24); 3	130.9 (131.66); 2	56.75 (); 1	112.65
	1985	52.6 (); 1		38.5 (); 1	
	1986	51.8 (); 1			0.00
	1987	39.7 (); 1			
	1988	45.12 (13.18); 5	63.2 (); 1	49.79 (); 1	53.64
	1989	40.67 (10.4); 3	42.78 (); 1	36.48 (); 1	58.16
	1990	33.3 (3.28); 2	34 (48.08); 2		94.43
	1991				72.23
	1992	86.76 (22.29); 3		74.75 (); 1	54.07
	1993	45.08 (18.19); 4	51.28 (); 1	37.15 (); 1	
	1994	45.44 (12.65); 3	48.83 (); 1	70.49 (); 1	
	1995			52.67 (); 1	
	1996	49.12 (16.45); 4		33.78 (); 1	
Summary Statistics					
	Grand Mean	48.06	66.99	50.04	63.60
	SD	18.35	66.73	15.12	35.81
	Min	28.65	0.00	33.78	0.00
	Max	109.85	224.00	74.75	112.65
	n	30	8	9	6
	CV(%)	38.19	99.61	30.21	31.79

Table 19. Estimated brook trout biomass (g/100 m^2) for all ages combined and age 0+ trout for riffles, flats, and pools in Northeast Brook, 1984-96. Estimates for Millers Pond are based on abundance (g), not density. Habitat replicates pooled within years. Notation is mean (Std. Dev.); sample size. Summary statistics based on all replicates of habitat type pooled over all years.

	Year	Riffle	Flat	Pool	Millers Pond
All ages combined					
	1984	43.07 (39.78); 5	107.17 (143.48); 2	113.45 (); 1	8798.54
	1985	69.59 (84.2); 5	6.64 (); 1	144.24 (); 1	4625.43
	1986	31.53 (28.17); 4	10.61 (); 1	23.01 (); 1	5897.13
	1987	88.69 (90.61); 4	2.78 (); 1		6051.18
	1988	117.15 (74.52); 6	19.85 (13.53); 2	184.14 (); 1	19681.00
	1989	104.53 (92.92); 6	453.62 (); 1	133.73 (); 1	20272.101
	1990	54.25 (71.56); 8	105.16 (); 1	158.93 (); 1	15609.65
	1991	70.58 (80.67); 8	28.25 (36.09); 2	252.39 (); 1	9668.45
	1992	76.75 (40.8); 5	38.87 (48.74); 2	52.93 (); 1	9020.43
	1993	145.11 (164.53); 9	60.79 (63.15); 3	210.53 (); 1	0.00
	1994	169.42 (119.18); 7	130.8 (161.85); 3	122.07 (); 1	4910.43
	1995			228.71 (); 1	0.00
	1996	140.86 (109.13); 6	8.4 (); 1	246.5 (); 1	0.00
Summary Statistics					
	Grand Mean	97.18	77.52	155.89	8041.10
	SD	99.44	119.76	72.89	6895.35
	Min	0.55	2.74	23.01	0.00
	Max	491.11	453.63	252.39	20272.11
	n	73	20	12	10
	CV(%)	102.32	154.49	46.76	78.37
Age 0+					
	1984	3.31 (4.36); 4	4.42 (1.82); 2	0 (); 1	133.32
	1985	3.29 (2.01); 4	0.49 (); 1	0.18 (); 1	25.87
	1986	5.34 (5.23); 2	0.63 (); 1		84.79
	1987	6.37 (8.16); 4	2.78 (); 1		54.74
	1988	2.32 (2.5); 6	10.28 (); 1	0.48 (); 1	79.31
	1989	1.85 (1.84); 6	89.73 (); 1	0 (); 1	75.86
	1990	5.5 (5.11); 8	7.38 (); 1	0.49 (); 1	3.34
	1991	12.43 (19.52); 7	11.54 (12.44); 2		51.79
	1992	6.56 (5.43); 4	0.44 (); 1	0.52 (); 1	
	1993	3.98 (3.86); 6	1.59 (0.73); 3	0 (); 1	
	1994	4.54 (6.1); 6	3.88 (3.82); 2	0 (); 1	60.31
	1995			0.29 (); 1	
	1996	3.22 (2.99); 5	2.43 (); 1		
Summary Statistics					
	Grand Mean	5.04	9.34	0.22	63.26
	SD	7.85	21.31	0.23	37.06
	Min	0.00	0.44	0.00	3.34
	Max	55.53	89.74	0.52	133.32
	n	62	17	9	9
	CV(%)	155.73	228.24	106.06	27.80

Table 19 (Cont'd.)

	Year	Riffle	Flat	Pool	Millers Pond
Age 1+					
	1984	8.59 (17.18); 4		47.62 (); 1	239.55
	1985	12.63 (15.58); 5	6.15 (); 1	39.55 (); 1	803.81
	1986	10.58 (10.67); 4	1.34 (); 1	17.56 (); 1	2022.32
	1987	41.11 (50.59); 4			2050.96
	1988	36.67 (32.12); 6		18.91 (); 1	251.78
	1989	51.65 (59.9); 6		16.39 (); 1	560.23
	1990	39.53 (51.64); 7	9.3 (); 1	66.74 (); 1	390.56
	1991	37.83 (22.43); 6	33.43 (); 1	91.98 (); 1	893.88
	1992	32.79 (33.85); 5	38.65 (49.05); 2	10.09 (); 1	624.23
	1993	57.15 (49.35); 8	14.21 (7.84); 2	33.06 (); 1	
	1994	25.23 (14.87); 7	53.91 (78.76); 3	38.29 (); 1	776.80
	1995			11.21 (); 1	
	1996	44.45 (41); 5	5.96 (); 1	1.75 (); 1	
Summary Statistics					
	Grand Mean	35.20	26.97	32.77	861.41
	SD	38.13	42.14	26.27	658.39
	Min	0.00	1.34	1.76	239.55
	Max	163.54	144.69	91.99	2050.96
	n	67	12	12	10
	CV(%)	108.33	156.25	80.16	274.85
Age 2+					
	1984	37.37 (31.21); 4	38.29 (); 1	65.82 (); 1	2736.98
	1985	85.77 (104.99); 3		44.63 (); 1	3795.76
	1986	11.93 (16.87); 2	8.63 (); 1	5.44 (); 1	3790.02
	1987	31.06 (35.96); 4			3945.48
	1988	45.17 (24.76); 5		39.65 (); 1	7154.17
	1989	28.48 (20.73); 5		46.7 (); 1	6535.83
	1990	42.18 (41.5); 2	33.44 (); 1	91.69 (); 1	4554.55
	1991	62.65 (46.83); 4		160.4 (); 1	3562.35
	1992	33.35 (11.67); 4		42.32 (); 1	8204.18
	1993	96.8 (104.26); 6	20.6 (0.92); 2	55.53 (); 1	
	1994	115.19 (108.72); 6	111.46 (80.88); 2	83.77 (); 1	4073.32
	1995			64.27 (); 1	
	1996	46.63 (47.36); 4		18.8 (); 1	
Summary Statistics					
	Grand Mean	58.17	49.22	59.92	4835.26
	SD	66.26	54.69	39.93	1803.27
	Min	0.00	8.64	5.45	2736.98
	Max	316.49	168.66	160.40	8204.18
	n	49	7	12	10
	CV(%)	113.92	111.12	66.63	65.89

Table 19 (Cont'd.)

Year	Riffle	Flat	Pool	Millers Pond
Age ≥3+				
1984	9.1 (12.87); 2	167.2 (); 1		5688.70
1985	14.27 (); 1		59.86 (); 1	
1986	49.24 (); 1			0.00
1987	40.54 (); 1			
1988	48.6 (23.12); 5	29.42 (); 1	125.09 (); 1	12195.74
1989	54.58 (46.39); 3	363.88 (); 1	70.64 (); 1	13100.19
1990	14.44 (20.43); 2	27.51 (38.91); 2		10661.20
1991				5160.44
1992	30.06 (42.51); 2		0 (); 1	192.02
1993	61.02 (45.14); 4	107.94 (); 1	121.93 (); 1	
1994	96.97 (91.94); 3	0 (); 1	0 (); 1	
1995			152.92 (); 1	
1996	105.04 (67.19); 4		225.94 (); 1	
Summary Statistics				
Grand Mean	56.19	103.36	94.55	6714.04
SD	51.52	129.83	77.47	5438.93
Min	0.00	0.00	0.00	0.00
Max	201.82	363.89	225.94	13100.19
n	28	7	8	6
CV(%)	91.69	125.62	81.93	95.61

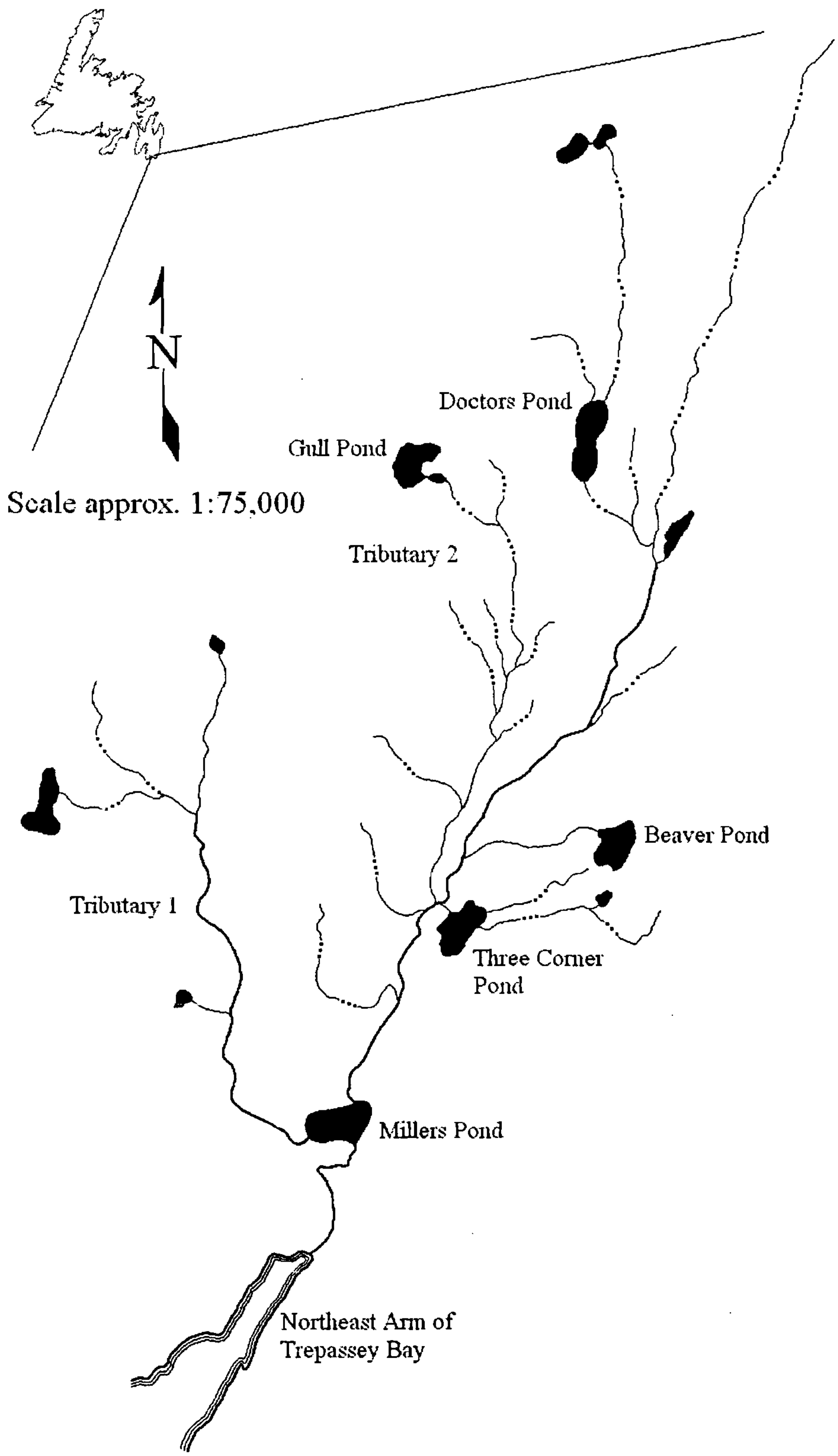


Figure 1. Study area of Northeast Brook, Trepassey.

