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Acidification Status of Rivers in Several Regions of Nova Scotia and Potential Impacts on Atlantic Salmon

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ABSTRACT

Lacroix, G. L., and Knox, D. 2005. Acidification status of rivers in several regions of Nova Scotia and potential impacts on Atlantic salmon. Can. Tech. Rep. Fish. Aquat. Sci. 2573: v + 71 p.

A survey of pH variation throughout eight river systems in three regions of Nova Scotia was completed to evaluate the potential impacts on Atlantic salmon. Sampling at 428 sites on seven occasions during a one year period provided a high level of resolution in pH distribution within each system and throughout the year. Rivers were either chronically acidic (near minimum pH at all times) or episodically acidic (minimum pH from November to March). Low pH episodes followed increased rainfall, and they were usually correlated with increased dissolved organic carbon concentrations with some regional exceptions where low pH episodes were not correlated with the flushing of organic acids. Minimum pH was <5.0 in 80–90% of sites in five of the river systems indicating that they had little habitat where salmon would survive acid episodes. Minimum pH was 5.0–5.5 in 30–40% of sites and >5.5 in about 15–40% of sites in the three other systems which were considered to be responsible for much of the salmon production within the regions surveyed. However, minimum pH during acid episodes was low enough to limit salmon survival in at least 35–50% of sites in the three least affected systems. The survey indicated that a high degree of both spatial and temporal resolution in pH distribution in a river is required to accurately assess potential acidification impacts on salmon populations.

RÉSUMÉ

Lacroix, G. L., and Knox, D. 2005. Acidification status of rivers in several regions of Nova Scotia and potential impacts on Atlantic salmon. Can. Tech. Rep. Fish. Aquat. Sci. 2573: v + 71 p.

Une inspection de la variation du pH dans huit rivières de trois régions de la Nouvelle Écosse nous a permis d'évaluer les effets probables de l'acidification sur le saumon atlantique. Un échantillonnage de 428 sites fait à sept occasions durant l'année fut utilisé pour décrire la distribution du pH et les conditions pour le saumon sur l'étendue de chaque système avec un haut degré de précision. L'acidification des rivières était soit chronique (près du pH minimum en tout temps de l'année) ou épisodique (pH minimum de novembre à mars). Les épisodes de bas pH faisaient suite aux périodes de pluies accrues en automne, lorsqu'il existait une corrélation entre le pH et la concentration de carbone organique dissout. Cependant quelques exceptions étaient évidentes dans certaines rivières où les épisodes de bas pH ne faisaient pas suite à un débit accru d'acides organiques. Un pH minimum de <5.0 dans 80 à 90% des sites sur cinq des rivières indiquait qu'il y avait très peu d'habitat où le saumon aurait pu survivre des épisodes acides. Sur les trois rivières moins acides un pH minimum entre 5.0 et 5.5 dans 30 à 40% des sites et de >5.5 dans 15 à 40% des sites indiquait que ces rivières étaient responsables pour l'ensemble de la production du saumon dans les régions examinées. Cependant, même dans les rivières les moins touchées par l'acidification, le pH minimum lors des épisodes acides était suffisamment bas pour réduire la survie du saumon dans au moins 35 à 50% des sites. L'étude a démontrée qu'un échantillonnage du pH sur toute l'étendue d'une rivière et à plusieurs reprises au cours d'une année était nécessaire pour compléter une évaluation précise des effets potentiels de l'acidification sur les populations de saumons en Nouvelle Écosse.

INTRODUCTION

The 1997 Canadian Acid Rain Assessment (Jeffries 1997) showed that the analysis of trends in pH in some of the rivers of Nova Scotia that can support Atlantic salmon (*Salmo salar* L.) could lead to contradictory and confusing assessments. Monitoring on the main stem of some large rivers suggested that mean pH had been increasing since 1980 and that there was some recovery of salmon populations (Watt *et al.* 1995, 1997; Watt 1997). In contrast, research in some small rivers indicated that there was little or no recovery in pH or salmon populations (Lacroix 1996; Lacroix and Korman 1996). Extrapolation of these limited assessments to a regional scale in Nova Scotia was therefore considered to be risky without a better resolution of the status of acidified salmon rivers.

A biological model to assess regional-scale effects of acidification on Atlantic salmon in Nova Scotia was developed by Korman *et al.* (1994). The model used pH data for 17 sites, mostly on large tributaries of the LaHave River, and extrapolated these upstream to 362 salmon-producing reaches in 55 tributaries. While this was convenient for model development and validation, the limited spatial sampling resolution used could affect model predictions by ignoring episodic or chronic acidification in extensive headwater areas that act as salmon nursery habitat. The model should use more extensive pH data, both spatially and temporally, if it is to be used to provide a reliable assessment of acidification impacts on salmon populations.

A few surveys of chemical characteristics have been conducted in selected rivers of Nova Scotia but the data are neither recent nor complete (Farmer *et al.* 1980, 1988; Ashfield *et al.* 1993). More recent monitoring of pH in selected rivers of Nova Scotia was mostly limited to the main stem of river systems (Watt *et al.* 1997), and episodic acidification in much of the salmon producing habitat in the systems monitored would have been missed. Such episodes can have a large influence on the survival and production of salmon depending upon timing and duration (Lacroix and Korman 1996).

A pH survey in representative rivers was conducted in response to the requirements to resolve the acidification status of salmon rivers in different regions of Nova Scotia. The survey was also considered necessary to evaluate the pH data resolution needed for accurate model predictions. The goal was to initiate a regional assessment of acidification impacts on salmon production by accurately classifying as much of the productive salmon habitat as possible. The survey also aimed to define the relationship between organic acids and pH in these river systems. Many acidified rivers of Nova Scotia are naturally rich in organic acids that can influence acidification, and the effects of organic acids should be included in predictive models (Lacroix and Kan 1986; Marmorek *et al.* 1998).

METHODS

SITE SELECTION AND DESCRIPTION

There are 63 rivers containing salmon habitat that flow through the region of Nova Scotia where the effects of acidification have been centered. About 50–60 of these rivers were categorised according to acidity status (annual pH from Watt 1986, 1997), and potential salmon parr production area (Diadromous Fish Division, Science Branch, Department of Fisheries and Oceans, Dartmouth, NS, unpublished data). Rivers with high potential parr production were selected over a broad pH range and a wide geographic distribution (i.e., each river selected for sampling was to be representative of an area and geology). An exploratory survey in 25 of the rivers in 1995 showed that in eight rivers, previously classified in the pH <4.7 category, pH was as low as 4.0–4.3 after acidic episodes (G. L. Lacroix, unpublished data). Some rivers in the pH 4.7–5.0 category had pH levels as low as 4.3–4.5, and five rivers in the pH >5.0 category had pH levels of 4.6–4.9, indicating that acidification had apparently become more severe since the 1990 Canadian Acid Rain Assessment (RMCC 1990).

The rivers were prioritised according to availability of historical chemistry and fisheries data and evaluated according to management needs and opportunities. The final selection of rivers was made keeping in mind that the resulting data should be suitable for extrapolation to other similar rivers within each region. They included: the Carleton River, Tusket River, Medway River, LaHave River, Gold River, West River Sheet Harbour, East River Sheet Harbour, and the Liscomb River (Fig. 1). Although the Carleton and Tusket rivers are part of the same drainage system, they were considered separately because of their diverse geology and watershed use. The West and East rivers entering Sheet Harbour were also considered separately because of differences in watershed management and use. The Tusket and East rivers both have hydroelectric dams that have created water reservoirs.

In each river system, as many sites as possible were sampled to obtain a detailed spatial resolution of pH. Starting in the headwaters of a system, sites were selected in each accessible stream both upstream and downstream of a point of confluence with another stream using 1:50,000-scale topographic maps (Surveys and Mapping Branch, Department of Energy, Mines and Resources). This was repeated down the length of the system to the head of tide. Sites were also selected along the main stem of a river downstream of where each minor tributary entered. One requirement was that sites be readily accessible throughout the year (i.e., by road or trail using a 4-wheel drive or all-terrain vehicle).

The location of water sampling sites is described and shown in Appendix A (Tables A1–A7 and Figs. A1–A7). Latitude and longitude were recorded using a Magellan Geographic Positioning System. The order of the stream or river at

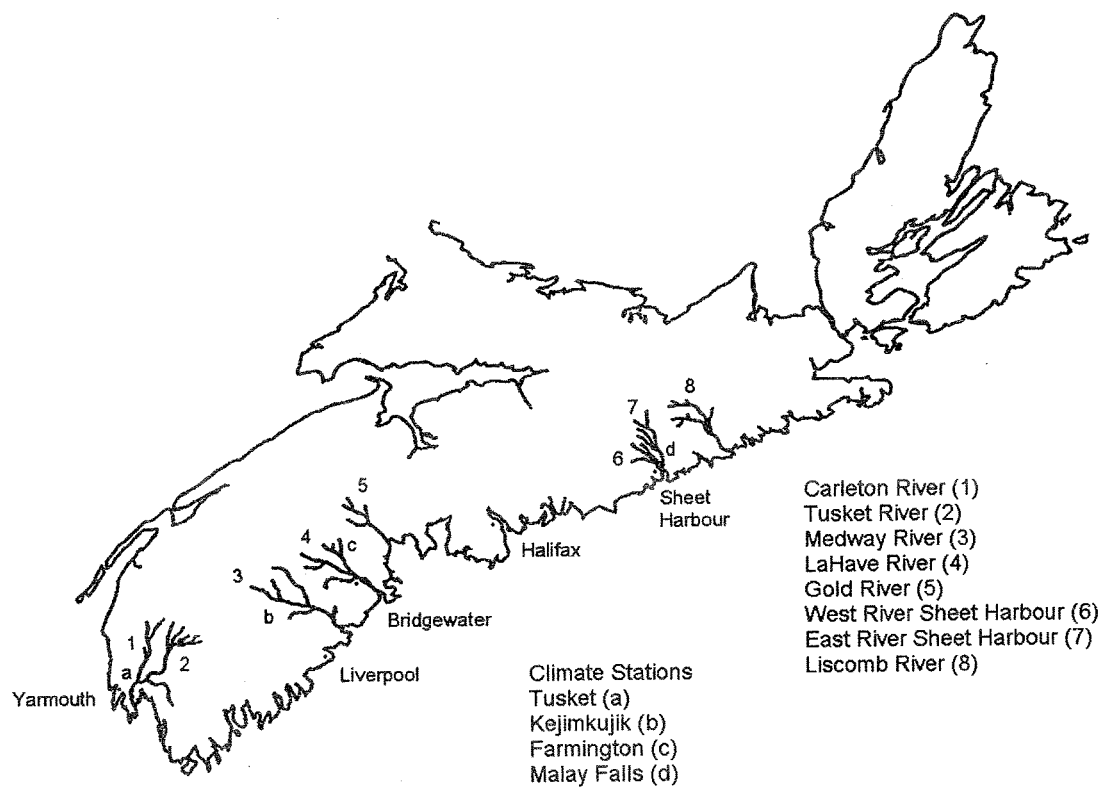


Fig. 1. Location of river systems surveyed (1-8) and nearest climate stations (a-d) in Nova Scotia.

each site was determined as described by Strahler (1957), and the watercourse distance from the site to the mouth of the river system (i.e., distance to the head of tide) was measured from 1:50,000-scale topographic maps.

Climate stations closest to the rivers sampled (Fig. 1) were used to assess total monthly precipitation in each region. Data from four climate stations were obtained from the Atmospheric Environment Service (Environment Canada, Bedford, NS). Monthly measurements from the Kejimikujik and Farmington stations were not significantly different ($P > 0.05$, t -test), and they were averaged to depict precipitation in the watersheds of the Medway, LaHave, and Gold rivers.

SAMPLE COLLECTION

Water samples were collected in each river system on seven occasions between November 1996 and November 1997. The times of sampling were selected to provide an indication of seasonal variation associated with precipitation and water flow (e.g., spring run-off, summer dry period, autumn precipitation episodes). All accessible sites within a river system were sampled when open water was found, and sampling was completed in the shortest time span possible on each occasion (Table 1).

Duplicate water samples (500 mL) were collected at each site using new, disposable plastic bottles that were rinsed three times with stream water before final filling. Samples were taken at mid-depth in the main channel when possible, and they were always collected upstream of any bridges or culverts. Bottles were filled and capped underwater to exclude air, and they were stored in coolers while in the field. Samples were then stored in a cold room (4°C) until analysed. Water temperature was measured at each site at the time of collection.

Table 1. Dates of water sampling within rivers of Nova Scotia during the 1996–1997 survey.

	Nov 96	Mar 97	May 97	Jul 97	Sep 97	Oct 97	Nov 97
Carleton River	21	26-27	28	23-24	17-18	22-23	26-27
Tusket River	21-25	26	28-29	23-24	17-19	22-23	26-27
Medway River	18-20	24-25	26-27	20-22	14-16	19-21	23-25
LaHave River	20-26	25-3 Apr	26-30	21-23	15-19	20-24	24-28
Gold River	22-26	4-7 Apr	27-29	24-25	18-19	23	17-25
West River	18-20	14-18	28-4 Jun	Aug 1-14	22-10 Oct	20-23	20-26
East River	18-20	14-18	28-4 Jun	Aug 1-14	22-10 Oct	20-23	20-26
Liscomb River	20-22	14-15	Jun 2-3	Aug 1-13	Oct 1-9	21-27	19-26

SAMPLE ANALYSIS

For measuring pH, samples were first allowed to come to room temperature overnight. A Selective Ion Analyser (Fisher Accumet, model 750) and glass combination pH electrode (Mettler Toledo, model "Acid Rain" for low conductivity samples) were used with two-point calibration (pH 4 and 7). Samples were randomly analysed as follows: a 100-mL sample was mechanically stirred in a glass beaker using a Teflon-coated magnetic stirring bar while measuring pH and the value was recorded after 3 min to allow the measurement to stabilise. After each sample measurement, the beaker, stirring bar, and electrode were rinsed with deionised water. The beaker was then rinsed four times with the next sample, and the electrode and stirring bar were rinsed with the sample before the next measurement. Duplicate samples were randomly introduced into a series of measurements for verification. The electrode calibration was routinely verified.

In November 1997, some of the samples from each river system were randomly selected for a determination of dissolved organic carbon (DOC). A 25-mL water sample was taken from the bottle with a syringe, filtered using a Nalgene syringe filter (0.45 μ m membrane porosity), and acidified for storage (pH <2, 50 μ L of concentrated HCl added). DOC was measured by the Water Quality Branch (Environment Canada, Moncton, NB) using the high temperature combustion (HTCO) method.

RESULTS AND DISCUSSION

SEASONAL pH VARIATION

A seasonal summary of pH was produced for each river system (Table 2) from individual pH measurements reported for each site in Appendix B where sites in each system were grouped by sub-drainage units moving from headwaters to the mouth of the river (Tables B1–B7).

The Carleton River was seasonally very acidic. There was considerable seasonal variation in pH throughout the system (Table 2). During dry periods in late summer (Fig. 2), the pH was >5.5 in the majority of sites. However, during wet periods that followed major precipitation episodes in autumn, winter and spring (Fig. 2), the pH was <5.0 at 17–40% of the sites (i.e., in November to May). Regardless of season or conditions, the pH was >5.0 in 60–97% of the sites. The proportion of sites with pH >5.5 could vary widely (15–83%) depending upon season.

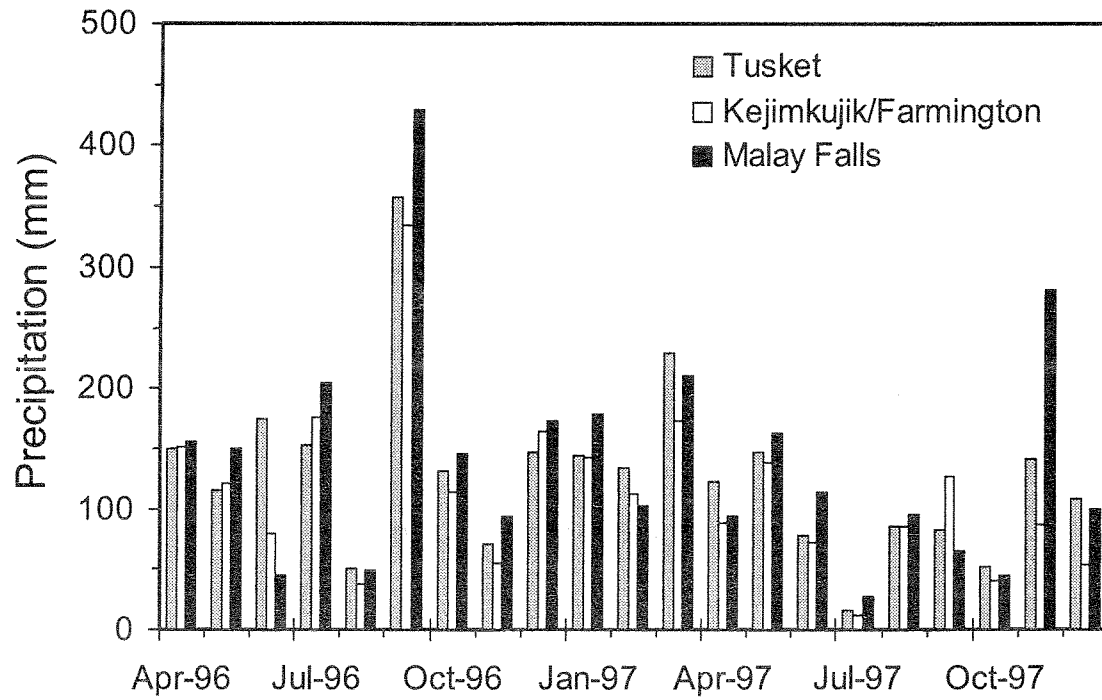


Fig. 2. Total monthly precipitation at the Tusket, Kejimkujik/Farmington, and Malay Falls climate stations in Nova Scotia during the 1996-1997 survey.

The Tusket River was chronically very acidic. The pH at many sites was <4.5 at all times throughout the year, and it was <5.0 at 48–89% of sites at all times (Table 2). Only during dry periods (i.e., July to October) was the pH >5.5 at more than 40% of sites. During wet periods (i.e., November to May), the majority of sites were very acidic and, in November 1997, the pH was <4.5 in 68% of the sites. Only 3–26% of sites had a pH >5.5 depending upon season.

The pH in the Medway River was seasonally very acidic at many sites but there was considerable seasonal variation throughout the system (Table 2). The pH was >5.5 in more than 50% of sites from July to October. However, after major episodes of precipitation in November, the pH was <4.5 in 10–18% of sites. Then, the pH remained <5.0 in 30–59% of sites throughout autumn and winter. Regardless of season, the pH was usually >5.0 in 41–89% of the sites. The proportion of sites with pH >5.5 was as low as 5% in winter, and up to 55–63% in the driest months (i.e., July and September).

The LaHave River also had a few very acidic sites on a seasonal basis (Table 2). The pH was <4.5 in only 5% or less of the sites after major episodes of precipitation. Throughout the year, pH was usually >5.0 in more than 80% of the sites, except for the precipitation episode in November 1997 which resulted in low pH (<5.0) at up to 27% of sites. However, more sites were in the pH 5.5–6.0 range than in any other pH categories at all times, and the pH was >6.0 in as many as 40% of sites in July. Generally, the proportion of sites that were within the pH 5.0–6.5 range throughout the year was well distributed.

There was considerable variability in pH at sites throughout the Gold River at all times of the year (Table 2). Some sites (4–18%) were always very acidic (pH <4.5), whereas many other sites (5–45%) always had pH levels >6.0 . Regardless of this wide range in pH throughout the system, there was some seasonal variation in acidity with pH <5.5 or 5.0 at more sites in November than at other times. The least acidic conditions were recorded in July (pH >5.5 in 78% of sites and pH <5.0 in only 7% of sites).

The West and East rivers, Sheet Harbour, like the Medway River, were seasonally very acidic rivers at many sites but there was considerable seasonal variation in pH throughout both systems (Table 2). From July to October, the pH was >5.0 in 82–85% of sites but it was >5.5 in only 28–35 % of sites. As a result, the West and East rivers were slightly more acidic than the Medway River but fewer sites than in the Medway had very low pH. After precipitation episodes in November, the pH was <4.5 in only a few sites ($<7\%$). The pH in the majority of sites was usually in the 4.5–5.0 or 5.0–5.5 ranges depending upon the season.

The Liscomb River, like the Tusket River, was very acidic but, in contrast to the Tusket which was chronically acidic, there was a strong seasonality to this acidity in the Liscomb (Table 2). The pH could be <5.0 in 58–85% of sites in November (e.g., in both years) and March, and it could then be >5.5 in 53% of sites in July

Table 2. Distribution of sites within specified pH ranges for rivers of Nova Scotia surveyed during 1996–1997. The pH range that includes the mode each month is in bold and underlined. *N*, number of sites sampled.

pH range	Frequency (%)						
	Nov 96	Mar 97	May 97	Jul 97	Sep 97	Oct 97	Nov 97
Carleton River							
4.00–4.49	6.7	7.4	5.9			2.9	17.1
4.50–4.99	10.0	29.6	14.7	3.3	3.1	2.9	22.9
5.00–5.49	23.3	<u>48.2</u>	<u>38.2</u>	13.3	28.1	20.6	<u>14.3</u>
5.50–5.99	<u>60.0</u>	14.8	41.2	<u>60.0</u>	<u>46.9</u>	<u>52.9</u>	37.1
6.00–6.49				23.3	18.8	20.6	8.6
6.50–6.99					3.1		
<i>N</i>	30	27	34	30	32	34	35
Tusket River							
4.00–4.49	34.5	9.1	25.0	2.9	10.5	7.5	<u>67.5</u>
4.50–4.99	<u>48.3</u>	<u>77.3</u>	<u>63.9</u>	<u>55.9</u>	31.6	40.0	20.0
5.00–5.49	10.3	9.1	8.3	23.5	<u>31.6</u>	<u>30.0</u>	7.5
5.50–5.99	3.5	4.5	2.8	11.8	26.3	20.0	5.0
6.00–6.49	3.5			5.7		2.5	
<i>N</i>	29	22	36	34	38	40	40
Medway River							
4.00–4.49	10.1				1.3		17.5
4.50–4.99	36.2	45.2	30.3	10.7	15.8	12.8	<u>41.2</u>
5.00–5.49	<u>43.5</u>	<u>50.0</u>	<u>59.2</u>	34.7	19.7	<u>38.5</u>	30.0
5.50–5.99	5.8	4.8	10.5	<u>52.0</u>	<u>51.3</u>	43.6	11.2
6.00–6.49	4.3			1.3	11.8	5.1	
6.50–6.99				1.3			
<i>N</i>	69	42	76	75	76	78	80
LaHave River							
4.00–4.49	2.9				2.2	0.8	5.0
4.50–4.99	17.1	19.3	8.5	5.6	8.7	5.3	22.0
5.00–5.49	22.9	<u>32.5</u>	28.4	12.8	16.7	18.9	21.3
5.50–5.99	<u>37.9</u>	35.1	<u>48.9</u>	<u>41.6</u>	<u>37.7</u>	<u>43.2</u>	<u>42.6</u>
6.00–6.49	17.9	13.2	14.2	40.0	34.1	34.9	9.2
6.50–6.99	1.4				0.7		
<i>N</i>	140	114	141	125	138	132	141

Table 2. Continued.

pH range	Frequency (%)						
	Nov 96	Mar 97	May 97	Jul 97	Sep 97	Oct 97	Nov 97
Gold River							
4.00-4.49	17.6	13.6	6.9	3.7	9.1	6.1	17.6
4.50-4.99	14.7	13.6	24.1	3.7	12.1	15.2	14.7
5.00-5.49	<u>41.2</u>	18.2	17.2	14.8	15.2	12.1	<u>35.3</u>
5.50-5.99	8.8	<u>50.0</u>	<u>44.8</u>	<u>33.3</u>	<u>39.4</u>	<u>33.3</u>	17.6
6.00-6.49	17.6	4.5	6.9	40.7	24.2	33.3	14.7
6.50-6.99				3.7			
N	34	22	29	27	33	33	34
West River Sheet Harbour							
4.00-4.49			5.9			5.3	10.5
4.50-4.99	47.4	<u>82.3</u>	<u>52.9</u>	21.1	31.6	26.3	<u>73.7</u>
5.00-5.49	<u>52.6</u>	17.7	41.2	<u>42.1</u>	<u>57.9</u>	<u>47.4</u>	15.8
5.50-5.99				36.8	10.5	21.0	
N	19	17	17	19	19	19	19
East River Sheet Harbour							
4.00-4.49	7.5					2.4	4.8
4.50-4.99	40.0	<u>55.3</u>	24.3	11.9	7.1	9.5	<u>59.5</u>
5.00-5.49	<u>40.0</u>	44.7	<u>67.6</u>	<u>57.1</u>	<u>47.6</u>	<u>57.1</u>	26.2
5.50-5.99	12.5		8.1	31.0	42.9	26.2	9.5
6.00-6.49					2.4	4.8	
N	40	38	37	42	42	42	42
Liscomb River							
4.00-4.49	13.9	7.4	14.3		16.7		5.6
4.50-4.99	<u>63.9</u>	<u>77.8</u>	25.7	5.6	30.6	24.3	<u>52.8</u>
5.00-5.49	13.9	14.8	<u>48.6</u>	41.7	<u>33.3</u>	<u>54.0</u>	41.7
5.50-5.99	8.3		11.4	<u>50.0</u>	19.4	21.6	
6.00-6.49				2.8			
N	36	27	35	36	36	37	36

when the pH was <5.0 in very few sites ($<6\%$). However, the very low pH that occurred at many sites after precipitation episodes in autumn tended to remain low throughout the winter with some recovery to higher pH at many sites by May. There was some indication that the system was susceptible to minor acidification episodes (e.g., in September 1997 when pH was <5.0 in 47% of sites), and also capable of rapid recovery between episodes (e.g., in October 1997 when the pH was back above 5.0 in 76% of sites).

