Environmental Studies of the Halfway River System Nova Scotia

Final Report
to
Minas Basin Pulp and Power
Company Limited

Prepared by
Graham R. Daborn, Michael Brylinsky
and Ruth Newell

September 2001

Acadia Centre for Estuarine Research
Publication No. 62

ACADIA ESTUARINE CENTRE FOR RESEARCH

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Table of Contents

Environmental Studies of the Halfway River System.

Executive Summary

3.0/3.1 Between May and August 2001 the Acadia Centre for Estuarine Research conducted extensive field investigations of the two impoundments and the lotic waters of the Halfway River system. Field studies for water quality, fish, macroinvertebrates and fish habitat were organised around two campaigns, one in late May and the other in July, and supplemented by extensive field observations at other times. A separate campaign in August characterized the aquatic flora at a time when many species were flowering or in fruit. A third campaign is scheduled for October 2001.

3.2. Waters of the Halfway River system are coloured, and very low in most dissolved constituents, including ions responsible for alkalinity, conductivity, and hardness. Nonetheless, pH values in the impoundments ranged from a moderate value (<6.7) in spring to > 7 in July; similar change and values occurred in stream waters, except those that issue from local bogs, which had pH values <6. Nitrogen and phosphorus concentrations were extremely low or undetectable. In early summer, the Upper Impoundment showed signs of early stratification, which became very strong during summer, with a thermocline at 2-4 m; there was complete depletion of oxygen in bottom waters in July. In the Lower Impoundment, stratification was less intense and less permanent, and although water temperatures were higher in summer, complete anoxia was not observed.

3.3. Surveys of fish populations were conducted in both impoundments and at selected sites on the Halfway River and its tributaries. Eight species were recorded from the impoundments. White suckers and eels occurred in both impoundments, brook trout only in the Upper Impoundment, and other species only occurred either in one or other impoundment. Although brook trout were quite numerous in the Upper Impoundment in spring, neither reservoir had suitable temperature or oxygen conditions for salmonids in

summer. The mercury content of brook trout ranged from 0.04 to 0.18 mg/kg, which is about average for Nova Scotia waters. Trout appeared to be in good condition.

Eight species were also captured in streams by electrofishing. Brook trout were the most abundant species in upper regions of the Halfway River system, particularly in Gold Brook, and white sucker or creek chub in lower reaches. Estimates of fish density were low to moderate. Semiquantitative samples of benthic invertebrates support the assessment that feeding conditions in streams are fair to good for fish, and the biodiversity of invertebrates was typical of a clean water fauna.

3.4. Littoral vegetation in the Lower Impoundment and much of the Upper impoundment is limited by the steep shoreline, but an extensive shore flora occurs in the western (inner) portion of the Upper Impoundment. Plants are a mix of native and non-native species, none of which are rare or threatened.

3.5. Extensive investigations of fish habitat indicated that conditions for fish growth were fair to good through most of the upper portion of the system, but few sites suitable for spawning were found. Most of the tributaries are intermittent, having no visible surface flow for considerable distances in late summer. Very high water temperatures and low water levels in summer limit the capacity of the system to support fish such as salmonids.

3.6 Macroinvertebrate populations of streams are indicative of clean water, and indicate that many parts of the Halfway River system provide suitable habitat for growing of fish. Estimates of abundance indicate low to moderate invertebrate densities, although the coarse substrates limit quantitative sampling. Analysis of the composition is continuing.

3.7. No rare or endangered species have been newly encountered during the study. Previous records have indicated a few rare species of plants (particularly *Carex sp.*) in the vicinity of Davidson Lake. No rare or endangered species were encountered in areas that are influenced by management of water levels in the impoundments. Records for amphibians and reptiles have been contributed to the Nova Scotia Herpetofaunal Atlas.

3.8. No record appears to exist of archaeological resources in the watershed. A proposed strategy for management of archaeological resources, should they be discovered in the Halfway River system, has been developed.

This study constitutes the first extensive study of the Halfway River system. The conclusion is that it provides moderately good rearing habitat for several species of fish in the streams and impoundments, but that productivity is very limited because of physical and chemical characteristics. The streams exhibit highly variable flows, and most tributaries are intermittent, drying up at the surface for extended periods during the summer months.

List of Figures

List of Tables

List of Appendices

ACADIA ESTUARINE CENTRE FOR RESEARCH

Environmental Studies of the Halfway River System, Nova Scotia

Final Report

25 September 2001

1. 0 Introduction.

During May through August 2001 the Acadia Centre for Estuarine Research (ACER) conducted environmental studies of the Halfway River system. The work was carried out in response to Terms of Reference dated 15 February 2001 provided by the Nova Scotia Department of Environment and Labour for Renewal of Water Licenses for the Halfway River system.

Environmental surveys of the Halfway River system were primarily organised around three field campaigns scheduled for late May, July and October-November 2001, respectively. The first campaign was conducted between 22 May and 1 June; the second field campaign took place between 16 and 23 July. Field measurements, observations and collections were also made on many other days to ensure comprehensiveness of the studies. In late August an additional survey was conducted to assess water flow and fish habitat conditions during the usual low water season. The third field campaign is scheduled for late October 2001.

All major objectives in meeting the Terms of Reference were achieved, with the exception of the fall series of studies, which will be completed in October. This report is organised with sections that correspond to the Terms of Reference. These sections

parallel those in a companion report dealing with the St. Croix River system. A Supplementary Report, containing data from the October field campaign will be submitted in November 2001.

1.1 Personnel.

The study was coordinated by Dr. Graham R. Daborn, Director of the Acadia Centre for Estuarine Research. The research team was composed of the following personnel:

Dr. Graham R. Daborn – Director, ACER, Acadia University
Dr. Michael Brylinsky –Honorary Research Associate, ACER

Ms. Ruth Newell, M.Sc. – E.C. Smith Herbarium, Acadia University
Mr. Michael Parker (B.Sc. Biol) – President, East Coast Aquatics

Ms. Dawn MacNeill (B.Sc.H. Environmental Science. 2001)
Ms. Kerri Seward (B.Sc. Environmental Science. 2001)
Ms. Melanie Barker (B.Sc. H. Environmental Science. 2001)
Mr. Steven Sandford (B.Sc. Environmental Science. 2001)
Ms. Susan Snyder (B.Sc.H. Environmental Science – in progress)
Mr. Leon deVreede (B.Sc. Environmental Science – in progress)
Ms. Marla MacAulay (B.Sc Biology – in progress).

Additional expertise and assistance was provided by the following:

Dr. Trefor Reynoldson , National Water Research Institute and ACER
Dr. Ian Spooner – Associate Professor of Geology, Acadia University
Mr. Fred Scott (M.Sc.) – Acadia Museum
Dr. David Christianson – Nova Scotia Museum

Dr. John Gilhen – Nova Scotia Museum

Dr. Alex Wilson – Nova Scotia Museum

Mr. Stephen Powell—Nova Scotia Museum

Mr. Peter Amiro—Department of Fisheries and Oceans

Mr. Douglas Parker – Bridgetown

3.1 Environmental Studies of the Halfway River System

3.1.1. Field Operations.

Field work on the Halfway River was conducted from Acadia University. Access to the Front (Lower) Impoundment was obtained courtesy of Mr. John Tracey.

Field activities were planned following examination of aerial photographs and orthophotographs of the region, and following consultation with Minas Basin Pulp and Power personnel, especially Mr. Terry Gerhardt, Mr. Bruce MacDonald, and Mr. Ken Moore.

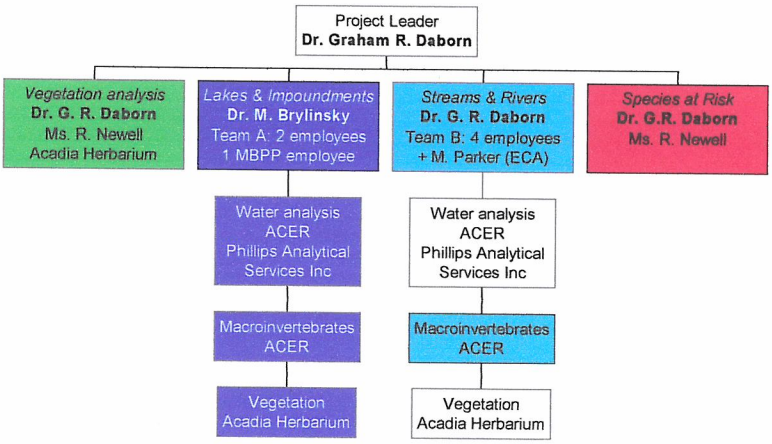
Field investigations were organized into the following activities, corresponding to sections of the Terms of Reference:

Water Quality (3.2)
Fish Surveys (3.3)
Shoreline and Littoral Zone Vegetation (3.4)
Fish Habitat (3.5)
Macroinvertebrates (3.6)
Species at Risk (3.7)

Two separate teams were constructed, one dealing primarily with stream studies, and the other with impoundments. Although in some respects the results involve overlapping information, this Report presents information on lentic (i.e. impoundments) and lotic (flowing waters) habitats separately under each of the above headings.

Dr. Michael Brylinsky supervised the work on the impoundments. Dr. Graham Daborn supervised the stream work, which was coordinated by Ms. Dawn McNeil. Mr. Michael Parker conducted the electrofishing surveys, and provided identification of fish captured. Data processing and analysis of invertebrates were a team effort.

Organisation of the study is as shown in Figure 3.1:



3.1.2. Laboratory Operations

Water samples for complete analysis were collected and sent to Phillip Analytical Services of Bedford, N.S. Analyses of other water and invertebrate samples were conducted at the Acadia Centre for Estuarine Research (ACER). Fish tissues for mercury analysis were prepared at ACER before being sent to Phillips Analytical Services for analysis.

3.2 Water Quality of the Halfway River System

3.2.1. Introduction

During field campaigns in spring and summer, direct *in situ* measurements of important water quality parameters were made at stream and impoundment sites. In addition, water samples were taken for analysis of major chemical constituents of both lotic and lentic waters. The objective was to provide an assessment of the water quality in the Halfway River system, and to provide a basis for interpreting results of faunal studies.

3.2.2 Methods

A. Impoundments

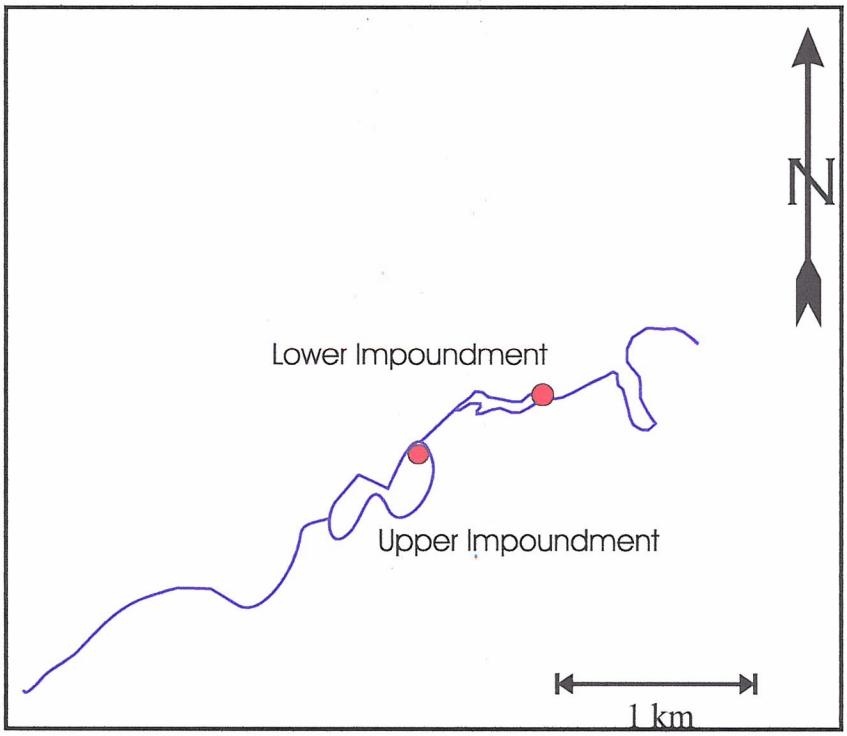
Field Procedures.

Water samples and depth profiles were taken at a single station, located at the greatest water depth, in each impoundment (Figure 3. 2.1). A Magellan 315 GPS was used to determine the UTM coordinates of each station. Water temperature and conductivity depth profiles were measured with a Yellow Springs Instrument 6920 Data Sonde. Surface water samples for water chemistry, suspended particulate matter (SPM) and phytoplankton pigment analyses were collected at depths of 0.5 or 1 m. Bottom water samples for the same parameters were collected at a depth of 1 m above the bottom. Water samples for dissolved oxygen analyses were collected in BOD bottles from the same surface and bottom depths as for water chemistry. Dissolved oxygen profiles were also collected using the Yellow Springs Instrument 6920 Data Sonde.

Laboratory Procedures.

Total SPM was measured by filtering up to 1 litre of water through pre-weighed Watman GF/C glass fibre filters and re-weighing the filters after oven drying at 70 °C to a constant dry weight.

Figure 3.2.1. Location of water quality sampling stations in Halfway Impoundments.



Samples for phytoplankton chlorophyll *a* and pheophytin measurements were collected in 1 litre polyethylene containers and stored refrigerated until analysis (usually within 12 h of collection). The samples were filtered through Watman GF/C filters under gentle vacuum (<20 mm Hg) and chlorophyll extracted from the filters by adding 18 ml of 95 percent acetone and storing the samples refrigerated in the dark for 24 h. After extraction the samples were centrifuged at 2500 rpm for 5 min, decanted into a 5 cm path length cuvette and absorption measured spectrophotometrically at 665 and 750 nm before and after acidification with 0.1 mL of 10 percent HCl. Chlorophyll *a* and pheophytin concentrations were calculated according to the equations presented by Wetzel and Likens (1990).

B. Streams

Water samples from flowing (i.e. lotic) waters for laboratory analysis were taken by filling pre-sterilized and washed 250 and 500 mL bottles by dipping beneath the surface.

Subsamples for Total Organic Carbon and Total Kjeldahl Nitrogen were transferred to brown glass bottles or prepared centrifuge tubes for preservation. Water samples for extensive water quality analyses from impoundments and streams were shipped on ice to Philip Analytical Services (Bedford, NS) for analysis.

Routine field determinations of temperature and conductivity, supported by measurements of pH and dissolved oxygen at various times, were made at all stream electrofishing sites (cf. Section 3.3) to amplify results from water samples analysed in the laboratory. Temperature and conductivity at stream sites were measured with a YSI S-C-T meter. Water samples for dissolved oxygen were taken using a Van Dorn water sampler, and analysed using the standard Winkler method at the Acadia Centre for Estuarine Research. pH was measured in streams using a Fisher Acumet Portable pH meter.

During May and early June, when flows were still quite high, water samples were obtained at each electrofishing site for analysis of suspended sediments.

3.2.3 Results: Impoundments

Results of all water chemistry analyses carried out by Phillips Analytical Services are contained in Appendix 3.2.1 and 3.2.2. Table 3.2.1 provides a summary of a number of these parameters as well as those analyzed at the ACER laboratory.

Water Temperature and Water Column Stratification

Depth profiles of spring and summer water temperatures (Figures 3.2.2 and 3.2.3) indicate that the Upper Impoundment was slightly stratified as early as 24 May. The Lower Impoundment also exhibited slight stratification during spring, but water temperatures were considerably higher, most likely a result of its upstream water input originating from the warm surface water of the Upper Impoundment. There was little evidence of significant stratification in the Lower Impoundment during summer (16 July). In contrast, the upper impoundment exhibited strong stratification with a

thermocline between 2 and 4 m and a temperature difference of more than 16 °C between the surface and bottom.

Table 3.2.1 Summary of selected water quality parameters.

SITE	Date	Sample Depth (m)	Temperature (Celsius)	Conductivity (uS/cm)	Total Hardness (mg/L)	pH	Alkalinity (mg/L)	Chlorophyll *a* (ug/L)	Pheophytin (ug/L)	SPM (mg/L)	Secchi Depth (m)	Turbidity (NTUs)	Color (TCUs)	Dissolved Oxygen (mg/L)	DO Saturation (%)
Lower Impoundment	23 May	0.5	18.4	38	9.4	6.7	<5	0.2	0.8	1.8	2.2	1.8	19	10.1	98
Lower Impoundment	23 May	5.0	11.8	38	9.1	6.4	<5	0.0	1.6	0.3	-	2.8	19	9.4	84
Lower Impoundment	16 July	0.5	25.2	54	17.0	7.3	14	0.0	2.4	2.5	1.8	0.6	11	8.6	100
Lower Impoundment	16 July	6.0	19.0	54	16.3	7.3	14	0.0	5.2	2.6	-	3.2	10	6.1	66
Upper Impoundment	24 May	0.5	12.9	40	9.4	6.5	<5	0.0	0.9	0.0	1.5	1.2	17	10.0	96
Upper Impoundment	24 May	8.0	7.0	39	9.8	6.4	<5	0.0	4.2	7.2	-	9.0	30	4.8	39
Upper Impoundment	17 July	0.5	23.1	55	18.6	7.2	14	0.0	4.6	3.0	1.8	1.2	11	9.0	102
Upper Impoundment	17 July	4.0	11.1	-	-	-	-	-	-	-	-	-	-	2.3	21
Upper Impoundment	17 July	7.0	7.0	68	23.6	7.3	24	0.0	2.5	6.8	-	14.4	66	0.0	0

Dissolved Oxygen and Percent Dissolved Oxygen Saturation

Depth profiles of dissolved oxygen and percent dissolved oxygen saturation (Figures 3.2.2. and 3.2.3) indicate that the lower water column of the Upper Impoundment showed signs of dissolved oxygen depletion as early as 24 May. The Lower Impoundment showed little change in dissolved oxygen with depth during this period. By mid-summer (16 July), the Lower Impoundment exhibited some oxygen depletion within the lower water column, but never became anaerobic. In contrast, the hypolimnion of the Upper Impoundment was nearly anaerobic.

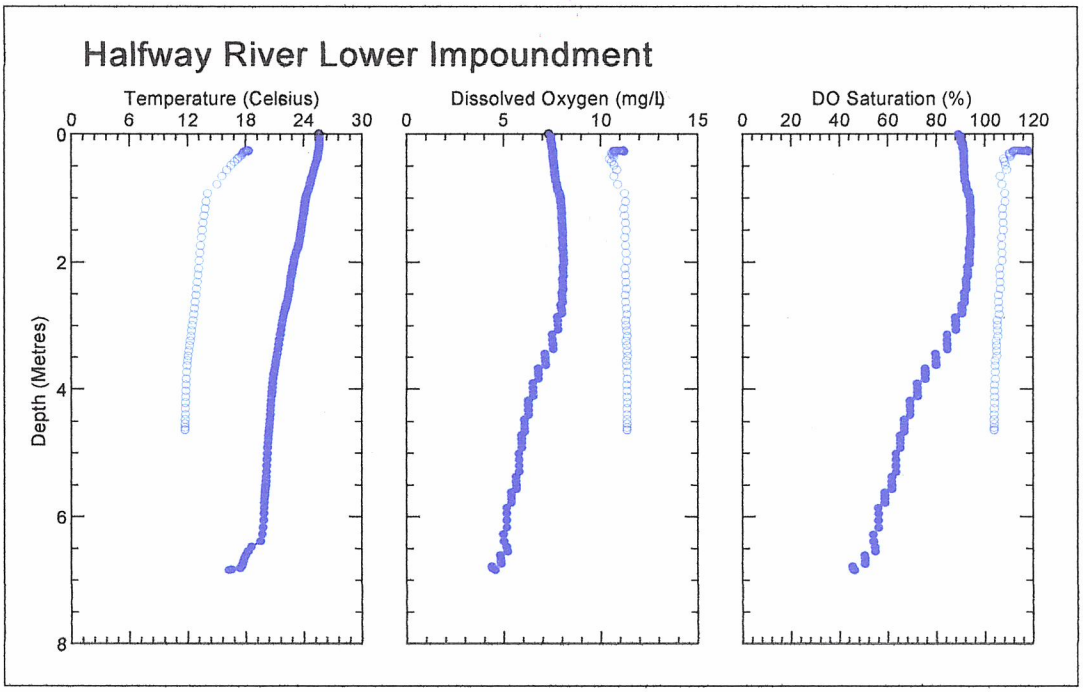


Figure 3.2.2. Temperature, dissolved oxygen and percent dissolved oxygen depth profiles for the lower impoundment during spring (◊) and summer (●).

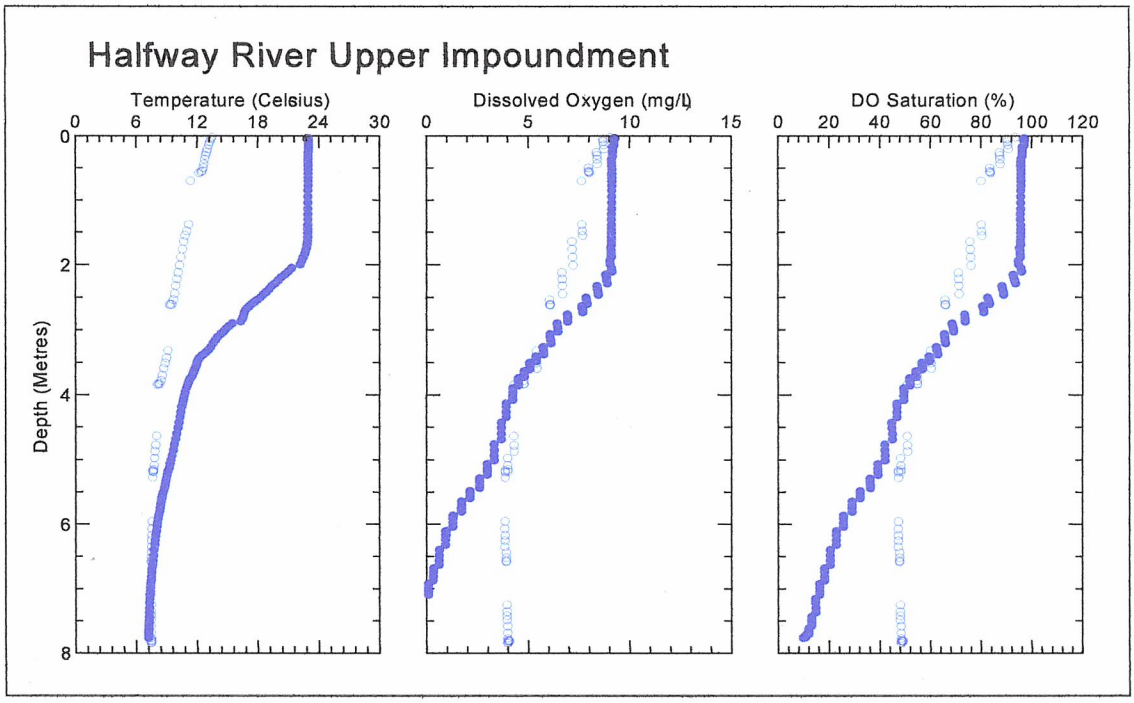


Figure 3.2.3. Temperature, dissolved oxygen and percent dissolved oxygen depth profiles for the Upper Impoundment during spring (◊) and summer (●).

Secchi Depth, Color, Turbidity and SPM

Secchi disk depths ranged from 1.5 to 2.2 m. The Lower Impoundment had slightly greater Secchi disk depths than the Upper Impoundment. SPM levels and turbidity were relatively low in both impoundments. True colour, however, was moderately high and typical of the brown, humic stained water common in Atlantic Maritime lakes.

Total Hardness, Conductivity, Alkalinity and pH

Total hardness and conductivity values were very low, less than 1 mg/L and 50 ③S/cm respectively, in both impoundments during spring. The low water hardness during spring was also reflected in the lack of any measurable alkalinity. Despite the absence of any measurable alkalinity, spring pH levels were about 6.5, a value that is considered quite acceptable in areas where acid precipitation is a factor.

There was a significant increase in all of these parameters in both impoundments during summer. Conductivity values increased to more than 50 $\mu S/cm^{-1}$, hardness to more than 15 mg/L and alkalinity to about 15 mg/L. This was accompanied by a corresponding increase in pH to about 7.3.

The differences between spring and summer values may be a result of spring samples containing significant amounts of surface run-off originating from snow melt, which is typically low in hardness, alkalinity and pH.

Nutrients, Chlorophyll *a* and Trophic Status

Nitrogen and phosphorus, the two most important nutrients determining the trophic status of freshwater systems, were very low in both impoundments. Phosphorus, nitrate and nitrite were usually below measurable levels. The only nutrient present in substantial concentrations was ammonia, and this occurred only during the summer in bottom waters, which is typical of systems having an anoxic hypolimnion. The almost complete

absence of chlorophyll *a* and the relatively high levels of pheophytin also indicate the productivity of both impoundments to be very low.

The depletion of dissolved oxygen within the hypolimnion of the Upper Impoundment, which would normally suggest a relatively productive system, is probably a result of decomposition of allochthonous organic inputs entering the impoundment via the main river as opposed to decomposition of autochthonous organics produced within the impoundment.

Heavy Metals

The concentrations of aluminium iron, zinc and copper measured in surface and bottom water samples are contained in Appendix 3.2.2. In most cases, levels were below the Canadian Water Quality Guidelines for freshwater aquatic life established by the Canadian Council of Resource and Environment Ministers (1996). One exception was iron, which exceeded the guidelines in the bottom water of the Upper Impoundment during both spring and summer. The high iron levels, however, are most likely the result of low dissolved oxygen concentrations, which results in the solubilization of sediment iron precipitates, which then diffuse into the water column. Aluminium was found to be present in concentrations slightly above the guidelines on one occasion, during summer in bottom waters of the Upper Impoundment.

3.2.4 Results: Streams

Complete water quality results obtained from samples at the Halfway River electrofishing sites (cf. Figure. 3.3.1) and sent for laboratory analysis are presented in Appendices 3.2.3 and 3.2.4. This section highlights specific results and characteristics that describe the overall quality of the Halfway River as a habitat, with particular reference to fish habitat and seasonal characteristics.

pH: Water of the Halfway River is generally only slightly acidic, except where local conditions contribute to a decreased pH level. Bogs and forested slopes dominated by coniferous trees tend to yield water that is acidic. At HW2, where the water is just issuing from the bog at Peck Meadow, pH was very low, both in spring (5.4) and summer (5.7), whereas pH at all other sites was > 6. The other somewhat lower pH site, HW4, also receives water from boggy areas further upstream.

pH values in summer were noticeably higher at all locations, reflecting the low rainfall, low water levels, and absence of hydrogen ions being released by the soils upstream. The anomalous value of 7.8 at station HW5 during summer is addressed below.

Alkalinity: Alkalinity values in spring were very low, mostly <5 $mg.L^{-1}$ except for HW5 and HW7, both of which are influenced by nearby roads. Alkalinity is a measure of the buffering capacity of water: the ability to neutralise hydrogen ions. It is related to the concentrations of salts, particularly carbonates and phosphates, that are usually derived from the weathering of sedimentary rocks. In the Halfway River watershed, there are few outcrops of carbonate-bearing sediments, and the concentrations of ions such as calcium, magnesium, carbonates and bicarbonates, are also very low (Appendix 3.2.3). Values of alkalinity in July (Appendix 3.2.4) were somewhat higher at most stations, but anomalously so at HW5, as discussed below.

Hardness: Hardness is a parameter related to the concentrations of cations such as calcium and magnesium, which will bind within available anions such as bicarbonate, carbonate, sulfate and chloride. This measure is related, therefore, to some of the parameters giving rise to alkalinity, but is not identical with it, and does not express the capacity of the water to absorb acid ions. In the Halfway River, the concentrations of hardness-inducing ions was low both in May and July samples (except, again, for HW5): these waters are very soft.

Nitrogen and Phosphorus: These two nutrients are important indicators of the trophic state of water, and may be the principal factors determining the productivity of a lake or

stream. In poorly buffered waters that receive very little in the way of dissolved ions from weathering of rock, nitrogen and phosphorus concentrations commonly reflect human activities and land use. The spring and summer samples from the Halfway River system generally show low to undetectable concentrations of forms of nitrogen (nitrite, nitrate, ammonia) and phosphorus (orthophosphate and total phosphate). The extraordinary values for total phosphorus in spring (1.3 – 6.1 $mg.L^{-1}$, cf. Appendix 3.2.3) are an unexplained anomaly. In general, the river waters have extremely low nutrient concentrations.

Conductivity: Conductivity was measured during electrofishing activities because it influences the efficiency of the shocking equipment. It is a measure of the electrical conductivity, and therefore reflects the concentrations of all soluble ions. Conductivity values varied from 25 to 60 $\mu S.cm^{-1}$, during the spring sampling, except for HW7. In summer, conductance was higher at all stations than in spring, with an extreme value associated with HW5. Table 3.2.2 gives temperature and conductivity records made during spot checks and stream surveys at the electrofishing sites.

Colour: Most waters flowing through well-treed hardwood forests, or over bedrock, tend to have low colour intensity. This is true for the some parts of the Halfway River (HW1, HW3, HW5 in spring, HW6). However, water issuing from bogs and coniferous woodlands is commonly stained yellow to brown as a result of humic acids or tannins. Water at HW2 is highly coloured as it leaves Peck Meadow, and HW4 exhibits some colour also. In summer, colour was little changed except for more intense staining at HW2.

Most other chemical constituents are consistent with water of low nutrient and ion concentration, typical of streams in well-forested watersheds. There is low turbidity throughout, indicating that even in wet weather (as occurred in May and early June), there is little sediment entering the streams in overland flow. This corresponds to the lack of fine sediment to be found anywhere in substrate at the upper portions of the river system; higher siltation seems only to be occurring in downstream portions (e.g. HW6)

where land has been cleared and is in active use, and where roadways pass close to the river.

Table 3.2.2. Incidental temperature and conductivity records for Halfway River sites.