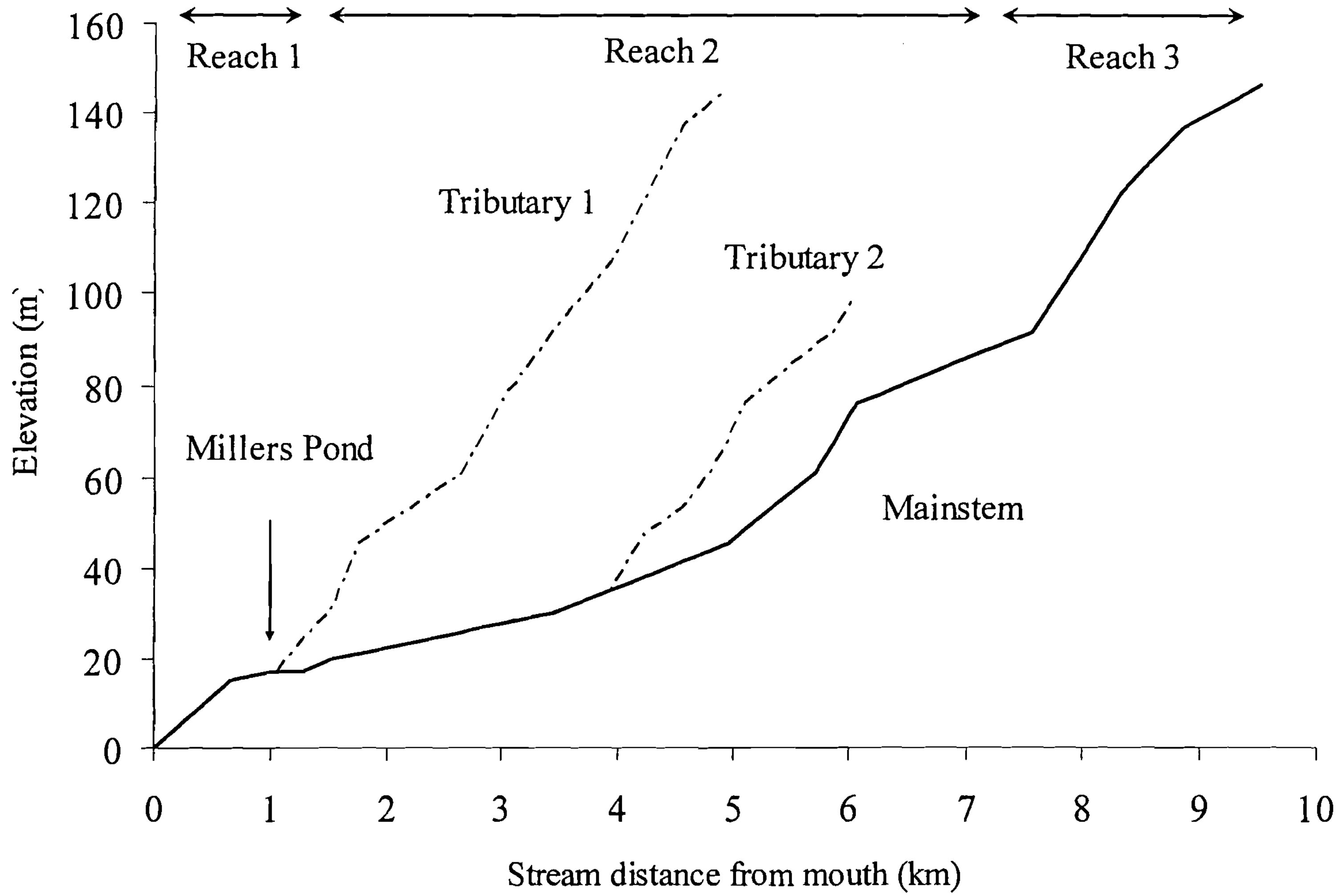


Figure 2. Longitudinal profile of Northeast Brook, Trepassey.

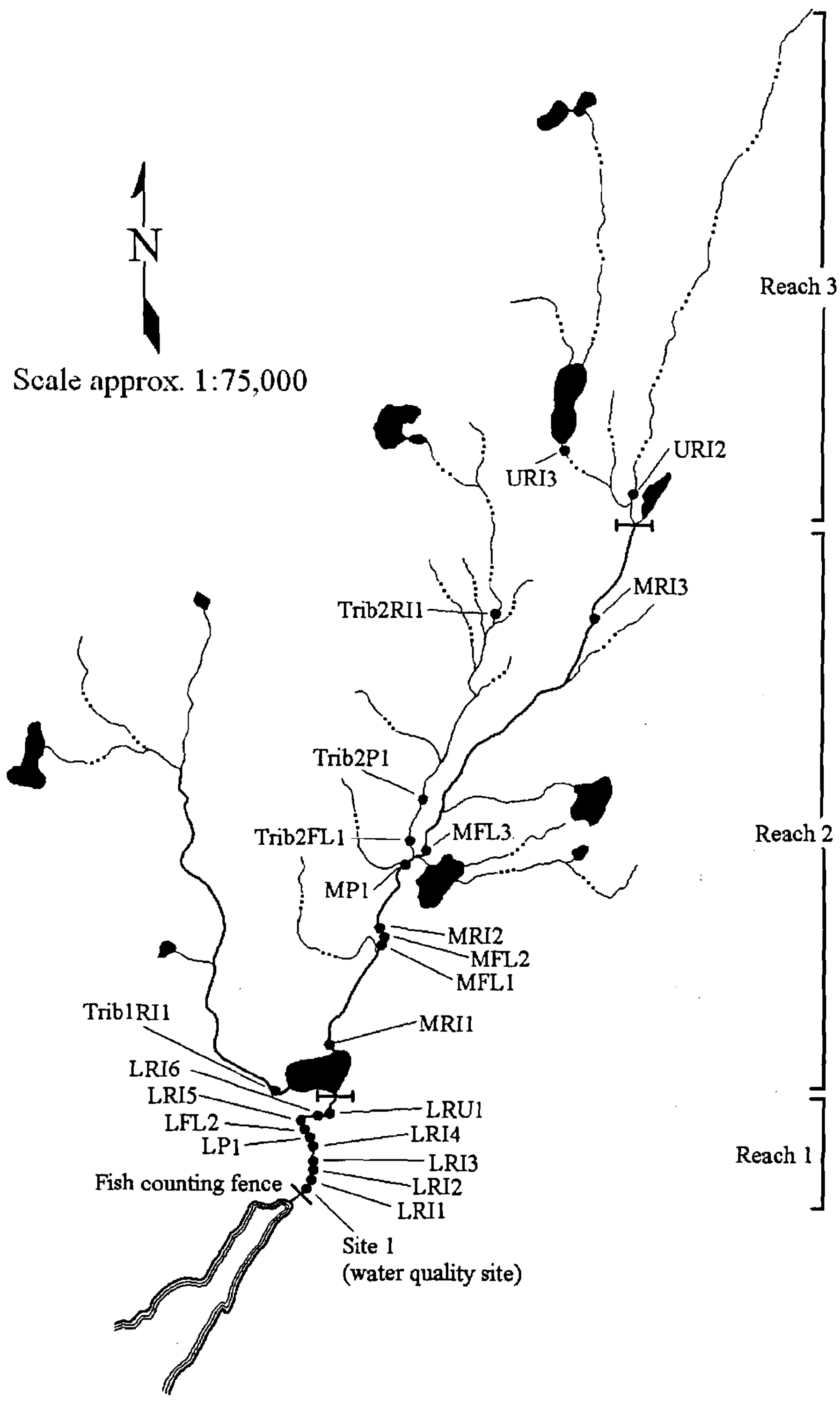
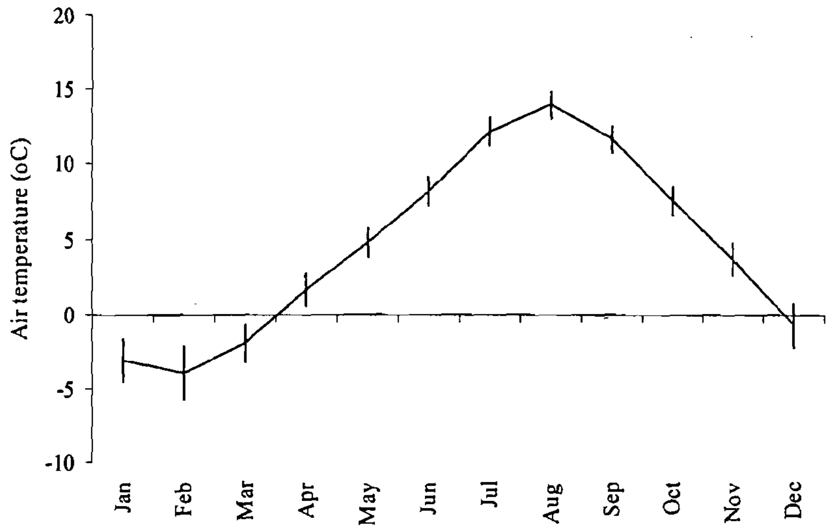


Figure 3. Northeast Brook reach delineations and sample site locations. See Table 2 for codes.

(a)



(b)

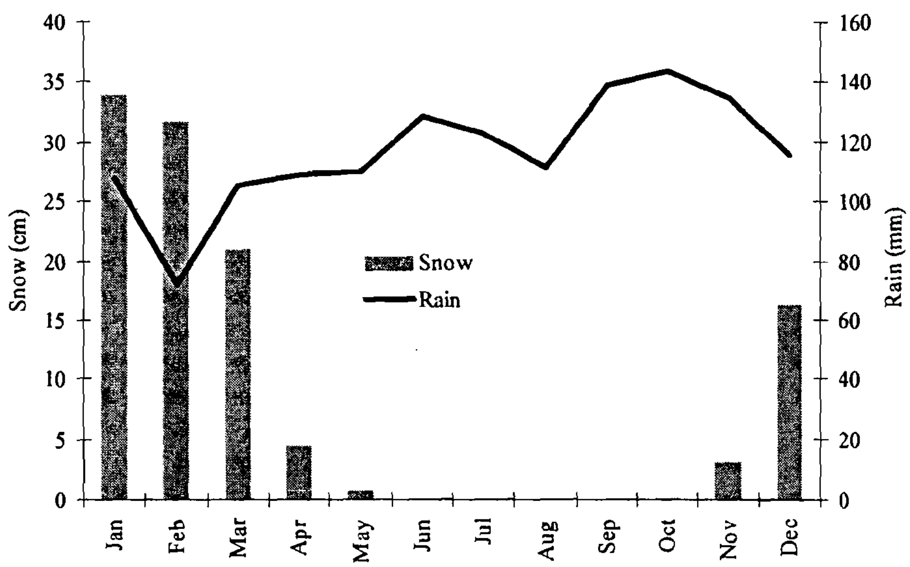


Figure 4. Air temperature (a) and precipitation (b) over a year near Northeast Brook, Trepassey. Data are climate normals (1971-2000) from St. Shotts station. Data from Environment Canada (Anonymous, 2005).

