Fraser River Sediment Removal Surveys

Statistical Meta-Analysis (2004 to 2008)

Prepared for:

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EXECUTIVE SUMMARY

During the annual spring freshet in the Fraser River, sediment deposits between Hope and Mission. This deposition can raise the river bed and, in some areas, increase pressure and potentially threaten the existing dyking system. Until recently sediment was removed from the river by for-profit operators. In January 2008 the Province of British Columbia assumed the responsibility for sediment removal, changing it from a business model to one of public safety. Emergency Management British Columbia (EMBC) is responsible for the removal of sediment from potential flood risk areas. Under a 2004 agreement with the Department of Fisheries and Oceans Canada (DFO), all sediment removal activities from these areas are required to undergo biophysical monitoring before and after removal takes place. These monitoring programs are intended to determine if potential impacts to biological communities and associated habitat have resulted from extraction activities. The results of these studies are to then be used to inform subsequent management decisions.

G3 Consulting Ltd. (G3) was requested by EMBC and DFO to obtain and compile monitoring reports from 2004 to 2008 and conduct an assessment of potential impacts to fish and fish habitat (e.g., fish, invertebrates, sediment, habitat and topography) resulting from sediment extraction activities. These studies were conducted prior to EMBC taking over responsibility for sediment removal and are not indicative of the current program. Since taking over the program in 2008 EMBC has yet to complete a program and has complied with all requirements stipulated under the *Letter of Agreement*.

G3 evaluated the effectiveness of the existing monitoring program through use of appropriate statistical analyses and made recommendations to optimize program design and improve the ability to detect impacts and, if possible, reduce overall project implementation costs. It was concluded that data collected to date do not provide evidence of an overall effect of scalping on benthic infauna or fish. This was attributed, to a large extent, to limitations in sampling design. This review assessment revealed that season (a reflection of time of year and associated river flow rates and biophysical conditions) and location were primary factors affecting benthic invertebrate communities. Sediment removal (scalping) effects on measures used to assess community health were shown to vary with season (time of year and associated flow rate and biophysical condition), location and study. When seasonal effects (e.g., flow rate and associated biophysical condition) were removed (as a measured influence in assessments) biological communities from the Reference and Scalped sites appeared similar.

Within the present design, fish were not found to be a useful indicator in assessing the effects of scalping. Analyses were hampered by limited Reference Site sampling and meaningful measurements and associated indices (e.g., length, weight, condition, etc.).

Discussions among EMBC, DFO and relevant consultants, as generated from an earlier draft of this report, concurred that the program, as currently designed, does not adequately address questions of magnitude and extent of effect. This is reflected in the inconclusive results to date of the work conducted by various consultants from 2004 to present (summarized in Section 4.1).

The program would be substantially improved by redesigning a modified Before-After/Control-Impact (MBACI) study or Reference Condition Approach (RCA) with efforts and associated resources directed to a few select locations which have been shown to have good comparable Reference Sites and limited additional confounding factors (e.g., interfering influences such as natural or human-based variability that affect a given site and which make comparisons difficult). Should it be decided that a fish community study is still desirable, inclusion of Reference Sites and more extensive assessment of fish community and habitat quality indicators would be imperative in the design. Additional ecological measurements (e.g., community structure endpoints and associated variables) would provide more meaningful information on habitat quality. Assessments should also be conducted over several seasons and, where conditions permit, before, immediately after and during each representative season (e.g. similar times of year reflective of important physical and biological characteristics and related rates of flow) after scalping. Assessments “before”, “as soon after as practical”, and at a comparable time and conditions “one year later” are recommended at a minimum. Formulation of clearly defined testable questions with use of established, standardized and most appropriate methods are also recommended (e.g., those employed in

the federal Environmental Effects Monitoring (EEM) program; EC, 2009). Methods should be clearly understood and consistently applied, including data collection, standardization and reporting formats. Finally, a Quality Assurance program that includes field and data analyses components should also be applied.

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1.0 INTRODUCTION

On behalf of the Ministry of Public Safety and Solicitor General, Emergency Management British Columbia (EMBC), the Department of Fisheries and Oceans Canada (DFO), G3 Consulting Ltd. (G3) conducted a summary assessment of fifteen (15) environmental reports and associated data (spreadsheets, maps and related correspondence) related to sediment removal activities in the Fraser River spanning the time period from 2004 through 2008. Originally eighteen (18) reports were identified; however, several were subsequently noted to be interim or draft reports of existing final reports and considered redundant.

1.1 Study Scope & Objectives

Activities were to include the analysis of existing biophysical monitoring data for the purpose of 1) impact assessment; and, 2) monitoring program evaluation.

The purpose of this contract was to:

- compile monitoring data collected at multiple removal and reference sites since 2004 by various professional consultants; and,
- apply defensible and rigorous statistical methods to analyze available monitoring data to determine the impacts, if any, to fish and fish habitat from gravel mining.

1.2 Background

Under a 2004 *Letter of Agreement* with the Department of Fisheries and Oceans Canada (DFO), sediment removal from the Fraser River requires biophysical monitoring at each site (and related reference locations) before and after sediment removal. Monitoring studies evaluated in this review were intended to determine if any impacts related to sediment removal occurred and what the magnitude and extent of any observed effects were. Sediment is deposited annually during spring freshet in the Fraser River between Hope and Mission (e.g., "sediment and gravel reach"). These deposits raise the river bed, which increases hydrologic pressure on the existing dyking system. Reports assessed in this report were produced by professional consultants on behalf of private, for-profit, companies which historically conducted sediment removal operations in the river. Since January 2008, Emergency Management BC (EMBC) has been responsible for these activities and changed the focus from a business-based model to one of public safety. EMBC now oversees flood protection in the Fraser River and removes sediment to reduce the risk of flooding. Under this new responsibility EMBC has yet to complete a program and has complied with all requirements stipulated in the Letter of Agreement with DFO.

The lower Fraser River, where the fifteen sediment removal operations occurred, provides many areas where sediment deposits and accumulates to form bars. These areas can form productive habitat for various fish species and aquatic organisms, including benthic invertebrates (Johnson and Jennings, 1998; Beechie *et al.*, 2005). Sediment removal alters channel morphology, affecting velocity, water depth, and substrate texture, all of which influence the distribution and abundance of aquatic organisms (Kondolf, 1997). Depending on a species tolerance, community composition and productivity will be altered (Riccardi and Rasmussen, 1999; Richter *et al.*, 1997).

At least 5,000,000 m^3 of sediment has been removed in the Fraser River between 1964 and 1999 (averaging 117,000 m^3/year; Weatherly and Church, 1999). Annual sediment influx to the lower Fraser River averages 250,000 m^3/year (Ham, 2005). Rempel and Church (2009) suggest that such a removal rate (e.g., approx. 50% of the natural influx rate) is comparatively low relative to many rivers where removal occurs. In addition, it is estimated that 1,000,000 m^3/year of sediment is redistributed by natural erosion and deposition processes during spring flooding (Ham and Church, 2003).

In 2000, a spatial and temporal study (Rempel and Church, 2009) examined the effects of a single, experimental, sediment removal on the physical habitat and invertebrate and fish communities in the lower Fraser River. This study could not confirm removal associated effects on the fish community. Results showed that benthic invertebrates re-colonized the removal site immediately after extraction and differences in community composition, compared with three reference sites, disappeared during the first freshet. The authors suggested that, given that the ecological response was modest and short-lived, physical changes associated with removal were within the range to which local aquatic populations accustomed to flooding; however, they also suggested that, despite extensive sampling efforts, inherent variability in the biological data reduced the ability to statistically distinguish sediment removal related effects. Rempel and Church (2009) hypothesized that habitat alterations and ecological response due to sediment removal are ameliorated by the annual freshet of the Fraser River in the spring, which delivers substantial sediment annually to the lower river.

1.3 Layout of Report

Methods used in this review are detailed in Section 2.0. The review and evaluation of individual studies and related design approaches is provided in Section 3.1. Results and discussion of the related effects assessment appear in Section 3.2. Recommendations for improvements to subsequent programs are given in Section 4.0. The report Appendices provide figures and assimilated data and statistical results.

2.0 METHODOLOGY

2.1 Report/Data Acquisition

G3 obtained and reviewed fifteen (15) environmental monitoring reports and additional documents and data files (spreadsheets, figures, maps and correspondence) provided by EMBC (Tables 1 and 2). These reports and other materials were evaluated and screened for usability in meta-statistical testing using criteria discussed in Sections 2.2 and 2.3. Six (6) sites within five (5) reports were identified, through the screening process, as eligible for meta-statistical analysis.

The fifteen (15) reports provided were mostly in PDF format. Table 1 lists these with dates of study and the firm that performed the study.

Table 1: List of Gravel Extraction Environmental Reports Provided to G3

	Report Citation	Study Dates
1	Scott Resource Services, Inc. 2008. *Big Bar 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal.* A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 18pp + appendices.	2004-2007 pre-, post-
2	Scott Resource Services, Inc. 2008. *Gill East 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal.* A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 19pp + appendices.	2004-2007 pre-, post-
3	Scott Resource Services, Inc. 2008. *Gill West 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal.* A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 23pp + appendices.	2004-2007 pre-, post-
4	Scott Resource Services, Inc. 2008. *Gill Central 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal.* A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 18pp + appendices.	2004-2007 pre-, post-
5	Scott Resource Services, Inc. 2008. *Herring Bar and Tranmer Bar Biological Monitoring Program Report Fraser River Gravel Removal.* A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 14pp + appendices.	2007 pre-
6	Nova Pacific Environmental. 2004. *Fraser River Gravel Removal Monitor's Report for 2004 (Big, Seabird, Harrison Bars).* A report prepared for Steelhead Aggregates. (Draft). 31p.	2004 pre-, post-
7	Nova Pacific Environmental. 2005. *Fraser River Gravel Removal Monitor's Report for Queens Bar 2005.* A report prepared for Land and Water BC & Steelhead Aggregates. 11p.	2005 pre-, post-
8	Nova Pacific Environmental. 2005a. *Fraser River Gravel Removal Monitor's Report for Popkum Bar 2005.* A report prepared for Popkum First Nation. 13p.	2005 monitoring
9	Nova Pacific Environmental. 2006. *2006 Environmental Monitor's Report for Gravel Excavation at Hamilton Bar, Fraser River, District of Kent, BC.* A report prepared for Bruce Van Dale. 4pp + appendices.	2006 pre-, monitoring
10	Nova Pacific Environmental. 2007. *Fraser River Gravel Removal Big, Harrison and Seabird Island Bars Environmental Monitor's Follow-up Report, 2007.* A report prepared for Steelhead Aggregates & The Ministry of Agriculture and Lands, Integrated Land Management Bureau. March, 2007. (Draft). 22p.	2004-2006 post-

Table 1 (Con'd): List of Gravel Extraction Environmental Reports Provided to G3		
	Report Citation	**Study Dates**
11	Nova Pacific Environmental. 2008. *Fraser River Gravel Excavation Monitor's Report Spring Bar, Sites C and D.* A report prepared for The Department of Fisheries and Oceans & The Ministry of Public Safety and Solicitor General. May, 2008. 9pp + appendices.	2008 Monitoring
12	Nova Pacific Environmental. 2008. *Fraser River Gravel Excavation Monitor's Report Hamilton Bar.* A report prepared for The Department of Fisheries and Oceans and The Ministry of Public Safety and Solicitor General. May, 2008. 6pp + appendices.	2008 pre-, Monitoring
13	Scott Resource Services, Inc. 2007. *Gill East Fraser River Gravel Removal 2006 Follow-up Monitoring Report.* A draft report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. March, 2007. 12pp + appendices.	2004-2006 pre-, post-
14	Scott Resource Services, Inc. 2007. *Gill Central Fraser River Gravel Removal 2006 Follow-up Monitoring Report.* A draft report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. March, 2007. 12pp + appendices.	2004-2006 pre-, post-
15	Scott Resource Services, Inc. 2007. *Big Bar Fraser River Gravel Removal 2006 Follow-up Monitoring Report.* A draft report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. March, 2007. 11pp + appendices.	2004-2006 pre-, post-

Pre = Data collected before excavation
Monitoring = Environmental monitoring completed during the excavation
Post = Data collected after excavation was complete

Additional information and data (e.g. in reports, papers, maps and technical documents) were later provided to G3 in several formats including Excel, PDF and Corel Draw. Table 2 lists these and identifies which data were used for the meta-statistical analyses.

Table 2: Additional Data Documents				
File Name	**File Type**	**Site(s)**	**Description**	**Appropriate for Statistical Analysis[1]**
FRG 08 Harrison Data	Excel	Harrison Bar	Fish Data for Harrison Bar	No
FRG08 – INVERT DATA	Excel	Hamilton Bar, Spring Bar C & D, Herrling, Railway, Seabird	Unformatted Benthos Data	No
Additional Benthos	Excel	Hamilton Bar, Spring Bar C & D, Herrling, Railway, Seabird	Formatted Benthos Data	Yes
Foster Aug08 invert samples 2.0	Excel	Foster	Additional Benthos Data	No
Fish Sampling Database	Excel	Harrison, Herrling, Spring, Popkum, Big Bar, Gill, Seabird, Railway, Queens	Fish Catch Data including small amount of WQ	Yes
Egg Sampling Results from Minto Channel	Excel	Minto Channel	Description of egg sampling sites	No
07 data compiled	Excel	Harrison, Herrling, Spring, Popkum, Seabird, Railway, Queens	Fish Catch Data With Associated Charts	No
Spring B October 2007 report	PDF	Seabird Island, Spring Bar Site B	Environmental Monitors Follow-up Report	No
FRG monitors report_04 final	PDF	Big Bar, Harrison, Seabird	Fraser River Gravel Removal Monitor's Report for 2004	No
Spring bar aerial – $4400m^3$	Corel Draw	Spring Bar	Aerial Photo of Spring Bar	No
Spring bar aerial – $2300m^3$	Corel Draw	Spring Bar	Aerial Photo of Spring Bar	No
Spring Bar – $4400m^3$	Corel Draw	Spring Bar	Aerial Photo of Spring Bar	No

1. rationale for acceptability in statistical testing provided in Sections 2.2 through 2.7.

2.2 Tiered Evaluation

Adobe (pdf) reports and additional data (provided in various formats) were subjected to several tiers of evaluation. These included:

Tier 1: Screening Evaluation, conducted on fifteen (15) reports and the additional data subsequently provided (Tables 1 and 2);

Tier 2: Screened Report Data Evaluation & Quality Assurance, conducted on five (5) reports; and,

Tier 3: Statistical Data Evaluation & Quality Assurance—conducted on meta-data set from five (5) reports.

2.3 Screening Evaluation

The Tier 1 Screening Evaluation of the fifteen (15) reports, and additional supporting data, consisted of an assessment for data completeness in biological and physical components such as fish, invertebrates and habitat (substrate). Acceptable data for inclusion in meta-statistical analysis were based on the following criteria:

- available as a complete (or near complete) data set and in final form (e.g., not a draft/interim or unfinished report);
- reported consistently and accurately for each component, and,
- comparable (or could be made comparable) with other data within a meta-statistical model.

Of the fifteen (15) reports provided, five (5) reports, containing data for six (6) sites, were selected for meta-statistical analysis based on complete, reliable and representative data. These included:

- Big Bar;
- Gill West Bar;
- Gill East Bar;
- Gill Central Bar;
- Herrling Bar; and,
- Tranmer Bar.

A majority of the supplemental information provided in Table 2 (above) was determined to be unacceptable for use in this meta-statistical analysis, based on the criteria above. Other data were found redundant as they were subsequently found in a final form in other reports.

2.4 Data Management & Transformation

Data from the five (5) screened reports were converted from Adobe (pdf) format via manual entry into digital format (e.g., Excel spreadsheet) to facilitate review, comparisons, QA and statistical evaluation. These complete reports were subjected to a second tier of scrutiny and quality assurance with regard to data content, format and method of data acquisition. Throughout the review process, issues, caveats, data gaps and recommendations were documented and reported in Section 3.0. Verification by at least two people occurred at each stage of data handling (e.g., data entry, transfer, conversion, manipulation, etc.).

Where data gaps or inconsistencies were found to impact meta-statistical performance these were noted and recommendations made related to study design or subsequent investigations (Section 4.0).

Standardization of benthic invertebrate data included:

- conversion of benthos organism abundance numbers from numbers/sample to number/m^2 for different collection devices (e.g., Surber and Ponar grab samples, which encompass different sample volumes and surface areas) for data comparison;
- creation of an ordered, hierarchical, master species list for benthic invertebrates and fish to facilitate data comparisons;
- calculation of averages (e.g., mean total density) and standard deviations (SDs) for benthic invertebrate data to facilitate statistical analysis; and,

- calculation of benthic invertebrate endpoints and indices such as total number, taxon richness, EPT richness, Simpsons 1-D Diversity Index (SDI), Schwartz Dominance Index, Shannon and Weiner H', and Bray-Curtis.

2.5 Statistical Analyses – Objectives & Hypothesis Testing

The following questions were tested (to address Objectives 2 and 3 from Section 1.1):

A. *Are sediment removal operations exerting an effect on the physical habitat, invertebrate communities and fish communities of the lower Fraser River?*

   a. *Do Scalped Sites show different benthic and fish communities from Reference Sites?*

B. *Are existing monitoring data adequate to answer Question A?*

   a. *How can studies done to date be more effective in assessing effect of sediment removal operations (e.g., design, methods, application, analyses)?*

2.6 Statistical Analyses – Data Management

Spreadsheet data for benthos, fish and habitat were imported to a cross-linked Access database and then underwent statistical analysis (as detailed in Sections 2.7.2 through 2.7.6).

