Seasonal Patterns of Biological and Physical Variables in Sediments of Lime Kiln Bay during 2000-2001

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December 2002

Canadian Technical Report of Fisheries and Aquatic Sciences 2447

Fisheries and Oceans Canada Pêches et Océans Canada

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

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This is the two hundred and forty-ninth Technical Report of
the Biological Station, St. Andrews, NB

Cat. No. Fs 97-6/2447E ISSN 0706-6457

Correct citation for this publication:

Wildish, D.J., Akagi, H.M., and Martin, A. 2002. Seasonal patterns of biological and physical variables in sediments of Lime Kiln Bay during 2000-2001 Can. Tech. Rep. Fish. Aquat. Sci. 2447: iii + 46 p.

ABSTRACT

Wildish, D.J., Akagi, H.M., and Martin, A. 2002. Seasonal patterns of biological and physical variables in sediments of Lime Kiln Bay during 2000-2001. Can. Tech. Rep. Fish. Aquat. Sci. 2447: iii + 46 p.

During the period from September 2000 to September 2001 we conducted monthly sediment interfacial and profile sampling at two stations within Lime Kiln Bay. This Bay has been utilized for salmon culture since 1981. Station R was seaward of a bar, which separated the two basins within the Bay and station E was located in the inner, landward basin. Both stations were close to salmon lease sites, but were >100 m away from cages and so were not exposed to direct, near-field deposition (waste food, salmon faeces) from the cages. Reported here are the monthly results for redox, total sulfide, chlorophyll a, phaeophytin, enzymatically hydrolyzable amino acids, sediment interfacial temperature, sediment profile imaging and macrofaunal community characteristics, for stations R and E.

RÉSUMÉ

Wildish, D.J., Akagi, H.M., and Martin, A. 2002. Seasonal patterns of biological and physical variables in sediments of Lime Kiln Bay during 2000-2001. Can. Tech. Rep. Fish. Aquat. Sci. 2447: iii + 46 p.

Pendant la période de septembre 2000 à septembre 2001, nous avons procédé à des échantillonnages mensuels (interfaciaux et de profil) de sédiments, à deux stations d'échantillonnage dans la baie Lime Kiln, où l'on pratique la salmoniculture depuis 1981. La station R partait d'une barre de sable, vers la mer, séparant les deux bassins de la baie, et la station E se situait dans le bassin intérieur, du côté de la terre. Les deux stations d'échantillonnage étaient situées à proximité de sites de salmoniculture, mais à plus de 100 mètres de distance des cages afin de ne pas être exposées aux dépôts de déchets alimentaires et de matières fécales des saumons autour des cages. Le présent rapport donne les résultats des prélèvements mensuels des caractéristiques suivantes aux stations R et E : conditions d'oxydo-réduction (rédox), sulfure total, chlorophylle *a*, amino-acides hydrolysables par action enzymatique, température de l'interface des sédiments, imagerie des sédiments de profil et caractéristiques de la communauté macrofaunique.

Sediments
Sediment sampling
chemical analysis
chemical properties
profiling
seasonal variation

INTRODUCTION

For marine coastal ecosystems at temperate latitudes, marked temporal, or seasonal, patterns of productivity and structure are driven by physical-chemical changes. These include, but are not limited to, climate, particularly temperature, as well as the distribution of plant nutrients by hydrodynamic forces and light availability. The purpose of this study was to investigate seasonality within sediments of a cold temperate climate at 45° North as part of the Fisheries and Oceans project - Environmental Studies for Sustainable Aquacuture, ESSA (see Hargrave 2002). There are many implications of seasonality for coastal ecosystem users. One current group of users within coastal areas of the Bay of Fundy is the salmon growers who place Atlantic salmon, *Salmo salar* L., smolts in floating sea-pens for growout in marine conditions, a process which takes 18-24 mo. The environmental effects which result from this activity have been studied in Canada and other parts of the World and are relatively well known (see reviews by Gowen and Bradbury 1987; Findlay and Watling 1997). Based on this understanding, environmental monitoring programs have been devised, e.g. for the Bay of Fundy (see Janowicz and Ross 2001), relying on geochemical measures which require a fall monitoring and spring follow-up, if the farm site shows a high level of organic enrichment. Thus we expected this research to have a practical application: to determine whether seasonality biases geochemical measures and thus influences the interpretation of monitoring results from fall to spring.

Lime Kiln Bay is approximately 2.5 km long by 1 km wide at the mouth (Fig. 1) and opens into Letang Inlet and thence the Bay of Fundy. Lime Kiln Bay is surrounded by salmon farms in Back Bay, Bliss Harbour and inner Letang Harbour (Fig. 1), where a total of 23 farms were present in 2001. Lime Kiln Bay has been continuously used for salmon culture since 1981, with six farms present in 1996. The increasing biomass of salmon carried in the Bay before this time probably contributed (Stewart 1998) to a virus disease epidemic (infectious salmon anemia, ISA) starting in 1996. Ecological models (e.g., Silvert 1994; Cranston 1994) had suggested that the Letang Inlet was exceeding its holding capacity limits for organic wastes, calculated as plant nutrients or ammonium with holding capacity limits estimated between 7000 and 10,000 tonnes of salmon per year for Letang Harbour and vicinity (geographic area defined in Gregory et al. (1993)). The results were refined with hydrodynamic modeling (Trites and Petrie 1995), which also suggested that Lime Kiln Bay was exceeding its holding capacity limits. These results were presented to the industry at a meeting held at the St. Andrews Biological Station in 1996 (unpublished). In 1996, the six farms present within Lime Kiln Bay had a combined allowable production limit of 735,000 fish. Assuming that all were marketed in the same year (unlikely, but the worst case scenario) and using the mean weight (4.36 kg) of ungutted fish at slaughter (Peterson et al. 2001), yields a total of 3205 tonnes per year. After 1998 and a fallowing period imposed by the provincial government following the ISA epidemic, the farm sites have been reduced to four (Fig. 1), presumably with a lower total biomass, and other Bay-wide management initiatives, such as single year-class stocking, implemented. Lime Kiln Bay is now stocked with a fresh batch of smolts every odd year. Thus in even years the total allowable production limit is 540,000 fish x 4.36 kg = 2354 tonnes. In odd years the production will be due only to smolt growth and hence less than this. Similar calculations for the whole of the Letang Harbour and vicinity area in 2001 (as used by Silvert (1994) and Cranston (1994) in their model predictions), based on a mean smolt biomass in the first year of 0.54 kg (Model 3 and initial 120-g smolt size at 17 September, from Peterson et al. (2001)) and market size of 4.36 kg, are shown in Table 1. These calculations suggest that holding capacity limits are still being exceeded.

Table 1. Calculation of annual salmon biomass (tonnes) in bay management areas (BMA's) 8, 9 and 10 based on allowable production limits (APL's as number of fish) for each lease. Lease in BMA 10 with dashed lines in Fig. 1 are excluded. An arbitrary # is used for each lease so that its APL remains confidential

BMA	#	APL x 1000	Smolt	Market
8	1	300		
	2	250		
	3	180		
	4	180		
	5	130		
	6	120		
	7	80		
	8	80	713	5755
10	9	150		
	10	120		
	11	120		
	12	150	292	2354
9	13	160		
	14	200		
	15	135		
	16	320		
	17	180		
	18	200		
	19	220	764	6169
	TOTALS	3,275	1,769	14,278

The purpose of this publication is to record the raw data that we collected in fieldwork in Lime Kiln Bay from the Pandalus III, beginning in September 2000, and terminating in September 2001. We sampled every month (except December 2000) at two fixed locations within Lime Kiln Bay, stations R and E (Fig. 1). The aim of this publication is to facilitate cooperation among scientific collaborators and stakeholders, as well as providing an archived source of detailed information available for reference and publication preparation.

METHODS

SAMPLING

Vessels

The Pandalus III was used to transport SCUBA divers and field crew to the two permanent stations (R, E) in Lime Kiln Bay. Macrofaunal sieving was done on board the Pandalus using pumped seawater. On one occasion when this vessel was not available we used the W.B. Scott (September 2000). We also used a small tender vessel (belonging to Advanced Net Cleaning Services) on some occasions for faster delivery of samples to shore.

Locations

Two permanent stations were established in Lime Kiln Bay, one seaward of a submerged bar R, and the other landward of it, E (Fig.1). Buoys marked each station with a rope going to concrete block anchors. The R station was based on a lease marking buoy, and the E site by an anchored buoy that we deployed. The sampling area was marked by steel pins and was established close to the concrete anchor. The position of the surface buoys taken from the Pandalus III navigation system was:

R - 45° 03.561 North, 66° 49.499 West
E - 45° 03.895 North, 66° 49.816 West

Dates

Sampling was undertaken on 12 occasions on the dates shown in Table 2:

Table 2. Sampling dates of the seasonal study.

Number	Year	Date	Predicted Low Water (AST)
1	2000	20/09	1215
2		31/10	0810
3		30/11	0825
4	2001	04/01	1240
5		28/02	0855
6		30/03	0915
7		30/04	1100
8		16/05	1240
9		27/06	1030
10		26/07	1010
11		22/08	0800
12		19/09	0735

SCUBA Team

Advanced Net Cleaning Services of St. George, New Brunswick, provided the diving team, consisting of two divers per trip: Luke Aymar and Dale Tucker. During their absence Joe

Hunt of Fundy Diving Equipment filled in for them. We attempted to begin the dives as near as possible to low water (LW) to limit the depth required for each dive.

Sampling Gear

For the initial phases of the work we used both tubular cores and Hargrave wedge cores (Wildish et al. 2003a) deployed by divers. The latter were initially only used for obtaining sediment profile images, but it soon became obvious that we could do all of the sampling with the Hargrave cores by drilling holes in the side walls and covering with duct tape during deployment. Thus for most of the monthly sampling, beginning in November 2000, only the diver-deployed Hargrave corer was used, with five replicate samples taken at each location, R and E.

The Hargrave corer used (diagram in Wildish et al. 2003a) sampled an area of 0.0263 m^2 and a completely full core had a volume of 6.2 L. The construction material was of Plexiglas with a hinged top lid and a sliding backplate, which was opened while pushing the corer into the sediment, and then closed to seal the core before transportation to the surface. An aluminum handle allowed the diver to push the wedge core into the sediment and was convenient for carrying two to three corers (filled with seawater at the surface) down to the sampling area. In addition, the Hargrave cores provided sufficient sediment sample to estimate macrofaunal densities. Ten different Hargrave corers were used on each sampling trip.

Subsampling

Of the five cores taken at each of the two stations, R and E, the two best were selected for sediment profile imaging (SPI). They were held upright, with the seawater above the core, and carried ashore for interpretation and photography. After this had been completed, they were taken into the building for subsampling. This was achieved by measuring surface sediment redox with a platinum probe and for sulfide drawing up a 5-cc aliquot with a cut-off 5-cc plastic syringe. A small amount of sediment at the surface and at each profile depth was taken on a spatula (<0.2 cc) for chlorophyll a determination. Approximately 5-cc samples were also taken for each of: enzymatically hydrolyzable amino acids (EHAA), sediment particle sizing, plus organic matter analysis. These two samples were placed in labeled plastic bags and stored frozen.

Subsampling on the three Hargrave cores/station left aboard the Pandalus was only for surface sediments scraped up in a 30-cc plastic container (analyzed in the shore laboratory for redox, sulfide, chlorophyll a, EHAA, sediment particle sizing and carbon). Once these samples had been taken, the sediment in the Hargrave cores was washed onto a series of sieves to separate the macrofauna.