Site	Date	Temp °C	Conductivity $\mu S.cm^{-1}$
H1	22-May	17	
	31-May	13	55
	13-Jun	12.5	45
	16-Jul	14	80
H2	31-May	13	15
	12-Jun	12.5	19
	16-Jul	13	25
H3	23-May	6	
	31-May	9	25
	14-Jun	10	30
	16-Jul	13	45
H4	24-May	12	
	31-May	12	15
	19-Jun	11	19
	16-Jul	10.8	28
H5	24-May	8	30
	31-May	14	45
	20-Jun	15.5	60
	17-Jul	19	195
H6	24-May	15	30
	31-May	18.3	40
	21-Jun	19	50
	17-Jul	22	82
H7	31-May	14	45
	22-Jun	14	80
H8	17-Jul	11.8	52

The most anomalous values for many constituents were found in the summer samples for HW5 (cf. Appendix 3.2.4). Exceptionally high values of alkalinity, calcium, chloride, conductance, hardness, pH and sulfate are most likely a result of the road paving that was under way during the summer months.

Dissolved Oxygen: Water samples for dissolved oxygen were taken at times of fish collection. Results are indicated in Table 3.2.3.

Table 3.2.3 Dissolved Oxygen Concentrations in Halfway River, May & July 2001.

Site	Temperature	DO Avg	%
	°C	$mg.L^{-1}$	Saturation
May			
HW1	12.5	9.12	82%
HW1	14.5	8.51	80%
HW2	20	3.69	39.5%
HW3	17	8.83	88.5%
HW3	17	9.10	92%
HW4	11	9.67	84%
HW4	11.5	9.60	83%
HW5	15.5	8.87	85%
HW5	15.5	8.33	80%
HW6	19	9.19	95.0%
HW6	19.5	9.00	94%
HW7	12	7.14	66.5%

Site	Temperature	DO Avg	%
	°C	$mg.L^{-1}$	Saturation
July			
HW1	14	8.82	81%
HW1	14	9.68	90%
HW2	13	4.84	45%
HW2	13	5.14	48%
HW3	13	9.8	89%
HW5	19	10.06	100%
HW6A	19.2	8.2	86%
HW8	15	10.8	100%

In spring, saturation levels at most sites were high, generally in excess of 80%. Exceptions were sites HW2 and HW7. At the Fielding Brook site (HW2), water flows from a relatively stagnant bog, with little turbulence, and is exposed to high organic loadings in the sediment. Oxygen levels were thus very undersaturated; it is not surprising that fish catches were low. At HW7, low oxygen is probably attributable to the effects of the roadway and culverts just upstream.

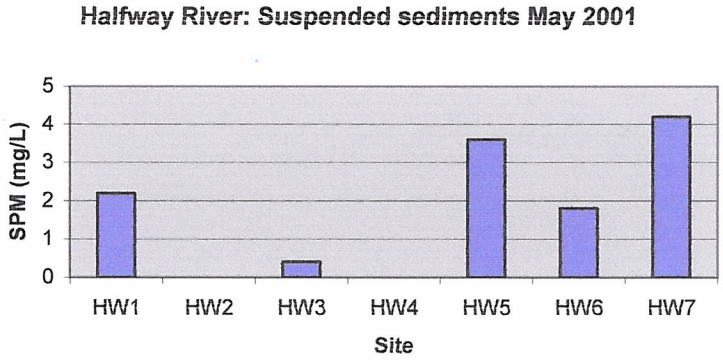
In summer, oxygen concentrations were also high at most stations, with the exception of HW2. Concentrations above 60% are necessary for trout and other game fish; if the oxygen levels drop below this, trout will generally seek out cooler or more turbulent stretches of stream. The results indicate that oxygen conditions in shallower streams can become limiting for trout during dry and warm summer months, even when water persists in the stream.

Suspended Sediments.

Even at times of high flow, when soil runoff from land and roads is expected to be high, suspended sediment concentrations in the upper part of the watershed were low (Figure

influenced by nearby roads. It is probable that later in June and July, as roadworks continued on Bishopville Rd., the amount of sediment entering Kelly Brook would have been much higher; in fact, collections in late July indicated that the substrate was covered with fine sediment at HW5.

Figure 3.2.4. Suspended sediment concentrations at Halfway River sites, May 2001.



3.2.5 Summary & Conclusions.

Waters of the Halfway River system are coloured, and very low in most dissolved constituents, including ions responsible for alkalinity, conductivity, and hardness. Nonetheless, pH values in the impoundments ranged from a moderate value (<6.7) in spring to > 7 in July; similar change and values occurred in stream waters, except those that issue from local bogs, which had pH values <6. Nitrogen and phosphorus concentrations were extremely low or undetectable. In early summer, the Upper Impoundment showed signs of early stratification, which became very strong during summer, with a thermocline at 2-4m; there was complete depletion of oxygen in bottom waters in July. In the Lower Impoundment, stratification was less intense and less permanent, and although water temperatures were higher in summer, complete anoxia was not observed.

In general, the Halfway River is a clean, nutrient-poor and relatively unproductive water system. Conditions during the low flow periods of summer are not favourable for game fish such as Brook trout, and cool refuges are not abundant.

3.3 Fish Surveys of the Halfway River System.

3.3.1 Introduction

Surveys of fish populations were conducted both within the two impoundments, and at selected sites on the streams of the Halfway River system. Field campaigns took place in late May and in July. Because the objectives, methods and results of the two major habitats were different, they are treated separately below.

A. Fish Surveys of the Upper and Lower Halfway River Impoundments.

3.3.2 Methods

Fish surveys were carried out using experimental gill nets, minnow traps, and angling. The experimental gill nets consisted of four 8 m long, 1.8 m deep, panels having stretched mesh sizes of 2.5, 5.0, 6.5 and 8.0 cm. The minnow traps were standard size traps and were baited with dog food.

At least two gill net sets were made at each impoundment during each survey. Two minnow traps were set in close proximity to each gill net, usually along the shoreline in water depths of less than 1 m (Figure 3.3.1). The nets and traps were typically set at dusk and retrieved early the following morning. The total time of the sets typically ranged between 10-12 h.

The numbers and species of all fish collected in the gill nets and minnow traps were recorded and, with the exception of white suckers, all gill net collections were retained for length/weight measurements. White suckers, which were often the most numerous species collected in the gill nets, were measured for length in the field.

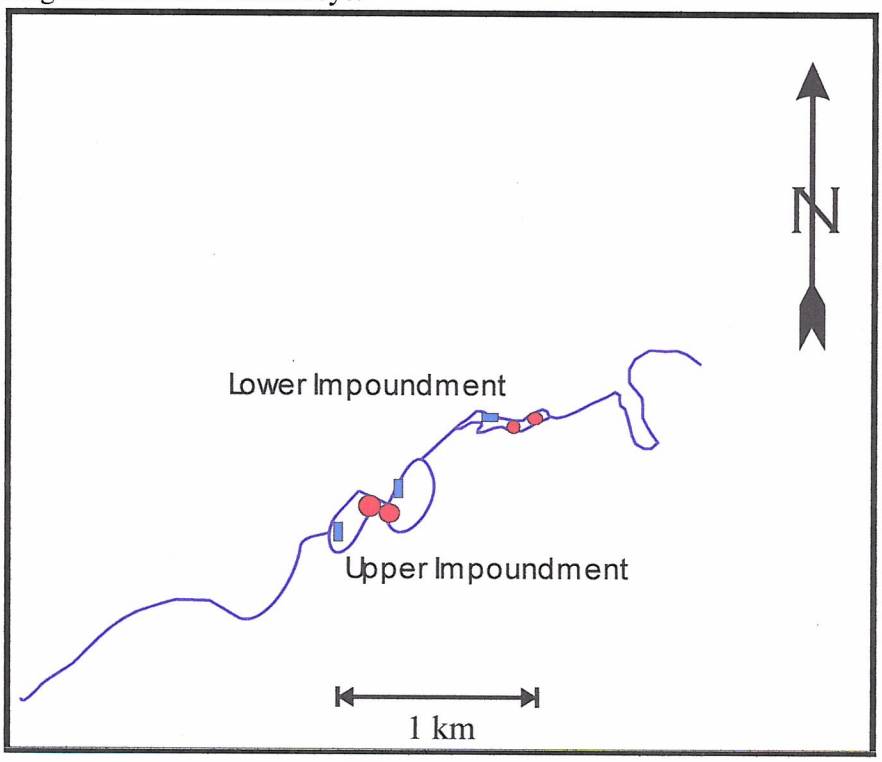
Locations of gill net sets are given in Table 3.3.1

Table 3.3.1. Locations of Gill Net sets in Halfway River Impoundments.

SITE	Station	Date	Time	Location (UTM)		Water Depth (m)
				Northing	Easting	
SPRING SURVEY: Halfway River System						
Lower Impoundment	HLOW	23/05/01	17:16	4988728	405505	6
Upper Impoundment	HUP	24/05/01	17:52	4988083	404108	7
SUMMER SURVEY: Halfway River System						
Lower Impoundment	LHSU	16/07/01	16:47	4988728	405505	6
Upper Impoundment	UHSU	17/07/01	16:38	4988083	404108	7

All fish specimens used for tissue mercury analysis were frozen within six hours of collection. Preparation of samples for mercury analysis consisted of removal and homogenization of an approximately 30 gram sample of epaxial muscle tissue, and refreezing the sample until analysis. Phillips Analytical Services, Bedford, N.S carried out the analysis of tissue mercury levels. A sub-sample of fish selected for mercury levels were also examined for stomach contents and, when possible, sexed.

Figure 3.3.1 Location of gill nets (•)and minnow traps (■)in the Lower and Upper Impoundment during the spring and summer fish surveys.



3.3.3. Results

A total of eight fish species was collected from the two impoundments (Table 3.3.2) and Appendix 3.3.1). These included brook trout (*Salvelinus fontinalis*), white sucker (*Catostomus commersoni*), American eel (*Anguilla americana*), banded killifish (*Fundulus diaphanus*), threespine stickleback (*Gasterosteus aculeatus*), golden shiner (*Notemigonus crysoleucas*), creek chub (*Semotilus atromaculatus*) and ninespine stickleback (*Pungitius pungitius*). White sucker was the only species collected in both impoundments although the American eel was noted feeding on fish caught in gill nets in both impoundments. Brook trout, golden shiner and ninespine stickleback were collected only in the Upper Impoundment, and banded killifish, threespine stickleback and creek chub were collected only in the Lower Impoundment.

Table 3.3.2 Summary of fish collections in Halfway River Impoundments.

Site	Date	Method		Location		Total Number Fish Collected	Total Number Species Collected	Number of Each Species							
		Gill Net	Minnow Trap	Northing	Easting			*S. fontinalis*	*C. commersoni*	*A. rostrata*	*F. diaphanous*	*G. aculeatus*	*N. cryoleucas*	*S. atrmaculatus*	*P. pungititus*
Lower	23/24 May	X		4988562	405452	0	0								
"	23/24 May	X		4988497	405139	2	2		1	1					
"	23/24 May		X	4988599	404863	0	0								
"	23/24 May		X	4988599	404863	3	2		2			1			
"	23/24 May		X	4988599	404863	3	1			3					
"	23/24 May		X	4988599	404863	38	2				14			24	
"	16/17 July	X		4988562	405452	6	1		6						
"	16/17 July	X		4988497	405139	7	1		7						
"	16/17 July		X	4988599	404863	0	0								
"	16/17 July		X	4988599	404863	7	2				6			1	
"	16/17 July		X	4988599	404863	7	2		1		6				
"	16/17 July		X	4988599	404863	0	0								
Upper	24/24 May	X		4987834	403765	25	2	1	24						

Site	Date	Method		Location		Total Number Fish Collected	Total Number Species Collected	Number of Each Species							
		Gill Net	Minnow Trap	Northing	Easting			*S. fontinalis*	*C. commersoni*	*A. rostrata*	*F. diaphanous*	*G. aculeatus*	*N. cryoleucas*	*S. atrmaculatus*	*P. pungititus*
"	16/17 July	X		4988562	405452	6	1		6						
"	16/17 July	X		4988497	405139	7	1		7						
"	16/17 July		X	4988599	404863	0	0								
"	16/17 July		X	4988599	404863	7	2				6			1	
"	16/17 July		X	4988599	404863	7	2		1		6				
"	16/17 July		X	4988599	404863	0	0								
Upper	24/24 May	X		4987834	403765	25	2	1	24						
"	24/24 May	X		4987811	403932	20	1	20							
"	24/24 May		X	4987627	403653	2	2		1						1
"	24/24 May		X	4987627	403653	0	0								
"	24/24 May		X	4987627	403653	3	1								3
"	24/24 May		X	4987627	403653	0	0								
"	17/18 July	X		4987834	403765	3	1		3						
"	17/18 July	X		4987811	403932	31	2	2	29						
"	17/18 July		X	4987627	403653	30	2		20				10		
"	17/18 July		X	4987627	403653	0	0								
"	17/18 July		X	4987627	403653	13	2		12					1	
"	17/18 July		X	4987627	403653	0	0								

Notable was the relatively large number of brook trout captured in the Upper Impoundment during the spring survey, the small number captured during the summer survey, and the lack of any brook trout captured in the Lower Impoundment during either survey. Neither of these impoundments appears to have favourable summer habitat for cold-water fish species such as salmonids. Although the Lower Impoundment contains levels of dissolved oxygen that are considered suitable for cold-water species, water temperatures are quite high and above the 20 °C maximum typically considered as the upper limit at which stress becomes significant (see Section 3.2.3). Although the Upper Impoundment contains cold water below the thermocline during summer, percent dissolved oxygen saturation levels are less than 50 percent, the level considered to be the

3.3.3.1 Length-weight relationships

The length-weight relationship of brook trout collected from the Upper Impoundment is shown in Figure 3.3.2. The regression coefficient in excess of 3 indicates that the trout collected were in good condition.

3.3.3.2 Mercury content of fish

The mercury content of eight brook trout collected from the upper impoundment ranged between 0.04 and 0.18 mg Hg/kg wet weight. These values are well below the Health Canada guideline of 0.5 mg Hg/kg and are about average for Nova Scotia brook trout. A survey of brook trout collected from lakes throughout Nova Scotia carried out by the Nova Scotia Department of Environment (1994) found an average and range of 0.18 and 0.03-0.26 mgHg/kg wet weight respectively. Similar averages and ranges have been reported for brook trout collected from Kejimkujik National Park, N.S. More relevant to the Halfway system is a study carried out by Nova Scotia Power Inc. (1995) on ten lakes and reservoirs associated with hydropower systems. Twenty-five brook trout were sampled from 10 lakes and reservoirs. The average and range of mercury levels was found to be quite high, 0.51 and <0.4-1.68 mg Hg/kg respectively.

In all of these studies, larger and heavier fish exhibited higher mercury levels per gram of tissue. This is also true for the brook trout collected from the Halfway River impoundments (Figure 3.3.3).

Figure 3.3.2 Length-weight relationship for brook trout collected from the Upper Impoundment.

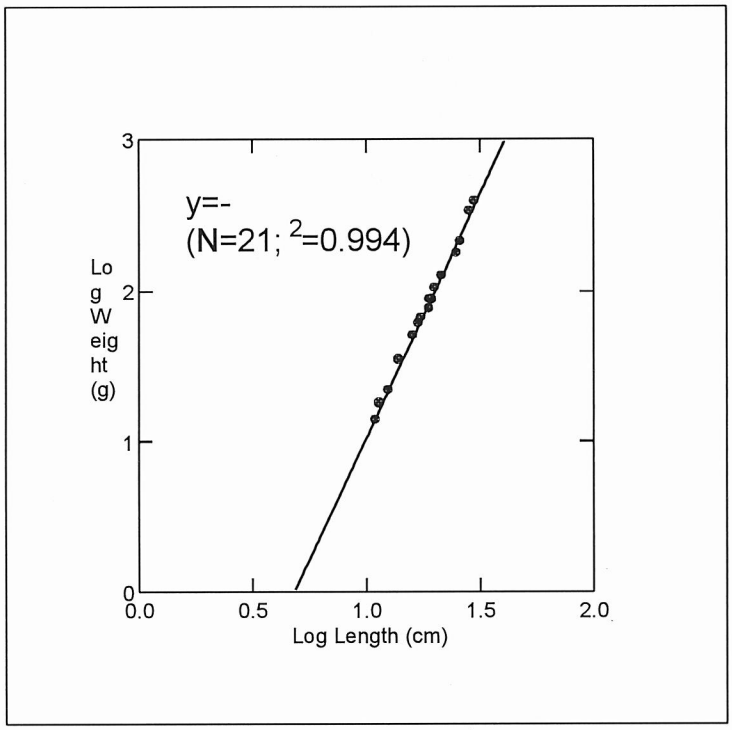
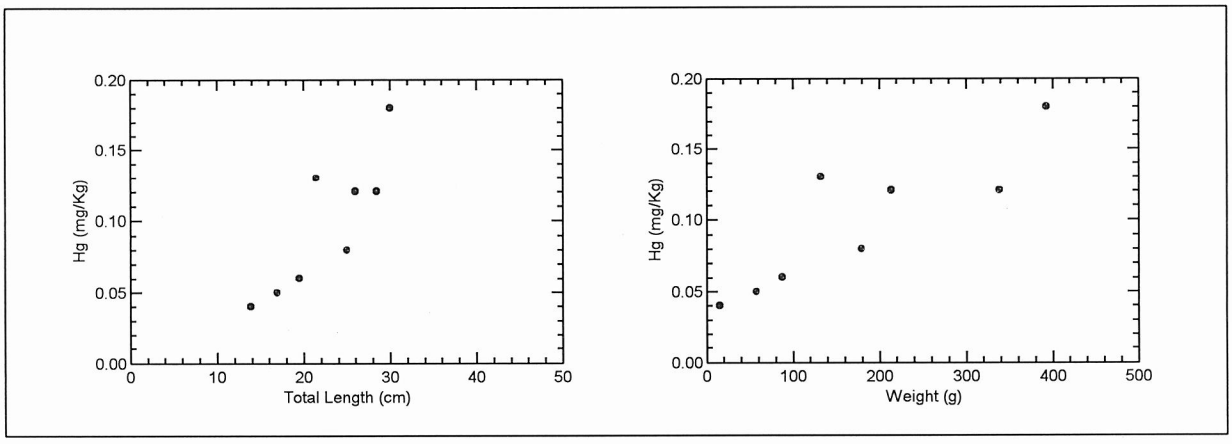


Figure 3.3.3 Relationship between mercury content and size for brook trout collected from the Upper Halfway River Impoundment.



3.3.3.3. Fish Stomach Contents

Fish collected and retained for mercury analysis were also examined to provide an assessment of principal dietary components in the impoundments. Results are given in Tables 3.3.3. Because the fish were caught in gill nets, it was common to find little or no identifiable material in the stomachs.

Table 3.3.3 Stomach Contents of Fish from Halfway River Impoundments

I.D. No.	Species	Sex	Fork Length (cm)	Total Length (cm)	Weight (g)	Collection Date	Stomach Contents
HW(3)	*S. fontinalis*		13.9	14.3	15.3	23/05	Trichoptera
HW(4)	*S. fontinalis*		17.0	17.5	58.0	23/05	(1) Diptera; Culicidae (2) Coleoptera; Elmidae (3) Coleoptera; Hydrophilidae
HW(5)	*S. fontinalis*	F	19.5	20.1	88.0	23/05	(1) Coleoptera; Elmidae
HW(6)	*S. fontinalis*		21.5	22.1	133.0	23/05	(1) Plecoptera; Pteronarcidae (2) Coleoptera;Gyrinidae (3) Odonata; Anisoptera;
HW(7)	*S. fontinalis*	F	25.0	25.5	180.0	23/05	(1) Plecoptera; Pteronarcidae (2) Odonata
HW(10)	*S. fontinalis*	F	30.0	31.0	393.0	23/05	(1) Mollusca; Gastropoda; Prosobranchia; Valvatidae (2) Odonata; Anisoptera (3) Plecoptera; Pteronarcidae (4) Trichoptera

B. Fish Surveys of the Halfway River Streams.

Fish collections were made at 6 selected sites (HW1-6) on the Halfway River and its tributaries, and at one site (HW7) on the Black River, a downstream tributary of the Halfway River, between 23 and 25 May 2001. The first six sites, and a new site (HW8) were revisited and sampled between 6 and 7 July 2001. Site locations are indicated on Figure 3.3.4, and geographic coordinates provided in Table 3.3.4. Sites 1-6 and 8 are to be re-examined in the fall.

Table 3.3.4 Geographic Coordinates of Halfway River Electrofishing Sites.

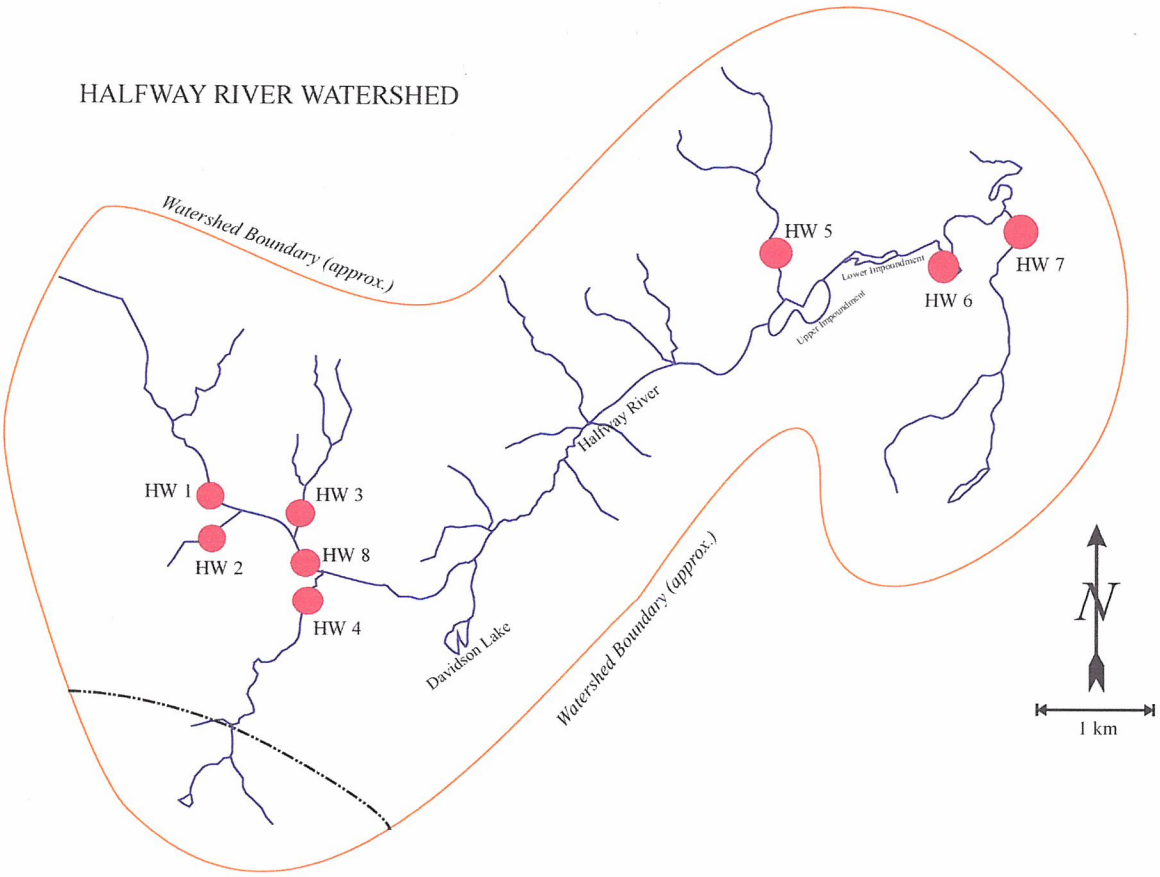
Site	UTM	UTM	Latitude	Longitude	Sample	Dates
HW1	395680 E	4984782 N	45 00.641' N	064 19.381' W	22/05/01	6/7/01
HW2	395497 E	4984259 N	43 00.450' N	064 18.539' W	23/05/01	6/7/01
HW3	396782 E	4984415 N	45 00.461' N	064 18.536' W	23/05/01	6/7/01
HW4	396979 E	4983597 N	45 00.018' N	064 18.378' W	23/05/01	7/7/01
HW5	395679 E	4984777 N	45 00.639' N	064 19.382' W	24/05/01	7/7/01
HW6	403575 E	4988211 N	45 02.560' N	064 13.411' W	24/05/01	7/7/01
HW7	407119 E	4988493 N	45 02.741' N	064 10.715' W	24/05/01	-
HW8	397142E	4983737N	45 00.090N	064 18.255W	-	7/7/01

3.3.4 Methods.

Electrofishing sites were chosen to provide varied examples of the fish habitats to be found in the Halfway River system. At each site where possible, a section of stream was enclosed between barrier nets of 1 cm stretched mesh. Each barrier net was carefully anchored into the stream bed, and supported by tripods. Electroseining was carried out by M. Parker of East Coast Aquatics, and proceeded in a downstream direction. In general, 3 passes were attempted, separated by 45 – 60 minute intervals; fewer passes were completed if few or no fish were obtained on the second or first pass. Electroseining was

completed if few or no fish were obtained on the second or first pass. Electroseining was not conducted when temperatures exceeded 20°C, or when it was raining. Occasionally either the width of the river (e.g. at HW6) or the high flows made it impossible to employ barrier nets; in these instances, spot electrofishing was conducted to identify the species present. No density figures are available from such sites.

Figure 3.3.4. Electrofishing Sites, Halfway River.



Conductivity and temperature were recorded at the time of each survey.

All fish captured were transferred to a holding tank for identification and measurement. Prior to measurements, the fish were moved into a tank containing stream water with Alka Seltzer Gold™ as a mild soporific. Most fish (except eels) were successfully sedated by immersion in the solution for a few minutes, making measurements easier and more accurate. All apparently recovered from the sedation. In the May collections, 1 of

fish died as a result of the shock treatment; in July, there were 4 mortalities among 486 fish caught in the Halfway River stations (some due to entanglement in the nets).

Total and Fork lengths (where appropriate) were recorded to the nearest 1 mm, and wet weight determined to the nearest 0.1 g. Not all fish obtained could be weighed in the field because of balance failure. Following measurement, all fish were transferred to a screened live box submersed in the stream, and held until release at the end of collection and recording.

Position of all sites was recorded using a Magellan Model 315 GPS, and results are given in Table 3.2.2. Below is a brief site description for the Halfway River sites. More complete locality descriptions, obtained from stream surveys conducted at other times, are included under Section 3.5.

3.3.5 Description of Electrofishing Sites.

Site HW1. Halfway River.

This site (Figure 3.3) is on the main stem of the Halfway River approximately 150 m below the waterfall at Greenfield. Sampling length was 58 m, with a wetted width of 4-5.7 m. Riparian vegetation is principally hardwoods (Maple, Birch), and provides 30-50% cover. Substrate is variable, primarily cobbles and boulders interspersed with slate outcrops that create both turbulent flow and calm areas below larger rocks. There is very little fine sediment in the bottom, attesting to the vigorous flows at some times of the year, and very limited habitat suitable for spawning of salmonids. Rocky substrates are often coated with mosses, especially on the downstream faces.

Figure 3.3.5. Halfway River Site 1.

Site HW2. Fielding Hollow Brook.

This site is on a tributary that issues from Peck Meadow, and enters the Halfway River just downstream of HW1. The site began at a culvert and ended approximately 100 m downstream. Vegetation is very dense on either side of the channel, which varies in width from 1-2 m, and consists of approximately 50% alders and 50% grasses. There were several deadfalls and extensive vegetation overhang and cover for 85-90% of the channel. Substrate was fine sediment, principally sand, but with large amounts of organic matter. Deep black sediments lay beneath the sediment surface, indicating anaerobic conditions there.

Figure 3.3.6. Halfway River Site 2. Fielding Hollow Brook. View downstream.

Site HW3. Gold Brook

This site (Figure 3.3.7) is on a tributary entering the Halfway River from the north. The reach begins approximately 10 m above the culvert beneath Bishopville Rd., and extends for 51 m upstream. Wetted width was 2-4 m. The stream was almost completely shaded, predominantly from surrounding softwoods. This stream was notably cooler during the spring survey (May) than the main Halfway River on sampling, indicating probable groundwater supply. Substrate was mostly coarse gravel (<3 cm) to cobble (<13 cm), and contains several riffle areas and suitable spawning sites.

Figure 3.3.7. Halfway River Site 3. Gold Brook. View upstream.

Site HW4. Thompson's Brook.

The electrofishing site was located approximately 2-300 m above the junction between Thompson's Brook and the Halfway River; reach length was 67 m, and width 4-8 m. This is a broad, shallow stream (Figure 3.3.8), in which the substrate varies from small pebbles to cobble. Most of the reach consists of riffles and runs, with few large rocks or outcrops. Canopy cover varies from 60% to 0% from a mix of hardwood and softwoods; on the north side just below the fish survey site is a low grassy bank, and similar low erodible banks occur at several locations. Between the site and the junction with the Halfway River the stream is braided. This tributary is potentially a good spawning area for trout and suckers.

Figure 3.3.8. Halfway River Site 4. Thompson's Brook. View upstream.

Site HW 5. Kelly Brook.

The sample area on Kelly Brook begins about 30 m downstream of a concrete weir below a culvert under Bishopville Rd. (Figure 3.3.9). This is a shallow, mostly exposed and degraded stream that empties into the Upper Impoundment. Substrate is a mix of bedrock, boulders and cobble, with very little fine substrate, and no obvious suitable spawning sites between the culvert and the reservoir. Riparian vegetation is a mix of softwoods (60%), hardwoods (30%), and alders (10%).

Site HW6. Halfway River.

The initial area chosen for this site (Figure 3.3.10) is on the main stem of the Halfway River approximately 100 m upstream of a small private suspension bridge that provides a crossing point for pedestrians and all-terrain vehicles. At this point the river is wide and exposed, with a tendency to braided channels. Much of the substrate is exposed bedrock,

either blue shale or sandstone, with some sand bars and cobble. A small floodplain with cobbles and alders (*Alnus* spp.) occupies the western bank. The river was too wide at this point to enclose with barrier nets, and during the survey of 24 May 2001, only spot checking was available. During the summer series (18 July), after spot-checking of the main stream, the site was relocated to a narrow braided channel about 100 m upstream, where it was possible to erect barrier nets.

Figure 3.3.9. Halfway River Site 5. Kelly Brook. View downstream.

Figure 3.3.10. Halfway River Site 6. View downstream toward footbridge.

Site HW6A Halfway River.