SPATIAL DISTRIBUTION OF MINIMUM pH

The minimum pH recorded at each site during 1996–1997 (from Appendix B, Tables B1–B7) was plotted on each river system map to examine the spatial distribution of low pH (Figs. 3–10). Minimum pH was selected because it is the value that is indicative of potential impacts on Atlantic salmon depending upon duration of the low pH episode, and it should therefore help pinpoint the areas of concern within each river system.

Minimum annual pH levels usually occurred after precipitation episodes in autumn and often lasted through the winter and until spring (Table 2 and Fig. 2). The duration was therefore sufficiently long for lethal effects to occur at low pH. In the Carleton River, the area of lowest pH was the east branch of the river flowing into Wentworth Lake (Fig. 3). Other areas of low pH (<5.0) were often 1st order tributaries along the main branch of the river.

Minimum annual pH levels in the Tusket River were <4.5 in most of the upper half of the system above the confluence of the east branch with the main river (Fig. 4). Similarly, minimum pH in most of the Quinan River system was <4.5 . Only several sites on minor tributaries draining into the lower part of the main river had minimum pH >5.0 . The minimum pH occurred mostly in November and would probably have lasted until late winter or spring at many sites (Table 2). This was long enough for some lethal effects on salmon to have occurred at the majority of sites in the Tusket River.

In the Medway River, minimum pH levels were <4.5 throughout the Pleasant River, in the tributaries to the Westfield River above Tupper Lake, and in many 1st order streams in headwaters and entering along the main river (Fig. 5). Minimum pH was 4.5–5.0 throughout most of the east and west branch and along the main river above Ponhook Lake, in the main Westfield River and in the Petite drainage entering near the mouth of the Medway. Most of the main river downstream of Ponhook Lake was at pH 5.0, and very few other sites had minimum pH levels >5.0 , indicating that the most of the Medway system was uniformly very acidic during specific episodes.

In the LaHave River, in contrast to the Medway system, no entire sub-drainage units had minimum pH levels <4.5 (Fig. 6). The majority of very acidic sites (pH <4.5) were on 1st order streams in headwater areas. Otherwise, pH was strongly related to geographic position of a sub-drainage unit. Sites with pH <5.0 were concentrated in the West River drainage and throughout the West LaHave River, both on the southwest side of the main river. Minimum pH levels in the North River system and North Branch LaHave, both located on the northeast side of the main river, were mostly in the pH 5.0–6.0 range except for a few minor tributaries with pH <5.0 in headwater sites. Much of the upper LaHave system above its confluence with North River had minimum pH levels of 5.0–5.5, except for headwater sites on minor tributaries. Downstream of North River, minimum pH in the main LaHave River was usually between pH 5.5 and 6.0, both above and below Morgan Falls.

In contrast to other rivers where pH generally increased from headwaters downstream to the river mouth, minimum pH in the Gold River was highest at sites in the headwaters (usually pH 5.0–6.0) and decreased to about pH 4.9–5.1 in the lower main river (Fig. 7). There were some minor tributaries (1st order streams) with minimum pH <4.5 , especially downstream of the confluence of the Larder River and the East Branch Gold River. Some headwater tributaries in these two sub-drainage units had minimum pH >6.0 (i.e., the highest in the entire system).

The West and East rivers, Sheet Harbour, had minimum pH levels ≤ 5.1 at all but two sites on the East River (Figs. 8 and 9). The West River was the most acidic with many sites having minimum pH levels in the 4.4–4.7 range. Minimum pH at all sites above the confluence of the Killag and West rivers were ≤ 4.8 , and this low pH persisted to the mouth of the main river (Fig. 9). In the East River, the most acidic sites (minimum pH <5.0) were in Seven Mile and Fifteen Mile streams, especially in 1st order tributaries in their headwaters (Fig. 8). Both Ten and Twelve Mile streams had some sites with minimum pH levels near 5.0–5.1 but, even there, minor tributaries were often very acidic (pH 4.5–4.7). In both the East and West rivers, minimum pH at the mouth above the head of tide was very acidic (pH 4.8).

Minimum pH levels were ≤ 5.1 at all sites throughout the Liscomb River (Fig. 10). In Little Liscomb River, there were many sites with minimum pH ≤ 4.5 , especially in tributaries on the north side. The main Liscomb River was only slightly less acidic and, in many sites along the main river, minimum pH was in the 4.7–4.9 range. No sites on the lower main stems of the Little Liscomb or Liscomb rivers had minimum pH >4.7 , indicating that at times of episodes this river system was very acidic and had no refuge habitat with non-lethal pH levels for salmon.

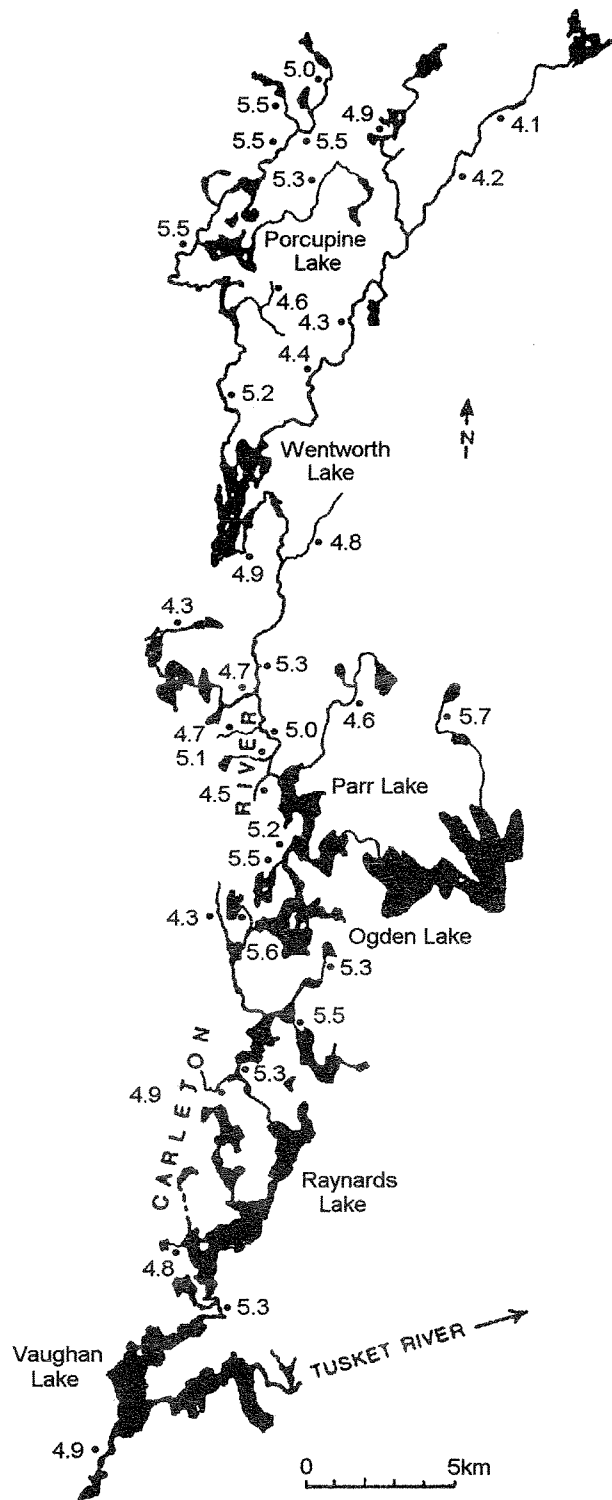


Fig. 3. Minimum pH recorded at each site on the Carleton River during the 1996–1997 survey.

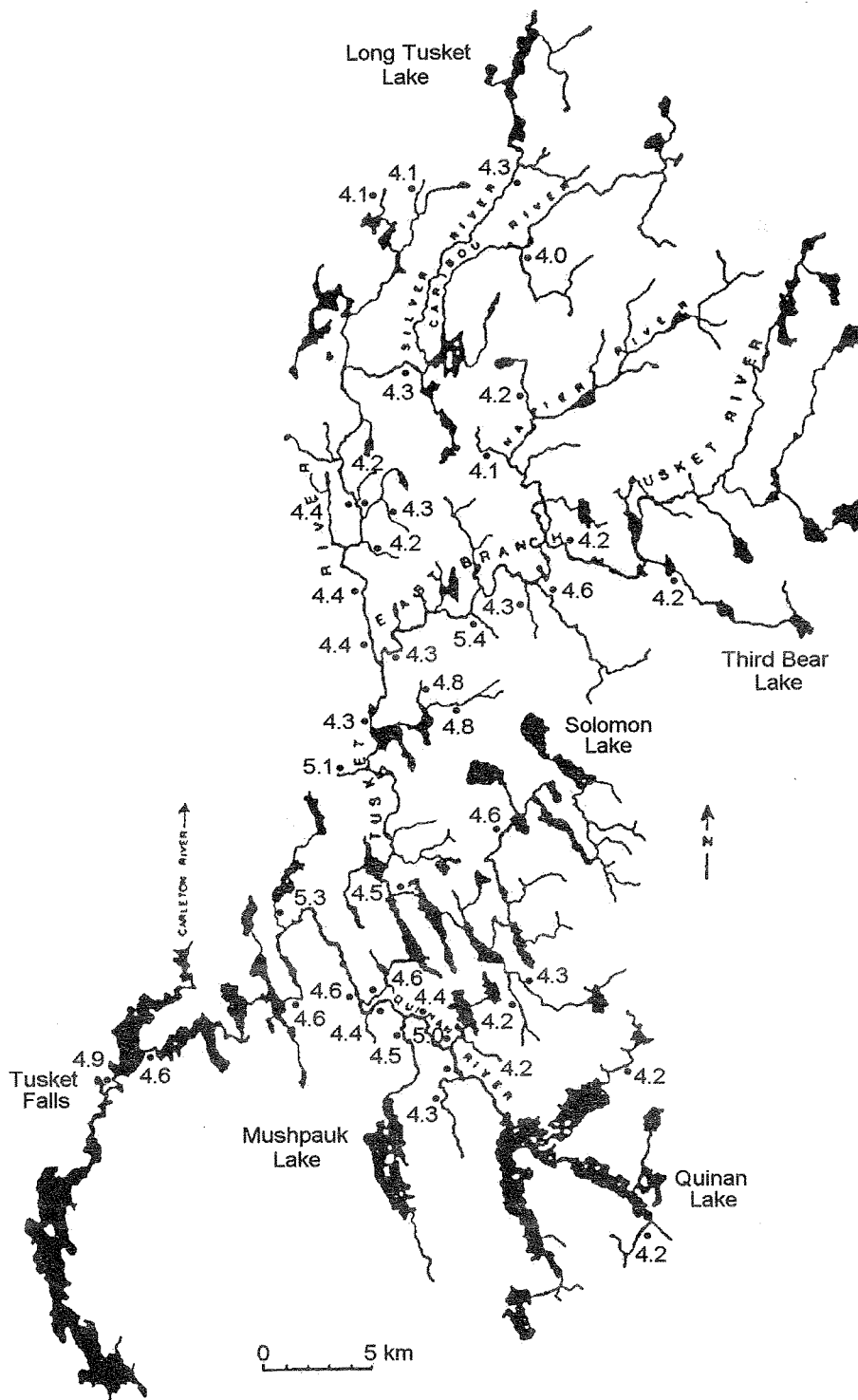


Fig. 4. Minimum pH recorded at each site on the Tusket River during the 1996–1997 survey.

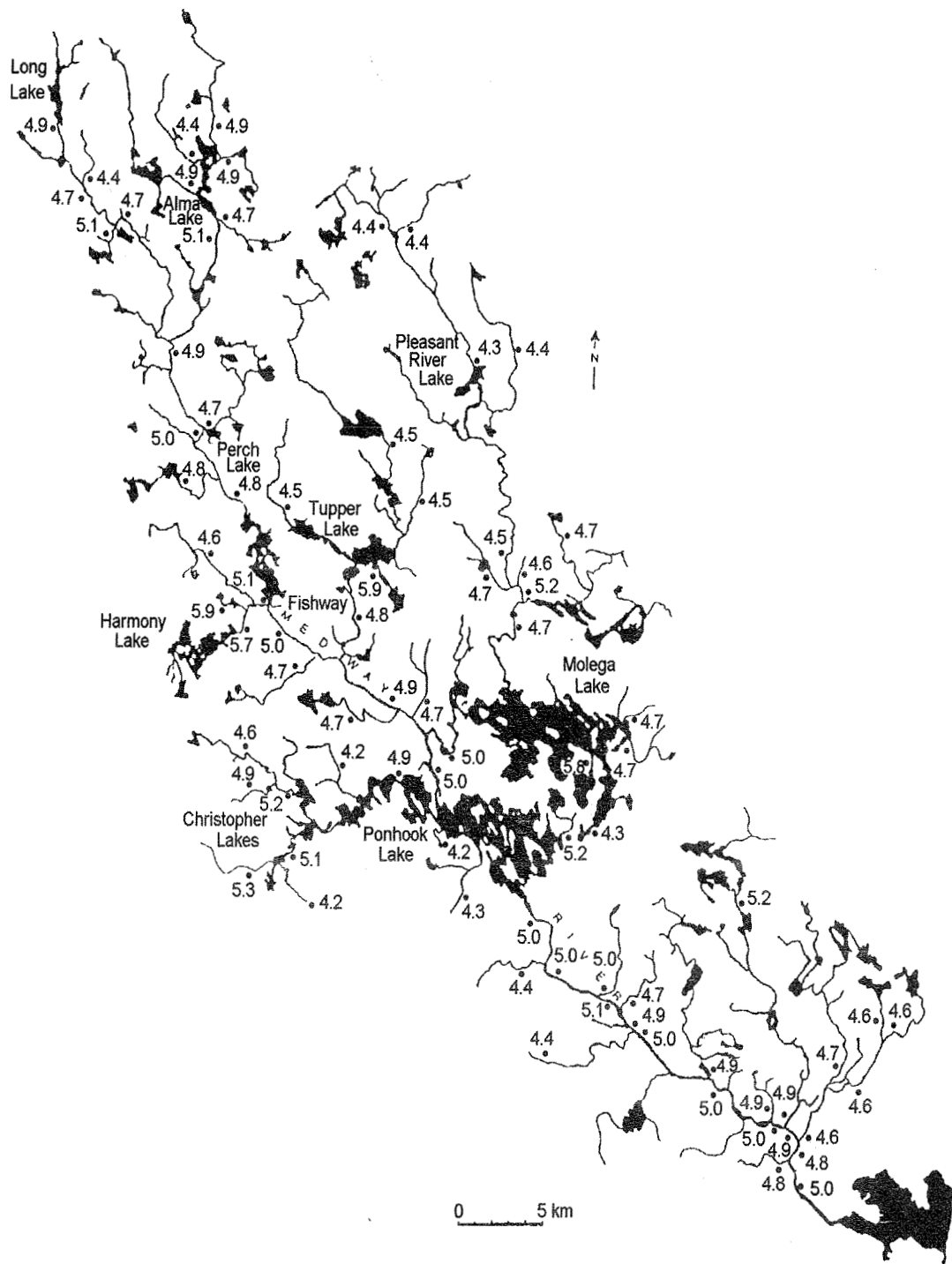


Fig. 5. Minimum pH recorded at each site on the Medway River during the 1996–1997 survey.

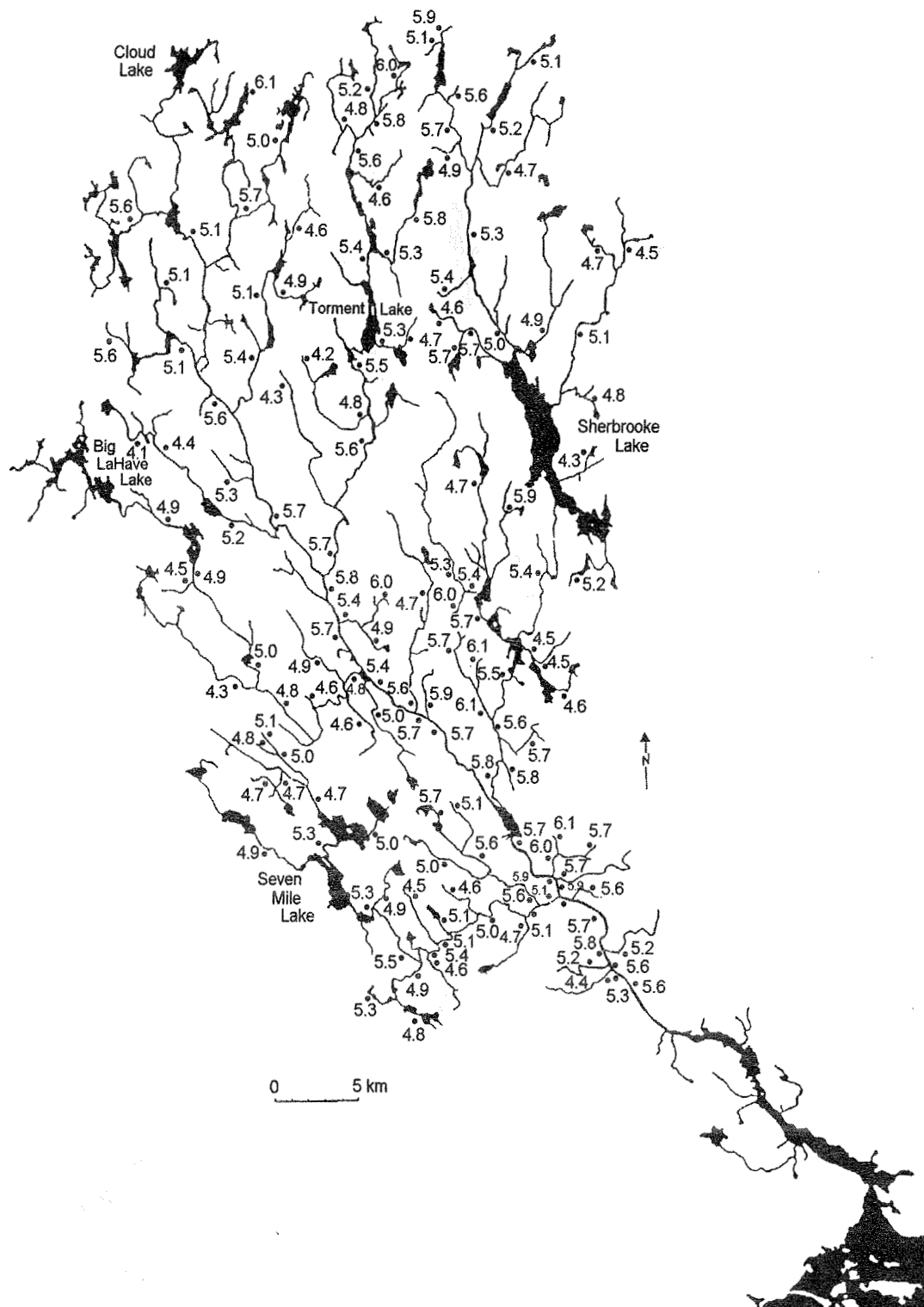


Fig. 6. Minimum pH recorded at each site on the LaHave River during the 1996–1997 survey.

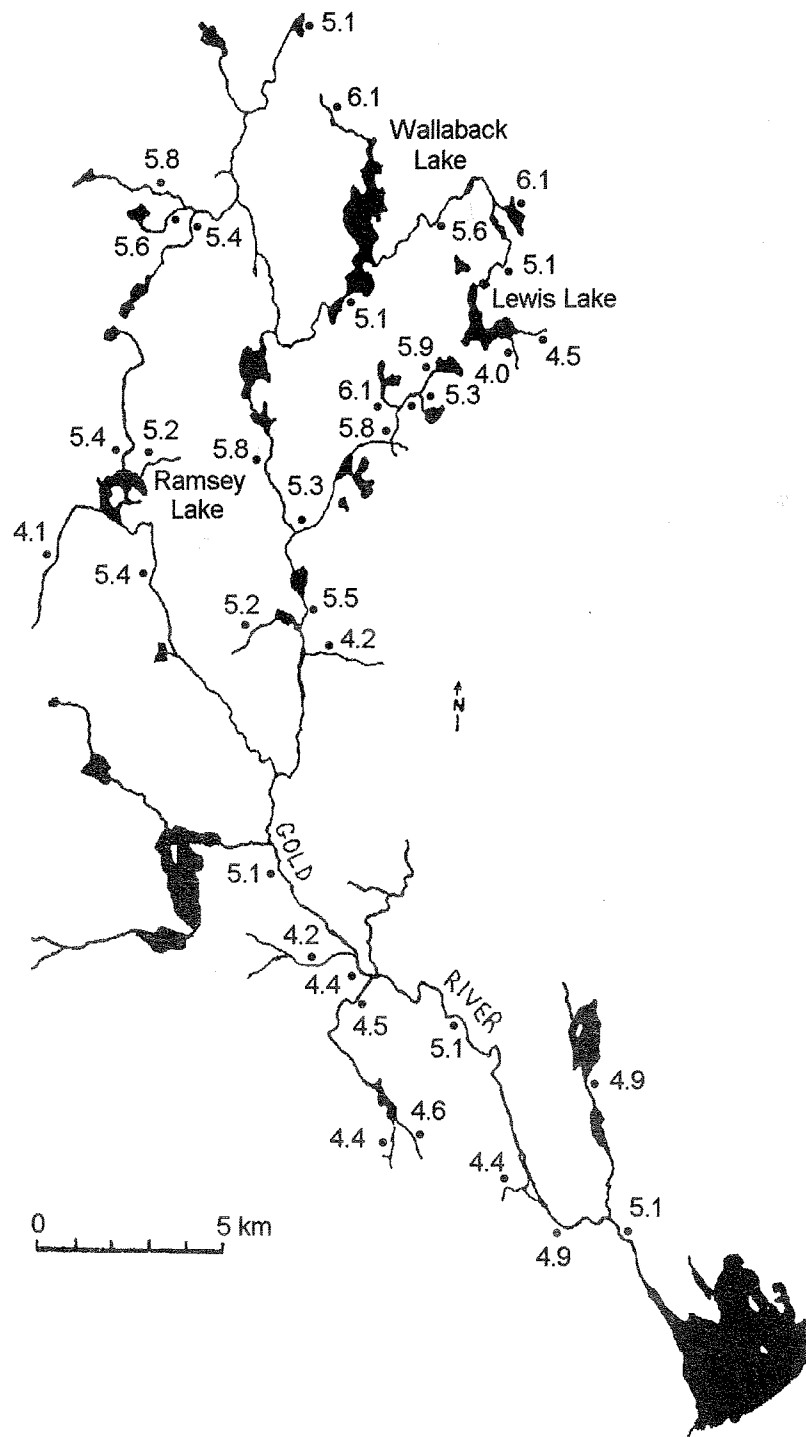


Fig. 7. Minimum pH recorded at each site on the Gold River during the 1996–1997 survey.