Sediment profiling was done on the two cores/station that were photographed, by inserting the platinum redox probe into the drill hole after removing the duct tape, followed by removal of sediment in a cut-off syringe, for sulfide, chlorophyll a, EHAA, and organic matter. During work-up of these samples, which took 4-6 h, the sediment heated up in the room. Because redox is temperature sensitive, we measured sediment temperature at the time of subsampling.

VARIABLES MEASURED

The following 10 variables were measured: redox, total sulfide, chlorophyll a, phaeo-pigments, EHAA, temperature, organic matter, sediment particle characterization, sediment profile imaging and macrofaunal community characteristics. In addition, we used wind speed and direction data from the Point Lepreau monitoring station (Environment Canada).

Because it is not given elsewhere, we present a detailed description of our of methods for SPI and plant pigment analysis.

Redox

The method followed was that in Wildish et al. (1999), except that the platinum electrode was filled with 4.0 M KCl (and not 0.2 M as erroneously stated on p. 5 of Wildish et al. 1999). The mV readings were read on an Accumet ion meter and corrected to the normal hydrogen electrode (NHE) at the measured sample temperature at the time of analysis:

$$\mathbf{E_{NHE} = E_O + C} \ ,$$

where E_O = mV of unknown and C = mV of NHE electrode at sample temperature (see Table 1 in Wildish et al. 1999).

Total Sulfide

Total sulfides in sediments were measured by the electrochemical method of Berner (1963) with the same Accumet ion meter and Orion silver/sulfide half cell and reference electrodes according to the detailed methods given in Wildish et al. (1999). The L-ascorbic acid was preweighed and added to the sulfide anti-oxidant buffer solution (SAOB) just before use. Standard solutions of sodium sulfide stock and SAOB, and unknown sediment slurries and SAOB were added together in the same 1: 1 volumetric ratios. The results are given as micromoles of sodium sulfide, µM.

Chlorophyll a (Chl a) and Phaeo-pigments

The method is based on that in Strickland and Parsons (1968) adapted for sediments.

Field equipment list

15-mL graduated tubes with screw caps
Each tube is filled with 10 mL of 90% acetone
Spatula for removing sediment
Vortex mixer
Magnesium carbonate slurry (1% solution in distilled water)
Pasteur pipets and rubber bulbs for dispensation of above
Ice chest half full of crushed ice

Initial field analysis

A small amount of sediment was added to a labeled tube containing 90% acetone (variable amounts according to how much green colour it produces); one to two drops of magnesium carbonate slurry were added; the tube was vortically mixed for 1 min; the tubes were then placed in the ice chest in the dark.

Laboratory analysis after ~12 h refrigeration

On return to the lab the graduated tubes were refrigerated in the dark overnight. The next day tubes were removed from the refrigerator and allowed to equilibrate to lab temperature. Each tube was centrifuged at 3000 g for 10 min and 5 mL of the supernate removed. Fluorescence was recorded in a Model 10-AU-005 Turner Designs fluorometer (Sunnyvale, CA, U.S.A.) fitted with a light-tight cuvet holder. The fluorometer was fitted with a blue excitation filter and a red filter, selected for chlorophyll a determination.

The supernate sample was pipetted into pyrex 1-cm cuvets and the fluorescence determined against a blank of 90% acetone. Standard samples of chlorophyll a (from Sigma) in 90% acetone were also run (R_B) to determine a calibration curve. Following the first reading 1-2 drops of 1N HCl was added to the cuvet which was mixed by inverting it twice, and the fluorescence value read again (R_A). The acid factor, r, was calculated for standard samples: $r = R_B/R_A$. The average r = 1.94, and the factor r/r-1 = 2.07. The calibration was gravimetrically based: the addition of 1 mg of pure chlorophyll a to 1 L of 90% acetone. The calculations for estimating chlorophyll a and phaeo-pigments were as in Strickland and Parsons (1968). The conversion factor, F = 0.03, was derived by dividing the chlorophyll a concentration by R_B.

To the remaining sediment, after discarding any supernate, 10 mL of deionized water was added, followed by vortex mixing. The tubes were left overnight to leach out the sea salts. The supernate was then discarded and the sediment pellet quantitatively transferred with a wash bottle to a pre-weighed and numbered aluminum dish for dry weight determination.

The dishes were placed in a convection oven for drying for 24 h at 80°C.

The sediment sample weight was the difference between the last and first weighings and results expressed as µg chlorophyll a or phaeo-pigment/g dry sediment. Total pigments were also calculated by adding the two values as in Hargrave and Phillips (1981).

Chlorophyll a:

Dilution factor (µg/mL) ÷ g dry sediment $0.03\ [(r/r-1)\ (R_B - R_A)]$

Phaeophytin:

Dilution factor (µg/mL) ÷ g dry sediment $0.03\ [(r \times R_A) - R_B](r/r-1)$

Enzymatically Hydrolyzable Amino Acids (EHAA)

Samples in plastic bags were stored in the freezer. They were delivered to the laboratory of Dr. Larry Mayer in a cooler chest, where they were analyzed for bioavailable amino acids by the method of Mayer et al. (1995). The sediments were freeze dried before incubation with Proteinase K (from Sigma) and microbial inhibitors and the products, amino acids, visualized with a fluorochrome (orthophthaldialdehyde reagent) and measured spectrofluometrically. The results are expressed as µg EHAA/g dry sediment.

Temperature

Continuous measurements of temperature were made with StowAway Tidbit units (available from Onset Computer Corp., 470 MacArthur Blvd., Bourne, MA 02532, U.S.A.). Each unit was set to record temperatures every 30 min and placed at the sediment-water interface secured to the anchor block. The results, as daily means, were downloaded to a laptop computer and analyzed with a Microsoft Excel pivot table.

Sediment Particle Analysis

Frozen samples in plastic bags were transported on ice to the Bedford Institute of Oceanography.

Organic matter

Some of the above samples were analyzed under contract for total carbon by weight loss on ignition at different temperatures to give labile (at 280°C) and total (at 520°C).

Wind direction and speed

An MS Excel data file for wind direction, speed, air temperature and % relative humidity was obtained from Environment Canada. Each of the four variables was averaged hourly in the period 1 September 2000 to 30 September 2001. The data for the 24 h prior to each sampling is presented in Appendix 3.

Sediment Profile Imaging (SPI)

Equipment list for fieldwork:

Hargrave core samplers (10)
Wooden stands for the samplers, painted matte black
Kodak DC 290 camera
Camera tripod
Felt for cleaning the Plexiglas surfaces of the sampler
Siphon apparatus for removing seawater above the sediment

Preparation for fieldwork: Camera batteries were recharged overnight; a blank picture card was installed in the camera; the camera was pre-set to use auto flash and highest picture resolution.

Fieldwork

After the SCUBA divers had taken the samples, they were kept upright by placing them on wooden stands. The Plexiglas surface through which the photographs were taken was cleaned with a seawater hose so that sediment smearing did not occur.

Best results were obtained if the photography was done on land, where diffused lighting and sun position could be better controlled.

The camera was set up on its tripod about 1-2 m from the samplers, preferably outside in natural lighting. Care was taken to see that the plane of the camera was nearly at right angles to the sediment profile. After adjusting the focus with the aid of the picture shown on the back of the camera, two exposures were made for each sample taken. All parts of the sediment profile were kept within the picture frame.

Downloading from the Kodak DC 290 to a PC: Remove the picture card from the camera and insert into the computer-compatible interface. Click and drag each JPEG file to a PC storage file. Check that each JPEG image is present on the PC file. Retain the images on the Picture Card as long as possible as backup in case of file crashes.

Analysis of digital profile images: The variables observed in the computerized images are as in Nilsson and Rosenberg (2000).

System requirements

PC with frame grabber board
Image analysis software (e.g. Optimas 6.2, Image Pro Plus, SigmaScan)
PC Log On
Put disks with the SPI in the PC and open it.
Define the redox potential discontinuity (RPD) layer with the Toolbar greenline
Calculate the total area of the RPD layer
Divide the area by the sampled width (= 17.5 cm wide in our corers) to give the mean RPD depth
If necessary the different areas can be enhanced by changing the contrast settings
Repeat this procedure to obtain the total mean core depth
Enter the SPI number, the mean core and RPD depths in cm, on the assessment sheet provided
Complete the assessment sheet by answering the yes/no questions shown from each SPI
Calculate the Benthic Habitat Quality index (BHQ) of Table 3, Nilsson and Rosenberg (2000) which can range from 0 to 15
Correspondence between the BHQ and the organic enrichment index (OE) from Pearson and Rosenberg (1978) is as in Table 3:

Table 3. Equivalent groups for Benthic Habitat Quality and the Organic Enrichment Index.

Description	BHQ	OE
Normal	>10	III
Oxic	5-10	II
Hypoxic	2-4	I
Anoxic	<2	0

Macrofauna

The three Hargrave core samples taken for macrofaunal analysis were lumped during sieving by washing with seawater through two sieves, the lower one having a mesh size of 1 mm^2. The sieve contents were carefully collected and placed in small plastic pails with a little seawater and full strength formalin (40%) in sufficient quantity to make a 5-10% solution.

Plastic tops were then hammered in place to make an airtight seal. The labeled pails were stored until analysis at the Atlantic Reference Centre (ARC), Huntsman Marine Science Centre. Standard sorting and taxonomic procedures developed at the ARC were employed (Lim and Gratto 1992; Pohle and Frost 1997). Species were identified to the lowest possible taxon, individuals counted and a total biomass (of alcohol preserved specimens) determined.

RESULTS

The results are summarized in Appendices 1-5 and a preliminary appraisal offered here. Primary publications expected to result from this work include Wildish et al. (2003b) regarding seasonality in sediment interfacial redoxes and a method for correcting for this in temperate climates of either southern or northern hemispheres. Another, concerning the seasonality of all variables measured, is in preparation.

SEDIMENT INTERFACE

Interfacial sediments are considered here to be within the top 2 cm of the profile from the sediment-water interface downwards. The sub-sampling tools used (probe tips, cut-off syringes, spatula) did not allow the mm - scale sampling reported by some investigators.

The data available are shown in Appendix 1, including phaeo-pigments. The organic matter measurements by ashing and particle sizes were not yet available. EHAA samples were taken only in the months of March (winter) and July (summer). The early attempts to deploy Tidbit units for temperature measurement resulted in losses of the units due to chafing with anchor chains and ropes, and only at the third attempt, were we able to place a unit which stayed in place, and we could find, after 7 mo (Appendix 2).

Temporal patterns of redox, sulfide, chlorophyll a and temperature are shown in Fig. 2-5. Redox shows a generally sine wave pattern with season (Fig. 2), with an anomalously low value in August. The August anomaly, which coincides with maximum temperatures (Fig. 5), was not correlated with high sulfide levels (Fig. 3). We propose (Wildish et al. 2003b) that this is because in aerobic sediments, redox values follow the general seasonal pattern in seawater; in the biologically active period there is a decline in oxygen, which is markedly accelerated when phytoplankton become limited late in the summer, when microbial aerobes are still actively respiring. Thus the negative redoxes of August are linked to the large deficit present then between oxygen production and utilization in favor of the latter. The chlorophyll a seasonality (Fig. 4) shows a summer high, which is reduced by August. This measure includes interfacial diatoms as well as phytoplankton which sediments from the water column.