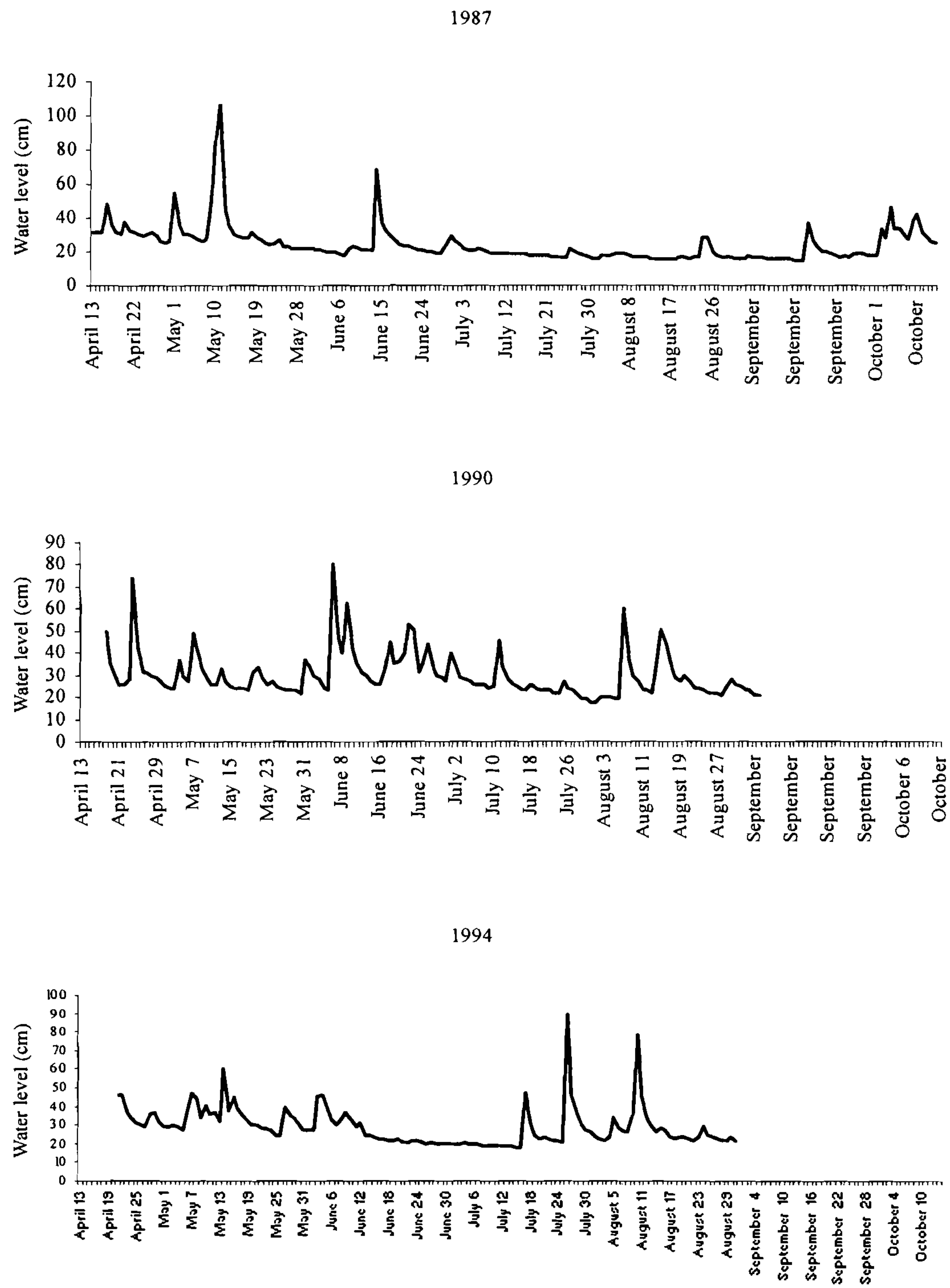


Figure 5. Representative hydrographs (water level) for Northeast Brook.

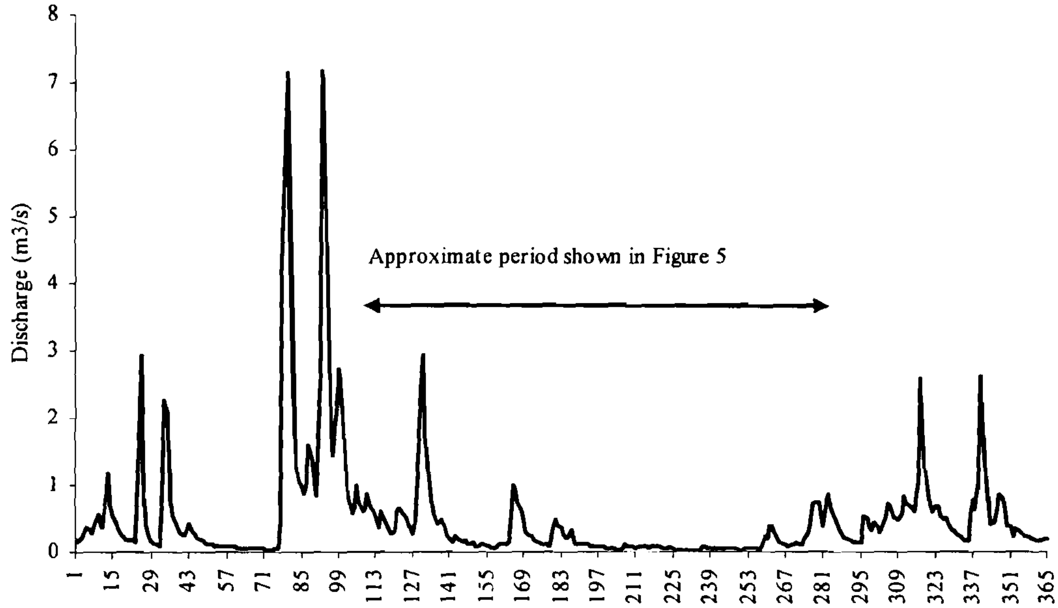


Figure 6. Estimated hydrograph for Northeast brook for the year 1987, based on pro-rating by drainage area the recorded discharge of St. Shotts River Station, (Station # 02ZN002; 46°42'32" N; 53°29'24" W; Drainage area 15.5 km2).

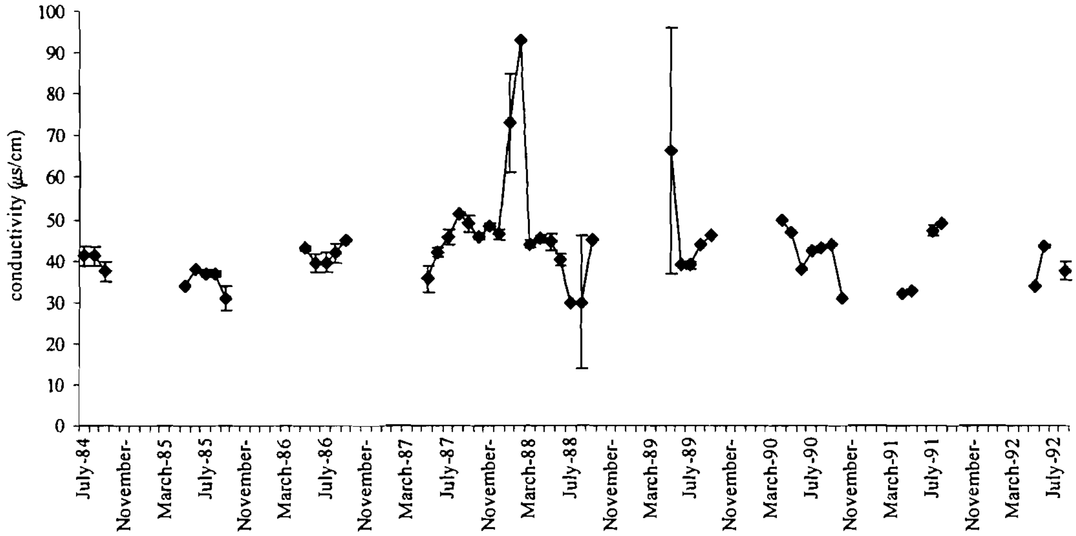


Figure 7 Specific Conductance of Northeast Brook water over period of sampling, 1984-1992. Error bars are SE.

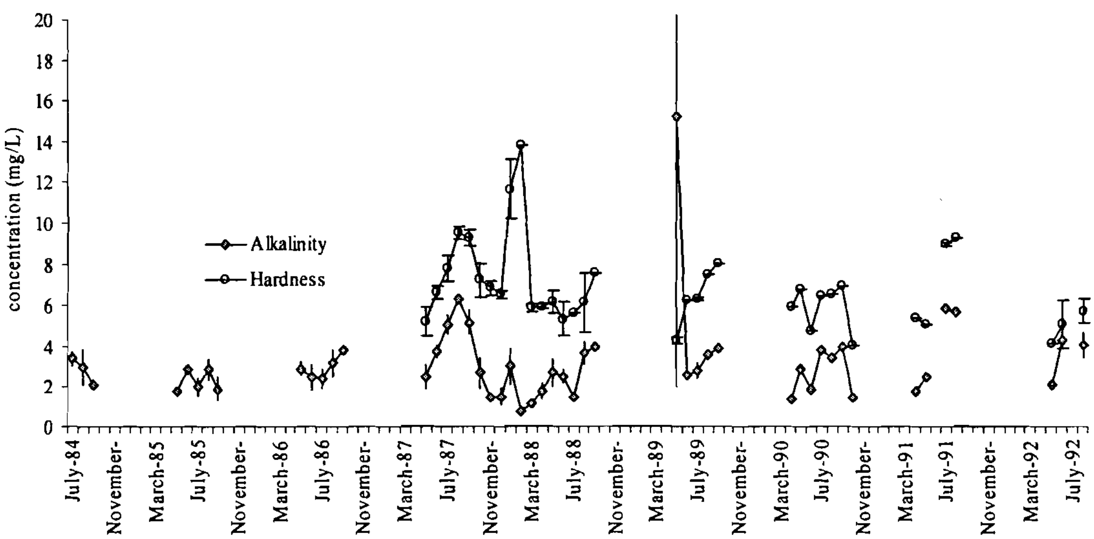


Figure 8: Alkalinity and hardness of Northeast Brook water over period of sampling, 1984-1992. Error bars are SE.

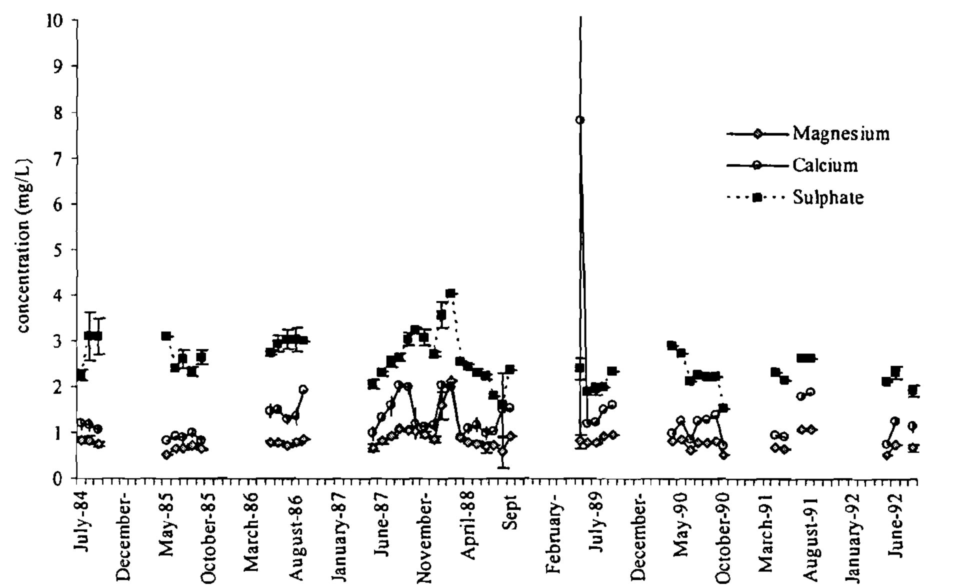


Figure 9: Magnesium, calcium, and sulphate concentrations of Northeast Brook water over period of sampling, 1984-1992. Error bars are SE.

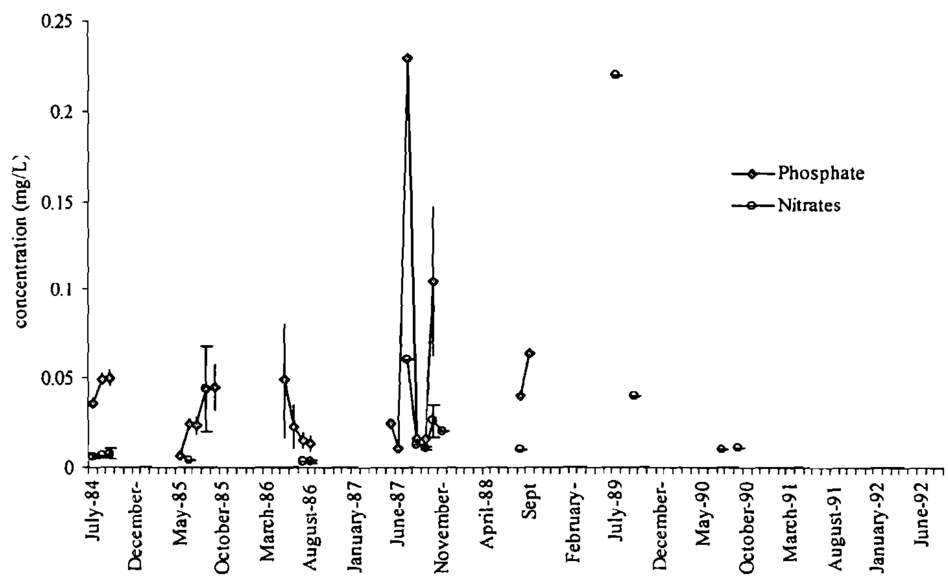


Figure 10: Phosphate and nitrate concentrations of Northeast Brook water over period of sampling, 1984-1992. Error bars are SE.