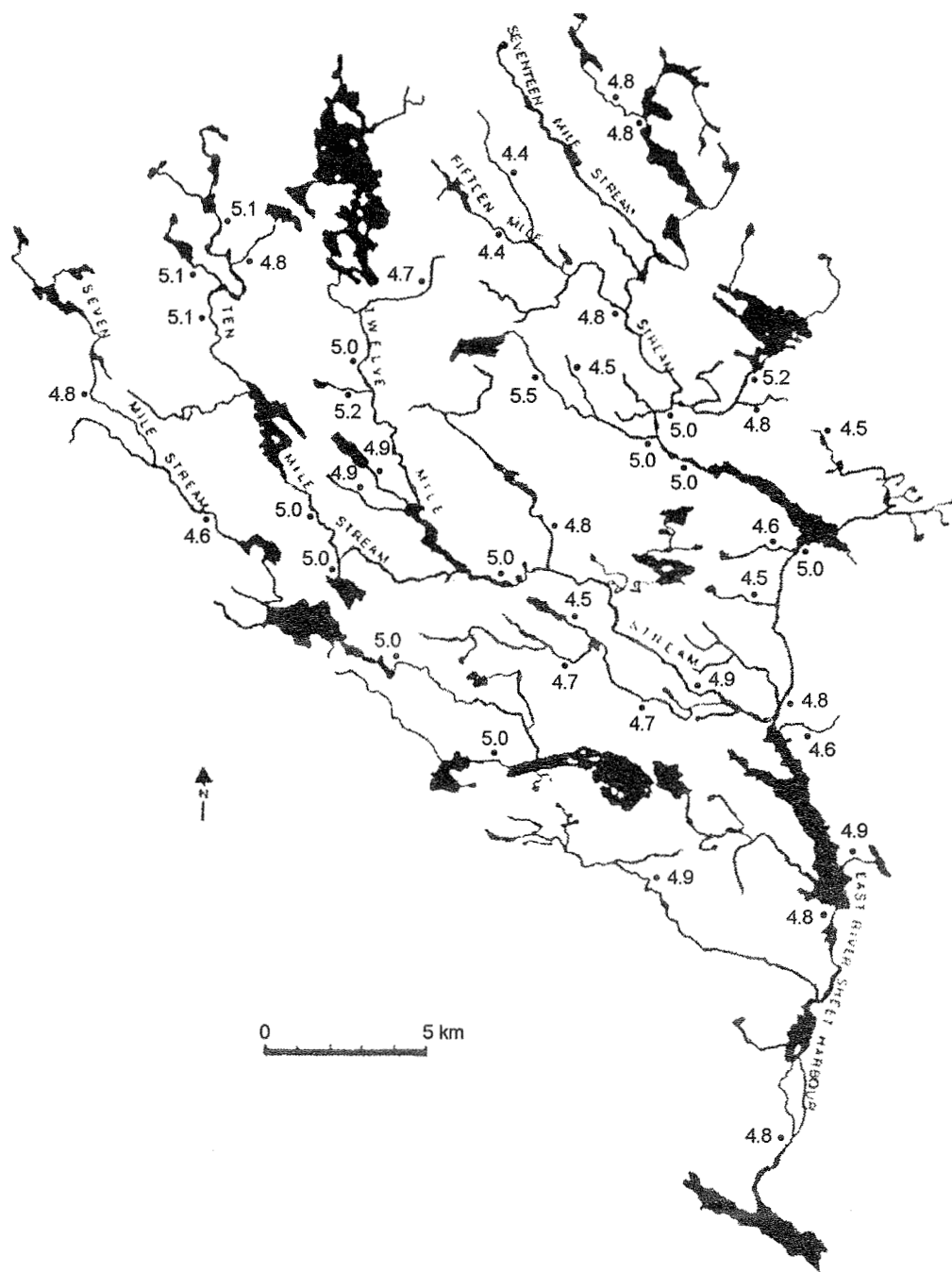


Fig. 8. Minimum pH recorded at each site on the East River, Sheet Harbour during the 1996-1997 survey.

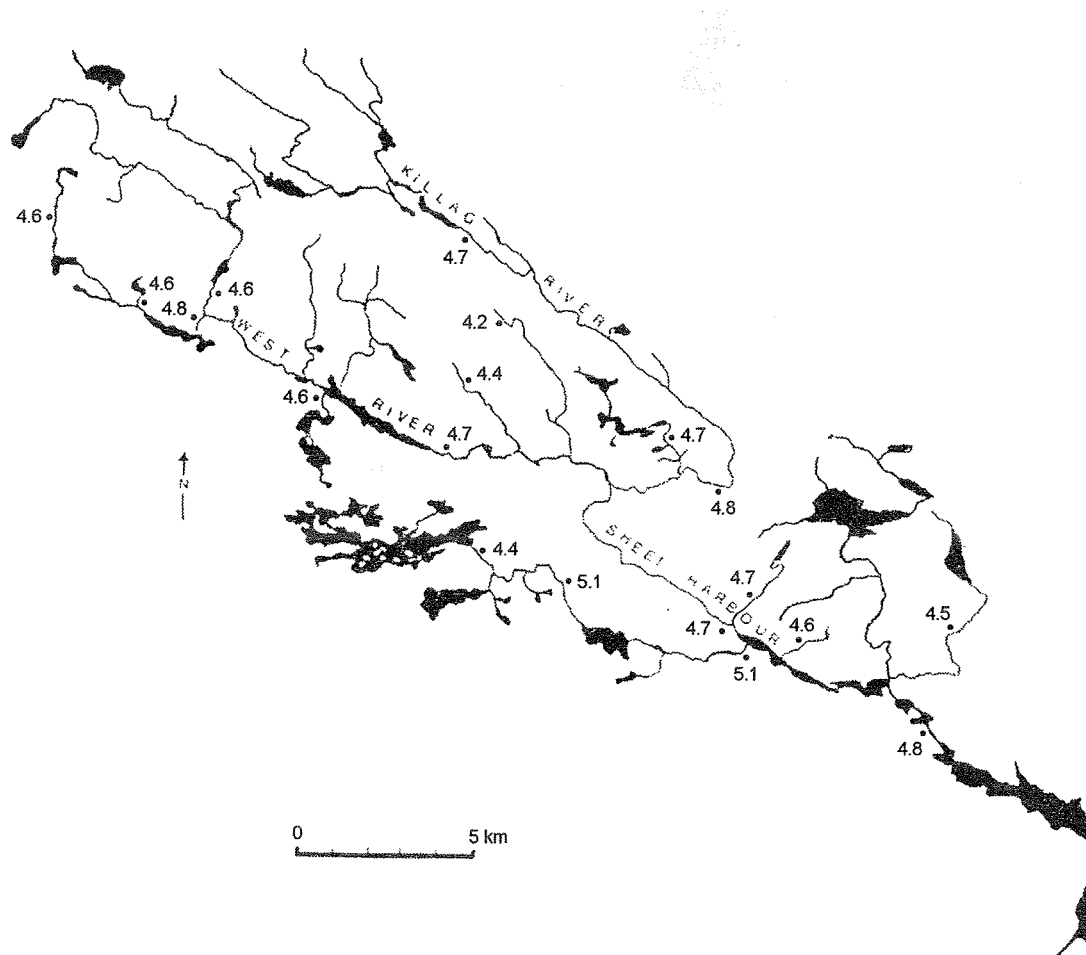


Fig. 9. Minimum pH recorded at each site on the West River, Sheet Harbour during the 1996–1997 survey.

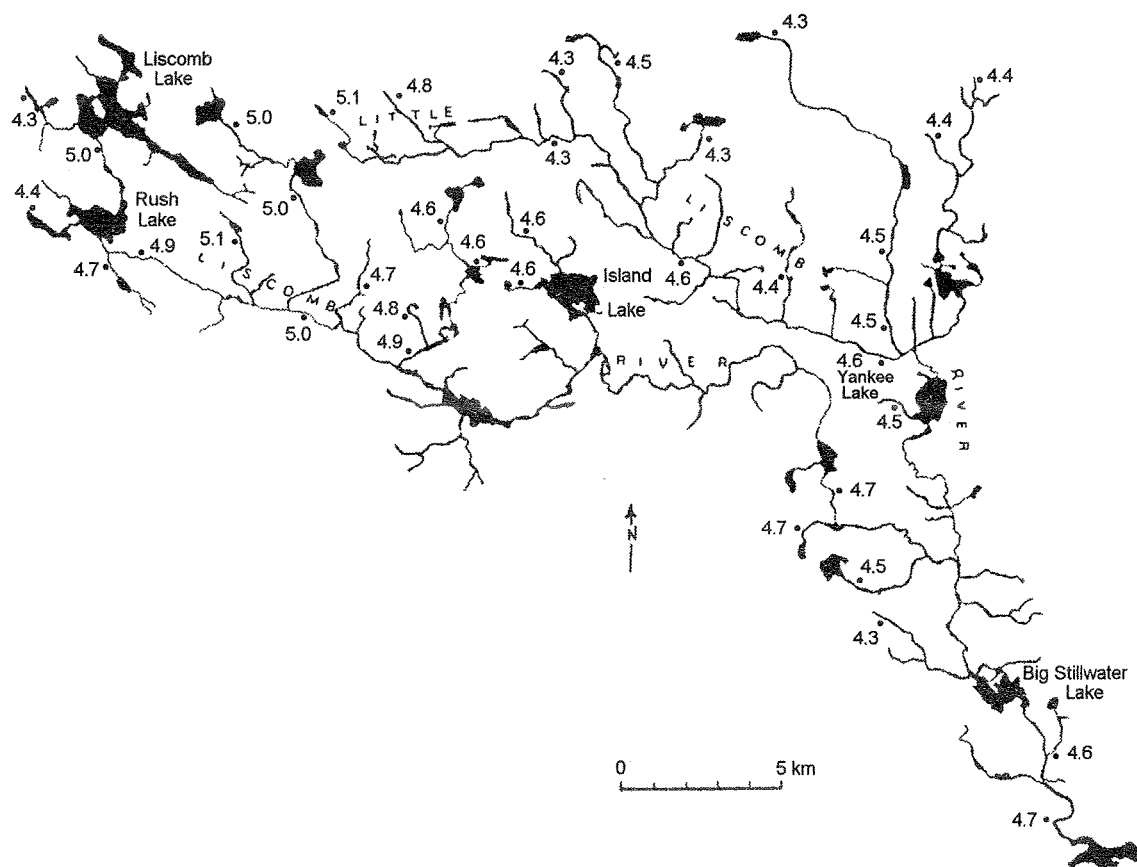


Fig. 10. Minimum pH recorded at each site on the Liscomb River during the 1996–1997 survey.

IMPORTANCE OF DISSOLVED ORGANIC CARBON

The relationship between dissolved organic carbon (DOC) and pH at a sub-sample of sites within each river system in November 1997 (from Appendix C, Tables C1–C7) was examined by regression analysis. This timing was selected to capture the effect of autumnal precipitation episodes that characterised each region (Fig. 2).

DOC in the Carleton River varied between 5–25 $\text{mg}\cdot\text{L}^{-1}$ but DOC was $<15 \text{ mg}\cdot\text{L}^{-1}$ at the majority of sites within the river (Fig. 11a). The correlation between pH and DOC ($r = 0.79$) indicated that pH decreased as DOC increased. The pH at sites with $\text{DOC} < 10 \text{ mg}\cdot\text{L}^{-1}$ was usually >5.2 , even after the precipitation episode. These sites with low DOC and high pH represented a high proportion of the Carleton River.

DOC, measured at the time of lowest pH in the Tusket River, was very high (15–35 $\text{mg}\cdot\text{L}^{-1}$) at most sites sampled (Fig. 11b). This was in contrast to the Carleton River where sites with low DOC and high pH represented a high proportion of the river, indicating that very different processes and geology probably influenced these two adjacent rivers (cf. Figs. 11a and 11b). The high DOC in the Tusket River corresponded to pH levels <4.8 , and there was an excellent correlation between pH and DOC ($r = 0.92$) in the river. The pH at the few sites with low DOC was comparatively high (about pH 5.8).

There was also an excellent correlation between pH and DOC ($r = 0.92$) in the Medway River (Fig. 12a). However, unlike the Tusket River, there was a wide range in DOC (3–30 $\text{mg}\cdot\text{L}^{-1}$) among sites indicative of variability in drainage characteristics throughout the system (i.e., areas with and without bogs in the headwaters). The pH was >5.3 at the many sites with low DOC ($<10 \text{ mg}\cdot\text{L}^{-1}$), and pH was usually <4.7 at sites where DOC was high ($>20 \text{ mg}\cdot\text{L}^{-1}$). A large cluster of sites fell in the DOC range of 10–15 $\text{mg}\cdot\text{L}^{-1}$, and pH at these was usually quite acidic (pH <5.2).

The DOC range in the LaHave River (3–23 $\text{mg}\cdot\text{L}^{-1}$) did not extend as high as in the Medway system, and the correlation between pH and DOC was relatively poor ($r = 0.62$) (Fig. 12b). There was a high variability in pH at a given DOC, especially for the large cluster of sites in the DOC range of 5–15 $\text{mg}\cdot\text{L}^{-1}$. In this case, localised differences in geology (e.g., drumlins) probably had a greater impact on pH after an episode than the influence of bogs which are of minor importance in the LaHave system compared to the Medway. Sites with high DOC ($>15 \text{ mg}\cdot\text{L}^{-1}$) invariably had the lowest pH (usually <5.0) but some sites with low DOC ($<10 \text{ mg}\cdot\text{L}^{-1}$) also had low pH. A large proportion of sites in the DOC range of 5–15 $\text{mg}\cdot\text{L}^{-1}$ range appeared to be relatively well buffered and, as a result, pH was >5.4 at these sites.

The correlation between pH and DOC was relatively good ($r = 0.83$) in the Gold River (Fig. 12c). The DOC range ($5\text{--}26\text{ mg}\cdot\text{L}^{-1}$) was similar to that in the LaHave River but there was considerably less variation in pH at a given DOC concentration in the Gold River. The pH was high (>5.7) at a number of sites within the DOC range of $5\text{--}13\text{ mg}\cdot\text{L}^{-1}$ where pH was usually <5.4 and correlated with the input of organic acids. This possibly reflected the local geology or, more likely, the input of buffering chemicals from agriculture prevalent in parts of this watershed.

The correlation between pH and DOC was also good ($r = 0.84$) in the West and East rivers, Sheet Harbour (Fig. 13a). Although DOC ranged from 3 to $23\text{ mg}\cdot\text{L}^{-1}$, there was a large cluster of sites in the DOC range of $10\text{--}15\text{ mg}\cdot\text{L}^{-1}$. These invariably had low pH (<5.0), indicating that organic acids from wetlands affected pH in these rivers as in some areas of the Medway system. DOC was highest at sites in the West River and, with the exception of one tributary, the pH was <4.8 at these sites, indicating that the influence of organic acids from wetlands in the drainage basin was significant. In the East River, reservoirs above hydroelectric dams could have moderated the flushing of organic acids and its impact on pH. The East River had the most sites of any of the river systems with very low DOC ($\leq 5\text{ mg}\cdot\text{L}^{-1}$) but the pH at these sites was not necessarily as high as would be expected when compared to other river systems. The pH was <4.9 at several of these low DOC sites indicating that other sources of acidity (e.g., mineral or sea salt episodes) could be important.

The Liscomb River had the narrowest DOC range ($5\text{--}15\text{ mg}\cdot\text{L}^{-1}$) of any of the rivers (Fig. 13b). Nevertheless, pH was correlated with DOC ($r = 0.81$) within that range but the sites were clustered in three distinct groups. There was a cluster of very acidic sites at about $15\text{ mg}\cdot\text{L}^{-1}$ of DOC. There was another cluster of sites at $8\text{--}10\text{ mg}\cdot\text{L}^{-1}$ of DOC and pH 5.0. However, two sites in this cluster were more acidic (pH <4.7) than the rest, indicative of some additional sources of acid input. In a third cluster of sites at about $5\text{ mg}\cdot\text{L}^{-1}$ of DOC, the pH varied widely with three sites more acidic (pH 5.0) than the rest. A higher pH would normally be expected at such low DOC concentrations based on the relationships observed in other river systems. Sources of acidity other than organic acids were probably increasingly important at these sites as mentioned for several sites in East River.

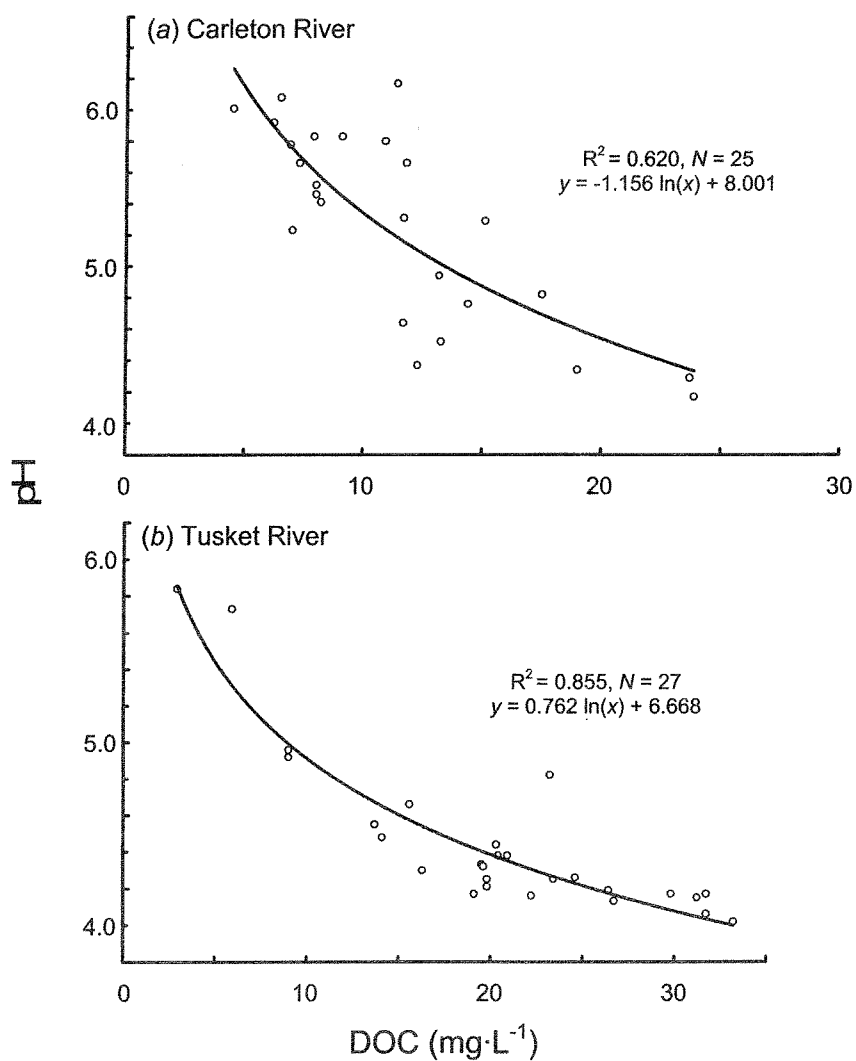


Fig. 11. Relationship between pH and dissolved organic carbon (DOC) measured in November 1997. (a) Carleton River and (b) Tuskett River.

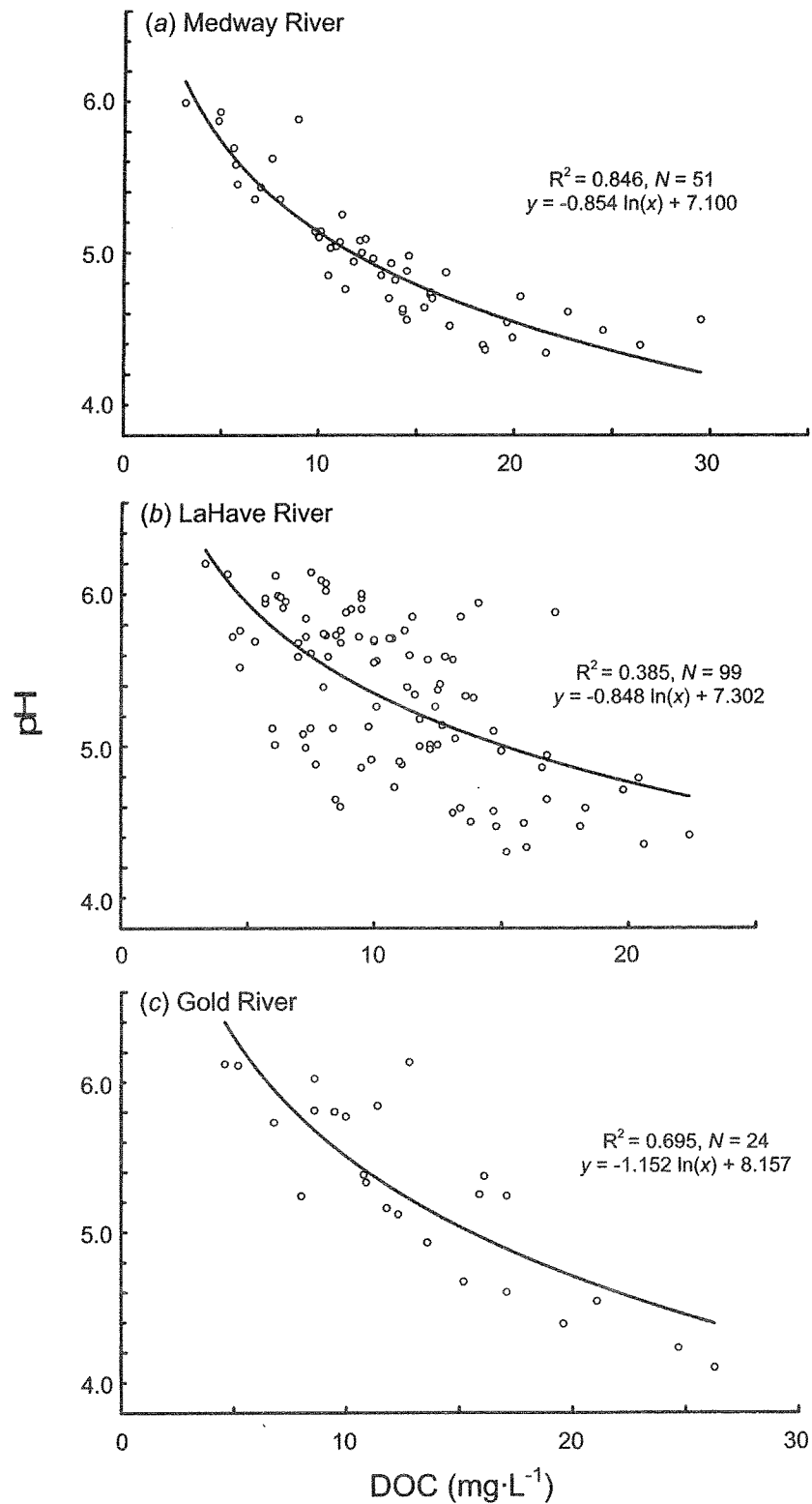


Fig. 12. Relationship between pH and dissolved organic carbon (DOC) measured in November 1997. (a) Medway River, (b) LaHave River, and (c) Gold River.