SEDIMENT PROFILES

Shown in Fig. 6 are examples of profiles from stations R and E for March 2001. For the former the maximum sampling depth was 12 cm due to penetration resistance in coarser sediments. At E, the finer sediments allowed greater penetration, to 20 cm. The redox and sulfide values are consistent with the visual data obtained, with SPI regarding the redox discontinuity depth, which for R6 was 4.8 cm and for E1 was 5.6 cm. The high chlorophyll a at E1 in the surface sediment suggests that an early season diatom bloom was in progress.

WHOLE CORE SAMPLES

The SPI data are presented as benthic habitat quality indices (BHQ), as RPD depths and the organic enrichment (OE) index equivalent to the BHQ (Appendix 4). There is slight evidence of seasonal changes of RPD, with maximum depths in the month before the lowest measure of redox was recorded. There is little evidence of seasonal change in BHQ and none in OE.

Macrofaunal data are given as species times density matrices in Appendix 5. Principal results from these data are that station R has a more diverse macrofaunal community, with 93 species versus E with 68 species from 11 monthly samplings. Since each monthly sampling was based on three lumped cores, the area sampled is 0.0263 x 3 = 0.0788 m^2. The density data of Appendix 5 can be converted to number/m^2 by multiplying by 12.67.

There was no evidence of seasonality in the data as far as species diversity or total biomass was concerned as shown in Table 4, extracted from Appendix 5:

Table 4. Monthly macrofaunal species number (S) and biomass (B) in g/m^2. Note that biomass is higher at R than E for all months except in May.

Month	E		R	
	S	B	S	B
October	27	19.82	41	195.24
November	23	7.41	42	60.45
January	21	4.38	51	54.71
February	22	5.90	48	41.60
March	20	20.50	45	148.24
April	21	2.55	50	126.89
May	25	35.48	30	22.82
June	36	16.76	44	90.65
July	21	21.68	34	50.55
August	31	8.95	48	33.79
September	26	9.96	43	31.65

DISCUSSION

Most of the data in Appendices 1-5 awaits further detailed analysis. Only sediment interfacial redoxes have been examined closely (Wildish et. al. 2003b) and shows that in sedimentary profiles with an aerobic upper layer, redoxes have a seasonal, sine wave pattern. The pattern decreases with increasing temperatures (when biological activity is high) and increases with decreasing temperatures (when biological activity is low). In highly organically enriched conditions where anaerobiosis reaches the sediment-water interface, interfacial redoxes are an inverse function of total sulfide as found previously (Hargrave et al. 1997; Wildish et al. 1999).

The demonstration here, that redox values in aerobic sediments are seasonal, has implications for environmental monitoring, notably in using geochemical measures to designate organic enrichment macrofaunal community stages. This is discussed in Wildish et al. (2003b) where the protocol proposed is as follows. In surficial sediments where an established farm is present, the redox is considered to be inversely related to sulfide and no seasonal correction is needed. Where farms are new and sulfide levels may not have built up in surficial sediments, the redox may be seasonal and a correction may be required. If necessary, we recommend correcting redox seasonally, with the aid of the simple models given in Wildish et al. (2003b), to correspond to the timing of original sampling.

Although there appears to be no evidence for seasonality in total sulfides in the present data (Fig. 3), the possibility that enriched sediments, where sulfides exceed 1300 μM, may show that a seasonal signal exists and needs to be investigated. In Chesapeake Bay sediments, Marvin-DiPasquale and Capone (1998) found that there was a seasonal periodicity of sulfate reduction. This was controlled by temperature, carbon and sulfate limitation, and the presence/absence of macrofauna or dissolved oxygen. Since our ion analytic method measures total sulfides, inclusive of iron pyrites which are stable in most sediments, the seasonal cycling of sulfate reduction may be masked by the presence of a large reservoir of metallic sulfides.

There are indications that sediments in Lime Kiln Bay are eutrophicated, particularly by the seasonal presence of high levels of chlorophyll a in the surface layers. These pigments originate from interfacial diatoms as well as phytoplankton from the water column, which may settle onto sediments during senescence. The generally high levels of total sulfide and low redoxes (which also varies seasonally) are indicators that microbial activity is high, consistent with a high level of sedimentary metabolism, and hence eutrophication. This is consistent with the plant nutrient predictive model outputs discussed in the "Introduction."

ACKNOWLEDGMENTS

We thank Captain Wayne Miner and Danny Loveless of Pandalus III and Captain Eldon Carter of the W.B. Scott for help in sampling. For high quality SCUBA diving services we thank Luke Aymar, Dale Tucker and Joe Hunt. We also acknowledge the help of Ms. Nell Halse and the NB Salmon Growers Association for permission to use their building for laboratory analysis and photography purposes. For information on allowable production limits in salmon culture and Fig. 1, we thank Blythe Chang and the NB Dept. of Agriculture, Fisheries and Aquaculture.

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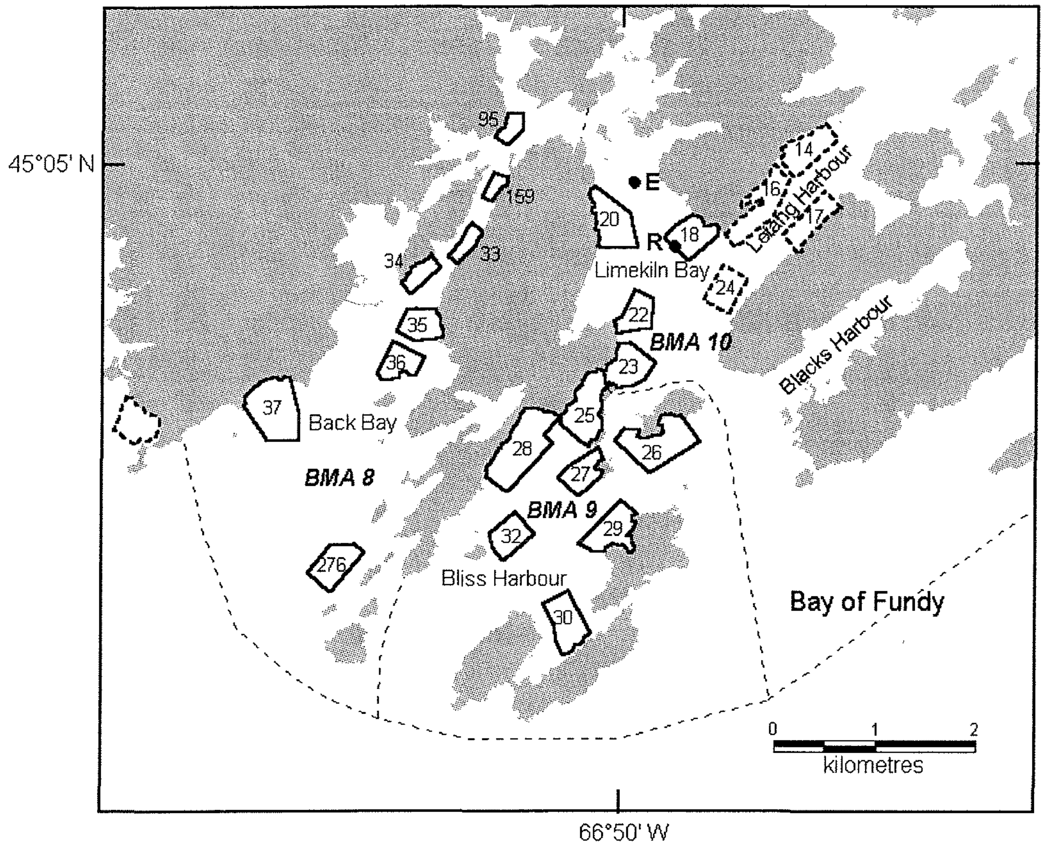

Fig. 1. Map of Letang Inlet showing Lime Kiln Bay and positions of stations R and E. Numbers refer to salmon farm leases in 2002. Sites 14, 16, 17 and 24 were not included in the Letang Harbour and vicinity model quoted. BMA = Bay Management Area.

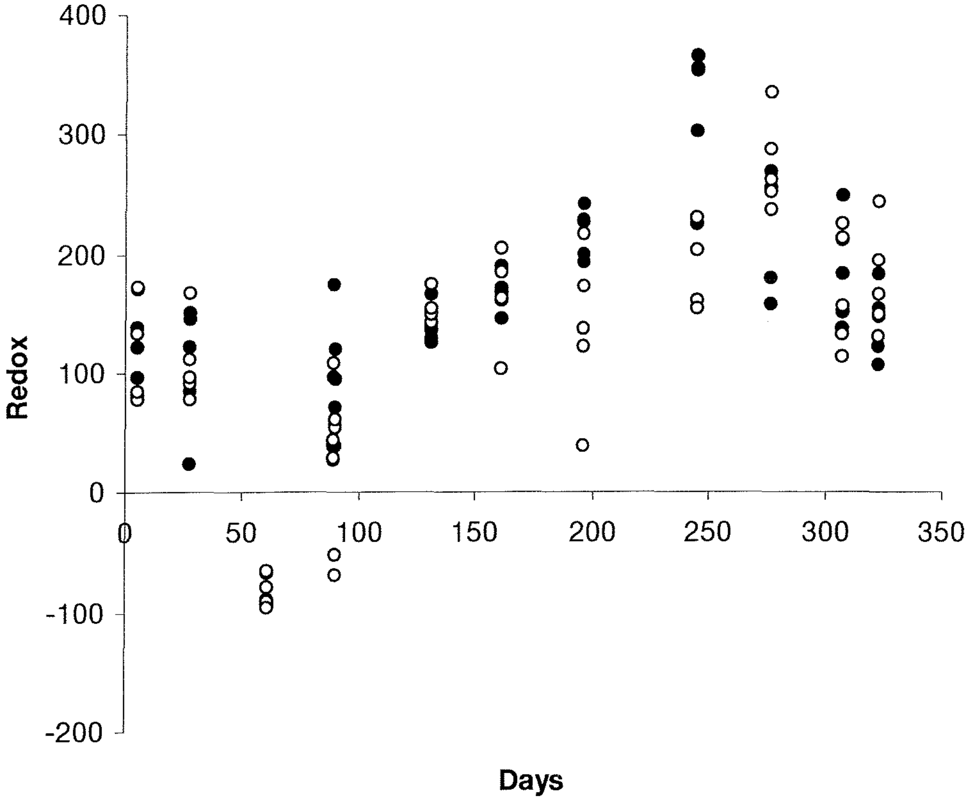

Fig. 2. Seasonality of redox in interfacial sediments at stations R (filled circles) and E (open circles), Lime Kiln Bay. Days are from the summer solstice (22 June in the northern hemisphere).

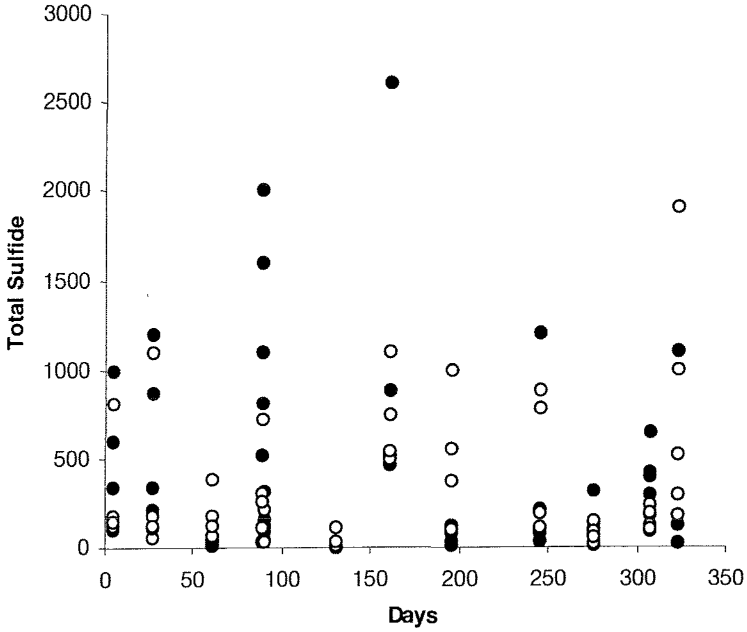

Fig. 3. Seasonality of total sulfides in interfacial sediments at station R and E, Lime Kiln Bay. Symbols as in Fig. 2.