This site is approximately 100 m upstream of site HW6, where the river narrows, and more stable shoreline vegetation (mostly grasses) is present. Substrate is of pebbles and cobbles, rather than bedrock. A complete survey has not yet been conducted.

Site HW7. Black River.

Site HW7 was located on the Black River, a tributary of the Halfway River, and was examined during the spring sampling in May (Figure 3.3.11). The reach began approximately 15 m downstream from the long culvert that extends under Highway 101, and was 45.8 m in length. The sample reach varied in width from 3-5 m. Substrate varied from pebble to gravel in size with several large boulders and a good deal of woody debris instream. Several of the boulders were of gypsum, and much of the shoreline is part of the Windsor gypsum beds, covered by grasses: consequently, the water in this stream is

neutral (pH=7), and therefore somewhat higher than the other sites of the Halfway River system.

Because of the obvious impact of the nearby highway, and because this stream is not directly influenced by water management operations of Minas Basin Pulp and Power Company Limited, this site was not sampled during the summer series in July. Instead, another site (HW8) was established on the main stem of the Halfway River. However, the Black River data may represent tributaries that are influenced by the gypsum deposits to be found north and east of the Halfway River watershed.

Figure3.3.11 Halfway River Site 7. View downstream.

3.3.6 Results

Species captured included brook trout (*Salvelinus fontinalis*), white sucker (*Catostomus commersonii*), creek chub (*Semotilus atromaculatus*), ninespine stickleback (*Pungitius* pungitius), common shiner (*Notropis cornutus*), and eel (*Anguilla rostrata*). Another cyprinid, tentatively identified in the field as a blacknose dace (*Rhinichthyes atratulus*), was also recorded, but the specimen was not retained for confirmation. All fish were returned alive except for a single brook trout that became entangled and died in a barrier net; this was retained for analysis of stomach contents.

Summaries of electrofishing results in the spring (May) and summer (July) are given in Tables 3.3.5 and 3.3.6, respectively. More detailed results, including length-weight measurements are in Appendix 3.3.2.

Table 3.3.5 Summary of Electrofishing Results, Halfway River, 22-25 May 2001.

Site	Pass	Total No. Fish	# Trout	# Suckers	# Eels	# Shiners	# Chub	# 9 Spine		Area Sampled sq.m	Fish per Habitat Unit 100 sq.m
HW1	1	15	10	3	1		1				
	2	15	10	4	1					288.3	13.18
	3	8	6	1	1						
	Totals	**38**	**26**	**8**	**3**	**0**	**1**				
HW2	1	5	3		2						
	2	3	2		1					150	5.33
	Totals	**8**	**5**	**0**	**3**						
HW3	1	3	3								
		7	7							140	7.86
		1	1								
	Totals	**11**	**11**								
HW4	1	3	2		1						
	2	17	11	1	3	2				330.3	7.87
	3	6	2	2	2						
	Totals	**26**	**15**	**3**	**6**	**2**					

Table 3.3.5 Summary of Electrofishing Results, Halfway River, 22-25 May 2001 (continued).

Site	Pass	Total No. Fish	# Trout	# Suckers	# Eels	# Shiners	# Chub	# 9 Spine		Area Sampled sq.m	Fish per Habitat Unit 100 sq.m
HW5	1	114	3	84			17	10			
	2	90	2	63			16	9		157.5	129.52
	Totals	**204**	**5**	**147**	**0**	**0**	**33**	**19**			
HW6	1	6			2		4				
	2	15		1	5	1	8			n.a.	n.a.
	Totals	**21**	**0**	**1**	**7**	**1**	**12**				
HW7	1	10	1	3	4		2				
	2	14		9	4			1		142.6	16.83
	Totals	**24**	**1**	**12**	**8**	**0**	**2**	**1**			

Total	**332**

Trout were noticeably less abundant in the more downstream stations, where the fish fauna was represented primarily by white sucker, creek chub and eels. Estimates of fish density during the spring series ranged from 5.3 to 129 per habitat unit (100 m^2). Highest density was found in Kelly Brook (HW5), which had large numbers of young suckers. The best trout catches were obtained at HW1, HW3 and HW4.

In summer, densities were higher, partly because falling water levels restricted the fish to areas that had been chosen as sampling sites. In fact, several streams or sections thereof had dried out completely by the July survey. The Gold River (HW3) had become completely dry downstream of the culvert under Bishopville Rd., leaving a number of trout stranded in a pool between the sample reach and the Halfway River. These fish were rescued and released further downstream.

As in spring, trout were much more prevalent at upstream sites (HW1, 3, 4 and 8), and poorly represented lower down the Halfway system. It is probable that this relates both to substrate and vegetation characteristics for spawning and feeding in the smaller streams, but also to more extensive cover, which keeps temperatures a little lower. However, the

'flashy' nature of the streams, and the tendency of tributaries to dry out in warmer months, represent limitations for sensitive fish fauna such as brook trout. In contrast, the lower half of the Halfway River system seems to be the province of suckers, eels and chub.

Table 3.3.6. Summary of Electrofishing Results, Halfway River, 18-20 July, 2001.

Site	Pass	Total No. Fish	# Trout	# Suckers	# Eels	# Shiners	# Chub	# 9-spine		Area Sampled sq.m	Fish per Habitat Unit 100 sq.m
HW1	1	28	13	15							
	2	12	7	3	2					288.3	15.61
	3	5	2	2			1				
	Totals	**45**	**22**	**20**	**2**	**0**	**1**	**0**			
HW2	1	0								150	0
HW3	1	39	39								
	2	24	24							140	62.14
	3	24	24								
	Totals	**87**	**87**								
HW4	1	42	33	4	4		1				
	2	40	32		2		6			330.3	29.97
	3	17	15		2						
	Totals	**99**	**80**	**4**	**8**	**0**	**7**	**0**			
HW5	1	59	3	16		5	22	13		157.5	37.46
	Totals	**59**	**3**	**16**		**5**	**22**	**13**			
HW6A	1	67		13	8	10	36			n.a.	0
	2	60		16	5	1	38				
	Totals	**127**	**0**	**29**	**13**	**11**	**74**				
HW8	1	43	41		1		1				
	2	13	11		1		1			n.a.	0
	3	13	10		3						
	Totals	**69**	**62**	**0**	**5**	**0**	**2**				

In mid-August, when a water level survey was conducted by M. Parker, site HW2 (Fielding Hollow Brook) was completely dry. Table 3.3.7 indicates that most of the sites had become reduced to narrow widths, or were completely dry, and exhibited very high temperatures that would be problematical for many fish.

Table 3.3.7 Habitat conditions at Halfway River sites, 19 Aug 2001.

Site	Date	Time	Name	Air Temp (^{0}C)	Wat. Temp.(^{0}C)	Wetted Width (m)	Wet. Depth (cm)
H1	19-Aug-01	10:40 AM	Upper Halfway	22	18.5	1.2	3 to 4
						0.38	5 to 8
						1.8	7 to 19
H2	19-Aug-01	10:20 AM	Fielding Hollow Bk.	24	19	NA	NA
	19-Aug-01	11:10 AM	Freshwater Spring		8		
H3	19-Aug-01	11:15 AM	Gold Brook	20	17	1.8	10 to 16
						1.63	16 to 22
						2.2	5 to 14
H4	19-Aug-01	12:20PM	Thompsons Brook	26	17	0.52	4 to 9
H8	19-Aug-01	12:37PM	Halfway River	29	19.5	3.69	3 to 7
						3	7 to 24
H5	19-Aug-01	1:05PM	Kelly Brook	29.5	**25**	NA	NA
H6	19-Aug-01	1:30 PM	Lower Halfway R.	29	**26**	3.1	7 to 8
						5.35	7 to 16

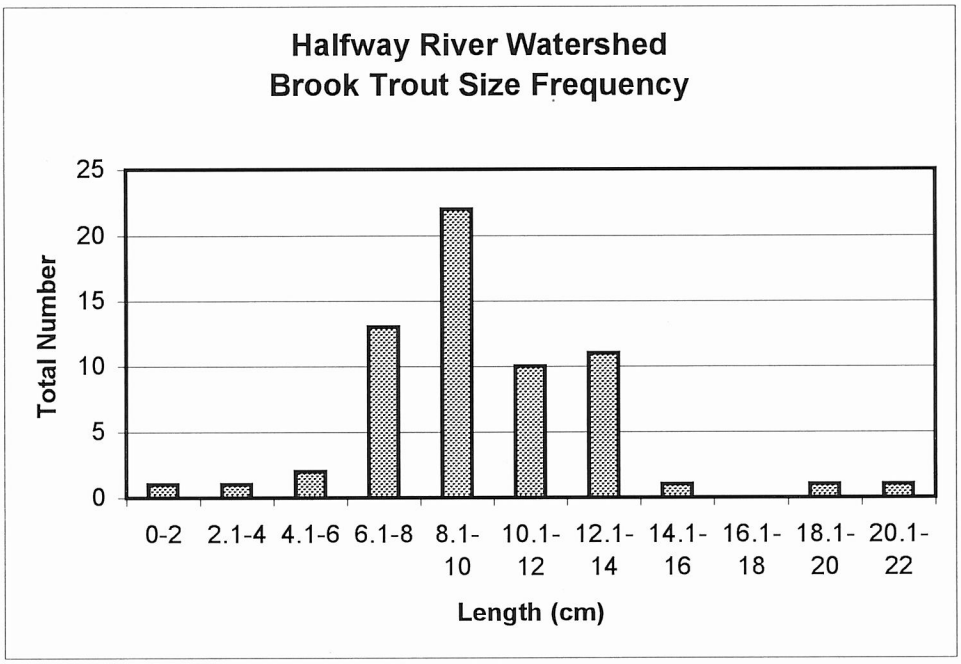
3.3.6.1. Fish Population Characteristics.

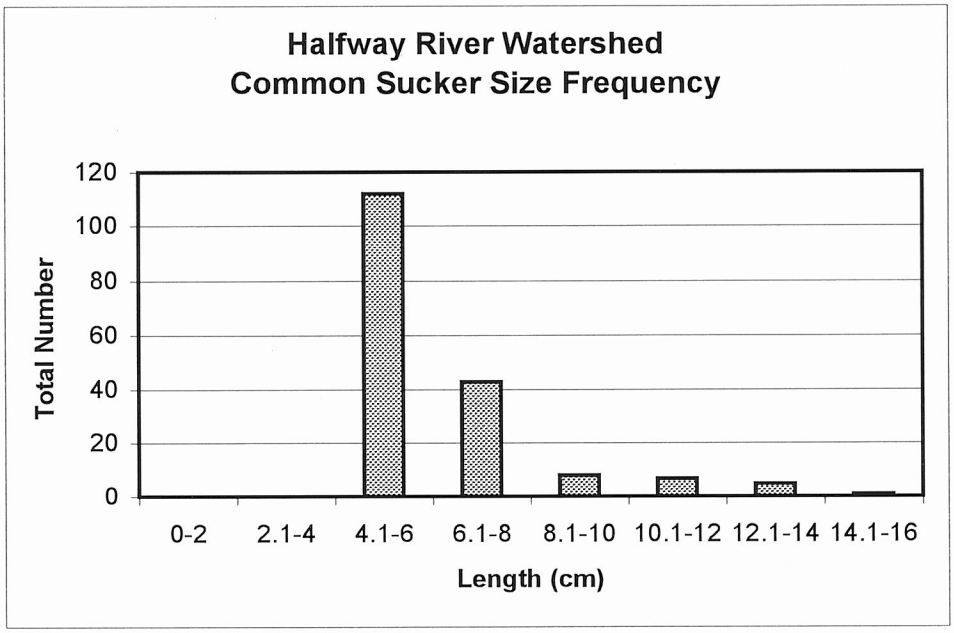
Results for common species in the Halfway River collections have been examined to investigate the population characteristics of the stock. Figure 3.3.13 shows size frequency distributions for brook trout and white sucker. All data from the two sample periods have been combined.

There is a notable difference in the two patterns. At the time of collections in late May, suckers were spawning in other rivers of the region, so that the smallest fish represented in the collections are the 2000 year class. For these fish, the streams of the Halfway River

system are rearing areas. One spawning adult was seen at HW6. The brook trout distribution is much wider, including young hatched in early spring and older specimens.

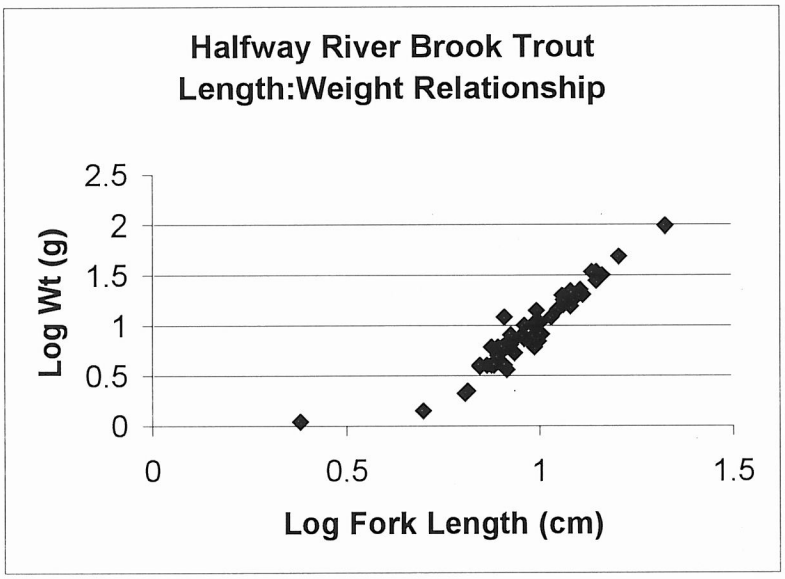
Figure 3.3.13 Size frequency distributions of brook trout and white sucker in Halfway River, May – July 2001





3.3.6.2. Length-weight Relationships

Figure 3.3.14 Length-Weight Relationships of Halfway River brook trout.



The length-weight relationship can be used as an indicator of fish health, but large number of values are needed. There does not appear to be anything exceptional about these results.

3.3.7. Summary & Conclusions

Electrofishing surveys of the Halfway River have been carried out at 9 different sampling stations in the Halfway system according to standard procedures. Sample locations were chosen to represent the variety of potential fish habitat to be found in the system, and were modified as necessary on the basis of experience.

Results indicate that the Halfway River supports a moderately abundant fish fauna, dominated by trout in the smaller streams, and by more tolerant suckers, 'minnows' and eels lower down the system. These distributions are probably related to temperature and substrate conditions. No obvious salmonid spawning sites were included in the sample areas, but riffle areas are extensive in the upper portions of the system, and there is

extensive cover available from riparian vegetation, undercut banks, deadfalls and large boulders. Overall productivity of the system is not particularly high, but the upper part of the Halfway River system sustains a good population of brook trout.

3.4 Shoreline & Littoral Zone Vegetation Surveys.

3.4.1 Introduction.

Shoreline and littoral zone investigations were conducted in the two impoundments of the Halfway River. The objectives of the survey were:

1. to characterize the terrestrial vegetation around the impoundments, to complement the study conducted under Section 2.7 and 2.8;
2. to conduct sampling in the littoral zone at representative transects to identify the presence and relative abundance of submerged and emergent vegetation.

These surveys were conducted by foot and boat on16 and 17 August by Ms. Ruth Newell, Curator of the E.C. Smith Herbarium at Acadia University, assisted by Ms. Dawn MacNeill, Leon deVreede and Stephen Sandford. Survey time was selected in order to capture the main flowering times of aquatic and coastal plain species. Extremely low water levels in August, however, prevented sampling for aquatic invertebrates associated with normally submersed vegetation except in a few locations. Representative plant specimens were collected to confirm identity of species; the data collected are very extensive, and still undergoing analysis.

3.4.2 (Lower) Front Impoundment, Halfway River.

At the western end of this impoundment at the time of survey, there were extensive, recently exposed sand bars and flats. Much of the aquatic vegetation was stranded because of extremely low water levels. Aquatic species found here which would normally be under or in water include: *Eleocharis acicularis* (needle-like rush), *Ludwigia palustris* (water purslane), *Isoetes sp.* (quillworts), *Potamogeton sp.* (pondweeds), *Sagittaria sp.* (arrowheads), and the mermaid weed, *Prosepinaca palustris*. Normal shoreline vegetation is quite extensive in this area and includes patches of: *Sparganium americanum* (American burreed), *Pontederia cordata* (pickerel weed), *Equisetum* sp. (horsetails) and *Lysimachia terrestris* (yellow loosestrife). There is also an open

floodplain at the upper end of the impoundment where the Halfway River enters. This is dominated by *Calamagrostis canadensis* (blue-joint), *Scirpus cyperinus* (common wool grass) and *Alnus incana* (speckled alder).

The following are aquatic species found at the western end of the impoundment, that have not been stranded: *Potamogeton* spp., (occurring in stagnant, still water channels at top of impoundment), and *Utricularia geminiscapa,* the twin-stemmed bladderwort (in very small amounts).

The shoreline along the impoundment is quite narrow and generally steeply sloped. Plant species found along the shoreline include: *Polygonum* sp., *Ludwigia sp. Dulichium arundinaceum* (three way sedge), *Scutellaria lateriflora* (mad-dog skullcap), *Eleocharis acicularis, Lysimachia terrestris, Carex crinita* (fringed sedge), *Pontederia cordata, Iris versicolor* (blue flag), *Leersia oryzoides* (rice cutgrass), *Aster umbellatus* (tall white aster), and *Alisma triviale* (water plantain).

Main tree species on the wooded slopes around the impoundment include hemlock, Balsam Fir, White Pine, Red Spruce and Red Maple. Other trees include: White Birch, White Ash and Red Oak.

3.4.3 (Upper) Back Impoundment, Halfway River

Water levels on the upper impoundment on the Halfway River had not dropped as extensively as on the lower impoundment. As a result, the lower end of the upper impoundment had very little shoreline below the steep, wooded bank. Plant species that do occur at the water's edge include: *Cicuta maculata* (water hemlock), *Carex crinita, Scirpus cyperinus* , *Pontedera cordata, Eleocharis acicularis, Sagittaria* sp. (occurs as sparse vegetative rosettes in a narrow zone just offshore), *Poa palustris* (fowl meadow grass), *Thalictrum pubescens* (tall meadow-rue), *Chelone glabra* (turtlehead), *Mentha arvensis* (field mint), *Onoclea sensibilis* (sensitive fern), *Arisaema triphyllum* (Jack-in-the-pulpit), and *Alnus incana.*

Due to the steep bottom, there is sparse to no aquatic vegetation at the lower (eastern) end of the impoundment.

In contrast, the upper end of the Upper Impoundment exhibited numerous sand bars, large stands of shoreline vegetation, and beds of aquatic plants offshore. Also, where the Halfway River flows into the impoundment, there is a large, rich backwater marsh plus an open, large, grassy floodplain.

Dominant species in the backwater marsh include: *Pontederia cordata, Sparganium americanum, Calamagrostis canadensis, Utricularia vulgaris* (the common bladderwort, forming thick, choking beds) and *Alnus incana*.

There are essentially two types of sand bars at the upper end of this impoundment. One is a higher, drier sand bar that has been exposed for most of the growing season. The other type is represented by more extensive areas of lower, moist to very wet sand bars, that do not appear to have been exposed for very long. The drier area is characterized by a variety of native and non-native herbaceous species. Examples of weedy species include: *Tussilago farafara* (coltsfoot), *Ambrosia artemisiifolia* (common ragweed) and *Setaria* sp (foxtails). The wetter sand bars had many areas of dense wetland vegetation at or near the water's edge. Plants forming large colonies included: *Leersia oryzoides, Pontederia cordata, Sparganium americanum* and *Calamagrostis Canadensis*, – and to a lesser extent, *Typha latifolia* (broad-leaved cat-tail). A great variety of other species occurs on these wetter sandbars as scattered plants. These include: *Scirpus rubrotinctus* (bulrush), *Polygonum sagittatum* (arrow-leaved tear-thumb), *Eleocharis ovata* (ovoid spike-rush), *Phalaris arundinacea* (reed canary-grass), *Eleocharis acicularis, Lysimachia terrestris, Eupatorium perfoliatum* (thoroughwort), *Dulichium arundinaceum,* and *Ludwigia palustris* (water purslane).

Plants occurring in the water include several species of pondweed (*Potamogeton* spp.), several bladderworts (including *Utricularia vulgaris, U. intermedia*), a species of arrowhead (*Sagittaria* sp.) and an aquatic Bur-reed (*Sparganium* sp.).

Just above the impoundment along the Halfway River, there is an extensive, open grassy floodplain. This is dominated by grasses such as Blue-joint (*Calamagrostis canadensis*), Cut-grass (*Leersia oryzoides*), Reed Canary Grass (*Phalaris arundinacea*), Rattlesnake Grass (*Glyceria canadensis*) and Northern Manna-grass (*Glyceria borealis*). Also present is a relatively restricted grass species in Nova Scotia, Muhly Grass (*Muhlenbergia mexicana*). Other species occurring here include: *Alnus incana, Clematis virginiana, Typha latifolia, Aster umbellatus, Solidago canadensis, Cirsium arvense* and *Impatiens capensis.*

The land surrounding the upper impoundment is forested and steeply-sloped. Coniferous tree species dominate. They include: White Pine, Red Spruce. Balsam Fir and Hemlock. Also present are Red Oak, Red Maple, White Birch, Ironwood, Sugar Maple and White Ash.

3.5. Qualitative Fish Habitat Surveys.

3.5.1 Introduction.

The Halfway River system consists of a network with about 46 km of intermittent streams (Table 3.5.1) draining a watershed of approximately 72 km^2 (behind Lower Impoundment). Fish and invertebrate collections covering a few habitat units (100 m^2 each) only provide the most modest indicator of fish habitat in a large watershed. To amplify the assessment, longer portions of the streams were surveyed to provide a qualitative account of stream conditions, with a focus on those characteristics that seem most permanent, or have most significance for determining quality of fish habitat.
No previous record of surveys of the Halfway River system has been identified.

Table 3.5.1. Stream Lengths of the Halfway River system.

Halfway River System		km
Main Stem	Head to Back (Upper) Reservoir	15.8
	Head to Mouth	24.1
Tributaries.	Fielding Hollow Brook	1.9
	Gold Brook (all branches)	5.4
	Thompson's Brook	4.6
	Davidson's Lake Brook	1.7
	Kelly Brook (all branches)	8.3
	Total Tributaries	**21.9**
	Total System	**46.0**

3.5.2. Methods.

Using the electrofishing sites as a base, upstream and downstream sections of the streams and main stem of the Halfway River system were surveyed on foot. Each survey attempted to cover at least 200m above and below the site selected for electrofishing, and

took several hours. Observations were made on substrate characteristics, instream vegetation, and bank stability, together with measurements of stream width, depth, and flow. Locations were recorded with a Magellan 315 GPS Unit. A photographic record was established for each site.

3.5.3. Results.

More complete field notes are provided in Appendix 3.5.1. Brief summaries from those notes are provided below.

Upper Halfway River near Site HW1.

The main stem of the Halfway River flows through a mixed, predominantly hardwood forest, that provides both reasonable shade, and some stability for banks (Figure 3.5.1). From the waterfall just below Greenfield cemetery, which falls into a large pool, the substrate varies from outcroppings of slate bedrock, to large cobble bars with established grasses, to riffle- run sequences. Near the pool, metal and other debris that might have been buried during construction of the Bishopville Rd., is evident.

Much of the cobble and bedrock substrate is coated with mosses or algae; in some areas an *aufwuchs* of brown, rather slimy material is evident, that includes diatoms and unidentifiable organic filaments. Instream grasses on bars indicate a fair degree of permanence, especially in the stretch between the waterfall pool and the electrofishing site. In riffle areas (e.g. distance in Figureure 3.5.1), the substrate is usually at least pebble size (<3.5 cm diam.), more commonly of cobble (<6 cm) and rubble (<14 cm), and except during freshets, some part is commonly exposed and dry. There was very little sign of finer sediments in this upper portion of the system, indicating that flows are frequently sufficient to clear out finer material that might collect during lower flow periods following rainfall or snow melt. One or two sites only seemed likely to be good spawning habitat for salmonids.

Cover was provided in many places by undercut river banks (cf. Figure 3.3.2) where tree roots continue to hold parts of the bank in place, and where deadfalls occur. Invertebrates were dominated by mayflies and stoneflies (cf. Section 3.6). The combinations of cover, the relatively abundant mosses, insects from overhanging vegetation, and holding areas below larger rocks, makes this stretch of the river a good rearing habitat.

Figure 3.5.1 Upper Halfway Brook showing varied shore vegetation

Figure 3.5.2. Upper Halfway Brook showing local woodland

Over the stretch covered by this survey, elevation changed from 136 m at the base of the waterfall to 126 m approximately 400 m downstream. Several locations were identified where trash or other evidence of human activity (ATV tracks, campsites etc.) was present.

Fielding Hollow Brook near Site HW2.

This small stream drains a large bog below Peck Meadow (Figure 3.3.4 and 3.5.3). At the top, where it issues from a culvert, the stream is shallow and meandering (i.e. a flat), mostly covered by riparian grasses and alders, and often largely blocked by debris. The substrate is organically rich and sandy, with very little coarse sediment. The high organic content undoubtedly contributes to low oxygen levels, and this, with the low pH and shallow water level, makes this a rather difficult environment for fish. Nonetheless, brook trout (and eels) were present during the May survey, although none were captured in July. Amphibians, were abundant, especially green (*Rana clamitans)* and pickerel frogs (*Rana palustris*). Although the instream food resources are limited in variety in the uppermost portions of the stream, insects are abundant in the surrounding vegetation, and probably provide adequate food resources.

Figure 3.5.3. Peck Meadow Bog view upstream from HW2.

Further downstream, the slope increases, and with it the flow. Riffle-run sequences predominate, with coarser substrates. Although little canopy cover is present, numerous

deadfalls and streamside vegetation, together with undercut banks, provide abundant fish cover. Insect collections (cf. Section 3.6) consisted of large numbers of blackfly (*Simulium* spp.) larvae, and a few caddis larvae. Mayflies and stoneflies were poorly represented in the fish survey reach, but became more common in riffle areas.

Gold Brook near Site HW3.

Gold Brook is a significant sub-watershed of the Halfway System, although at the point of access from Bishopville Road it is largely obscured by alders and other streamside vegetation (including *Prunus virginiana, Amelanchia arborea* and ferns). The stream was shallow at all sample times, with a substrate ranging from a mudstone bedrock and boulders to pebbles. Further away from the roadway, both upstream and downstream, the canopy was relatively open, exposing the streambed to sunlight. Overall, there was very little overhang or canopy cover through the river. Forest type varies from predominantly hardwoods and shrubs nearer the road and the junction with Halfway River, to a mixed forest further upstream, and in some areas to predominantly softwoods.

The substrate alternates between massive bedrock and broken bedrock; generally, where the substrate is bedrock there is a riffle area, and where there is broken rock there is a run. Substantial outcropping forms the banks in many parts, and the material all seems to be from this source. There were 3 input streams along the river that brought finer sediment to the river. The riverbanks are well supported by ferns and grasses in areas where the bank is not an outcrop of bedrock.

Macroinvertebrates in this stream were predominately mayflies, caddis flies and stoneflies. A semiquanitative Surber sample in the electrofishing reach produced far more aquatic insects than any other location in the Halfway River system, indicating a relatively rich feeding environment. Temperatures in May and early June were also significantly (< 7 °C) lower in Gold Brook (Table 3.2.2) than at other sites, suggesting an important groundwater influence. However, this advantage disappeared later in July, and when the fish survey was conducted it was discovered that the lower end of Gold Brook

had become completely dry in places, trapping fish in occasional pools and in the sampling reach. Although the biological productivity of this stream appears to be high, the intermittent nature of the water supply limits its fish habitat suitability.

Figure 3.5.4. Gold Brook, looking downstream toward the Halfway River

Figure 3.5.5. Gold Brook showing riparian cover

Thompson's Brook, near HW4.

Thompson's Brook was surveyed for almost 400 m, including the reach used for electrofishing. This is a wide, shallow stream (Figure 3.3.6), meandering through variable woodland, and sometimes quite exposed. Unlike Gold Brook, there are few rocky outcrops; substrate tends to be relatively small pebbles and cobbles, often collected into bars forming a braided channel where boulders dominate. Much of the stream flows smoothly, as a run, but riffles occur at intervals, often associated with fine gravel, pebbles and sand.

Figure 3.5.6. Thompson's Brook looking upstream

Riparian vegetation varies from softwoods to hardwoods, the latter occurring especially on the southern banks, and the softwoods commonly being dominant on the northern banks. Hardwoods in this area (maples and poplars) provide less canopy cover; whereas shading is sometimes almost complete where mature softwoods prevail. On both banks there is plenty of cover in undercut areas. Upstream of the electrofishing site, an extended riffle-run sequence occurs, and vegetation shifts to more softwoods. Woody debris in the stream is more common, and occurrence of larger boulders increases.

Invertebrates in this reach were dominated by mayflies, but the semiquantitative Surber sample produced very few; a D-net sample near the banks produced large numbers of

mayflies and caddis larvae. There were few mosses or algae attached to the rocks, and in general this stream would appear to be rather poor growing habitat, although it might provide some good spawning sites. Temperatures remained steady from late May through July, and thus this stream was cooler than other sites in summer.

Kelly Brook near HW5.

About 200 m of this stream was surveyed downstream from the electrofishing site, which begins just below a culvert and concrete weir under Bishopville Road (Figure 3.5.7). This is a relatively degraded stream, with a good deal of metal debris along its length. Much of the banks are covered with alders, and in between these are boulder fields partially covered with grasses, testifying to the periodic overflows that probably occur here. In some parts the stream flows against a sharp outcropping of bedrock (cf. Figure 3.3.7).

More distant from the bank, the vegetation is predominantly of softwoods, and provides relatively little canopy cover. Some stretches are completely exposed. In the stream itself there are often grassy bars, but the other rocks show little algae or moss growth.

Figure 3.5.7. Kelly Brook, looking downstream along HW5 site.

This site is more obviously impacted by human activities than those higher in the Halfway River system. Temperatures during July were sharply higher (<19.5C), and, as noted in Section 3.2, high conductivity (cf. Table 3.2.2) and suspended sediments (Fig. 3.2.1) are probably attributable to the road repair activities going on only a few metres above the electrofishing site (Fig. 3.5.8). During the habitat survey in June, fine sediment was noted as collecting in the weir and in calm areas behind boulders.