2.6.1 Variables & Caveats

Variables subject to statistical investigation included:

1) season (meaning time of year and reflective of flow rate and associated biophysical conditions at that time) and year that the study was conducted;

2) substrate type;

3) river location; and,

4) treatment (Scalped) versus no treatment (Reference).

Factors which confounded the studies and were acknowledged as caveats in the meta-statistical investigation, included:

- variable dates and duration of scalping operation relative to sampling dates (required to be within DFO approved work windows);
- lack of concurrent substrate and benthos monitoring;
- lack of fish sampling in reference or background areas; and,
- incomplete factor sampling (e.g., all seasons for all locations and treatments, acknowledging that seasonal flow rates (e.g., those during freshet) are important in determining sampling conditions and times and are reflective of biophysical conditions at that time of year.

Section 3.1 provides a detailed evaluation of the effectiveness of the biophysical monitoring program in terms of design, methods, and analysis and reporting.

2.6.2 Summary & Univariate Analyses

A number of habitat factors were sampled, some of which were redundant or inter-dependent. To reduce the factor list to those which could be considered independent, a Pearson Correlation between all factors was performed and reduced according to results.

In addition to summary measures for benthic faunal data (total abundance, species number and abundance of major taxonomic groups), sampling precision (SE/mean, Elliott 1977), Swartz Dominance Index (SDI, Swartz 1978), Shannon-Weiner H' (Shannon and Weaver 1963) and Simpson's 1-D (Simpson 1951) indices were calculated for each replicate for all locations, treatments and dates. Similar summaries were conducted for fish community data.

Indices H' and 1-D indices were considered to be of limited additional value to measures of total abundance, number of taxa and a simple dominance index (SDI). In addition, these measures had limitations which made them problematic for use with highly non-normal data. For these reasons, the SDI was considered most useful for interpretation of results.

The Swartz Dominance Index (SDI) measures the number of species that comprise approximately 75% of the sample. The SDI was calculated on total abundance for each sample replicate. A high SDI value indicates that abundance is spread relatively evenly over a variety of species. A low SDI indicates that one or two taxa are dominating the community, presumably because of physical or chemical factors reducing the competitive ability of more sensitive species.

The null hypothesis that "selected biotic factors are the same for Scalped versus Reference locations, for different seasons and for different habitat types", was tested using multiple Analysis of Variance (ANOVA) for benthic "total abundance", "species number", "SDI" and "abundance of dominant faunal groups".

Since fish community data was available only for Scalped Sites, the null hypothesis that fish Catch Per Unit Effort (CPUE) is the same for all seasons (time of year, biophysical conditions and flow rates) and locations was tested using a 2-factor ANOVA.

2.6.3 Multivariate Statistical Analyses

Hypotheses involving multivariate factors (e.g., multi-species community data or multi-factor habitat tests) were considered exploratory and used to assess variance patterns in overall faunal (or substrate) composition based on multiple factors (species or habitat factors). Exploratory analyses of this type are typically based on some form of pair-wise similarity measure of the overall faunal composition between samples. From this pair-wise compilation of similarities, various graphical displays could then be used to illustrate temporal and spatial faunal patterns. The graphical method selected may be some form of spatial gradient plot, frequency plot, cluster analysis or ordination. For this study cluster analyses were selected given their visual and interpretive simplicity, ability to combine all data from all years into a 2-dimensional array, and, lack of "parametric" assumptions of normality in what is typically non-normal data. The cluster method was agglomerative, using an unweighted, pair group, mean-average sort (Sneath and Sokal, 1973).

The Bray-Curtis (Bray and Curtis, 1957) dissimilarity coefficient was then used to compare pair-wise faunal composition for each sample. This measure was strongly influenced by the most abundant species and therefore sensitive to high dominance effects.

Using replicate data for each station, a statistical re-sampling or "bootstrap" method called SIGTREE (Nemec and Brinkhurst, 1988) was used to generate multiple simulations to test the generalized null hypothesis (H_o) at each cluster linkage that two station groups being linked together were homogeneous (not significantly different). The method was non-parametric and made no assumptions about the underlying distribution of the multivariate data. The method examined the relative variability within and between station groups independently for each linkage, to determine whether or not a cluster grouping would be statistically valid.

A variable significance level (p) was then used to reject the null hypothesis, depending on the total number of linkages being tested in a given analysis. This is because the overall Type I error of the cluster dendrogram increases (additively) as the number of linkages being tested increases. The total potential Type I error was kept between 15 and 20%. Stations which were linked together at a probability greater than the critical level, but were linked as a group with the other groups at a probability of less than the critical level, were therefore significantly distinct and homogeneous from all other stations; however, if a significantly distinct and homogeneous grouping was present, then all other stations were, by definition, distinct from that group, even if the linkage between the homogeneous grouping and other stations has a probability greater than the critical level.

The statistical power calculated for each linkage in SIGTREE was included as an output result for each SIGTREE analysis. For exploratory analyses, this output was not relevant. In practice, the "power" estimate in the SIGTREE output was useful only for determining how reliable the "rejection of the null hypothesis" was for each linkage, based on the data used. For example, if a given linkage was rejected at the critical level, it concluded that the two groups in the linkage were not the same; however, if the power was low, (high type II or Beta error) the opposite could not be concluded (i.e., that the two groups were different). The bootstrap distribution for the alternate hypothesis (H_a) simulations might not support this conclusion given the variability within the data (for discussion and methodology see Nemec, 2000). In essence, the Ha testing provided a confidence interval for the result (range depended on critical p value for Beta).

A more intuitively obvious way to examine statistical reliability was to plot the cumulative frequency distribution for the faunal composition, separated into "Scalped" and "Reference" groups. The cumulative frequency distribution approach was more appropriate than power analysis for data that were never intended to be tested for a specific null hypothesis or "effect size" (as is true for most monitoring data).

For this approach, each replicate sample was included separately, to incorporate all of the sample variance into the distribution. This procedure did not test for differences between mean values for Reference and Scalped groups, with a normalized $\pm$2SD (standard deviation) confidence interval, as in a parametric analysis of variance (ANOVA). Rather, it tested for differences in the actual overall frequency distributions of the samples (no matter how non-normal) for the two groups. For the overall community composition, the reference distribution was generated by calculating the mean composition of all the Reference Stations grouped together, then calculating pair-wise Bray-Curtis similarities between the mean "Reference" community and all other Reference Sample replicates. The similarity between the mean "Reference" and all other sampled Reference replicates was plotted to show the distribution of variability around the mean Reference (e.g., reference distribution). The similarity of all "Scalped" replicate samples to the mean Reference composition was then plotted as a separate distribution and the overlap between the two distributions compared. If <5% of the exposed distribution overlapped the reference distribution, there was 95% confidence that the two groups being compared could also be distinguished based on faunal composition. In addition, those replicate samples that fell outside the 95%

reference range could also be said to have exceeded the statistical "effects" criteria, and those stations in the exposed group that were within the reference range could be considered marginally "affected" or "unaffected".

2.6.4 Habitat

A Correlation Table (Pearson Correlation) was created to determine redundancy and inter-dependence of habitat factors such as seasonal flow rate (e.g., freshet, post-freshet and associated biophysical conditions), percent (%) sand, number of stones/m^2, and percent (%) shadow. Subsequently, factors were reduced to independent factors only. Bray-Curtis analysis was then conducted on selected standardized habitat factors (i.e., test H_o that habitat type was the same for "Scalped" and "Reference" sites for each location and time). Based on these results, habitat pooling was then considered and tested using Bray-Curtis (on pooled data) to determine statistical power.

Each benthos and fish sample was assigned a code to indicate habitat type as per results above. Not all benthos samples could be assigned a habitat type. Season (as defined by flow rate and reflective of biophysical conditions) were designated as follows: Apr-July=spring freshet (2,000-10,000 m^3/s in 2007); Aug-Sept=summer post-freshet (2,500-6,000 m^3/s in 2007); Oct/Nov=fall (2,000-3,500 m^3/s); and Dec-Mar=winter low flow (700-1,500 m^3/s in 2007; Scott Resource Services, 2008).

Initial multivariate hypotheses included:

Ho_1 - Reference (Ref) sites are homogeneous in terms of substrate factors for a given site and season (as defined above);

Ho_2 - Scalped sites are homogeneous in terms of substrate factors for a given site and season (as defined above); and,

Ho_3 - Scalped sites are the same as reference sites in terms of substrate factors for a given site and season (as defined above).

2.6.5 Benthos

Data were evaluated in two separate tiers of statistical analysis. When a few taxa were found very dominant, a step-wise analysis was then run to eliminate the most abundant fauna to examine the stability of the pattern.

Tier 1

Tier 1 analyses consisted of the following:

1. Overall Bray-Curtis cluster analysis with SIGTREE and power to determine what samples were most like others;

2. Bray Curtis for each location (Ref and Scalped, all times);

3. Bray-Curtis for all Ref locations for each season (similar dates);

4. Bray-Curtis for all Ref locations for each habitat type (all times of the year and reflective flow rates);

5. Bray-Curtis for all Ref locations for each habitat type and season (as defined above);

6. Bray Curtis for all Scalped locations for each season (similar dates);

7. Bray Curtis for all Scalped locations for each habitat type (all times of the year and reflective flow rates); and,

8. Bray Curtis for all Scalped locations for each habitat type and season (as defined above).

If analysis 3 through 5 showed pooling was reasonable, then all Reference (Ref) samples were pooled accordingly and compared with matching Scalped locations. If analyses 6 through 8 showed pooling was reasonable, then all Scalped locations were pooled and compared with the appropriate pooled Reference samples.

Relevant hypotheses included:

Ho_1 - Reference Sites are homogeneous in terms of overall benthos composition for a given site and season (reflective of time of year and associated flow rates and biophysical conditions);

Ho_2 - Reference Sites are homogeneous in terms of overall benthos composition for a given habitat type and season (reflective of time of year and associated flow rates and biophysical conditions);

Ho_3 - Scalped Sites are homogeneous in terms of overall benthos composition for a given site and season (reflective of time of year and associated flow rates and biophysical conditions);

Ho_4 - Scalped Sites are homogeneous in terms of overall benthos composition for a given habitat type and season (reflective of time of year and associated flow rates and biophysical conditions);

Ho_5 - Scalped Sites and Reference Sites are homogeneous in terms of benthos composition for a given location and season (reflective of time of year and associated flow rates and biophysical conditions); and,

Ho_6 - Scalped Sites and Reference Sites are homogeneous, with samples pooled based on relevance of habitat type and season (reflective of time of year and associated flow rates and biophysical conditions).

Tier 2

Multiple Analysis of Variance (ANOVA) of habitat factors and season versus selected biotic factors was conducted to determine reasons for differences between Reference locations (e.g., dominant taxa groups, unusual or missing groups, etc.), overall abundance, number of taxa types, and Swartz Dominance Index (SDI). If habitat and time of year and associated flow rates and related biophysical conditions (season) were determined not to be the reason for differences, t-tests were conducted to identify where the differences occurred. The relevant hypothesis was:

Ho_1 - selected biotic factors are the same for all habitat factors and seasons (as defined above)

2.6.6 Fish Community

Fish community data underwent the following statistical analyses:

- Sampling precision for Scalped Sites, taxa/area curves, including associated habitat factors such as total abundance, Swartz Dominance Index;
- Bray-Curtis for all locations and dates;
- Bray-Curtis for all scalped locations for each season (representative of time of year and reflecting biophysical condition and flow rate for similar dates);
- Bray-Curtis for all scalped locations for each habitat type and season (as defined above);
- Bray-Curtis for all scalped locations for each habitat type (all seasons, as defined above);

If analyses 2 through 5 showed pooling was reasonable, then all Scalped locations were pooled accordingly and community analyses repeated.

Relevant Hypotheses included:

Ho_1 - Fish communities are the same for all Scalp locations and dates;

Ho_2 - Fish communities are the same for all Scalp locations taken in a given season (time of year and associated biophysical conditions and flow rates);

Ho_3 - Fish communities are the same for all Scalped habitat types and season (i.e., time of year and associated biophysical conditions and flow rates); and,

Ho_4 - Fish communities are the same for all Scalped habitat types regardless of season (i.e., time of year and associated biophysical conditions and flow rates).

2.7 Data Reporting & Interpretation

Data reporting and interpretation consisted of:

- reporting of compiled, reviewed, verified, and organized information and data files;
- presentation of methods of data screening and statistical meta-assessment with hypothesis testing;
- reporting, analysis and discussion of limitations and caveats in current investigations (as evaluated through reports received);
- reporting, interpretation and discussion of univariate and multivariate statistical analyses that correlate “effects” of sediment removal on biophysical factors (benthic invertebrate and fish communities and habitat);
- generation of a comprehensive reference list; and,
- generation of an appendix containing
  - figure of sediment removal locations;
  - summary tables of report/data quality review and data gaps;
  - graphs and tables of statistical analyses of effects assessment of sediment removal on benthos, fish and substrates; and,
  - standardized raw data tables.

Discussion of results related to questions regarding effects of sediment removal operations appear in Section 3.2.

3.0 RESULTS

Assessments were intended to address the following:

A. examine the effects of sediment removal on the physical habitat and biotic communities (e.g., fish and benthic invertebrates) in the lower Fraser River; and,

B. evaluate study sampling, analysis and reporting requirements for “effect detection” within a large river system.

The results discussed below include:

- a detailed review of data reports (15 reviewed with additional excel data provided) on sediment removal operations on the lower Fraser River spanning from 2004 to 2008 (Section 3.1); and,

- results of statistical analysis within a meta-analysis framework of five (5) reports (covering six extraction sites) with usable biological and substrate data to determine the potential effects of sediment removal (Section 3.2).

Recommendations for improvements to subsequent programs are provided in Section 4.0.

3.1 Review of Fifteen Reports & QA/QC

The report review consisted of several tiers to evaluate sediment removal impacts on fish and fish habitat and the effectiveness of the existing biophysical monitoring program. The evaluation generated issues regarding:

- data acquisition (e.g., field design and methods, including site location, replication, timing and handling of components); and,

- data handling and reporting (e.g., issues of clarity, completeness, accuracy and precision, consistency, quality assurance and control).

Issues identified in the review are provided in Sections 3.1.1 through 3.1.4 (below).

3.1.1 Sampling Methods (Field Studies)

Tables 2 through 7 (Appendix 2) summarize methods used by the firms conducting the environmental and biological monitoring studies. Studies for the biophysical monitoring program included the following:

1) benthic invertebrate sampling;

2) fish sampling;

3) surface sediment sampling (e.g., visual observation via photographic means);

4) habitat mapping; and,

5) topographic and bathymetric surveys.

Sampling occurred on multiple dates before and between one and three years after sediment removal. Sampling times were typically based on flow rate.

The five (5) biological monitoring studies eligible for analysis employed a modified Before-After/Control-Impact (BACI) design as outlined by Stewart-Oaten *et al.*, (1986) and recommended in Rempel (2003). Each study contained one (1) Scalp Site and three (3) Reference Sites. The intent of these sampling programs was to enable an asymmetrical analysis of variance (A-ANOVA; Underwood, 1992, 1994, 1997) in which sources of environmental variance could be assessed from data for multiple reference sites.

3.1.2 Screening Evaluation

Table A2-1 (Appendix 2) summarizes the screening evaluation of the 15 reports (see Table 1, above, for a list and Section 2.1 for methods) and provides rationale for conducting or excluding data reports from the meta-statistical analysis. Tables A2-2 through A2-7 (Appendix 2) provide details on objectives, timing, components studied and design for each report that passed the screening evaluation for meta-statistics.

Reports which passed the screening included five (5) reports that included six removal sites:

- Big Bar;
- Gill Central Bar;
- Gill East Bar;
- Gill West Bar;
- Herrling; and,
- Tranmer Bars.

A summary of additional reports (e.g., Big, Seabird and Harrison Bars; Table A2-7) was also included given the level of study detail and inclusion of an excavation bar detailed in another report and included in the meta-statistical analysis (e.g., Big Bar). Though the studies were completed, remaining data on Seabird and Harrison Bars was incomplete and, therefore, not included in this meta-statistical analysis.

3.1.3 Screened Report Data Evaluation

Screened reports were examined for data errors and inaccuracies. Table 3 summarizes data errors and inconsistencies found in the five reports used for this meta-statistical analysis. Details are provided in Table A2-1 (Appendix 2).

Table 3: Errors & Inconsistencies of Data Reporting in Reviewed Reports

	Site	Ref/Scalp	Episode	Sample	Error	Measures Taken
Original Tables	Gill West	Ref 4	1	1-5 & Total	Total # of species incorrect	Totals corrected and entered into the master table (in turn receiving internal QA)
	Gill West	Ref 4	2	1-3 & Total		
	Gill West	Ref 4	3	1-3 5 & Total		
	Gill West	Ref 4	4	1-5 & Total		
	Gill West	Scalp	4	2,3,5 & Total		
	Gill West	Scalp	5	1-5 & Total		
Additional Inconsistencies/Caveats	Gill West sampling (May 2005), sample area was inconsistent with previous methods and did not reflect standard seine net techniques. Errors may be reflected in the statistical analysis results.					
	Samples collected in Gill Central 2007 used a grab sampling device that differed from previous sampling devices used. The type and size of the grab was not reported. Given that data were reported quantitatively and based on the flow, boat size and resources available, it was deduced that a Petit Ponar was used to collect benthos samples.					