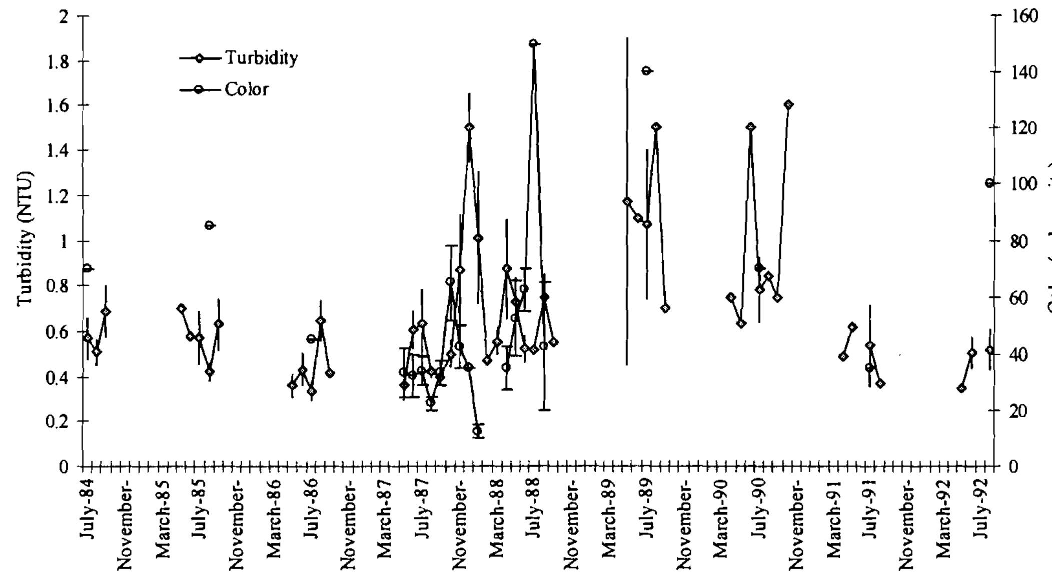


Figure 11: Turbidity and color of Northeast Brook water over period of sampling, 1984-1992. Error bars are SE.

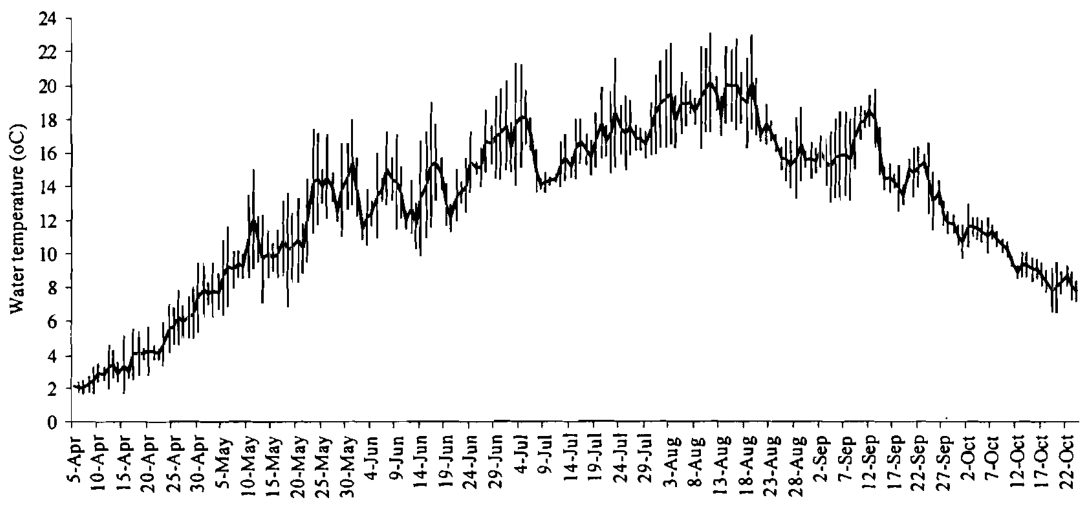


Figure 12 Daily mean water temperature in Northeast Brook for the year 1989. Error bars indicate daily range of minimum and maximum temperature

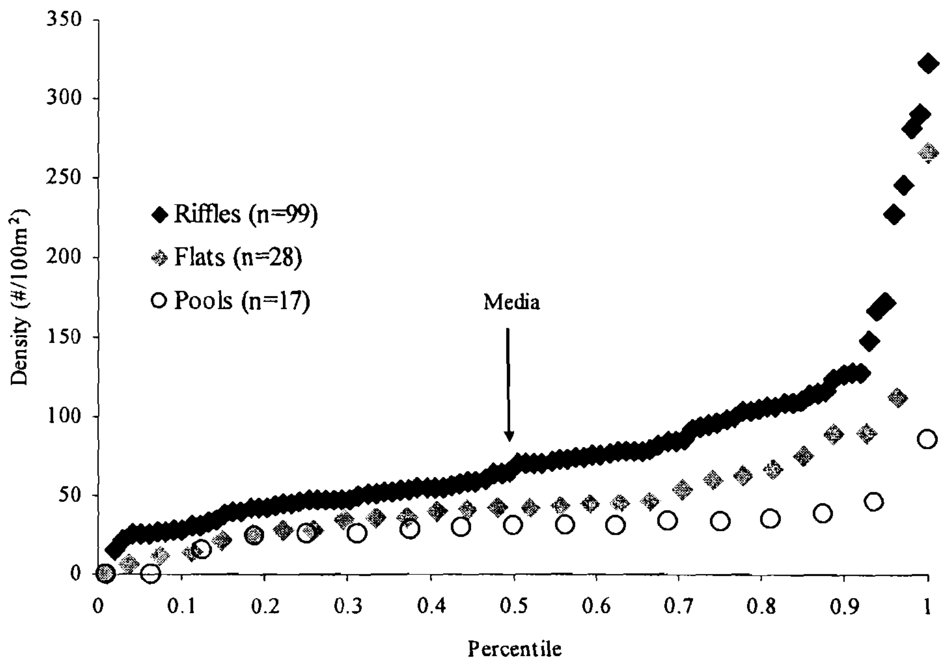


Figure 13: Frequency distribution of Atlantic salmon density estimates (all ages combined) for sampling of riffles, flats and pools in Northeast Brook, 1984-1996.

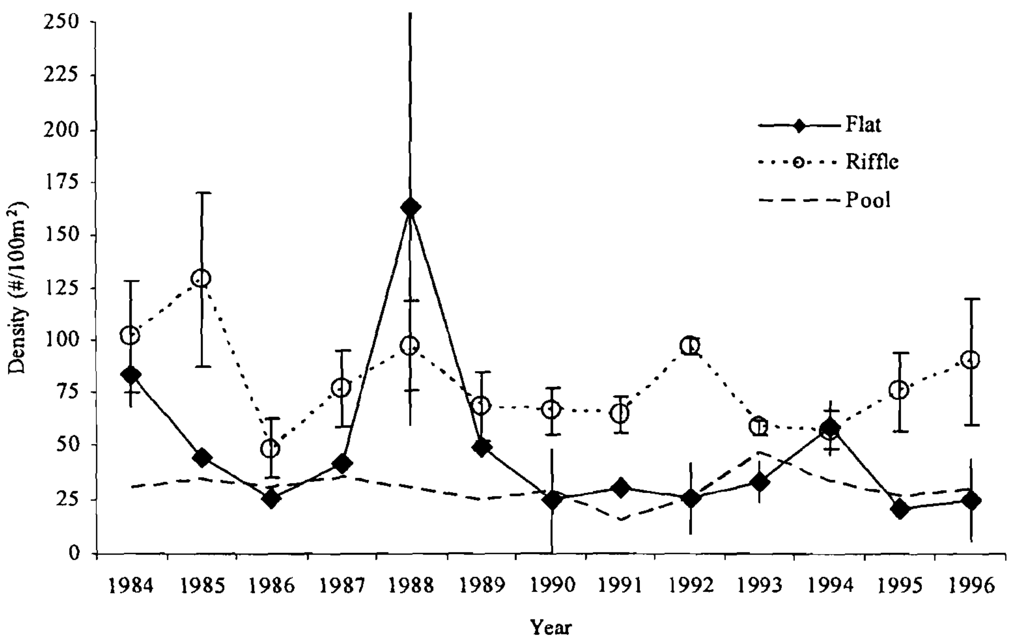


Figure 14: Mean Atlantic salmon density (all ages combined) over time in flats, riffles and pools, Northeast Brook, 1984-1996. Error bars are SE.

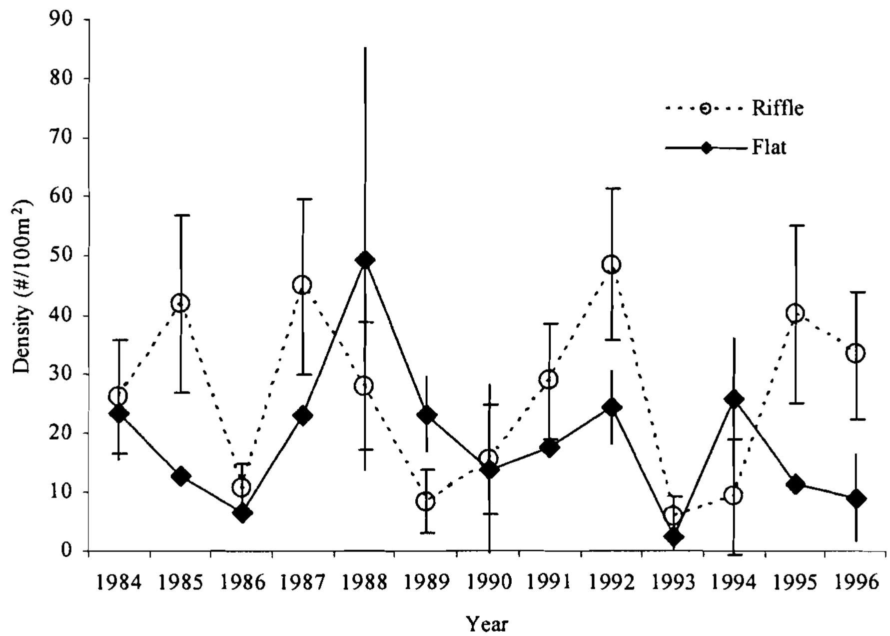


Figure 15: Mean Atlantic salmon age 0+ density over time in flats and riffles, Northeast Brook, 1984-1996. Error bars are SE. Pools not presented as they are an order of magnitude lower than riffles and flats.