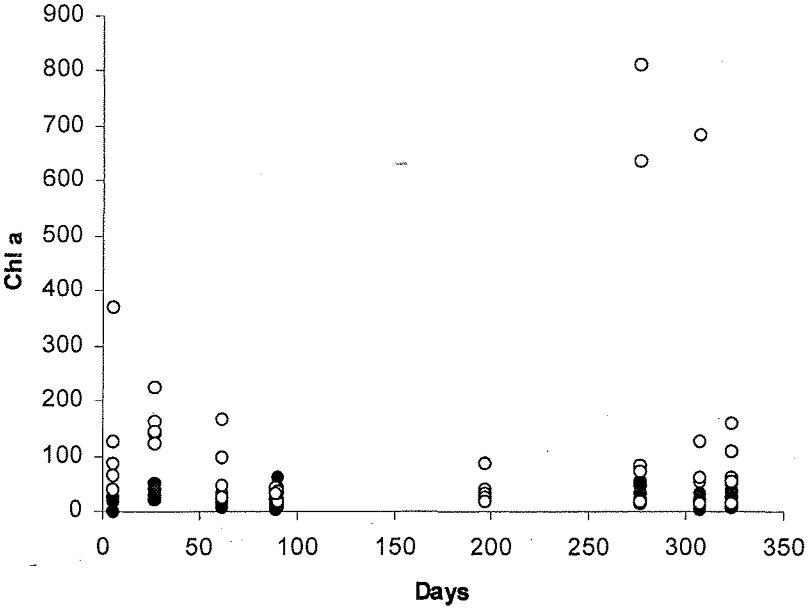

Fig. 4. Seasonality of chlorophyll a in interfacial sediments at station E and R, Lime Kiln Bay. Symbols as in Fig.2.

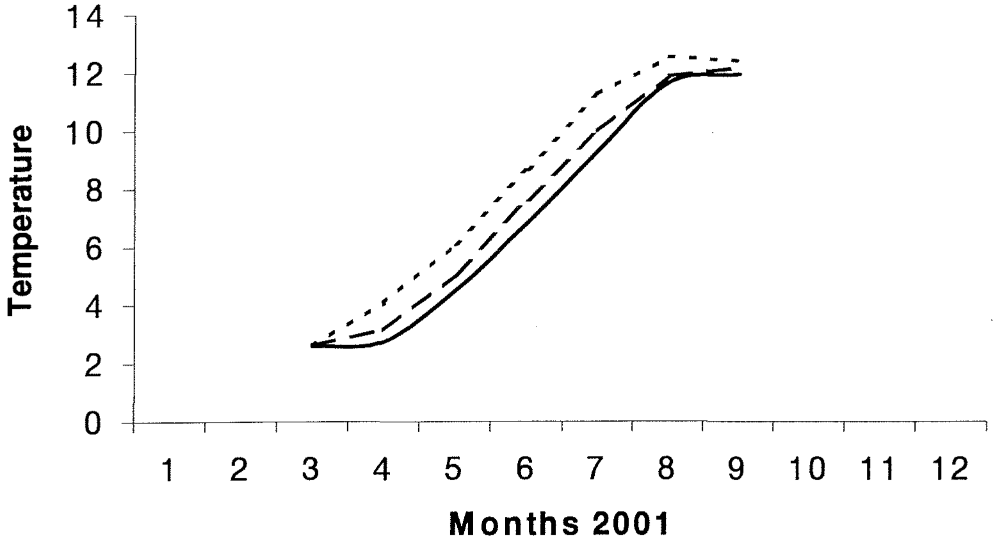

Fig. 5. Sediment interfacial temperatures at station E, Lime Kiln Bay. Upper line is the maximum and lower line the minimum daily mean temperature. The middle line is the monthly average of all daily mean temperatures.

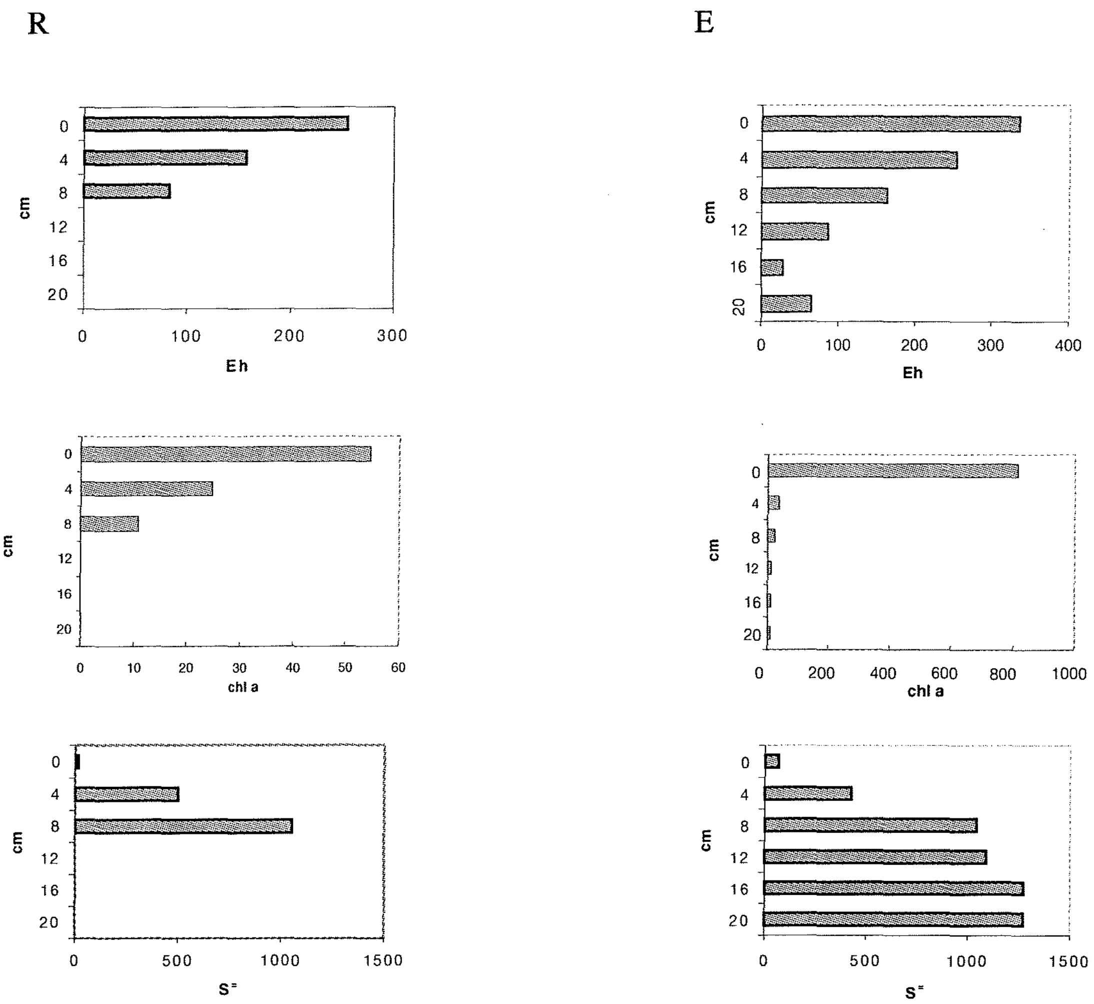

Fig. 6. Sediment profiling at stations R and E, Lime Kiln Bay on 30 March 2001 for chlorophyll a (Chl a), redox (Eh) and total sulfide ($S^{=}$) as μM. Profile depths are in centimeters (cm).

Appendix 1. Monthly sediment interface and profiling results at stations R and E, Lime Kiln Bay for the period 20 September 2000 to 19 September 2001. The numbers after R or E indicate the sequential core used and the numbers after the dash show the sampling depth in cm (0 = 0-2 cm)

20-Sept-00

No.	Chl a µg/g	Phaeo., µg/g	Total	Eh_{NHE}, mV	$S^=$ µM
Surface					
R1-0	7.79	63.21	70.99	72	91
R2-0	7.98	52.98	60.97	40	120
R3-0	60.42	238.00	298.42	120	220
R4-0	44.88	309.12	353.99	95	160
R5-0	15.72	97.67	113.39	39	320
E1-0	16.30	167.13	183.43	57	110
E2-0	20.95	87.03	107.97	-51	220
E3-0	19.50	78.13	97.63	54	35
E4-0	32.52	153.79	186.31	61	40
E5-0	36.98	165.36	202.34	-69	31
Profile					
R1-0	17.08	169.41	186.49	58	69
R1-4	9.13	90.62	99.76	78	320
R1-8	0.74	8.63	9.37	-63	2300
R1-12	2.36	22.91	25.27	-60	1700
R1-16	0.70	8.76	9.47	-156	1100
R2-0	12.24	306.00	318.23	28	180
R2-4	19.85	97.43	117.28	35	270
R2-8	3.55	45.33	48.87	-20	340
R2-12	1.79	28.61	30.39	-115	2200
R2-16	0.55	9.61	10.16	-109	3700
R2-20	0.47	8.07	8.54	-174	5800
E1-0	43.48	148.78	192.26	97	120
E1-4	14.20	85.27	99.47	7	510
E1-8	7.00	42.95	49.95	-3	880
E1-12	1.96	33.30	35.27	-44	890
E1-16	2.81	53.91	56.72	-46	360
E1-20				-70	700
E1-24				-62	340
E1-28				-82	1600
E2-0	33.06	109.89	142.94	21	410
E2-4	36.47	130.10	166.57	51	170
E2-8	13.96	98.41	112.37	-39	700
E2-12	13.59	66.87	80.46	-31	730
E2-16	1.37	65.37	66.74	-90	1800
E2-20	6.25	43.19	49.45	-100	3100
E2-24	3.92	29.26	33.18	33	190

31–Oct-00

No.	Chl a, μg/g	Eh_{NHE}, mV	$S^{=}$, μM
<u>Surface</u>			
R1-0		126	1.2
R2-0		135	0.73
R3-0		140	2.7
R4-0		129	13
R5-0		166	13
E1-0		174	11
E2-0		150	30
E3-0		142	110
E4-0		149	12
E5-0		154	30
<u>Profiles</u>			
R4-4		111	120
R5-4		115	110
R5-8		85	110
E1-4		71	110
E1-8		56	240
E1-12		-30	260
E3-4		-30	210
E3-8		-67	260
E3-12		-14	120
E3-16		-3	32

30-Nov-00

No.	Chl a, µg/g	Eh_{NHE}, mV	$S^{=}$, µM
Surface			
R1-0		146	460
R3-0		167	1100
R4-0		189	880
R5-0		170	520
R6-0		161	2600
E1-0		204	1100
E2-0		184	750
E4-0		162	500
E6-0		103	1100
E7-0		184	540
Profiles			
R3-4		83	2000
R3-8		-34	4100
R5-4		131	3100
R5-8		57	5500
E1-4		214	5300
E1-8		19	6100
E1-12		-65	7500
E1-16		-47	6900
E2-4		148	3800
E2-8		-25	5200
E2-12		21	3300
E2-16		14	3600