Fig. 3.5.8. Culvert and weir on Kelly Brook

Because of the substrate, no Surber or D-net samples could be taken, and consequently collections were limited to spot retrievals of larger macroinvertebrates. These were almost all caddis fly larvae (Fam. Limnephilidae). Despite the apparently poor conditions in terms of substrate, cover and productivity, this was the richest site in the spring fish survey, and the second richest in the summer. While the catches were dominated by white sucker, creek chub and ninespine stickleback, brook trout were captured on both occasions.

Halfway River main stem near HW6.

No extensive survey was conducted at this site, since it is really very similar from this location downstream to tidal waters. The river is broad and shallow, flowing over

outcropping bedrock with occasional cobble- and boulder-based bars-- stabilised to some extent by alders -- that are overflowed in spring, and dry and grass-covered in summer. Bedrock is primarily blue shale and sandstones, and even during the high spring flows, these seem to be covered with a fine silt. Surrounding vegetation is primarily hardwood (alder, oak, maple, birch) with a few softwoods. Eels and a snapping turtle (*Chelydra serpentina)* were observed during the survey.

Figure. 3.5.9. Halfway River looking toward footbridge

A Surber sample obtained from the few areas of small pebbles yielded very little except oligochaetes, but a dip-net sample produced a variety of caddis larvae.

Because of the lack of suitable habitat, and the high water temperature in the main stream, a shallower, less exposed, section upstream was used in the July electrofishing survey (HW8). This has not been completely surveyed to date. It is certainly productive of fish (mostly suckers, eels and minnows), but did not produce any trout.

Black River near HW7.

This small river that empties into the Halfway River just north of the Highway 101 interchange was initially included as a possible alternate site for migratory species. On the south side of the highway, the stream arises in Lusby Marsh, which is a controlled structure developed and maintained by Ducks Unlimited Canada.

Unlike the rest of the Halfway watershed, this stream is also affected by sedimentary rocks, including gypsum, which outcrop along the side of the stream. Consequently, it is chemically different: neutral pH, high alkalinity, hardness and conductance. Several other constituents, such as chloride, may be derived from the roadway rather than the natural valley substrate.

The electrosurvey site began approximately 20 m downstream from a 150 m culvert beneath Highway 101 (Figure.3.5.9), so the survey was conducted for 200 m downstream of the lower end of the fish sample reach. In the upper part of the stream, it is a narrow channel in a sharp defile, with outcropping gypsum rocks and a variety of shale pebbles and cobbles.

Figure. 3.5.10. Black River showing vegetation and gypsum boulder

Canopy cover is up to 90% in places, with some overhang and instream cover. Substrate is a complex mix of bedrock (mostly slates), gypsum, gravel and even some mud. There is evidence of erosion on some of the softer banks. Further downstream, deadfalls of the surrounding spruces tend to pond up water, increasing depths, and when the stream leaves the defile completely, it becomes more exposed. During the survey a good deal of anthropogenic debris was encountered, and some foam formation noted where the water was especially turbulent. The latter is probably natural plant organics that have been derived from the marsh and woodland on the south side of the highway.

Despite the apparently poor conditions, this reach yielded quite a few fish in May, including 1 trout, and several suckers and small eels. A composite Surber sample produced a group of stoneflies, caddis and mayflies, indicating a reasonable water quality exists there most of the time.

3.5.3.1. Substrate Characteristics

One of the principal factors affecting fish habitat is the nature of the substrate. During the habitat surveys, the proportion of different types of substrate was estimated visually for each reach of the stream used for electrofishing surveys. The relative distribution of substrate sizes at sites in the Halfway River system is illustrated in Figure 3.5.11.

These plots show clearly how varied the sites are in terms of substrate. Best fish catches are associated with reaches in which the dominate substrate type is intermediate cobble or rubble. Such areas seem to provide favourable rearing habitat. None of the reaches exhibit extensive areas where gravel or pebbles dominate, which is usually more favourable for spawning. It seems clear that sufficient spawning habitat must exist in the system in view of the prevalence of brook trout.

3.5.4. Summary & Conclusions

Detailed habitat surveys have been conducted on about 4 km of the 46 km length of streams in the Halfway River. More complete descriptions of those sections are provided in Appendix 3.5.1.

Results indicate that fish habitat is generally better in the upper reaches of the Halfway system, where a combination of variable substrate type, good and varied cover, abundant food and clean, cool water is found. However, a significant limitation to some tributaries,

Figure. 3.5.11 Substrate Characteristics for Halfway River Site HW1.

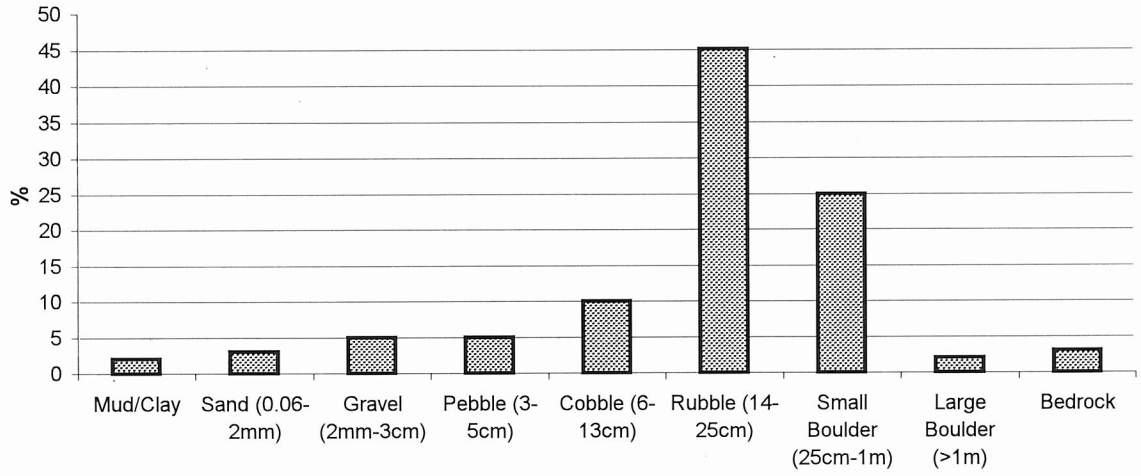


Figure. 3.5.12. Substrate Characteristics for Halfway River Site HW2.

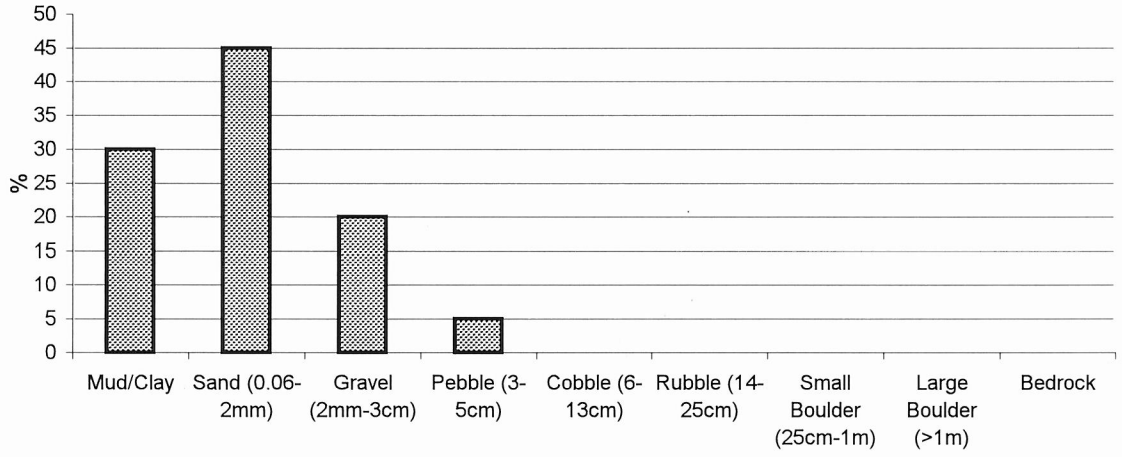


Figure. 3.5.13. Substrate Characteristics for Halfway River Site HW3.

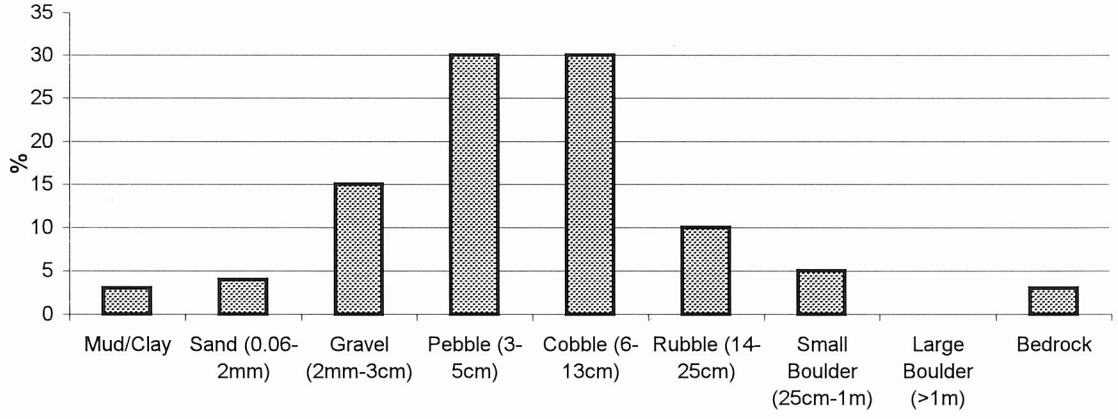


Figure. 3.5.14. Substrate Characteristics for Halfway River Site HW4.

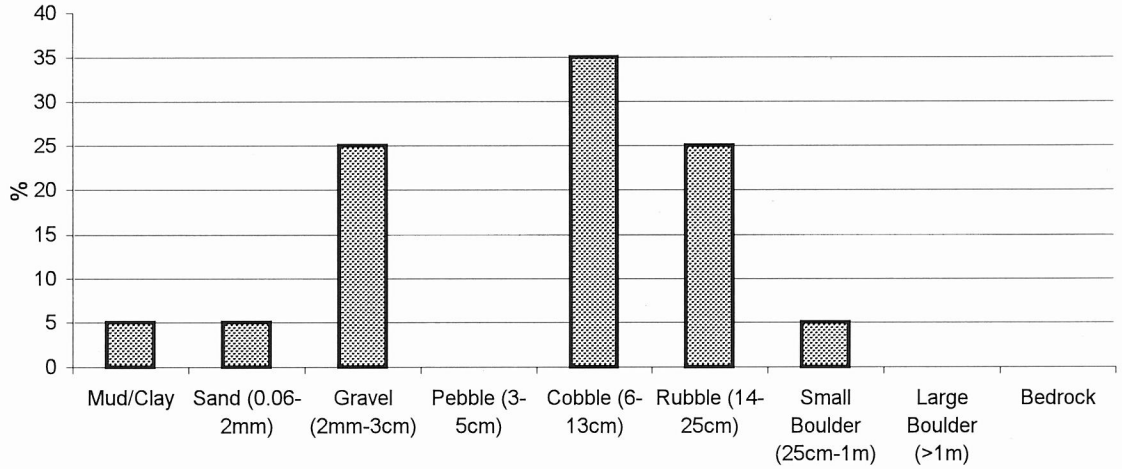


Figure 3.5.15. Substrate Characteristics for Halfway River Site HW5.

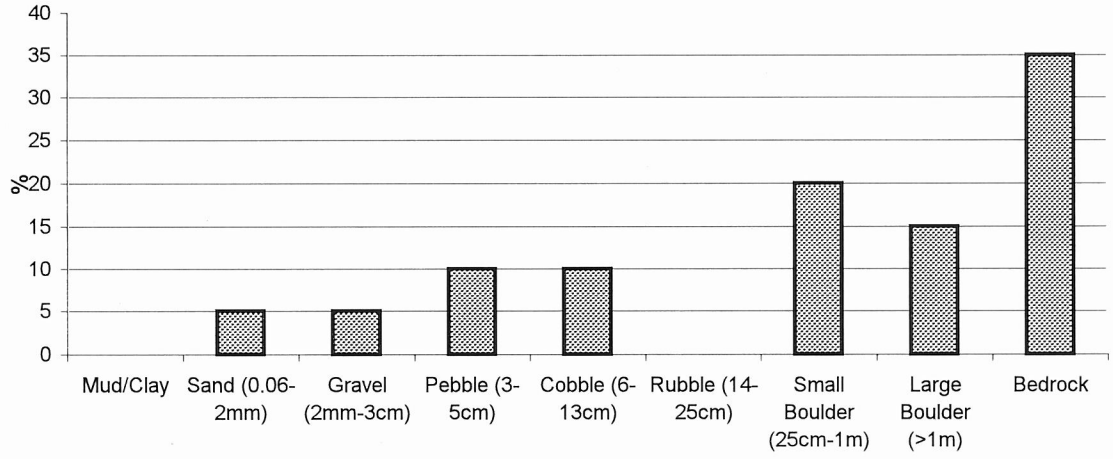


Figure. 3.5.16. Substrate Characteristics for Halfway River Site HW6.

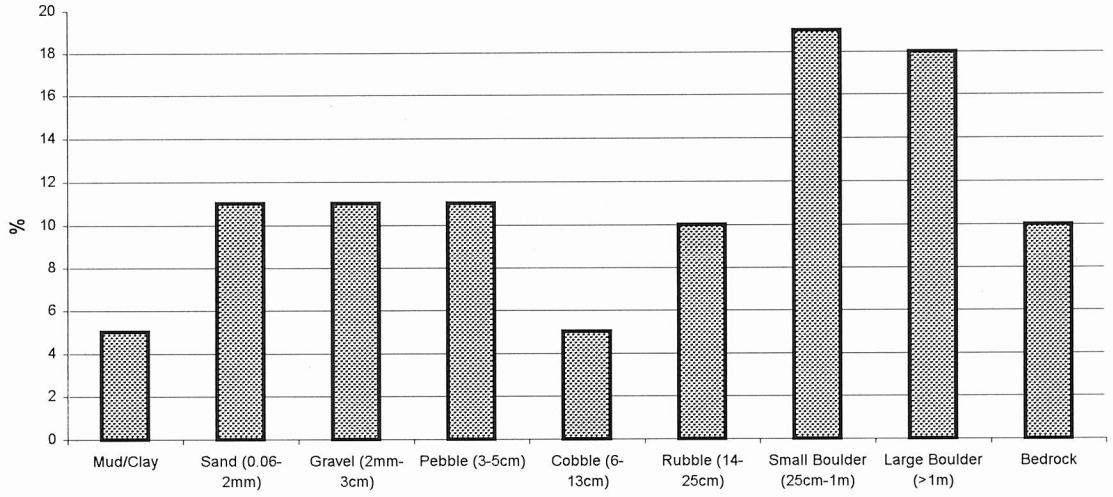
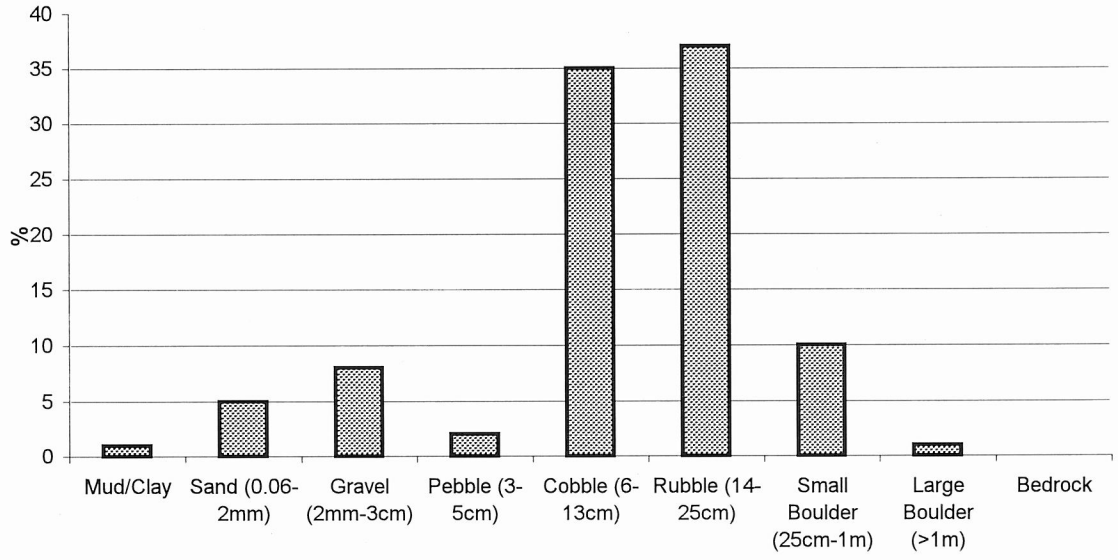


Figure. 3.5.17. Substrate Characteristics for Halfway River Site HW7.



such as the Gold River, would appear to be their non-permanent nature. Although the summer of 2001 was much drier and warmer than usual, all of the streams in the system seem to be 'flashy', undergoing large fluctuations in flow rate, and intermittent (i.e. with a tendency to become completely dry in summer). Gold Brook became dry at its downstream end in July as the water went underground, effectively trapping fish in pools and shallow wetted areas. The falling water table was clearly not able to sustain above ground flow. The main stem of the Halfway River, while becoming very shallow at times in some places, nonetheless remained available for fish, although summer time temperatures reached levels that would be stressful for salmonids.

Productivity of the upper portion of the Halfway system, a feature that is unrelated to the management of water levels in the impoundments, seems to be moderately high. However, our surveys (c. 5-6% of the total) failed to discover many suitable habitats for spawning of salmonids.

The habitat surveys did, however, note a number of places where human activities such as dumping and road building appeared to have potential for diminishing habitat quality.

The lower portion of the Halfway River system is degraded, and supports primarily coarse fish. Part of this is attributable to the storage and redirection of water, but it is also due to other land use activities. The present width, exposure, lack of cover, and unsuitable substrates in lower stations limit the potential for improving fish habitat.

3.6 Macroinvertebrate Survey

3.6.1. Introduction.

Aquatic invertebrates represent the major food supplies of fish in streams and lakes. Their abundance is a primary factor that determines the presence and abundance of highly desired species such as trout, or migratory species such as alewife or shad (*Alosa* spp.), especially in winter when shore-derived food is minimal. The species composition of the macroinvertebrates can be also used to indicate water quality in a very general way. No previous studies have apparently been conducted on the streams of the Halfway River system; hence the studies undertaken as part of this project represent the first collections.

3.6.2. Methods.

Samples for macroinvertebrates were taken at each of the electrofishing sites, coincident with, or shortly after the electrosurvey was conducted. Where suitable riffles were found, samples were taken using a standard $1ft^2$ Surber sample. The sampler was positioned in the stream where the substrate was sufficiently fine for removal and scraping. All rocks were removed from the $1ft^2$ area, brushed by hand so that the flow would carry any dislodged material into the net, and then the rocks were set aside. The procedure was repeated twice, and the three samples combined into a single composite sample.

A Surber sample is best described as semiquantitative, since it provides an estimate of abundance that is subject to many sources of error. In addition, seemingly homogeneous substrates nonetheless are heterogeneous, so the selection of appropriate sampling sites becomes a factor influencing results. For this study, Surber collections were made wherever feasible, however the substrate often dictated that the three samples taken were from the only areas suitable (i.e. the majority of the substrate was inappropriate).

At many sample reaches, where the substrate was bedrock or large boulders, use of a Surber sampler was inappropriate or impossible. Also, riffle areas or shallow runs, where

a Surber sampler can be used, do not represent the only significant habitat for invertebrates that are important indicators or food for fish: undercut banks, and areas with cobble or boulders provide microhabitat that supports different species that may also become part of the stream drift utilised by fish.

In circumstances where a semiquantitative Surber sample was impossible, a dip-net collection was made using a D-net. These results cannot be related to area, and therefore provide no indication of invertebrate density, but provide a wealth of information on species presence and relative abundance to one another.

Samples were stored in glass jars fixed in ethanol.

Analysis of invertebrate samples is a long, time-consuming process. An adequate representation of aquatic fauna requires identification at least to the level of Family, and preferably to Genus and Species. At the higher level of Order, diversity of invertebrates may yield very little information about habitat quality or productivity that is relevant to fish, because several Orders have representatives living in a wide variety of habitats, both favourable and unfavourable for fish. For the purposes of the present report, identification to Order, which is the first step in analysis, has been modified to represent quality of fish habitat. The records are presented according to the association of particular groups with good, fair or poor habitat: e.g. beetles (O. Coleoptera) and flies (O. Diptera) are subdivided according to whether they are associated with Good, Fair or Poor water quality.

Analysis of the invertebrate samples is continuing. Eventually it is intended to record the data as part of the national database of stream invertebrates being designed by Dr. Trefor Reynoldson (National Water Research Institute and Acadia University).

3.6.3 Results.

Surber samples collected where feasible, produced small numbers of macroinvertebrates at most stations. The relative abundance of major taxonomic indicator groups is shown in Figures 3.6.1 to 3.6.7. Full data are presented in Appendix 3.6.2.

Figure 3.6.1. Relative Macroinvertebrate Abundance at HW1.

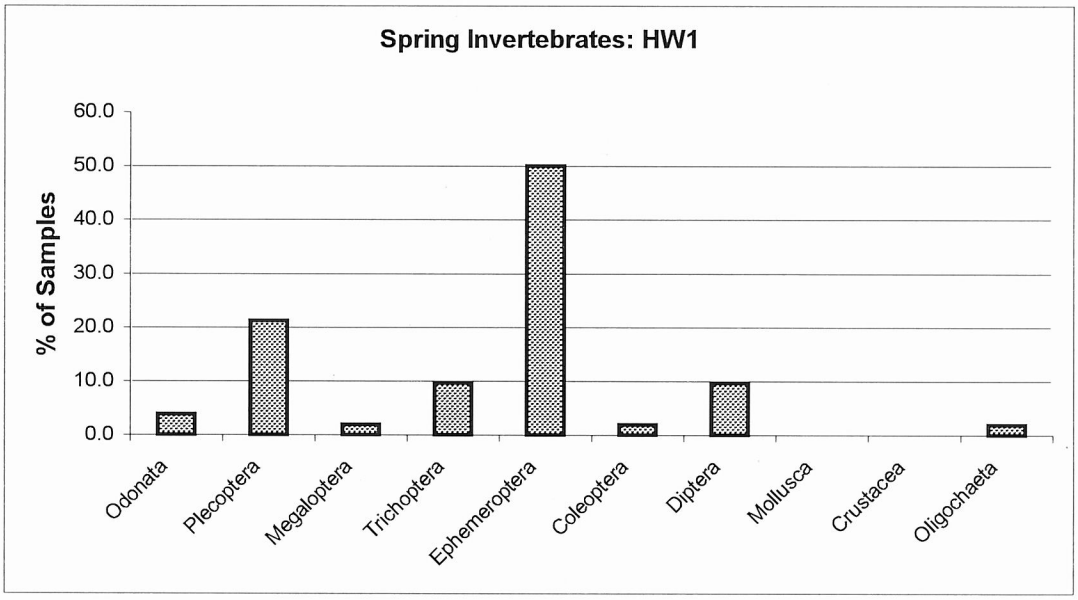


Figure 3.6.2. Relative Macroinvertebrate Abundance at HW2.

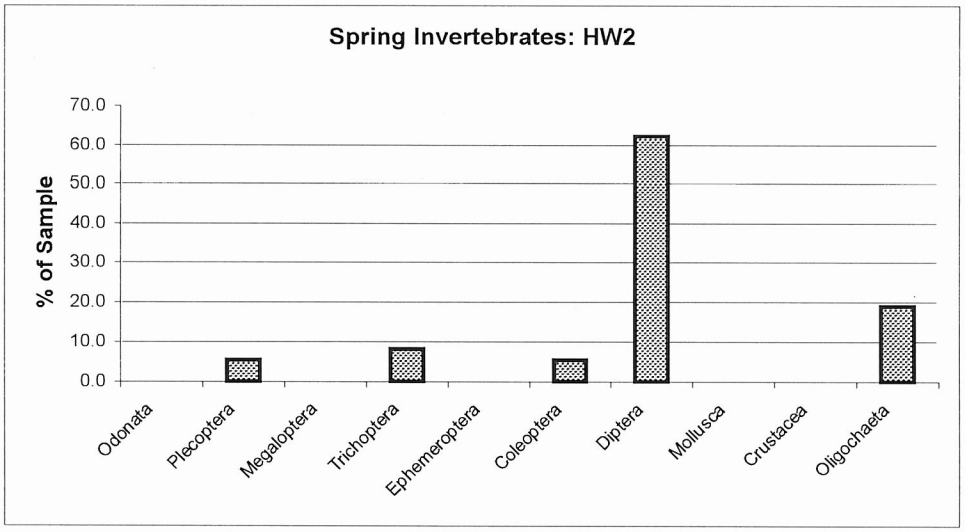


Figure. 3.6.3. Relative Macroinvertebrate Abundance at HW3.

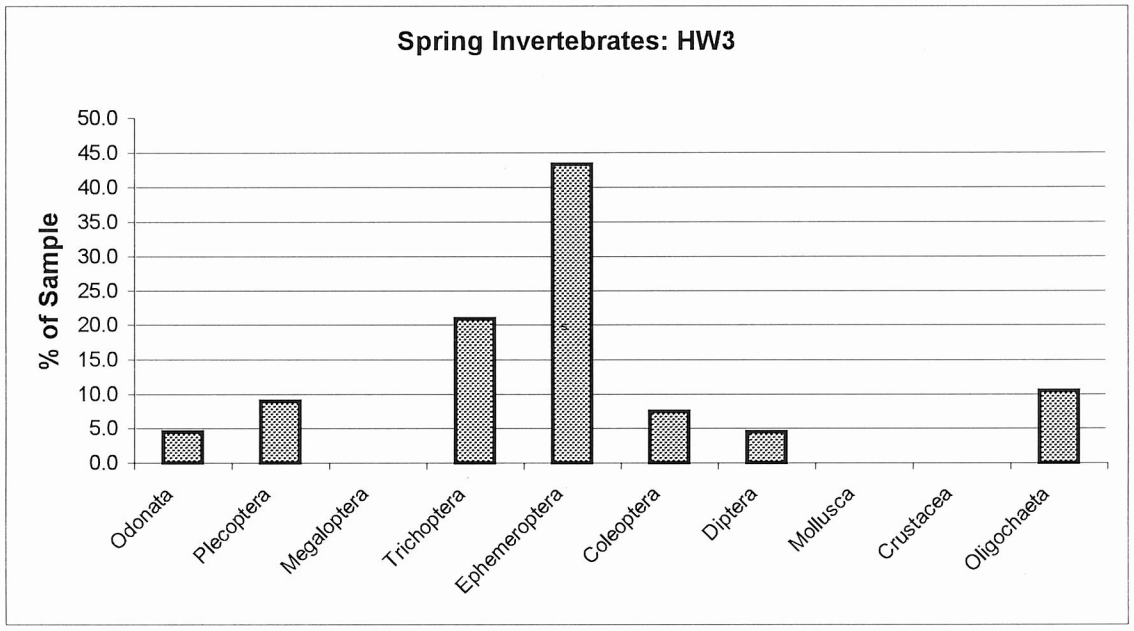


Figure. 3.6.4. Relative Macroinvertebrate Abundance at HW4.

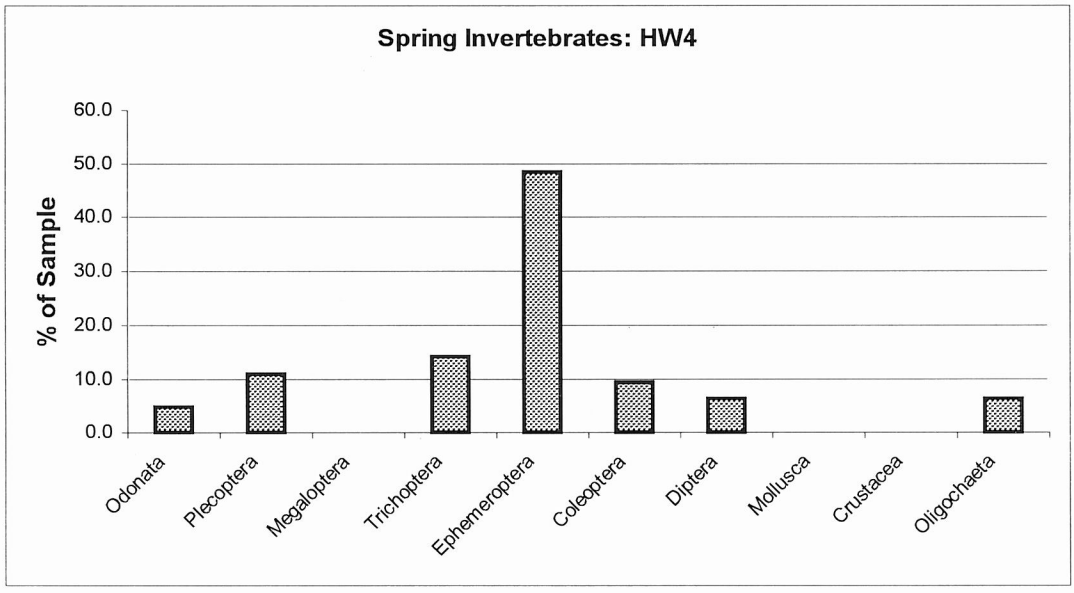
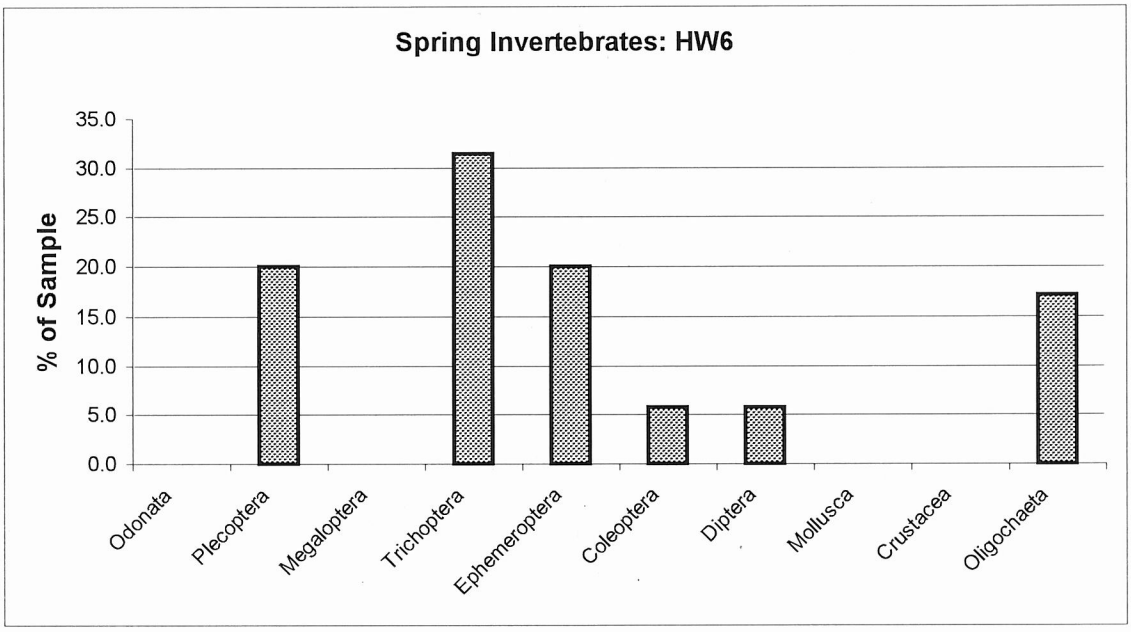


Figure. 3.6.5. Relative Macroinvertebrate Abundance at HW6.