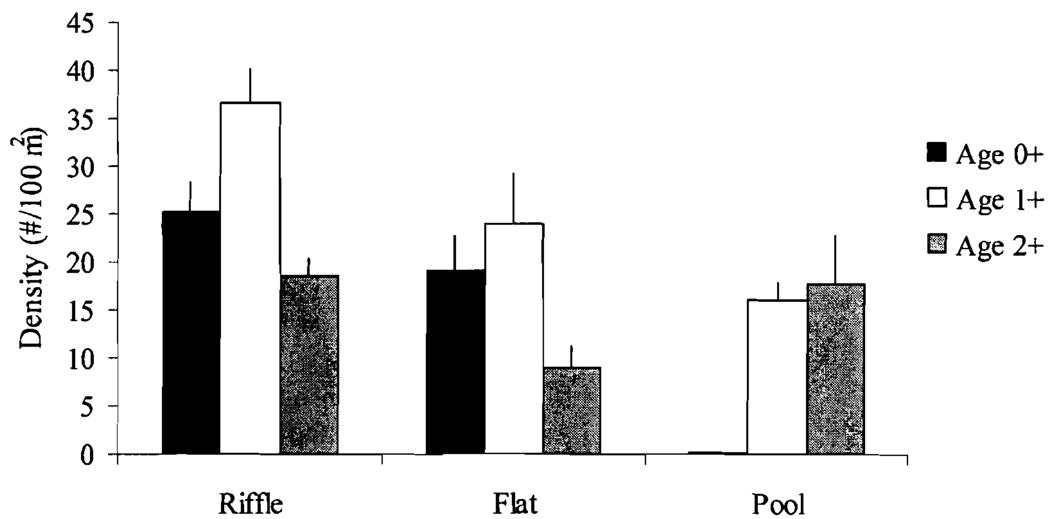


Figure 16: Mean density (all years combined) for the individual salmon age classes in riffles, flats and pools of Northeast Brook, 1984-1996. Error bars are SE

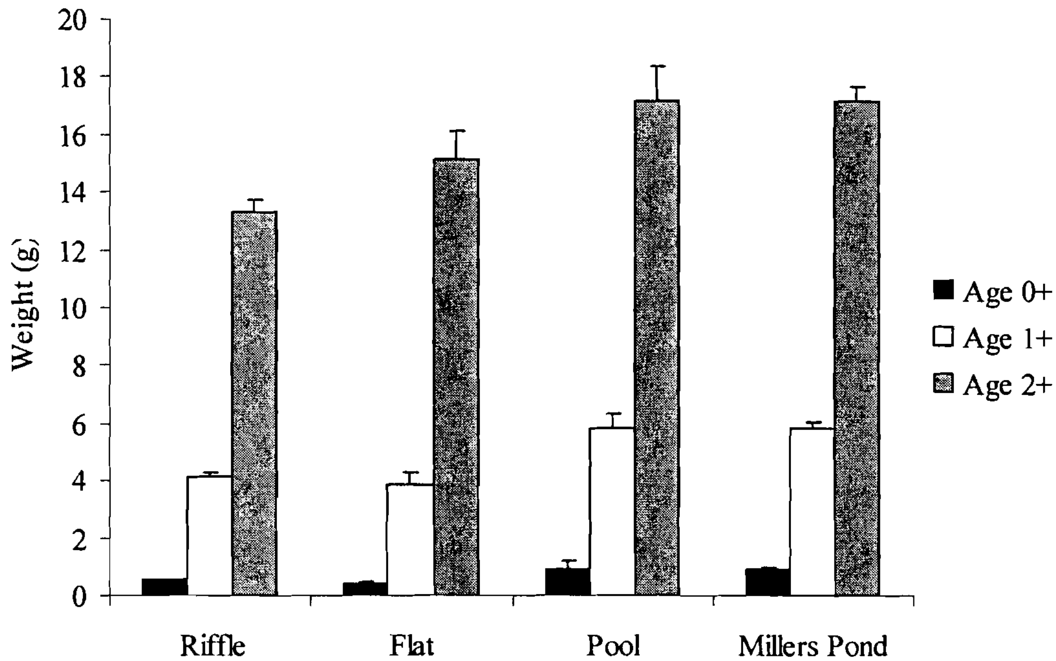


Figure 17: Mean weight (all years combined) for the individual salmon age classes in riffles, flats, pools and Millers Pond in Northeast Brook, 1984-96. Error bars are SE.

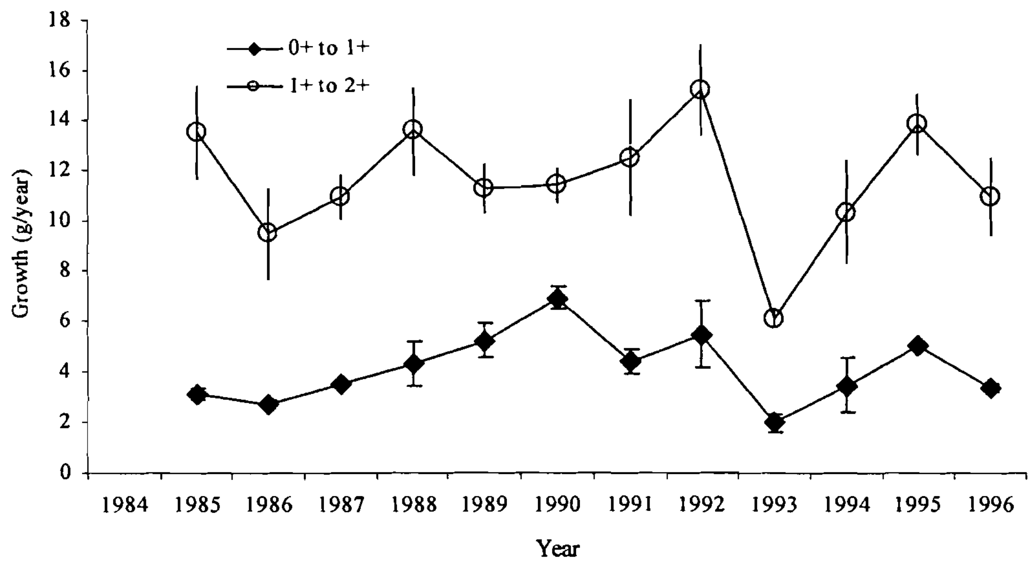


Figure 18: Mean growth of salmon between age classes (all habitat types pooled) in Northeast Brook, 1984-1996. Error bars are SE.

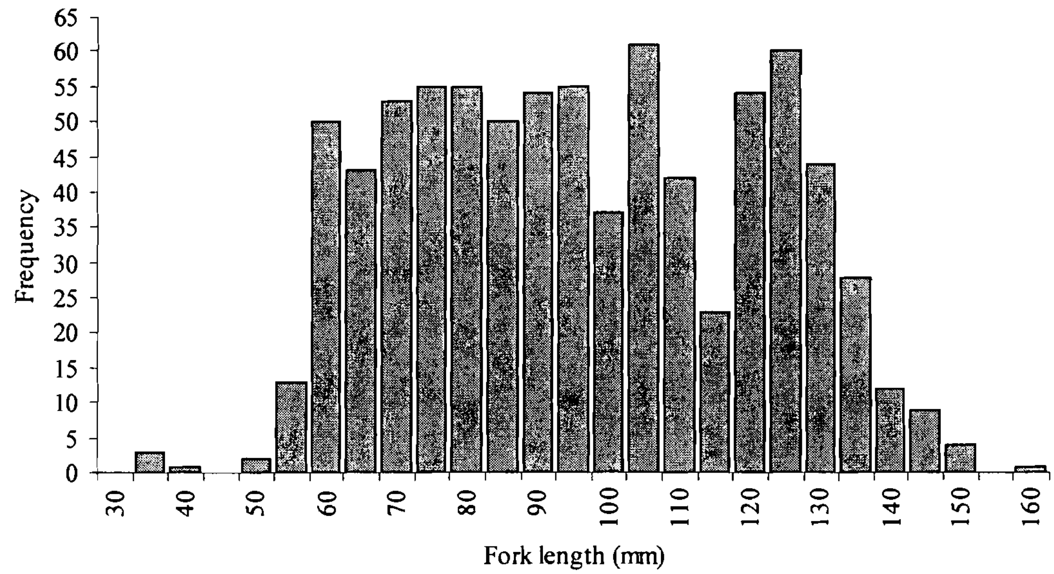


Figure 19: Length frequency plot of salmon from Millers Pond (n=808 fish)

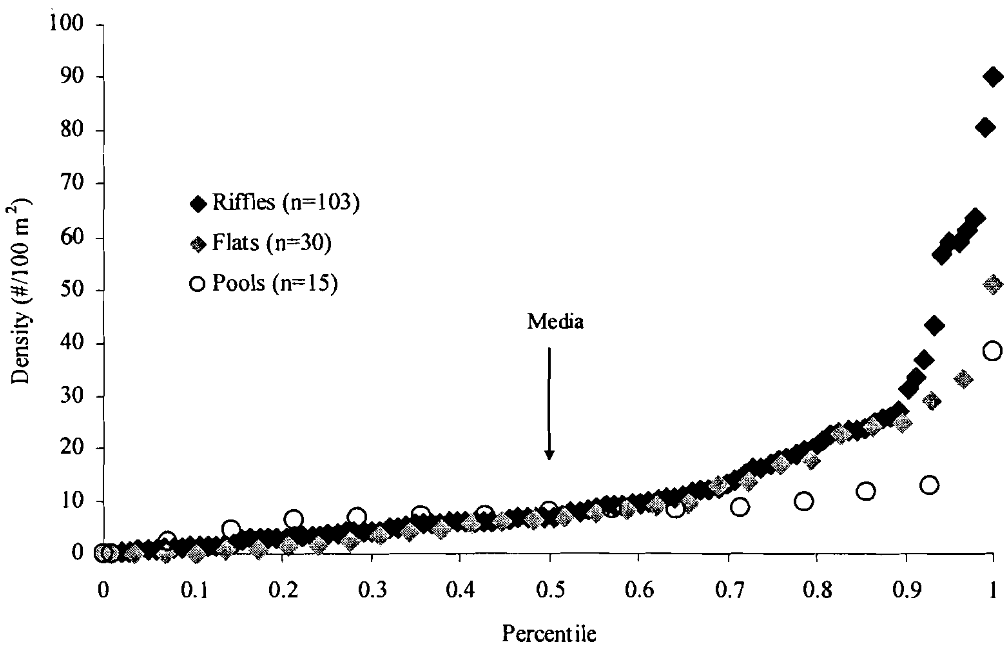


Figure 20: Frequency distribution of brook trout density estimates (all ages combined) for sampling of riffles, flats, and pools in Northeast Brook, 1984-1996.

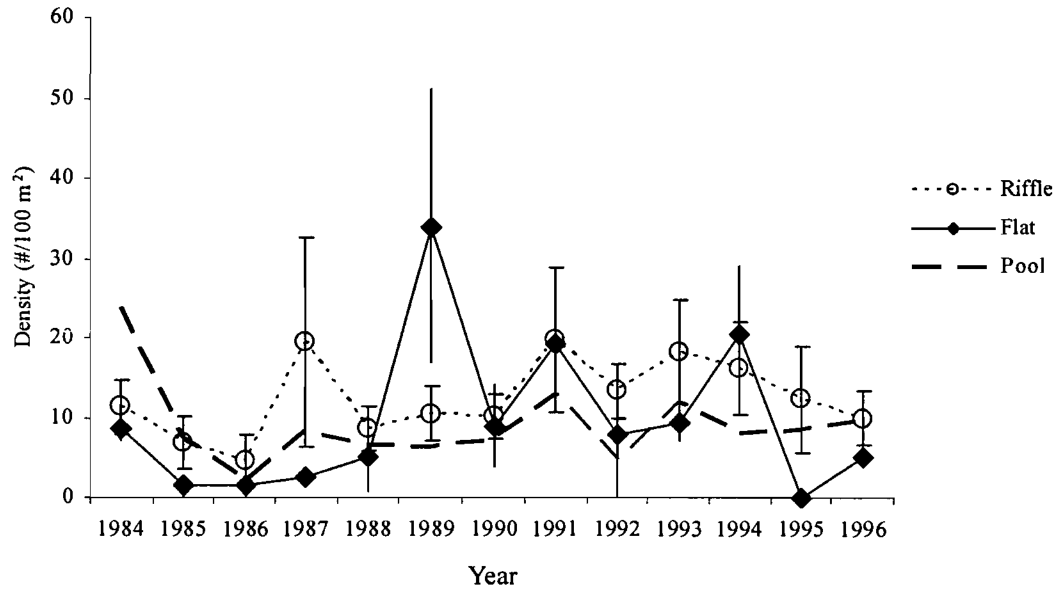


Figure 21: Mean brook trout density (all ages combined) over time in flats, riffles, and pools, Northeast Brook, 1984-96. Error bars are SE.