4-Jan-01

No.	Chl a, µg/g	Phaeo., µg/g	Total	Eh_{NHE}, mV	$S^{=}$, µM
Surface					
R1-0	39.57	147.22	186.79	226	120
R2-0	22.29	104.60	126.88	242	12
R3-0	20.59	84.75	105.34	193	76
R4-0	29.96	119.14	149.10	228	34
R5-0	19.18	69.06	88.24	199	16
E2-0	40.70	176.57	217.27	217	100
E4-0	31.26	86.89	118.15	40	550
E5-0	25.78	102.17	127.94	122	1000
E6-0	18.69	67.65	86.34	137	370
E7-0	87.88	350.75	438.64	172	100
Profiles					
R1-4	32.31	141.13	173.44	100	1100
R1-8				6	1100
R3-4	5.12	23.74	28.85	73	940
R3-8	5.11	23.72	28.84	27	1000
E5-4	19.80	77.65	97.45	123	1200
E5-8				107	1500
E5-12	2.02	51.62	53.65	34	2100
E5-16	14.39	78.50	92.89	-6	2300
E5-20	5.14	37.71	42.85	5	1200
E6-4	23.55	53.97	77.52	141	1000
E6-8	18.92	58.41	77.33	59	1200
E6-12	9.02	36.26	45.28	-16	1300
E6-16	6.99	37.31	44.29	17	800
E6-20	9.90	75.90	85.79	182	420

28-Feb-01

No.	Chl a, µg/g	Eh_{NHE}, mV	$S^{=}$, µM
Surface			
R1-0		334	100
R2-0		344	210
R3-0		204	74
R4-0		332	1200
R5-0		282	37
E1-0		141	110
E2-0		182	190
E3-0		134	7800
E4-0		209	880
E5-0*			
Profiles			
R1-4		385	21
R1-8		228	320
R1-12		139	1100
R5-4		213	160
R5-8		-38	1600
E4-4		139	5400
E4-8		105	1100
E4-12		-31	2700
E4-16		-20	1400

* Absent

30-March-01

No.	Chl a, μg/g	Phaeo., μg/g	Total	Eh_{NHE}, mV	$S^{=}$, μM	EHAA mg(AA)/g
Surface						
R2-0	20.98	87.57	108.55	268	96.8	0.78
R3-0	16.33	51.52	67.85	157	316	0.68
R5-0	48.92	83.03	131.95	184	59.6	2.13
R6-0	54.51	114.99	169.50	255	14.9	1.05
R7-0	33.99	67.30	101.29	269	135	0.83
E1-0	813.96	75.74	889.70	339	67.9	1.95
E2-0	19.96	49.75	69.70	287	23.4	4.50
E4-0	637.00	119.10	756.10	221	177	2.12
E5-0	84.17	127.32	211.48	236	95.3	2.38
E6-0	73.69	118.94	192.63	252	59.4	1.05
Profile						
R5-8	32.29	75.31	107.60	113	561	1.01
R6-4	24.72	64.67	89.39	172	500	1.03
R6-8	10.83	39.60	50.44	98	1050	0.78
E1-4	35.75	138.18	173.93	269	428	1.38
E1-8	22.02	69.33	91.35	179	1040	1.24
E1-12	9.62	43.96	53.58	101	1090	1.05
E1-16	9.64	44.14	53.78	43	1270	1.00
E1-20	7.90	36.73	44.63	81	1270	0.78
E4-4	148.69	145.84	294.53	165	485	1.24
E4-8	47.91	168.72	216.63	149	771	1.30
E4-12	34.53	98.54	133.07	114	1010	0.89
E4-16	12.91	56.83	69.74	170	740	0.57
E4-20	8.53	39.95	48.47	102	1060	0.51

30-April-01

No.	Chl a, μg/g	Phaeo., μg/g	Total	Eh_{NHE}, mV	$S^{=}$, μM
Surface					
R1-0	10.39	41.96	52.35	137	400
R2-0	23.20	75.03	98.24	248	420
R3-0	4.06	27.25	31.31	151	650
R6-0	21.17	65.96	87.13	211	180
R7-0	31.21	118.97	150.18	183	290
E1-0	683.49	252.45	935.93	213	240
E3-0	13.88	53.56	67.44	114	190
E4-0	127.45	162.61	290.06	224	130
E5-0	53.54	135.57	189.11	132	93
E6-0	60.81	141.02	201.83	156	100
Profile					
R1-4	23.78	82.25	106.04	71	930
R1-8	32.33	113.52	145.85	-88	1900
R2-4	9.60	41.72	51.31	116	1200
R2-8	3.54	29.15	32.69	58	1100
R2-12	14.72	65.91	80.63	11	2400
E1-4	52.64	94.83	147.47	201	1000
E1-8	11.46	65.24	76.70	176	910
E1-12	5.12	81.69	86.81	122	1200
E1-16	12.28	55.56	67.85	54	1100
E1-20	11.17	45.58	56.76	30	1100
E4-4	58.58	97.35	155.93	162	1000
E4-8	35.69	65.75	101.44	88	900
E4-12	8.60	47.25	55.85	78	1300
E4-16	5.89	37.93	43.82	55	1700
E4-20	7.43	34.49	41.92	-41	2000

16-May-01

No.	Chl a, µg/g	Phaeo., µg/g	Total	Eh_{NHE}, mV	$S^{=}$, µM
Surface					
R2-0	25.20	120.48	145.68	147	21
R3-0	49.42	159.89	209.31	183	21
R5-0	6.13	35.35	41.47	122	130
R6-0	34.82	87.52	122.34	154	1100
R8-0	34.72	153.45	188.17	107	180
E1-0	62.83	134.47	197.3	149	520
E4-0	55.86	67.65	123.51	166	1000
E7-0	158.61	195.19	353.8	244	180
E9-0	108.73	129.07	237.8	130	300
E10-0	14.98	125.47	140.44	194	1900
Profile					
R5-4	28.93	144.9	173.84	55	1100
R6-4	16.00	103	119	118	1600
R6-8	6.84	36.95	43.79	81	1800
E7-4	37.64	138.97	176.6	148	1000
E7-8	18.85	84.03	102.88	139	1800
E7-12	13.43	60.13	73.55	81	2200
E7-16	11.9	61.18	73.08	77	2300
E10-4	21.97	85.64	107.6	157	2600
E10-8	9.64	52.09	61.73	171	3400
E10-12	13.22	69.5	82.72	95	3400
E10-16	8.54	40.08	48.62	37	3800
E10-20	6.33	35.46	41.79	84	3800

27-June-01

No.	Chl a, µg/g	Phaeo., µg/g	Total	Eh$_{NHE}$, mV	S$^{=}$, µM
Surface					
R1-0	0.49	6.24	6.73	122	100
R2-0	16.60	57.93	74.54	171	1000
R3-0	38.62	95.90	134.52	139	130
R4-0	25.30	80.03	105.32	97	600
R5-0	26.58	76.03	102.61	84	340
E6-0	66.72	97.23	163.94	82	130
E7-0	371.23	263.69	634.92	133	170
E8-0	127.53	138.33	265.86	78	180
E9-0	41.66	84.22	125.88	172	810
E10-0	87.32	99.71	187.03	84	150
Profiles					
R1-4	17.05	50.35	67.39	52	650
R1-08	144.54	560.00	704.55	43	1200
R2-4	6.21	31.18	37.40	16	1200
R2-8	7.45	41.32	48.77	-42	1100
E7-4	12.00	41.01	53.01	158	1600
E7-8	20.95	79.63	100.58	98	2100
E7-12	83.57	208.24	291.81	24	2500
E7-16	326.41	610.78	937.20	0	1800
E7-20	46.52	137.49	184.01	15	2100
E9-4	32.65	123.11	155.77	158	880
E9-8	24.47	80.30	104.77	126	620
E9-12	26.16	90.38	116.54	53	890
E9-16	12.19	50.25	62.45	36	1100
E9-20	15.51	50.03	65.54	17	1200

19-July-01

No.	Chl a, µg/g	Phaeo., µg/g	Total	Eh_{NHE}, mV	$S^{=}$, µM	EHAA mg(AA)/g	Carbon vial #
Surface							
R6-0	25.45	101.23	126.68	25	340	1.16	2696
R7-0	20.99	78.43	99.42	122	870	1.37	2697
R8-0	50.42	140.97	191.39	146	210	1.55	2709
R9-0	41.80	139.36	181.17	150	60	1.47	2698
R10-0	28.17	109.88	138.05	84	1200	1.02	2705
E1-0	162.54	263.77	426.30	92	51	1.54	2693
E2-0	140.45	299.25	439.70	78	180	1.93	2694
E3-0	224.81	332.87	557.68	96	110	2.14	2695
E4-0	145.49	224.36	369.85	111	1100	1.58	2681
E5-0	123.83	208.69	332.52	167	130	2.06	2687
Profile							
R8-4	22.98	79.04	102.02	104	3300	0.94	2710
R10-4	42.55	141.16	183.71	173	1000	1.53	2706
R10-8	18.27	58.14	76.42	96	3700	0.79	2707
R10-12	7.81	29.40	37.21	89	4100	0.51	2708
E4-4	132.11	250.36	382.48	106	360	1.55	2682
E4-8	41.54	136.80	178.34	164	2000	1.35	2683
E4-12	16.93	66.18	83.11	139	1100	1.10	2684
E4-16	14.11	48.65	62.76	164	1100	1.01	2685
E4-20	7.28	38.32	45.59	94	1700	0.88	2686
E5-4	96.91	184.85	281.76	162	1100	1.49	2688
E5-8	24.84	75.83	100.67	179	2300	1.30	2689
E5-12	10.90	47.16	58.07	95	2900	1.03	2690
E5-16	10.42	35.96	46.38	58	3700	0.96	2691
E5-20	8.50	35.69	44.19	108	3700	0.99	2692

22-Aug-01

No.	Chl a, µg/g	Phaeo., µg/g	Total	Eh_{NHE}, mV	$S^{=}$, µM	Carbon vial#
Surface						
R1-0	6.11	29.48	35.58	-92	120	2727
R2-0	20.98	84.76	105.74	-67	45	2723
R3-0	20.96	54.58	75.54	-88	30	2736
R4-0	14.82	48.33	63.15	-79	16	2732
R5-0	15.91	59.72	75.63	-94	390	2718
E6-0	169.09	173.87	342.95	-88	380	2717
E7-0	31.12	117.47	148.59	-91	120	2737
E8-0	97.27	148.59	245.86	-65	73	2731
E9-0	24.76	98.02	122.78	-79	180	2734
E10-0	46.30	118.31	164.61	-95	130	2728
Profile						
R2-4	27.61	8.54	36.15	-93	1000	2729
R2-8	7.22	36.38	43.60	-108	1300	2733
R5-4	6.52	23.56	30.08	-103	1100	2719
R5-8	2.89	14.19	17.08	-100	1300	2722
E6-4	67.72	99.54	167.25	-92	210	2720
E6-8	39.05	101.45	140.50	-106	1100	2715
E6-12	19.06	67.78	86.84	-123	1000	2704
E6-16	16.65	51.46	68.12	-140	1000	2712
E6-20	17.68	71.50	89.18	-130	1100	?
E10-4	21.45	53.09	74.54	-96	200	2724
E10-8	19.56	73.04	92.60	-91	810	2721
E10-12	19.92	67.14	87.07	-105	1000	2730
E10-16	11.82	52.26	64.08	-113	1100	2725
E10-20	16.76	46.65	63.41	-93	1500	2762