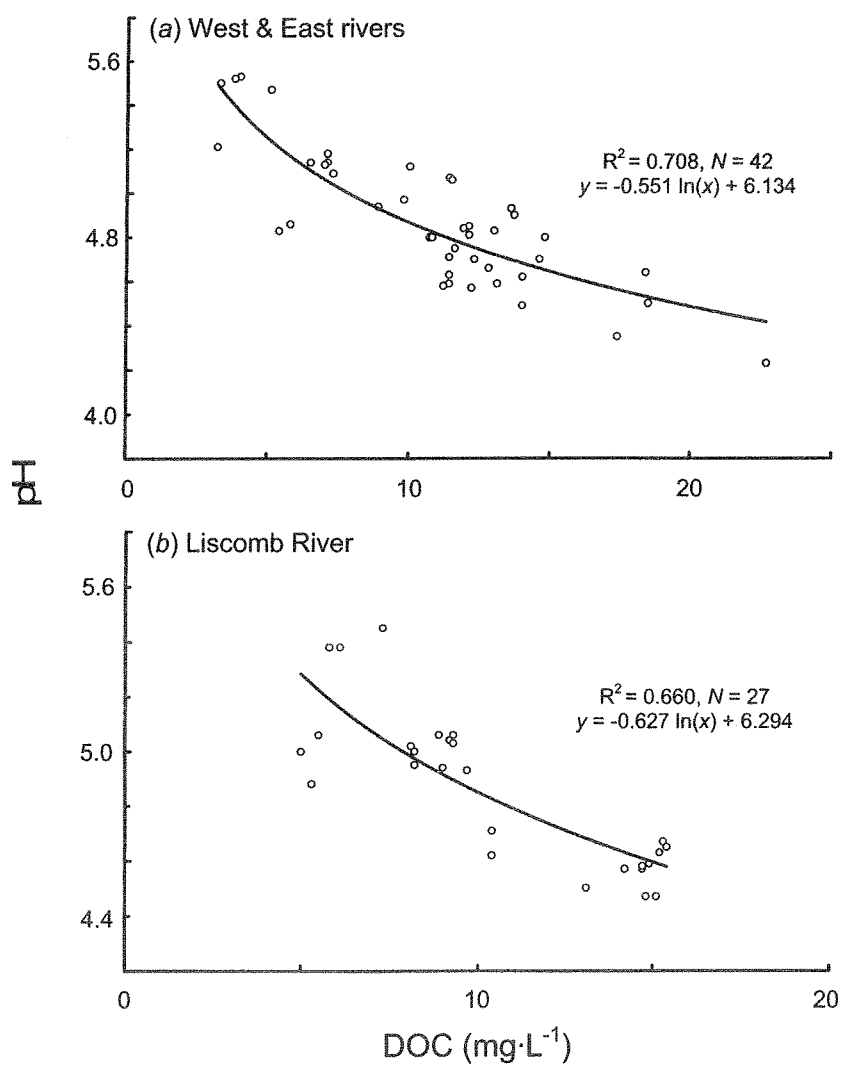


Fig. 13. Relationship between pH and dissolved organic carbon (DOC) measured in November 1997. (a) West and East rivers, Sheet Harbour, and (b) Liscomb River.

POTENTIAL IMPACTS ON ATLANTIC SALMON

The potential impacts of acidification on salmon in each of the river systems were evaluated using minimum pH recorded annually at all sites within a system (Fig. 14). Relative survival values were ascribed to each of the minimum pH ranges as follows: (1) pH 4.0–4.5 would result in complete mortality of salmon at all stages even if acidic episodes were of short duration (i.e., hours to days); (2) pH 4.5–5.0 would be lethal to a large proportion of salmon at all stages, the extent of the mortality dependent upon duration of the acid episode (i.e., days to weeks); (3) pH 5.0–5.5 would only be lethal to a small proportion of salmon during specific life-history stages (i.e., dependent on timing) and for long exposures (i.e., weeks to months); (4) pH 5.5–6.0 should not result in any salmon mortality at any stage regardless of the length of exposure. These were based on the toxicity functions developed for Atlantic salmon between the egg and smolt stages and the effects of timing and duration of low pH episodes on these life-history stages (Korman *et al.* 1994; Lacroix and Korman 1996).

The Tusket River was the most acidic and conditions were chronic with low pH persisting throughout the year. More than 60% of sites would not sustain any salmon production (Fig. 14a). Survival would be minimal in another 20% of sites because of the chronic acidification in this river. Less than 10% of sites were suitable for salmon survival and, even in those sites, some mortality would be expected based on the persistence of acidic conditions.

The Liscomb River was also considered to have a poor salmon production potential based on minimum pH distribution throughout the system. Conditions were considered lethal to salmon in almost 40% of sites (Fig. 14b). Mortality would also be high for some life-history stage in about 55% of sites, and only the episodic nature of acidification in this river would allow some salmon production to persist in those sites in some years. About 5% of sites were considered to be suitable for salmon, only because pH returned to relatively high levels for long periods in the river.

The entire Sheet Harbour river system was also very acidic, but there were some periods when pH increased enough to have allowed some salmon survival. Nevertheless, more than 10% of sites were too acidic to support salmon, and production in almost 70% of sites would only be marginal based on minimum pH distribution and duration (Figs. 14c and 14d). About 20% of sites would be suitable for salmon but even in these sites some mortality would be expected for some of the life-history stages.

In the Medway River, almost 20% of sites would be lethal to all salmon, and mortality would be high to all life-history stages in almost 60% of sites because of the long duration of acid episodes (i.e., from autumn to spring) (Fig. 14e). There would be some mortality of some life-history stages in about 20% of sites, but these sites and another 5% of sites where no pH-related mortality was expected

to occur would form the habitat base for salmon production in the Medway River. The Medway River, having a large proportion of sites in the pH 4.5–5.5 range, would probably be very dependent upon the inter-annual variability in the duration of acid episodes for continued salmon production.

The Carleton River had lethal acidic conditions in almost 20% of sites, but many other sites (about 50%) were considered suitable for salmon production with little mortality anticipated from the seasonal acidification in this river (Fig. 14f). However, over 40% of sites were considered to be in the pH range where mortality could be extremely high depending upon the duration of the low pH episodes. Much of this river system had habitat where conditions were in transition between non-lethal and lethal pH.

In the Gold River, as in the Carleton River, a good 20% of sites had acidic conditions that would be lethal to salmon and these sites were unsuitable for salmon production (Fig. 14g). However, fewer sites (<15%) were in the pH range where a high mortality of all life-history stages would be expected even during short exposures. The pH levels were relatively safe for salmon in the remaining 65% of sites, especially given the seasonal nature of the low pH episodes in this system.

The LaHave River was the least acidic of the rivers surveyed, and almost 40% of sites had pH levels that would have had no adverse effect on salmon survival at any time (Fig. 14h). Some salmon mortality would be expected in some of the sites (less than 30%) in the pH 5.0–5.5 range in years with acidic episodes of long duration. However, mortality of salmon at all life-history stages would probably be high in more than 25% of sites, and another 5-10% of sites in the LaHave system would not support any salmon production because of acutely low pH levels during autumn and winter acid episodes. In a previous survey (1988/89), almost 80% of habitat area in the LaHave River above Morgan Falls was considered to have no acidification impact on salmon, and the remaining 20% of habitat was equally distributed between moderate and severe impact categories (Korman *et al.* 1994). These estimates were based on assigning pH data from 17 monitoring sites, mostly on main tributaries, to upstream habitat in 55 tributaries.

Overall, the salmon production potential of all of these rivers was considered to be extremely low because of the chronic or acutely low pH levels at sites in a high proportion of the total salmon production habitat. A few sub-drainage areas within several of the major river systems were probably sustaining much of the salmon production in rivers along the south-west and eastern shores of Nova Scotia. Although some rivers have relatively good pH conditions during dry, low flow periods of the year, the seasonal nature and severity of acidic episodes in most systems indicated that they had poor salmon production potential.

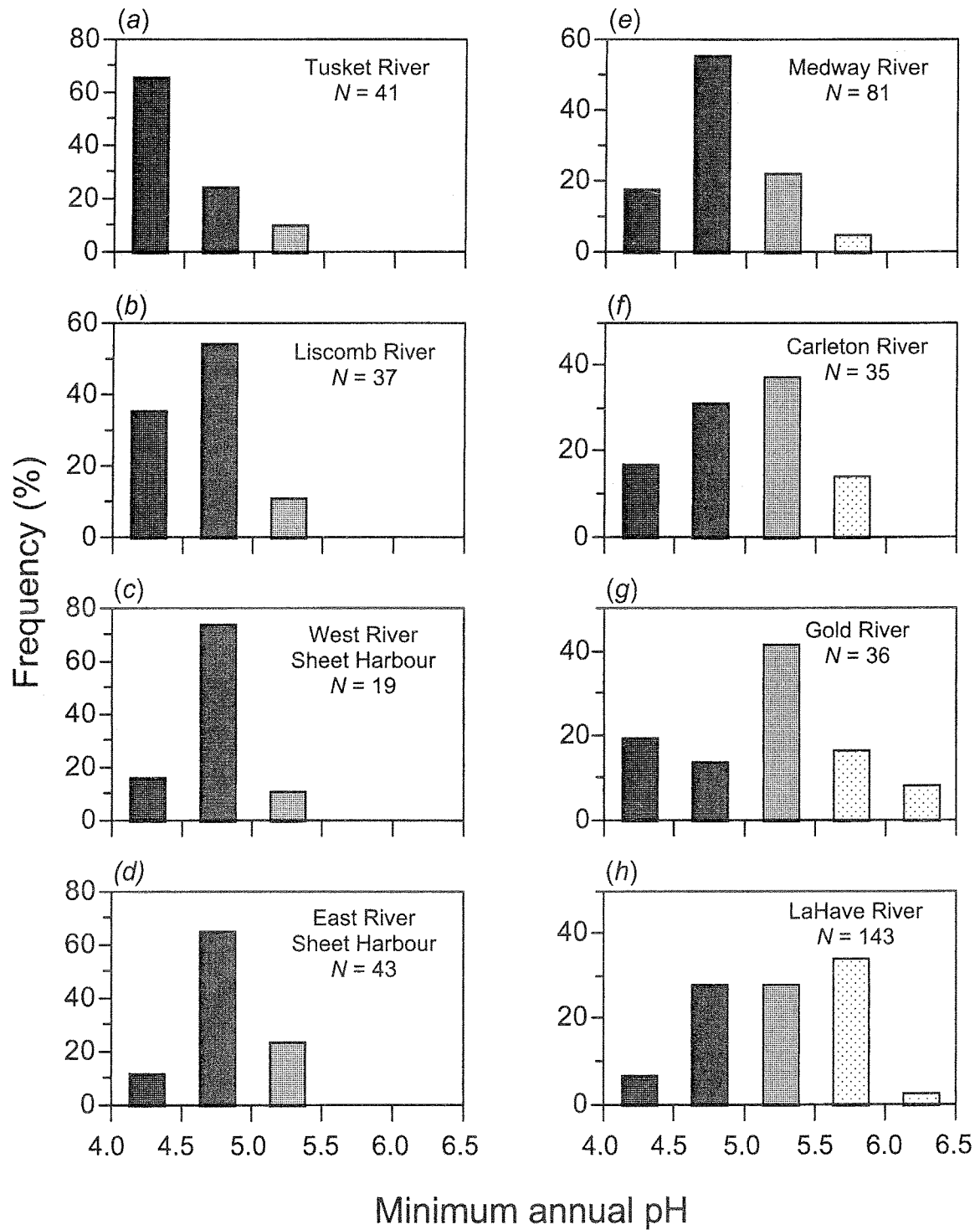


Fig. 14. Frequency distribution of minimum pH in each river system during the 1996–1997 survey. Rivers are arranged in order of decreasing acidity from (a) to (h). (a) Tuskett River, (b) Liscomb River, (c) West River, (d) East River, (e) Medway River, (f) Carleton River, (g) Gold River, and (h) LaHave River.

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APPENDIX A. SAMPLING SITES

Table A1. Description of sites sampled in the Carleton River, Nova Scotia during 1996–1997 (see Fig. A1 for location of site number). Stream order is Strahler number, and DM is distance from river mouth.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
Wentworth River	1	Bill Lake	2	70.5	44.19.47	65.54.43
	2	Simonds Lake	2	69.5	44.18.94	65.54.62
	3	Hourglass Lake	1	69.0	44.18.84	65.55.01
	4	Wentworth River	2	68.0	44.18.31	65.55.38
	5	Mullen Brook	1	67.3	44.17.07	65.54.36
	6	Wentworth River	2	61.5	44.16.29	65.57.62
	7	unnamed	1	58.0	44.15.67	65.55.78
	9	Wentworth River	3	51.0	44.14.26	65.56.09
Halfpenny Brook	10	Sullivans Brook	1	68.0	44.18.68	65.52.65
	11 ¹	Halfpenny Brook	1	69.3	44.19.22	65.49.87
	11	Halfpenny Brook	1	65.8	44.17.90	65.51.03
	12	Halfpenny Brook	3	58.0	44.14.47	65.54.36
	13	Halfpenny Brook	3	54.0	44.13.94	65.54.55
Upper Carleton R.	14	Carleton River	3	45.0	44.10.37	65.55.76
	15	Bear Brook	1	42.0	44.10.88	65.54.45
	16	Carleton River	3	34.3	44.07.62	65.55.33
	17	The Boarsback	1	42.0	44.08.85	65.57.10
	18	Briar Lake Brook	2	34.5	44.07.61	65.55.61
	19 ¹	unnamed	1	33.0	44.06.94	65.55.36
	19	Carleton River	3	33.0	44.06.90	65.54.90
	20	Hamilton Pond	1	32.0	44.06.45	65.55.22
	21	unnamed	1	31.0	44.05.87	65.55.20
Lower Carleton R. Lakes Region	23	Salmon Lake Brook	2	33.9	44.07.46	65.53.20
	22	Back Brook	1	41.5	44.06.66	65.52.47
	24	Carleton River	3	27.0	44.04.32	65.54.65
	25	Godfrey Lake	1	26.8	44.05.41	65.54.65
	26	Dove Lake	1	23.3	44.03.17	65.55.45
	27	Rounding Lake Bk.	1	22.5	44.02.91	65.56.13
	29	Crawleys Lake	1	20.1	44.01.82	65.54.10
	28	Mink Lake	1	20.1	44.01.29	65.54.17
	30	Carleton River	3	16.9	44.00.40	65.55.52
	31	Ryerson Brook	1	17.4	44.00.15	65.55.96
	35	Beaver Pond	1	10.0	43.56.71	65.56.76
	36	Carleton River	3	6.0	43.55.80	65.55.74
	37	Tusket River	4	0.0	43.53.22	65.58.36

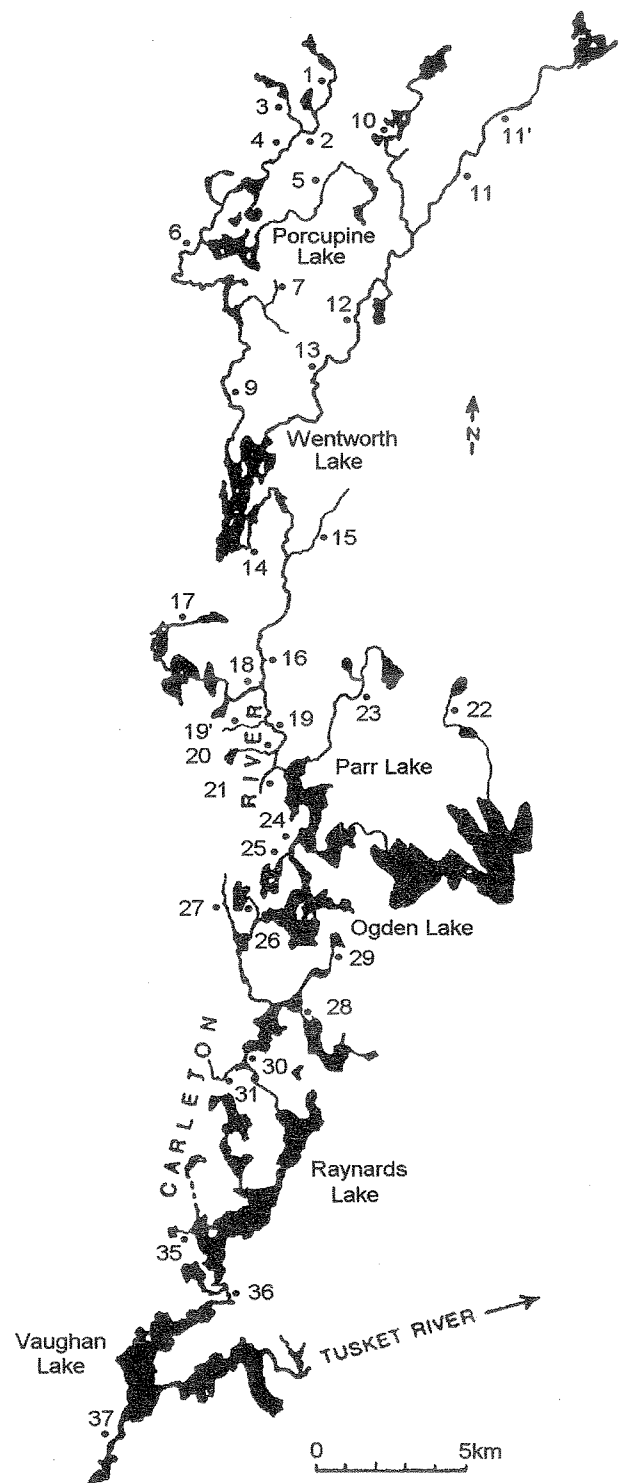


Fig. A1. Location of water sampling sites on the Carleton River, Nova Scotia. Site numbers correspond to those listed in Tables A1, B1, and C1.

Table A2. Description of sites sampled in the Tusket River, Nova Scotia during 1996–1997 (see Fig. A2 for location of site number). Stream order is Strahler number, and DM is distance from river mouth.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
Upper Tusket River	2	Beaverdam Brook	1	73.0	44.17.03	65.50.38
	3	Barn Brook	1	72.8	44.17.11	65.48.07
	4	Silver River	3	76.0	44.16.34	65.46.86
	11	Caribou River	2	74.1	44.15.71	65.46.45
	6	Silver River	4	65.1	44.12.46	65.49.39
	7 ¹	Tusket River	4	53.0	44.08.35	65.50.62
	7	Whistler Brook	2	53.0	44.08.37	65.50.51
	8	Georgie Meadow Bk.	1	55.0	44.08.57	65.49.83
	14	Bradys Brook	1	51.5	44.07.74	65.50.47
	15	Tusket River	4	49.0	44.06.95	65.50.80
	16	Tusket River	4	45.0	44.04.78	65.49.91
East Branch Tusket	10	Toms Savannah Bk.	2	68.5	44.11.28	65.44.86
	9	unnamed	1	67.9	44.10.48	65.46.16
	25	Bear Lakes Brook	1	68.0	44.07.08	65.39.74
	24	East Branch Tusket	2	60.8	44.07.79	65.43.88
	23	Big Meadow Brook	2	59.0	44.06.17	65.43.94
	22	Little Meadow Brook	1	58.5	44.06.04	65.44.48
	21	unnamed	1	53.0	44.05.36	65.45.80
	17	East Branch Tusket	4	45.5	44.04.91	65.49.30
Main Tusket River	18	Tusket River	5	41.0	44.02.93	65.49.95
	19	Schoolhouse Brook	1	44.0	44.03.84	65.48.46
	20	Meadow Brook	2	41.0	44.02.93	65.48.92
	29 ¹	Calling Meadows Bk.	1	40.3	44.01.69	65.51.29
<i>Kegeshook L.</i>	46	Cold Stream	3	43.0	43.58.78	64.45.48
	39	Shunacadie Brook	2	37.8	43.56.25	65.44.63
	38	unnamed	2	37.5	43.56.29	65.44.73
	44	Kegeshook outflow	4	30.8	43.58.32	65.48.50
	31	Tusket River	5	24.0	43.55.34	65.49.44
<i>Quinan River</i>	42	unnamed	2	43.0	43.50.49	65.39.13
	41	Little Gull Lake Bk.	2	41.0	43.53.73	65.41.35
	35	unnamed	1	32.0	43.53.43	65.46.89
	36	Quinan River	3	31.3	43.53.42	65.46.34
	37	Biggars Lake outflow	2	30.0	43.54.50	65.46.10
	34	Mushpauk Brook	3	27.0	43.54.71	65.48.39
	33	Quinan River	3	26.5	43.55.05	65.48.01
	32	Quinan River	4	24.5	43.55.34	65.49.35
	30	Tusket River	5	23.0	43.55.27	65.49.87
	47	Mill Lake outflow	1	16.5	43.57.46	65.52.89
	48	Tusket River	5	12.0	43.55.49	65.52.16
	49	Tusket River	5	2.5	43.53.76	65.56.83
	50	Tusket River	5	0.0	43.53.22	65.58.36

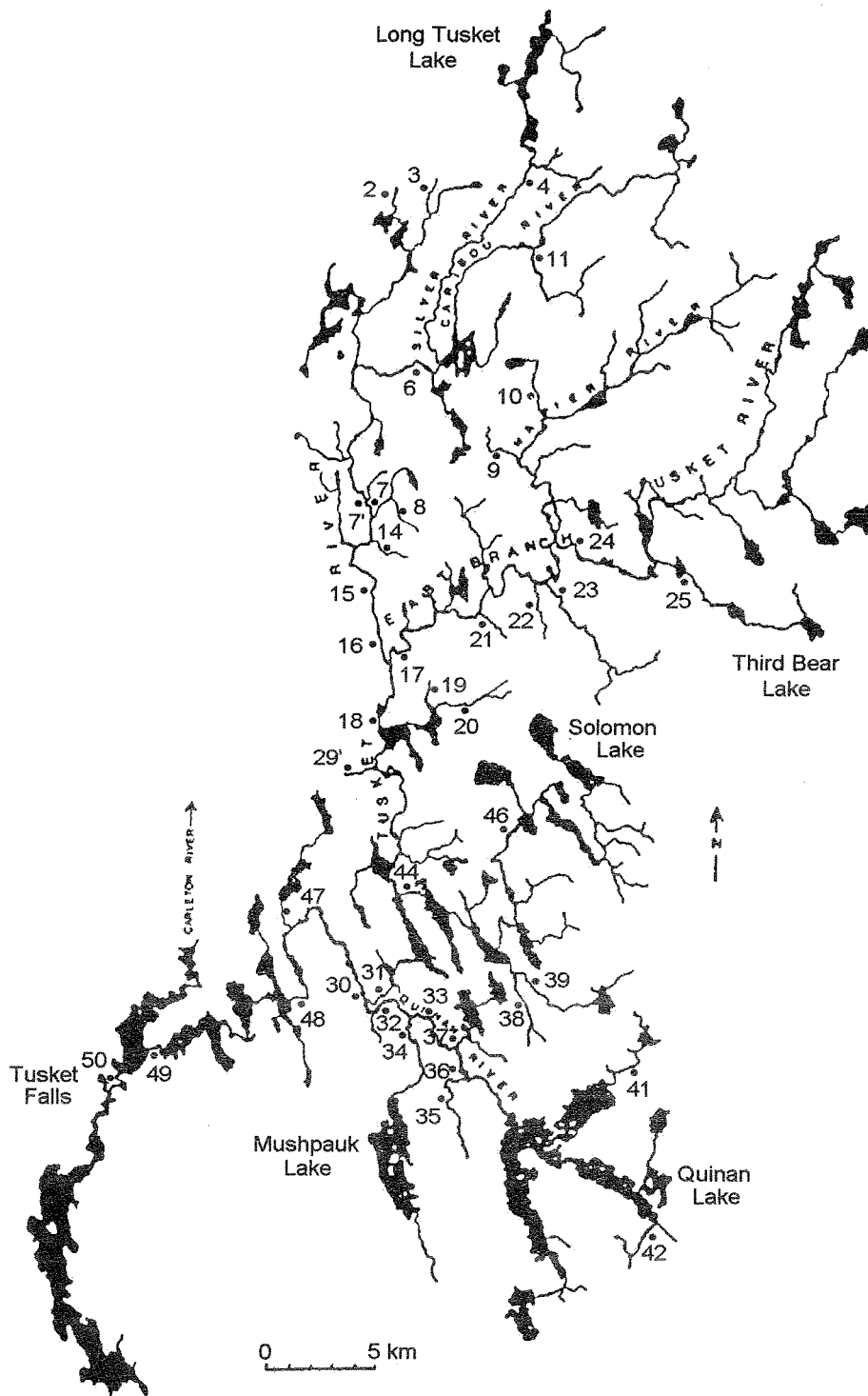


Fig. A2. Location of water sampling sites on the Tusket River, Nova Scotia. Site numbers correspond to those listed in Tables A2, B2, and C2.