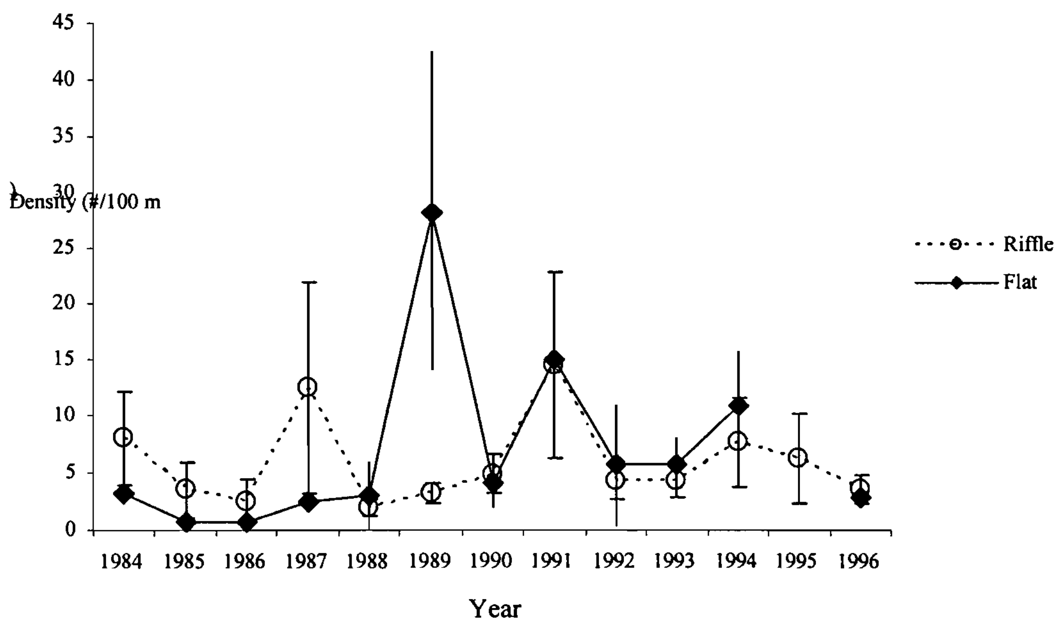


Figure 22: Mean brook trout age 0+ density over time in flats and riffles, Northeast Brook, 1984-96. Error bars are SE. Pools not presented as they are an order of magnitude lower than riffles and flats.

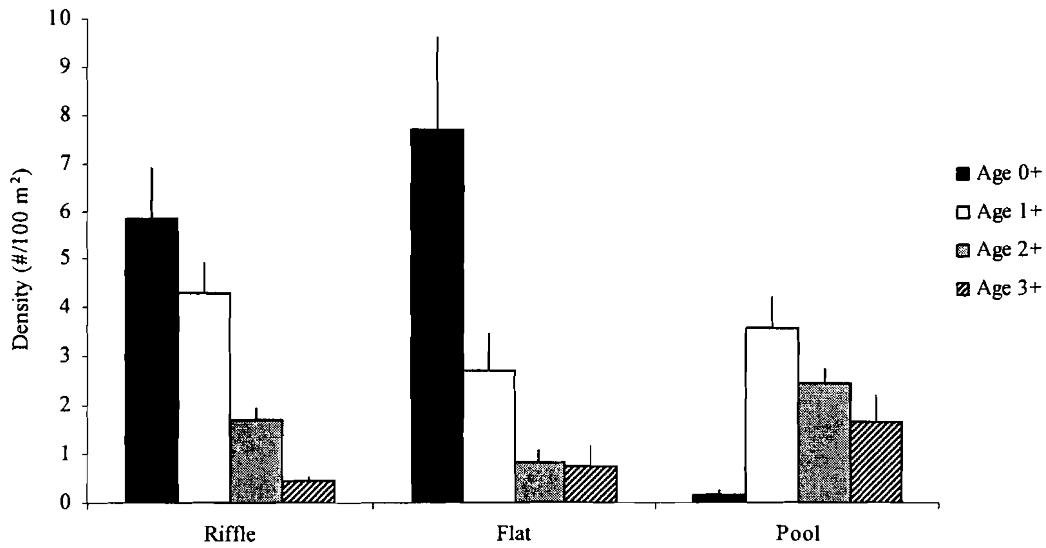


Figure 23: Mean density (all years combined) for the inividual brook trout age classes in riffles, flats and pools of Northeast Brook, 1984-96. Error bars are SE.

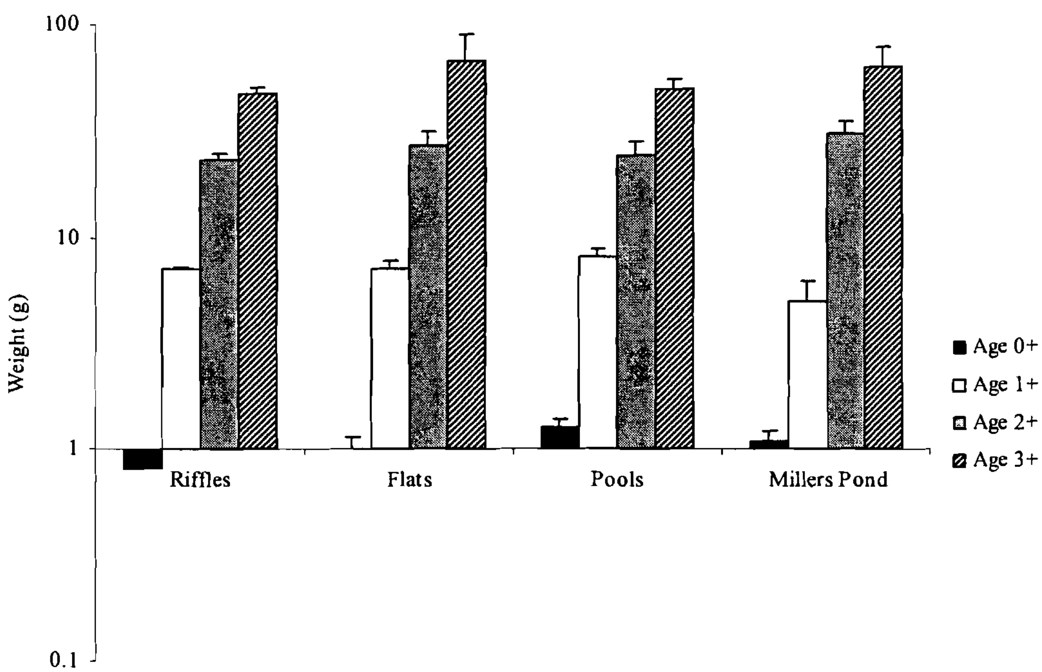


Figure 24: Mean weight (all years combined) for the individual brook trout age classes in riffles, flats, pools and Millers Pond in Northeast Brook, 1984-96. Error bars are SE. Note logarithimic scale.

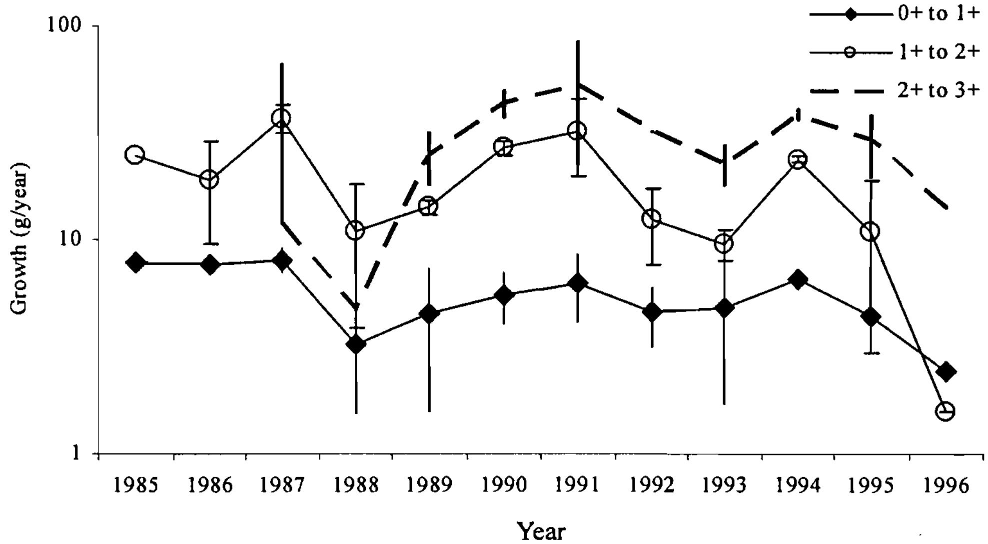


Figure 25: Mean growth of brook trout between age classes (all habitat types pooled) in Northeast Brook, 1984-96. Error bars are SE. Note logarithmic scale

Appendix 1. Size classes (cm) of Atlantic salmon by sites summarized by reach and habitat type, for Northeast Trepassey, 1984-96. Note: only when n>50 was the size frequency assessed; <50 was thought to have too few individuals to represent a meaningful distribution. When n<50 cutoffs are averages from same habitat type within the year.

		Lower				Millers	Middle		Upper	Tributary		
Year	Age	Riffle	Pool	Flat	Run	Pond	Riffle	Flat	Riffle	Pool	Riffle	Flat
1984	0+	<4.2	<5.0	<3.8	<3.8	<3.6	<4.2	<4.0	<4.2	<5.0	<4.2	
	1+	4.2-9.0	5.0-9.2	3.8-9.2	3.8-8.2	3.6-6.2	4.2-7.0	4.0-6.4	4.2-8.0	5.0-8.6	4.2-8.0	
	≥2+	>9.0	>9.2	>9.2	>8.2	>6.2	>7.0	>6.4	>8.0	>8.6	>8.0	
	n	944	158	91	59	1210	349	170	29	140	46	0
1985	0+	<5.0	<5.0	<5.0		<5.0	<4.4					
	1+	5.0-8.8	5.0-8.8	5.0-8.6		5.0-9.0	4.4-7.2					
	≥2+	>8.8	>8.8	>8.6		>9.0	>7.2					
	n	570	247	69	0	1913	349	0	0	0	0	0
1986	0+	<5.0	<5.0	<4.0		<5.0	<4.2					
	1+	5.0-9.0	5.0-8.4	4.0-7.8		5.0-10.0	4.2-7.0					
	≥2+	>9.0	>8.4	>7.8		>10.0	>7.0					
	n	248	228	95	0	1091	183	0	0	0	0	0
1987	0+	<4.8	<5.0	<4.2		<5.0	<3.8					
	1+	4.8-8.8	5.0-9.2	4.2-8.4		5.0-10.0	3.8-6.8					
	≥2+	>8.8	>9.2	>8.4		>10.0	>6.8					
	n	396	297	69	0	1588	181	0	0	0	0	0
1988	0+	<5.6	<5.0	<5.2		<5.0	<4.2	<3.8	<4.4		<5.0	
	1+	5.6-9.8	5.0-9.4	5.2-10.2		5.0-10.0	4.2-8.2	3.8-10.2	4.4-9.0		5.0-9.6	
	≥2+	>9.8	>9.4	>10.2		>10.0	>8.2	>10.2	>9.0		>9.6	
	n	302	244	119	0	2775	401	96	95	0	77	0

Appendix 1 (Cont'd.)

		Lower				Millers	Middle		Upper	Tributary		
Year	Age	Riffle	Pool	Flat	Run	Pond	Riffle	Flat	Riffle	Pool	Riffle	Flat
1989	0+	<4.8	<5.0	<5.4		<5.0	<4.4	<5.4	<5.0		<5.0	
	1+	4.8-10.0	5.0-10.2	5.4-9.6		5.0-10.0	4.4-7.8	5.4-9.6	5-10.6		5.0-10.6	
	≥2+	>10.0	>10.2	>9.6		>10.0	>7.8	>9.6	>10.6		>10.6	
	n	270	212	91	0	809	214	37	68	0	69	0
1990	0+	<5.0	<5.0	<5.0		<5.0	<5.4	<5.0	<5.0		<4.4	
	1+	5.0-10.6	5.0-10.0	5.0-10.8		5.0-10.0	5.4-8.4	5.0-10.8	5.0-10.0		4.4-10.6	
	≥2+	>10.6	>10.0	>10.8		>10.0	>8.4	>10.8	>10.0		>10.6	
	n	177	158	39	0	900	346	52	80	0	56	0
1991	0+	<5.2	<5.0	<4.2		<5.0	<5.0	<5.0	<4.0		<4.8	
	1+	5.2-10.0	5.0-9.8	4.2-10.0		5.0-7.2	5.0-8.4	5.0-11.2	4.0-8.0		4.8-8.8	
	≥2+	>10.0	>9.8	>10.0		>7.2	>8.4	>11.2	>8.0		>8.8	
	n	321	126	69	0	1142	322	64	93	0	44	0
1992	0+	<5.8	<5.0	<5.2		<5.6	<5.2	<5.2	<5.2		<5.4	
	1+	5.8-10.0	5.0-10.6	5.2-10.2		5.6-10.0	5.2-8.2	5.2-10.2	5.2-9.2		5.4-9.2	
	≥2+	>10.0	>10.6	>10.2		>10.0	>8.2	>10.2	>9.2		>9.2	
	n	508	194	89	0	696	460	35	202	0	37	0
1993	0+	<4.2	<5.2	<5.0			<4.4	<4.2	<5.0		<4.6	
	1+	4.2-8.4	5.2-8.4	5.0-7.8			4.4-7.4	4.2-7.2	5.0-7.4		4.6-7.8	
	≥2+	>8.4	>8.4	>7.8			>7.4	>7.2	>7.4		>7.8	
	n	283	295	74	0	0	308	51	102	0	40	0

Appendix 1 (Cont'd.)