19-Sept-01

No.	Chl a, µg/g	Phaeo., µg/g	Total	Eh$_{NHE}$, mV	S$^{=}$, µM	Carbon vial #
<u>Surface</u>						
R1-0	10.29	50.49	60.78	174	1100	2750
R2-0	6.17	41.48	47.64	97	2000	2756
R3-0	15.15	97.14	112.30	42	520	2751
R4-0	7.29	40.30	47.59	41	1600	2752
R10-0	3.75	24.67	28.43	40	810	2738
E5-0	38.88	186.62	225.50	27	310	2753
E6-0	21.50	117.83	139.33	44	30	2744
E7-0	36.72	150.10	186.82	109	110	2742
E8-0	42.33	177.01	219.35	44	260	2754
E9-0	31.80	109.07	140.87	30	720	2755
<u>Profile</u>						
R2-4	3.87	30.60	34.47	8	1900	2757
R2-8	3.81	25.63	29.44	6	2400	2758
R2-12	3.14	17.93	21.07	11	3600	2759
R10-4	4.19	29.18	33.37	-2	1800	2739
R10-8	6.32	45.42	51.74	-23	2500	2740
R10-12	3.72	23.69	27.41	-32	3300	2741
E6-4	30.37	72.09	102.45	-101	600	2745
E6-8	28.78	71.84	100.62	-127	1100	2746
E6-12	8.33	48.11	56.44	-128	1200	2747
E6-16	8.39	46.17	54.56	-122	1200	2748
E7-4	33.10	81.22	114.32	73	910	2743
E7-8	31.46	82.87	114.33	55	1200	2749
E7-12	26.51	93.73	120.24	7	1300	2760
E7-16	9.83	70.09	79.92	-29	1400	2761
E7-20	7.03	40.95	47.98	-12	2400	2762

Appendix 2. Sediment interfacial temperatures in degrees centigrade, as daily average X and standard error S.E., at station E from 30th March to 19th September, 2001.

	March		April		May		June		July		August		September	
Date	X	S.E	X	S.E.	X	S.E.	X	S.E.	X	S.E.	X	S.E.	X	S.E.
1			2.60	0.00	4.11	0.00	5.84	0.01	8.73	0.02	10.97	0.02	12.26	0.00
2			2.60	0.00	4.27	0.00	5.98	0.01	8.79	0.03	11.27	0.02	12.26	0.00
3			2.48	0.01	4.18	0.01	6.17	0.01	8.56	0.02	11.34	0.02	12.34	0.01
4			2.42	0.01	4.22	0.01	6.44	0.01	8.68	0.01	11.58	0.02	12.30	0.01
5			2.57	0.01	4.17	0.01	6.62	0.01	8.82	0.02	11.80	0.02	12.13	0.01
6			2.62	0.01	4.30	0.01	6.68	0.00	9.08	0.02	11.84	0.02	12.02	0.01
7			2.76	0.00	4.66	0.00	6.71	0.01	9.20	0.01	11.72	0.02	11.94	0.01
8			2.88	0.01	4.38	0.01	6.80	0.01	9.31	0.01	11.77	0.02	11.84	0.01
9			2.83	0.01	4.50	0.01	6.82	0.02	9.39	0.01	11.68	0.02	11.94	0.01
10			2.76	0.00	4.54	0.00	6.88	0.01	9.29	0.02	11.67	0.01	12.01	0.01
11			2.85	0.01	4.63	0.01	7.17	0.02	9.47	0.00	11.64	0.02	12.06	0.01
12			3.02	0.01	4.91	0.01	7.58	0.03	9.60	0.01	11.83	0.02	12.11	0.00
13			3.07	0.00	4.91	0.00	7.88	0.01	9.75	0.02	12.05	0.02	12.24	0.01
14			3.09	0.01	4.69	0.01	7.77	0.02	9.96	0.02	12.00	0.02	12.38	0.01
15			3.07	0.00	4.58	0.00	7.88	0.02	10.22	0.01	12.00	0.01	12.31	0.01
16			3.07	0.00	5.35	0.00	7.77	0.02	10.14	0.02	12.12	0.02	12.30	0.01
17			3.13	0.01	5.33	0.01	8.13	0.03	10.43	0.02	12.29	0.03	12.23	0.01
18			3.23	0.00	5.44	0.00	8.20	0.03	10.59	0.02	12.53	0.01	12.21	0.01
19			3.14	0.01	5.25	0.01	8.11	0.02	10.62	0.01	12.41	0.02	12.23	0.01
20			3.20	0.01	4.86	0.01	8.24	0.02	10.84	0.02	12.35	0.01		
21			3.35	0.01	5.02	0.01	8.17	0.02	11.17	0.02	12.35	0.01		
22			3.55	0.00	5.14	0.00	8.26	0.02	11.26	0.02	12.15	0.01		
23			3.51	0.01	5.33	0.01	8.49	0.01	10.90	0.02	12.06	0.01		
24			3.61	0.01	5.43	0.01	8.53	0.00	10.75	0.02	11.87	0.01		
25			3.61	0.01	6.00	0.01	8.47	0.01	10.65	0.02	11.89	0.01		
26			3.78	0.01	6.10	0.01	8.42	0.01	10.48	0.02	11.96	0.01		
27			3.87	0.00	6.03	0.00	8.60	0.02	10.35	0.01	11.80	0.02		
28			4.03	0.01	6.07	0.01	8.58	0.01	10.42	0.01	11.64	0.00		
29			4.09	0.01	6.08	0.01	8.61	0.01	10.49	0.01	11.73	0.01		
30	2.60	0.00	3.95	0.01	6.09	0.01	8.67	0.02	10.64	0.01	11.90	0.01		
31	2.63	0.01			5.98	0.02			10.75	0.01	12.13	0.01		

Appendix 3. Climatic data for Point Lepreau, New Brunswick (45°16'N, 66°04'W). Wind direction, as compass points it is from; wind in km/h, temperature as °C and the percentage relative humidity in the air. Entries are for the 24-h period prior to sampling.

Date DST	Wind direction	Speed, km/h	Temperature, °C	Relative humidity, %
SEPTEMBER				
2000/9/19				
Time				
12:00	200	17	16	93
13:00	190	15	15.6	93
14:00	200	19	15.6	93
15:00	180	9	15.2	96
16:00	190	15	15.2	96
17:00	220	11	15.3	97
18:00	200	9	14.8	98
19:00	190	6	14.5	99
20:00	200	4	14.6	99
21:00	210	7	14.5	99
22:00	200	6	14.6	99
23:00	200	6	14.7	99
2000/9/20 0:00	190	7	14.5	99
1:00	200	9	14.6	99
2:00	210	7	14.4	99
3:00	200	7	14.2	99
4:00	190	9	14.2	99
5:00	310	4	14	99
6:00	20	7	14.3	99
7:00	60	9	15.1	99
8:00	60	11	15.1	100
9:00	60	13	16	100
10:00	50	17	16.3	100
11:00	50	13	16.8	97
12:00	70	13	17.8	94
OCTOBER				
2000/10/30				
9:00	30	15	6	90
10:00	40	17	7.3	84
11:00	30	15	8.1	82
12:00	30	13	8.5	88
13:00	20	17	8.4	93
14:00	30	13	8.8	95
15:00	30	30	9.6	93
16:00	30	28	9.8	92
17:00	40	28	9.6	92
18:00	40	33	9.7	91

Date DST	Wind direction	Speed, km/h	Temperature, °C	Relative humidity, %
19:00	40	32	9.4	91
20:00	40	26	8.9	92
21:00	40	28	8.3	92
22:00	30	22	7.7	93
23:00	40	24	7.6	92
2000/10/31 0:00	30	26	7.3	90
1:00	30	24	7.1	88
2:00	30	28	6.9	88
3:00	30	24	6.5	89
4:00	30	22	6.3	90
5:00	40	24	6.5	90
6:00	40	30	6.5	92
7:00	40	20	7	91
8:00	50	24	7.1	90
NOVEMBER				
2000/11/29				
9:00	350	6	2.1	95
10:00	320	4	2.6	95
11:00	330	2	3.5	93
12:00	290	9	4	91
13:00	290	6	4.9	90
14:00	300	7	5.1	88
15:00	290	9	5	84
16:00	290	7	4.7	87
17:00	320	4	4.2	89
18:00	300	7	4.4	89
19:00	290	7	4.5	84
20:00	290	6	4.4	85
21:00	300	6	3.1	91
22:00	290	6	4.3	91
23:00	270	7	4.3	91
0:00	300	7	3.7	92
2000/11/30 1:00	310	6	3.1	93
2:00	310	4	2.7	93
3:00	310	6	2.7	93
4:00	310	6	2.3	93
5:00	330	7	1.9	93
6:00	320	6	0.1	93
7:00	330	9	0.9	95
8:00	350	11	1.3	93
JANUARY				
2001/01/03				
12:00	330	17	-6.9	54
13:00	10	9	-6.5	55
14:00	320	15	-6.5	55

Date DST	Wind direction	Speed, km/h	Temperature, °C	Relative humidity, %
15:00	340	9	-6	57
16:00	320	7	-6.8	59
17:00	350	2	-8.6	69
18:00	360	6	-9.8	76
19:00	10	9	-9.8	77
20:00	350	9	-9.7	77
21:00	30	7	-10.7	79
22:00	350	7	-10.4	79
23:00	10	9	-11.5	83
2001/01/04 0:00	360	11	-10	75
1:00	10	11	-10	75
2:00	20	9	-10	75
3:00	360	7	-9.8	75
4:00	360	7	-10.1	75
5:00	30	9	-9.2	74
6:00	20	9	-8.6	78
7:00	20	11	-7.2	87
8:00	160	30	-1.1	90
9:00	150	33	-0.4	95
10:00	150	41	0	96
11:00	150	44	0.7	97
12:00	240	13	0.2	91
FEBRUARY				
2001/02/27				
9:00	320	26	-6	64
10:00	320	22	-5	63
11:00	320	11	-3.3	60
12:00	300	15	-1.2	53
13:00	290	15	0	52
14:00	300	17	0.4	47
15:00	290	19	1	43
16:00	300	20	0.9	42
17:00	290	17	0.8	43
18:00	320	20	-0.8	44
19:00	310	20	-1.8	45
20:00	310	17	-2.8	47
21:00	300	15	-4	53
22:00	310	15	-4.9	53
23:00	310	24	-5.8	53
2001/02/28 0:00	300	15	-6.8	56
1:00	300	17	-7.6	58
2:00	310	13	-8.7	63
3:00	320	15	-9.6	65
4:00	330	9	-10.5	66
5:00	310	9	-10.9	67

Date DST	Wind direction	Speed, km/h	Temperature, °C	Relative humidity, %
6:00	320	9	-11.6	67
7:00	320	20	-12.3	60
8:00	310	22	-12.4	58
MARCH				
2001/03/29				
10:00	250	9	4.7	50
11:00	220	9	3.8	64
12:00	220	15	4.4	66
13:00	220	15	5.2	60
14:00	210	15	5.2	54
15:00	190	20	4.2	65
16:00	210	15	4.2	59
17:00	220	11	4	61
18:00	210	15	2.9	66
19:00	220	9	2.7	70
20:00	220	9	2.4	75
21:00	220	11	2.4	81
22:00	190	7	2.2	83
23:00	210	6	2.4	83
2001/03/30 0:00	210	7	2.5	82
1:00	250	6	2.4	84
2:00	240	2	1.2	85
3:00	260	4	-0.6	93
4:00	290	2	-1.9	94
5:00	310	4	-1.8	94
6:00	320	4	-1.9	95
7:00	0	0	-1.6	94
8:00	0	0	2.9	82
9:00	100	7	2.7	82
APRIL				
2001/04/29				
12:00	300	19	9.4	23
13:00	320	19	10.4	19
14:00	300	17	10.7	19
15:00	330	19	11.1	17
16:00	330	19	11.5	17
17:00	330	19	11.7	17
18:00	330	19	11.2	19
19:00	330	7	9.9	23
20:00	340	6	5.6	35
21:00	320	4	2.1	50
22:00	320	7	1.7	48
23:00	320	7	1	52
2001/04/30 0:00	320	9	0.9	53
1:00	320	9	0.7	54