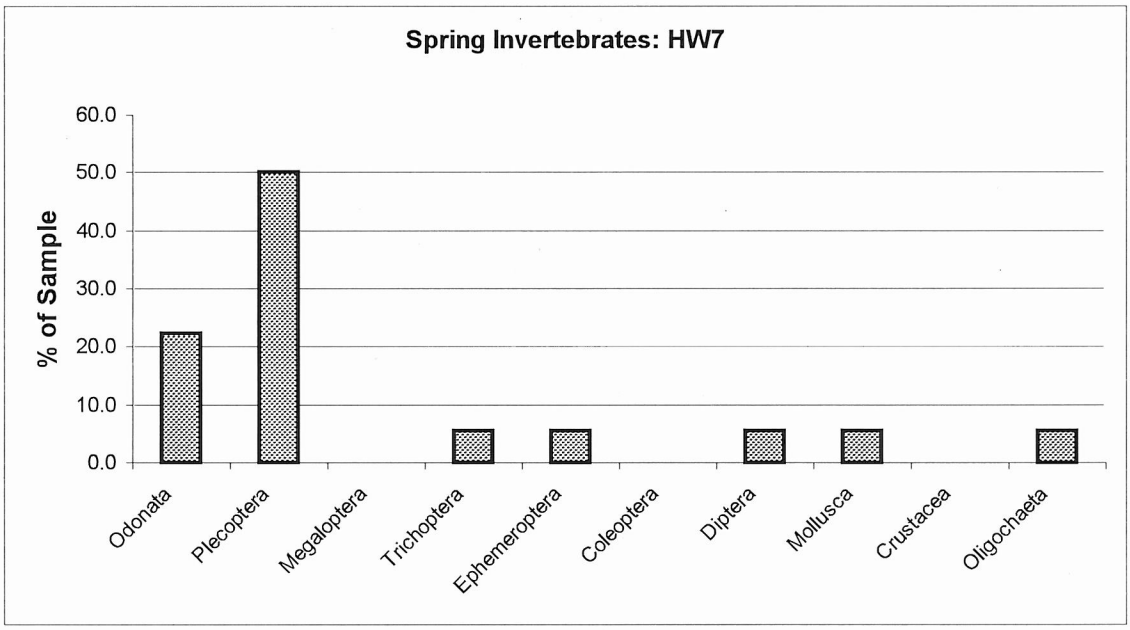


As mentioned above, the sample locations may not represent the most productive sections of the Halfway River system, but the composition of the invertebrate fauna generally indicates relatively clean water, with very few indicators of poor quality habitat. Most abundant organisms were mayflies (Ephemeroptera), stoneflies (Plecoptera), and Caddis flies (Trichoptera), with a variety of clean water beetles (Coleoptera).

The total numbers, however, do suggest that, as far as streams go, the truly aquatic fauna is not abundant. The Gold River represents the most prolific habitat sampled, but at 20 organisms per ft^2, it ranks as only moderately productive. Numbers, however, are not a sufficient indicator: Site HW2, the next, most productive, is a stressed habitat, both from low pH and high organic demand (potential oxygen deficit), and the fauna was dominated by blackfly larvae (Diptera: Simuliidae). It is not very favourable habitat where sampled, although would be a little lower down the stream where conditions improve.

Dip net samples commonly provided a variety of organisms not represented in the Surber samples, but the distributions reflected a generally clean water fauna. Complete results as obtained so far are given in Appendix 3.6.1.

Figure. 3.6.6. Relative Macroinvertebrate Abundance at HW7.



A few dip net collections have been made in vegetation beds in the impoundments, in association with vegetation studies during August. However, these have not yet been sorted or analysed.

3.6.4 Summary & Conclusions

Collections of macroinvertebrates in the Halfway River streams indicate that most waters are relatively fair to good quality from the perspective of fish habitat. They do not appear to be very productive of aquatic forms, however the extensive riparian vegetation in many areas undoubtedly provides a significant fraction of the food needed by fish. The relatively small numbers of fish caught by electrofishing at most stations may be a reflection of generally low productivity, although other factors such as highly variable water levels, high summer temperatures, or limited spawning habitat are probably equally or more important.

The intermittent nature of most of the Halfway River tributaries is probably a limiting factor for many invertebrates, such as the Odonata, that have a long life cycle. Shorter-

lived mayflies (Ephemeroptera) and stoneflies (Plecoptera) have some species that are well adapted to intermittent streams, but until the species can be identified, it is not possible to determine if the present fauna is represented by species adapted to temporary habitat.

3.7 Species at Risk

3.7.1. Introduction.

During the course of field investigations during May to August 2001, attempts were made to determine if any species or habitats of significance exist in the Halfway River watershed. Because of extensive land changes associated with forestry, agriculture and settlement in the watershed, the principal concerns about species at risk are focussed on species of wetlands, or terrestrial habitats in close proximity to watercourses. For this reason, an extensive survey was conducted of the riparian and submersed flora associated with the two impoundments (cf. Section 3.4) and portions of the Halfway River. In addition, during surveys of fish habitat on the main river and selected tributaries, observers were instructed to record observations of reptiles, amphibians, and birds, or any unusual plant species.

Investigation in the field and consultation with personnel at the Nova Scotia Museum and the Nova Scotia Department of Natural Resources have produced no records of species listed with COSEWIC (Committee on the Status of Endangered Wildlife in Canada) occurring in the Halfway River watershed. However, a number of records exist of species that are considered rare or at risk in Nova Scotia, particularly of wetland plants.

3.7.2. Species at Risk: Flora.

Table 3.7.1 lists the wetland species that are considered of concern, and expected to occur in the Halfway River area (derived from Zinck *et al.* 1994). None of these species was recorded during the vegetation survey (Section 3.4).

Table 3.7.1 Potential Wetland Plant Species of Concern

Species	Common name	NS Status
Fraxinus pennsylvanica	Red ash	R
Salix candida	Hoary willow	R
Salix sericea	Silky willow	R
Rumex mexicanus	Sorrel	R
Listera australis	Southern twayblade	I
Hepatica americana	Blunt-leaved hepatica	T
Cryptogramma stelleri	Slender cliff-brake	R
Carex bromoides	Brome-like sedge	R
Carex comosa	Sedge	R
Carex tuckermanii	Sedge	R
Verbena hastata	Blue vervain	R
Cypripedium calceolus	Yellow lady's-slipper	T
Ranunculus flammula	Buttercup	R
Anemone canadensis	Canada anemone	R
Lilium canadense	Canada lily	T
Bartonia virginica	Bartonia	R
Euthamia tenuifolia		R
Asclepias incarnata	Swamp milkweed	R
Polygonum puritanorum	Smartweed	R
Thuja occidentalis	Cedar	R
Source: Zinck, M. et al. 1994. Wetland Plants of Nova Scotia: Species of Concern.		R= rare, T= threatened

The Nova Scotia Department of Natural Resources maintains a database of species and habitats at risk or of special interest, the Significant Wildlife Habitat database. Communications with Mr. Doug Archibald, Regional Biologist, have indicated that five records of species of interest have been found in the vicinity of Davidson Lake, which is the headwater of Thompson's Brook. One record relates to two rare grass species that grow in the marsh adjacent to CKF Inc in Hantsport. An attempt to confirm the species was not successful because the field crew was unable to gain access to Davidson Lake in August 2001.

3.7.3 Species at Risk: Fauna

Table 3.7.2 Animal Species at Risk

Source: Nova Scotia Government/Natural Resources Website

Species	Common Name	Status	Possible in Watershed?
MOLLUSCS:Bivalvia			
Lampsilis cariosa	Yellow lamp mussel	R	U
Lampsilis ochraceae	Delicate lamp mussel	S	U
Lampsilis radiata	Eastern lamp mussel	S	U
Strophitus undulatus	Squawfoot	R	U
Alasmidonta varicosa	Brook floater	S	U
Margaritifera margaritifera	Eastern r. pearl mussel	S	U
INSECTS:Odonata			
Ophiogomphus adspersus	Brook snaketail	R	Y
Ophiogomphus rupinsulensis	Rusty snaketail	R	Y
Aeshna verticalis	Greenstriped darner	S	Y
Aeshna sitchensis	Zigzag darner	S	Y
Aeshna clepsydra	Mottled darner	S	Y
Enallagma minusculum	Little bluet	S	Y
Gomphaeschna furcillata	Harlequin darner	S	Y
Sympetrum danae	Black meadowfly	S	Y
INSECTS: Lepidoptera			
Oeneis jutta	Arctic jutta	R	N
Incisalia lanoraieensis	Bog elfin	R	Y
Stylurus scudderi	Zebra clubtail	R	Y
Erora laetus	Early Hairstreak	R	Y
Boloria chariclea	Arctic fritillary	R	Y
Thorybes pylades	Northern cloudywing	S	N
Danaus plexippus	Monarch	S	Y
Polygonia satyrus	Satyr angelwing	S	Y
Papilio brevicauda	Short-tailed swallowtail	S	N
Polygonia gracilis	Hoary comma	S	Y
Nannothemis bella	Elfin skimmer	S	Y
Somatochlora septentrionalis	Muskeg emerald	S	Y
Epitheca princeps	Prince baskettail	S	Y
Lanthus parvulus	Zorro clubtail	S	Y
FISH:			
Salmo salar	Atlantic salmon	R	N
Coregonus huntsmani	Atlantic whitefish	R	N
Acipenser oxyrhynchus	Atlantic sturgeon	R	N
Morone saxatilis	Striped bass	R	N
Salvelinus namaycush	Lake char	R	N

Table 3.7.2 Animal Species at Risk (continued)

Species	Common Name	Status	Possible in Watershed?
Alosa pseudoharengus	Alewife	S	N
Apeltes quadracus	Fourspine stickleback	S	Y
Margariscus margarita	Pearl dace	S	Y
Salvelinus fontinalis	Brook trout	S	Y
AMPHIBIANS:			
Hemidactylium scutatum	Four-toed salamander	S	Y
REPTILES:			
Embydoidea blandingi	Blanding's turtle	R	N
Thamnophis s. septentrionalis	Northern Ribbon Snake	S	N
Clemmys insculpta	Wood turtle	S	Y
BIRDS:			
Sialia sialis	Eastern bluebird	S	Y
Bucephala islandica	Barrow's goldeneye	S	Y
Egretta thula	Snowy egret	S	N
Branta bernicla	Brant	S	Y
Nycticorax nycticorax	Bk-crwned night heron	S	N
Sturnella magna	Eastern meadowlark	S	N
Phalaropus lobatus	Red-necked phalarope	S	N
Phalaropus fulicaria	Red phalarope	S	N
Asio flammeus	Short-eared owl	S	Y
Falco peregrinus	Peregrin falcon	R	Y
Sterna dougallii	Roseate tern	R	N
Sterna paradisea	Arctic tern	S	N
Sterna hirundo	Common tern	S	Y
Charadrius melodus	Piping plover	R	N
Histrionicus histrionicus	Harlequin duck	R	Y
Asio otus	Long-eared owl	S	Y
Fratercula arctica	Atlantic puffin	S	N
Alca torda	Razorbill	S	N
Accipiter gentilis	Northern goshawk	S	Y
Calidris pusilla	Semipalmated sandpiper	S	Y
MAMMALS:			
Lasiurus cinereus	Hoary bat	S	Y
Lasiurus borealis	Red bat	S	Y
Lasionycteris noctivagans	Silver-haired bat	S	Y
Pipistrellus subflavus	Eastern pipistrelle	S	Y
Myotis septentrionalis	Northern long-eared bat	S	Y
Myotis lucifugus	Little brown bat	S	Y
Alces alces	Moose	R	Y
Lynx lynx	Lynx	R	Y
Martes pennanti	Fisher	S	N
Martes americana	Marten	R	N

Of the above species, several are expected to be present in the Halfway River watershed, but only one, the brook trout (*Salvelinus fontinalis)* was recorded during surveys in 2001. This species has been widely raised in hatcheries and released for many years. It has not been determined whether the brook trout occurring in the Halfway River are an original stock or whether they are remnants of stocking programs. It is probable that they are native, since stocking of the river has been reduced in recent years, and hatchery-reared fish do not survive well under stressed conditions in the wild. Intermittent streams, such as those of the Halfway River, represent a stressed habitat that requires a suite of genetic adaptations for a stock to persist; such genotypes are not usually present in hatchery-reared fish. Until it is determined otherwise, it is prudent to assume the stock is a natural one.

Three other fish species at risk, the Atlantic salmon (*Salmo salar*), alewife (*Alosa pseudoharengus*) and striped bass (*Morone saxatilis)* may historically have spawned in the Halfway River, although no documentary evidence has so far been found.

During the course of field work in the summer of 2001, several records of amphibians and reptiles were contributed to the Nova Scotia Herpetofaunal Atlas (contact Ms. Sonya Teichert, Acadia University). These included: *Rana clamitans* (Green frog), *Rana palustris* (Pickerel frog), *Rana pipiens* (Leopard frog), and *Bufo* americanus (American toad). None of these represented new records, as the area has been well scrutinized in the past.

A possible extension of record is associated with capture of a cyprinid tentatively identified as a blacknose dace (*Rhinichthyes atratulus*). This would represent a significant range extension for the species which, according to Dr. John Gilhen (Nova Scotia Museum), is distributed primarily to the west in the province. The single specimen collected was returned alive, and so we shall attempt to confirm the identification during the fall survey in October 2001.

An extensive survey of riparian and sublittoral flora failed to record any rare, endangered or species of special interest among those species recorded.

3.8 Archaeological Assessment[1]

3.8.1 Introduction.

Discussions with Dr. David Christianson, and Mr. Stephen Powell (Nova Scotia Museum), and Mr. Mark Pulsifer (NS Department of Natural Resources) have indicated that there are no sites of archaeological significance officially recorded for the Halfway River watershed at this time. It is thought that, in Colonial time, the Halfway River valley might have been a common route between the Atlantic shore settlements such as Bedford, Halifax and Chester and the Annapolis Valley settlements of Melanson, Grand Pré and Nictaux.

Contacts have been made with known collectors in the area in an attempt to ascertain the presence and location of any archaeological sites. Mr. Ellis Gertridge of Gaspereau is widely recognised as an authority on pre-Contact sites, but has not made any collections himself in the Halfway River valley. No other individuals have been identified as having explored in the area of Bishopville and the Halfway River watershed in general.

Requirements of the Terms of Reference are for submission of a Management Strategy that will take advantage of any extensive drawdown of water in the impoundments. Seasonal lows within the normal operating range provide only limited opportunities for archaeological investigations, because of the extensive planning and time requirements of a formal investigation, and because the only material exposed has been equally accessible since 1927 (Front Reservoir) and 1961 (Back Reservoir), respectively. Prolonged unofficial and unregulated collecting of artefacts occurred prior to establishment of the *Special Places Protection Act.* R.S., c. 438, s.1 in 1989. It is probable that such normally exposed sites have potentially been disturbed or destroyed.

The following section outlines a proposed Management Strategy.

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[1] This section was prepared by Fundy Environmental & Educational Consultants, Wolfville, NS.

3.8.2. Management Strategy for Archaeological Resources of the Halfway River, N.S.

The following Management Strategy outlines the plans of Minas Basin Pulp and Power Company Limited for management of archaeological and historical resources that may be encountered in the Halfway River system in areas that are affected by management of the water resources. These areas consist principally of the Front and Back Reservoirs, including the land covered by water and the adjacent riparian zone, and access roads or paths to control facilities.

1. Inventory of Known Archaeological and Historic Resources.

At the present time, there are no records held by the Nova Scotia Museum in the Maritime Archaeological Resource Inventory of any archaeological or historical sites in the Halfway River watershed. Information may be in the possession of individuals who have been involved in the collection of artefacts in the watershed; however, such information has not so far been provided to the Company.

2. Procedure for Survey of Archaeological or Historical Resources.

The Company undertakes to consider the spirit and requirements of the *Special Places Protection Act* in relation to archaeological and historical resources that are discovered as a result of

a) normal operations;

b) special investigations conducted at times of planned exceptional lowering of water levels in the Halfway River impoundments; and

c) prior to any new work that has the potential for affecting or detecting archaeological or historical resources.

In the event that water levels must be dropped to levels below the normal Operating Levels for maintenance or repair purposes, the Company will initiate procedures for a more comprehensive survey, the extent of which will depend upon initial results, and on

the expected period of low water levels. Because of the long establishment of the two impoundments, sediment accumulation on the bottom in deeper portions may prevent ready observation of artefacts *in situ*, and thus the expected area of investigation will be limited to the swash zone within a few feet (vertically) of the normal lowest water level.

Procedures to be followed in such a survey are indicated below.

Procedures for Site Investigation.

A. Contract with a professional archaeologist registered with the Nova Scotia Museum to plan and supervise the survey.
B. Complete an application for a Heritage Research Permit through the Nova Scotia Museum.
C. Invite the Curator of Archaeology or his/her designate to participate in planning and fieldwork.
D. Form a Site Investigation Team consisting of the Consultant Archaeologist, the Curator of Archaeology (or designate), at least one company official, and such other persons as the Company shall determine.
E. Compile and examine aerial photographs, and any historic maps held in the Provincial Archives of Nova Scotia, relating to the study area.
F. Conduct an Initial Pedestrian Survey of the site. The survey will be under the direction of the Consultant Archaeologist and the Curator of Archaeology (or designate).
G. Location of all artefacts and suspected sites of archaeological or historical significance will be recorded as precisely as possible, using Global Positioning System (GPS) techniques and/or measured distances and directions from permanent anthropogenic, geological or geographic features.
H. Following the Initial Survey, any decisions to be made regarding collection of surface artefacts or further site investigation will be the

responsibility of the Consultant Archaeologist and the Curator of Archaeology (or designate).

I. Sites containing rich assemblages of artefacts or indicators of undisturbed archaeological resources will be properly mapped prior to removal of any artefacts. Photographs of *in situ* condition and context will accompany documentation of collections or other records wherever feasible.

3. Procedure for Notification of Discovery.

The Company will establish a policy to ensure appropriate notification of discovery in the event that archaeological or historical resources are discovered during routine operations. The essence of this policy is as follows.

a. Any employee of Minas Basin Pulp and Power Company Limited encountering potential indicators of previously unknown archaeological or historical resources on land owned or managed by the Company along the shoreline of the impoundments will inform their immediate supervisor, providing information on the location and nature of the indicator(s).

b. The Supervisor will forward this report to the Electrical/Project Engineer of the Company, who will advise the following company officials:

1) The President and Chief Operating Officer;
2) The General Manager
3) The Operator, Halfway Dams.

4. The General Manager will advise the Curator of Archaeology at the Nova Scotia Museum of the discovery, providing such information as exists.

Further official reporting action will be the responsibility of the Curator of Archaeology, and may include notifying the Advisory Committee on Protection of Special Places.

5. Responses following Discovery.

Following the discovery of new archaeological or historical resources in association with the impoundments owned or managed by the Company, the Company will attempt an initial determination of the condition and degree of vulnerability of the resources to continued company operations. This determination may be made with the assistance of the Curator of Archaeology (or designate) and/or a Consultant Archaeologist engaged for the purpose.

The Company will be diligent in keeping the nature and location of the discovery confidential until all appropriate notifications have been made. No public announcement will be made without the prior approval of the Curator of Archaeology (or designate), and will only be made if it is conformable with the spirit and letter of the *Special Places Protection Act*.

If it is determined that the newly discovered resources are at risk of destruction or serious damage from continued company activities (e.g. if the discovery is associated with excavation or other earthworks), such activity shall stop for a reasonable time to permit a more careful evaluation of:

i. the nature of the discovery;
ii. the extent of risk associated with continued Company activities;
iii. the extent of risk associated with no action for protection or removal of the resource; and
iv. appropriate measures to be taken for documentation and protection of the resource.

If, on the other hand, it is determined that normal operations, once resumed, render no new threat to the resource, the Company will continue activities and reserve further study or documentation of the resource until more convenient opportunity. This response would be appropriate where the discovery is associated with temporary change in water levels such that returning the system to normal operating levels would act to preserve the resource.

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3.9.1. Appendices

Halfway River System Report

September 2001.

Appendix 3.2.1 Water Quality of the Halfway River Impoundments, May 2001

Results of water quality analyses carried out by Phillips Analytical Services for water samples collected from the Halfway River system impoundments on 23 and 24 May 2001.

Parameter	Method	EQL	Units	Sample ID*			
				UHSP 0.5	UHSP 7.0	LHSP 0.5	LHSP 5.0
Kjeldahl Nitrogen	Blk Digest	0.1	mg/L	0.5	0.6	0.4	0.4
Total Organic Carbon	SM5310	2	mg/L	6	7	6	6
Sodium	ICP-OES	0.1	mg/L	2.9	2.8	3.2	3
Potassium	ICP-OES	0.1	mg/L	0.3	0.4	0.4	0.3
Calcium	ICP-OES	0.1	mg/L	2.1	2.1	2.1	2
Magnesium	ICP-OES	0.1	mg/L	1	1.1	1	1
Alkalinity (as CaCO3)	COBAS	1	mg/L	< 5	< 5	< 5	< 5
Sulfate	COBAS	2	mg/L	8	10	9	9
Chloride	COBAS	1	mg/L	4.6	4	4.5	4.7
Reactive Silica (as SiO2)	COBAS	0.5	mg/L	3.9	3.8	3.6	3.7
Ortho Phosphate (as P)	COBAS	0.01	mg/L	< 0.01	0.02	0.01	< 0.01
Nitrate + Nitrite (as N)	COBAS	0.05	mg/L	< 0.05	0.06	< 0.05	< 0.05
Ammonia (as N)	COBAS	0.05	mg/L	< 0.05	0.11	< 0.05	< 0.05
Iron	ICP-OES	0.02	mg/L	0.14	0.74	0.15	0.18
Manganese	ICP-OES	0.01	mg/L	0.04	0.25	0.03	0.04
Copper	ICP-OES	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Zinc	ICP-OES	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Color	COBAS	5	TCU	17	30	19	19
Turbidity	NEPH.	0.1	NTU	1.2	9	1.8	2.8
Conductivity (RCAp)	Electrode	1	uS/cm	40	39	38	38
PH	Electrode	-	Units	6.5	6.4	6.7	6.4
Hardness (as CaCO3)	Calculated	0.1	mg/L	9.4	9.8	9.4	9.1
Bicarbonate (as CaCO3)	Calculated	1	mg/L	< 5	< 5	< 5	< 5
Carbonate (as CaCO3)	Calculated	1	mg/L	< 5	< 5	< 5	< 5
TDS (Calculated)	Calculated	1	mg/L	26	28	27	27
Cation Sum	Calculated	0.1	meq/L	0.32	0.34	0.34	0.32
Anion Sum	Calculated	0.1	meq/L	0.4	0.43	0.42	0.42
Ion Balance	Calculated	-	%	10.3	11.8	10.2	13.3
Langlier Index @ 4C	Calculated	-		-4.29	-4.4	-4.1	-4.42
Langlier Index @ 20C	Calculated	-		-3.89	-4	-3.7	-4.02
Saturation pH @ 4C	Calculated	-	Units	10.8	10.8	10.8	10.8
Saturation pH @ 20C	Calculated	-	Units	10.4	10.4	10.4	10.4
Dissolved Organic Carbon	U.V.-ox	0.5	mg/L	2.8	3.2	3	2.9

* Sample ID Numbers are as follows: UHSP 0.5 – Upper impoundment at 0.5 m depth; UHSP 7.0 – Upper Impoundment at 7.0 m depth; LHSP 0.5 – Lower Impoundment at 0.5 m depth; - LHSP 5.0 – Lower Impoundment at 6.0 m depth.

Appendix 3.2.2 Water Quality of the Halfway River Impoundments, July 2001

Results of water quality analyses carried out by Phillips Analytical Services for water samples collected from the Halfway River system impoundments on 16 and 17 July 2001.

Parameters	Method	EQL	Units	Sample ID*			
				UHSU 0.5	UHSU 7.0	LHSU 0.5	LHSU 6.0
Kjeldahl Nitrogen	Blk Digest	0.1	mg/L	0.3	0.4	0.3	0.3
Total Organic Carbon	SM5310	2	mg/L	5	13	3	4
Sodium	ICP-OES	0.1	mg/L	4.4	3.8	4.1	4
Potassium	ICP-OES	0.1	mg/L	0.5	0.5	0.4	0.4
Calcium	ICP-OES	0.1	mg/L	4.5	5.5	4	3.9
Magnesium	ICP-OES	0.1	mg/L	1.8	2.4	1.7	1.6
Alkalinity (as CaCO3)	COBAS	1	mg/L	14	24	14	14
Sulfate	COBAS	2	mg/L	4	< 2	4	4
Chloride	COBAS	1	mg/L	5.5	4.7	5.8	5.8
Reactive Silica (as SiO2)	COBAS	0.5	mg/L	4.7	4.8	3.9	4.4
Ortho Phosphate (as P)	COBAS	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Nitrite	COBAS	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Nitrate + Nitrite (as N)	COBAS	0.05	mg/L	0.08	< 0.05	< 0.05	< 0.05
Nitrate (as N)	COBAS	0.05	mg/L	0.08	< 0.05	< 0.05	< 0.05
Ammonia (as N)	COBAS	0.05	mg/L	0.05	0.53	< 0.05	0.07
Color	COBAS	5	TCU	11	66	11	10
Turbidity	NEPH.	0.1	NTU	1.2	14.4	0.6	3.2
Conductivity (RCAp)	Electrode	1	uS/cm	55	68	54	54
PH	Electrode	-	Units	7.2	7.3	7.3	7.3
Hardness (as CaCO3)	Calculated	0.1	mg/L	18.6	23.6	17	16.3
Bicarbonate (as CaCO3)	Calculated	1	mg/L	14	24	14	14
Carbonate (as CaCO3)	Calculated	1	mg/L	< 1	< 1	< 1	< 1
TDS (Calculated)	Calculated	1	mg/L	34	39	33	33
Cation Sum	Calculated	0.1	meq/L	0.58	0.69	0.53	0.52
Anion Sum	Calculated	0.1	meq/L	0.52	0.66	0.53	0.53
Ion Balance	Calculated	-	%	5.12	2.25	0.13	1.41
Langlier Index @ 4C	Calculated	-		-2.82	-2.4	-2.77	-2.78
Langlier Index @ 20C	Calculated	-		-2.42	-2	-2.37	-2.38
Saturation pH @ 4C	Calculated	-	Units	10	9.7	10.1	10.1
Saturation pH @ 20C	Calculated	-	Units	9.62	9.3	9.67	9.68
Aluminium	ICP-MS	10	µg/L	20	120	10	10
Antimony	ICP-MS	2	µg/L	< 2	< 2	< 2	< 2
Arsenic	ICP-MS	2	µg/L	< 2	2	< 2	< 2
Barium	ICP-MS	5	µg/L	35	59	26	19
Beryllium	ICP-MS	5	µg/L	< 5	< 5	< 5	< 5
Bismuth	ICP-MS	2	µg/L	< 2	< 2	< 2	< 2
Boron	ICP-MS	5	µg/L	14	9	7	8
Cadmium	ICP-MS	0.3	µg/L	< 0.3	< 0.3	< 0.3	< 0.3
Chromium	ICP-MS	2	µg/L	< 2	< 2	< 2	< 2
Cobalt	ICP-MS	1	µg/L	< 1	1	< 1	< 1
Copper	ICP-MS	2	µg/L	< 2	< 2	2	< 2

* Sample ID Numbers are as follows: UHSU 0.5 – Upper Impoundment at 0.5 m depth; UHSU 7.0 – Upper Impoundment at 7.0 m depth; LHSU 0.5 – Lower Impoundment at 0.5 m depth; - LHSU 6.0 – Lower Impoundment at 6.0 m depth.

Parameters	Method	EQL	Units	Sample ID*			
				UHSU 0.5	UHSU 7.0	LHSU 0.5	LHSU 6.0
Iron	ICP-MS	20	µg/L	320	5300	230	260
Lead	ICP-MS	0.5	µg/L	< 0.5	< 0.5	< 0.5	< 0.5
Manganese	ICP-MS	2	µg/L	18	1700	10	32
Molybdenum	ICP-MS	2	µg/L	< 2	< 2	< 2	< 2
Nickel	ICP-MS	2	µg/L	< 2	2	< 2	< 2
Selenium	ICP-MS	2	µg/L	< 2	< 2	< 2	< 2
Silver	ICP-MS	0.5	µg/L	< 0.5	< 0.5	< 0.5	< 0.5
Strontium	ICP-MS	5	µg/L	16	21	14	14
Thallium	ICP-MS	0.1	µg/L	< 0.1	< 0.1	< 0.1	< 0.1
Tin	ICP-MS	2	µg/L	< 2	< 2	< 2	< 2
Titanium	ICP-MS	2	µg/L	< 2	2	< 2	< 2
Uranium	ICP-MS	0.1	µg/L	0.1	0.1	< 0.1	< 0.1
Vanadium	ICP-MS	2	µg/L	< 2	< 2	< 2	< 2
Zinc	ICP-MS	2	µg/L	4	6	6	4
Phosphorus	ICP-OES	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Dissolved Organic Carbon	U.V.-ox	0.5	mg/L	2.3	6.2	2.4	2.3

Appendix 3.2.3 Water Quality of the Halfway River Stations, May 2001.