		Lower				Millers	Middle		Upper	Tributary		
Year	Age	Riffle	Pool	Flat	Run	Pond	Riffle	Flat	Riffle	Pool	Riffle	Flat
1994	0+	<4.2	<5.0	<4.2		<5.0	<4.0	<4.6	<5.0		<4.2	
	1+	4.2-8.6	5.0-7.8	4.2-7.8		5.0-10.0	4.0-7.0	4.6-6.8	5.0-7.5		4.2-7.8	
	≥2+	>8.6	>7.8	>7.8		>10.0	>7.0	>6.8	>7.5		>7.8	
	n	333	219	186	0	592	262	106	79	0	39	0
1995	0+	<5.6	<5.0	<5.0			<5.0		<4.8			
	1+	5.6-9.8	5.0-10.0	5.0-9.6			5.0-8.8		4.8-9.8			
	≥2+	>9.8	>10.0	>9.6			>8.8		>9.8			
	n	210	147	54	0	0	255	0	103	0	0	0
1996	0+	<4.4	<5.0	<5.0			<4.0	<5.0	<5.4		<5.2	
	1+	4.4-9.6	5.0-9.8	5.0-9.0			4.0-7.6	5.0-9.0	5.4-9.8		5.2-7.4	
	≥2+	>9.6	>9.8	>9.0			>7.6	>9.0	>9.8		>7.4	
	n	317	236	115	0	0	282	22	132	0	134	0

Appendix 1. (Cont'd.) Size classes (cm) of brook trout by sites summarized by reach and habitat type, for Northeast Trepassey, 1984-96. Note: only when n>50 was the size frequency assessed; <50 was thought to have too few individuals to represent a meaningful distribution. When n<50 cutoffs are averages from same habitat type within the year.

		Lower				Millers	Middle		Upper	Tributary		
Year	Age	Riffle	Pool	Flat	Run	Pond	Riffle	Flat	Riffle	Pool	Riffle	Flat
1984	0+	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	
	1+	5.8-10.8	5.8-10.8	5.8-10.8	5.8-10.8	5.8-8.6	5.8-10.8	5.8-10.8	5.8-10.8	5.8-9.8	5.8-10.8	
	2+	10.8-14.0	10.81-14.0	10.81-14.0	10.81-14.0	8.6-14.8	10.81-14.0	10.81-14.0	10.81-14.0	9.8-14.2	10.81-14.0	
	≥3+	>14.0	>14.0	>14.0	>14.0	>14.8	>14.0	>14.0	>14.0	>14.2	>14.0	
	n	68	32	9	6	620	24	23	11	76	12	0
1985	0+	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8				
	1+	5.8-10.8	5.8-10.8	5.8-10.8	5.8-10.8	5.8-10.8	5.8-10.8	5.8-10.8				
	2+	10.81-14.0	10.81-14.0	10.81-14.0	10.81-14.0	>10.8	10.81-14.0	10.81-14.0				
	≥3+	>14.0	>14.0	>14.0	>14.0		>14.0	>14.0				
	n	33	47	4	0	487	10	10	0	0	0	0
1986	0+	<5.8	<5.8	<5.8		<6.4	<5.8					
	1+	5.8-10.8	5.8-10.8	5.8-10.8		6.4-13.4	5.8-10.8					
	2+	10.81-14.0	10.81-14.0	10.81-14.0		13.4-17.4	10.81-14.0					
	≥3+	>14.0	>14.0	>14.0		>17.4	>14.0					
	n	22	26	9	0	592	9	0	0	0	0	0
1987	0+	<5.8	<5.8	<5.8		<6.4	<5.8					
	1+	5.8-11.0	5.8-10.8	5.8-10.8		6.4-13.6	5.8-10.8					
	2+	>11.0	10.81-14.0	10.81-14.0		>13.6	10.81-14.0					
	≥3+		>14.0	>14.0			>14.0					
	n	75	58	6	0	572	21	0	0	0	0	0

Appendix 1. (Cont'd.) Size classes (cm) of brook trout by sites summarized by reach and habitat type, for Northeast Trepassey, 1984-96. Note: only when n>50 was the size frequency assessed; <50 was thought to have too few individuals to represent a meaningful distribution. When n<50 cutoffs are averages from same habitat type within the year.

		Lower				Millers	Middle		Upper	Tributary		
Year	Age	Riffle	Pool	Flat	Run	Pond	Riffle	Flat	Riffle	Pool	Riffle	Flat
1988	0+	<5.8	<5.8	<5.8		<5.0	<5.8	<5.8	<5.8		<5.8	
	1+	5.8-10.8	5.8-10.8	5.8-10.8		5.0-7.2	5.8-10.8	5.8-10.8	5.8-10.8		5.8-10.8	
	2+	10.81-14.0	10.81-14.0	10.81-14.0		7.2-14.0	10.81-14.0	10.81-14.0	10.81-14.0		10.81-14.0	
	≥3+	>14.0	>14.0	>14.0		>14.0	>14.0	>14.0	>14.0		>14.0	
	n	38	45	16	0	684	18	3	8	0	12	0
1989	0+	<5.8	<5.8	<5.8		<5.0	<5.8	<5.8	<5.8		<5.8	
	1+	5.8-10.8	5.8-10.8	5.8-10.8		5.0-9.2	5.8-10.8	5.8-10.8	5.8-10.8		5.8-10.8	
	2+	10.81-14.0	10.81-14.0	10.81-14.0		9.2-14.0	10.81-14.0	10.81-14.0	10.81-14.0		10.81-14.0	
	≥3+	>14.0	>14.0	>14.0		>14.0	>14.0	>14.0	>14.0		>14.0	
	n	46	43	6	0	596	18	6	10	0	12	0
1990	0+	<5.8	<6.2	<5.8		<4.6	<5.8	<5.8	<5.8		<5.8	
	1+	5.8-10.8	6.2-13.0	5.8-10.8		4.6-7.6	5.8-10.8	5.8-10.8	5.8-10.8		5.8-10.8	
	2+	10.81-14.0	>13.0	10.81-14.0		7.6-15.2	10.81-14.0	10.81-14.0	10.81-14.0		10.81-14.0	
	≥3+	>14.0		>14.0		>15.2	>14.0	>14.0	>14.0		>14.0	
	n	30	56	9	0	689	36	25	18	0	11	0
1991	0+	<6.0	<6.0	<5.8		<5.0	<6.0	<5.8	<5.8		<5.8	
	1+	6.0-12.0	6.0-12.0	5.8-10.8		5.0-8.2	6.0-14.0	5.8-10.8	5.8-10.8		5.8-10.8	
	2+	>12.0	>12.0	10.81-14.0		8.2-15.2	>14.0	10.81-14.0	10.81-14.0		10.81-14.0	
	≥3+			>14.0		>15.2		>14.0	>14.0		>14.0	
	n	81	114	9	0	939	83	43	9	0	8	0

Appendix 1. (Cont'd.) Size classes (cm) of brook trout by sites summarized by reach and habitat type, for Northeast Trepassey, 1984-96. Note: only when n>50 was the size frequency assessed; <50 was thought to have too few individuals to represent a meaningful distribution. When n<50 cutoffs are averages from same habitat type within the year.

		Lower				Millers	Middle		Upper	Tributary		
Year	Age	Riffle	Pool	Flat	Run	Pond	Riffle	Flat	Riffle	Pool	Riffle	Flat
1992	0+	<5.8	<5.8	<5.8		<4.6	<5.8	<5.8	<5.8		<5.8	
	1+	5.8-10.8	5.8-10.8	5.8-10.8		4.6-7.4	5.8-10.8	5.8-10.8	5.8-10.8		5.8-10.8	
	2+	10.81-14.0	10.81-14.0	10.81-14.0		7.4-14.0	10.81-14.0	10.81-14.0	10.81-14.0		10.81-14.0	
	≥3+	>14.0	>14.0	>14.0		>14.0	>14.0	>14.0	>14.0		>14.0	
	n	49	26	2	0	672	43	23	25	0	18	0
1993	0+	<5.8	<5.8	<5.8			<5.8	<5.8	<5.8		<5.8	
	1+	5.8-10.8	5.8-9.8	5.8-10.8			5.8-10.8	5.8-10.8	5.8-10.8		5.8-10.8	
	2+	10.81-14.0	9.8-12.4	10.81-14.0			10.81-14.0	10.81-14.0	10.81-14.0		10.81-14.0	
	≥3+	>14.0	>12.4	>14.0			>14.0	>14.0	>14.0		>14.0	
	n	46	72	17	0	0	28	21	34	0	5	0
1994	0+	<5.8	<5.8	<5.8		<6.2	<5.8	<4.0	<5.8		<5.8	
	1+	5.8-10.0	5.8-11.0	5.8-10.8		6.2-11.2	5.8-10.8	4.0-10.4	5.8-10.8		5.8-10.8	
	2+	>10.0	11.0-15.4	10.81-14.0		>11.2	10.81-14.0	>10.4	10.81-14.0		10.81-14.0	
	≥3+		>15.4	>14.0			>14.0		>14.0		>14.0	
	n	86	63	11	0	343	40	54	26	0	4	0
1995	0+	<5.0	<5.8				<5.8		<5.8			
	1+	5.0-9.2	5.8-10.8				5.8-10.8		5.8-10.8			
	2+	>9.2	10.81-14.0				10.81-14.0		10.81-14.0			
	≥3+		>14.0				>14.0		>14.0			
	n	52	44	0	0	0	27	0	11	0	0	0

Appendix 1. (Cont'd.) Size classes (cm) of brook trout by sites summarized by reach and habitat type, for Northeast Trepassey, 1984-96. Note: only when n>50 was the size frequency assessed; <50 was thought to have too few individuals to represent a meaningful distribution. When n<50 cutoffs are averages from same habitat type within the year.

		Lower				Millers	Middle		Upper	Tributary		
Year	Age	Riffle	Pool	Flat	Run	Pond	Riffle	Flat	Riffle	Pool	Riffle	Flat
1996	0+	<5.8	<5.2	<5.8			<5.8	<5.8	<5.8		<5.8	
1996	1+	5.8-10.8	5.2-7.4	5.8-10.8			5.8-10.8	5.8-10.8	5.8-10.8		5.8-10.8	
1996	2+	10.81-14.0	7.4-10.0	10.81-14.0			10.81-14.0	10.81-14.0	10.81-14.0		10.81-14.0	
1996	≥3+	>14.0	>10.0	>14.0			>14.0	>14.0	>14.0		>14.0	
1996	n	34	90	5	0	0	35	14	29	0	5	0

Appendix 2. Physical habitat data summary for Northeast Brook, 1984-96. Notation is mean (SD); sample size. Sample size is number of years sampled.