Table A3. Description of sites sampled in the Medway River, Nova Scotia during 1996–1997 (see Fig. A3 for location of site number). Stream order is Strahler number, and DM is distance from river mouth.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
W. Branch Medway	1	Long Lake	2	87.0	44.38.74	65.13.56
	2	Bog Brook	1	83.0	44.36.67	65.12.24
	3	W. Branch Medway	2	82.5	44.36.39	65.12.02
	4	Hendry Lake outflow	2	79.5	44.36.23	65.11.20
	5	W. Branch Medway	3	79.0	44.35.70	65.10.72
E. Branch Medway	6	Donnelly Brook	2	85.8	44.39.64	65.06.93
	9	Birch Bridge Brook	2	82.0	44.37.40	65.07.78
	7	Kelly Lake Brook	1	83.0	44.37.81	65.05.76
	10	Randolph Stream	1	81.5	44.36.16	65.08.46
	8	Mitchell Brook	2	78.0	44.34.60	65.05.10
Upper Medway River	11	E. Branch Medway	3	77.0	44.35.45	65.06.19
	12	Medway River	4	68.5	44.31.60	65.08.26
	13	Perch Lake outflow	2	63.8	44.27.59	65.05.58
	14	Medway River	4	64.4	44.29.86	65.06.69
	15	Mill Lake Brook	2	65.0	44.27.69	65.07.38
	16	Medway River	4	59.0	44.27.99	65.04.57
	17	Mount Merrit Brook	2	57.5	44.26.42	65.06.20
	18 ¹	Martin Lake outflow	1	55.8	44.25.02	65.05.34
	18	Harmony Brook	1	54.5	44.24.37	65.04.56
	19 ¹	Medway River	4	52.3	44.24.79	65.03.17
	19	Medway River	4	49.0	44.24.02	65.01.30
Westfield River	20	Lakeview Stream	2	51.5	44.21.80	65.03.75
	23	Round Lake Brook	2	63.5	44.29.40	64.58.32
	24	Halfway Brook	1	59.5	44.27.98	64.57.01
	22	Moose Pit Brook	1	59.0	44.27.69	65.02.91
	26	Little Tupper outflow	2	55.5	44.26.08	64.54.48
	30	Westfield River	2	49.5	44.24.36	64.59.31
	31	Medway River	4	43.5	44.22.57	64.58.45
	36	Mary Lake outflow	1	43.3	44.22.11	64.58.25
Wildcat/Pleasant	32	Beaver Brook	2	42.5	44.22.20	64.56.27
	65 ¹	Upper Wildcat River	3	86.0	44.35.66	64.58.44
	65 ¹¹	Black Brook	1	77.0	44.36.23	64.57.17
	65	Wildcat River	3	86.5	44.35.29	64.52.58
	64	Dexter Brook	2	82.0	44.33.12	64.52.74
	66	Pleasant River	3	61.5	44.26.30	64.53.03
	62	Shinglemill Brook	2	62.1	44.26.17	64.53.57
	63	Deep Brook	1	60.5	44.26.05	64.52.47
	57	Keddy Brook	1	67.8	44.27.30	64.50.69
	60	Shingle Lake outflow	2	58.5	44.25.38	64.51.86
	61	Pleasant River	3	58.5	44.25.33	64.52.43
	55 ¹	Little Brook	1	56.1	44.22.22	64.47.12
	54	Hanley Brook	2	56.5	44.20.93	64.47.18

Table A3. Continued.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
<i>Wildcat/Pleasant</i>	53	Whynott Lake	1	58.0	44.18.99	64.48.58
	52	Black Rattle outflow	1	54.8	44.20.37	64.49.12
	34	Wildcat River	3	42.6	44.20.92	64.55.14
<i>Christopher Lakes</i>	35	Medway River	4	38.6	44.20.78	64.56.17
	43	Whiteburn Brook	2	51.5	44.20.64	65.03.84
	44	Red Brook	1	50.3	44.19.87	65.03.56
	45	Whiteburn Brook	2	48.5	44.19.86	65.02.31
	41	McBride Brook	2	51.0	44.18.09	65.03.65
	40	Bull Moose Brook	2	49.8	44.16.30	66.01.15
	42	Telfer Lake outflow	3	48.0	44.18.30	65.02.04
	48	Meagher Brook	1	44.5	44.20.20	64.59.95
	49	Sec. Christopher L.	3	41.5	44.19.63	64.58.59
	49 ¹	Beartrap Lake inflow	1	38.3	44.19.20	64.57.39
<i>Ponhook Lake</i>	49 ¹¹	Eighteen Mile Brook	2	39.4	44.16.34	64.55.09
	50	LaBelle Brook	2	34.5	44.18.88	64.50.07
Lower Medway River	56	Medway River	4	27.0	44.16.33	64.51.20
	67	Fifteen Mile Brook	1	24.5	44.14.89	64.51.01
	68	Medway River	4	22.5	44.14.77	64.50.13
	69	Buggy Hole Brook	1	19.5	44.14.04	64.48.15
	70	Medway River	4	19.3	44.14.20	64.48.01
	71	Dean Brook	2	17.5	44.13.65	64.47.04
	72	Medway River	4	17.5	44.13.63	64.46.98
	73	Twelve Mile Brook	1	25.5	44.12.93	64.51.53
	74	Medway River	4	16.5	44.13.12	64.46.28
	77	Wentworth Brook	3	10.5	44.11.95	64.42.55
	78	Medway River	4	9.0	44.13.45	64.40.70
	81	Glode Meadows Bk.	2	5.5	44.10.82	64.40.68
	82	Medway River	4	5.3	44.10.82	64.40.68
	83	Salters Brook	2	19.5	44.16.82	64.42.21
	89	Salters Brook	3	4.0	44.10.69	64.39.97
<i>Salters Brook</i>	90	Medway River	4	3.6	44.10.70	64.39.96
	90	Medway River	4	3.6	44.10.70	64.39.96
<i>Oakes Mills/Petite</i>	84	Hell Lake	1	13.0	44.12.82	64.36.01
	85	Island Lake	2	13.0	44.12.66	64.36.11
	86	Petite Brook	2	10.0	44.12.22	64.37.36
	87	Oakes Mills Brook	2	9.9	44.12.36	64.37.83
	91	Petite Brook	3	3.6	44.10.21	64.39.31
	92	Medway River	4	3.0	44.10.29	64.39.28
	93	Tumblingdown Bk.	1	3.0	44.09.91	64.40.29
	94	Medway River	4	0.0	44.08.74	64.38.96

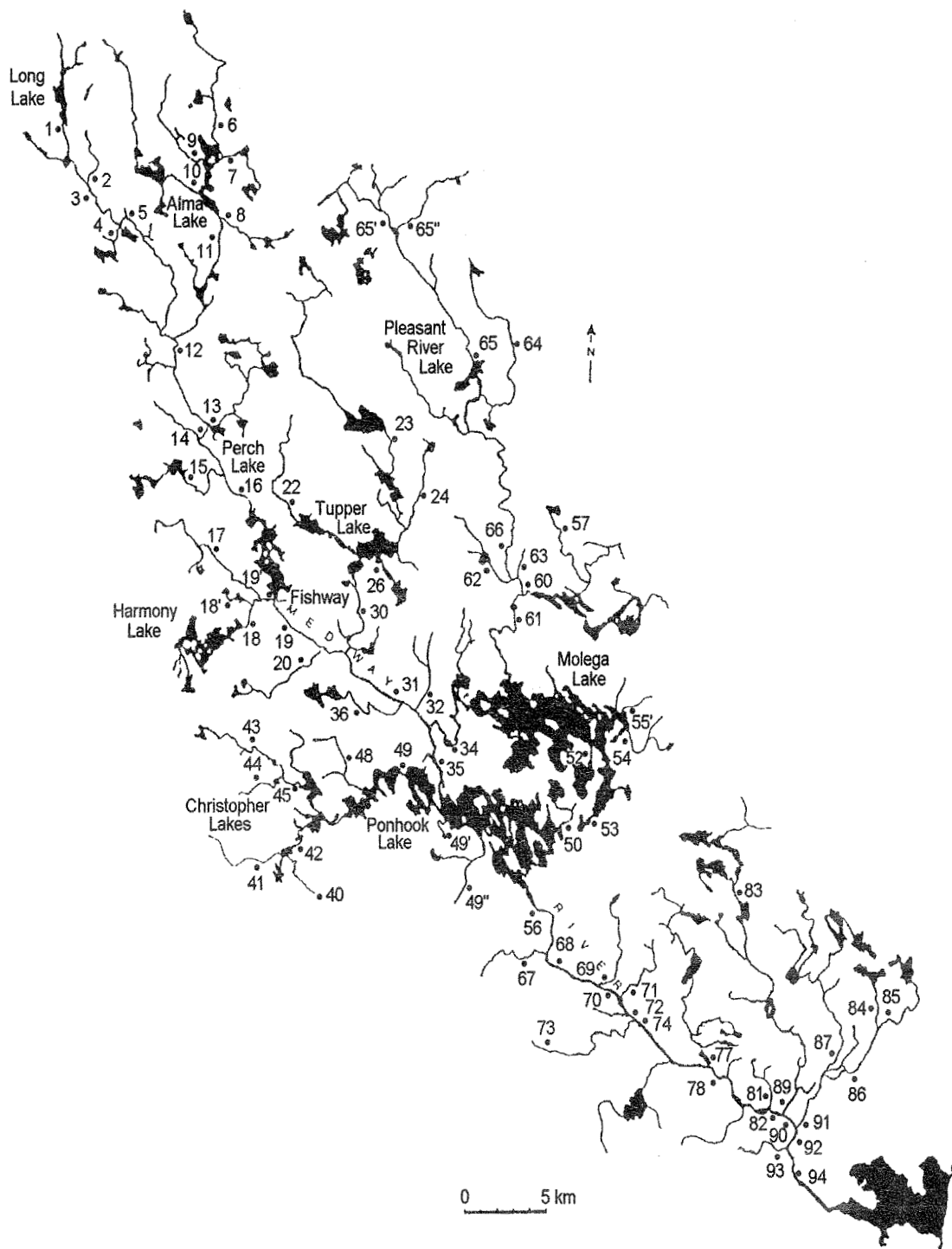


Fig. A3. Location of water sampling sites on the Medway River, Nova Scotia. Site numbers correspond to those listed in Tables A3, B3, and C3.

Table A4. Description of sites sampled in the LaHave River, Nova Scotia during 1996–1997 (see Fig A4 for location of site number). Stream order is Strahler number, and DM is distance from river mouth.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
Upper LaHave River	2	Frog Lake	1	73.0	44.50.42	64.50.46
	3	Shell Camp Stream	2	70.0	44.48.98	64.48.84
	5	Shell Camp Stream	3	61.0	44.45.79	64.51.12
	1	Joe Simon Stream	3	67.0	44.46.71	64.55.50
	6	Fred's Lake outflow	3	61.5	44.46.08	64.52.23
	12	Rocky Lake Brook	1	60.5	44.41.20	64.53.34
	10	Upper Thirty inflow	1	60.0	44.43.42	64.56.65
	11	Thirty Brook	3	55.0	44.43.27	64.53.18
	15	LaHave River	4	51.0	44.42.61	64.50.65
	4	East Twin L. Brook	2	58.0	44.46.40	64.48.26
	8	Eel Lake Brook	2	58.0	44.44.57	64.48.68
	9	Crossburn Brook	3	54.5	44.44.13	64.48.74
	16	Sixty Brook	3	49.5	44.42.42	64.49.71
	17	Mason Brook	1	42.5	44.38.97	64.50.49
	13	Miletree L. outflow	1	50.0	44.40.29	64.54.83
	14	Roop Brook	2	47.5	44.39.66	64.53.54
	19	Mason Meadow Bk.	2	38.5	44.37.31	64.48.55
	18	LaHave River	4	38.0	44.42.11	64.48.24
North River	20	North Twin L.	1	69.5	44.51.49	64.43.21
	21	Up. Tomahawk Stm.	2	67.1	44.50.18	64.44.38
	22	Tomahawk Stream	3	65.5	44.50.19	64.44.38
	23	Hamilton Brook	1	65.5	44.48.79	64.46.71
	24	Tomahawk Stream	3	63.8	44.49.56	64.45.17
	25	Wentzell Brook	2	62.3	44.48.59	64.44.96
	26	Nimchin Page Brook	1	62.6	44.47.35	64.42.64
	27	Ozie Meadows Bk.	2	57.8	44.46.06	64.44.09
	28	Armstrong L. outflow	3	56.4	44.45.92	64.44.68
	29	Black Duck Lake Bk.	1	54.0	44.43.25	64.42.91
	30	Black Duck Lake Bk.	1	52.8	44.43.40	64.43.60
	31	North River	3	49.8	44.42.69	64.45.02
	32	Bob & Joan Brook	1	52.3	44.42.26	64.47.28
	33	Bob & Joan Brook	2	46.0	44.40.90	64.44.75
	34	North River	3	44.0	44.40.30	64.44.30
	35	Robar's Brook	1	48.5	44.42.10	64.48.25
	36	North River	3	34.8	44.36.32	64.45.48
Main LaHave River	117	LaHave River	4	33.0	44.36.05	64.46.20
	120	Shinglemill Brook	1	35.1	44.35.19	64.43.13

Table A4. Continued.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
Main LaHave River	121	Feindel Lake outflow	1	32.4	44.34.22	64.44.18
	119	Shinglemill Brook	2	30.5	44.34.40	64.45.28
	118	LaHave River	4	29.5	44.33.38	64.44.40
West River	75	West River	3	52.3	44.37.63	64.52.82
	76	West River	3	49.8	44.36.44	64.52.24
	77	Sucker Brook	2	48.5	44.35.78	64.52.18
	78	West River	3	41.8	44.33.14	64.49.28
	79	Little River	2	41.1	44.32.45	64.49.53
	80	West River	3	37.4	44.31.40	64.47.36
	81	unnamed	1	34.0	44.32.23	64.46.58
	82	Varnier Brook	1	31.5	44.33.26	64.46.12
	84	Sheridon Brook	1	31.5	44.31.45	64.44.24
	85	Manning Brook	2	29.4	44.31.56	64.43.56
	83	West River	3	28.5	44.33.03	64.44.47
	86	LaHave River	4	25.0	44.32.22	64.43.00
Main LaHave River	124	Indian Brook	2	29.5	44.34.64	64.41.40
	123	Indian Brook	2	23.8	44.32.01	64.41.58
	122	LaHave River	4	23.0	44.31.55	64.41.44
	126	Ross Brook	1	22.5	44.31.20	64.40.32
	125	LaHave River	4	21.5	44.31.08	64.40.29
N. Branch LaHave	37	Lake Paul inflow	1	67.5	44.52.60	64.41.55
	38	Lake Paul inflow	1	67.6	44.52.33	64.41.74
	39	unnamed	1	63.8	44.50.08	64.40.49
	40	Lake Paul Brook	2	61.0	44.49.71	64.40.81
	41	unnamed	1	60.1	44.49.45	64.40.85
	42	Caribou Lake	1	66.3	44.51.79	64.37.93
	43	Hardwood L. outflow	2	62.0	44.49.75	64.38.76
	44	Sand Brook	2	63.5	44.48.62	64.38.56
	45	Sherbrooke River	3	53.9	44.47.75	64.40.32
	46	McClintock Brook	1	54.5	44.44.55	64.41.22
	47	Sherbrooke River	3	48.3	44.43.38	64.38.75
	48	Burke Lake outflow	1	51.5	44.44.05	64.41.37
	49	Butler Lake outflow	1	49.5	44.37.31	64.48.55
	50	Butler Lake Brook	2	48.9	44.43.84	64.39.83
	51	Gully River	2	49.4	44.43.52	64.36.23
	52	Roast Lake outflow	1	56.0	44.46.28	64.34.38
	53	Muddy Lake Brook	2	52.5	44.45.23	64.33.42
	54	Forty River	2	48.3	44.43.82	64.35.10
	55	Harlow Brook	1	46.8	44.44.56	64.34.27

Table A4. Continued.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
N. Branch LaHave	56	Pine Lake Brook	1	42.5	44.40.79	64.34.08
	57	Holbert Lake inflow	1	45.5	44.36.27	64.34.39
	58	N. Branch LaHave	4	32.9	44.36.23	64.36.13
	60	Nelson Brook	2	38.1	44.38.57	64.39.23
	59	William Ross Brook	1	37.5	44.38.13	64.37.49
	61	Solomon Brook	2	33.5	44.36.10	64.40.22
	62	Johnson Brook	1	33.0	44.35.30	64.40.08
	63	Solomon Brook	2	31.6	44.35.45	64.39.26
	64	Lower Nelson Brook	3	30.6	44.35.18	64.39.14
	66	Shingle Brook	1	28.8	44.33.29	64.36.15
	65	Cape Marsh Brook	1	30.4	44.33.00	64.35.44
	67	Church Lake Brook	1	28.0	44.33.44	64.36.39
	68	N. Branch LaHave	4	25.1	44.33.05	64.37.40
	70	Upper Patten Brook	2	25.9	44.33.36	64.40.05
	69	Biscuit Brook	1	24.9	44.33.13	64.39.11
	71	Lower Patten Brook	2	21.9	44.31.44	64.38.36
	72	N. Branch LaHave	4	21.5	44.31.40	64.38.29
	73	MacKay's Brook	2	22.5	44.30.45	64.37.13
	74	unnamed	1	19.5	44.30.15	64.37.46
	127	N. Branch LaHave	4	17.0	44.29.39	64.38.29
Main LaHave River	128	LaHave River	5	11.1	44.27.43	64.37.31
	131	Rhodenizer Brook	1	12.0	44.22.33	64.34.26
	132	Feener Brook	1	11.0	44.27.50	64.35.29
	130	Rhodenizer Brook	2	9.8	44.27.15	64.35.39
	129	LaHave River	5	9.0	44.26.51	64.35.30
	134	Darrs Marsh	1	9.0	44.26.51	64.35.22
	133	LaHave River	5	8.5	44.26.49	64.35.27
W. Branch LaHave	87	Upper King Brook	1	40.8	44.30.47	64.48.24
	88	King Brook	1	40.8	44.30.39	64.48.47
	89	King Brook	2	39.5	44.30.21	64.47.52
	90	Lower Smith Brook	1	40.3	44.29.37	64.48.22
	91	Smith Brook	2	39.3	44.30.03	64.48.00
	93	Smith Brook	3	36.0	44.28.56	64.46.19
	94	Rocky Lake outflow	1	35.8	44.28.13	64.43.48
	95	Hirtle Lake outflow	3	33.0	44.27.37	64.45.39
	92	Ash Brook	1	36.0	44.27.38	64.48.45
	97	Rhodenizer Lake	1	27.0	44.26.17	64.43.15
	96	Seven Mile outflow	3	27.3	44.25.45	64.43.56
	98	W. Branch LaHave	3	22.0	44.24.20	64.41.43

Table A4. Continued.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
W. Branch LaHave	99	Huey Lake outflow	1	27.4	44.23.19	64.43.52
	100	Fire Lake outflow	1	26.6	44.22.43	64.41.46
	101	Harley L. Mill Brook	2	22.5	44.23.57	64.41.44
	102	Fire Brook	1	21.3	44.24.06	64.40.51
	103	W. Branch LaHave	3	20.1	44.24.38	64.41.11
	104	unnamed	1	19.3	44.24.53	64.41.01
	105	W. Branch LaHave	3	18.8	44.24.55	64.40.36
	106	Cook's Lake outflow	1	18.5	44.25.19	64.40.33
	107	unnamed	1	17.3	44.26.14	64.39.26
	108	W. Branch LaHave	3	14.9	44.25.40	64.38.36
	109	Little Wiles L. Brook	1	11.0	44.25.40	64.36.56
	110	W. Branch LaHave	3	10.5	44.25.43	64.36.43
	111	New Canada Lake	2	19.6	44.28.41	64.40.53
	112	unnamed	1	18.8	44.28.26	64.39.57
	113	Zwicker Brook	2	14.9	44.27.09	64.38.37
	114	Luck Brook	1	15.0	44.26.47	64.39.03
Main LaHave River	115	Zwicker Brook	2	10.0	44.26.03	64.36.32
	116	W. Branch LaHave	3	9.1	44.26.00	64.36.16
	135	LaHave River	5	7.8	44.26.11	64.34.42
	137	Joudrey Brook	1	7.6	44.26.12	64.34.43
	136	LaHave River	5	6.5	44.26.12	64.34.40
	139	Cooks Brook	2	3.8	44.24.42	64.33.13
	138	LaHave River	5	3.0	44.24.37	64.33.16
	141	Heckmans Brook	1	2.0	44.24.14	64.33.02
	140	LaHave River	5	1.9	44.24.09	64.33.01
	143	Grouse Brook	2	1.9	44.24.04	64.32.58
	142	LaHave River	5	1.8	44.24.06	64.32.53
	144	LaHave River	5	0.0	44.23.35	64.32.07

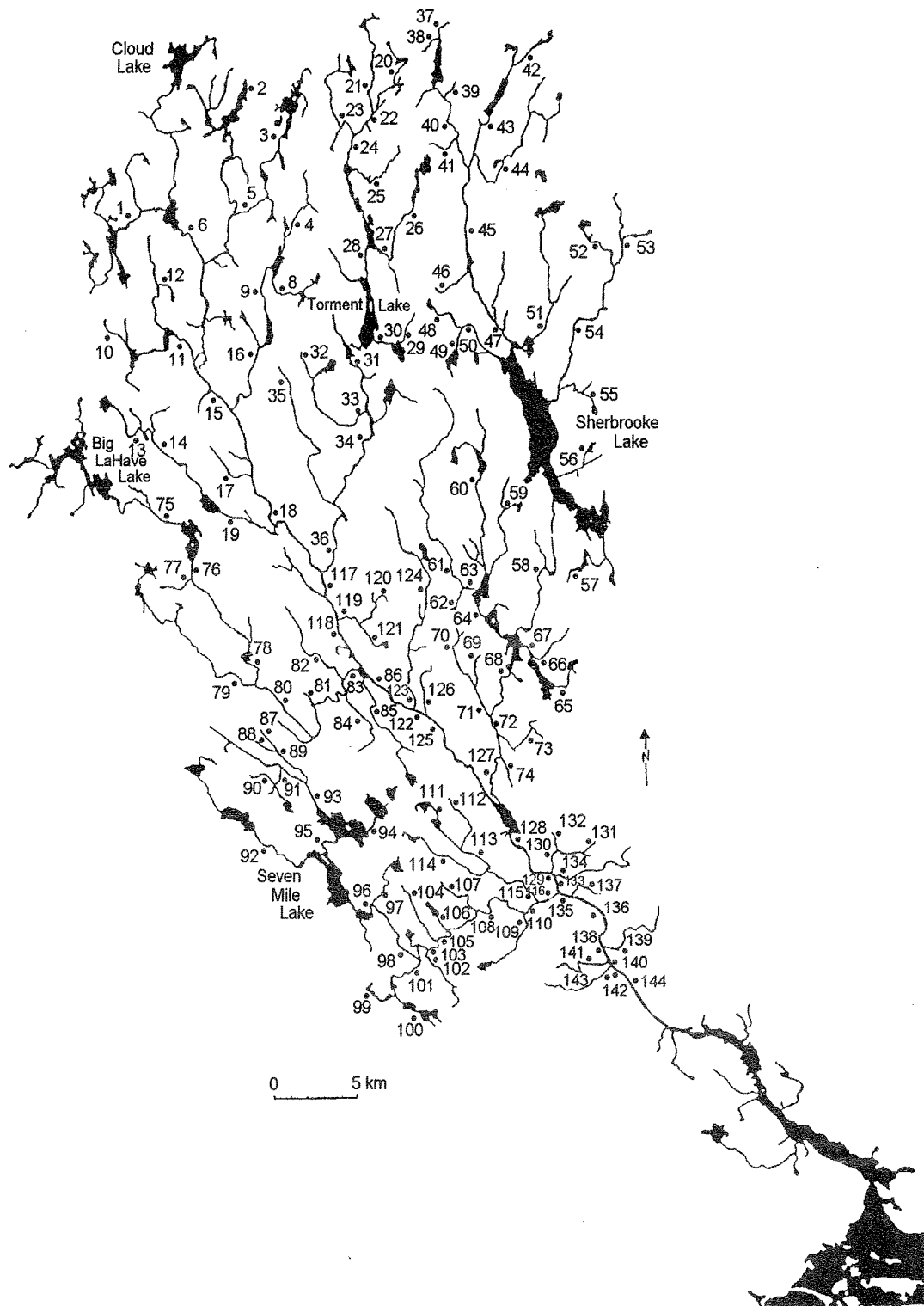


Fig. A4. Location of water sampling sites on the LaHave River, Nova Scotia. Site numbers correspond to those listed in Tables A4, B4, and C4.