Parameter	Units	HW1	HW2	HW3	HW4	HW5	HW6	HW7
Kjeldahl Nitrogen	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	0.7
Total Organic Carbon	mg/L	12	18	8	9	5	6	16
Sodium	mg/L	6.3	2.3	2.8	2.6	4.6	3.5	12
Potassium	mg/L	0.3	0.2	0.4	0.2	0.4	0.3	0.6
Calcium	mg/L	3.2	0.9	2.3	0.9	3	2.8	7.1
Magnesium	mg/L	1.7	0.7	1.3	0.5	1.5	1.2	2.3
Alkalinity (as CaCO3)	mg/L	6	< 5	< 5	< 5	13	6	21
Sulphate	mg/L	10	19	10	12	7	8	18
Chloride	mg/L	10	5	4.2	3.6	5.4	5.1	16.2
Reactive Silica (as SiO2)	mg/L	3.3	2.7	3.9	3.2	5.1	3.9	2.8
Ortho Phosphate (as P)	mg/L	0.01	0.02	< 0.01	0.01	0.01	< 0.01	0.02
Nitrite	mg/L	< 0.01	0.01	20	< 0.01	< 0.01	< 0.01	< 0.01
Nitrate + Nitrite (as N)	mg/L	< 0.05	< 0.05	0.11	< 0.05	< 0.05	< 0.05	0.05
Nitrate (as N)	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05
Ammonia (as N)	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05
Colour	TCU	34	62	15	38	11	14	77
Turbidity	NTU	1	0.4	0.3	0.2	1	1	4.8
Conductivity (RCAp)	uS/cm	60	26	38	25	55	44	111
pH	Units	6.6	5.4	6.4	6.1	6.9	6.9	7
Hardness (as CaCO3)	mg/L	15	5.1	11.1	4.3	13.7	11.9	27.2
Bicarbonate (as CaCO3)	mg/L	6	< 5	< 5	< 5	13	6	21
Carbonate (as CaCO3)	mg/L	< 1	< 5	< 5	< 5	< 1	< 1	< 1
TDS (Calculated)	mg/L	39	34	28	26	35	29	72
Cation Sum	meq/L	0.59	0.22	0.36	0.21	0.49	0.4	1.08
Anion Sum	meq/L	0.61	0.64	0.43	0.45	0.56	0.43	1.25
Ion Balance	%	2.37	49.7	9.66	37.1	7.08	3.79	7.28
Langlier Index @ 4C		-3.94	-5.72	-4.36	-5.02	-3.33	-3.69	-2.66
Langlier Index @ 20C		-3.54	-5.32	-3.96	-4.62	-2.93	-3.29	-2.26
Saturation pH @ 4C	Units	10.5	11.1	10.8	11.1	10.2	10.6	9.66
Saturation pH @ 20C	Units	10.1	10.7	10.4	10.7	9.83	10.2	9.26
Aluminum	µg/L	80	210	70	140	70	70	130
Antimony	µg/L	5	9	6	5	8	10	24
Arsenic	µg/L	2	3	2	2	2	3	7
Barium	µg/L	5	8	7	9	6	23	10
Beryllium	µg/L	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Bismuth	µg/L	< 2	< 2	< 2	< 2	< 2	2	4
Boron	µg/L	5	< 5	6	5	10	5	7
Cadmium	µg/L	3.5	6.7	4.3	3.4	5.7	7.1	18
Chromium	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Cobalt	µg/L	50	92	73	77	87	75	210
Molybdenum	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Selenium	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Silver	µg/L	2.8	7.1	4.5	3.5	6	7.8	19

Appendix 3.2.3 Water Quality of the Halfway River Stations, May 2001 (continued).

Parameter	Units	HW1	HW2	HW3	HW4	HW5	HW6	HW7
Strontium	µg/L	11	5	8	6	13	11	30
Thallium	µg/L	0.1	0.2	0.1	0.1	0.1	0.2	0.5
Titanium	µg/L	< 2	2	< 2	2	2	< 2	2
Uranium	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Vanadium	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Phosphorus	mg/L	1.3	2.1	1.6	1.1	1.9	2.2	6.1
Dissolved Organic Carbon	mg/L	4.7	8.9	2.6	4.7	1.9	2.1	11.7

Appendix 3.2.4 Water Quality of the Halfway River Stations, July 2001

Parameter	Units	HW1	HW2	HW3	HW4	HW5	HW6A	HW8
Kjeldahl Nitrogen	mg/L	-	-	-	-	-	-	-
Total Organic Carbon	mg/L	-	-	-	-	-	-	-
Sodium	mg/L	8.6	3.4	3.3	3	14.3	5.1	4.4
Potassium	mg/L	0.7	0.1	0.4	0.3	1.2	0.5	0.4
Calcium	mg/L	6.3	1.4	3.7	2.1	16.1	5.6	3.5
Magnesium	mg/L	3.1	1	2.2	1	9.2	2.5	1.8
Alkalinity (as CaCO3)	mg/L	20	2	10	7	68	22	11
Sulphate	mg/L	3	< 2	8	3	13	4	5
Chloride	mg/L	14.8	5.9	5.1	3.9	27.8	6.7	7.6
Reactive Silica (as SiO2)	mg/L	7.1	3.7	5.9	5.3	4.2	3.9	6.2
Ortho Phosphate (as P)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01
Nitrite	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Nitrate + Nitrite (as N)	mg/L	0.12	< 0.05	0.26	< 0.05	< 0.05	0.07	0.13
Nitrate (as N)	mg/L	0.12	< 0.05	0.26	< 0.05	< 0.05	0.07	0.13
Ammonia (as N)	mg/L	0.1	0.09	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Colour	TCU	39	150	10	14	7	7	11
Turbidity	NTU	5.1	2.2	0.2	0.8	1.1	0.6	0.6
Conductivity (RCAp)	uS/cm	98	31	55	33	228	73	57
pH	Units	7.2	5.7	6.9	6.9	7.8	7.2	7.1
Hardness (as CaCO3)	mg/L	28.5	7.6	18.3	9.4	78.1	24.3	16.1
Bicarbonate (as CaCO3)	mg/L	20	2	10	7	68	22	11
Carbonate (as CaCO3)	mg/L	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TDS (Calculated)	mg/L	56	19	36	23	127	42	36
Cation Sum	meq/L	0.97	0.31	0.52	0.33	2.22	0.72	0.53
Anion Sum	meq/L	0.89	0.25	0.53	0.32	2.42	0.72	0.55
Ion Balance	%	4.33	10.6	0.53	2.02	4.34	0.44	1.81
Langlier Index @ 4C		-2.53	-5.67	-3.35	-3.75	-1.01	-2.53	-3.13
Langlier Index @ 20C		-2.13	-5.27	-2.95	-3.35	-0.61	-2.13	-2.73
Saturation pH @ 4C	Units	9.73	11.4	10.3	10.6	8.81	9.73	10.2
Saturation pH @ 20C	Units	9.33	11	9.85	10.2	8.41	9.33	9.83
Aluminum	µg/L	40	270	10	50	< 10	10	10
Antimony	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Arsenic	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Barium	µg/L	5	8	9	13	12	24	34
Beryllium	µg/L	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Bismuth	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Boron	µg/L	6	5	7	8	39	14	5
Cadmium	µg/L	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Chromium	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Cobalt	µg/L	< 1	1	< 1	< 1	< 1	< 1	< 1

Appendix 3.2.4 Water Quality of the Halfway River Stations, July 2001 (continued).

Parameter	Units	HW1	HW2	HW3	HW4	HW5	HW6A	HW8
Copper	µg/L	< 2	3	< 2	< 2	< 2	< 2	< 2
Iron	µg/L	2000	1400	30	50	100	120	130
Lead	µg/L	< 0.5	0.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Manganese	µg/L	320	55	4	7	39	9	13
Molybdenum	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Nickel	µg/L	2	2	< 2	< 2	< 2	< 2	< 2
Selenium	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Silver	µg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Strontium	µg/L	20	6	12	9	67	21	12
Thallium	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Tin	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Titanium	µg/L	< 2	5	< 2	< 2	< 2	< 2	< 2
Uranium	µg/L	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1
Vanadium	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Zinc	µg/L	5	12	5	3	3	3	2
Phosphorus	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dissolved Organic Carbon	mg/L	3.5	14.3	1.4	2.6	1.1	1.5	0.9

Appendix 3.3.1. Mercury concentrations and Stomach contents of Fish from Halfway River Impoundments.

I.D. No.	Species	Sex	Fork Length (cm)	Total Length (cm)	Weight (g)	Collection Date	Hg (mg/kg)	A. Stomach Contents
HW(3)	*S. fontinalis*		13.9	14.3	15.3	23/05	**0.04**	Trichoptera
HW(4)	*S. fontinalis*		17.0	17.5	58.0	23/05	**0.05**	(1) Diptera; Culicidae (2) Coleoptera; Elmidae (3) Coleoptera; Hydrophilidae
HW(5)	*S. fontinalis*	F	19.5	20.1	88.0	23/05	**0.06**	(1) Coleoptera; Elmidae
HW(6)	*S. fontinalis*		21.5	22.1	133.0	23/05	**0.13**	(1) Plecoptera; Pteronarcidae (2) Coleoptera;Gyrinidae (3) Odonata; Anisoptera;
HW(7)	*S. fontinalis*	F	25.0	25.5	180.0	23/05	**0.08**	(1) Plecoptera; Pteronarcidae (2) Odonata
HW(10)	*S. fontinalis*	F	30.0	31.0	393.0	23/05	**0.18**	(1) Mollusca; Gastropoda; Prosobranchia; Valvatidae (2) Odonata; Anisoptera (3) Plecoptera; Pteronarcidae (4) Trichoptera

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, May 2001.

ID	Site	Date	P	Species	T. Length (cm)	Weight (g)	F. Length (cm)	Comments
1	HW1	22/05/01	1	Brook Trout	8.6	5.3	7.8	
2	HW1	22/05/01	1	Brook Trout	12	15.4	11.6	
3	HW1	22/05/01	1	Brook Trout	7	3.9	6.7	
4	HW1	22/05/01	1	Brook Trout	9.9	6.9	9.3	
5	HW1	22/05/01	1	Brook Trout	2.4	1.1	N/A	
6	HW1	22/05/01	1	Brook Trout	6.5	2.2	6.2	
7	HW1	22/05/01	1	Creek Chub	9.4	7.1	9	
8	HW1	22/05/01	1	Brook Trout	8.2	3.6	7.6	
9	HW1	22/05/01	1	Sucker	7.7	4.2	7.3	
10	HW1	22/05/01	1	Sucker	13.1	21.6	12.5	
11	HW1	22/05/01	1	Brook Trout	12.7	22.6	12.1	
12	HW1	22/05/01	1	Brook Trout	14.5	31.9	14.1	
13	HW1	22/05/01	1	Brook Trout	10.1	8.1	9.6	
14	HW1	22/05/01	1	Sucker	7.6	3.8	7.2	
15	HW1	22/05/01	1	Eel	25	21.4	N/A	15 in pass 1
16	HW1	22/05/01	2	Brook Trout	16	48.8	15.6	
17	HW1	22/05/01	2	Sucker	12	18.4	11.6	
18	HW1	22/05/01	2	Brook Trout	11.1	14.3	10.7	
19	HW1	22/05/01	2	Brook Trout	9.7	10.6	9.4	
20	HW1	22/05/01	2	Brook Trout	12.9	20.1	12.5	
21	HW1	22/05/01	2	Eel	26	22.1	N/A	
22	HW1	22/05/01	2	Brook Trout	5	1.4	4.3	
23	HW1	22/05/01	2	Brook Trout	9.1	7.3	8.8	
24	HW1	22/05/01	2	Sucker	8.2	4.9	7.8	
25	HW1	22/05/01	2	Sucker	4.9	1.1	4.4	
26	HW1	22/05/01	2	Sucker	7.8	4.3	7.5	
27	HW1	22/05/01	2	Brook Trout	9.1	7.3	8.7	
28	HW1	22/05/01	2	Brook Trout	7.8	5.0	7.5	
29	HW1	22/05/01	2	Brook Trout	8.5	7.0	8.1	lower barrier net down ~ 5 min
30	HW1	22/05/01	2	Brook Trout	6.4	2.1	6.2	15 in pass 2
31	HW1	22/05/01	3	Brook Trout	8.4	6.4	8.2	
32	HW1	22/05/01	3	Brook Trout	8.4	7.2	7.9	
33	HW1	22/05/01	3	Brook Trout	9.6	7.7	9.2	
34	HW1	22/05/01	3	Brook Trout	14.0	27.7	13.2	
35	HW1	22/05/01	3	Sucker	10.6	11.7	10.1	
36	HW1	22/05/01	3	Eel	30.0	29.3	N/A	
37	HW1	22/05/01	3	Brook Trout	10.0	10.5	9.5	
38	HW1	22/05/01	3	Brook Trout	12.5	21.4	12.0	8 in pass 3

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, May 2001 (continued).

ID	Site	Date	P	Species	T. Length (cm)	Weight (g)	F. Length (cm)	Comments
39	HW2	23/05/01	1	Brook Trout	9.7	6.0	9.4	
40	HW2	23/05/01	1	Brook Trout	21.1	98.0	20.7	Field's: Creek just below road crossing
41	HW2	23/05/01	1	Brook Trout	9.6	10.0	9.3	
42	HW2	23/05/01	1	Eel	N/A	N/A	N/A	
43	HW2	23/05/01	1	Eel	20.0	14.0	N/A	5 in pass 1
44	HW2	23/05/01	2	Brook Trout	9.8	14.0	9.4	
45	HW2	23/05/01	2	Brook Trout	11.4	20.0	11.0	
46	HW2	23/05/01	2	Eel	15.5	6.0	N/A	3 in pass 2
47	HW3	23/05/01	1	Brook Trout	8.1	4.0	7.8	Gold Creek, 14m above road crossing
48	HW3	23/05/01	1	Brook Trout	14.0	34.0	13.6	
49	HW3	23/05/01	1	Brook Trout	11.5	16.0	11.1	3 in pass 1
50	HW3	23/05/01	2	Brook Trout	8.3	6.0	8.0	
51	HW3	23/05/01	2	Brook Trout	7.3	4.0	7.0	
52	HW3	23/05/01	2	Brook Trout	7.5	4.0	7.3	
53	HW3	23/05/01	2	Brook Trout	12.5	20.0	12.0	
54	HW3	23/05/01	2	Brook Trout	11.4	16.0	11.0	
55	HW3	23/05/01	2	Brook Trout	8.2	6.0	8.0	
56	HW3	23/05/01	2	Brook Trout	9.1	10.0	8.7	7 in pass 2
57	HW3	23/05/01	3	Brook Trout	8.3	6.0	7.9	1 in pass 3
58	HW4	23/05/01	1	Brook Trout	7.0	4.0	6.5	
59	HW4	23/05/01	1	Brook Trout	9.0	8.0	8.6	
60	HW4	23/05/01	1	Eel	15.0	8.0	15.0	3 in pass 1
61	HW4	23/05/01	2	Brook Trout	8.0	4.0	7.7	
62	HW4	23/05/01	2	Brook Trout	7.0	4.0	6.8	
63	HW4	23/05/01	2	Common Shiner	8.7	6.0	8.4	
64	HW4	23/05/01	2	Brook Trout	7.5	6.0	7.0	
65	HW4	23/05/01	2	Eel	16.0	12.0	N/A	
66	HW4	23/05/01	2	Sucker	16.6	34.0	15.5	
67	HW4	23/05/01	2	Brook Trout	13.6	34.0	13.3	
68	HW4	23/05/01	2	Brook Trout	10.7	12.0	10.1	
69	HW4	23/05/01	2	Brook Trout	11.5	18.0	11.0	
70	HW4	23/05/01	2	Brook Trout	8.1	12.0	7.8	
71	HW4	23/05/01	2	Brook Trout	8.4	8.0	8.1	
72	HW4	23/05/01	2	Brook Trout	7.6	4.0	7.3	
73	HW4	23/05/01	2	Brook Trout	7.8	6.0	7.4	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, May 2001 (continued).

ID	Site	Date	P	Species	T. Length (cm)	Weight (g)	F. Length (cm)	Comments
74	HW4	23/05/01	2	Common Shiner	8.3	8.0	7.7	
75	HW4	23/05/01	2	Brook Trout	12.0	22.0	11.6	
76	HW4	23/05/01	2	Eel	16.0	4.0	N/A	
77	HW4	23/05/01	2	Eel	18.0	10.0	N/A	17 in pass 2
78	HW4	23/05/01	3	Sucker	10.5	8.0	10.2	
79	HW4	23/05/01	3	Brook Trout	8.0	6.0	7.8	
80	HW4	23/05/01	3	Brook Trout	12.2	18.0	11.7	
81	HW4	23/05/01	3	Sucker	11.9	16.0	10.9	
82	HW4	23/05/01	3	Eel	39.0	N/A	N/A	
83	HW4	23/05/01	3	Eel	27.0	24.0	N/A	6 in pass 3, scale still bad
84	HW5	24/05/01	1	Sucker	5.5		5.2	scale totally whacked...
85	HW5	24/05/01	1	Sucker	5.7		5.4	
86	HW5	24/05/01	1	Sucker	5.5		5.1	
87	HW5	24/05/01	1	Creek Chub	8.5		7.9	
88	HW5	24/05/01	1	Sucker	5.7		5.3	
89	HW5	24/05/01	1	Sucker	5.2		4.8	
90	HW5	24/05/01	1	Sucker	5.5		5.1	
91	HW5	24/05/01	1	Sucker	7.1		6.7	
92	HW5	24/05/01	1	Sucker	7.6		6.9	
93	HW5	24/05/01	1	Stickleback	5.9		N/A	
94	HW5	24/05/01	1	Stickleback	5.4		N/A	
95	HW5	24/05/01	1	Sucker	5.3		4.9	
96	HW5	24/05/01	1	Stickleback	5.6		N/A	
97	HW5	24/05/01	1	Sucker	5.4		5.0	
98	HW5	24/05/01	1	Creek Chub	5.6		5.2	
99	HW5	24/05/01	1	Creek Chub	8.0		7.4	
100	HW5	24/05/01	1	Sucker	5.5		5.2	
101	HW5	24/05/01	1	Brook Trout	5.8		5.4	
102	HW5	24/05/01	1	Sucker	8.0		7.5	
103	HW5	24/05/01	1	Creek Chub	8.0		7.5	
104	HW5	24/05/01	1	Creek Chub	7.3		6.8	
105	HW5	24/05/01	1	Sucker	6.2		5.8	
106	HW5	24/05/01	1	Sucker	6.8		6.4	
107	HW5	24/05/01	1	Sucker	9.0		8.2	
108	HW5	24/05/01	1	Creek Chub	6.2		5.9	
109	HW5	24/05/01	1	Sucker	6.5		6.0	
110	HW5	24/05/01	1	Sucker	5.4		5.0	
111	HW5	24/05/01	1	Sucker	6.4		6.1	
112	HW5	24/05/01	1	Brook Trout	12.4		11.9	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, May 2001 (continued).

ID	Site	Date	P	Species	T. Length (cm)	Weight (g)	F. Length (cm)	Comments
113	HW5	24/05/01	1	Creek Chub	4.7		4.3	
114	HW5	24/05/01	1	Creek Chub	4.4		3.9	
115	HW5	24/05/01	1	Creek Chub	5.6		5.3	
116	HW5	24/05/01	1	Sucker	5.6		5.4	
117	HW5	24/05/01	1	Stickleback	4.6		N/A	
118	HW5	24/05/01	1	Creek Chub	7.2		6.5	
119	HW5	24/05/01	1	Creek Chub	4.7		4.4	
120	HW5	24/05/01	1	Sucker	9.2		8.3	
121	HW5	24/05/01	1	Sucker	5.8		5.5	
122	HW5	24/05/01	1	Creek Chub	4.4		4.1	
123	HW5	24/05/01	1	Creek Chub	4.0		3.6	
124	HW5	24/05/01	1	Brook Trout	12.6		11.9	
125	HW5	24/05/01	1	Stickleback	4.3		N/A	
126	HW5	24/05/01	1	Sucker	6.0		5.7	
127	HW5	24/05/01	1	Sucker	5.1		4.8	
128	HW5	24/05/01	1	Stickleback	5.7		N/A	
129	HW5	24/05/01	1	Creek Chub	5.0		4.7	
130	HW5	24/05/01	1	Creek Chub	4.7		4.4	
131	HW5	24/05/01	1	Creek Chub	4.5		4.3	
132	HW5	24/05/01	1	Sucker	6.2		5.9	
133	HW5	24/05/01	1	Sucker	6.5		6.1	
134	HW5	24/05/01	1	Stickleback	4.5		N/A	
135	HW5	24/05/01	1	Sucker	6.0		5.6	
136	HW5	24/05/01	1	Sucker	5.0		4.8	
137	HW5	24/05/01	1	Sucker	5.3		4.9	
138	HW5	24/05/01	1	Sucker	6.4		5.9	
139	HW5	24/05/01	1	Sucker	5.3		5.1	
140	HW5	24/05/01	1	Stickleback	5.1		N/A	
141	HW5	24/05/01	1	Sucker	5.7		5.4	
142	HW5	24/05/01	1	Sucker	5.2		5.0	
143	HW5	24/05/01	1	Sucker	5.6		5.2	
144	HW5	24/05/01	1	Sucker	6.2		5.6	
145	HW5	24/05/01	1	Stickleback	5.6		N/A	
146	HW5	24/05/01	1	Sucker	5.6		5.3	
147	HW5	24/05/01	1	Sucker	5.3		4.9	
148	HW5	24/05/01	1	Sucker	5.5		5.2	
149	HW5	24/05/01	1	Sucker	5.8		5.6	
150	HW5	24/05/01	1	Sucker	5.5		5.0	
151	HW5	24/05/01	1	Sucker	5.0		4.7	
152	HW5	24/05/01	1	Sucker	7.2		6.8	
153	HW5	24/05/01	1	Sucker	5.7		5.5	
154	HW5	24/05/01	1	Sucker	5.5		5.2	
155	HW5	24/05/01	1	Sucker	5.6		5.2	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, May 2001 (continued).

ID	Site	Date	P	Species	T. Length (cm)	Weight (g)	F. Length (cm)	Comments
156	HW5	24/05/01	1	Sucker	5.5		5.1	
157	HW5	24/05/01	1	Sucker	6.4		6.0	
158	HW5	24/05/01	1	Sucker	5.3		5.0	
159	HW5	24/05/01	1	Sucker	5.4		5.2	
160	HW5	24/05/01	1	Sucker	6.5		6.0	
161	HW5	24/05/01	1	Stickleback	5.5		N/A	
162	HW5	24/05/01	1	Sucker	6.7		6.3	
163	HW5	24/05/01	1	Sucker	5.5		5.1	
164	HW5	24/05/01	1	Sucker	5.4		5.0	
165	HW5	24/05/01	1	Sucker	5.6		5.2	
166	HW5	24/05/01	1	Sucker	5.3		4.9	
167	HW5	24/05/01	1	Sucker	6.0		5.5	
168	HW5	24/05/01	1	Sucker	5.7		5.1	
169	HW5	24/05/01	1	Sucker	5.5		5.1	
170	HW5	24/05/01	1	Sucker	6.2		5.7	
171	HW5	24/05/01	1	Sucker	6.4		5.9	
172	HW5	24/05/01	1	Sucker	5.3		5.0	
173	HW5	24/05/01	1	Sucker	5.3		5.0	
174	HW5	24/05/01	1	Sucker	5.3		5.0	
175	HW5	24/05/01	1	Sucker	5.1		4.6	
176	HW5	24/05/01	1	Sucker	5.0		4.7	
177	HW5	24/05/01	1	Sucker	5.4		5.1	
178	HW5	24/05/01	1	Sucker	5.2		4.8	
179	HW5	24/05/01	1	Sucker	5.6		5.4	
180	HW5	24/05/01	1	Sucker	5.2		5.0	
181	HW5	24/05/01	1	Sucker	5.2		4.9	
182	HW5	24/05/01	1	Sucker	6.0		5.7	
183	HW5	24/05/01	1	Sucker	5.2		4.9	
184	HW5	24/05/01	1	Sucker	5.7		5.4	
185	HW5	24/05/01	1	Sucker	6.0		5.8	
186	HW5	24/05/01	1	Sucker	5.6		5.4	
187	HW5	24/05/01	1	Sucker	6.2		5.9	
188	HW5	24/05/01	1	Sucker	5.2		4.9	
189	HW5	24/05/01	1	Sucker	5.4		5.1	
190	HW5	24/05/01	1	Sucker	5.7		5.4	
191	HW5	24/05/01	1	Sucker	5.5		5.2	
192	HW5	24/05/01	1	Sucker	6.2		6.0	
193	HW5	24/05/01	1	Sucker	5.2		4.9	
194	HW5	24/05/01	1	Sucker	5.2		4.8	
195	HW5	24/05/01	1	Sucker	5.4		5.2	
196	HW5	24/05/01	1	Sucker	4.4		4.1	
197	HW5	24/05/01	1	Creek Chub	4.6		4.3	114 for pass 1
198	HW5	24/05/01	2	Trout	19.9		15.5	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, May 2001 (continued).

ID	Site	Date	P	Species	T. Length (cm)	Weight (g)	F. Length (cm)	Comments
199	HW5	24/05/01	2	Stickleback	5.5		N/A	
200	HW5	24/05/01	2	Creek Chub	5.0		4.8	
201	HW5	24/05/01	2	Creek Chub	4.7		4.4	
202	HW5	24/05/01	2	Sucker	6.5		6.2	
203	HW5	24/05/01	2	Stickleback	5.5		N/A	
204	HW5	24/05/01	2	Creek Chub	6.0		5.5	
205	HW5	24/05/01	2	Creek Chub	4.8		4.4	
206	HW5	24/05/01	2	Sucker	7.7		7.4	
207	HW5	24/05/01	2	Creek Chub	6.7		6.1	
208	HW5	24/05/01	2	Sucker	5.5		5.1	
209	HW5	24/05/01	2	Sucker	5.8		5.4	
210	HW5	24/05/01	2	Sucker	6.3		5.9	
211	HW5	24/05/01	2	Creek Chub	6.3		5.7	
212	HW5	24/05/01	2	Sucker	6.3		6.0	
213	HW5	24/05/01	2	Creek Chub	5.6		5.3	
214	HW5	24/05/01	2	Creek Chub	4.5		4.1	
215	HW5	24/05/01	2	Creek Chub	5.6		5.3	
216	HW5	24/05/01	2	Creek Chub	4.4		4.1	
217	HW5	24/05/01	2	Brook Trout	13.0		12.2	
218	HW5	24/05/01	2	Sucker	6.7		6.4	
219	HW5	24/05/01	2	Stickleback	5.2		N/A	
220	HW5	24/05/01	2	Sucker	5.9		5.5	
221	HW5	24/05/01	2	Creek Chub	4.8		4.5	
222	HW5	24/05/01	2	Sucker	5.6		5.3	
223	HW5	24/05/01	2	Creek Chub	5.2		4.9	
224	HW5	24/05/01	2	Sucker	5.8		5.5	
225	HW5	24/05/01	2	Creek Chub	4.8		4.5	
226	HW5	24/05/01	2	Sucker	5.3		4.9	
227	HW5	24/05/01	2	Sucker	5.3		4.8	
228	HW5	24/05/01	2	Sucker	6.0		5.8	
229	HW5	24/05/01	2	Sucker	6.0		5.8	
230	HW5	24/05/01	2	Sucker	5.9		5.6	
231	HW5	24/05/01	2	Sucker	5.6		5.3	
232	HW5	24/05/01	2	Stickleback	4.5		N/A	
233	HW5	24/05/01	2	Sucker	5.6		5.3	
234	HW5	24/05/01	2	Sucker	5.5		5.3	
235	HW5	24/05/01	2	Sucker	5.3		4.9	
236	HW5	24/05/01	2	Sucker	5.5		5.3	
237	HW5	24/05/01	2	Sucker	11.7		11.0	
238	HW5	24/05/01	2	Sucker	5.6		5.3	
239	HW5	24/05/01	2	Sucker	5.7		5.4	
240	HW5	24/05/01	2	Sucker	6.6		6.3	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, May 2001 (continued).

ID	Site	Date	P	Species	T. Length (cm)	Weight (g)	F. Length (cm)	Comments
241	HW5	24/05/01	2	Sucker	5.4		5.1	
242	HW5	24/05/01	2	Sucker	5.5		5.0	
243	HW5	24/05/01	2	Sucker	5.8		5.4	
244	HW5	24/05/01	2	Stickleback	5.5		N/A	
245	HW5	24/05/01	2	Sucker	6.5		6.1	
246	HW5	24/05/01	2	Sucker	7.1		6.8	
247	HW5	24/05/01	2	Sucker	5.9		5.5	
248	HW5	24/05/01	2	Sucker	7.8		7.3	
249	HW5	24/05/01	2	Sucker	6.1		5.8	
250	HW5	24/05/01	2	Sucker	5.4		5.0	
251	HW5	24/05/01	2	Sucker	5.3		5.0	
252	HW5	24/05/01	2	Sucker	5.4		4.9	
253	HW5	24/05/01	2	Sucker	6.2		5.8	
254	HW5	24/05/01	2	Sucker	5.7		5.4	
255	HW5	24/05/01	2	Sucker	6.0		5.6	
256	HW5	24/05/01	2	Stickleback	5.4		N/A	
257	HW5	24/05/01	2	Sucker	6.3		5.9	
258	HW5	24/05/01	2	Sucker	5.6		5.4	
259	HW5	24/05/01	2	Sucker	5.8		5.4	
260	HW5	24/05/01	2	Sucker	5.8		5.5	
261	HW5	24/05/01	2	Sucker	5.7		5.4	
262	HW5	24/05/01	2	Sucker	5.3		4.9	
263	HW5	24/05/01	2	Sucker	5.4		5.0	
264	HW5	24/05/01	2	Sucker	6.0		5.6	
265	HW5	24/05/01	2	Sucker	5.8		5.4	
266	HW5	24/05/01	2	Sucker	7.6		7.3	
267	HW5	24/05/01	2	Sucker	5.9		5.5	
268	HW5	24/05/01	2	Sucker	4.9		4.6	
269	HW5	24/05/01	2	Sucker	5.9		5.5	
270	HW5	24/05/01	2	Sucker	7.8		7.3	
271	HW5	24/05/01	2	Sucker	5.7		5.3	
272	HW5	24/05/01	2	Stickleback	4.4		N/A	
273	HW5	24/05/01	2	Sucker	5.4		4.9	
274	HW5	24/05/01	2	Stickleback	4.8		N/A	
275	HW5	24/05/01	2	Sucker	5.8		5.4	
276	HW5	24/05/01	2	Sucker	5.4		5.0	
277	HW5	24/05/01	2	Sucker	5.9		5.4	
278	HW5	24/05/01	2	Sucker	6.1		5.8	
279	HW5	24/05/01	2	Sucker	5.1		4.8	
280	HW5	24/05/01	2	Sucker	5.2		4.9	
281	HW5	24/05/01	2	Sucker	5.4		5.2	
282	HW5	24/05/01	2	Creek Chub	4.3		3.9	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, May 2001 (continued).