3.1.4 Caveats, Limitations & Confounding Factors in Statistical Evaluation

There were a number of confounding factors that affected the performance of the meta-statistical analysis on the data and subsequent interpretation of results. These included those listed in the table below:

Table 4: Limitations & Issues for Meta-Statistical Analysis and Associated Caveats (Five Reports)

	Issue/Limitation	Discussion/Caveat
Ecological Design (general)	Inconsistencies in sampling strategy and methods among studies (reports), particularly between different firms conducting the studies. Lack of specific rationale for selection of locations and numbers of sampling sites/stations. Sites appeared to have (in instances) been collected opportunistically and were incomplete.	Inability to adequately address specific hypotheses within a scientific design.
	Lack of clarity on whether substrate sampling occurred within the same sampling grid as benthos; substrates apparently sampled within areas where fish were sampled.	Given the importance of substrate to benthos this incongruity can affect the ability to derive important links to benthos community health.
	Not all seasons were sampled for Reference and Scalped sites for all locations. This likely reflected sites sampling limitation based on water flow and level.	Compromised ability to address this important confounding factor in determining "effects" by gravel extraction.
Reference Site(s)	Inconsistent use of Reference Site locations and number of locations compared with Scalp Sites.	Compromised statistical comparisons and ability to interpret "effect".
	No Reference Sites were used for fish sampling.	Compromise d use of data for valid comparisons and determinations of "effect". With no comparative reference data, "effects" on fish communities by gravel extraction operations cannot be adequately addressed.
Sample Replication	Number of fish assemblage replicates for each location and season were limited. Sampling precision was too high[1] and did not provide sufficient data to indicate that fish were representatively sampled.	Lacked the power to make confident statistical conclusions on "effect".
	Number of benthos replicates for each location and season were inadequate in approximately 1/3 of sample sites, based on sampling precision. The replicate number was particularly inadequate in locations with low abundance, which tended to be incomplete (patchy).	Lack of power to make confident statistical conclusion on "effect".
Timing	Timing and duration of extraction activities was variable, based on water level and flow.	Could not fully assess this variable despite their likely important influence on benthos and fish assemblages.

1. Refer to Section 3.3.2 for details.

When the sampling limitations above are considered, analysis of the existing data set must be viewed as exploratory. Data was used to suggest trends and facilitate assessment of program strengths and weaknesses and help focus more precise sampling protocols to address Objectives 2 and 3 (Section 1.1) and Questions A and B (Section 2.5).

3.1.5 Quality Assurance & Quality Control

A rigorous quality assurance/quality control program (QA/QC) was applied to every aspect of the review and meta-analysis and was documented by personnel (Appendix 2). G3 reviewers performed QA/QC on data in three tiered evaluations (see Section 2.2 through 2.4).

3.2 Statistical Assessment of Sediment Removal Effects

Statistical assessment correlated physical and biological factors in the following analyses and results.

3.2.1 Habitat

The Pearson Correlation Matrix of all habitat factors (Table A3-1, Appendix 3) identified those factors which are strongly co-dependant (inter-correlations greater than r=0.80). Based on the matrix, the number of habitat factors was reduced to produce a relatively independent subset of factors which might be expected to affect benthos and fish communities. The reduced habitat factor list for analyses included;

- date or season (time of year as reflective by date, flow rate and representative of biophysical conditions);
- percent (%) sand;
- percent (%) shadow; and,
- number of stones/m^2.

Figure A4-1 (Appendix 4) shows the results of the cluster analysis (and significance testing) of the equally-weighted habitat factors for each location, date and treatment. All samples were <20% dissimilar (except location Gill Central scalped November 2007 and which was approximately 50% dissimilar to all other samples), with no linkages at p<0.005 (total potential Type I error=18%). The unusual outlier (Gill Central) had 100% loss of gravel in 2 of 4 replicates.

When data were pooled by season (time of year reflective of flow rate and associated biophysical conditions), regardless of year, the resulting analysis (Figure A4-2, Appendix 4) showed all habitats to be <10% dissimilar (33 linkages) with no linkages at p<0.005. Based on this result, all habitat types were considered homogeneous, with the possible exception of the Gill Central Scalped Site (November 2007), which required additional statistical work-up. There were no clear differences in habitat factors between Scalped and Reference Sites such that habitat differences were not considered to be a factor in the data set.

3.2.2 Benthos

Table A3-2 (Appendix 3) shows summary measures (e.g., taxon number, total numbers) as well as Swartz Dominance Index (SDI), Shannon-Weiner Diversity (H') and Simpson's Diversity (1-D) for all sample locations, dates and treatments for each replicate sample. Table A3-3 (Appendix 3) provides means and standard deviations (SDs) for all sample locations, dates and treatments. Substrate factors for matched locations, season (time of year reflective of flow rates and biophysical condition), treatments (Scalped vs. Non-Scalped) and sampling precision, based on standard error (as a percentage of the mean; see Elliott 1977), is included in Table A3-3. Precision estimates showed that 27 out of 72 sample locations, for different treatments and dates, had a sampling precision higher than 20%. The highest value measured was at the Gill Central Scalped location (58% in

November, 2007). The most abundant benthic faunal groups were Diptera, Ephemeroptera, Plecoptera, Oligochaeta and Trichoptera.

The effects of three (3) factors: treatment, location and season (time of year reflective of flow rate and biophysical condition) on a series of summary factors (total abundance, taxa number, SDI, 1-D, and abundance of the groups Diptera, Ephemeroptera, Plecoptera, Oligochaeta and Trichoptera) were tested using multi-factor ANOVA. The null hypothesis in each case was that the three factors had no effect on each of the summary biotic variables tested (Table 5). These results should be viewed with caution since the abundance data in particular tended to be non-normally distributed; however, the ANOVA was relatively robust with respect to this requirement and results may be useful for suggesting trends and further analyses. For completeness, results are shown using raw data as well as log-transformed data (which tended to normalize abundance data). Results suggested that location and seasonal flow conditions had a significant effect on all tested factors; however, treatment type (Scalped vs. Reference) had no significant effect on raw taxa number, SDI, or abundance of Diptera as well as Plecoptera. Log-transformed data results were the same, except that treatment type showed no significant effect on Ephemeroptera. The significant effect of treatment type on total abundance for both raw and log-transformed data was related to the significance of effects on the sub-groups of major taxa, particularly Oligochaeta and Tricoptera.

Table 5: ANOVA Results (3-way testing of summary benthic biotic factors)[1]								
Variable	Factor	SS	Df	Mean Square	F	P	F (log values)	P (log values)
Taxa Number	Location	1054.37	5	210.87	24.98859	0.000	21.33	0.00
	Treatment	8.11	1	8.11	0.960978	0.328	1.10	0.30
	Season (flow rate and related biophysical condition)	1528.97	3	509.66	60.39403	0.000	61.05	0.00
	Error	2894.52	343	8.44	N/A	N/A	N/A	N/A
Total Abundance	Location	2504601.37	5	500920.27	24.78516	0.000	79.96	0.00
	Treatment	137898.53	1	137898.53	6.823115	0.009	3.99	0.05
	Season (flow rate and related biophysical condition)	1898633.87	3	632877.96	31.31432	0.000	130.81	0.00
	Error	6932199.92	343	20210.50	N/A	N/A	N/A	N/A
SDI	Location	18.92	5	3.78	2.733456	0.019	2.58	0.03
	Treatment	3.64	1	3.64	2.631364	0.106	2.36	0.13
	Season (flow rate and related biophysical condition)	161.95	3	53.98	39.00145	0.000	37.80	0.00
	Error	474.76	343	1.38	N/A	N/A	N/A	N/A
Diptera	Location	864418.46	5	172883.69	9.387436	0.000	50.91	0.00
	Treatment	21022.89	1	21022.89	1.141525	0.286	3.23	0.07
	Season (flow rate and related biophysical condition)	975646.92	3	325215.64	17.65893	0.000	102.73	0.00
	Error	6316858.38	343	18416.50	N/A	N/A	N/A	N/A
Ephemeroptera	Location	67472.14	5	13494.43	21.67994	0.000	40.20	0.00
	Treatment	7708.04	1	7708.04	12.38362	0.000	2.23	0.14
	Season (flow rate and related biophysical condition)	60724.47	3	20241.49	32.51967	0.000	33.47	0.00
	Error	213496.39	343	622.44	N/A	N/A	N/A	N/A

1. SS=sum of squares; df = degrees of freedom; F = F statistic; P = probability

Table 5 (Con'd): ANOVA Results (3-way testing of summary benthic biotic factors)[1]								
Variable	**Factor**	**SS**	**Df**	**Mean Square**	**F**	**P**	**F (log values)**	**P (log values)**
Plecoptera	Location	14765.48	5	2953.10	9.194462	0.000	10.93	0.00
	Treatment	12.11	1	12.11	0.037697	0.846	1.38	0.24
	Season (flow rate and related biophysical condition)	33161.51	3	11053.84	34.4161	0.000	46.42	0.00
	Error	110165.46	343	321.18	N/A	N/A	N/A	N/A
Oligochaeta	Location	53457.96	5	10691.59	10.07646	0.000	51.45	0.00
	Treatment	21206.17	1	21206.17	19.98608	0.000	12.80	0.00
	Seasonal Flow Condition	20195.83	3	6731.94	6.344623	0.000	32.04	0.00
	Error	363939.02	343	1061.05	N/A	N/A	N/A	N/A
Trichoptera	Location	2601.09	5	520.22	17.11232	0.000	21.97	0.00
	Treatment	253.43	1	253.43	8.336607	0.004	5.74	0.02
	Season (flow rate and related biophysical condition)	3404.12	3	1134.71	37.32562	0.000	62.83	0.00
	Error	10427.28	343	30.40	N/A	N/A	N/A	N/A

2. SS=sum of squares; df = degrees of freedom; F = F statistic; P = probability

Hypotheses Ho_2 and Ho_4 for benthos (Section 2.6.5) were no longer relevant as there was no significant difference in habitat type; however, results for Gill Central (Scalped November 2007) must be viewed with caution as this habitat was approximately 50% dissimilar to all other habitats sampled. Field observations indicated that the site had changed from a gravel bar top habitat to a bay and deposition site (Scott, pers. com., 2009). Therefore, hypotheses Ho_1, Ho_3, Ho_5 and Ho_6 remained to be tested:

Ho_1 - Reference Sites are homogeneous in terms of overall benthos composition for a given site and season (i.e., time of year and associated flow rate and associated biophysical properties);

Ho_3 - Scalped Sites are homogeneous in terms of overall benthos composition for a given site and season (i.e., time of year and associated flow rate and associated biophysical properties); and,

Ho_5 - Scalped Sites and Reference Sites are homogeneous in terms of benthos composition for a given location and season (i.e., time of year and associated flow rate and associated biophysical properties).

The multivariate testing of hypotheses Ho_1, Ho_3, Ho_5, samples were initially done by grouping by location only. The three hypotheses were tested concurrently for each location, with results shown in Figures A4-3 through A4-8 (Appendix 4).

Gill West Bar (Figure A4-3, Appendix 4; Figure 1, Appendix 1)

The overall analysis for each date and treatment showed a clear seasonal (time of year reflective of flow rates and biophysical conditions) separation (fall/winter vs. spring vs. summer), but no clear separation of Reference and Scalped stations. This was more apparent in the summary analysis using treatment and season only, which showed that all seasons (i.e., times of year and associated flow rates and associated biophysical properties) were significantly distinct from each other; however, within all seasons (except winter), Scalped and Reference sites were significantly distinct from each other.

Gill East (Appendix A4-4, Appendix 4; Figure 1, Appendix 1)

Site Gill East showed no clear separation of Scalped and Reference sites for many dates; however, seasonal differences (i.e., time of year and associated flow rates and biophysical conditions) were suggested by the groupings. When the samples were grouped by season and treatment this separation was significant for all seasons. In all cases, Scalped and Reference samples grouped together. Of three (summer, winter, fall) seasons (i.e., times of the year and associated flow rates and biophysical properties) only summer Scalped and Reference samples could not be concluded to have the same faunal composition (reject Ho_5).

Gill Central (Figure A4-5; Figure 1, Appendix 1)

For Gill Central, only Scalped samples were collected; therefore, it was not possible to test for Ho_1 or Ho_5 at this location. For hypothesis Ho_3, it could be concluded that the August, February and December samples were all significantly distinct, whereas November and March samples were homogeneous with each other; however, the November and March grouping was significantly distinct from the other dates. The analysis of samples by season (i.e., times of the year and associated flow rates and biophysical properties) showed the same trend, with spring and fall being homogenous, but both significantly distinct from winter and summer.

Big Bar (Figure A4-6, Appendix 4; Figure 1, Appendix 1)

The analysis of Big Bar samples using separate dates and treatments showed no discernable pattern related to season (i.e., time of year reflective of flow rates and biophysical conditions) or treatment; however, when the samples were combined by season, samples separated into summer, fall and winter. Scalped and Reference samples were homogenous for fall and summer, but significantly distinct for winter. All three seasons were significantly distinct from each other.

Herrling Bar (Figure A4-7, Appendix 4; Figure 1, Appendix 1)

Samples for Herrling Bar were taken only in December, 2007 and included three (3) Reference Sites and three (3) Scalped Sites. Two of the Scalped Sites formed a homogeneous pair and were significantly distinct from the grouping of all three Reference Sites plus one Scalped Site. When the Scalped and Reference sites were each grouped together they were significantly distinct, albeit at a low dissimilarity (0.23).

Tranmer Bar (Figure A4-8, Appendix 4; Figure 1, Appendix 1)

Samples for Tranmer Bar were also taken only in December, 2007 and included three Reference Sites and one Scalped Site. The Scalped Site was homogeneous with Reference Site 2. When the Reference Sites were combined and compared with the one Scalped Site there was no significant difference between the two groups.

All Sites

To test the null hypothesis (Ho_1) that all Reference Sites sampled during the study period were homogeneous, Reference Sites from all locations were grouped by site and date and analyzed together. The analysis was then repeated with all Reference Samples pooled for each location and season (regardless of year) and finally with all samples pooled by season (i.e., time of year and associated flow rates and biophysical conditions), regardless of location or year. Results are shown in Figures A4-9 through A4-11 (Appendix 4). The overall analysis with all locations, treatments and dates considered separately (Figure A4-9, Appendix 4) showed no discernable pattern with respect to seasonal or location differences; however, there were some significant linkages within the pattern, suggesting that all Reference locations were not homogeneous. The same was true of the analysis in which samples were grouped by season and location (Figure A4-9, Appendix 4); however, when the replicates for each season were grouped together (regardless of location and year of sampling; Figure A4-11, Appendix 4) each season (i.e., time of year and associated flow rates and biophysical conditions) was significantly distinct for all other seasons.

To test the null hypothesis (Ho_3) that all Scalped Sites sampled during the study period were homogeneous, Scalped sites for all locations were grouped by site and date and analyzed together. The analysis was then repeated with all scalped samples pooled for each location and season (regardless of year) and finally with all samples pooled by season (i.e., time of year and associated flow rates and biophysical conditions) regardless of location or year. Results are shown in Figures A4-12 through A4-14 (Appendix 4). As with the Reference Site analyses the overall pattern with all locations and dates considered separately (Figure A4-12, Appendix 4) showed no discernable pattern, but did identify significant linkages. This suggested that the Scalped Sites were not homogeneous in terms of benthic fauna (reject Ho_3). The same was true for the analysis of all locations grouped by season (Figure A4-13, Appendix 4); however, the analysis grouped by season (regardless of location and year of sampling; Figure A4-14, Appendix 4) showed that winter and fall were homogeneous. This grouping was significantly distinct from both summer and spring Scalped samples.

Results of the above analyses indicated that there were significant differences in faunal composition by location and season (i.e., time of year and associated flow rates and biophysical conditions) and in some locations by treatment (Scalping). The final hypothesis to be tested was;

Ho_6 - Scalped Sites and Reference Sites are homogeneous (with samples pooled based on relevance of habitat type and season (i.e., time of year and associated flow rates and biophysical conditions).

Hypothesis Ho_6 was tested using SIGTREE with samples grouped by: a) location, treatment and date; b) location, treatment and season (i.e., time of year and associated flow rates and biophysical conditions); and, c) treatment and season. Results are shown in Figures A4-15 through A4-17 (Appendix 4). The first analysis (Figure A4-15, Appendix 4) was largely exploratory and provided for completeness. The result reflected a mixture of location, treatment and seasonal effects which varied over the spectrum of the sampling program. The second analysis (Figure A4-16, Appendix 4) showed a mixture of locations and treatments with indications of some significant seasonal (i.e., time of year and associated flow rates and biophysical conditions) differences. In addition, this analysis tended to reflect the same results as for each individual location (see Figure A4-15, Appendix 4), such as the significant difference between Scalped and Reference samples for Big Bar in winter. The SIGTREE analyses for season and treatment (Figure A4-17, Appendix 4) showed a significant distinction between all seasons, but no significant distinctions between Scalped and Reference samples within a given season (i.e., time of year and associated flow rates and biophysical conditions). The power for this set of results is extremely high, due mainly to the pooling of a large number of samples for each grouping.

Hypothesis Ho_6 was also tested using a simple cumulative frequency distribution, which examined the distribution of similarities between all Reference Samples and an averaged "mean" Reference composition. The distribution of similarities between all Scalped samples and mean Reference composition is shown for comparison. The result (Chart 1, below) shows that <5% of all Reference samples have a dissimilarity >0.95 to the mean Reference composition. By comparison, approximately 18% of all Scalped samples had a dissimilarity to mean reference composition >0.95.

In conclusion, there was considerable overlap between the Reference and the Scalped distributions and, as a result, they could not be concluded to be significantly different. Therefore, even though some differences were noted for specific locations between reference and mined sites, when viewing the entire dataset these are lost. This is primarily due to the great range in faunal composition possible in reference conditions. Despite individual differences noted, faunal composition remained within the natural variability expected throughout the study region.