Date DST	Wind direction	Speed, km/h	Temperature, °C	Relative humidity, %
2:00	0	0	-0.7	68
3:00	300	7	-0.2	62
4:00	340	9	1.2	57
5:00	310	9	2.6	56
6:00	310	7	3.7	45
7:00	00	0	4.4	58
8:00	130	2	5	60
9:00	190	7	5.8	65
10:00	170	4	8.4	51
11:00	180	11	8.9	67
MAY				
2001/05/15				
13:00	60	20	9.3	90
14:00	70	20	9.4	90
15:00	60	17	9.7	91
16:00	60	19	10.4	86
17:00	60	19	9.6	86
18:00	70	19	9.7	85
19:00	60	19	9.7	89
20:00	50	15	9.7	90
21:00	40	19	9.7	90
22:00	30	13	9.6	93
23:00	50	19	9.7	93
2001/05/16 0:00	40	11	9.5	92
1:00	40	15	9.1	88
2:00	30	19	9.1	84
3:00	20	15	8.7	87
4:00	10	19	8.2	89
5:00	30	15	8.2	87
6:00	30	17	8.3	86
7:00	20	17	8.6	85
8:00	30	17	9.2	83
9:00	30	22	10.1	78
10:00	30	26	11.2	73
11:00	40	24	11.7	69
12:00	30	17	11.5	68
JUNE				
2001/06/26				
11:00	140	4	21.4	76
12:00	100	4	22.3	73
13:00	150	6	20	78
14:00	100	7	19.1	81
15:00	100	7	18.7	82
16:00	110	9	18.5	77
17:00	130	4	20.1	76
18:00	110	4	18.1	83

Date DST	Wind direction	Speed, km/h	Temperature, °C	Relative humidity, %
19:00	0	0	17.1	86
20:00	0	0	16.3	91
21:00	280	7	16.5	87
22:00	280	9	16.5	86
23:00	260	4	16.9	86
2001/06/27 0:00	280	6	15.5	88
1:00	280	4	14.4	90
2:00	280	7	12.5	92
3:00	290	6	12.3	93
4:00	290	6	11.9	92
5:00	310	11	11.8	93
6:00	270	11	14	88
7:00	270	11	16.4	84
8:00	260	11	17.8	78
9:00	240	11	20.9	72
10:00	230	11	21.7	67
JULY				
2001/07/25				
11:00	240	9	24.4	59
12:00	270	9	27.2	48
13:00	230	7	24.1	58
14:00	190	4	21.3	64
15:00	220	9	25.9	48
16:00	280	11	26.2	47
17:00	250	7	21.9	59
18:00	280	2	20.6	65
19:00	250	4	20.3	68
20:00	280	4	20.3	66
21:00	310	9	18	76
22:00	320	7	17.9	80
23:00	280	7	16.4	86
0:00	260	7	15.9	90
2001/07/26 0:00	290	7	15	89
1:00				
2:00	290	9	15.7	87
3:00	300	6	15.1	90
4:00	300	7	15.5	88
5:00	320	11	15.9	74
6:00	330	11	16	69
7:00	320	9	16.1	68
8:00	330	9	16.7	63
9:00	340	9	17.7	56
10:00	320	13	17.3	57

Date DST	Wind direction	Speed, km/h	Temperature, °C	Relative humidity, %
AUGUST				
2001/08/21				
9:00	50	15	16	97
10:00	50	15	16.2	97
11:00	60	6	16.4	97
12:00	60	11	16.2	96
13:00	70	9	16.3	97
14:00	90	6	16.6	97
15:00	90	9	16	97
16:00	90	4	15.9	97
17:00	90	7	15.8	97
18:00	80	6	15.4	97
19:00	110	6	15.4	98
20:00	0	0	14.7	98
21:00	0	0	14.8	97
22:00	120	2	14.4	98
23:00	120	2	14.2	99
2001/08/22 0:00	140	2	13.7	98
1:00	300	2	13.8	98
2:00	300	4	14.7	98
3:00	90	2	13.6	99
4:00	180	2	13.8	99
5:00	260	4	14.1	99
6:00	310	7	15	98
7:00	0	0	15.4	99
8:00	0	0	14.5	99
SEPTEMBER	0			
2001/09/18	0			
8:00	310	2	14.8	81
9:00	140	2	14.5	84
10:00	270	4	21.1	59
11:00	190	9	16.2	77
12:00	180	7	19.1	64
13:00	180	9	17.1	74
14:00	190	7	18.2	69
15:00	270	7	21.8	54
16:00	140	6	19.9	64
17:00	10	11	23.8	43
18:00	350	7	22.2	48
19:00	340	9	20.2	55
20:00	320	9	19.5	58
21:00	360	6	17.3	54
22:00	330	9	15.7	59
23:00	10	6	14.6	66
2001/09/19 0:00	320	7	13.4	75

Date DST	Wind direction	Speed, km/h	Temperature, °C	Relative humidity, %
1:00	330	6	12.6	80
2:00	360	7	12.8	79
3:00	350	7	11.9	77
4:00	350	7	10.6	76
5:00	320	9	9.8	74
6:00	340	7	8	80
7:00	350	6	9.5	75

Appendix 4. Monthly SPI results as the benthic habitat quality (BHQ), RPD depths and organic enrichment (OE) indices at stations R and E in the period 30 November 2000 to 19 September 2001.

STATION R

Date	Station	Photo. #	RPD depth, cm	BHQ	OE index	Core depth, cm
30-Nov-00	R5	77	6.8	5	II	14.4
	R3	78				13.7
4-Jan-00	R1	98	6.8	7	II	14.4
	R3	101	7.8	5	II	14.7
28-Feb-01	R1	122	7.0	7	II	17.3
	R5	125	9.7	7	II	17.2
30-Mar-01	R5	139	3.2	5	II	15.8
	R6	143	4.8	6	II	12.7
30 Apr-01	R1	147	8.3	7	II	14.7
	R2	151	2.1	8	II	16.7
16-May-01	R6	152	4.4	8	II	13.8
	R5	156	5.7	10	II	13.1
27-Jun-01	R2	168	7.6			15.2
	R1	173	6.3	9	II	12.8
19-Jul-01	R10	208	6.5	7	II	17.4
	R8	211	2.9	6	II	11
22-Aug-01	R2	270	6.9	8	II	13.3
	R5	273	5.5	8	II	15.6
19-Sept-01	R10	313	2.0	6	II	15.8
	R2	314	4.7	8	II	15.8

STATION E

	Station	Photo. #	RPD depth, cm	BHQ	OE index	Core depth, cm
30-Nov-00	E1	83	4.6	5	II	22.7
	E3	86	2.7	6	II	23.2
4-Jan-00	E6	103				24.6
	E5	105				24.5
28-Feb-01	E4	127	4.3	6	II	23.5
	E5	128				
30-Mar-01	E4	132	4.7	4	II	26.3
	E1	137	5.6	6	II	24.4
30-Apr-01	E1	144				
	E4	146				
16-May-01	E7	157	6.9	10	II	23.8
	E10	160	4.0	6	II	23.2
27-Jun-01	E9	175	6.6	10	II	25.6
	E7	176	5.6	7	II	25.2
19-Jul-01	E4	203	7.2	6	II	27.8
	E5	205	11.2	7	II	28.6
22-Aug-01	E6	279	7.8	9	II	23.9
	E10	276	7.2	8	II	23.2
19-Sept-01	E6	312	6.5	9	II	22.1
	E7	311				22.6

Appendix 5. Monthly macrofaunal community data at stations R and E in the period 31October 2000 to 19 September 2001. Diversities and biomasses are per 0.0789 m^2. To convert to per m^2 multiply by 12.67. LKE = station E followed by sampling month. LKR = station R followed by sampling month.

Binomen	LKEOCT	LKENOV	LKEJAN	LKEFEB	LKEMAR	LKEAPR	LKEMAY	LKEJUN	LKEJUL	LKEAUG	LKESEPT	Total
Foviella affinis	3	0	1	0	0	0	0	0	0	0	0	4
Nemertea (sp.2)	0	0	0	0	0	0	0	2	2	1	2	7
Cerebratulus lacteus	2	2	1	1	3	1	5	2	2	3	3	25
Nematoda	66	7	54	16	26	7	16	5	0	36	125	358
Harmothoe imbricata	0	0	0	0	0	0	0	1	2	3	1	7
Hartmania moorei	0	0	0	0	0	0	0	0	0	2	0	2
Pholoe minuta	0	0	0	0	0	1	0	0	0	0	0	1
Pholoe tecta	0	0	0	0	1	2	1	1	0	6	0	11
Eteone longa	1	1	1	5	3	0	0	1	0	1	6	19
Phyllodoce mucosa	0	3	4	9	11	1	3	2	0	0	2	35
Aglaophamus neotenus	206	61	97	119	87	40	22	13	11	51	91	798
Nephtys incisa	8	1	1	1	1	1	1	0	1	0	0	15
Ophelina acuminata	0	0	0	0	0	0	0	0	1	2	0	3
Capitella capitata	0	0	0	2	0	2	0	0	1	0	2	7
Mediomastus ambiseta	1	2	3	1	2	0	4	6	3	4	2	28
Rhodine gracilior	0	0	0	0	0	0	0	0	0	0	2	2
Sternaspis scutata	0	0	0	0	0	0	0	0	0	1	0	1
Aricidea sp.	0	1	0	1	0	0	1	1	0	0	2	6
Aricidea quadrilobata	1	0	0	0	0	0	0	1	0	1	0	3
Levensinea gracilis	1	4	2	18	11	3	8	21	8	11	23	110
Polydora sp.	0	0	0	0	0	0	2	0	0	0	0	2
Prionospio steenstrupi	3	2	7	11	4	7	9	5	0	6	13	67
Spio sp.	1	0	0	0	0	0	0	0	0	0	0	1
Lumbrineris tenuis	0	0	1	0	0	0	0	0	0	0	0	1
Lumbrineris impatiens	1	1	0	0	1	2	1	0	0	1	0	7
Ninoe nigripes	1	10	8	10	0	5	8	6	1	1	1	51
Leitoscoloplos robustus	0	0	0	1	0	1	0	0	0	0	0	2
Tharyx sp.	1	0	0	0	0	1	0	1	0	0	4	7
Chaetozone setosa	4	1	5	0	0	0	0	1	0	0	3	14
Cossura longocirrata	12	2	31	7	48	8	23	11	8	27	24	201
Cistena granulata	0	0	0	0	0	0	0	0	0	1	0	1
Asabellides oculata	0	0	0	0	0	0	0	0	0	2	0	2
Melinna elizabethae	0	1	0	0	0	0	0	0	0	0	0	1
Ampharete lindstroemi	2	0	0	0	0	0	0	0	0	0	4	6
Ampharete acutifrons	1	0	0	0	0	0	0	1	0	0	0	2