Table A5. Description of sites sampled in the Gold River, Nova Scotia during 1996–1997 (see Fig. A5 for location of site number). Stream order is Strahler number, and DM is distance from river mouth.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
West Branch Gold	8	Porcupine Lake	1	45.5	44.51.31	64.29.03
	9	Hatchard L. outflow	1	42.5	44.49.40	64.30.43
	10	Sefferns L. outflow	1	42.5	44.48.79	64.30.15
	11	Hunts Lake outflow	1	43.0	44.49.60	64.30.37
East Branch Gold	1	Marsh Brook	1	44.5	44.50.47	64.27.08
	2	Rocky Brook	1	50.8	44.47.17	64.23.01
	3	unnamed	1	51.8	44.47.49	64.22.73
	4	Lewis Lake outflow	2	47.5	44.46.02	64.24.47
	5	Cleanwater Lake	1	46.0	44.45.94	64.24.53
	6	East Branch Gold	2	43.0	44.46.02	64.24.47
	7	East Branch Gold	2	38.0	44.47.84	64.26.49
Upper Gold River <i>Mill Brook</i>	12	Gold River	3	30.8	44.45.13	64.27.97
	13	Indian Lake outflow	1	34.5	44.46.42	64.24.82
	14	Round Lake outflow	2	34.5	44.46.21	64.24.46
	15	Cross Brook	2	34.0	44.46.27	64.25.07
	16	Whalen Lake outflow	1	34.0	44.46.29	64.25.54
	17	Cross Brook	2	33.0	44.45.88	64.25.25
	18	Mill Brook	2	29.0	44.44.57	64.26.58
	19	Gold River	3	26.5	44.43.19	64.26.93
	21	Bench Brook	1	26.5	44.43.00	64.27.54
	20	Cobbler Brook	2	26.5	44.42.07	64.26.09
<i>Larder River</i>	23	Larder Brook	1	32.5	44.45.10	64.30.47
	25	Gully Brook	1	32.5	44.44.54	64.30.16
	24	Twenty Brook	1	33.5	44.44.24	64.31.91
	26	Larder Brook	2	29.5	44.44.31	64.29.95
Lower Gold River	29	Gold River	4	16.5	44.38.10	64.25.67
	30	Alder Island Brook	2	14.8	44.39.07	64.22.46
	31	Gold River	4	14.5	44.37.43	64.25.20
<i>Beech Hill Brook</i>	33	DeMonts Brook	1	19.5	44.35.45	64.24.69
	34	Pennal Brook	1	20.0	44.35.60	64.24.55
	32	Beech Hill Brook	2	14.0	44.37.58	64.25.21
	35	Gold River	4	7.5	44.35.55	64.22.30
	36	unnamed	1	4.5	44.33.98	64.21.41
	37	Gold River	4	3.0	44.33.43	64.19.79
	38	Clarke Brook	1	4.5	44.35.69	64.20.99
	39	Gold River	4	0.0	44.33.42	64.19.78

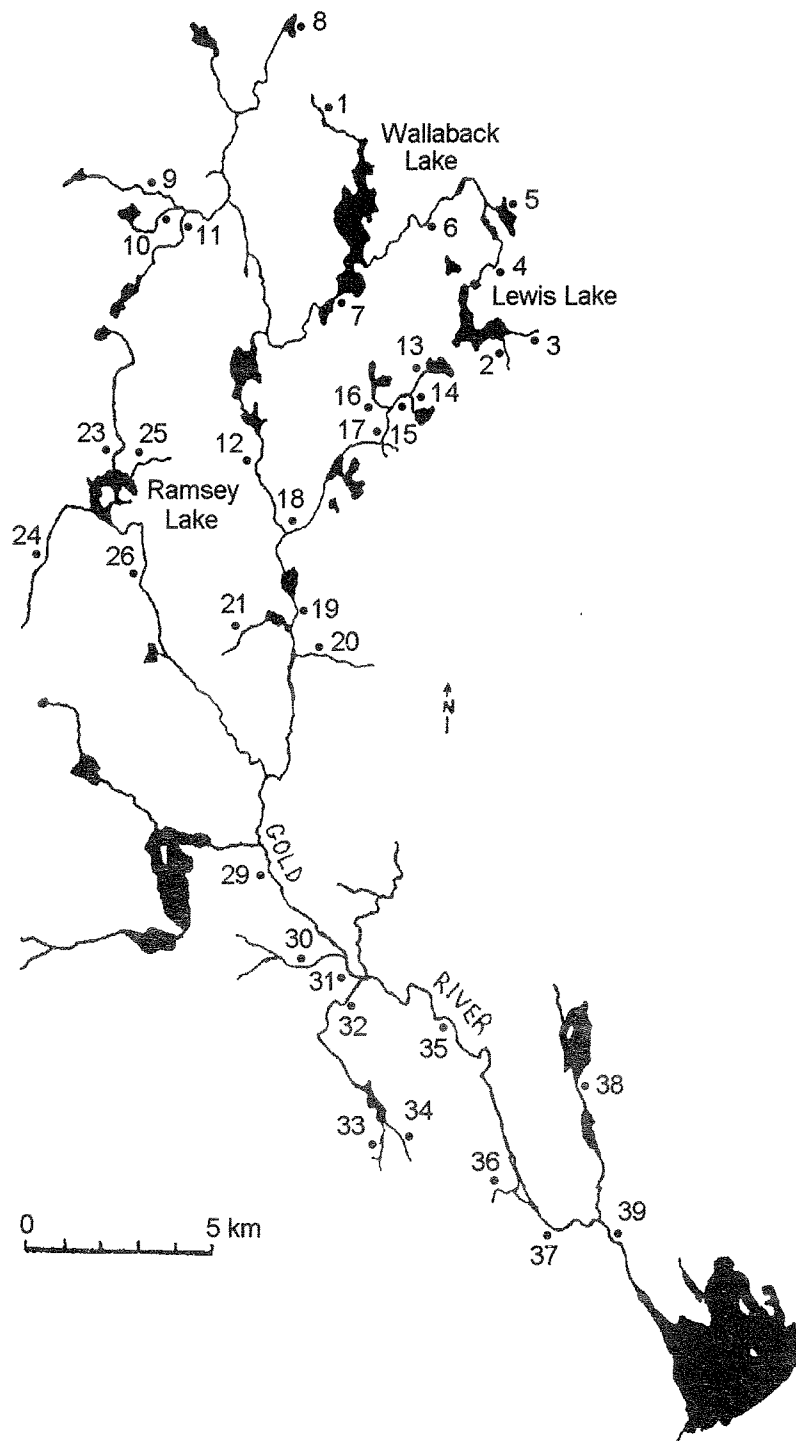


Fig. A5. Location of water sampling sites on the Gold River, Nova Scotia. Site numbers correspond to those listed in Tables A5, B5, and C5.

Table A6. Description of sites sampled in the East and West rivers, Sheet Harbour, Nova Scotia during 1996–1997 (see Figs. A6a, A6b for location of site number). Stream order is Strahler number, and DM is distance from river mouth.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
<u>East River System</u>						
Fifteen Mile Stream	1	Bottle Brook	1	43.0	45.13.60	62.32.76
	2	Second Rocky Lake	2	42.4	45.13.24	62.31.43
	3	Fifteen Mile Stream	1	38.0	45.11.20	62.34.77
	4	Indian Lake outflow	2	38.5	45.11.10	62.35.17
	5	Fifteen Mile Stream	2	33.3	45.09.89	62.33.75
	11	Seloam L. outflow	2	32.5	45.09.21	62.30.74
	10	unnamed	1	31.3	45.08.59	62.30.80
	9	Fifteen Mile Stream	3	28.5	45.08.52	62.33.14
	6	Bear Brook	1	33.0	45.09.62	62.36.50
	7	unnamed	1	31.5	45.09.40	62.37.85
	8	Bear Brook	2	27.5	45.07.81	62.33.00
	13	Fifteen Mile Stream	3	26.5	45.07.84	62.32.87
	12	East Brook	1	26.9	45.07.56	62.28.99
	14	Fifteen Mile Stream	4	20.9	45.06.10	62.29.83
	15	McMillan L. Brook	1	20.6	45.05.64	62.30.22
	16	Spectacle L. Brook	1	19.3	45.05.32	62.30.71
	17	Fifteen Mile Stream	4	15.0	45.09.19	62.30.40
Ten Mile Stream	23	Ten Mile Stream	2	46.0	45.11.50	62.43.67
	25	Moose Lake Brook	1	44.5	45.11.48	62.42.76
	24	Ten Mile L. outflow	2	43.5	45.11.56	62.43.89
	26	Ten Mile Stream	3	41.3	45.09.07	62.47.79
	27	Ten Mile Stream	3	33.0	45.06.90	62.41.10
	28	Diamond L. Brook	1	32.0	45.05.94	62.40.66
Twelve Mile Stream	22	Caribou Lake Brook	1	38.3	45.11.50	62.39.41
	18	Twelve Mile Stream	2	34.4	45.10.94	62.40.08
	19	McDonald L. Stream	1	34.4	45.11.50	62.40.39
	20	Biggar Lake Brook	1	30.0	45.07.48	62.39.58
	21	Deadwater Brook	1	30.5	45.07.82	62.40.08
	29	Twelve Mile Stream	3	24.5	45.05.60	62.36.34
	30	Smith Brook	3	24.4	45.06.26	62.35.61
	31	Reynolds L. outflow	1	21.5	45.04.72	62.34.67
	32	Beaver Brook	2	21.3	45.03.74	62.33.71
	33	Beaver Brook	2	19.0	45.03.58	62.32.94
	34	Twelve Mile Stream	4	16.5	45.03.89	62.31.46
	40	White Lake	1	14.1	45.02.50	62.29.47
	41	Black Lake	1	10.0	44.59.72	62.29.34

Table A6. Continued.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
<u>East River System</u>						
Seven Mile Stream	35	Seven Mile Stream	2	43.1	45.08.72	62.48.67
	36	Seven Mile Stream	2	37.1	45.07.44	62.44.35
	37	Seven Mile Stream	2	26.5	45.04.34	62.39.08
	38	Fraser Lake Brook	2	22.5	45.03.16	62.38.82
Lower East River	42	East River	5	8.0	45.29.62	62.29.36
	39	Grant River	3	11.9		
	43	East River	5	0.0	44.56.25	62.30.11
<u>West River System</u>						
Upper West River	44	Fisher Brook	1	34.5	45.04.44	62.51.23
	47	Grassy Lake Brook	1	31.0	45.03.20	62.49.52
	48	Rocky Brook	2	28.5	45.02.56	62.48.25
	49	West River	3	28.8	45.03.25	62.48.05
	50	Beaver Lake Stream	1	24.4	45.01.15	62.45.64
	51	West River	3	20.5	45.00.54	62.43.18
	52	Keef Brook	1	20.0	45.02.86	62.46.02
	54	Tent Brook	1	22.5	45.02.12	62.42.20
Killag River	53	Killag River	3	29.6	45.03.88	62.42.36
	56	Killag River	3	18.0	44.00.25	62.36.78
	55	Black Brook	2	17.3	44.59.06	62.37.59
Lower West River	57	West River	4	7.5	44.57.67	62.37.19
	58	unnamed	1	8.0	44.57.85	62.37.14
<i>Little River</i>	61	Little River	2	16.3	44.39.29	62.42.14
	62	Little River	3	13.0	44.58.09	62.40.61
	63	Little River	3	7.0	44.57.22	62.36.80
	59	Connors L. outflow	1	5.8	44.57.66	62.36.59
	60	Big Brook	1	4.5	44.55.88	62.32.56
	64	West River	4	0.0	44.55.74	62.32.71

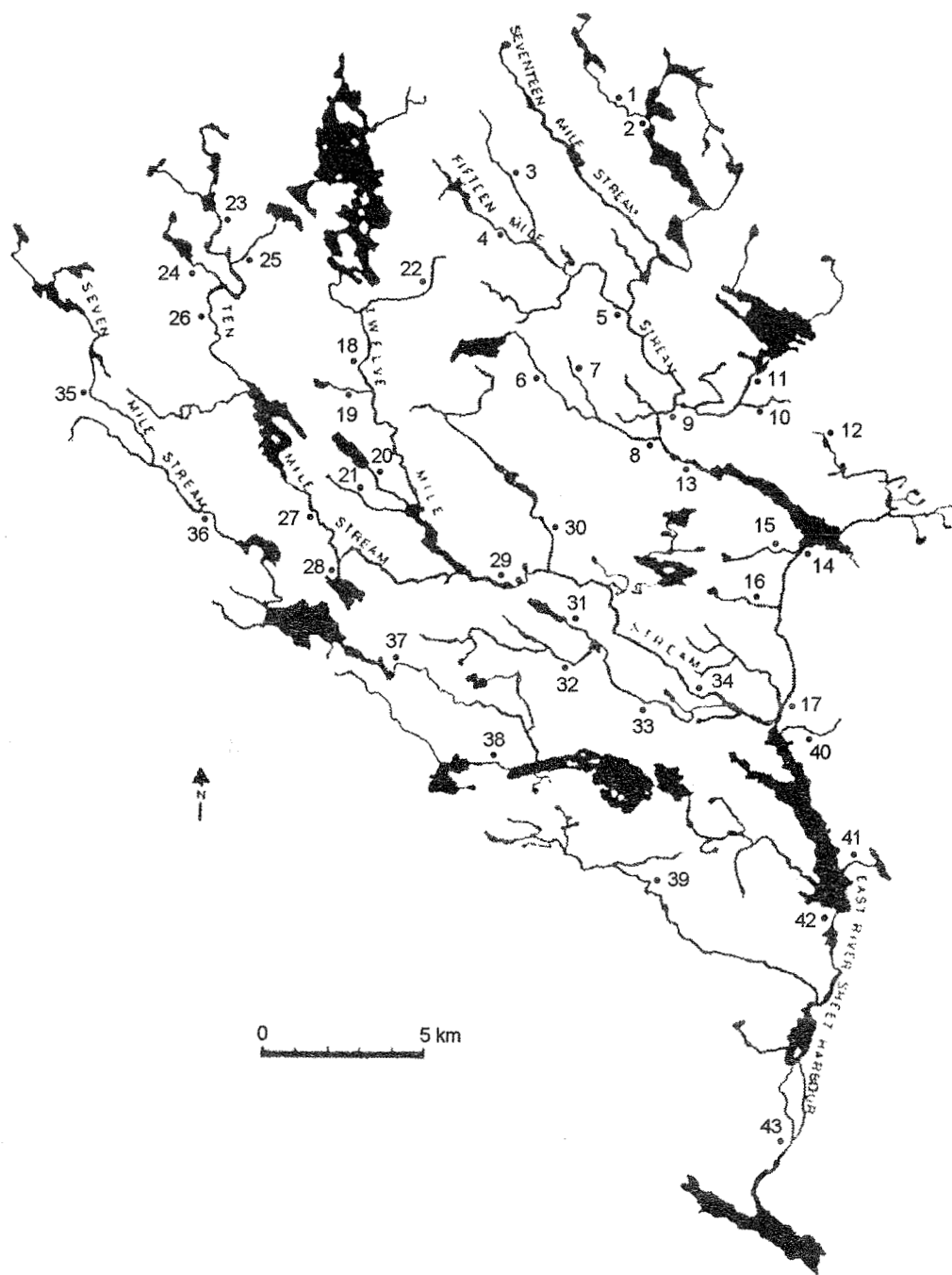


Fig. A6a. Location of water sampling sites on the East River, Sheet Harbour, Nova Scotia. Site numbers correspond to those listed in Tables A6, B6, and C6.

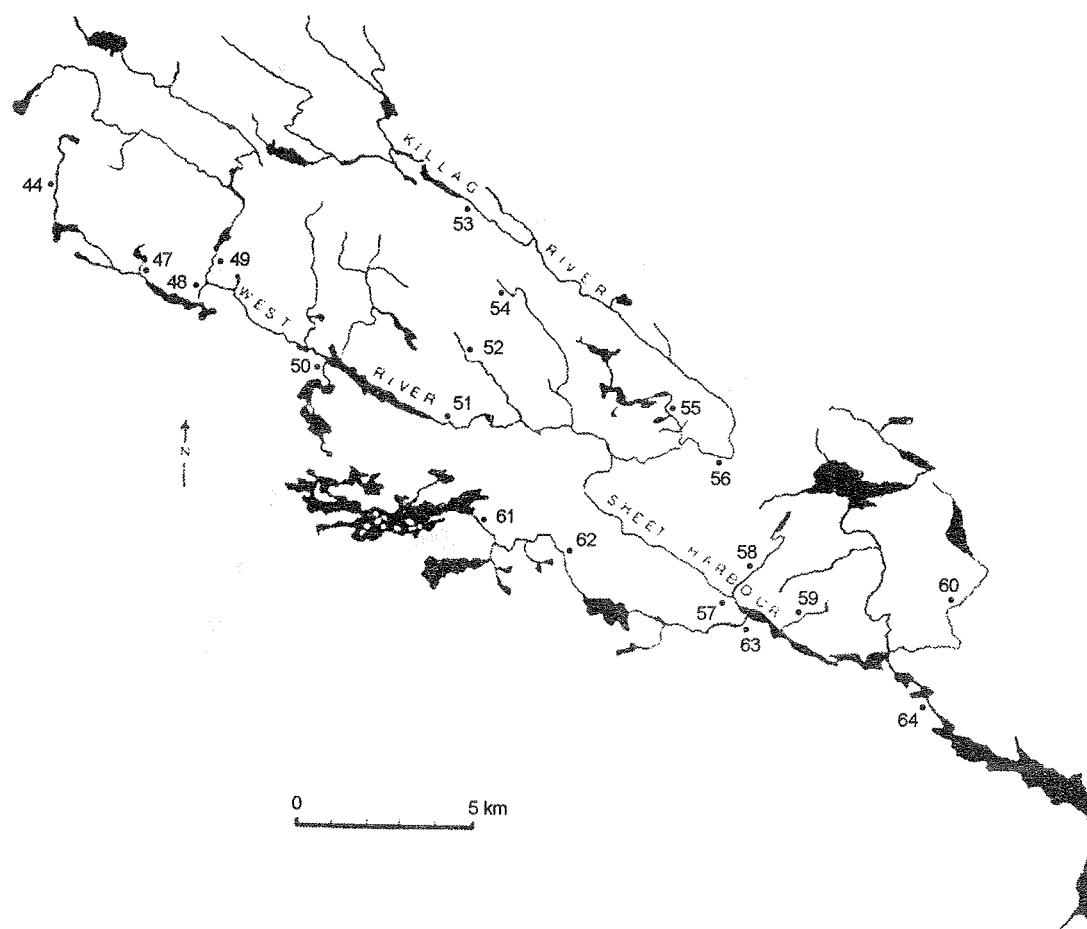


Fig. A6b. Location of water sampling sites on the West River, Sheet Harbour, Nova Scotia. Site numbers correspond to those listed in Tables A6, B6, and C6.

Table A7. Description of sites sampled in the Liscomb River, Nova Scotia during 1996–1997 (see Fig. A7 for locations of site number). Stream order is Strahler number, and DM is distance from river mouth.

Sub-drainage	Site no.	Stream name	Order	DM (km)	Lat. °N	Long. °W
Little Liscomb River	17	Long Lake outflow	1	43.0	45.13.83	62.22.74
	18	unnamed	1	40.5	45.13.58	62.20.57
	20	Little Liscomb River	3	34.9	45.15.34	62.19.62
	19	Metkiff Mill Brook	1	35.0	45.14.41	62.18.35
	21	Frances Gut	2	35.0	45.14.36	62.16.10
	22	Trout Lake Brook	1	33.0	45.13.17	62.13.15
	24	Little Liscomb River	4	28.8	45.11.02	62.14.58
	25	Slate Brook	2	25.5	45.10.52	62.11.82
	30	Little Liscomb River	4	20.8	45.09.11	62.09.77
	23	Cranberry L. outflow	1	33.0	45.14.24	62.11.00
	26	Hardwood L. Brook	1	24.8	45.11.18	62.09.39
	29	Hardwood L. Brook	2	21.3	45.09.49	62.09.51
	28	Black Brook	1	30.0	45.13.16	62.07.11
	27	Black Brook	1	28.1	45.12.58	62.07.87
	31	Runaround Brook	1	16.5	45.07.18	62.09.90
Upper Liscomb R.	1	Bruin Lake outflow	1	54.5	45.15.36	62.30.64
	2	Liscomb River	3	50.8	45.11.24	62.31.30
	3	Barren Lake inflow	1	49.0	45.12.49	62.29.39
	8	Laura Lake outflow	1	49.1	45.09.20	62.30.74
	7	Liscomb River	3	44.5	45.11.07	62.26.47
	6	Jordan Brook	1	44.5	45.11.55	62.24.12
	4	Three Is. L. outflow	1	49.5	45.13.68	62.24.66
	5	Big Brook	1	46.3	45.12.37	62.23.78
	10	Liscomb River	3	40.3	45.10.23	62.23.40
	9	Golden Fleece Bk.	1	41.0	45.10.25	62.22.53
	13	Upper Rocky L. Bk.	1	42.5	45.11.23	62.19.88
	14	Calf Moon Lake	1	41.5	45.10.96	62.19.32
	11	unnamed	1	39.5	45.10.18	62.21.37
	12	Crooked Brook	2	37.5	45.09.55	62.21.14
	16	Island Brook	2	33.0	45.11.12	62.17.63
	15	West Lake Brook	1	33.9	45.10.29	62.17.81
	32	Liscomb River	4	15.0	45.06.32	62.11.10
Lower Liscomb R.	33	Clam Lake Brook	1	15.0	45.06.09	62.11.42
	34	Sinclair Brook	1	13.5	45.04.89	62.09.95
	35	Creighton Brook	1	9.5	45.04.11	62.09.50
	36	Liscomb River	5	2.6	44.55.69	62.08.89
	37	Liscomb River	5	0.0	45.00.74	62.05.79

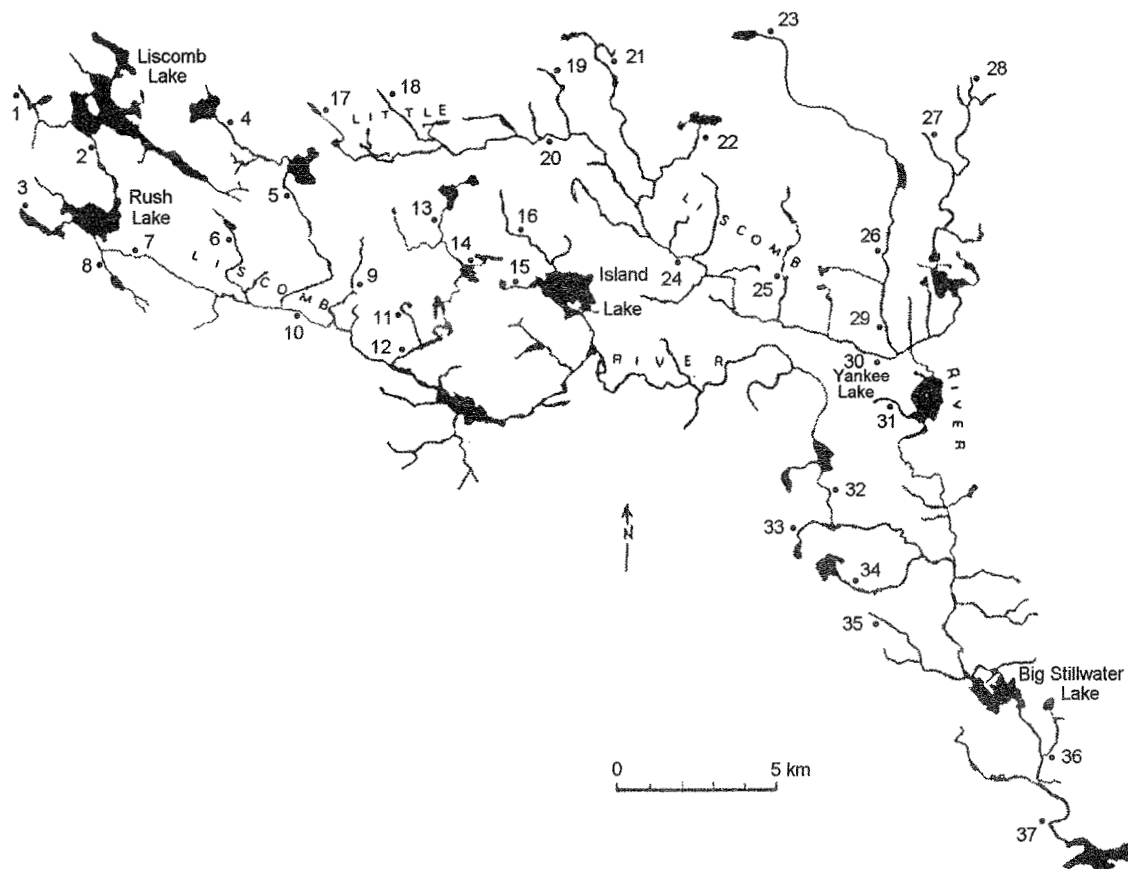


Fig. A7. Location of water sampling sites on the Liscomb River, Nova Scotia. Site numbers correspond to those listed in Tables A7, B7, and C7.