ID	Site	Date	P	Species	T. Length (cm)	Weight (g)	F. Length (cm)	Comments
283	HW5	24/05/01	2	Creek Chub	4.5		4.3	
284	HW5	24/05/01	2	Stickleback	5.7		N/A	
285	HW5	24/05/01	2	Sucker	5.5		5.0	
286	HW5	24/05/01	2	Sucker	5.5		5.3	
287	HW5	24/05/01	2	Creek Chub	7.4		7.0	90 in pass 2
288	HW6	24/05/01	1	Creek Chub	4.5		N/A	busted fin
289	HW6	24/05/01	1	Creek Chub	4.6		4.4	this site we didn't use barrier nets
290	HW6	24/05/01	1	Creek Chub	3.5		3.2	
291	HW6	24/05/01	1	Eel	23.0		N/A	
292	HW6	24/05/01	1	Eel	25.0		N/A	
293	HW6	24/05/01	1	Creek Chub	4.1		3.9	6 in pass 1
294	HW6	24/05/01	2	Eel	26.0		N/A	
295	HW6	24/05/01	2	Eel	23.0		N/A	
296	HW6	24/05/01	2	Eel	19.0		N/A	
297	HW6	24/05/01	2	Eel	21.0		N/A	
298	HW6	24/05/01	2	Creek Chub	5.6		5.2	
299	HW6	24/05/01	2	Sucker	12.9		11.9	
300	HW6	24/05/01	2	Creek Chub	3.9		3.6	
301	HW6	24/05/01	2	Common Shiner	6.9		6.3	
302	HW6	24/05/01	2	Creek Chub	3.2		3.0	
303	HW6	24/05/01	2	Creek Chub	3.5		3.3	
304	HW6	24/05/01	2	Eel	23.0		N/A	
305	HW6	24/05/01	2	Creek Chub	4.0		3.8	
306	HW6	24/05/01	2	Creek Chub	3.4		3.2	
307	HW6	24/05/01	2	Creek Chub	3.6		3.4	
308	HW6	24/05/01	2	Creek Chub	3.4		3.1	15 in pass 2
309	HW7	24/05/01	1	Brook Trout	11.8		11.0	
310	HW7	24/05/01	1	Sucker	7.0		6.5	
311	HW7	24/05/01	1	Creek Chub	5.0		4.3	
312	HW7	24/05/01	1	Creek Chub	4.7		4.5	
313	HW7	24/05/01	1	Sucker	7.7		7.3	
314	HW7	24/05/01	1	Sucker	7.7		7.2	
315	HW7	24/05/01	1	Eel	17.0		N/A	
316	HW7	24/05/01	1	Eel	29.0		N/A	
317	HW7	24/05/01	1	Eel	17.0		N/A	
318	HW7	24/05/01	1	Eel	11.0		N/A	10 in pass 1
319	HW7	24/05/01	2	Sucker	8.5		N/A	broken fin
320	HW7	24/05/01	2	Sucker	7.8		8.1	
321	HW7	24/05/01	2	Sucker	11.4		10.8	
322	HW7	24/05/01	2	Eel	N/A		N/A	got away
323	HW7	24/05/01	2	Eel	N/A		N/A	got away

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, May 2001 (continued).

ID	Site	Date	P	Species	T. Length (cm)	Weight (g)	F. Length (cm)	Comments
324	HW7	24/05/01	2	Sucker	12.5		11.7	
325	HW7	24/05/01	2	Sucker	8.9		8.4	
326	HW7	24/05/01	2	Sucker	6.2		5.7	
327	HW7	24/05/01	2	Stickleback	4.9		4.7	
328	HW7	24/05/01	2	Sucker	7.2		6.7	
329	HW7	24/05/01	2	Sucker	8.7		8.4	
330	HW7	24/05/01	2	Sucker	5.4		5.0	
331	HW7	24/05/01	2	Eel	20.0		N/A	
332	HW7	24/05/01	2	Eel	22.0		N/A	14 in pass 2
333	HW7	24/05/01	2	Sucker	9.4		8.9	outside reach
334	HW7	24/05/01	2	Sucker	9.9		9.3	outside reach
335	HW7	24/05/01	2	Sucker	13.7		13.2	outside reach
336	HW7	24/05/01	2	Sucker	10.4		9.6	outside reach
337	HW7	24/05/01	2	Sucker	12.9		12.0	outside reach

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW1	7/16/01	1	Brook Trout	10.9	10	10.3	Water is cloudy
HW1	7/16/01	1	Brook Trout	9.1	4	8.5	saw a groundHWog
HW1	7/16/01	1	Brook Trout	7.9	4	7.6	saw 1 eel
HW1	7/16/01	1	Sucker	2.3	very low	2.2	scale is questionable
HW1	7/16/01	1	Brook Trout	9.5	10	9	
HW1	7/16/01	1	Brook Trout	9	6	8.5	
HW1	7/16/01	1	Brook Trout	4.3	N/A	4	
HW1	7/16/01	1	Sucker	10	12	9.4	
HW1	7/16/01	1	Brook Trout	13.4	16	12.8	
HW1	7/16/01	1	Brook Trout	17.3	52	16.8	
HW1	7/16/01	1	Sucker	11.3	14	10.6	
HW1	7/16/01	1	Brook Trout	11.2	12	10.7	
HW1	7/16/01	1	Sucker	10.5	16	9.8	
HW1	7/16/01	1	Brook Trout	8.7	2	8.2	
HW1	7/16/01	1	Sucker	13.1	26	12.5	
HW1	7/16/01	1	Sucker	11.2	16	10.6	
HW1	7/16/01	1	Brook Trout	13.2	20	12.6	
HW1	7/16/01	1	Sucker	13	22	11.9	
HW1	7/16/01	1	Brook Trout	14	24	13.4	
HW1	7/16/01	1	Sucker	14.2	28	13.5	
HW1	7/16/01	1	Brook Trout	10.1	10	9.6	
HW1	7/16/01	1	Sucker	11.5	16	11	
HW1	7/16/01	1	Sucker	11.6	18	10.9	
HW1	7/16/01	1	Sucker	9.5	6	8.8	
HW1	7/16/01	1	Sucker	8.1	6	7.8	
HW1	7/16/01	1	Sucker	9.2	8	8.7	
HW1	7/16/01	1	Sucker	2.2	N/A	N/A	
HW1	7/16/01	1	Sucker	2.3	N/A	N/A	28 in pass 1
HW1	7/16/01	2	Sucker	7	2	6.5	real time 11:40
HW1	7/16/01	2	Sucker	8.7	8	8.1	
HW1	7/16/01	2	Brook Trout	5	N/A	4.8	
HW1	7/16/01	2	Eel	35	N/A		
HW1	7/16/01	2	Brook Trout	2.2	N/A	1.9	
HW1	7/16/01	2	Brook Trout	12.1	20	11.6	
HW1	7/16/01	2	Brook Trout	8.7	12	8.2	
HW1	7/16/01	2	Brook Trout	12.1	16	11.5	
HW1	7/16/01	2	Brook Trout	14.6	28	13.8	
HW1	7/16/01	2	Brook Trout	9.7	8	9.1	
HW1	7/16/01	2	Sucker	11.9	N/A	11.1	
HW1	7/16/01	2	Eel	35.5	N/A		
HW1	7/16/01	2	Eel	29	N/A		10 fish in pass 2 (+ 3 eels)

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW1	7/16/01	3	Sucker	10	N/A	9.4	real time 1:50
HW1	7/16/01	3	Brook Trout	10.3	N/A	9.8	
HW1	7/16/01	3	Brook Trout	10.5	N/A	10.2	
HW1	7/16/01	3	Dace	8.1	N/A	7.6	
HW1	7/16/01	3	Sucker	6.9	N/A	6.6	5 in pass 3
HW2	7/16/01	1	3 tadpoles were caught and an eel had been seen				real time is 9:37
HW3	7/16/01	1	Brook Trout	5		4.8	very dense bank vegetation and areas of the stream are dried up. Water is very high in tannins. (H2)
HW3	7/16/01	1	Brook Trout	13		12.5	stream is largely discontinuous (H2)
HW3	7/16/01	1	Brook Trout	4.9		4.7	
HW3	7/16/01	1	Brook Trout	10		10.5	
HW3	7/16/01	1	Brook Trout	4.8		4.7	
HW3	7/16/01	1	Brook Trout	9.5		9	
HW3	7/16/01	1	Brook Trout	5.6		5.4	
HW3	7/16/01	1	Brook Trout	8.5		8.2	
HW3	7/16/01	1	Brook Trout	10		9.5	
HW3	7/16/01	1	Brook Trout	5.5		5.4	
HW3	7/16/01	1	Brook Trout	14.8		14.4	
HW3	7/16/01	1	Brook Trout	9.6		9.3	
HW3	7/16/01	1	Brook Trout	4.8		4.6	
HW3	7/16/01	1	Brook Trout	11		10.5	
HW3	7/16/01	1	Brook Trout	5.5		5.2	
HW3	7/16/01	1	Brook Trout	5.1		4.9	
HW3	7/16/01	1	Brook Trout	10		9.5	
HW3	7/16/01	1	Brook Trout	5		4.8	
HW3	7/16/01	1	Brook Trout	5.5		5.1	
HW3	7/16/01	1	Brook Trout	6.7		6.4	
HW3	7/16/01	1	Brook Trout	5.2		5	
HW3	7/16/01	1	Brook Trout	5.1		4.9	
HW3	7/16/01	1	Brook Trout	4.7		4.5	
HW3	7/16/01	1	Brook Trout	4		3.8	
HW3	7/16/01	1	Brook Trout	4.8		4.6	
HW3	7/16/01	1	Brook Trout	5.5		5.2	
HW3	7/16/01	1	Brook Trout	5.3		5.1	
HW3	7/16/01	1	Brook Trout	5.4		5.1	
HW3	7/16/01	1	Brook Trout	5.2		5	
HW3	7/16/01	1	Brook Trout	4.5		4.2	
HW3	7/16/01	1	Brook Trout	4.4		4.3	
HW3	7/16/01	1	Brook Trout	4.8		4.5	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW3	7/16/01	1	Brook Trout	5.4		5.2	
HW3	7/16/01	1	Brook Trout	4.6		4.4	no fish passage through
HW3	7/16/01	1	Brook Trout	6		5.7	culvert (road)
HW3	7/16/01	1	Brook Trout	5.4		5.2	dry for 75m below then
HW3	7/16/01	1	Brook Trout	5.6		5.3	a pool, dry for another 25 then a pool
HW3	7/16/01	1	Brook Trout	5.5		5.3	Total for pass1 is 39 fish
HW3	7/16/01	1	Brook Trout	9.1		8.6	mortality
HW3	7/16/01	2	Brook Trout	5		4.8	
HW3	7/16/01	2	Brook Trout	9		8.5	
HW3	7/16/01	2	Brook Trout	5.6		5.4	
HW3	7/16/01	2	Brook Trout	5		4.8	
HW3	7/16/01	2	Brook Trout	5		4.8	
HW3	7/16/01	2	Brook Trout	5.7		5.2	
HW3	7/16/01	2	Brook Trout	5		4.6	
HW3	7/16/01	2	Brook Trout	5.4		5.1	
HW3	7/16/01	2	Brook Trout	3.9		3.7	
HW3	7/16/01	2	Brook Trout	5.3		5.1	
HW3	7/16/01	2	Brook Trout	8.9		8.5	
HW3	7/16/01	2	Brook Trout	5		4.7	
HW3	7/16/01	2	Brook Trout	4.7		4.4	
HW3	7/16/01	2	Brook Trout	10		9.4	
HW3	7/16/01	2	Brook Trout	8.6		8.1	
HW3	7/16/01	2	Brook Trout	9.5		9.1	
HW3	7/16/01	2	Brook Trout	5		4.7	
HW3	7/16/01	2	Brook Trout	13.6		13.1	
HW3	7/16/01	2	Brook Trout	5.3		5	
HW3	7/16/01	2	Brook Trout	5.2		5	
HW3	7/16/01	2	Brook Trout	4.5		4.2	
HW3	7/16/01	2	Brook Trout	5.5		5	
HW3	7/16/01	2	Brook Trout	5.7		5	
HW3	7/16/01	2	Brook Trout	4		3.8	24 in total for pass 2
HW3	7/16/01	Isolated pool	Brook Trout	14.2		13.8	rescues from isolated
HW3	7/16/01	Isolated pool	Brook Trout	17.6		16.8	pool outside the reach
HW3	7/16/01	Isolated pool	Brook Trout	10.4		9.9	going downstream
HW3	7/16/01	Isolated pool	Brook Trout	4.7		4.4	
HW3	7/16/01	Isolated pool	Brook Trout	11.1		10.5	
HW3	7/16/01	Isolated pool	Brook Trout	10.7		10.3	
HW3	7/16/01	Isolated pool	Brook Trout	12.2		11.8	
HW3	7/16/01	Isolated pool	Brook Trout	14		13.3	
HW3	7/16/01	Isolated pool	Brook Trout	14.3		13.8	
HW3	7/16/01	Isolated pool	Brook Trout	11.4		10.8	
HW3	7/16/01	Isolated pool	Brook Trout	9.8		9.4	
HW3	7/16/01	Isolated pool	Brook Trout	18		17.3	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW3	7/16/01	3	Brook Trout	11.1	12.4	10.7	
HW3	7/16/01	3	Brook Trout	11	14.6	10.5	
HW3	7/16/01	3	Brook Trout	11.2	13	10.6	
HW3	7/16/01	3	Brook Trout	8.3	6	7.9	
HW3	7/16/01	3	Brook Trout	5.2	1.8	4.8	
HW3	7/16/01	3	Brook Trout	5	1.5	4.8	
HW3	7/16/01	3	Brook Trout	9.3	9	8.9	
HW3	7/16/01	3	Brook Trout	5.2	2.4	4.9	
HW3	7/16/01	3	Brook Trout	9.2	7	8.6	
HW3	7/16/01	3	Brook Trout	5.2	1.3	4.9	
HW3	7/16/01	3	Brook Trout	5.7	2.1	5.4	
HW3	7/16/01	3	Brook Trout	4.8	0.8	4.6	
HW3	7/16/01	3	Brook Trout	3.7	0.6	3.4	
HW3	7/16/01	3	Brook Trout	6.5	3.2	6	
HW3	7/16/01	3	Brook Trout	4.8	1.3	4.4	
HW3	7/16/01	3	Brook Trout	8.5	5.7	8.2	
HW3	7/16/01	3	Brook Trout	5.5	1.6	5.1	3cm Odonata larvae
HW3	7/16/01	3	Brook Trout	5	0.9	4.8	
HW3	7/16/01	3	Brook Trout	5	1.1	4.8	
HW3	7/16/01	3	Brook Trout	5.9	2	5.7	
HW3	7/16/01	3	Brook Trout	12.9	21.1	12.3	
HW3	7/16/01	3	Brook Trout	5.5	1.5	5.2	
HW3	7/16/01	3	Brook Trout	4.6	0.9	4.4	
HW3	7/16/01	3	Brook Trout	5.3	1.7	5.1	24 fish in pass 3
HW4	7/16/01	1	Brook Trout	9.9		9.6	
HW4	7/16/01	1	Brook Trout	5		4.8	
HW4	7/16/01	1	Brook Trout	4.8		4.4	
HW4	7/16/01	1	Brook Trout	11.3		10.5	
HW4	7/16/01	1	Brook Trout	6.5		6.2	
HW4	7/16/01	1	Brook Trout	6		5.8	
HW4	7/16/01	1	Brook Trout	5.1		4.9	
HW4	7/16/01	1	Brook Trout	6.3		6	
HW4	7/16/01	1	Brook Trout	8.4		8.1	
HW4	7/16/01	1	Brook Trout	9.5		9	
HW4	7/16/01	1	Brook Trout	8.9		8.4	
HW4	7/16/01	1	Brook Trout	5.5		5.3	
HW4	7/16/01	1	Brook Trout	6		5.6	
HW4	7/16/01	1	Sucker	8.5		8.1	
HW4	7/16/01	1	Brook Trout	5.8		5.4	
HW4	7/16/01	1	Brook Trout	9.7		9.4	
HW4	7/16/01	1	Sucker	5.2		4.9	
HW4	7/16/01	1	Brook Trout	9.9		9.5	
HW4	7/16/01	1	Dace	8.8		8.3	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW4	7/16/01	1	Sucker	8.2		7.7	
HW4	7/16/01	1	Brook Trout	16.7		16.1	
HW4	7/16/01	1	Sucker	7		6.6	
HW4	7/16/01	1	Brook Trout	12.8		12.5	
HW4	7/16/01	1	Brook Trout	14.5		14	
HW4	7/16/01	1	Brook Trout	5.5		5.3	
HW4	7/16/01	1	Brook Trout	11.9		11.1	
HW4	7/16/01	1	Brook Trout	10.2		9.9	
HW4	7/16/01	1	Brook Trout	11.1		10.6	
HW4	7/16/01	1	Brook Trout	8.1		7.5	
HW4	7/16/01	1	Brook Trout	9.6		9	
HW4	7/16/01	1	Brook Trout	5.2		5	
HW4	7/16/01	1	Brook Trout	9.7		9.1	
HW4	7/16/01	1	Brook Trout	6.1		5.8	
HW4	7/16/01	1	Brook Trout	6		5.7	
HW4	7/16/01	1	Brook Trout	5.2		5	
HW4	7/16/01	1	Brook Trout	6.1		5.9	
HW4	7/16/01	1	Brook Trout	5.5		5.3	
HW4	7/16/01	1	Brook Trout	4.6		4.5	
HW4	7/16/01	1	Eel	25			
HW4	7/16/01	1	Eel	18			
HW4	7/16/01	1	Eel	19			35 trout, 4suckers, 1 dace, 4 eels
HW4	7/16/01	1	Eel	36			42 total in pass 1
HW4	7/17/01	2	Brook Trout	3.5	0.4	3.4	
HW4	7/17/01	2	Brook Trout	5.5	1.8	5.3	
HW4	7/17/01	2	Brook Trout	17	48.1	16.4	
HW4	7/17/01	2	Brook Trout	18.6	69.9	16.8	
HW4	7/17/01	2	dace	6.7	2.5	6.3	
HW4	7/17/01	2	Brook Trout	5.6	1.5	5.4	
HW4	7/17/01	2	dace	9.3	7.9	8.6	
HW4	7/17/01	2	Brook Trout	5.2	1.3	5	
HW4	7/17/01	2	Brook Trout	4.4	0.9	4.3	
HW4	7/17/01	2	Dace	9.2	7.6	8.5	
HW4	7/17/01	2	Dace	8	4.4	7.4	
HW4	7/17/01	2	Dace	8	5	7.5	
HW4	7/17/01	2	Brook Trout	11.5	14.4	11	
HW4	7/17/01	2	Brook Trout	15	25.2	14.5	
HW4	7/17/01	2	Dace	8	4.9	7.4	
HW4	7/17/01	2	Brook Trout	10	10.5	9.5	
HW4	7/17/01	2	Dace	7.2	4.1	6.5	
HW4	7/17/01	2	Brook Trout	13.5	24.1	13	
HW4	7/17/01	2	Brook Trout	10	11.1	9.6	
HW4	7/17/01	2	Brook Trout	5.2	3.1	5	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW4	7/17/01	2	Brook Trout	5.7	5.1	5.4	
HW4	7/17/01	2	Brook Trout	9	7.3	8.5	
HW4	7/17/01	2	Brook Trout	5.4	2.9	5.1	
HW4	7/17/01	2	Brook Trout	9.6	7.1	8.1	
HW4	7/17/01	2	Brook Trout	5.5	3	5.3	
HW4	7/17/01	2	Brook Trout	6.1	2.2	5.9	
HW4	7/17/01	2	Brook Trout	6.4	2	6.2	
HW4	7/17/01	2	Brook Trout	3.9	0.6	3.8	
HW4	7/17/01	2	Brook Trout	9	6.9	8.5	
HW4	7/17/01	2	Brook Trout	5.2	1.1	5	
HW4	7/17/01	2	Brook Trout	10.8	11.8	10.3	
HW4	7/17/01	2	Brook Trout	9.6	8	9.1	
HW4	7/17/01	2	Brook Trout	6.2	2.4	6	
HW4	7/17/01	2	Brook Trout	3.6	0.4	3.5	
HW4	7/17/01	2	Eel	34	N/A	N/A	diameter is about 4cm
HW4	7/17/01	2	Brook Trout	5.4	2.4	5.2	
HW4	7/17/01	2	Brook Trout	5.3	2.8	5.2	
HW4	7/17/01	2	Brook Trout	6	2.4	5.6	
HW4	7/17/01	2	Brook Trout	5.9	2.9	5.7	
HW4	7/17/01	2	Brook Trout	5.2	2	5	
HW4	7/17/01	2	Eel	28	N/A	N/A	
HW4	7/17/01	3	Brook Trout	10.8	10.1	10.3	11:45 is real time
HW4	7/17/01	3	Brook Trout	6.3	3	6	
HW4	7/17/01	3	Brook Trout	8.2	5.8	7.8	
HW4	7/17/01	3	Brook Trout	8.6	7.2	8.2	
HW4	7/17/01	3	Brook Trout	4.5	1.1	4.4	
HW4	7/17/01	3	Brook Trout	6.8	2.9	6.4	
HW4	7/17/01	3	Brook Trout	5.7	1.7	5.4	
HW4	7/17/01	3	Eel	34			
HW4	7/17/01	3	Eel	21			
HW4	7/17/01	3	Brook Trout	11.8	18.2	11.2	
HW4	7/17/01	3	Brook Trout	6.4	2.5	6	
HW4	7/17/01	3	Brook Trout	10.5	10.1	9.9	
HW4	7/17/01	3	Brook Trout	11	12.2	10.3	
HW4	7/17/01	3	Brook Trout	8.7	7.3	8.3	
HW4	7/17/01	3	Brook Trout	14.5	27.8	13.7	
HW4	7/17/01	3	Brook Trout	6.1	2.3	5.7	
HW4	7/17/01	3	Brook Trout	5.1	1.1	4.8	17 total, 15 fish
HW5	17-Jul	1	Shiner	6.9	3.4	6.7	dead fish observed
HW5	17-Jul	1	Shiner	7.7	4.1	7.3	pools are not connected on the surface
HW5	17-Jul	1	9-Stickleback	5.7	1.3	na	
HW5	17-Jul	1	Dace	5.2	1.2	4.9	
HW5	17-Jul	1	Dace	4.9	1.1	4.6	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW5	17-Jul	1	Dace	5.6	2.1	5.5	
HW5	17-Jul	1	9-Stickleback	4.5	0.5	na	
HW5	17-Jul	1	Dace	6	1.8	5.5	
HW5	17-Jul	1	Trout	4.7	1.1	4.5	
HW5	17-Jul	1	Dace	5.6	1.8	5.3	
HW5	17-Jul	1	Dace	10.4	11.8	10	
HW5	17-Jul	1	Dace	4	0.5	3.7	
HW5	17-Jul	1	Dace	6.5	2	6	
HW5	17-Jul	1	Dace	6	1.8	5.7	
HW5	17-Jul	1	9-Stickleback	5.6	0.3	na	
HW5	17-Jul	1	Dace	6.4	2.1	5.9	
HW5	17-Jul	1	Trout	5.2	1.4	5	
HW5	17-Jul	1	Shiner	5.7	2.1	5.5	
HW5	17-Jul	1	Shiner	4.6	0.7	4.2	
HW5	17-Jul	1	Trout	5.3	1.5	5.1	
HW5	17-Jul	1	Dace	4.7	0.9	4.5	
HW5	17-Jul	1	9-Stickleback	5	0.9	na	
HW5	17-Jul	1	Dace	6.3	2.6	6.1	
HW5	17-Jul	1	Dace	6.3	2	6	
HW5	17-Jul	1	Dace	5.5	2	5.2	
HW5	17-Jul	1	Dace	6.1	2	5.7	
HW5	17-Jul	1	Sucker	5.8	1.8	5.5	
HW5	17-Jul	1	Dace	8.4	6.4	8	
HW5	17-Jul	1	9-Stickleback	5.5	0.9	na	
HW5	17-Jul	1	Dace	5.7	1.7	5.4	
HW5	17-Jul	1	Shiner	5.7	2.1	5.5	
HW5	17-Jul	1	9-Stickleback	4.5	0.7	na	
HW5	17-Jul	1	Dace	4.1	0.7	3.9	
HW5	17-Jul	1	Dace	9.1	9	8.6	
HW5	17-Jul	1	Dace	6.3	2.1	5.9	
HW5	17-Jul	1	9-Stickleback	5	1	na	
HW5	17-Jul	1	Sucker	6.3	2.6	6	
HW5	17-Jul	1	9-Stickleback	4.9	0.7	na	
HW5	17-Jul	1	Dace	5.1	1.3	4.9	
HW5	17-Jul	1	9-Stickleback	4.9	1	na	
HW5	17-Jul	1	Sucker	6.6	2.6	6.3	
HW5	17-Jul	1	9-Stickleback	5.7	0.7	na	
HW5	17-Jul	1	Sucker	5.4	1.5	5.2	
HW5	17-Jul	1	Dace	6.1	3.2	5.7	
HW5	17-Jul	1	Sucker	6.1	2.2	5.8	
HW5	17-Jul	1	Sucker	5.3	1.5	5.1	
H5	17-Jul	1	Sucker	6.1	2.2	5.8	
HW5	17-Jul	1	Sucker	5.7	1.7	5.5	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW5	17-Jul	1	Sucker	6.6	2.8	6.3	
HW5	17-Jul	1	Sucker	6.2	2.6	6	
HW5	17-Jul	1	9-Stickleback	5.4	0.8	na	
HW5	17-Jul	1	Sucker	7	3.3	6.6	
HW5	17-Jul	1	Sucker	5.4	1.6	5.2	
HW5	17-Jul	1	Sucker	6	2.3	5.7	
HW5	17-Jul	1	Unknown dead fish	2.1	0.1	1.9	
HW5	17-Jul	1	9-Stickleback	5.2	0.9	na	
HW5	17-Jul	1	9-Stickleback	4.2	0.4	na	
HW5	17-Jul	1	Sucker	7.5	4.6	7.1	
HW5	17-Jul	1	Sucker	6	2.1	5.6	
HW5	17-Jul	1	Unknown dead fish	2	na	1.8	
HW5	17-Jul	1	Unknown dead fish	2	0.1	1.8	
HW5	17-Jul	1	Sucker	5.6	1.8	5.4	62 fish in pass 1 (but 3 dead)
HW6	18-Jul	1	Dace	4.9	0.7	4.6	
HW6	18-Jul	1	Sucker	6.4	2.3	6	
HW6	18-Jul	1	Dace	3.4	0.3	3.1	
HW6	18-Jul	1	Dace	7.5	3.8	7	
HW6	18-Jul	1	Shiner	5.6	1.5	5.2	
HW6	18-Jul	1	Dace	5.5	1.5	5.2	
HW6	18-Jul	1	Dace	6.6	2.8	6.2	
HW6	18-Jul	1	Dace	6.7	3.2	6.5	
HW6	18-Jul	1	Dace	5.6	2.1	5.4	
HW6	18-Jul	1	Shiner	7.4	4	6.9	
HW6	18-Jul	1	Shiner	5.6	1.6	5.3	
HW6	18-Jul	1	Sucker	7.5	3.5	7	
HW6	18-Jul	1	Sucker	6.3	2.3	5.9	
HW6	18-Jul	1	Dace	5.4	1.4	5	
HW6	18-Jul	1	Dace	5.4	1.3	5	
HW6	18-Jul	1	Dace	5.1	1.4	4.8	
HW6	18-Jul	1	Dace	5.2	1.2	4.9	
HW6	18-Jul	1	Dace	6.3	2.3	6	
HW6	18-Jul	1	Dace	6	1.9	5.6	
HW6	18-Jul	1	Dace	5.4	1.4	5	
HW6	18-Jul	1	Shiner	5.2	1.4	5	
HW6	18-Jul	1	Dace	5.4	1.3	5	
HW6	18-Jul	1	Dace	5	1.1	4.7	
HW6	18-Jul	1	Dace	5.8	1.1	5.5	
HW6	18-Jul	1	Shiner	5.4	1.4	5	
HW6	18-Jul	1	Dace	7.9	4.8	7.6	
HW6	18-Jul	1	Dace	5.3	1.5	4.9	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW6	18-Jul	1	Dace	6.5	2.8	6.1	
HW6	18-Jul	1	Dace	5.2	1.1	4.7	
HW6	18-Jul	1	Shiner	7.5	4	7.3	
HW6	18-Jul	1	Shiner	5.4	1.4	5	
HW6	18-Jul	1	Dace	5.4	1.5	5.1	
HW6	18-Jul	1	Dace	4.6	0.9	4.2	
HW6	18-Jul	1	Shiner	5.7	1.6	5.5	
HW6	18-Jul	1	Dace	5.6	1.5	5.1	
HW6	18-Jul	1	Sucker	6.4	2.6	6	
HW6	18-Jul	1	Eel	6.4	0.3		
HW6	18-Jul	1	Dace	5.6	1.6	5.2	
HW6	18-Jul	1	Dace	5	1.1	4.7	
HW6	18-Jul	1	Sucker	4.3	0.7	4	
HW6	18-Jul	1	Dace	5.5	1.5	5.1	
HW6	18-Jul	1	Shiner	5.6	1.5	5.2	
HW6	18-Jul	1	Dace	5	1.1	4.6	
HW6	18-Jul	1	Shiner	6	1.8	5.5	
HW6	18-Jul	1	Sucker	6.7	4.3	6.4	huge abscess on side
HW6	18-Jul	1	Sucker	7.6	4.8	7.4	
HW6	18-Jul	1	Dace	2.7	0.4	2.5	
HW6	18-Jul	1	Dace	3	0.2	2.7	
HW6	18-Jul	1	Eel	46	>300		
HW6	18-Jul	1	Eel	36	na		
HW6	18-Jul	1	Sucker	9.5	8.2	8.7	
HW6	18-Jul	1	Sucker	8.8	5.7	8	
HW6	18-Jul	1	Sucker	7.5	5.8	7	
HW6	18-Jul	1	Sucker	4	1.1	3.5	
HW6	18-Jul	1	Dace	3	0.3	2.7	
HW6	18-Jul	1	Dace	3.5	0.4	3.2	
HW6	18-Jul	1	Dace	3.8	0.8	3.6	
HW6	18-Jul	1	Sucker	3.8	0.5	3.6	
HW6	18-Jul	1	Dace	3.5	0.4	3.3	
HW6	18-Jul	1	Dace	2.5	0.4	2.4	
HW6	18-Jul	1	Sucker	4	0.6	3.8	
HW6	18-Jul	1	Dace	3.8	1	3.6	
HW6	18-Jul	1	Eel	16			
HW6	18-Jul	1	Eel	23			
HW6	18-Jul	1	Eel	21			
HW6	18-Jul	1	Eel	18			
HW6	18-Jul	1	Eel	19			
HW8	17-Jul	1	Trout	5.2	1.4	4.9	
HW8	17-Jul	1	Trout	5.8	1.9	5.5	
HW8	17-Jul	1	Trout	4.8	0.9	4.5	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW8	17-Jul	1	Trout	9.3	8	8.8	
HW8	17-Jul	1	Trout	4.8	1.3	4.6	
HW8	17-Jul	1	Trout	5.5	1.5	5.2	
HW8	17-Jul	1	Trout	4.7	0.9	4.5	
HW8	17-Jul	1	Trout	4.8	1.1	4.5	
HW8	17-Jul	1	Trout	4.5	1.3	4.1	
HW8	17-Jul	1	Trout	6	2.2	5.7	
HW8	17-Jul	1	Trout	5.3	1.4	5.1	
HW8	17-Jul	1	Trout	6.7	2.3	6.2	
HW8	17-Jul	1	Trout	6.8	3.1	6.4	
HW8	17-Jul	1	Trout	9.6	8.6	8.9	
HW8	17-Jul	1	Trout	5	1.1	4.6	
HW8	17-Jul	1	Trout	6	2.2	5.7	
HW8	17-Jul	1	Trout	4.5	0.8	4.4	
HW8	17-Jul	1	Trout	5.6	1.6	5.3	
HW8	17-Jul	1	Trout	6	2.4	5.6	
HW8	17-Jul	1	Trout	11.3	13.6	10.9	
HW8	17-Jul	1	Trout	11.5	15.4	10.9	
HW8	17-Jul	1	Trout	14	23.2	13.4	
HW8	17-Jul	1	Trout	5.6	1.6	5.3	
HW8	17-Jul	1	Trout	12.8	18.2	12.4	
HW8	17-Jul	1	Trout	5.9	1.9	5.7	
HW8	17-Jul	1	Trout	5.4	1.4	5.1	
HW8	17-Jul	1	Trout	5.2	1.6	5	
HW8	17-Jul	1	Trout	4.7	1	4.5	
HW8	17-Jul	1	Trout	13.8	na	13.1	
HW8	17-Jul	1	Trout	22.8	na	na	
HW8	17-Jul	1	Dace	4.8	0.6	4.4	
HW8	17-Jul	1	Trout	9.6	3.6	9.1	
HW8	17-Jul	1	Trout	4.3	0.6	4.1	
HW8	17-Jul	1	Trout	6.6	2.7	6.2	
HW8	17-Jul	1	Trout	4.8	1.2	4.5	
HW8	17-Jul	1	Trout	4.7	1.1	4.4	
HW8	17-Jul	1	Trout	11.4	16.1	10.9	
HW8	17-Jul	1	Trout	5.3	1.2	4.9	
HW8	17-Jul	1	Trout	5.2	1.5	4.8	
HW8	17-Jul	1	Trout	6.8	2.9	6.3	
HW8	17-Jul	1	Trout	5.2	1.2	4.9	
HW8	17-Jul	1	Trout	6.3	2.2	6	
HW8	17-Jul	1	eel	23			43 in pass 1 (42 fish)
HW8	17-Jul	2	eel	20.5			
HW8	17-Jul	2	Trout	13.1	22.1	12.6	
HW8	17-Jul	2	Dace	5.1	1.1	4.7	