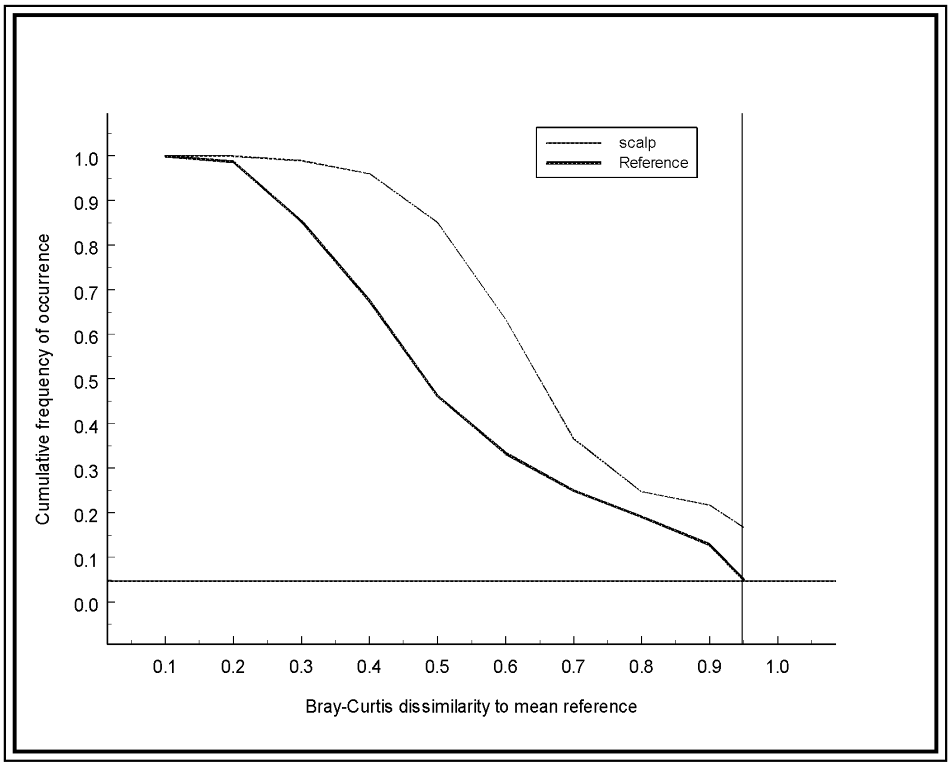

Chart 1: A comparison of cumulative frequency distributions for pair-wise dissimilarity comparisons of a) each Reference Sample with the mean reference benthos composition; and, b) each Scalped Sample with the mean reference benthos composition (seasons and locations combined)

Fish Community

Table A3-5 (Appendix 3) includes summary data of fish catches, SDI, H' and 1-D for each location, replicate, habitat type, date and treatment type. Table A3-6 (Appendix 3) depicts means and standard deviations (SD) as well as precision for these factors for all locations, dates and treatments, along with matched substrate factors. Table 6 provides ANOVA results for the comparison of location and season with fish CPUE.

Results for CPUE and log (x+1) CPUE were similar with the exception that location effects were significant in the raw analysis and not in the log analysis. Removal of one extreme outlier (unusually high abundance of fish) in the Big Bar area (September, 2005) resulted in a comparable and significant effect arising from location for both the raw and log analyses. This outlier tended to add high variability to the mean for that location, producing an unreliable test result.

Table 6: ANOVA Results for Fish CPUE

Endpoint	Factor	SS	df	Mean square	F	p
CUPE	Location	4.44	4	1.11	2.36	0.06
	Season	0.30	2	0.15	0.32	0.73
	Error	25.87	55	0.47	N/A	N/A
Log CUPE	location	0.17	4	0.04	3.29	0.02
	season	0.03	2	0.01	1.17	0.32
	Error	0.70	55	0.01	N/A	N/A

Null hypotheses testing for the fish community were restricted due to a limited sampling at Reference Areas. Due to the similarity in habitat types described above, Ho_3 and Ho_4 were found redundant with respect to measured substrate parameters and the hypotheses tested were required to be amended; however, different habitat types within the river were sampled (i.e., bar, flat, nook, etc.). The series of SIGTREE analyses that follow represent a progressive summarization of data into larger groupings. Results are included in Figures A4-18 through A4-20 (Appendix 4).

Ho_1 - Fish communities are the same for all Scalped locations, habitat types and seasons.

Results in Figure A4-18 (Appendix 4) indicated no clear difference in fish composition in different habitat types within the river; however, Herrling Site samples were statistically different from remaining samples. These were the only winter samples (i.e., reflective of time of year and associated flow rates and biophysical conditions) collected and as a result the difference could be attributed to either season or location.

Ho_2 - Fish communities are the same for all Scalped habitat types and seasons (i.e., reflective of time of year and associated flow rates and biophysical conditions), all locations combined.

This analysis (Figure A4-19, Appendix 4) showed that there may be significant differences between riffle habitats and other habitat types sampled during summer flow rates; however, the remaining significant linkages suggested that the resulting pattern was more clearly explained by season (i.e., time of year and associated flow rates and biophysical conditions) than habitat type. In addition, since not all habitat types were represented in all locations or seasons, and some of the samples did not have a defined habitat type, this factor was considered to be of limited utility.

Ho_3 - Fish communities are the same for all seasons (i.e., time of year and associated flow rates and biophysical conditions) regardless of habitat type or location

This analysis (Figure A4-20, Appendix 4) indicated that there was a significant difference in the number and type of fish caught between seasons (i.e., time of year and associated flow rates and biophysical conditions); however, only one location was sampled at different seasons (spring and summer) for location Gill West; as a result, the significant differences for the other locations may not have been related to season. Data suggested that fish assemblages may have been more similar between seasons at a given location, than between different locations for a given season. This emphasized the problem with combining samples from different locations for larger-scale analysis.

3.3 Discussion of Statistical Results

3.3.1 Effects of Scalping on Benthic Invertebrates

Given that the analysis of substrate factors indicated that there were no statistically significant differences (and high similarity) between substrate types for all locations, dates and treatments (Reference vs. Scalped) it may be concluded that substrate type was consistent enough between samples to be eliminated as a factor affecting comparative analyses. The exception was one completely Scalped Site (Gill Central Bar, November, 2007) which was markedly different (due to higher variability) from the other sites. It should be noted, however, that substrates were not sampled consistently for all benthic locations; therefore, this result is of limited use in understanding the effects of scalping. Further, substrate examinations were limited to coarse surface examination. Detail particle size analysis (2-5 cm in depth) would provide enhanced information with respect to correlations between observed communities and substrate types.

The remaining factors considered important (based on the sampled parameters) included location, season of sampling (i.e., time of year and associated flow rates and biophysical properties) and treatment (Reference or Scalped). The null hypothesis that stated that these three factors had no effect on the general assemblage parameters (i.e., total abundance, number of taxa, abundance of major taxonomic groups or dominance) was tested using multiple ANOVA. The analysis was asymmetric, given that there were far more Reference than Scalped samples, all seasons (reflective of different times of the year, associated flow rates and biological properties) were not sampled with the same frequency, and all locations were not sampled with the same intensity. In addition, taxa number and dominance were near-normally distributed, so raw data could be used; however, abundance data were not usually normally-distributed. Results underwent log-transformation to enable more meaningful (stable) use in analysis. Fortunately, results were similar for the two types of data in most other cases.

ANOVA analyses consistently showed that season (time of year and associated flow rates and biophysical properties) and location significantly affected benthic faunal factors but were variable for treatment type. The abundance of certain faunal groups was affected by scalping (notably Oligochaeta and Tricoptera), whereas the number of species, dominance and other dominant groups were not. Taxonomy to genus or species level may have enabled further identification of certain impacted indicator species which tend to be conspicuously absent or abundant in Scalped locations and, therefore, further assist understanding conditions and potential impacts at a given site.

Hypotheses were addressed for each location separately in the community analyses using SIGTREE. This test illustrated in which locations, time of year and flow rates (season) and possibly treatment had the most obvious effects. At all locations, the clearest trend was a separation of faunal types by season (i.e., time of year, flow rate and associated biophysical properties); therefore, this factor was a consistent effector of benthic composition. The response within a given season to treatment is inconsistent. In Gill West, the winter Reference and Scalped sites (reflective of that time of time of year and associated flow rates and biophysical conditions at that time) were significantly distinct, whereas in Gill East, this was noted for summer samples only. At Gill Central, no Reference Sites were collected so this trend could not be examined. No differences were noted for Big Bar or Tranmer (sampled only once in December), whereas Herrling (also only sampled in December) showed a significant distinction at two out of three Scalped Sites.

Reference samples at all locations and all seasons were combined and analyzed to determine how these differ in terms of faunal composition. This approach poses the utility of using a “Reference Condition Approach” in assessing benthic invertebrate impacts, previously described for the lower Fraser River by Reynoldson *et al* (2001). The rationale behind this approach is that there is a broad range in background faunal types found in the river for a given substrate type and that samples with faunal composition which fall outside the 95% confidence interval of the “reference range” are then considered “impacted”. Using this approach, it is not expected that all Reference Sites would therefore be homogeneous; rather, if there are enough Reference Sites, they will collectively encompass the entire range of benthic assemblage types typically found in the given substrate condition. For this reason, results showed significant differences in faunal composition, but with no pattern in terms of location. There was a significant pattern noted associated with season (i.e., flow rates and associated biophysical conditions), but within each season variability was higher than between seasons. Only fall and winter samples were noted to be homogeneous overall. A similar result was seen when the analysis including only Scalped samples from all locations and dates.

From this it could be concluded that “season” (i.e., flow rate and biophysical properties at a given time of year) is the overwhelming driver of benthic faunal composition, followed by location. The specific effect of “scalping” is inconsistent and varies for different times of the year in some locations. The final SIGTREE grouping of all samples (Reference and Scalped) for all locations and dates confirmed the observed pattern.

When seasonal differences were removed from analysis the cumulative frequency distribution showing the range in Reference similarity to a “mean” Reference composition was strongly overlapped with the distribution of similarities between Scalped sites and mean Reference composition. It was concluded that data do not provide sufficient evidence of an overall effect of gravel scalping on benthic infauna. This conclusion was made within the confines of the multiple limitations noted above and range of samples collected. Location-specific effects were evident in certain seasons (which may be related more to the time of year [flow rate and biophysical properties] in which scalping took place).

3.3.2 Effects of Scalping on Fish Community

The current monitoring design did not provide the means to effectively assess effects of gravel extraction activities on fish assemblages given that data was limited or not available for Reference areas and for particular parameters. ANOVA results suggested that CPUE was distinct between locations, but did not differ with time of year; however, data demonstrated a high precision value (defined as “standard error as a proportion of the mean”). Precision describes the degree of variability amongst replicates at a sampling location. A high precision value therefore reflects high variability around a mean for a given location, making statistical analysis unreliable. A low precision value demonstrates a good agreement amongst replicates (i.e., standard error is a small proportion of the mean value). Elliott (1977) suggests that 20% is the upper limit that should be accepted. A high value indicates that variability among replicates is sufficiently high to prevent confidence in accurately sampling the community (establishing an accurate mean) with the number and/or size of replicates used.

In addition, seasonal sampling for all locations was extremely unbalanced. For example, Herrling Bar was the only site sampled in winter and it was not sampled again given that the removal project did not proceed. For this reason, assessments were confounded between the independent variables in the ANOVA. Community analyses were similarly hampered by sampling inconsistencies and therefore results were of limited utility. No conclusions could be drawn from or about fish assemblages related to Scalping, location or season (i.e., time of year and associated flow rates and biophysical properties).

4.0 SUMMARY & RECOMMENDATIONS

Discussions among EMBC, DFO and relevant consultants, as generated from an earlier draft of this review report, concurred that the program, as currently designed, does not adequately address questions of magnitude and extent of effect. This is reflected in the inconclusive results to date of the work conducted by various consultants from 2004 to present (summarized in Section 4.1).

Further elucidation of specific design questions, based on agency requirements and nature of activities, need to be formulated to better design a program to assess potential magnitude and extent of any effects. Such a design would need to be based on identified endpoint questions and test scenarios (depending on intent, activities and other criteria) derived through discussion among stakeholders (e.g., EMBC and DFO). Study design considerations and recommendations that follow in Sections 4.2 and 4.3 provide suggestions for discussion and subsequent creation of a revised study design.

4.1 Statistical Summary & Conclusions

4.1.1 Habitat Results Summary

When substrate data were pooled by time of year (representative of seasonal flow conditions), regardless of date or year, the Pearson Correlation analysis demonstrated no clear differences between Scalped and Reference Sites. Sites were considered homogeneous, with the exception of the Gill Central Scalped Site (November 2007).

4.1.2 Benthic Invertebrates Results Summary

The most abundant benthic faunal groups were the Diptera, Ephemeroptera, Plecoptera, Oligochaeta and Trichoptera. Results of the multivariate cluster analyses indicated that there were significant differences in faunal composition by location, season and in some instances treatment (Scalping). The effects of treatment, location and seasonal flow conditions on taxa number, SDI, 1-D, and total abundance and abundance of the groups Diptera, Ephemeroptera, Plecoptera, Oligochaeta and Trichoptera were tested using multi-factor ANOVA. Results suggested that location and season had a significant effect on all tested factors. While treatment (Scalped vs. Reference) significantly affected total abundance (related to the significance of effects on the sub-groups of major taxa, particularly Oligochaeta and Tricoptera) it had no significant effect on taxa number, SDI, or abundance of Diptera, Plecoptera and Ephemeroptera. Results must be viewed with caution given that abundance data in particular tended to be non-normally distributed; however, the ANOVA was relatively robust with respect to this requirement and results were useful for suggesting trends and guiding further analyses and design modifications.

SIGTREE cluster analyses for seasonal flow effects and treatment showed a significant distinction between all seasons, but no significant distinctions between Scalped and Reference samples within a given time of year (and related seasonal flow effects). The statistical power for this set of results was extremely high and due mainly to the pooling of a large number of samples for each grouping. SIGTREE analysis with all locations, treatments and dates considered separately, showed no discernable pattern with respect to seasonal or location differences; however, there were some significant linkages within the pattern, suggesting that all Reference locations were not homogeneous. SIGTREE analyses also showed that the Scalped Sites were not homogeneous in terms of benthic fauna. The same was true for the analysis of all locations grouped by season. When grouped to assess seasonal flow effects (regardless of location and year of sampling) results showed that winter and fall were homogeneous. This grouping was significantly distinct from both summer and spring for Scalped samples.

A simple cumulative frequency distribution was used to examine the distribution of similarities between all Reference samples and an averaged "mean" Reference composition. The distribution of similarities between all Scalped samples and mean Reference composition showed that <5% of all Reference samples had a dissimilarity >0.95 to the mean Reference composition. By comparison, approximately 18% of all Scalped samples had a dissimilarity to mean Reference composition >0.95. In conclusion, there was considerable overlap between the Reference and Scalped distributions and they could not be concluded to be significantly different.

4.1.3 Fish Results Summary

SIGTREE cluster analyses showed no clear difference in fish composition in different habitat types within the river; however, the Herrling site samples were significantly distinct (in abundance) from remaining samples. Given these were the only winter samples collected differences may be the result of either time of year (season) or location.

Analyses further showed that there may be significant differences between riffle habitats and other habitat types sampled in summer; however, the resulting pattern was more clearly explained by season (time of year and associated flow conditions and related biophysical properties) than habitat type. In addition, since not all habitat types were represented in all locations or seasons and some of the samples did not have a defined habitat type, this factor was considered to be of limited utility. Analyses showed a significant difference in fish assemblages between seasons; however, only Gill West was sampled over different times of the year (spring and summer). Data suggested that fish assemblages may have been more similar between seasons for any given location than between different locations in a given season.

4.1.4 Statistical Conclusions

Based on substrate information available it was concluded that substrate type was consistent enough between samples to be eliminated as a factor affecting comparative analyses; however, given that substrates were not sampled consistently for all benthic locations and times this result is of limited use in understanding the effects of Scalping.

Results of the ANOVA analyses consistently showed that the time of year and associated flow rate and biophysical conditions (season) and location significantly affected benthic faunal factors; however, results showed variable responses for treatment type (scalped vs. non-scalped). The abundance of certain faunal groups was affected by scalping (notably Oligochaeta and Tricoptera), whereas number of species, dominance and the other dominant groups were not.

Seasonal flow conditions and associated biophysical state were concluded to be the overwhelming driver of benthic faunal composition, followed by location. The specific effect of "scalping" is inconsistent and varies by time of year in some locations. SIGTREE grouping of all samples (Reference and Scalped) for all locations and dates confirmed the same conclusion. When seasonal differences were removed from the analysis the cumulative frequency distribution showing the range in Reference similarity to a "mean" Reference composition strongly overlapped with the distribution of similarities between Scalped sites and mean Reference composition.

It was concluded that data do not provide evidence of an overall effect of sediment scalping on benthic infauna. This conclusion is made within the confines of the existing study design and the multiple limitations of this study and range of samples collected.

The current fish monitoring design did not provide the means to effectively assess effects of gravel extraction activities on fish assemblages, due in part to the lack of samples collected in Reference Sites for any location and the limitations to particular parameters examined. No conclusions could be drawn from or about fish assemblages related to Scalping, location or season.

4.2 Overall Study Design Discussion

When assessing the question of "effect", it is stating the obvious when noting that large volumes of sediment are removed from the river, which is in itself an "effect". More specifically the question of effect is one of the magnitude and extent of any effect, defined in terms of how such effects relate specifically to biological communities and associated habitat. The existing program is very broad and applies a coarse level of evaluation from which to answer this question. The high degree of natural variability and confounding influences associated with a given site, combined with variability in study timing (reflecting flow rates and biophysical properties at a given time of year), use and application of Reference Sites and which parameters are or are not measured, together with low sample replication, lack of ecological context and data manipulation and presentation issues, limit meaningful and defensible conclusions with respect to the effects of gravel extraction and the timing and location of those effects.