APPENDIX B. pH

Table B1. Annual pH summary for the Carleton River, Nova Scotia during the 1996–1997 survey (see Fig. A1 for location of site number).

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
Wentworth River	1	5.60	5.04	5.53	5.95	5.98	6.04	5.29	5.63
	3	5.96	5.53	5.79	6.08	6.15	6.13	5.98	5.95
	2	5.75	5.45	5.82	5.85	5.99	5.93	5.66	5.78
	4	5.94	5.47	5.78	6.00	6.58	6.14	6.17	6.01
	5	5.78	5.32	5.83	5.92	5.96	5.78	5.80	5.77
	6	5.86	5.49	5.83	6.01	5.94	5.93	5.83	5.84
	7	5.75	5.03	5.49	5.95	5.71	5.93	4.64	5.50
	9	5.88	5.19	5.73	5.87	5.78	5.84	5.31	5.66
	10	5.50	4.87	5.37	5.55	5.86	5.75	5.66	5.51
Halfpenny Brook	11 ¹						4.41	4.09	4.25
	11	4.48	4.43	4.45	5.56	5.45	5.14	4.17	4.81
	12	4.77	4.60	4.81	5.42	5.52	5.35	4.29	4.97
	13	4.84	4.66	4.80	5.47	5.34	5.35	4.36	4.98
	14	5.26	4.93	5.29	5.75	5.53	5.63	5.52	5.42
Up. Carleton R.	15			5.12		5.02	5.45	4.76	5.09
	16			5.39	6.16	5.32	5.74	5.46	5.61
	17	4.37	4.32	4.49	4.62	4.57	4.57	4.37	4.47
	18	5.35	4.73	5.03	6.25	5.37	6.15	4.93	5.40
	19 ¹	5.47		5.28	5.68	5.10	5.71	4.73	5.33
	19	5.39	4.96	5.36		5.45	5.78	5.41	5.39
	20	5.58	5.06	5.53	5.76	6.07	5.70	5.81	5.64
	21			4.80				4.52	4.66
	23	5.27		5.16	5.51	5.21	5.20	4.59	5.16
	22	5.77		5.81	5.95	5.81	6.02	5.66	5.84
Low. Carleton R. Lakes Region	24	5.58	5.16	5.46	5.92	6.05	5.92	5.78	5.70
	25	5.97	5.51	5.90	6.05	5.96	6.23	5.92	5.93
	26	5.78	5.62	5.86	5.91	5.91	5.73	5.83	5.81
	27	5.30	4.62	4.73			5.64	4.34	4.93
	29	5.70	5.25	5.67	6.21	6.04	5.94	6.08	5.84
	28	5.90	5.50	5.75	5.84	5.89	5.87	5.85	5.80
	30	5.62	5.30	5.56	5.85	6.04	5.88	5.91	5.74
	31			5.06	5.49	5.47	5.41	4.94	5.27
	35	5.38	5.04	5.27	5.59	5.54	5.47	4.82	5.30
	36	5.97	5.35	5.25	5.91	6.06	5.98	6.01	5.79
	37	4.98	4.93	4.86	5.34	5.96	6.01	5.23	5.33

Table B2. Annual pH summary for the Tusket River, Nova Scotia during the 1996–1997 survey (see Fig. A2 for location of site number).

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
Upper Tusket R.	2			4.34		4.13	4.26	4.13	4.22
	3						4.66	4.13	4.40
	4					4.89	4.84	4.30	4.68
	11						4.57	4.02	4.30
	6	4.34		4.53	4.67	4.67	4.86	4.33	4.57
	7 ¹	4.60	4.58	4.63	5.17	5.19	5.10	4.37	4.81
	7	4.47	4.59	4.55	4.93	4.85	4.70	4.17	4.61
	8	4.45	4.62	4.58	5.03	5.63	4.80	4.25	4.77
	14	4.60	4.54	4.59		5.47	4.74	4.17	4.69
	15	4.72	4.60	4.63	5.22	5.39	5.00	4.38	4.85
	16			4.65	5.30	5.48	5.14	4.38	4.99
E. Br. Tusket	10	4.51		4.59	4.87	4.45	4.59	4.23	4.54
	9	4.27		4.43	4.71	4.24	4.44	4.06	4.36
	25	4.20	4.24	4.33	4.44	4.43	4.40	4.17	4.32
	24	4.28	4.28	4.36	4.56	4.65	4.61	4.16	4.41
	23	6.05	5.80		6.00	5.99	5.74	4.56	5.69
	22	5.41	4.69	4.97	6.01	5.90	5.91	4.32	5.32
	21				5.76	5.77	5.38	5.84	5.69
	17	4.61	4.63	4.55	5.30	5.67	5.35	4.25	4.91
Main Tusket R.	18	4.57	4.60	4.66	5.00	5.15	5.38	4.34	4.81
	19	5.59	4.95	5.48	5.84	5.77	5.82	4.82	5.47
	20	5.30	4.81	5.10	5.67	5.78	5.69	5.38	5.39
	29 ¹	5.44	5.12	5.38		5.72	5.51	5.35	5.42
Kegeshook L.	46			4.59	5.13	5.32	4.92	4.55	4.90
	39	4.39		4.49	4.67	4.71	4.87	4.25	4.56
	38	4.46		4.43	4.89	4.80	4.93	4.23	4.62
	44	4.67	4.52	4.68	4.93	5.10	5.12	4.92	4.85
	31	4.57	4.55	4.68	4.88	4.91	4.96	4.66	4.74
Quinan River	42			4.37	4.54	4.52	4.61	4.15	4.44
	41	4.48		4.44	4.60	4.69	4.56	4.21	4.50
	35	4.35		4.41	4.80	4.70	5.08	4.26	4.60
	36	4.72		4.56	4.84	5.03	5.16	4.19	4.75
	37			4.95					4.95
	34			4.57	4.78	5.03	5.17	4.48	4.81
	33	4.68	4.65	4.68	4.88	5.21	5.66	4.42	4.88
	32	4.84	4.61	4.64	4.85	5.18	5.51	4.44	4.87
	30			4.65	4.88	4.89	4.99	4.60	4.80
	47		5.34	5.58	5.93	5.99	5.95	5.73	5.75
	48	4.85	4.60	4.67	4.94	5.07	5.12	4.67	4.85
	49	4.70	4.61	4.67	4.94	4.99	5.02	4.96	4.84
	50	4.98	4.93	4.86	5.34	5.91	6.01	5.23	5.32

Table B3. Annual pH summary for the Medway River, Nova Scotia during the 1996–1997 survey (see Fig. A3 for location of site number).

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
W. Br. Medway	1	4.96		4.91	5.13		5.51	5.45	5.19
	2	4.49		4.52	4.88	5.29	5.38	4.39	4.82
	3			4.72	5.21	5.50	5.33	4.73	5.10
	4			5.08	5.86	6.22	5.90	5.87	5.79
	5	4.80		5.18	5.26	5.46	5.62	4.72	5.17
E. Br. Medway	6	4.88		5.03	5.50	5.75	5.97	5.08	5.37
	9	4.42		4.56	4.73	4.92	5.04	4.39	4.68
	7	4.89		5.06	5.13	5.27	5.20	5.35	5.15
	10	5.00		4.91	5.26	5.63	5.50	5.26	5.26
	8	4.71		4.65	4.86	4.96	5.07	4.65	4.82
Upper Medway R.	11	5.05		5.06	5.42	5.60	5.52	5.35	5.33
	12	4.88		4.90	5.59	5.72	5.99	5.09	5.36
	13	4.69		4.76	5.03	5.08	5.09	4.88	4.92
	14				5.44	5.53	5.56	4.96	5.37
	15	5.23	4.82	5.14	5.56	5.66	5.61	5.58	5.37
	16	4.91	4.82	5.03	5.40	5.73	5.82	4.98	5.24
	17	5.06	4.99	5.09	5.31	4.87	5.16	4.61	5.01
	18 ¹	6.06		5.89	5.96	5.92	6.05	5.88	5.96
	18	6.05	5.69	5.82	5.85	6.29	5.81	5.89	5.91
	19 ¹			5.12	5.43	5.70	5.48	5.39	5.42
Westfield River	19	5.07	4.96	5.11	5.50	5.63	5.39	5.45	5.30
	20	5.25	5.20	5.49	5.57	5.51	5.64	4.65	5.33
	23	4.61	4.51	4.67	5.01	5.14	5.14	4.98	4.87
	24	4.70	4.78	4.78	5.03	4.96	5.01	4.54	4.83
	22	4.61	4.77	4.79	5.03	4.67	4.81	4.49	4.74
	26	6.05		5.89		6.09	5.97	5.99	6.00
	30	4.91	4.76	4.91	5.35	5.32	5.18	5.22	5.09
	31	5.08	4.93	5.13	5.53	5.86	5.44	5.10	5.30
	36	5.37		5.45	5.69	5.86	5.46	4.56	5.40
	32	5.34	5.25	5.38	5.46	5.40	5.21	4.71	5.25
Wildcat/Pleasant	65 ¹	4.45		4.71	4.99	4.47	4.81	4.41	4.64
	65 ¹¹	4.53		4.67	5.08	4.78	4.99	4.38	4.74
	65	4.51		4.67	4.76	4.76	4.71	4.34	4.62
	64	4.48		4.87	5.58	4.70	4.82	4.36	4.80
	66	4.53	4.63	4.69	5.15	4.99	4.95	4.52	4.78
	62	5.03	4.74	5.08	5.29	5.49	5.41	5.04	5.15
	63	4.95		5.20			5.38	4.55	5.02
	60	5.55	5.23	5.62	5.79	5.71	5.68	5.86	5.63
	57	4.72	4.65	5.00	4.99	5.16	4.98	4.85	4.91
	61	4.86		4.94	5.42	5.06	5.03	4.70	5.00
	55 ¹	5.00		5.30	5.67	5.67	5.53	4.70	5.31

Table B3. Continued.

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
<i>Wildcat/Pleasant</i>	54	5.13	5.08	5.23	5.52	5.50	5.42	4.76	5.24
	53	4.56		4.66				4.28	4.50
	52				5.79	6.00	6.06	5.93	5.95
	34	5.34	4.98	5.39	5.70	5.76	5.89	5.62	5.53
<i>Christopher L.</i>	35	5.19	4.98	5.25	5.63	5.76	5.69	5.14	5.38
	43	5.60	5.55	5.62	5.96	5.75	5.23	4.64	5.48
	44	5.16	5.04	5.27	5.95	5.46	5.67	4.94	5.36
	45			5.21					5.21
	41	5.63		5.64	5.95	6.17	5.99	5.25	5.77
	40					4.90	5.11	4.17	4.73
	42					5.35	5.24	5.07	5.22
	48	4.42	4.51	4.52	4.71			4.18	4.47
	49	5.08	4.90	5.12	5.52	5.47	5.46	5.43	5.28
	49 ¹	4.44	4.55	4.56	4.66	4.75	4.75	4.22	4.56
<i>Ponhook Lake</i>	49 ¹¹	4.45		4.63	5.33	5.57	5.81	4.28	5.01
	50	5.70	5.46	5.53	5.81	5.88	5.60	5.15	5.59
Lower Medway R.	56	5.32	5.00	5.26	5.67	5.65	5.74	5.69	5.48
	67	5.00	5.03	5.00	6.50	6.33	6.13	4.44	5.49
	68	5.31	5.04	5.27	5.69	5.75	5.96	5.26	5.47
	69	5.32	5.34	5.59	5.86	5.84	5.72	5.03	5.53
	70	5.37	5.08	5.40	5.78	5.81	5.83	5.21	5.50
	71	4.95		5.18	5.51	5.74	5.38	4.74	5.25
	72				5.67	5.87	5.89	4.85	5.57
	73	4.63	4.70	4.79	5.32	5.74	5.24	4.41	4.98
	74	5.38	5.04	5.33	5.67	5.92	5.86	5.14	5.48
	77	5.29	5.30	5.37	5.60	5.63	5.32	4.93	5.35
	78	5.28	5.07	5.33	5.82	6.03	5.71	5.01	5.47
	81			5.34	5.98	6.14	6.05	4.87	5.68
	82			5.32	5.62	6.06	5.80	5.00	5.56
	83	5.24	5.15	5.37	5.78	5.72	5.86	5.38	5.50
<i>Salters Brook</i>	89	5.21		5.25	5.74	5.85	5.50	4.88	5.40
	90	5.25	5.07	5.27	5.70	5.77	5.79	4.86	5.39
<i>Oakes/Petite</i>	84	4.89	5.08	5.01	5.26	4.80	4.82	4.56	4.92
	85	4.95	4.99	5.07	5.33	5.28	4.97	4.61	5.03
	86	4.96	5.03	5.13	5.43	5.38	5.18	4.63	5.11
	87	5.10		5.18	5.47	5.58	5.18	4.70	5.20
	91	4.96	5.12	5.14	5.63	5.62	5.18	4.64	5.18
	92			5.27	5.58	5.71	5.61	4.82	5.40
	93	5.33	5.22	5.23	5.92	5.84	5.31	4.83	5.38
	94	5.28	5.09	5.32	6.14	5.91	5.80	5.04	5.51

Table B4. Annual pH summary for the LaHave River, Nova Scotia during the 1996–1997 survey (see Fig. A4 for location of site number).

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
Up. LaHave R.	2	6.50		6.07	6.20	6.19	6.20	6.13	6.21
	3	5.53	5.04	5.45	5.67	5.82	5.74	5.81	5.58
	5	5.72		5.71	6.00	5.97	5.81	5.85	5.84
	1	5.58		5.60	5.88	5.84	5.87	5.94	5.78
	6	5.70		5.52				5.14	5.46
	12	5.09		5.72	5.87	5.90	5.62	5.39	5.60
	10	5.95		6.15	6.07	5.74	5.64	5.56	5.85
	11	5.08		5.41	5.66	5.81	5.53	5.61	5.52
	15	5.63	5.70	5.71	6.00	5.99	5.78	5.97	5.83
	4	4.57	4.89	4.99	5.72	5.41	5.24	5.01	5.12
	8	4.94	4.98	5.09	5.33	4.88	5.28	5.07	5.08
	9	5.08		5.40	5.60	5.59	5.41	5.73	5.47
	16	5.36	5.48	5.64	5.96	6.11	6.05	5.95	5.79
	17			6.13	6.00	5.27		5.84	5.81
	13	4.50	4.61	4.66	4.89	4.10	5.15		4.65
	14	4.74	4.72	4.90	4.91	4.93	4.92	4.41	4.79
	19	5.38	5.36	5.55	5.83	5.22	5.48	5.26	5.44
	18	5.67	5.74	5.77	6.06	6.20	5.91	5.96	5.90
North River	20	6.27	5.98	6.05	6.03	6.20	6.17	6.16	6.12
	21	5.22	5.33	5.48	5.81	6.01	5.93	5.59	5.62
	22	5.97	5.84	5.87	6.01	5.98	6.03	6.02	5.96
	23	5.44		5.61	4.78	5.09		5.38	5.26
	24	5.58	5.73	5.78	6.12	6.10	6.15	5.94	5.92
	25	5.17	4.64	5.37	5.55	5.24	5.34	4.94	5.18
	26	5.85		5.75	5.86	6.09	6.09		5.93
	27	5.46	5.34	5.56	6.05	5.72	5.70	5.33	5.59
	28	5.38	5.57	5.78	5.89	6.01	5.96	6.01	5.80
	29	4.93	5.06	5.24	5.25	4.65	5.10	4.79	5.00
	30	5.55	5.28		5.72	5.73	5.66	5.61	5.59
	31	5.69	5.54	5.72	5.97	6.15	5.82	5.99	5.84
	32	4.24	5.69	5.71		5.22	5.91	5.37	5.36
	33	4.93	5.00	5.12	5.25	4.93	4.81	4.76	4.97
	34	5.55	5.58	5.69	5.73	5.73	5.75	5.56	5.66
	35	4.45		4.58		4.36		4.30	4.42
	36	5.67	5.76	5.73	6.05	5.83	6.07	5.72	5.83
Main LaHave R.	117		5.84	5.83	6.02	5.99	6.27	5.90	5.97
	120	6.40		6.18	6.42	5.96	6.04	6.12	6.19

Table B4. Continued.

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
Main LaHave R.	121	5.05		5.43	5.89	5.07	5.54	4.88	5.31
	119	6.11	6.23	6.09		6.15	5.99	5.41	6.00
	118	5.68		5.78	6.03	6.07	6.02	5.67	5.88
West River	75		4.96	5.46	5.70	5.41	5.69	4.86	5.35
	76	5.31	4.90	5.48	5.87	5.73	5.69	5.68	5.52
	77	4.54	4.55	4.69	4.95	4.52	4.88	4.50	4.66
	78	5.09	4.98	5.34	5.62	5.55	5.57	4.97	5.30
	79	4.45	4.56	4.63	4.81	4.65	4.71	4.33	4.59
	80	5.12	4.99	5.34	5.59	5.57	5.59	4.82	5.29
	81	4.84	4.93	5.00	5.86	5.51	5.94	4.59	5.24
	82	5.16	5.24	5.41	6.08	5.51	5.93	4.90	5.46
	84	4.89	5.10	5.19	5.75	5.77	5.78	4.57	5.29
	85	5.90	5.99	5.82	6.05	6.36	6.18	5.00	5.90
	83	5.14	5.10	5.39	6.28	5.95	6.09	4.79	5.54
Main LaHave R.	86	5.61	5.53	5.66	6.15	5.95	6.32	5.39	5.80
	124	5.68	5.76	5.74	6.17	5.69	5.93	4.73	5.67
	123	6.17	6.09	6.14	6.31	5.55	5.95	5.75	5.99
	122	5.84	5.80	5.80	6.08	6.13	6.08	5.72	5.92
	126	6.48	6.27	6.36	6.37	6.33	6.23	5.91	6.28
	125	5.70	5.69	5.95	6.35	5.86	6.30	5.90	5.96
N. Br. LaHave	37	5.89		5.88	6.20	6.18	6.15	5.85	6.02
	38	5.08	5.21	5.51	6.10	6.05	6.17	5.22	5.62
	39	6.17	5.64	5.99		6.09	6.40	5.88	6.03
	40	5.88	5.74	5.78	5.92	6.02	6.10	5.86	5.90
	41	5.02		5.79		4.86	5.07	5.57	5.26
	42	5.07		5.49	5.73	5.75	6.05	5.69	5.63
	43	5.80	5.18	5.66	5.95	6.59	6.11	6.02	5.90
	44	4.76		5.05	5.53	5.24	5.30	4.65	5.09
	45	5.57		5.70	5.99	5.79	6.09	5.32	5.74
	46	5.38		5.45				5.57	5.47
	47	5.26	5.51	5.61	6.18	5.49	5.78	4.97	5.54
	48	6.50	6.00	6.03	5.84	6.07	4.62	6.05	5.87
	49	5.99	5.72	5.75	6.15	5.91	5.88	5.72	5.87
	50	6.12	6.07	5.96	6.08	5.77	6.12	5.65	5.97
	51	4.85	4.93	5.08	5.30	4.95	5.33	4.91	5.05
	52	4.70		5.70	5.98	5.97	5.92	5.69	5.66
	53	4.65		5.04	5.26	4.52	4.89	4.84	4.87

Table B4. Continued.

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
N. Br. LaHave	54	5.15		5.51	5.82	5.21	5.79	5.10	5.43
	55	4.83	4.89	5.14	5.40	5.27	5.39	5.05	5.14
	56	4.34		5.18				4.35	4.62
	57	6.46		5.98		5.22		5.71	5.84
	58	5.54	5.43	5.62	5.75	5.85	5.92	5.49	5.66
	60	4.89	4.74	5.01	4.96	5.09	5.21	5.02	4.99
	59	6.31	5.95	5.98	5.90	5.99	6.30	6.12	6.08
	61	5.63	5.79	5.69	5.95	5.25	5.74	5.34	5.63
	62	6.21	6.04	6.06		5.96		6.00	6.06
	63	5.93	5.65	5.86	6.02	5.36	5.96	5.50	5.75
	64	5.74	5.71	5.76	5.99	5.89	5.95	5.74	5.83
	66	4.64	4.82	4.82		5.10	4.93	4.47	4.80
	65	4.88	4.91	5.02	5.27	5.31	5.02	4.59	5.00
	67	6.05	4.80	4.81	5.12	5.29	5.16	4.49	5.10
	68	5.71	5.53	5.76	5.87	5.76	5.99	5.90	5.79
	70	6.03	5.92	6.12		6.12	6.24	5.67	6.02
	69	6.40	6.25	6.17			6.30	6.14	6.25
	71	6.49	6.24	6.22	6.24	6.28	6.19	6.09	6.25
	72	5.78	5.64	5.78	5.94	6.14	6.09	5.97	5.91
	73	6.24	6.07	6.11		6.02	6.33	5.65	6.07
	74	5.93	5.82	5.90	6.26	6.21	6.24	5.76	6.02
Main LaHave R.	127	5.86	5.80	5.83	6.22	6.02	6.17	5.98	5.98
	128	5.66	5.68	5.73	6.37	6.08	6.09	5.80	5.92
	131	6.28	6.02	5.96	6.18	6.33	6.06	5.68	6.07
	132	6.43	6.15	6.08	6.37	6.48	6.21	6.07	6.26
	130	6.44	6.28	6.24	6.16	6.26	6.00	5.98	6.19
	129	6.01	5.87	5.87	6.15	6.12	5.86	5.88	5.97
	134	6.05	5.85	5.96	6.27	6.25	5.90	5.70	6.00
W. Br. LaHave	133	5.94		5.90		5.99	5.98	5.89	5.94
	87	5.37	5.40	5.47	5.72	5.76	5.75	5.13	5.51
	88	4.95	5.04	4.83	5.75	5.65	5.74	4.89	5.26
	89	5.17	5.18	5.32	5.83	5.43	5.57	5.01	5.36
	90	4.88	5.00	5.57	5.92	4.84	5.25	4.67	5.16
	91	4.85	4.98	5.01	5.33	4.94	5.39	4.71	5.03
	93	5.00	5.12	5.25	5.87	5.17	5.39	4.74	5.22
	94	5.24	5.29	5.42	5.49	5.72	5.61	4.99	5.39
	95	5.50	5.30	5.49	5.66	5.75	5.70	5.59	5.57

Table B4. Continued.