Appendix 3.3.2. Electrofishing Data for Halfway River Sites, July 2001 (continued).

Site Name	Date	P	Species	Tot Length (cm)	Weight (g)	Fork Length (cm)	Comments
HW8	17-Jul	2	Trout	12.3	17.4	11.6	
HW8	17-Jul	2	Trout	5.9	2.2	5.6	
HW8	17-Jul	2	Trout	11.8	14	11.4	
HW8	17-Jul	2	Trout	4.8	0.9	4.6	
HW8	17-Jul	2	Trout	4.6	0.7	4.5	
HW8	17-Jul	2	Trout	5.5	1.3	5.2	
HW8	17-Jul	2	Trout	5.7	1.7	5.4	
HW8	17-Jul	2	Trout	5.3	1.9	5.1	
HW8	17-Jul	2	Trout	4.6	1	4.4	
HW8	17-Jul	2	Trout	4.9	0.7	4.7	13 in pass 2 (12 fish)
HW8	17-Jul	3	Trout	6.6	2.5	6.2	
HW8	17-Jul	3	Trout	4.5	1	4.3	
HW8	17-Jul	3	Trout	5.5	2	5.3	
HW8	17-Jul	3	Trout	10.2	10.6	9.9	
HW8	17-Jul	3	Trout	6.3	2.2	6	
HW8	17-Jul	3	Trout	9.4	7.8	9	
HW8	17-Jul	3	Trout	10.5	9	10	
HW8	17-Jul	3	Trout	6.5	2.5	6.3	
HW8	17-Jul	3	Trout	5.4	1.6	5	
HW8	17-Jul	3	Trout	6.6	2.5	6.3	
HW8	17-Jul	3	eel	13.5			
HW8	17-Jul	3	eel	12.5			
HW8	17-Jul	3	eel	12.5			13 in pass 2 (10 fish)

Appendix 3.5.1. Field Notes from Fish Habitat Surveys, Halfway River, June 2001.

Reach Walks Descriptions

H1: (June 13)
45 00.654 N/064 19.398 W 3956586 E/4984805 N elevation 120m

0-25 m (upstream from electrofishing reach)
-slate outcrop with vertical bedding, protrusions act as more natural digger logs
-river widens

25-50 m
-large vegetated island
-cascade on one side, run along the other
-more slate outcrop, substrate is platy slate cobbles
-brown organic ooze covering all of the substrate
-grassy banks
-30% canopy
-iron staining on outcrops
-lots of stinky garbage adjacent to the road

50-75 m
-more "digger bedrock"
-lots of hardwood
-riffle-pool sequence
-instream grass
-some overhang
-very tall, steep bank on the right side, very slaty

75-100 m
-dry channel on left bank 8-10m from the main channel
-steep bank shows evidence of erosion
-instream vegetation provides lots of cover
-very little canopy cover

100-125 m
-same as above

125-end
-very large pool below a waterfall
-pool is bordered on either side by precipitous drop (guard rail along Bishopville road)
-some evidence of bank erosion
-vegetation on banks but no cover in the centre of the pool
-lots of garbage
-GPS: 45 00.695 N/064 19.434 W 395610 E/4984881 N elevation 136m

Downstream
0-25 m
-massively undercut banks
-steep eroding banks
-predominately hardwood vegetation
-some instream vegetation (grasses)
-dominant substrate: cobbles

25-50 m
-shallow riffle
-sheltered canopy (60%)
-banks bordered by grasses, alders, some softwood, ferns (2 types)
-more instream vegetation
-ledges of bedrock acting as digger logs

50-75 m
-stream widens
-much instream vegetation
-natural deflection by big rock (possible reason for widening)
-island of rocky, pool area
-75% canopy cover dominated by hardwood

75-100 m
-campsite area (looks well used), road access
-grassy, more natural digger log action
-some large woody debris
-run-riffle area
-some significant overhang and an incoming brook
-deeper area behind ledge
-lots of butterflies

100-125 m
-long run
-cobble to boulder substrate
-less canopy cover ~25%
-grasses & ferns dominate riparian zone
-water striders (Hemiptera:Gerridae) numerous
-some fine-grained substrate
-mossy banks

125-150 m
-lots of cover-overhang, woody debris, large patch of instream grasses
-very steep banks
-layer of brown ooze on substrate (cobbles)
-20% canopy cover
-on the right there is a gently sloping pebble bank

150-175 m
-calmer run area
-left bank steep, eroding
-right bank gently sloping
-grass overhang
-good canopy cover
-more softwoods
-some woody debris

175-200 m
-large point bar to the left
-cut bank deeply undercut (good cover)
-flood plain is mixed (more softwoods)
-then very steep hill ~20m from bank
-incoming channel from road (-+1m), 2 other small incoming trickles (20cm wide) from mountain
-lots of overhang
-50% canopy
45 00.622 N/064 19.236 W
395876 E/4984757 N
126m elevation

H2: (June 12)
-Site H2 started at a culvert and ended 203 m downstream from the culvert.
-Vegetation is very dense on either side of stream with approximately 50% alders and 50% grasses.
- Lots of overhang present - approximately 85 to 90% of the stream channel.
-Some wildlife is evident- snakes, frogs, lots of insects and several avian species.
- Approximately 8 metres laterally from the site (off the left bank looking downstream) near the culvert start point a large face of eroding sediment is present but did not appear to directly enter the stream at the time of the visit

<u>Survey Looking Upstream -starting at the end of the selected survey reach at 203m downstream</u>
-at 200 m the stream floodplain becomes densely vegetated and infringes on much of the stream channel
-a small oil spill (<0.5 L) was found near the downstream end of the habitat reach
- throughout the reach there is a minimum slope to the stream
-at 203 m the left slope is marshy and steep. A great deal of strawberries and ferns are present. There is a great deal of undercutting but the banks appear to be stable other than the undercutting. Substrate is sand, gravel, cobble and pebble. On the right side, instream debris and cutbanks are present.
-As one moves upstream there is a series of riffles and runs with a few natural occurring digger logs.
-On the right bank there is a mixed forest with many mushrooms, mosses and clovers.

-On left side there are 4 sites of fallen logs and areas of instream debris, also on the left bank is a large fern patch
-The stream then focuses into two channels and riffles with plenty of opportunities for shade, and cover, rocks, and stable banks.
-There is lots of ground cover but open canopy throughout much of this section
-Canopy then increases slightly upstream and overhang decreases slightly.
-Substrate becomes muddy/ silty with a pool
-Stream channel then narrows with undercut banking
-A dry channel is present from the left side of the bank at the base of the slope.
-Channel becomes open with tufts of grass in and near the stream.
-While the channel remains much the same, bars and riffles become more abundant and the water flow narrows with the channel remaining the same width.
-Water becomes more shallow near the culvert and the channel more open.
-There appears to be a dry channel on the right side near the culvert (at 0m).

H4 :(June 19)
Survey looking upstream : downstream from the end of the electrofishing reach to the end of downstream - low water levels

Survey Reach from 66.6 m to 91.6 m
- Left bank has grassy bar jutting into stream and is muddy with low gradient .
- Right bank is high and left is flat and grassy
-10% canopy cover with left open side
-pebble substrate
-narrow section
-right bank is undercut and steep
-woody debris and good overhang
-increasing canopy cover to approximately 60%
-rocky bar on left with a high population of young hardwoods along the left bank
-mostly softwoods (especially on shadier right bank) , vegetation is mostly younger
-grassy banks with much less moss
-sharp meander in the stream with the right side being the cutbank side and the left bank being the point bar side
-rocks present around the meander
-the meander canopy cover was about 60 % and decreased to approximately 20% after the meander

Survey Reach from 91.6 m to 116.6 m
-slow moving water
-substrate is mostly pebbles with fine gravel and coarse sand
-grassy banks, predominantly hardwoods
-sunny (0% canopy cover)
-some moss especially on rocks
-runs dominate with small pool formation along the banks

-approaching the bridge sinuosity continues with a riffle leading into the bridge, water is moving much faster as the bridge is approached
-substrate is mostly rubble
-sheet metal present
-large woody debris
-dominantly hardwoods
-pool on right side about 3 m from the stream

Survey Reach from 116.6 m to 141.6 m
-substrate is pebble to cobble with some sand and is unstable
-instream woody debris
-VERY sharp meander
-rocky/grassy bar on left with the formation of a pool behind the bar
-very deep at meander (>1 m)
-lots of pollen and floating instream materials
-banks are muddy and eroding with undercutting on the left bank
-lots of instream woody debris almost laterally blocking the stream (very deep here as well).
--pebble to cobble substrate

Survey reach from 141.6 m to 166.6 m
-left side is steep and mostly softwood, right side is flat and grassy with softwood/hardwood mixed forest
-pebble to cobble substrate
-braided (gravel) within the channel
-undercut banks
-moss on left bank
-good canopy cover but shallow water
-very monotonous
-rocky bar on right side entering into the stream and creating a small riffle
-undercutting on left bank
-channel is broad, shallow and pebbly

Survey reach from 166.6 m to 191.6 m
-undercut banks
-evenly distributed hardwood/softwood
-fine gravel, pebble and sand substrate
-meandering within channel
-braided sections
-point bar on right, across from undercut banks (1 m) with dark sludgy root exposed on left
-rocky point bar on left, with undercut banks and small riffle on the right
-water flow picks up slightly in this area

Survey reach from 191.6 m to 216.6 m
-same substrate
-almost 100% overhang
-pebbles and gravel on left side with grassy bar and instream gravel creating small riffles
-open, sparse canopy cover until overhang starts
-alders increasing, meander in stream
-stream enters river slightly after the bend
-mostly dense hardwoods and alders from meander to river entry

End of electrofishing reach to upstream

Survey reach 0 m to 25 m upstream
-substrate is cobbles and rubble with small boulders and coarse sand
-undercut banks
-50/50 run/riffle
-70% softwood, 30% hardwood and instream grasses
-slight sinuosity
-left bank looking upstream is steep and the right bank is flat
-light is patchy
-small pool present on the right side
-large woody debris instream and there is a rocky bar
-relatively stable banks; covered by rocks, mosses and ferns
-fine gravel and overhang near the end of this reach

Survey reach 25 m to 50 m upstream
-small riffle of overland flow (constant)
-lots of ferns
-right bank is densely vegetated and flat with undercutting
-channel is littered with small boulders
-small pool near riffle entry on the left side of the channel
-undercut banks
-mostly runs
-good canopy cover (about 80%) and some overhang (5%)
-instream and bank moss
-cobble and pebble substrate
-little floodplain on left bank but is more developed on the right bank
-slight sinuosity
-little island of grass and rocks with major riffles on either side
-large sheer drop on left (road above)

Survey reach 50 m to 75 m upstream
-mostly softwoods on both sides with undercut banks
-instream rocks
-deep on left (about 0.5 m) side
-scattered large boulders

-rocky bar (no vegetation but good cover/overhang on left providing deep dark waters
-large instream woody debris especially on the right side
-overhang at a height of just under 0.5m
-almost braided
-mossy cover
-sharp protruding rock as substrate
-knee-deep pool with instream boulder providing good cover
-60% canopy cover
-many significant riffles
-stream gets shallower
-lots of foam formation
-rise in hinterland
-another rock/grassy island with two channels on either side
-undercut banking

Survey reach 75 m to 100 m upstream
-lowering gradient to the left-developed floodplain rising at the right
-lots of grass and ferns on the left with some undercutting banking and less on the right
-point bar on the right; loss moss and more sunlight exposure
-lots of gravel but still dominated but cobble and rubble and 10% boulder
-50% canopy and much more sunlight
-mostly softwood but increasing hardwood
-pools on either side of channel
-run to glide with much stiller water
-mossy banks
-overland input from left with white flowers
-much more sun exposure and overhang
-lots of water striders
-increasing undercutting of banks
-fine gravel and coarse sand substrate
-noticeably narrowing channel

Survey reach 100 m to 125 m upstream
- large floodplain on both sides and much flatter banks
-slightly more hardwoods
-dried conduit (possible overland flow) on right bank
-riffle and run series with faster waters
-more boulders and sunny patches along the banks
-large pool on left floodplain about 1m higher elevation than the stream- part of standing water system
-increasing sinuosity
-grassy/rocky banks
-some erosion (undercutting on left, rocky on right)
-trees along water line
-elevated bank water system mentioned earlier ends at this point but dried channel continues

-woody debris and overhang present
-channel widens with pool on the right side of the channel

Survey reach 125 m to 150 m upstream
-narrow channel with grassy bar to the left and a small channel about 10 m long on the other side
-large riffle
-some pooling
-run/riffle sequence with runs dominating
-major undercutting and root exposure providing a dark knee-deep pool on the right
-large meander; left grassy point bar and right undercut point bank
-same substrate throughout
-dried up pool about 4 m from the stream on the right side and dried overland input channel about 1 m down
-rocky cutbank on left
-woody debris
-major riffle system with small boulders to right of rocky cutbank
-mostly runs with steepening right bank

Survey reach 150 m to 175 m upstream
-high steep right bank
-braided with a lot more light exposure
-much less cover; about 25% canopy
-more grasses and less moss
-small boulders and gravel with gravel, cobble and rubble as the main substrate somewhat moss covered
-grassy tufts instream
-grassy/rocky bars with split channels
-LOTS of wood debris with VERY large pool fed by riffle around large boulders
-very deep with lots of light but also lots of instream cover
-lots of overhang
-entering the smaller end of the substrate spectrum
-incised banks, especially on the left (undercutting)
-lots of gravel
-end of reach marked by large and small boulders with increasing canopy cover

Survey reach 175 m to end of upstream
-left bank rising and right falling
-LOTS of small and large boulders instream and supporting the bank (moss covered)
-creates a narrow riffle channel extending from the pool, which continues from the previous reach.
-riffles mostly with runs and minimal pools near banks
-more hardwoods in the increasing light but still dominated by softwoods
-undercutting and eroding banks to the left and another dried overland channel on the right
-dark boulder crevices for cover along the left bank with spaces largely between boulders

-large boulders peppered throughout (about 25%), especially on the left side
-small pools near the right bank but no undercutting
-large riffle at the end of the reach

Survey reach to the end
- lots of riffles with large boulders and increasing canopy

GPS at end of survey reaches (upstream) 44 59.955N, 64 18.397 W , elevation=154m
UTM 396952 E, 4983489 N

GPS at end of survey reaches (downstream) 44 59.955N, 64 18.397 W , elevation=154m
UTM 396952 E, 4983489 N

H5: (June 20)
263.8 m-238.8 m (downstream from the electrofishing reach)
- still channel
-small riffle
-cobble to boulder (mudstones) with bedrock outcropping
-mostly softwoods (about 70%) with some alders and hardwoods (about 30%)
-mosses
-eroding banks
-steep right banks and extensive left floodplain
-wild cucumber
-low gradient
-standing water
-rocky bar with channel on either side of bar just after debris deposit
-sinuosity about 10 m

238.8 m-220.8 m
-dried channel entry just before debris deposit
-extensive wide rocky bar jutting into the stream just before the debris
-same substrate but gets smaller in clast size upstream
-runs and pools
-grassy banks
-good cover/overhang
-small pool on right bank under fallen tree
-rusting metal rod
-very large instream woody debris
-large rocks protruding from watercourse

220.8 m-195.8 m
-undercutting on right bank
-about 85% hardwood/alders
-increasing pebble/gravel substrate
-softwoods more dominant on right than left banks

- mostly runs with small pools and riffles
-large pool
-eroding banks with sediment input on both sides
-scrap metal (culvert)
-vegetation about 10% alders, 30% hardwood, 60% softwood
-runs but some pooling
-water in 50% of channel
-good cover
-canopy not as low
-wide floodplain on left and eroding bank on right
-more culvert salvage
-left eroding bank and right well vegetated bank (grass)
-large pieces of loose bedrock

195.8 m-170.8 m
-the banks are undercut
-the rock size is increasing, there are a number of boulders
-in the first half of this section the water occupies 90% of the channel width, while it only occupies <50% in the second half
-on the right side (looking upstream) there is heavy undercutting (~40 cm)
-as we near the 195.8 m mark it gets sunny, there is less cover and the area is very open
-we think there are wild cucumbers growing on the banks

170.8 m-145.8 m
-lots of alders, some hardwood, less softwood
-grass bars within the stream
-lower amounts of canopy cover
-lots of grass on the banks
-the water covers about 50-60% of the channel width
-the area is a run

145.8 m-120.8 m
-there is some instream debris (mostly trees)
-the covered substrate (with water) is smaller in size (rubble→ fine sand)
-the dry substrate is rubble→boulder
-the grass tufts take over the river and narrow the channel
-pretty open (~85%)
-there are some alders, the bank is pretty stable although there is some erosion
-there is fine sediment collecting behind some of the small boulders

120.8 m-95.8 m
-there is increased alder cover for the first half and then it is open again
-the rocks are almost splitting the stream into two halves
-to the left is a small bar, to the right is heavy grass cover
-the amount of softwood is increasing
-there is a rocky bar on the right bank that grades into grass

-the channel narrows with lots of grass on the sides
-near the 120 mark there is good alder cover, some softwood cover, and just less than 100% overhang
-there is more organic and sediment deposition
-run

95.8 m-70.8 m
-the left bank is dominated by softwoods and ferns, while the left bank is dominated by hardwoods and is more open
-there is little cover, very sunny
-the bank is steeper on the right bank than the left
-there is erosion from the banks
-the first ¼ is cobble → boulder, then bedrock, and the water occupies 60-90% of the channel width, but near 95.8m <50%

Upstream
0 m -30 m
-to the concrete culvert
-bedrock to the culvert, covered with fines
-to the first concrete block there is good alder cover ~75%
-to the next concrete block also good cover
-to the culvert is very open
-cobble dominated
-lots of scrap metal and grass
-the left bank is eroding
-there are ponds between the concrete where lots of fish were observed

H6: (June 21)
-the river is wide and unable to promote canopy cover
-the bedrock is blue shale and sandstone
-the river substrate ranges from sand-cobble with areas of exposed bedrock
-there are no river cut banks or undercuts, only grass or sand leading edges
-the reach is 80-90% silt laden
-the vegetation consists of oak, alder, willow, maple, birch, possibly mountain ash, pine, and poplar
-the river is very straight: long flows interspersed by a few riffles
-eels, squirrels and a large snapping turtle was observed

H7 :(June 22)
Distance from culvert to electrofishing reach- looking upstream:
-large pool at culverts (2) outflow-approximately 1 m at its deepest and approximately 5 m in width
-steep banks- grassy
-some hardwood- predominantly alders
- rocks in reach creating a riffle

-channel has steep sides with a very small gradient throughout its length
-substrate is pebble and gravel

Electrofishing reach length is 45.8 m
30% canopy cover
grassy tufts on left bank
narrowing flood plain on left
channel has riffles and foam formation
instream there are large rocks and woody debris
pebble and gravel substrate
gypsum outcrops are on the right bank
water in channel slows
increasing overhang
on right there is a rubble bar jutting into the channel

Reach from electrofishing reach end to 70.8 m:
-high right bank eroding
-lower left bank
-lots of overhang
-mostly alders with softwoods behind
-surrounding channel vegetation clears with a muddy bar on the left and a rocky bar to the right with a narrowing channel
-foam formation
-gypsum outcrop
-riffle
-pool with lots of foam formation
-cut bank/point bar series
-substrate is rubble underlain by coarse sand and mud that eventually grades into bedrock (salty bedrock)
-lots of instream debris
-meandering stream- at first bend there's a deep pool, sandy substrate, major undercutting on right, dark waters
-wild cucumber plants
-at second bend there's undercutting on the right bend, a rubble barrier creating a pool against the right bank with foam formation
-algae present around this area
-cutbank/point bar series
-decent cover (70%) , mixed forest
-runs

Reach from 70.8 m to 95.8 m
-Grassy banks on right with rubble extending from the left bank into the stream.
-90% canopy cover
-Steep banks on right, eroding and undercut on left
-Rubble progressing into bedrock from the right bank
-25% overhang/canopy cover

-light patches with extensive ferns and grasses on left floodplain
-eroding uncovered right bank
-riffle
-bedrock/mud bottom, sand and cobble
-increasing overhang but only about 50% canopy cover
-dark brown water

Reach from 95.8 m to 120.8 m
- habitat is very similar to previous reach
- substrate is larger rubble and small boulder
-increasing light exposure
-mostly alders and softwood with good overhang (approximately 30%)
-decreasing canopy cover
-near the end of this reach the floodplain increases on both sides of stream
-banks are steeping on both sides
-instream debris present
-small input from left side
-mostly softwoods with good canopy (approximately 85-90%)
-riffle with narrowing channel (only about 60% water of the channel width)
-mud on either side
-braided channel to end of reach with sediment bar instream and large channel on left
-extensive grass cover

Reach from 120.8 m to 145.8 m
-lots of instream debris, especially fallen trees (conifers)
-outside instream debris there is very little overhang
-good canopy cover (approximately 85%)
-widening floodplain on right with less floodplain on the left side with increasing left slope.
-deeper waters
-eroding banks; especially on the left side where sediment input is evident
-stream input (not active) on steep left side
-substrate returns to bedrock overlain by pebble and rubble
-ferns on right side of bank
-mixed softwood/hardwood
-lots of decaying leaves present
-watercourse is mostly runs
-foam formation is present
-dried channel (about 2 m width, 10 m length) approximately 4m from the right floodplain
-slightly increasing gradient
-lots of grasses and ferns
-good flow

Reach from 145.8 m to 170.8 m
-substrate is bedrock overlain by finer sediment
-floodplain appears to be unchanging with relatively stable banks with the exception of evidence of left bank erosion
-about 85% canopy with little overhang
-some instream woody debris
-flat bedrock
-some rock scattered throughout as instream debris
-increasing conifers
-about 10% overhang
-bullet casing found
-slightly tilting bedrock near far end
-increasing stream width and decreasing floodplain on the right

Reach from 170.8 m to 195.8 m
-long bar of cobble-rubble of about 10m in length with channel on either side
-pool with a deep substrate (5-6 cm) of gravel and sand
-generally the same mixed forest type but slightly more softwoods
-7m from the end of this reach there is virtually no canopy (about 75% canopy cover until this point) and the stream becomes much narrower with a great deal of instream debris
-instream dry gravel deposits
-full width of channel is occupied
-ferns and grasses cover right bank
-no cover with great sun exposure on the steep left bank slowly developing into low level high grasses, alders and meadow-like conditions (power line corridor).
-small eroding sediment input obvious from right bank
-mostly alders at the end of this reach
-all runs
-great sun exposure (warm)
-at the end the stream becomes a section of deep standing water with fine sand and bedrock substrate

Appendix 3.6.1. Halfway River Macroinvertebrate Collections, May 2001.

Table 3.6.1 Semi-quantitative Surber samples from the Halfway River, May 2001.

Station	HW1	HW2	HW3	HW4	HW6	HW7
Date Sampled	**23/05/01**	**23/05/01**	**23/05/01**	**24/05/01**	**31/05/01**	**31/05/01**
Number of Samples	3x	3x	3x	3x	3x	3x
Sample Type	Surber	Surber	Surber	Surber	Surber	Surber
Water depth (cm)	<30	<10	<20	<15	<50	<15
Substrate	cobble	sand/organic	pebble/gravel	gravel, cobble	sand, pebbles	boulder-pebble
Sample Number	230501H1B	230501H2	230501H3	240501H4	240501HW6	240501HW7
Recorders Name	Steve Sanford	Kerri Seward	Dawn MacNeill	Dawn MacNeill	Dawn MacNeill	Dawn MacNeill
Good Water Quality:						
Order Plecoptera (stonefly)	11	2	6	0	1	9
Suborder Megaloptera (dobsonfly)	1	0	0	0	0	0
Order Trichoptera (caddisfly)	3	3	10	2	2	1
Order Coleoptera (waterpenny/riffle beetle)	1	0	5	0	1	0
Order Ephemeroptera (mayfly)	7	0	27	3	2	1
Phylum Mollusca (snails/bivalves)	0	0	0	0	0	1
Total GWQ	**23**	**5**	**48**	**5**	**6**	**12**
Fair Water Quality:						
Order Crustacea (crayfish/sow bug/scuds)	0	0	0	0	0	0
Order Odonata (damselfly/dragonfly)	2	0	2	1	0	4
Order Diptera (watersnipe fly larva)	0	1	0	1	0	0
Order Coleoptera (beetle larvae)	0	2	0	0	0	0
Phylum Mollusca (clams)	0	2	0	0	0	0
Total FWQ	**2**	**0**	**2**	**2**	**0**	**4**
Poor Water Quality:						
Order Oligochaeta (worms)	1	7	7	0	6	1
Order Hirudinea (leeches)	0	0	0	0	0	1
Order Diptera (midge/blackfly larva)	2	22	3	1	0	1
Phylum Mollusca (pouch snails)	0	0	0	0	0	0
Total PWQ	**3**	**29**	**10**	**1**	**6**	**3**
GWQ:FWQ:PWQ	23:02:03	5:07:29	48:02:10	5:02:01	6:00:06	12:04:03
Unknown				1	1	1
Water Strider						
Other		Fly pupa (1)				
Diptera : Chironomidae						
Egg					1	
Totals per sample	**9.3**	**11.3**	**20.0**	**2.7**	**4.0**	**6.3**