In general the program would be substantially improved and economized by reducing the number of mining sites attempted to be studied and by focusing effort and associated resources on a few locations which have been shown to have good, comparable, Reference Sites (i.e., selection of test areas with low comparative variability). Further, program design should clearly state, in advance, the specific questions or hypothesis to be examined then define tangible, testable endpoints. Methods should then maximize the utility of conservative, sedentary, benthic invertebrates communities through more detailed taxonomy and assessment of ecological significance through use of indicator species and applicable indices (e.g., as recommended by the federal EEM protocols). Consideration should be given to dropping the study of fish given exposure, mobility and behaviour issues. Alternatively, if fish studies are to be considered, they should include, at minimum, comparable reference sites and sampling of appropriate biophysical measures and comparative measures. Maximization of supportive biophysical measurements (e.g., particle size analysis and total organic carbon) would be beneficial in ensuring extraction and reference sites are comparable and properly characterized over each time of study. Methods should be clearly understood and consistently applied, including data collection, standardization and reporting formats. Finally, a defined Quality Assurance/Quality Control (QA/QC) program that includes field, laboratory and data analyses components should be considered mandatory.

4.2.1 Defining "Effect" & Asking the "Right Question"

A significant limitation to the existing program is a lack of clear intent behind the question of "effect". Assessing "effect" can, and does, have many facets. Effect in this case is intended to mean those effects arising from the removal of sediment; however, the mere fact that a bar is removed is an effect and the nature of removal (whether permanent or ongoing, with or without recruitment, etc.) will further determine the nature and subsequent handling of effect. Whether effect is primarily physical or has larger ecological ramifications (defined in through magnitude and extent) depends on the time frame being assessed within the scope of practices being followed and the natural cycles of the river. Immediately after habitat removal, all or most of the biological communities associated with substrates are also removed, creating a significant effect; however, after some time, biological communities may re-colonize the affected area, along with the return of gravel (Rempel and Church, 2009).

The larger question of "effect" and its mitigation and/or compensation is best served through several composite sub-questions in a revised design defined by scale of investigation (e.g., reach-scale vs. site by site). These may include:

1. once gravel is removed how long does a site take to recover in terms of physical size and volume or its biological community?

2. can a given site be adequately characterized, prior to scalping, such that an estimate of loss can be made and can any commensurate habitat compensation be defined in terms of the time taken for the original habitat to recover (as reflected by specific abundance, composition and biophysical habitat measures);

3. can a select number of locations be studied as "proxies" with the resulting information used and applied to other locations of study (i.e., where variability or confounding influences complicate an appropriate study of effect);

4. what level of statistical resolution, tools, parameters and methods would be best used to answer the above questions?

The existing program would be greatly enhanced both in terms of economy and overall utility if its design followed a strategically based set of specific questions (and hypotheses) based on the overall EMBC program, the range and scope of its activities, and associated environmental criteria for protection, mitigation, and compensation.

4.3 Recommendations for Study Design & Components

The large number of potentially confounding factors requires a focused sampling program that specifically addresses questions specific to program use and criteria for protection, mitigation and compensation. A modified BACI approach as described by the Pulp and Paper EEM Technical Guidance (EC, 2009) for rivers may be appropriate in some instances. This applied ANOVA design is well suited to a grouping method such as agglomerative cluster analyses.

Variations on the traditional BACI, such as MBACI and the Reference Condition Approach (RCA) should be considered. Multi-site, multi-time BACI monitoring programs (MBACI; Downes et al., 2002) provide an improvement to inappropriate spatial and temporal replication from which earlier BACI designs suffered (Underwood, 1994; Roberts et al., 2007). The Reference Condition Approach uses cluster analysis and discriminant function analysis (DFA) to predict a test site to a reference group with similar species composition. DFA defines a key set of environmental variables that discriminate between the reference groups and can be used as predictor variables (Reece and Richardson, 1999). The advantage of the RCA is its ability to accommodate the large scale dynamic nature of the river and its inherent natural variability. It may be best to adopt a broader scope investigation that encompasses reach-scale phenomena vs. site-specific events.

In the interests of "effects" analysis, within a constrained time window and budget, it is recommended that the new study design be evaluated for "effectiveness", based on the specific nature of scalping operations. The following considerations may be a desirable discussion issue:

- consider focusing on fewer sites (e.g., pilot/representative sites) for more focused/intense study. This may include:

- comprehensive ecological habitat survey, including EEM-type substrate survey, on-site vegetation and topographic survey (to properly characterize site and related ecology);
- increased number of sampling times (with sufficient focus on "before" representation), when possible, and sampling replicates for benthos (at both Reference and Scalp Sites) to increase power, confidence and certainty (of model predictability);
- focus on benthos and habitat;
- if fish study is included, consider using parameters other than CPUE (e.g., length and weights, condition factors, age and size class, sex and fecundity, etc.) and add corresponding study of Reference Sites;

- Consider a program based on statistical grouping methods (e.g., agglomerative cluster analysis) that are, in turn, based on a specific set of testable hypotheses.

Given that statistical design relies on the specific questions asked (e.g., hypotheses being tested) and how samples are collected, these must be given considerable thought prior to embarking on a program design. Given that power is related to effect size of the difference one is trying to detect, and given that in these current studies no *apriori* effect size appears to have been considered, issues regarding sampling precision as well as within vs. between group variance (essentially confidence intervals) are most appropriate to assess.

During monitoring, it is important to ensure that substrate and habitat type remain as consistent as possible, to reduce confounding influences as much as possible. The principal habitat factor which might be expected to change is the percent (%) loss of sediment (and therefore percent [%] sand). This was only evident at one site (Gill Central, November 2007, Scalped Site). It is not clear if this was the reason for the very low abundances of benthos at this location, as well as if the substrate and benthos sites sampled were concurrent. Information provided subsequent to preliminary analyses done in this assessment suggest that the method of sample collection may have had a direct influence on producing the low numbers at this site and time. This underscores the need for field reconnaissance and other investigation prior to sampling.

It is also important to avoid sampling in areas which may be seriously confounded by other contaminant inputs, anthropogenic effects or high system variability. These should be avoided through selection of sites that are most comparable and least influenced by these factors.

4.4 Recommendations for Benthic Invertebrate Community

The following recommendations to the benthic invertebrate study component are provided.

4.4.1 Scope of Study Design

Before/After Component of Scalped Sites

In a BACI study design, the monitoring program would be improved if locations (several Scalped Sites) were sampled with a minimum of 10 replicates per site (to be analyzed sequentially until an acceptable sampling precision was reached – typically 20%). Sampling should be conducted prior to scalping (whatever the season), as soon as permissible after scalping (same season preferably) with subsequent sampling during all permissible seasons including the pre-scalping season.

Given that benthic invertebrate community composition changes seasonally (Hynes, 1970; Furse et al., 1984; Reece and Richardson, 1999), BACI or RCA predictive models must incorporate this notable factor to reduce uncertainty in identifying stress-related vs. seasonally-imposed changes. This is accomplished by collecting over multiple seasons and adding to the reference database, allowing seasonal variation to be incorporated into the model, including properly representing "ambient" prior to scalping activities. The creation of a comprehensive reference database is a prerequisite to assessing before and after effect. Without a clear comprehension of the inherent variability (both natural and human created) of a given reach, changes due to imposed stress cannot be distinguished as important from those imposed by natural means.

Control/Impact Component of Reference vs. Scalped Sites

Sampling at Reference Sites should be from the same locations and seasons as the Scalped Sites (e.g., a matched sampling). While the number of Reference Sites in the current sampling design (e.g., generally 3 Reference to 1 scalped) meets the criteria of greater sampling coverage due to the variability in background conditions (even in similar habitat types), selection of Reference Sites requires a high degree of consideration. Reference sites should be as comparable as possible to the Scalped sites prior to gravel extraction to enable a meaningful assessment of natural system variability and consideration to effects of any confounding factors. These criteria remain true for the Reference Condition Approach as well, which utilizes a larger data set of reference sites to represent the full range of habitat natural variability reflected in the scalped sites. This sampling strategy provides a Control/Impact component to the sampling.

Reductions Due to Limited Monitoring Resources

If the seasonal extent of sampling is not possible as described, due to limitations in funding or resources, then the program could be scaled back to address limited but focused monitoring questions. A suggested list of priority reductions should maintain the BACI structure of the program, but reduce the scale of sampling as follows:

- reduce the number of locations (mines) sampled;
- eliminate one or more seasons (times of year) in the sampling program;
- due to the variability in faunal composition at different sites, develop a reference database of samples for a variety of locations in the river, for available times of year reflective of different biological condition and associated flow and biophysical conditions over several years. This approach is similar to that developed by Reynoldson *et al.* (2001) as part of the Reference Condition Approach (RCA); and,
- investigate and apply existing monitoring data from the Lower Fraser River *Reference Condition Program* (Environment Canada) where appropriate and applicable for defining variability in reference biotic assemblages (i.e., to supplement gaps in monitoring).

More specific recommendations regarding investigations in the field, laboratory and office are suggested below.

- **Sampling Design:** it is recommended that standardized templates for data collection, sample descriptions, taxonomic lists, indices, spreadsheets, etc. be used on all EMBC programs. Most appropriate methods for the environment and specific hypotheses being tested should be adopted (e.g., Hess vs. Surber sampler; field sieving methods, etc.) and used according to specified protocol. Methods and protocol should be documented along with appropriate QA/QC by the firm conducting the work.

4.4.2 Field Methods & Reporting

- **Sampling Devices:** the sampling device (Surber or grab) were often not specified and had to be assumed through use of photographs or sample sizes. Given the quantitative and likely qualitatively difference in community collected (see note above) details of field methods need to clearly state what was used to collect samples, how they were collected and how they were treated in the field. If *in situ* water profiling is done these instruments should be calibrated daily with appropriate logs kept. Field data should be reported as an appendix to the report;

- **Sampling Design:** as with above, rationale for location and number of replicates, reference sites, etc. should be given for each individual study and be based on overall rationale of the overall study;

- **Standardized Methods:** Currently, mixed methods are used with data reported as volumes. Nationally-based standardized methods (e.g., EEM, EC 2009) should be used and results standardized to scientific convention (e.g., organisms/m^2). Equipment such as a steel Hess may provide the ability to sample in deeper water and heavier substrates as well as penetrating further into the substrate as opposed to a Surber/Ponar. Consistency in method is critical. Method and how long substrates are scrubbed, by hand or with a soft brush, mesh size used, how deep the sampler is pushed into the substrate, etc. can affect the outcome of the results and every effort should be made to standardize approach; and,

- **Sample Treatment:** Benthos sampled should be sieved at a 1.0 mm and 0.5 mm sieve size to facilitate a higher level of taxonomic analysis. This would provide more robust abundance and diversity data for indices, information about recruitment, opportunists, etc. Many specialized organisms, simply by being present, can provide a great of information with respect to stage of site succession and habitat quality. Sample handling, shipping, labeling, preservation and staining techniques should be standardized. Representative species should be taken and a Reference Collection (library) created to enable reference to or examination of specific organisms when necessary.

4.4.3 Analysis & Reporting

- **Reporting of Raw Data**: the reporting of raw data (e.g., single replicate data) is essential for quality assurance and general verification procedures. Several reports did not include the basic data from which several analysis were performed and presented (e.g., mean totals, diversity indices, etc.) and could not be submitted to quality assurance verification. Raw field notes should be included in an appendix to the report;

- **Inclusion of a QA Program**: given the observation of various errors in data presentation and interpretation, a quality assurance program is recommended. The program should include the full range of assessment from simple transcription errors to calculations and statistical work-up. Benthos efforts should include appropriate QA protocols such as documented re-sorts with an efficiency level defined (10% resort with 95% accuracy);

- **Data Standardization**: All benthos data should be entered into standardized spreadsheets that use conventional taxonomic order and treatment of features (e.g., epibenthos, juveniles, etc.);

- **Benthic Endpoints:** It is suggested that specific indicator associations that typify the river environment (both r-type and K-type colonizers; tolerant and intolerant, etc.) be assessed (requires species-level taxonomy) and appropriate endpoints and indices adopted (e.g., EPT index, early sere vs. later sere communities, etc.);

- **Established Protocol**: Specific assessments for data work-up should be included as part of reporting. It is recommended that federal Environmental Effects Monitoring (EEM; EC, 2009) or similar protocols be followed and include: total abundance, relative abundance, diversity, richness and measured indices such as: Simpsons, Hillsenhoff, Bray Curtis, etc. and use of indicator species; and,

- **Units of Reporting**: Given that the standard reporting method (e.g., Environment Canada, EEM protocol) is to provide data that can be accurately viewed and unequivocally interpreted by anyone, it is highly recommended that all benthos data be converted from numbers per "sample" (which is highly ambiguous, particularly when the sampler is not specified) to numbers/m^2. This provides a common basis for scientific comparison and is less confusing (particularly given that a grab was apparently used at times, which would provide a different surface area coverage than the Surber).

- **Standard Data Recording**: It is standard practice in field programs to append (in an appendix) relevant raw data materials so that reviewers may: 1) conduct quality assurance and verification; 2) conduct their own analyses based on results; 3) conduct meta-analyses as part of a larger study. Raw data and pertinent information in these investigations consists of all regulatory documentation (e.g., DFO Authorization, etc.), raw data (e.g., taxonomic enumeration, laboratory data and notes, field notes), photographs with standard scientific captions (e.g., position, aspect, date and time, etc.), quality assurance documents such as chain of custody forms, laboratory methods, etc.

4.5 Fish Community Recommendations

Fish community sampling can be problematic given that fish are mobile. It is difficult to say with certainty that a given fish collected at any given area has resided and relates to habitat quality for a given area without residency and exposure studies. Program design to date has had limited utility in this regard. Inclusion of fish and the value to date to the program should be seriously reviewed.

Should fish still be identified as important to a revised study design, the following recommendations are provided to improve the study.

4.5.1 Field Methods & Reporting

- **Sampling Device:** The size (length and width) of the seine net was often not clearly specified. To obtain an accurate statistical analysis of the results, the net dimensions and mesh sizes must be clearly stated (see Section 4.2). Other collection and population measures/techniques may be more appropriate and should be reviewed within the context of revised program objectives and endpoints.

- **Sampling Design:** Rationale for location and number of replicates, reference sites, etc. should be given for each individual study and be based on overall rationale of the overall study. The sampling technique (see Section 4.2) must be comparable at all locations.

- **Inclusion of a QA Program**: given the observation of various errors in data presentation and interpretation, a quality assurance program is recommended. The program should include the full range of assessment from simple transcription errors to calculations and statistical work-up.

- **Standard Data Recording**: As with the benthic field portion, relevant raw data materials should be provided in an appendix for the reasons given above. To reiterate, raw data and pertinent information in these investigations consists of all regulatory documentation (e.g., DFO Authorization, etc.), raw data (e.g., taxonomic enumeration, laboratory data and notes, field notes), photographs with standard scientific captions (e.g., position, aspect, date and time, etc.), quality assurance documents such as chain of custody forms, laboratory methods, etc.

4.6 Recommendations for Habitat

- **Habitat Parameters**: detailed habitat evaluations and mapping should include ecologically-based components to better understand the biophysical quality of the site (e.g., riparian area vegetation, adjacent aquatic habitat quality features [substrate, banks, *in situ* structures, sinuosity, compaction, flow, light, etc].).

- **Grain size distribution:** given that benthos are an important measure of habitat quality, an assessment of the top 2-5 cm of substrate is recommended. This could include particle size distribution and potentially total organic carbon. Both measures provide meaningful insight as to habitat quality and also correlation with benthos communities observed – both before and after extraction.

- **Physical descriptions:** Physical descriptions such as those used for the federal EEM) also provide very valuable insight to the ecology of an area (e.g., smell, appearance, consistency, homogeneity, etc. provide information on benthic community habitat as well as possible fish usage such as spawning vs. rearing, fish use and life-stage, habitat-flow relationships, etc.). Photos and raw data should accompany each substrate sample and be provided in an appendix.

LITERATURE SOURCES

Backiel, T. and R.L. Welcomme (eds) 1980. Guidelines for sampling fish in inland waters. EIFAC Tech. Paper (33). 176 p.

Beechie, T.J., Lierman, M., Beamer, E.M., and Henderson, R. 2005. A classification of habitat types in a large river and their use by juvenile salmonids. Trans. Am. Fish. Soc. 134: 717-729.

Bray, J.R. and J.T. Curtis. 1957. An ordination of the upland forest communities of southwestern Wisconsin. Ecol. Monogr. 27:325-349.

Burd, B.J., A. Nemec, and R.O. Brinkhurst. 1990. The development and application of analytical methods in benthic marine infaunal studies. Adv. Mar. Biol. 26: 169-247.

Burd, B.J. 2002. Evaluation of mine tailings effects on a benthic marine infaunal community over 29 years. Mar. Environ. Res. 53:481-519.

CCME. 2006. Canadian Council of Ministers of the Environment. Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg.

Cole, Gerald A. 1975. Textbook of Limnology. The C.V. Mosby Company. Saint Louis. 283pp.

Elliott, J.M. 1977. Some methods for the statistical analysis of samples of benthic invertebrates. 2nd Ed. Scientific Publications of the Freshwater Biological Association, No. 25.

Environment Canada. 2009. Federal Environmental Effects Monitoring Website. http://www.ec.gc.ca/esee-eem/default.asp?lang=En&n=453D78FC-1.

Furse, M.T., D. Moss, J.F. Wright, and P. Armitage. 1984. The influence of seasonal and taxonomic factors on the ordination and classification of running-water sites in Great Britain and on the prediction of their macro-invertebrate communities. Freshwater Biol. 14: 257-280.

Ham, D.G. 2005. Morphodynamics and sediment transport in a wandering gravel-bed channel: Fraser River British Columbia. Ph.D. thesis, Department of Geography, The University of British Columbia, Vancouver, B.C.