Site	Mean Velocity	COVER Instream	Overhanging	Canopy	SUBSTRATE Rating	FB and Fines	Gravel	Pebble	Cobble	Rubble	Boulder
Units	(m/s)	(%)	(%)	(%)		(%)	(%)	(%)	(%)	(%)	(%)
LFL2	0.22 (0.09); 13	15.83 (9.31); 12	14.75 (6.29); 12	6.08 (6.05); 12	4.55 (0.54); 11	0.66 (1.15); 12	7.16 (5.4); 12	11.16 (8.95); 12	16.5 (4.54); 12	35.58 (12.88); 12	28.91 (12.92); 12
LP1	0.06 (0.03); 8	8.75 (8.29); 12	4.3 (2.68); 13	1.75 (1.81); 12	4.2 (0.56); 11	7.25 (9.48); 12	9.58 (8.91); 12	14 (12.03); 12	21.33 (12.33); 12	27.5 (14.38); 12	20.33 (12.01); 12
LRI1	0.34 (0.06); 13	9.46 (10.35); 13	5.33 (3.7); 12	4.18 (3.48); 11	5.15 (0.26); 12	0.46 (1.39); 13	3.3 (1.79); 13	5.92 (3.06); 13	13.15 (5.09); 13	27.38 (10.07); 13	49.76 (13.26); 13
LRI2	0.33 (0); 2	8 (9.89); 2	7 (7.07); 2	0 (0); 2	5.15 (0.21); 2	0 (0); 2	2.5 (0.7); 2	4 (1.41); 2	12 (2.82); 2	37.5 (17.67); 2	44 (19.79); 2
LRI3	0.35 (0.04); 2	8 (9.89); 2	7 (7.07); 2	0 (0); 1	5.3 (0.42); 2	0 (0); 2	1 (1.41); 2	1.5 (2.12); 2	17.5 (17.67); 2	27.5 (17.67); 2	52.5 (31.81); 2
LRI4	0.34 (0.04); 4	36.25 (10.3); 4	12.5 (5); 4	0 (0); 2	4.35 (0.05); 4	1.5 (1.73); 4	7.5 (2.88); 4	10.5 (7.37); 4	31 (9.38); 4	31.25 (6.29); 4	18.25 (7.22); 4
LRI5	0.3 (0.06); 11	21.36 (10.38); 11	8.63 (6.12); 11	7.63 (3.69); 11	4.31 (0.44); 10	0.9 (1.7); 11	7.81 (4.26); 11	18.18 (10.52); 11	24 (12.24); 11	32.27 (15.38); 11	16.72 (10.93); 11
LRI6	0.23 (0.16); 5	9 (9.92); 5	5.8 (7.98); 5	0.8 (0.44); 5	4.76 (0.4); 5	0 (0); 5	0.2 (0.44); 5	5 (5); 5	42 (20.49); 5	24.8 (9.36); 5	28 (14.4); 5
LRU1	0.19 (0); 1	20 (0); 1	30 (0); 1	0 (0); 1	4.2 (0); 1	0 (0); 1	5 (0); 1	5 (0); 1	60 (0); 1	30 (0); 1	0 (0); 1
MFL1	0.15 (0.02); 5	13.16 (13.79); 6	23.83 (7.62); 6	40.33 (10.13); 6	3.42 (0.16); 5	2.33 (2.58); 6	13.16 (7.78); 6	46 (7.72); 6	26 (9.81); 6	8.83 (2.4); 6	3.66 (3.5); 6
MFL2	0.18 (0.09); 9	5.77 (3.83); 9	10.44 (9.26); 9	19.66 (12.73); 9	3.6 (0.35); 8	3.66 (3.96); 9	15.44 (9.7); 9	31.33 (11.92); 9	25.55 (16.28); 9	17.66 (7.15); 9	6.33 (5.65); 9
MFL3	0.15 (0); 1	6 (0); 1	20 (0); 1	0 (0); 1	3.3 (0); 1	5 (0); 1	15 (0); 1	30 (0); 1	45 (0); 1	5 (0); 1	0 (0); 1
MRI1	0.32 (0.1); 13	4.33 (2.96); 12	10.75 (8.72); 12	36.25 (15.39); 12	4.38 (0.31); 12	1 (1.52); 13	4.84 (3.02); 13	17.61 (10.12); 13	28.84 (7.5); 13	30.69 (9.25); 13	17 (8.48); 13
MRI2	0.27 (0.1); 9	4.44 (2.83); 9	4.75 (1.58); 8	9.75 (5.39); 8	3.88 (0.39); 8	2.22 (3.34); 9	7.88 (4.51); 9	26.11 (7.81); 9	32.88 (7.75); 9	21.33 (9.98); 9	9.55 (5.98); 9
MRI3	0.29 (0.11); 10	2.5 (2.54); 10	3.1 (4.14); 10	1.9 (1.72); 10	4.12 (0.22); 9	0.8 (2.2); 10	5 (2.94); 10		35.6 (6.88); 10	33.4 (11.73); 10	5.1 (4.9); 10

Appendix 2 (Cont'd.)

Site	Mean Velocity	Instream	COVER Overhanging	Canopy	Rating	FB and Fines	Gravel	Pebble	SUBSTRATE Cobble	Rubble	Boulder	IB
Units	(m/s)	(%)	(%)	(%)		(%)	(%)	(%)	(%)	(%)	(%)	(%)
URI2	0.28 (0.12); 10	8.8 (14.77); 10	18.3 (14.54); 10	23.6 (13.68); 10	4.8 (0.23); 9	0 (0); 10	3 (3.19); 10	10.1 (8.02); 10	25.3 (5.85); 10	31.5 (6.68); 10	30.1 (8.46); 10	0 (0); 10
Trib1RI1	0.26 (0.13); 13	13 (20.1); 12	14 (7.54); 12	15.08 (8.83); 12	4.11 (0.36); 12	0.76 (1.58); 13	8.38 (7.29); 13	18.15 (8.33); 13	35.23 (12.61); 13	26.69 (14.07); 13	10.76 (4.14); 13	0 (0); 13
Trib2FL1	0.21 (0); 1	15 (0); 1	20 (0); 1	5 (0); 1	3.2 (0); 1	2 (0); 1	15 (0); 1	50 (0); 1	30 (0); 1	3 (0); 1	0 (0); 1	0 (0); 1
Trib2P1		30 (0); 1	0 (0); 1	0 (0); 1	4.6 (0); 1	5 (0); 1	0 (0); 1	10 (0); 1	20 (0); 1	40 (0); 1	25 (0); 1	0 (0); 1
Trib2RI1	0.24 (0.13); 8	13.62 (22.12); 8	14.5 (19.92); 8	16.87 (18.11); 8	4.44 (0.33); 7	0.62 (1.76); 8	4.75 (3.1); 8	16 (8.75); 8	33.75 (5.82); 8	21 (6.04); 8	23.87 (8.44); 8	0 (0); 8

Appendix 3. Water quality data summary for Northeast Brook, 1984-96. Notation is mean (SD); sample size. Sample size is total number of samples over period of sampling

Site	Water temperature	Turbidity	Colour	pH	Specific Conductance	Total Alkalinity	Total Hardness
Units	(deg. C)	(NTU)	(Colour Units)	(pH units)	(μS/cm)	(mg/L)	(mg/L $CaCO_3$)
Site 1		0.55 (0.29); 71	36.59 (17.48); 22	6.37 (0.52); 71	42.16 (8.66); 71	3.66 (3.38); 70	7.36 (1.8); 33
LFL2	17.63 (2.27); 11	0.52 (0.12); 6	77.85 (42.31); 7	6.44 (0.33); 6	39.8 (3.63); 5	3.15 (0.76); 6	6.32 (1.41); 3
LP1	17.46 (2.87); 12	0.55 (0.23); 5	75.83 (35.83); 6	6.61 (0.35); 5	43 (4.24); 5	3.62 (1.32); 5	7.72 (1.29); 2
LRI1	17.93 (2.3); 13	0.75 (0.37); 52	54.64 (34.63); 28	6.31 (0.49); 52	46.9 (15.37); 51	2.69 (1.33); 52	6.85 (2.41); 48
LRI2	16.25 (0.77); 2	0.52 (0.08); 2	77.5 (10.6); 2	6.3 (0.14); 2	36.5 (2.12); 2	2.85 (0.49); 2	
LRI3	17 (0.14); 2	0.52 (0.08); 2	77.5 (10.6); 2	6.3 (0.14); 2	36.5 (2.12); 2	2.85 (0.49); 2	
LRI4	12.7 (3.5); 3	0.43 (0.08); 5	88.75 (22.5); 4	5.79 (0.49); 5	37.2 (4.65); 5	1.62 (1.09); 4	
LRI5	15.61 (5.92); 11	0.61 (0.12); 6	96.66 (41.19); 6	6.46 (0.44); 6	40 (5.05); 6	3.38 (1.28); 6	6.2 (1.07); 5
LRI6	18.57 (1.33); 4						
LRU1	19.5 (0); 1						
MFL1	15.78 (1.91); 6	0.4 (0.14); 2		6.72 (0.09); 2	46 (1.41); 2	4.5 (0.14); 2	
MFL2	15.33 (1.61); 9	0.8 (0.42); 2		6.58 (0.09); 2	42.5 (3.53); 2	4.1 (0.7); 2	
MFL3	17.4 (0); 1						
MRI1	15.7 (2.21); 13	0.55 (0.17); 8	52.75 (43.41); 8	6.79 (0.36); 8	45.57 (4.57); 7	4.65 (1.16); 8	8 (0.74); 5
MRI2	16.58 (2.17); 8	0.43 (0.16); 3	93.33 (37.85); 3	6.18 (0.17); 3	35.33 (2.08); 3	2.8 (0.51); 3	5.26 (0.26); 2
MRI3	15.93 (1.63); 10	0.54 (0.34); 7	65.83 (47.79); 6	6.29 (0.37); 7	36.16 (3.76); 6	2.48 (0.69); 7	5.24 (0.64); 6
URI2	17.07 (1.31); 9	0.57 (0.21); 7	84 (35.95); 5	6.01 (0.3); 7	34.16 (3.65); 6	1.68 (0.43); 7	4.26 (0.63); 6
Trib1RI1	13.16 (4.61); 13	0.72 (0.38); 10	76.25 (48.45); 8	6.09 (0.38); 10	39.55 (3.71); 9	1.9 (0.65); 10	4.71 (0.82); 7
Trib2FL1	18.1 (0); 1						
Trib2P1	20.3 (0); 1						
Trib2RI1	15.76 (1.56); 8	0.59 (0.26); 6	68.33 (33.86); 6	6.67 (0.27); 6	36.66 (4.08); 6	3.65 (1.12); 6	6.27 (1.25); 5

Appendix 3. (Cont'd.)

Site	Chloride	Magnesium	Calcium	Total Phosphate	Nitrates	Sulphates
Units	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Site 1	7.57 (1.21); 71	0.83 (0.15); 71	1.53 (1.67); 71	0.03 (0.04); 71	0.01 (0.02); 70	2.68 (0.51); 71
LFL2	7.2 (1.56); 6	0.74 (0.09); 6	1.25 (0.22); 6	0.03 (0); 6		2.3 (0.46); 6
LP1	8.1 (0.67); 5	0.81 (0.15); 5	1.32 (0.21); 5	0.03 (0); 5		2.56 (0.34); 5
LRI1	10.25 (8.48); 52	0.9 (0.38); 52	1.25 (0.34); 52	0.03 (0.01); 38	0.03 (0.08); 52	2.49 (0.59); 52
LRI2	7.2 (0); 2	0.72 (0); 2	0.91 (0.15); 2	0.03 (0); 2		2.5 (0.14); 2
LRI3	7.2 (0); 2	0.72 (0); 2	0.91 (0.15); 2	0.03 (0); 2		2.5 (0.14); 2
LRI4	7.44 (1.8); 5	0.55 (0.28); 6	1 (0.21); 5	0.03 (0.01); 5		3.06 (0.55); 5
LRI5	6.96 (1.71); 6	0.77 (0.14); 6	1.16 (0.22); 6			2.26 (0.45); 6
LRI6						
LRU1						
MFL1	8.25 (0.35); 2	0.93 (0.07); 2	1.46 (0.42); 2			2.56 (0.22); 2
MFL2	7.9 (0.14); 2	0.8 (0.11); 2	1.21 (0.07); 2			2.27 (0.17); 2
MFL3						
MRI1	8.31 (0.5); 8	0.9 (0.14); 8	1.55 (0.26); 8	0.04 (0.03); 8	0.07 (0.13); 8	2.58 (0.35); 8
MRI2	6.06 (1.85); 3	0.63 (0.03); 3	1.07 (0.02); 3	0.04 (0); 3		2.14 (0.48); 3
MRI3	6.48 (0.93); 7	0.59 (0.07); 7	1.06 (0.17); 7	0.03 (0.01); 7		2.28 (0.29); 7
URI2	6.4 (3.68); 7	0.52 (0.08); 7	0.83 (0.1); 7	0.02 (0.03); 7	0.01 (0); 7	2.1 (0.32); 7
Trib1RI1	13.47 (18.62); 10	0.66 (0.12); 10	0.82 (0.11); 10	0.03 (0.02); 10		2.33 (0.32); 10
Trib2FL1						
Trib2P1						
Trib2RI1	5.88 (1.07); 6	0.63 (0.11); 6	1.42 (0.27); 6	0.04 (0); 6	0.01 (0.01); 6	2.11 (0.27); 6