Binomen	LKEOCT	LKENOV	LKEJAN	LKEFEB	LKEMAR	LKEAPR	LKEMAY	LKEJUN	LKEJUL	LKEAUG	LKESEPT	Total
Anobothrus gracilis	1	1	0	1	0	1	0	2	0	1	2	9
Polycirrus medusa?	0	0	0	0	0	0	0	7	1	16	0	24
Terebellides stroemi	0	0	0	0	0	0	0	1	0	7	12	20
Apistobranchus typicus	0	0	2	0	0	0	0	0	0	0	0	2
Pherusa affinis	0	0	0	0	0	0	0	0	0	0	1	1
Brada villosa	0	0	0	0	0	0	0	2	1	0	0	3
Euchone incolor	1	1	3	5	2	2	2	10	0	1	8	35
Oligochaeta	7	8	32	7	30	0	9	7	2	25	30	157
Ilyanassa trivittata	0	0	0	0	0	0	0	0	0	1	0	1
Nucula proxima	2	5	2	3	0	1	4	3	4	4	0	28
Nucula delphinodonta	0	0	0	0	0	0	1	0	0	0	0	1
Yoldia sapotilla	0	1	0	0	1	0	1	1	2	2	0	8
Mytilus edulis	7	3	2	0	0	1	0	1	1	1	4	20
Astare undata	0	0	0	0	0	0	1	1	0	0	0	2
Cerastoderma pinnulatum	2	1	0	0	2	1	1	3	0	0	0	10
Solenidae	1	0	0	0	0	0	0	0	0	0	0	1
Ensis directus	0	0	0	0	0	0	0	0	0	2	2	4
Mya arenaria	0	0	0	1	2	1	2	1	0	0	0	7
Thyasira flexuosa	0	0	0	1	0	0	0	0	0	0	0	1
Balanus sp.	0	0	0	0	0	0	0	2	0	0	0	2
Diastylis quadrispinosa	0	0	0	0	0	0	0	12	4	0	0	16
Diastylis sculpta	0	1	0	2	1	0	4	3	0	0	0	11
Ampelisca abdita	1	0	1	1	2	0	0	1	1	0	0	7
Ischyrocerus anguipes	0	0	0	0	0	0	0	1	0	0	0	1
Monoculodes edwardsi	0	0	0	0	0	0	0	0	1	0	0	1
Monoculodes tesselatus	0	0	0	0	0	0	1	0	0	2	0	3
Dyopedos monacanthus	0	0	1	0	0	0	0	1	0	0	0	2
Caprellidae	0	0	0	0	1	0	0	0	0	0	0	1
Caprella linearis	0	0	0	0	0	0	0	0	0	1	0	1
Crangon septemspinosa	2	0	0	0	0	0	0	0	0	0	0	2
Sipuncula (juv.)	0	0	0	0	0	0	0	0	2	0	0	2
Priapulus caudatus	0	0	0	0	0	0	0	0	0	0	1	1
Molpadia oolitica	0	0	0	0	0	0	1	0	0	0	0	1
Biomass (gm)	1.564	0.585	0.346	0.466	1.618	0.201	2.8	1.323	1.711	0.706	0.784	2192

Binomen	LKROCT	LKRNOV	LKRJAN	LKRFEB	LKRMAR	LKRAPR	LKRMAY	LKRJUN	LKRJUL	LKRAUG	LKRSEPT	Total
Edwardsiidae	0	0	0	0	0	2	0	0	0	0	0	2
Foviella affinis	0	0	1	0	0	0	0	0	0	0	0	1
Nemertea (juveniles)	0	0	1	0	0	0	0	0	0	0	1	2
Cerebratulus lacteus	1	0	4	2	4	2	2	2	2	1	0	20
Nematoda	24	85	29	178	250	427	32	49	11	66	313	1464
Harmothoe extenuata	0	0	0	0	0	0	0	0	1	0	0	1
Harmothoe imbricata	0	0	0	0	0	0	0	1	0	3	4	8
Hartmania moorei	0	0	0	0	0	0	0	0	0	0	1	1
Pholoe minuta	8	1	7	17	12	10	2	4	0	5	0	66
Pholoe tecta	0	4	9	7	4	2	0	1	2	1	1	31
Eteone longa	1	0	4	9	1	1	3	2	0	5	0	26
Paranaitis speciosa	0	0	0	1	0	0	0	0	0	1	0	2
Phyllodoce mucosa	2	12	5	5	6	1	0	2	0	1	1	35
Sphaerosyllis sp.	1	1	0	0	0	0	0	0	0	0	0	2
Nereis grayi	0	0	0	0	0	0	0	1	0	1	0	2
Nephtys incisa	13	11	4	8	9	6	6	12	7	7	9	92
Glycera capitata	0	0	0	0	0	1	0	0	0	0	0	1
Clavodorum sp.	0	0	0	1	0	0	0	0	0	0	0	1
Scalibregma inflatum	0	0	0	1	0	0	0	0	0	0	0	1
Ophelina acuminata	0	0	0	0	0	1	0	1	0	0	1	3
Mediomastus ambiseta	1	2	5	1	3	22	2	3	0	5	1	45
Praxillella praetermissa	3	0	1	1	3	1	1	1	0	0	0	11
Rhodine gracilior	1	5	4	2	1	7	2	4	2	5	0	33
Sternaspis scutata	5	4	12	6	7	14	2	2	3	2	4	61
Aricidea sp.	1	5	11	23	29	36	5	3	3	14	12	142
Aricidea quadrilobata	0	1	0	1	0	0	0	0	0	0	1	3
Levensinea gracilis	17	12	19	16	35	34	4	12	0	14	18	181
Prionospio steenstrupi	0	0	2	2	2	6	0	0	0	0	1	13
Lumbrineris impatiens	6	8	8	6	15	7	0	3	5	11	7	76
Ninoe nigripes	14	28	24	28	39	66	19	49	19	30	35	351
Tharyx sp.	2	3	6	3	5	3	2	3	1	3	4	35
Chaetozone sp.	0	0	0	0	1	0	0	0	0	0	1	2
Chaetozone setosa	0	0	0	0	1	1	2	1	1	2	2	10
Cossura longocirrata	0	2	1	2	7	18	0	3	1	16	17	67
Galathowenia oculata	0	6	1	2	0	0	0	0	0	0	0	9
Melinna elizabethae	1	0	1	0	0	0	0	0	0	1	2	5
Ampharete lindstroemi	7	2	1	0	0	2	1	1	1	35	9	59

Binomen	LKROCT	LKRNOV	LKRJAN	LKRFEB	LKRMAR	LKRAPR	LKRMAY	LKRJUN	LKRJUL	LKRAUG	LKRSEPT	Total
Anobothrus gracilis	18	16	8	26	12	23	1	4	6	27	16	157
Polycirrus medusa?	0	0	0	0	0	0	0	0	0	6	0	6
Terebellides stroemi	0	0	1	3	8	18	4	13	13	221	84	365
Trichobranchus glacialis	0	0	0	1	0	1	0	1	0	1	0	4
Apistobranchus typicus	3	20	70	49	7	13	6	8	7	8	5	196
Pherusa affinis	0	0	0	0	0	0	0	0	0	0	3	3
Brada villosa	2	0	0	0	0	6	0	0	0	0	0	8
Diplocirrus hirsutus	1	1	0	0	0	0	0	0	0	1	2	5
Euchone incolor	0	2	3	3	4	2	2	0	0	15	2	33
Oligochaeta	0	1	4	2	2	9	0	0	0	13	10	41
Frigidoalvania pelagica	1	3	2	2	11	10	6	3	0	5	1	44
Lunatia heros	1	0	1	0	1	0	0	0	0	0	0	3
Astyris zonalis	0	8	0	1	3	2	0	0	0	1	0	15
Nassarius trivittatus	0	0	2	0	1	0	0	0	2	0	0	5
Diaphana minuta	0	2	0	0	0	0	0	0	0	0	0	2
Cylichna alba	0	3	2	3	3	2	0	1	1	0	0	15
Retusa obtusa	0	1	1	0	1	0	0	3	2	12	1	21
Nucula proxima	3	16	25	18	18	28	8	5	14	24	7	166
Nucula delphinodonta	1	7	2	9	15	1	2	6	2	4	7	56
Nucula tenuis	0	0	1	0	1	1	2	0	1	0	0	6
Nuculana tenuisulcata	0	0	0	1	0	0	0	0	0	0	0	1
Yoldia sapotilla	25	9	12	17	28	22	9	12	17	11	7	169
Mytilus edulis	10	5	0	2	0	3	0	0	2	0	0	22
Musculus niger	0	0	0	0	0	0	0	0	0	1	0	1
Crenella glandula	3	7	1	6	0	1	1	0	3	0	1	23
Astare undata	7	16	7	7	7	6	4	9	12	4	4	83
Cyclocardia borealis	2	11	0	1	0	0	1	0	0	0	0	15
Arctica islandica	0	0	1	0	0	1	0	0	0	0	0	2
Cerastoderma pinnulatum	18	36	9	15	3	11	0	1	1	4	7	105
Pitar morrhuana	1	0	1	0	0	0	0	0	0	0	0	2
Ensis directus	0	0	0	0	0	0	0	0	0	1	0	1
Mya arenaria	12	11	10	21	1	25	3	5	2	0	5	95
Mya truncata	0	0	1	0	1	0	0	0	0	0	0	2
Lyonsia hyalina	4	7	1	1	1	0	0	1	0	0	0	15
Periploma fragile	8	10	8	8	6	6	2	2	4	7	2	63
Thyasira flexuosa	12	19	6	19	7	10	0	1	3	1	5	83
Crystallophrisson nitidulum	1	0	0	0	0	0	0	0	0	1	0	2
Ostracoda	0	0	0	0	0	0	0	1	0	0	0	1

Binomen	LKROCT	LKRNOV	LKRJAN	LKRFEB	LKRMAR	LKRAPR	LKRMAY	LKRJUN	LKRJUL	LKRAUG	LKRSEPT	Total
Pseudoleptocuma minor	0	0	0	2	0	2	0	2	4	3	0	13
Diastylis quadrispinosa	1	0	0	0	0	0	0	0	6	0	1	8
Diastylis sculpta	1	2	0	0	0	0	0	2	0	0	1	6
Edotea montosa	0	0	0	2	0	0	0	0	0	3	0	5
Corophium bonelli	0	0	0	0	0	0	0	0	0	1	0	1
Corophium crassicorne	0	0	0	0	0	0	0	1	1	0	0	2
Erichthonius rubricornis		0	1	0	0	0	0	0	0	0	0	1
Photis macrocoxa	0	0	0	0	0	1	0	0	0	0	0	1
Ischyrocerus anguipes	0	0	0	0	0	0	0	4	0	0	0	4
Monoculodes tesselatus	0	0	0	0	0	1	0	0	0	1	1	3
Westwoodilla sp.	0	3	1	0	0	0	0	0	0	0	0	4
Harpinia propinqua	0	0	0	1	1	0	0	0	0	0	0	2
Metopella angusta	0	0	0	0	0	0	0	1	0	0	0	1
Dyopedos monacanthus	0	0	1	0	0	0	0	0	0	0	0	1
Caprellidae	0	0	1	0	2	0	0	0	0	0	0	3
Maera danae	0	0	0	0	0	2	0	0	0	0	0	2
Crangon septemspinosa	1	0	0	0	1	1	0	0	0	0	0	3
Phascolion strombi	0	0	0	0	0	0	0	0	0	1	0	1
Biomass (gm)	15.14	4.771	4.318	3.283	11.7	10.015	1.801	7.155	3.99	2.667	2.498	4761