Ham, D.G., and Church, M. 2003. The sediment budget in the gravel-bed reach of the Fraser River: 2003 revision. Department of Geography. The University of British Columbia, Vancouver, B.C.

Hynes, H. B. 1970. The ecology of running waters. Liverpool University Press, Liverpool, U.K.

Integrated Land Management Bureau (ILMB). 2007. RISC Standards: http://\\ilmbwww.gov.bc.ca\risc\pubs\aquatic\index.htm

James, A.G. 1999. Time and the persistence of alluvium: river engineering, fluvial geomorphology, and mining sediment in California. Geomorphology 31: 265-290.

Johnson, B.L. and Jennings, C.A. 1998. Habitat associations of small fishes around islands in the upper Mississippi River. North Am. J. Fish. Manage. 18: 327-336.

Kordolf, G.M. 1997 Hungry water: effect of dams and gravel mining on river channels. Environ. Manage. 21: 533-551.

Nemec, A.F.L. 2000. Bootstrap estimation of the statistical power of hierarchical cluster analysis. Chapter 4. In: Development of a Receiving Environment Monitoring Approach to Liquid Waste Management, Progress Workshop 2, December 6, 2000, Support Materials Part 2 of 3: Iona WWTP Receiving Environment, Draft Technical Reports. Prepared for the Greater Vancouver Regional District, Burnaby, BC.

Nemec, A.F.L. and R.O. Brinkhurst. 1988. Using the Bootstrap to assess statistical significance in the cluster analysis of species abundance data. Can. J. Fish. Aquat. Sci. 45:965-970.

Nova Pacific Environmental. 2004. Fraser River Gravel Removal Monitor's Report for 2004 (Big, Seabird, Harrison Bars). A report prepared for Steelhead Aggregates. (Draft). 31p.

Nova Pacific Environmental. 2005. Fraser River Gravel Removal Monitor's Report for Queens Bar 2005. A report prepared for Land and Water BC & Steelhead Aggregates. 11p.

Nova Pacific Environmental. 2005a. Fraser River Gravel Removal Monitor's Report for Popkum Bar 2005. A report prepared for Popkum First Nation. 13p.

Nova Pacific Environmental. 2006. 2006 Environmental Monitor's Report for Gravel Excavation at Hamilton Bar, Fraser River, District of Kent, BC. A report prepared for Bruce Van Dale. 4pp + appendices.

Nova Pacific Environmental. 2007. Fraser River Gravel Removal Big, Harrison and Seabird Island Bars Environmental Monitor's Follow-up Report, 2007. A report prepared for Steelhead Aggregates & The Ministry of Agriculture and Lands, Integrated Land Management Bureau. March, 2007. (Draft). 22p.

Nova Pacific Environmental. 2008. Fraser River Gravel Excavation Monitor's Report Spring Bar, Sites C and D. A report prepared for The Department of Fisheries and Oceans & The Ministry of Public Safety and Solicitor General. May, 2008. 9pp + appendices.

Nova Pacific Environmental. 2008. Fraser River Gravel Excavation Monitor's Report Hamilton Bar. A report prepared for The Department of Fisheries and Oceans & The Ministry of Public Safety and Solicitor General. May, 2008. 6pp + appendices.

Reece, Pamela F. and John S. Richardson. 1999. Biomonitoring with the Reference Condition Approach for the detection of aquatic ecosystems at risk. Proc. Biology and Management of Species and Habitats at Risk, Kamloops, B.C. 15-19 Feb., 1999.

Rempel, L.L. 2003. Recommendations for Fraser River Gravel Monitoring. Prepared for the BC Integrated Land Management Bureau. Unpublished.

Rempel, L.L. and M. Church. 2009. Physical and ecological response to disturbance by gravel mining in a large alluvial river. *Can. J. Fish. Aquat. Sci*. 66: 52-71.

Reynoldson, T.B., Rosenberg, D.M., Resh, V.H. 2001. Comparison of models predicting invertebrate assemblages for biomonitoring in the Fraser River catchment, British Columbia. Can. J. Fish. Aquat. Sci. 58: 1395-1410.

Ricciardi , A., and Rasmussen, J.B. 1999. Extraction rates of North America freshwater fauna. Conserv. Biol. 13: 1220-1222.

Richter, B.D., Braun, D.P., Mendelson, M.A., and Master, L.L. 1997. Threats to imperilled freshwater fauna. Conserv. Biol. 11: 1081-1093.

Rinaldi, M., Wyzga, B., and Surian, N. 2005. Sediment mining in alluvial channels: physical effects and management perspectives. River Res. Appl. 805-828

(RISC) Resource Information Standards Committee. 1997. Fish Collection Methods and Standards. BC Ministry of Environment, Land and Parks. Fish Inventory Unit.

(RISC) Resource Information Standards Committee. 1997a. Freshwater Biological Sampling Manual. BC Ministry of Environment, Land and Parks. Water Management Branch.

Roberts, D.A., A. G. B. Poore, E. L. Johnston. 2007. MBACI sampling of episodic disturbance: stormwater effects on algal epifauna. Marine Environmental Research 64: 514-523.

Rovira, A., Batall, R.J., and Sala, M. 2005. Response of a river sediment budget and historical gravel mining (the Lower Tordera, NE Spain). River Res. Appl. 21: 829-847.

Scott Resource Services, Inc. 2008. Big Bar 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal. A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 18pp + appendices.

Scott Resource Services, Inc. 2008. Gill East 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal. A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 19pp + appendices.

Scott Resource Services, Inc. 2008. Gill West 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal. A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 23pp + appendices.

Scott Resource Services, Inc. 2008. Gill Central 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal. A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 18pp + appendices.

Scott Resource Services, Inc. 2008. Herring Bar and Tranmer Bar Biological Monitoring Program Report Fraser River Gravel Removal. A report prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Surrey, BC. January, 2008. 14pp + appendices.

Scott, Jim. 2009. Personal Communication. Response to G3 draft report in an email of June 02, 2009 to EMBC.

Shannon, C.E. and Weaver, W. 1963. "The Mathematical Theory of Communication". University of Illinois Press. Urbana

Simpson,E. H. (1951). "The Interpretation of Interaction in Contingency Tables". Journal of the Royal Statistical Society, *Ser. B* **13**: 238–241.

Sneath, P.H.A. and R.R. Sokal. 1973. Numerical Taxonomy: The Principles and Practice of Numerical Classification. W.H. Freeman & Co., San Francisco, CA. 573 pp.

Stewart-Oaten, A., Murdoch, W.W., and Parker, K.R. 1986. Environmental impact assessment: "Pseudoreplication" in time? Ecology, 67: 929-940.

Surian, N. 1999. Channel changes due to river regulation: the case of the Piave River, Italy. Earth Surf. Process. Landf. 24: 1135-1151.

Swartz, R.C. 1978. Techniques for sampling and analyzing the marine macrobenthos. U.S. Environmental Protection Agency (EPA), Doc. EPA-600/3-78-030, EPA, Corvallis Oregon. 27p.

Underwood A.J. 1992. Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. J. Exp. Mar. Biol. Ecol. 161: 145-178

Underwood A.J. 1994. Beyond BACI: On beyond BACI: sampling designs that might reliably detect environmental disturbances. Ecol. Appl. 4: 3-15

Underwood, A.J. 1997. Experiments in ecology: their logical design and interpretation using analysis of variance. Cambridge University Press, Cambridge, UK.

Weatherly, H., and Church, M. 1999. Gravel extraction inventory for Lower Fraser River (Mission to Hope) – 1964 to 1998. Report prepared by Department of Geography, The University of British Columbia, For District of Chilliwack, Chilliwack B.C. Available for www.geog.unb.ca/fraserriver/reports/gravelextraction.pdf.

Wetzel, Robert. G. 1983. Limnology. W.B. Saunders Company. 860pp.

Appendices

- Appendix 1: Figures
- Appendix 2: Assessment Summary Tables
- Appendix 3: Statistical Tables
- Appendix 4: SIGTREE Dendrograms of Cluster Analysis
- Appendix 5: Standardized Raw Data Tables

Appendix 1

Figures

Figure 1: Fraser River Gravel Extraction Site Locations (2004-2009)

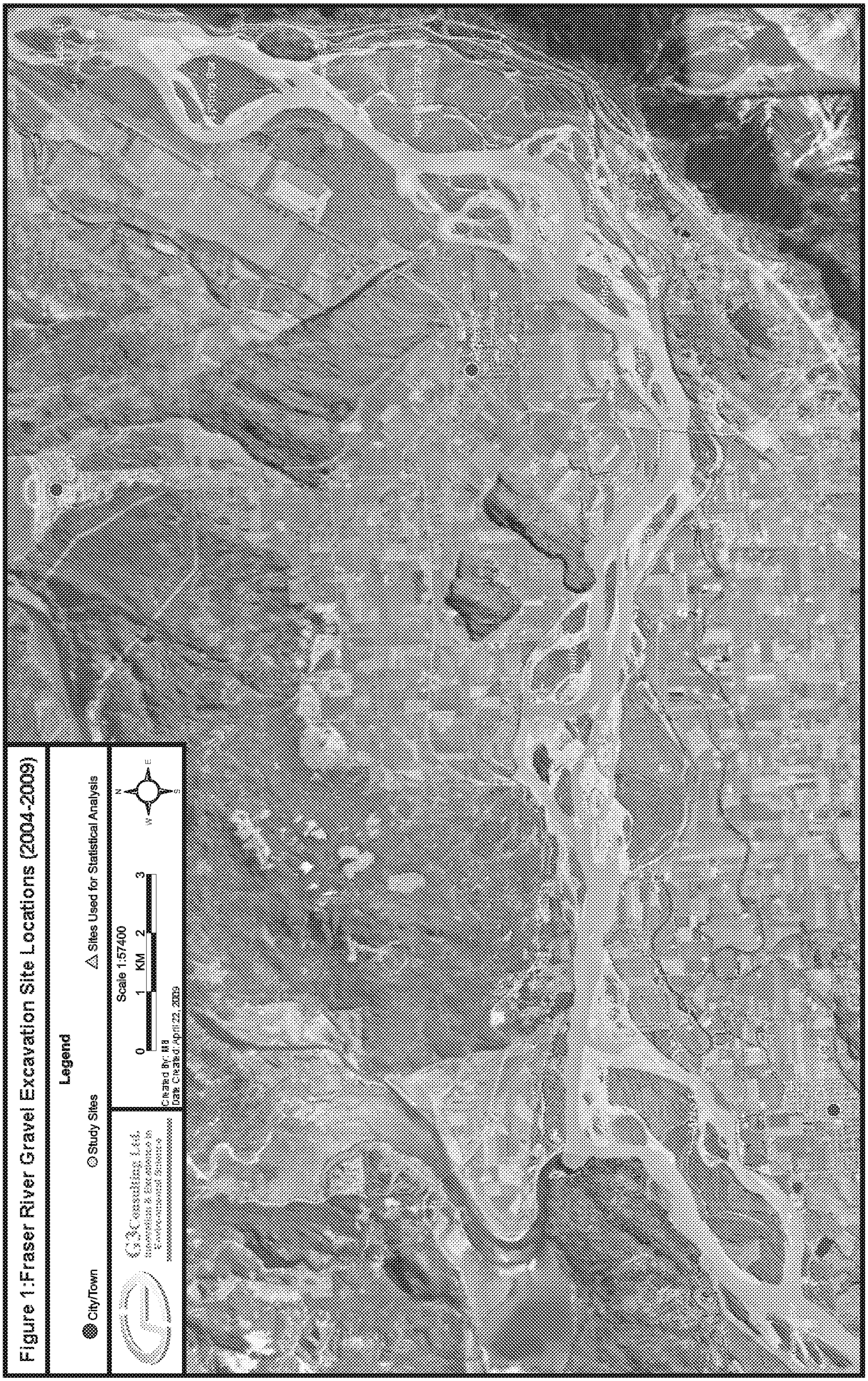

Figure 1:Fraser River Gravel Excavation Site Locations (2004-2009)

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Appendix 2

Assessment Summary Tables

Table A2-1: Data Reporting Assessment of Studies Provided to G3 (15 Reports)

Document(s)/Study	Author[1]	Data Status	Meta Analysis Completed	Comments[2]
Big Bar 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal	SRS	Complete (data available for pre- and post-excavation)	Yes QA of data and reporting, statistical Analysis	• Comprehensive biological/environmental assessment according to authorization, which includes habitat mapping, fish, benthic invertebrates and substrate analysis. Statistical analyses done (t-test); exposure and reference sites with replication; "soft" comparisons made using substrate, fish and benthos • Appendix includes fish, benthos and substrate data, topographic survey • Report mentions but does not include a copy of the Authorization.
Gill East 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal	SRS	Complete (data available for pre- and post-excavation)	Yes QA of data and reporting, statistical Analysis	• Comprehensive biological/environmental assessment completed according to authorization, which includes habitat mapping, fish, benthic invertebrates and substrate analysis. Photos included and appendices with data. • Statistical analyses done (t-test); exposure and reference sites with replication; "soft" comparisons made using substrate, fish and benthos • Appendix includes fish data, benthos data, substrate observations, topographic survey • Report mentions but does not include a copy of the Authorization.
Gill West 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal	SRS	Complete (data available for pre- and post-excavation)	Yes QA of data and reporting, statistical Analysis	• Comprehensive biological/environmental assessment according to authorization, which includes habitat mapping, fish, benthic invertebrates and substrate analysis. • Statistical analyses used (t-test); exposure and reference sites with replication; "soft" comparisons made using substrate, fish and benthos • Appendix includes fish data, benthos data, substrate observations and topographic survey • Report mentions but does not include a copy of the Authorization.

1. NPE = Nova Pacific Environmental; SRS = Scott Resources Services
2. "soft" comparisons = refers to comparisons or speculations not supported with substantiated data or literature
NA = not applicable

Table A2-1 (Cont): Data Reporting Assessment of Studies Provided to G3 (15 Reports)

Document(s)/Study	Author[1]	Data Status	Meta Analysis Completed	Comments[2]
Gill Central 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal	SRS	Complete (data available for pre- and post-excavation)	Yes QA of data and reporting, statistical Analysis	• Comprehensive biological/environmental assessment according to authorization, which includes habitat mapping, fish, benthic invertebrates and substrate analysis. Photos included and appendices with data. • Statistical analyses used (t-test); exposure and reference sites with replication; “soft” comparisons made using substrate, fish and benthos • Appendix includes fish data, benthos data, substrate observations, photos, topographic survey • Report mentions but does not include a copy of the Authorization.
Herring Bar and Tranmer Bar Biological Monitoring Program Report Fraser River Gravel Removal	SRS	Partially Complete (data available for only pre-excavation)	Yes QA of data and reporting, statistical Analysis	• Comprehensive biological/environmental assessment according to authorization, which includes habitat mapping, fish, benthic invertebrates and substrate analysis. Photos included and appendices with data. • Statistical analyses not used; exposure and reference sites with replication; “soft” comparisons made using substrate, fish and benthos • Data only for pre-excavation • Appendix includes fish data, benthos data, substrate observations, photos, topographic survey • Report mentions but does not include a copy of the Authorization.
Fraser River Gravel Removal Big, Harrison and Seabird Island Bars Environmental Monitor’s Follow-up Report (2007)	NPE	Partially Complete (some data available for pre- and post-excavation)	Partially No QA possible, some statistical analysis	• Compliance report by an environmental monitor for post- excavation. • Report discusses some environmental issues during excavation • Reports on benthic invertebrate sampling for pre- and immediately post-excavation assessment (by Laura Rempel, UBC), describes some methods and some data (e.g., mean density/m2, richness, diversity [D]). No benthos listing. Numbers and means and calculated indices cannot be QA’d. • Report also includes substrate grain size (D5, D50, D95) • Some observations recorded of fish redds and general habitat • Report does not include copy of the Authorization, although mentioned • fish data included (number of species and total number of fish). Appendix includes example fish data sheet (incomplete) • Habitat mapping conducted and provided

2. NPE = Nova Pacific Environmental; SRS = Scott Resources Services
2. “soft” comparisons = refers to comparisons or speculations not supported with substantiated data or literature
NA = not applicable

Table A2-1 (Cont): Data Reporting Assessment of Studies Provided to G3 (15 Reports)

Document(s)/Study	Author[1]	Data Status	Meta Analysis Completed	Comments[2]
Fraser River Gravel Removal Monitors Report for Queens Bar 2005	NPE	Partially (no biological/ environmental monitoring)	No No data collected to perform meta-analysis	• Compliance report by an Environmental Monitor for during excavation. Although the report mentions that NPE conducted pre-excavation site assessment. No environmental data, results or discussion are included. Post-excavation survey consists of engineer's drawing • Report mentions but does not include copy of the Authorization
Fraser River Gravel Removal Monitors Report for Popkum Bar 2005	NPE	Partially (no biological/ environmental monitoring)	No No data collected to perform meta-analysis	• Compliance report by an Environmental Monitor for during excavation. Although the report mentions that NPE participated in planning of pre- and post-excavation site assessment, no environmental data, results or discussion are included. • Report does not include copy of the Authorization • NO META-ANALYSIS POSSIBLE
2006 Environmental Monitor's Report for Gravel Excavation at Hamilton Bar, Fraser River, District of Kent, BC	NPE	Partially (no biological/ environmental monitoring)	No No data collected to perform meta-analysis	• Compliance report by an Environmental Monitor for during excavation. Although not included in this report, it states that a pre-removal assessment was conducted by NPE. Statements not supported with any data (e.g., "works were carried out in compliance with the conditions of authorization," "excavations were carried out in an environmentally responsible manner."—pg 4: Conclusions were not supported by any data). • Report mentions but does not include a copy of the Authorization.
2008 Fraser River Gravel Excavation Monitors Report Hamilton Bar	NPE	Partially (no biological/ environmental monitoring)	No No data collected to perform meta-analysis	• Compliance report by an Environmental Monitor for during excavation. Although the report states that environmental monitoring is described in the report, this is in the form of qualitative observation, not supported with any data (e.g., "by the following day, all the suspended sediment had dispersed or settled." "no turbidity was released into the side channel from the stockpile"—pg 5: Conclusions were not supported by any data). • Report includes a copy of the Authorization, which provides conditions of excavation, mitigation and compensation. The Authorization also includes monitoring and assessment, which is not provided in this report. Monitoring was to include pre-removal and post-removal monitoring of topography, substrate, benthic invertebrates, fish and habitat mapping