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
W. Br. LaHave	92	4.89	4.96	4.92	5.20	5.84	5.38	5.01	5.17
	97	5.13	5.20	5.26	5.50	5.69	5.52	4.86	5.31
	96	5.66	5.27	5.55	5.84	5.89	5.94	5.76	5.70
	98	5.62	5.46	5.53	6.02	6.04	5.97	5.54	5.74
	99	5.61	5.28	5.55	5.83	5.93	6.13	5.52	5.69
	100	4.90	4.96	4.86	5.01	4.97		4.82	4.92
	101	5.08	5.12	5.00	5.14	5.26	5.18	4.88	5.09
	102	5.19	5.24	5.26	5.26	5.41	5.24	4.60	5.17
	103	5.61	5.48	5.50	5.99	6.02	5.79	5.38	5.68
	104	4.63	5.04	4.80	5.11	5.62	5.29	4.47	5.00
	105	5.52	5.36	5.37	5.90	6.06	5.81	5.12	5.59
	106	5.48	5.15	5.49	5.77	5.99		5.12	5.50
	107	4.89	4.95	5.07	5.53	5.59	5.56	4.56	5.16
	108	5.53	5.31	5.52	6.02	6.14	5.93	5.04	5.64
	109	5.71	5.31	5.84	5.37	5.65	5.60	4.65	5.45
	110	5.56	5.42	5.63	5.84	6.14	6.04	5.08	5.67
	111	6.40	5.80	5.66	6.04	6.07	6.13	6.20	6.04
	112	5.78	5.68	5.75				5.12	5.58
	113	6.12	5.96	6.02	6.41	6.28	6.32	5.58	6.10
	114	5.41	5.40	5.22	6.05	6.25	6.20	4.98	5.64
Main LaHave R.	115	6.25	6.05	6.00	6.21	6.35	6.14	5.55	6.08
	116	5.65	5.47	5.63	6.08	6.07	6.03	5.08	5.72
	135	5.69	5.75	5.77	6.03	6.20	5.94	5.73	5.87
	137	6.01	6.03	5.87	6.26	6.28	6.02	5.60	6.01
	136	5.70	5.82	5.76	6.12	6.22	5.96	5.76	5.90
	139	5.76	5.86	5.78	6.18	6.11	5.85	5.18	5.82
	138	5.75	5.85	5.93	5.94	5.98	6.13	5.83	5.92
	141	6.13	6.26	5.17	6.22	6.46	6.07	5.71	6.00
	140	5.63				6.15	5.92	5.62	5.83
	143	5.02	5.14	6.18	4.67	4.44	4.38	4.61	4.92
	142	5.57		6.03		5.98	5.80	5.26	5.73
	144	5.62	5.68	5.83	5.95	5.91	5.89	5.59	5.78

Table B5. Annual pH summary for the Gold River, Nova Scotia during the 1996–1997 survey
(see Fig. A5 for location of site number).

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
W. Branch Gold	8	5.13			5.43	5.45	5.57	5.34	5.38
	9	6.25	5.85	6.04	6.19	5.98	5.99	5.84	6.02
	10	6.22	5.63	5.96	6.03	5.92	6.08	6.10	5.99
	11	5.69	5.58	5.81	6.01	5.64	6.04	5.38	5.74
E. Branch Gold	1	6.30						6.13	6.21
	2	4.15	4.35	4.35	4.36	4.04	4.26	4.10	4.23
	3	4.82	4.96	4.88		4.50	4.76	4.61	4.76
	4	5.08		5.90	5.29	5.43	5.40	5.24	5.39
	5	6.21			6.57	6.16	6.12	6.12	6.24
	6				5.56	5.61	5.61		5.59
	7	5.37	5.09	5.39	5.77	5.86	5.81	5.73	5.58
Upper Gold R. <i>Mill Brook</i>	12	5.54	5.71	5.66	5.99	5.99	5.90	5.81	5.80
	13	6.09	5.87	5.95	6.04	6.04	5.98	5.93	5.99
	14	5.37					5.51	5.33	5.40
	15	5.37	5.68	5.95	6.05	5.98	6.03	5.77	5.83
	16	6.20	6.16	6.06	6.28	6.30	6.46	6.11	6.22
	17	5.82	5.83	5.85	6.06	6.18	6.17	5.80	5.96
	18	5.30	5.63	5.71	5.82	6.20	6.18	5.44	5.75
	19	5.45	5.64	5.71	5.95	6.06	6.05	6.02	5.84
	21	5.23	5.78	5.74	6.33	5.52	6.00	5.25	5.69
	20	4.22	4.41	4.93		4.38		4.16	4.42
<i>Larder River</i>	23	5.49		5.63	5.86	5.98	6.18	5.40	5.76
	25	5.38	5.38	5.60	6.06	5.70	5.77	5.24	5.59
	24	4.40	4.41	4.49	4.50	4.09	4.25	4.23	4.34
	26	5.39	5.48	5.66	5.67	5.66	5.49	5.37	5.53
Lower Gold R.	29			5.45		5.88	5.96	5.12	5.60
	30	4.33		4.56		4.79	4.73	4.21	4.52
	31	4.39		5.22	6.00	5.79	5.93	4.67	5.33
<i>Beech Hill Bk.</i>	33	4.48		4.75		5.15	4.93	4.41	4.74
	34	4.65		4.69		4.72	4.75	4.60	4.68
	32	4.65	4.83	4.78	5.07	5.34	5.44	4.54	4.95
	35	5.07			5.85				5.46
	36	4.76	4.66	4.60	5.15	4.83	4.66	4.39	4.72
	37	5.07	5.21	5.24	5.91	6.16	5.96	4.93	5.50
	38	4.93				5.39	5.38	5.20	5.22
	39	5.07	5.53	5.40	6.04	6.20	6.07	5.16	5.64

Table B6. Annual pH summary for the East and West rivers, Sheet Harbour, Nova Scotia during the 1996–1997 survey (see Fig. A6a, A6b for location of site number).

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
<u>East R. System</u>									
Fifteen Mile Stm.	1	4.84	4.95	5.25	5.52	5.60	5.23	4.86	5.18
	2	5.48	4.95	5.21	5.49	5.58	5.66	4.83	5.31
	3	4.38	4.94	4.88	5.54	5.71	5.29	4.78	5.07
	4	4.38	4.56	5.04	5.56	5.43	5.27	4.94	5.02
	5	4.98	4.95	4.92	5.54	5.77	5.27	4.80	5.18
	11	5.47	5.17	5.34	5.38	5.41	5.44	5.47	5.38
	10	5.54	5.30	5.37	5.16	4.83	5.05	4.83	5.15
	9	5.42	5.03	5.18	5.68	5.73	5.71	5.18	5.42
	6	5.58	5.46	5.47	5.56	6.03	6.21	5.53	5.69
	7	4.48	5.34	4.82	5.10	5.29	5.13	5.50	5.09
	8	5.18	5.14		5.58	5.70	5.48	5.00	5.35
	13	5.27	4.98	5.11	5.64	5.82	5.71	5.17	5.39
	12	4.77	4.95	5.03	5.28	4.85	5.03	4.50	4.92
	14	5.09	4.95	5.11	5.33	5.61	5.40	5.14	5.23
	15	4.78	4.69	5.15	4.92	5.65	4.79	4.59	4.94
	16	4.66	4.53	4.68	5.10	5.24	5.02	4.59	4.83
	17	5.16	5.01	5.07	5.37	5.62	5.28	4.80	5.19
Ten Mile Stream	23	5.17	5.11	5.20	5.67	5.76	5.60	5.09	5.37
	25	4.98	4.93	5.05	5.29	5.57	5.08	4.80	5.10
	24	5.65	5.33	5.54	5.71	5.75	5.86	5.07	5.56
	26				5.62	5.76	5.28	5.06	5.43
	27	5.18	5.02		5.43	5.49	5.46	5.12	5.28
28	5.76	5.44	5.56	5.03	5.09	5.81	5.75	5.49	
Twelve Mile Stm.	22	4.75	4.74	4.78	5.91	5.29	4.96	5.52	5.14
	18	5.46	5.28	5.88	5.80	5.93	6.13	4.98	5.64
	19	5.55		5.33	5.28	5.18	5.36	5.21	5.32
	20	4.86	4.90	5.18	5.24	5.21	4.88	4.93	5.03
	21	4.99	4.97	5.09	5.25	5.23	5.06	4.90	5.07
	29	5.17	5.10	5.20	5.46	5.59	5.58	4.97	5.30
	30	4.97	4.87	5.10	5.32	5.46	5.26	4.77	5.11
	31				5.31	5.28	5.53	4.49	5.15
	32	4.82	4.84	5.00	4.94	5.08	4.93	4.70	4.90
	33	4.82	4.85	4.92	4.97	5.07	5.02	4.69	4.91
	34	5.13	5.01	5.07	5.42	5.51	5.61	4.85	5.23
	40	4.67	4.56	4.56	4.81	5.04	5.11	4.62	4.77
	41	4.98	5.14	5.29	5.42	5.44	5.58	4.93	5.25

Table B6. Continued.

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
Seven Mile Stm.	35				5.36	5.21	5.31	4.75	5.16
	36	4.97	4.88	4.99	5.38	5.24	5.03	4.63	5.02
	37	5.15	4.95	5.16	5.39	5.50	5.36	5.13	5.24
	38	5.17	4.56	4.54	4.71	4.69	4.36	4.39	4.63
Lower East River	42	5.15	5.16	5.04	5.43	5.46	5.51	4.84	5.23
	39	4.88							4.88
	43	5.06	5.12	5.10	5.40	5.46	5.47	4.83	5.20
<u>West R. System</u>									
Upper West R.	44	4.74	4.87	4.80	5.39	4.70	5.18	4.58	4.89
	47	4.79	4.77	4.88	4.86	4.73	4.77	4.62	4.77
	48	5.05	4.84	4.96	5.21	5.29	5.19	4.97	5.07
	49	4.69	4.70	4.73	4.88	4.71	5.09	4.57	4.77
	50	4.98	4.60	4.90	5.20	5.22	5.17	4.85	4.99
	51	4.80	4.73	4.78	5.31	5.07	5.04	4.66	4.91
	52	4.65	4.79	4.55	4.61	4.59	4.71	4.35	4.61
	54	4.51			4.59	4.64	4.42	4.23	4.48
Killag River	53	4.88	4.79	5.00	5.43	5.06	5.45	4.70	5.04
	56	5.19	4.99		5.98	5.31	5.91	4.83	5.37
	55	5.04		5.16	5.73	5.16	4.68	4.71	5.08
Lower West R.	57	5.06	4.91	4.99	5.77	5.56	5.86	4.70	5.26
	58	5.27	5.02	5.27	5.72	5.52	5.66	4.68	5.31
<i>Little River</i>	61	5.41	4.94	4.38	5.48	5.46	5.37	5.09	5.16
	62	5.44	5.13	5.26	5.50	5.45	5.66	5.14	5.37
	63	5.37	5.13	5.27	5.54	5.46	5.46	5.13	5.34
	59	5.04	4.90	5.02	5.63	5.48	4.90	4.64	5.09
	60	4.70	4.70	4.72	5.07	4.89	4.96	4.54	4.80
	64	5.06	4.92	5.00	5.40	5.46	5.47	4.81	5.16

Table B7. Annual pH summary for the Liscomb River, Nova Scotia during the 1996–1997 survey (see Fig. A7 for location of site number).

Sub-drainage	Site #	pH							Mean
		Nov96	Mar97	May97	Jul97	Sep97	Oct97	Nov97	
Little Liscomb R.	17	5.66	5.12	5.56	5.66	5.88	5.84	5.38	5.58
	18	4.80	4.97	5.36	5.74	5.84	4.87	5.41	5.28
	20	4.28		4.84	5.03	4.68	5.37	4.80	4.83
	19	4.33		5.53	5.37	4.68	5.44	4.93	5.05
	21	4.46		5.10	5.80	4.68	4.74	4.94	4.95
	22	4.94		5.10	5.50	4.26	5.39	4.88	5.01
	24	4.75	4.77	4.87	5.24	4.84	5.15	4.57	4.88
	25	4.50	4.65	4.40	5.14	4.72	4.83	4.50	4.68
	30	4.68	4.75	4.92	5.31	4.84	5.18	4.55	4.89
	23	4.71			5.51	4.26	4.96	4.88	4.86
	26	4.61	4.65	4.82	5.24	4.72	5.11	4.47	4.80
	29	4.52	4.60	4.83	5.99	4.74	5.22	4.47	4.91
	28	4.51		4.40	5.96	4.46	4.97	5.01	4.88
	27	4.60		4.40	5.80	4.54	5.73	5.00	5.01
	31	4.47	4.58	4.79	5.26	4.45	5.25	4.62	4.78
Up. Liscomb R.	1	5.17		4.49	4.81	4.33	5.01	5.06	4.81
	2	5.65	5.06	5.72	5.77	5.85	5.68	5.00	5.53
	3	5.62	4.38	4.53	4.80	5.91	4.72	4.91	4.98
	8						4.69		4.69
	7	5.00	4.93	5.28	5.59	5.34	5.59	5.02	5.25
	6	5.20		5.31	5.30	5.44	5.58	5.06	5.32
	4	5.41	5.04	5.51	5.35	5.91	5.33	5.38	5.42
	5	5.27	4.95	5.30	5.52	5.49	5.46	5.04	5.29
	10	4.98	4.96	5.17	5.58	5.22	5.34	5.02	5.18
	9	4.73	4.90	5.04	5.24	5.04	5.24	5.03	5.03
	13	4.70	5.21	5.31	5.78	5.55	4.91	4.57	5.15
	14	4.70	4.57	4.90	5.03	5.26	5.05	4.57	4.87
	11	4.76	4.92	4.99	5.27	5.42	5.39	5.45	5.17
	12	4.95	4.92	5.20	5.60	5.54	5.06	5.06	5.19
	16	4.62	4.95	5.10	6.07	5.22	5.63	4.58	5.17
	15	4.84	4.96	5.15	5.41	5.27	4.56	4.59	4.97
	32	4.89	4.82	5.06	5.59	5.41	5.43	4.67	5.12
	33	4.83	4.96	5.31	5.83	4.69	5.86	5.06	5.22
	34	4.66	4.91	5.20	5.54	4.52	5.40	4.95	5.03
Low. Liscomb R.	35	4.31	4.49	4.44	5.65	4.49	5.76	4.71	4.84
	36	4.89	4.80	5.04	5.30	5.35	5.40	4.63	5.06
	37	4.88	4.80	5.01	5.44	5.35	5.42	4.65	5.08

APPENDIX C. DISSOLVED ORGANIC CARBON

Table C1. Dissolved organic carbon (DOC) concentration and pH in a sub-sample of the sites in the Carleton River in November 1997 (see Fig. A1 for location of site number).

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
Wentworth River	1	5.29	15.1
	2	5.66	11.8
	4	6.17	11.4
	5	5.80	10.9
	6	5.83	7.9
	7	4.64	11.7
	9	5.31	11.7
	11	4.17	23.9
	12	4.29	23.7
Halfpenny Brook	14	5.52	8.0
Upper Carleton River	15	4.76	14.4
	16	5.46	8.0
	17	4.37	12.3
	19	5.41	8.2
	21	4.52	13.3
	22	5.66	7.3
Lower Carleton River <i>Lakes Region</i>	24	5.78	6.9
	25	5.92	6.2
	26	5.83	9.1
	27	4.34	19.0
	29	6.08	6.5
	31	4.94	13.2
	35	4.82	17.5
	36	6.01	4.5
	37	5.23	7.0

Table C2. Dissolved organic carbon (DOC) concentration and pH in a sub-sample of the sites in the Tusket River in November 1997 (see Fig. A2 for location of site number).

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
Upper Tusket River	2	4.13	26.7
	4	4.30	16.3
	11	4.02	33.2
	6	4.33	19.5
	7	4.17	31.7
	14	4.17	29.8
	15	4.38	20.4
	16	4.38	20.9
East Branch Tusket	9	4.06	31.7
	25	4.17	19.1
	24	4.16	22.2
	22	4.32	19.6
	21	5.84	2.9
	17	4.25	23.4
Main Tusket River	19	4.82	23.2
<i>Kegeshook Lake</i>	46	4.55	13.7
	39	4.25	19.8
	44	4.92	9.0
	31	4.66	15.6
<i>Quinan River</i>	42	4.15	31.2
	41	4.21	19.8
	35	4.26	24.6
	36	4.19	26.4
	34	4.48	14.1
	32	4.44	20.3
	47	5.73	5.9
	49	4.96	9.0

Table C3. Dissolved organic carbon (DOC) concentration and pH in a sub-sample of the sites in the Medway River in November 1997 (see Fig. A3 for location of site number).

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
West Branch Medway	1	5.45	5.8
	2	4.39	18.4
	4	5.87	4.8
	5	4.72	15.7
East Branch Medway	6	5.08	12.1
	9	4.39	26.4
	7	5.35	6.7
	11	5.35	8.0
Upper Medway River	12	5.09	12.4
	14	4.96	12.8
	15	5.58	5.7
	16	4.98	14.6
	17	4.61	22.7
	19	5.88	8.9
	24	4.54	19.6
<i>Westfield River</i>	22	4.49	24.5
	26	5.99	3.1
	31	5.10	10.0
	36	4.56	29.5
	32	4.71	20.3
<i>Wildcat/Pleasant</i>	65	4.34	21.6
	64	4.36	18.5
	66	4.52	16.7
	62	5.04	10.8
	57	4.85	10.5
	61	4.70	13.6
	54	4.76	11.4
	52	5.93	4.9
	34	5.62	7.6
	35	5.14	10.1
<i>Christopher Lakes</i>	44	4.94	11.8
	41	5.25	11.2
	42	5.07	11.1
	49	5.43	7.0
Lower Medway River	56	5.69	5.6
	67	4.44	19.9
	69	5.03	10.6
	71	4.74	15.7
	72	4.85	13.2
	74	5.14	9.8
	77	4.93	13.7

Table C3. Continued.

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
Lower Medway River	81	4.87	16.5
	82	5.00	12.2
<i>Salters Brook</i>	89	4.88	14.5
<i>Oakes Mills/Petite</i>	84	4.56	14.5
	85	4.61	14.3
	86	4.63	14.3
	87	4.70	15.8
	91	4.64	15.4
	92	4.82	13.9
	94	5.04	10.9

Table C4. Dissolved organic carbon (DOC) concentration and pH in a sub-sample of the sites in the LaHave River in November 1997 (see Fig. A4 for location of site number).

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
Upper LaHave River	2	6.13	4.2
	5	5.85	13.4
	1	5.94	5.7
	6	5.14	12.7
	12	5.39	8.0
	11	5.61	7.5
	15	5.97	9.5
	4	5.01	12.5
	9	5.73	8.1
	16	5.95	6.5
	17	5.84	7.3
	14	4.41	22.4
	19	5.26	12.4
	21	5.59	12.8
North River	22	6.02	8.1
	24	5.94	14.1
	25	4.94	16.8
	27	5.33	13.6
	29	4.79	20.4
	31	5.99	6.2
	32	5.37	12.5
	34	5.56	10.1
	35	4.30	15.2
	36	5.72	9.4

Table C4. Continued.

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
Main LaHave River	117	5.90	9.1
	121	4.88	11.1
	119	5.41	12.6
West River	75	4.86	16.6
	76	5.68	7.0
	77	4.50	13.8
	79	4.33	16.0
	81	4.59	18.3
	82	4.90	11.0
	84	4.57	14.7
	85	5.00	11.8
Main LaHave River	86	5.39	11.3
	124	4.73	10.8
	122	5.72	7.3
	126	5.91	6.4
	125	5.90	9.5
North Branch LaHave	37	5.85	11.5
	39	5.88	17.1
	41	5.57	12.1
	42	5.69	5.3
	44	4.65	16.8
	45	5.32	13.9
	46	5.57	13.1
	47	4.97	15.0
	49	5.72	4.4
	51	4.91	9.9
	52	5.69	10.0
	54	5.10	14.7
	55	5.05	13.2
	56	4.35	20.6
	57	5.71	10.7
	59	6.12	6.1
	61	5.34	11.6
	62	6.00	9.5
	64	5.74	8.0
	66	4.47	14.8
	65	4.59	13.4
	67	4.49	15.9
	69	6.14	7.5
	71	6.09	7.9
	72	5.97	5.7
	74	5.76	11.2
	127	5.98	6.3

Table C4. Continued.

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
Main LaHave River	131	5.68	8.7
	132	6.07	8.1
	129	5.88	8.9
	134	5.70	10.0
West Branch LaHave	87	5.13	9.8
	89	5.01	12.2
	91	4.71	19.8
	94	4.99	7.3
	95	5.59	7.0
	92	5.01	6.1
	97	4.86	9.5
	96	5.76	4.7
	99	5.52	4.7
	101	4.88	7.7
	102	4.60	8.7
	104	4.47	18.1
	105	5.12	7.5
	106	5.12	6.0
	107	4.56	13.1
	109	4.65	8.5
	111	6.20	3.3
	112	5.12	8.4
Main LaHave River	114	4.98	12.2
	115	5.55	10.0
	116	5.08	7.2
	135	5.73	8.5
	137	5.6	11.4
	136	5.76	8.7
	139	5.18	11.8
	141	5.71	10.6
	142	5.26	10.1
	144	5.59	8.2

Table C5. Dissolved organic carbon (DOC) concentration and pH in a sub-sample of the sites in the Gold River in November 1997 (see Fig. A5 for location of site number).

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
West Branch Gold	9	5.84	11.4
East Branch Gold	1	6.13	12.8
	2	4.10	26.3
	4	5.24	8.0
	5	6.12	4.6
	7	5.73	6.8
Upper Gold River	12	5.81	8.6
Mill Brook	14	5.33	10.9
	15	5.77	10.0
	16	6.11	5.2
	17	5.80	9.5
	19	6.02	8.6
	21	5.25	15.9
Larder River	25	5.24	17.1
	24	4.23	24.7
	26	5.37	16.1
Lower Gold River	29	5.12	12.3
	31	4.67	15.2
Beech Hill Brook	34	4.60	17.1
	32	4.54	21.1
	36	4.39	19.6
	37	4.93	13.6
	39	5.16	11.8

Table C6. Dissolved organic carbon (DOC) concentration and pH in a sub-sample of the sites in the East and West rivers, Sheet Harbour in November 1997 (see Figs. A6a, A6b for location of site number).

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
<u>East River System</u>			
Fifteen Mile Stream	1	4.86	5.8
	2	4.83	5.4
	4	4.94	8.9
	5	4.80	10.7
	11	5.47	5.1
	9	5.18	7.1
	6	5.53	4.0
	7	5.50	3.3
	12	4.50	18.5
	14	5.14	7.1
	15	4.59	13.1
	16	4.59	11.4
	17	4.80	14.8
	25	4.80	10.8
Ten Mile Stream	24	5.07	11.4
	26	5.06	11.5
	27	5.12	10.0
	22	5.52	3.8
Twelve Mile Stream	19	5.21	3.2
	21	4.90	13.7
	29	4.97	9.8
	31	4.49	14.0
	32	4.70	12.3
	34	4.85	12.1
	41	4.93	13.6
	35	4.75	11.6
Seven Mile Stream	36	4.63	11.4
	37	5.13	7.0
Lower East River	42	4.84	11.9
<u>West River System</u>			
Upper West River	44	4.58	11.2
	47	4.62	14.0
	49	4.57	12.2
	51	4.66	12.8
	52	4.35	17.4
	54	4.23	22.7
	56	4.83	13.0
Killag River	55	4.71	11.4

Table C6. Continued.

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
Lower West River	57	4.70	14.6
<i>Little River</i>	61	5.09	7.3
	62	5.14	6.5
	59	4.64	18.4
	64	4.81	12.1

Table C7. Dissolved organic carbon (DOC) concentration and pH in a sub-sample of the sites in the Liscomb River in November 1997 (see Fig. A7 for location of site number).

Sub-drainage	Site no.	pH	DOC (mg·L ⁻¹)
Little Liscomb River	17	5.38	6.1
	19	4.93	9.7
	21	4.94	9.0
	22	4.88	5.3
	24	4.57	14.2
	25	4.50	13.1
	26	4.47	15.1
	29	4.47	14.8
	27	5.00	5.0
	31	4.62	10.4
Upper Liscomb River	1	5.06	5.5
	2	5.00	8.2
	7	5.02	8.1
	6	5.06	8.9
	4	5.38	5.8
	5	5.04	9.2
	9	5.03	9.3
	14	4.57	14.7
	11	5.45	7.3
	12	5.06	9.3
	16	4.58	14.7
	15	4.59	14.9
	32	4.67	15.3
	34	4.95	8.2
Lower Liscomb River	35	4.71	10.4
	36	4.63	15.2
	37	4.65	15.4