3. NPE = Nova Pacific Environmental; SRS = Scott Resources Services
2. "soft" comparisons = refers to comparisons or speculations not supported with substantiated data or literature
NA = not applicable

Table A2-1 (Cont): Data Reporting Assessment of Studies Provided to G3 (15 Reports)

Document(s)/Study	Author[1]	Data Status	Meta Analysis Completed	Comments[2]
2008 Fraser River Gravel Excavation Monitor's Report Spring Bar, Sites C and D	NPE	Partially (some biological/ environmental monitoring)	No No data collected to perform meta-analysis	• Compliance report by an Environmental Monitor for during excavation. Observations are supported by some data (e.g., turbidity measured) • Report includes copy of Authorization which provides conditions of excavation, mitigation and compensation. The Authorization also includes Monitoring and Assessment, which is not provided in this report. Monitoring was to include pre-removal and post-removal monitoring of topography, substrate, benthic invertebrates, fish and habitat mapping • Report includes separate biological study of salmonid eggs for temporary crossing
Fraser River Gravel Removal Monitor's Report for 2004	NPE	Partially Complete (some data available for pre- and post-excavation)	Partially No QA possible, some statistical analysis	• Compliance report by an Environmental Monitor for pre- and post- excavation. • Report discusses some environmental issues during excavation • Reports on benthic invertebrate sampling for pre- and immediately post-excavation assessment (Laura Rempel, UBC), describes some methods and some data (e.g., mean density/m^2, richness, diversity [D]). No raw benthos data provided. • Report also includes substrate grain size (D5, D50, D95) • Some observations recorded of fish redds and general habitat • Report does not include copy of the Authorization, although mentioned • Habitat mapping conducted and provided
Gill East Fraser River Gravel Removal 2006 Follow-up Monitoring Report. Draft Report	SRS	Incomplete (refer to final draft)	No	• NA –Data from the final draft used in META-ANALYSIS. Draft report supported by final version.
Gill West Fraser River Gravel Removal 2006 Follow-up Monitoring Report. Draft Report	SRS	Incomplete (refer to final draft)	No	• NA – Data from the final draft used in META-ANALYSIS. Draft report supported by final version.
Gill Central Fraser River Gravel Removal 2006 Follow-up Monitoring Report. Draft Report	SRS	Incomplete (refer to final draft)	No	• NA – Data from the final draft used in META-ANALYSIS. Draft report supported by final version.

4. NPE = Nova Pacific Environmental; SRS = Scott Resources Services
2. "soft" comparisons = refers to comparisons or speculations not supported with substantiated data or literature
NA = not applicable

Report Title: "Big Bar 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal"

Area/Region: lower Fraser River, near Chilliwack—PRE- AND POST-EXTRACTION

Timing/Objectives: Obtain Pre-and Post-extraction data on habitat, fish, invertebrates covering from pre-extraction in August 2004 to post-extraction up to November 2007. Extraction occurred Feb 24 to March 28, 2006.

Table A2-2A: Big Bar 2007 Data Components

Component	Method/replication	Endpoints/Analyses (Stats)
Habitat	Mapping via Aerial Photos, descriptions via Church et al (2000)	Photographs with morphological descriptions
Fish	Beach seine (RIC, 1997) – 12.5 m by 1.8 m seine (6.3mm mesh)—five sets done in each habitat type at 2 sites (1. Bar edge flat and 2. Bay) Methods of Rempel (2003) and Church et al. (2000)	Mean CPUE ± SD (no. of fish caught per m^2 of swept area/set x 5 sets per site [2]) SPUE ± SD (no. of species caught per m^2 of swept area/set) total number of species mean species richness ± SD
Benthic Inverts	Surber sampler (500 µm mesh); near shore ~ 0.25 m deep, velocity < 1m/s; 5 replicates/site; five times 1 Scalp site, 5 replicates/site – pre- and post-removal 3 Ref sites, 5 replicates/site – pre- and post-removal	Benthic taxonomy to family level Mean total abundance ± SD Mean total by family/order Taxonomic richness (by family) –to indicate diversity t-test used to test significant difference between pre- and post-extraction abundance and between scalp and ref
Substrate (surface sediments)	Photographs from Church et al. (2000) to determine grain size distribution, random samples with 0.25 m^2 quadrat completed at four stations 1 Scalp site, 5 replicates – pre-, post-, and post-freshet 1 Ref site, 5 replicates – pre-, post-, and post-freshet	Mean particle size (D5; D50; D95) ± SD t-test used to test significant difference between pre- and post-extraction and between scalp and ref

Table A2-2B: Big Bar 2007 Sites and Descriptions

Site	Number/replicates	Description/Comments
Exposure/Test	1 scalp site	Habitat: 5 sampling times (1 pre- and 4 post) Substrate: 4 sampling times (1 pre- and 3 post) Invertebrate: 5 sampling times (2 pre 3 post) Fish: 1 sampling time (post—first inundation after extraction)
Reference	3 Biological Ref sites (off bar) 1 Sediment ref site (on bar)	Habitat: 5 sampling times (1 pre- and 4 post) Substrate: 4 sampling times (1 pre- and 3 post) Invertebrate: 5 sampling times (2 pre 3 post)

Results/Analyses: t-test used to analyze significance between scalp and ref and pre- and post-extraction. Means & SD provided. "Soft" comparisons made using substrate, fish and benthos.

Recommendations Provided: Yes

Report Title: "Gill Central 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal"

Area/Region: lower Fraser River, near Chilliwack—PRE- AND POST-EXTRACTION

Timing/Objectives: Obtain Pre-and Post-extraction data on habitat, fish, invertebrates covering from pre-extraction in August 2004 to post-extraction up to November 2007. Extraction occurred Feb 20 to March 8, 2006.

Table A2-3A: Gill Central 2007 Data Components		
Component	**Method/replication**	**Endpoints/Analyses (Stats)**
Habitat	Mapping via aerial photos, descriptions via Church et al (2000)	Photographs with morphological descriptions
Fish	Beach seine (RIC, 1997) – 12.5 m by 1.8 m seine (6.3mm mesh)—five sets done at one site (bay)	Mean CPUE ± SD (no. of fish caught per m^2 of swept area/set) SPUE ± SD (no. of species caught per m^2 of swept area/set) Total number of species Mean species richness ± SD
Benthic Inverts	Surber sampler (500 µm mesh); near shore ~ 0.25 m deep, velocity < 1m/s; 5 replicates/site; EXCEPT Herring Bar scalp site 1 and 3 used a grab (Petit Ponar) 1 Scalp site, 5 replicates/site – pre- and post-removal 3 Ref sites, 5 replicates/site – pre- and post-removal	Benthic taxonomy to family level. Mean total abundance ± SD; Mean total by family/order Taxonomic richness (by family) –to indicate diversity t-test used to test significant difference between pre- and Post-extraction and between Scalp and Ref
Substrate (surface sediments)	Photographs via Church et al. (2000) to determine grain size distribution, random samples with 0.25 m^2 quadrat 1 Scalp site, 5 replicates – pre-, post-, and post-freshet 1 Ref site, 5 replicates – pre-, post-, and post-freshet	Mean particle size (D5; D50; D95) ± SD T-test used to test significant difference between pre- and post-extraction and between scalp and ref

Table A2-3B Gill Central 2007 Sites and Descriptions		
Site	**Number/replicates**	**Description/Comments**
Exposure/Test	1 Scalp site	Habitat: 5 sampling times (1 pre- and 4 post) Substrate: 4 sampling times (1 pre- three post) Invertebrate: 7 sampling times (2 pre, 5 post) Fish: 1 sampling time (post)
Reference	3 Biological Ref sites (off bar) 1 Sediment ref site (on bar)	Habitat: 5 sampling times (1 pre- and 4 post) Substrate: 4 sampling times (1 pre- three post) Invertebrate: 7 sampling times (2 pre, 5 post)

Results/Analyses: t-test used to analyze significance between scalp and ref and pre- and post-extraction. Means & SD provided. "Soft" comparisons made using substrate, fish and benthos.

Recommendations Provided: Yes

Report Title: "Gill East 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal"

Area/Region: lower Fraser River, near Chilliwack—PRE- AND POST-EXTRACTION

Timing/Objectives: Obtain Pre-and Post-extraction data on habitat, fish, invertebrates covering from pre-extraction in August 2004 to post-extraction up to November 2007. Extraction occurred January 24 to March 11, 2006.

Table A2-4A Gill East 2007 Data Components

Component	Method/replication	Endpoints/Analyses (Stats)
Habitat	Mapping via overflights (photographs), descriptions via Church et al. (2000)	Photographs with morphological characteristics provided
Fish	Beach seine (RIC, 1997) – 12.5 m by 1.8 m seine (6.3mm mesh)—five sets done in each habitat type = 3 scalp sites (1. Bar edge steep and 2. Riffle 3. Nook) x 2 times Methods of Rempel (2003) and Church et al. (2000)	Mean CPUE ± SD (no. of fish caught per m^2 of swept area/set x 5 sets per site [2]) SPUE ± SD (no. of species caught per m^2 of swept area/set) Total number of species Mean species richness ± SD
Benthic Inverts	Surber sampler (500 µm mesh); near shore ~ 0.25 m deep, velocity < 1m/s; 5 replicates/site; five times 1 Scalp site, 5 replicates – pre-, post- 3 Ref sites, 5 replicates – pre-, post-	Benthic taxonomy to family level. Mean total abundance ± SD; Mean total by family/order Taxonomic richness (by family) –to indicate diversity t-test used to test significant difference between pre- and post-extraction abundance and between scalp and ref
Substrate (surface sediments)	Photographs via Church et al (2000) to determine grain size distribution, random samples with 0.25 m^2 quadrat, four times 1 Scalp site, 5 replicates – pre-, post- 1 Ref site, 5 replicates – pre-, post-	Mean particle size (D5; D50; D95) ± SD T-test used to test significant difference between pre- and post-extraction and between scalp and ref

Table A2-4B Gill East 2007 Sites and Descriptions

Site	Number/replicates	Description/Comments
Exposure/Test	1 Scalp site (benthos) 3 Scalp sites (fish)	Habitat: 5 sampling times (1 pre- and 4 post) Substrate: 4 sampling times (1 pre- three post) Invertebrate: 6 sampling times (2 pre, 4 post) Fish: 2 sampling times (post)
Reference	3 Biological Ref sites (off bar) 1 Sediment ref site (on bar)	Habitat: 5 sampling times (1 pre- and 4 post) Substrate: 4 sampling times (1 pre- three post) Invertebrate: 6 sampling times (2 pre, 4 post)

Results/Analyses: T-test used to analyze significance between scalp and ref and pre- and post-extraction. Means & SD provided. "Soft" comparisons made using substrate, fish and benthos.

Recommendations Provided: Yes

Report Title: Gill West 2007 Biological Monitoring Program Summary Report Fraser River Gravel Removal"

Area/Region: lower Fraser River, near Chilliwack—PRE- AND POST-EXTRACTION

Timing/Objectives: Get Pre-and Post-extraction data on habitat, fish, invertebrates covering from pre-extraction in August 2004 to post-extraction up to November 2007. Extraction occurred March 3 to 17, 2005.

Table A2-5A Gill West 2007 Data Components

Component	Method/replication	Endpoints/Analyses (Stats)
Habitat	Mapping via aerial photos, descriptions via Church et al. (2000)	Photographs with morphological characteristics provided
Fish	Beach seine (RISC, 1997) – 12.5 m by 1.8 m seine (6.3mm mesh)—five sets done in each habitat type = 2 scalp and 2 ref = 4 sites (1. Bar edge flat and 2. Open Nook) x 2 times (post) Methods of Rempel (2003) and Church et al. (2000)	Mean CPUE ± SD (no. of fish caught per m^2 of swept area/set x 5 sets per site [2]) SPUE ± SD (no. of species caught per m^2 of swept area/set) Total number of species Mean species richness ± SD
Benthic Inverts	Surber sampler (500 µm mesh); near shore ~ 0.25 m deep, velocity < 1m/s; 5 replicates/site; five times 1 Scalp site, 5 replicates – pre-, post 6 Ref sites, 5 replicates – pre-, post-	Benthic taxonomy to family level. Mean total abundance ± SD; Mean total by family/order Taxonomic richness (by family) –to indicate diversity t-test used to test significant difference between pre- and post-extraction abundance and between Scalp and Ref
Substrate (surface sediments)	Photographs via Church et al (2000) to determine grain size distribution, random samples with 0.25 m^2 quadrat 1 Scalp site, 5 replicates – pre-, post- 1 Ref site, 5 replicates – pre-, post-	Mean particle size (D5; D50; D95) ± SD t-test used to test significant difference between pre- and Post-extraction and between Scalp and Ref

Table A2-5B Gill West 2007 Sites and Descriptions

Site	Number/replicates	Description/Comments
Exposure/Test	1 Scalp site	Habitat: 5 sampling times (1 pre- and 4 post) Substrate: 4 sampling times (1 pre- three post) Invertebrate: 7 sampling times (1 pre, 6 post) Fish: 2 sampling times (post)
Reference	6 Biological Ref sites (off bar) 1 Sediment Ref site (on bar)	Habitat: 5 sampling times (1 pre- and 4 post) Substrate: 4 sampling times (1 pre- three post) Invertebrate: 7 sampling times (1 pre, 6 post) Biological: 3 Ref sites (1, 2, 3) used; remaining 3 Ref sites (4, 5, 6) found unsuitable in 2007 due to proximity to extraction works.

Results/Analyses: t-test used to analyze significance between scalp and ref and pre- and post-extraction. Means & SD provided. "Soft" comparisons made using substrate, fish and benthos.

Recommendations Provided: Yes

Report Title: "Herring Bar and Tranmer Bar Biological Monitoring Program Report Fraser River Gravel Removal"

Area/Region: lower Fraser River, upstream of the Rosedale Bridge: PRE-EXTRACTION

Timing/Objectives: Get Pre-extraction data on habitat, fish, invertebrates over three time periods. This report covers only December (of June, September, December) 2007.

Table A2-6A: Herrling and Tranmer 2007 Data Components

Component	Method/replication	Endpoints/Analyses (Stats)
Habitat	Mapping via aerial photos, descriptions via Church et al (2000) of Herring and Tranmer Bars	Photographs with morphological descriptions
Fish	Beach seine at Herring Bar (RIC, 1997) – 12.5 m by 1.8 m seine (6.3mm mesh)—five sets done at 2 sites Herring Bar Scalp sites 2 and 3 (not done at Tranmer)	CPUE ± SD (no. of fish caught per m^2 of swept area/set) Mean CPUE ± SD Total number of species Limited length measurements at Herring
Benthic Inverts	Surber sampler (500 µm mesh); near shore ~ 0.25 m deep, velocity < 1m/s; 5 replicates/site; EXCEPT Herring Bar scalp site 1 and 3 used a grab (what kind?) 3 Scalp sites 3 Ref sites	Benthic taxonomy to family level. Mean total abundance ± SD; mean total by family/order Taxonomic richness (by family) –to indicate diversity
Substrate (surface sediments)	Photographs via Church et al (2000) to determine grain size distribution, random samples with 0.25 m^2 quadrat 3 Scalp sites; 1 Ref (Herring) 1 Scalp; 1 Ref (Tranmer)	Mean particle size (D5; D50; D95) ± SD

Table A2-6B: Herrling and Tranmer 2007 Data Components

Site	Number/replicates	Description/Comments
Exposure/Test	Herring: 3 scalp sites Tranmer: 1 scalp site	One sampling time period (December 2007)
Reference	Herring: 3 ref sites – 1 sampling time (Dec,07) Tranmer: 3 ref sites– 1 sampling time (Dec,07) Herring & Tranmer: Sediment Ref site same as one of the Biological Ref sites	One sampling time period (December 2007)

Results/Analyses: no statistical analysis between scalp and ref done. Only means & SD provided. "Soft" comparisons made using substrate, fish and benthos.

Recommendations Provided: Yes

Report Title: "Fraser River Gravel Removal Monitor's Report for 2004"

Area/Region: lower Fraser River, Agassiz area—PRE- AND DURING-EXTRACTION of Big, Seabird and Harrison Bars

Timing/Objectives: Get Pre-and During-extraction data on habitat, fish, invertebrates covering from pre-extraction in spring 2004 to post-extraction up to winter 2004. Extraction occurred Feb 17 to March 19, 2004.

Table A2-7A: Big, Seabird and Harrison Bar 2004 Data Components

Component	Method/replication	Endpoints/Analyses (Stats)
Habitat	Mapping aerial photos descriptions via Church et al. (2000)	Photographs with morphological characteristics provided
Fish	Beach seine (RIC, 1997) – 12.5 m by 1.8 m seine (6.3mm mesh)—five sets done	Mean CPUE ± SD (no. of fish caught per m^2 of swept area/set) SPUE ± SD (no. of species caught per m^2 of swept area/set) Total number of species Mean species richness ± SD
Benthic Inverts	Surber sampler (500 µm mesh); near shore ~ 0.25 m deep, velocity < 1m/s; 5 replicates/site; EXCEPT Herring Bar Scalp site 1 and 3 used a grab (presumed Petit Ponar) 1 Scalp site 3 Ref sites	Benthic taxonomy to family level. Mean total abundance ± SD; Mean total by family/order Taxonomic richness (by family) –to indicate diversity t-test used to test significant difference between pre- and Post-extraction and between scalp and ref
Substrate (surface sediments)	Photographs via Church et al (2000) to determine grain size distribution, random samples with 0.25 m^2 quadrat 1 Scalp site & 1 Ref site	Mean particle size (D5; D50; D95) ± SD t-test used to test significant difference between pre- and post-extraction and between Scalp and Ref

Table A2-7B: Big, Seabird and Harrison Bar 2004 Sites and Descriptions

Site	Number/replicates	Description/Comments
Exposure/Test	1 scalp site	Habitat: 5 sampling times (1 pre, 4 post) Substrate: 4 sampling times (1 pre, 3 post) Invertebrate: 7 sampling times (2 pre, 5 post) fish: 1 sampling time (post)
Reference	3 Biological Ref sites (off bar) 1 Sediment ref site (on bar)	Biological sampling was carried on 3 occasions prior to excavations. Substrate : 2 sampling time (1 pre, 1 post)

Results/Analyses: t-test used to analyze significance between Scalp and Ref (pre- and post-extraction). Means & SD provided. "Soft" comparisons made using substrate, fish and benthos.

Recommendations Provided: Yes

Appendix 3

Statistical Tables

Table A3-1: Pearson Correlation Matrix of Habitat Factors

Table A3-2: Summary Measures (including SDI, H' and 1-D for All Sample Locations, Dates and Treatments for a Each Replicate Sample)

Table A3-3: Means and Standard Deviations for Sample Locations, Dates and Treatments

Table A3-4: Summary Statistics Showing Averages of Sediment Characteristics

Table A3-5: Summary Data for Fish Catches, SDI, H' and 1-D for Each Location, Replicate, Habitat Type, Date and Treatment Type

Table A3-6: Means and SD's and Precision for SDI, H' and 1-D for Locations, Dates or Treatments and Substrate Factors

Key to Coded Terms
BB = Site Location (e.g. Big Bar)
sc/R = Scalp/Reference
# After sc/R = Sample Replicate Number
Nov07 = Date (e.g. November 2007)
Examples:
1) GCscNov07 = Gill Central, Scalp Site, November 2007
2) R1BBDec04 = Big Bar, Reference Site, Replicate 1, December 2004
Legend Key
GW = Gill West
GC = Gill Central
GE = Gill East
BB = Big Bar
H = Herrling
T = Tranmer

Table A3-1: Pearson Correlation Matrix of Habitat Factors

	Date	Stones	PerSand	PerShadow	Perlost	Perleft	Stonesquadr	Stonesm2	D5mm	D50mm	D95mm
stones	-0.30	1.00									
perSand	0.29	-0.47	1.00								
perShadow	-0.54	0.12	-0.36	1.00							
perlost	0.12	-0.46	0.94	-0.02	1.00						
perleft	-0.12	0.46	-0.94	0.02	-1.00	1.00					
Stonesquadr	-0.31	0.95	-0.26	0.16	-0.22	0.22	1.00				
Stonesm2	-0.31	0.95	-0.26	0.16	-0.22	0.22	1.00	1.00			
D5mm	0.26	-0.78	0.42	-0.26	0.35	-0.35	-0.82	-0.82	1.00		
D50mm	0.21	-0.81	0.30	-0.21	0.25	-0.25	-0.86	-0.86	0.95	1.00	
D95mm	0.28	-0.80	0.49	-0.28	0.42	-0.42	-0.80	-0.80	0.98	0.93	1.00
AverageSton	0.22	-0.81	0.34	-0.22	0.28	-0.28	-0.85	-0.85	0.96	1.00	0.95

Factors which should be left in the analysis include date, persand, pershadow, stones/m2

Table A3-2: Summary Measures, Including SDI, H' and 1-D for All Sample Locations, Dates and Treatments for a Each Replicate Sample									
Rep	location	Treatment	Date	Taxon	Total	SDI	SDI level	H-prime	1-D
1	GC	scalp	Aug-06	8	161	1	85.09	-0.65	0.73
2	GC	scalp	Aug-06	6	118	1	84.75	-0.60	0.73
3	GC	scalp	Aug-06	8	318	1	91.82	-0.42	0.84
4	GC	scalp	Aug-06	7	135	1	84.44	-0.66	0.72
5	GC	scalp	Aug-06	3	53	1	88.68	-0.40	0.80
1	GC	scalp	Dec-04	10	116	5	83.62	-1.94	0.16
2	GC	scalp	Dec-04	9	89	4	79.78	-1.80	0.21
3	GC	scalp	Dec-04	14	148	6	82.43	-2.18	0.14
4	GC	scalp	Dec-04	11	103	4	79.61	-1.90	0.20
5	GC	scalp	Dec-04	11	110	5	80.91	-1.95	0.19
1	GC	scalp	Feb-07	3	10	2	90.00	-0.80	0.54
2	GC	scalp	Feb-07	4	31	2	80.65	-1.02	0.44
3	GC	scalp	Feb-07	3	22	1	77.27	-0.69	0.62
4	GC	scalp	Feb-07	4	44	3	90.91	-1.30	0.29
5	GC	scalp	Feb-07	5	96	2	84.38	-1.10	0.42
1	GC	scalp	Mar-05	0	0	0	0.00	0.00	0.00
2	GC	scalp	Mar-05	3	4	3	100.00	-1.04	0.38
3	GC	scalp	Mar-05	3	4	3	100.00	-1.04	0.38
4	GC	scalp	Mar-05	4	7	3	85.71	-1.15	0.39
5	GC	scalp	Mar-05	4	12	2	83.33	-1.08	0.42
1	GC	scalp	Nov-07	2	11	2	100.00	-0.69	0.50
2	GC	scalp	Nov-07	0	0	0	0.00	0.00	0.00
3	GC	scalp	Nov-07	4	5	3	80.00	-1.33	0.28
4	GC	scalp	Nov-07	1	1	1	100.00	0.00	1.00
5	GC	scalp	Nov-07	1	2	1	100.00	0.00	1.00
1	GW	ref	Aug-05	7	128	1	89.84	-0.49	0.81
2	GW	ref	Aug-05	5	82	1	93.90	-0.31	0.88
3	GW	ref	Aug-05	3	73	1	94.52	-0.24	0.90
4	GW	ref	Aug-05	5	61	1	91.80	-0.39	0.84
5	GW	ref	Aug-05	7	63	1	85.71	-0.65	0.74
1	GW	ref	Dec-04	9	87	3	81.61	-1.52	0.31
2	GW	ref	Dec-04	9	87	3	81.61	-1.62	0.26
3	GW	ref	Dec-04	10	95	4	76.84	-1.82	0.22
4	GW	ref	Dec-04	11	80	4	80.00	-1.95	0.17
5	GW	ref	Dec-04	11	84	5	79.76	-1.97	0.19
1	GW	ref	Dec-05	11	39	4	76.92	-1.75	0.29
2	GW	ref	Dec-05	8	26	3	76.92	-1.52	0.33
3	GW	ref	Dec-05	7	44	2	84.09	-1.26	0.37
4	GW	ref	Dec-05	8	71	1	76.06	-1.01	0.59
5	GW	ref	Dec-05	10	47	2	78.72	-1.22	0.51
1	GW	ref	Mar-05	3	5	2	80.00	-0.95	0.44
2	GW	ref	Mar-05	2	2	2	100.00	-0.69	0.50
3	GW	ref	Mar-05	6	6	5	83.33	-1.79	0.17
4	GW	ref	Mar-05	2	2	2	100.00	-0.69	0.50
5	GW	ref	Mar-05	2	4	2	100.00	-0.56	0.63
1	GW	ref	Aug-05	8	194	1	88.66	-0.54	0.79
2	GW	ref	Aug-05	4	142	1	87.32	-0.49	0.77
3	GW	ref	Aug-05	7	108	1	84.26	-0.69	0.72
4	GW	ref	Aug-05	6	150	1	76.00	-0.84	0.60
5	GW	ref	Aug-05	10	151	2	83.44	-1.00	0.55
1	GW	ref	Dec-04	12	167	4	79.04	-1.78	0.25
2	GW	ref	Dec-04	13	171	4	78.36	-1.95	0.19
3	GW	ref	Dec-04	15	247	4	76.92	-2.07	0.16
4	GW	ref	Dec-04	12	146	5	79.45	-1.99	0.19
5	GW	ref	Dec-04	11	142	4	80.99	-1.91	0.18
1	GW	ref	Dec-05	9	43	3	81.40	-1.65	0.25
2	GW	ref	Dec-05	10	95	4	82.11	-1.77	0.22
3	GW	ref	Dec-05	13	75	5	76.00	-2.14	0.15
4	GW	ref	Dec-05	8	48	5	83.33	-1.89	0.17
5	GW	ref	Dec-05	9	31	5	80.65	-1.99	0.16
1	GW	ref	Mar-05	1	2	1	100.00	0.00	1.00
2	GW	ref	Mar-05	2	3	2	100.00	-0.64	0.56
3	GW	ref	Mar-05	1	2	1	100.00	0.00	1.00
5	GW	ref	Mar-05	2	7	2	100.00	-0.60	0.59
1	GW	ref	Aug-05	7	116	1	89.66	-0.49	0.81
2	GW	ref	Aug-05	8	109	1	91.59	-0.42	0.84
3	GW	ref	Aug-05	10	140	1	94.78	-0.31	0.90
4	GW	ref	Aug-05	11	173	1	92.26	-0.42	0.85
5	GW	ref	Aug-05	11	229	5	81.25	-1.93	0.16

Table A3-2: Summary Measures, Including SDI, H' and 1-D for All Sample Locations, Dates and Treatments for a Each Replicate Sample									
Rep	location	Treatment	Date	Taxon	Total	SDI	SDI level	H-prime	1-D
1	GW	ref	Dec-04	7	31	3	80.65	-1.56	0.26
2	GW	ref	Dec-04	7	27	4	85.19	-1.67	0.23
3	GW	ref	Dec-04	5	21	2	76.19	-1.14	0.43
4	GW	ref	Dec-04	3	14	2	92.86	-0.90	0.44
5	GW	ref	Dec-04	5	26	2	84.62	-1.16	0.38
2	GW	ref	Mar-05	3	5	2	80.00	-1.05	0.36
3	GW	ref	Mar-05	3	4	3	100.00	-1.04	0.38
4	GW	ref	Mar-05	1	1	1	100.00	0.00	1.00
5	GW	ref	Mar-05	1	2	1	100.00	0.00	1.00
1	GW	scalp	Aug-05	9	341	1	83.28	-0.69	0.70
2	GW	scalp	Aug-05	9	437	1	83.07	-0.63	0.71
3	GW	scalp	Aug-05	7	301	1	79.40	-0.74	0.65
4	GW	scalp	Aug-05	9	336	1	84.82	-0.65	0.73
5	GW	scalp	Aug-05	9	394	1	80.96	-0.73	0.67
1	GW	scalp	Dec-04	12	116	4	83.62	-1.80	0.23
2	GW	scalp	Dec-04	12	96	5	80.21	-2.01	0.18
3	GW	scalp	Dec-04	13	84	6	80.95	-2.24	0.13
4	GW	scalp	Dec-04	13	100	6	78.00	-2.23	0.13
5	GW	scalp	Dec-04	14	81	5	76.54	-2.07	0.18
1	GW	scalp	Dec-05	10	62	2	75.81	-1.55	0.30
2	GW	scalp	Dec-05	9	41	2	78.05	-1.35	0.41
3	GW	scalp	Dec-05	9	68	2	77.94	-1.28	0.43
4	GW	scalp	Dec-05	10	36	5	77.78	-2.03	0.16
5	GW	scalp	Dec-05	9	44	4	81.82	-1.78	0.22
1	GW	scalp	Mar-05	1	3	1	100.00	0.00	1.00
2	GW	scalp	Mar-05	1	1	1	100.00	0.00	1.00
3	GW	scalp	Mar-05	3	5	2	80.00	-1.05	0.36
4	GW	scalp	Mar-05	4	6	3	83.33	-1.33	0.28
5	GW	scalp	Mar-05	3	16	2	81.25	-0.92	0.46
1	GW	scalp	Nov-07	7	32	2	78.13	-1.13	0.49
2	GW	scalp	Nov-07	5	32	2	87.50	-0.96	0.51
3	GW	scalp	Nov-07	7	47	2	78.72	-1.25	0.42
4	GW	scalp	Nov-07	5	25	2	76.00	-1.31	0.32
5	GW	scalp	Nov-07	5	37	2	78.38	-1.12	0.43
1	H	ref	Dec-07	14	18	5	77.78	-1.89	0.16
2	H	ref	Dec-07	10	10	4	80.00	-1.61	0.20
3	H	ref	Dec-07	6	6	3	100.00	-1.10	0.33
4	H	ref	Dec-07	6	14	2	85.71	-0.96	0.43
5	H	ref	Dec-07	10	14	4	85.71	-1.48	0.27
1	H	ref	Dec-07	12	46	2	82.61	-1.18	0.43
2	H	ref	Dec-07	12	52	2	80.77	-1.08	0.50
3	H	ref	Dec-07	10	10	4	80.00	-1.61	0.20
4	H	ref	Dec-07	6	26	2	92.31	-0.79	0.54
5	H	ref	Dec-07	12	22	4	81.82	-1.54	0.27
1	H	ref	Dec-07	6	6	3	100.00	-1.10	0.33
2	H	ref	Dec-07	4	4	2	100.00	-0.69	0.50
3	H	ref	Dec-07	8	8	4	100.00	-1.39	0.25
4	H	ref	Dec-07	6	6	3	100.00	-1.10	0.33
5	H	ref	Dec-07	10	12	4	83.33	-1.56	0.22
1	H	scalp	Dec-07	4	4	2	100.00	-0.69	0.50
3	H	scalp	Dec-07	2	2	1	100.00	0.00	1.00
5	H	scalp	Dec-07	2	4	1	100.00	0.00	1.00
2	H	scalp	Dec-07	8	10	3	80.00	-1.33	0.28
3	H	scalp	Dec-07	4	4	2	100.00	-0.69	0.50
4	H	scalp	Dec-07	2	2	1	100.00	0.00	1.00
5	H	scalp	Dec-07	4	4	2	100.00	-0.69	0.50
1	H	scalp	Dec-07	2	4	1	100.00	0.00	1.00
2	H	scalp	Dec-07	2	8	1	100.00	0.00	1.00
3	H	scalp	Dec-07	2	4	1	100.00	0.00	1.00
4	H	scalp	Dec-07	2	2	1	100.00	0.00	1.00
5	H	scalp	Dec-07	4	8	2	100.00	-0.56	0.63
1	BB	ref	Aug-06	8	190	1	84.21	-0.70	0.71
2	BB	ref	Aug-06	9	125	1	84.80	-0.73	0.72
3	BB	ref	Aug-06	5	126	1	91.27	-0.39	0.84
4	BB	ref	Aug-06	10	239	1	87.87	-0.60	0.78
5	BB	ref	Aug-06	7	160	1	86.25	-0.62	0.75
1	BB	ref	Dec-04	13	256	4	78.52	-1.94	0.20
2	BB	ref	Dec-04	16	188	5	78.72	-1.94	0.24
3	BB	ref	Dec-04	15	313	4	80.51	-1.82	0.25

Table A3-2: Summary Measures, Including SDI, H' and 1-D for All Sample Locations, Dates and Treatments for a Each Replicate Sample									
Rep	location	Treatment	Date	Taxon	Total	SDI	SDI level	H-prime	1-D
4	BB	ref	Dec-04	15	214	4	75.70	-1.89	0.24
5	BB	ref	Dec-04	15	354	5	79.38	-1.94	0.22
1	BB	ref	Jan-07	14	264	1	86.36	-0.71	0.75
2	BB	ref	Jan-07	10	143	2	81.12	-1.24	0.44
3	BB	ref	Jan-07	12	168	1	76.79	-1.02	0.60
4	BB	ref	Jan-07	12	159	1	76.10	-1.05	0.59
5	BB	ref	Jan-07	11	179	1	79.33	-0.92	0.64
1	BB	ref	Nov-07	10	110	2	78.18	-1.45	0.34
2	BB	ref	Nov-07	12	99	2	77.78	-1.49	0.33
3	BB	ref	Nov-07	8	106	2	76.42	-1.30	0.42
4	BB	ref	Nov-07	14	132	3	77.27	-1.66	0.32
5	BB	ref	Nov-07	13	91	4	79.12	-1.79	0.27
1	BB	ref	Oct-04	10	51	3	76.47	-1.75	0.23
2	BB	ref	Oct-04	6	27	2	77.78	-1.36	0.32
3	BB	ref	Oct-04	6	18	4	83.33	-1.61	0.23
4	BB	ref	Oct-04	8	22	3	77.27	-1.52	0.33
5	BB	ref	Oct-04	5	13	2	76.92	-1.33	0.31
1	GE	ref	Aug-06	6	217	2	89.40	-0.87	0.57
2	GE	ref	Aug-06	9	152	2	90.13	-0.99	0.51
3	GE	ref	Aug-06	9	189	2	85.71	-1.06	0.49
4	GE	ref	Aug-06	8	138	2	77.54	-1.19	0.41
5	GE	ref	Aug-06	5	216	2	86.57	-1.03	0.45
1	GE	ref	Dec-04	15	296	5	83.78	-2.08	0.16
2	GE	ref	Dec-04	15	303	5	81.52	-2.07	0.16
3	GE	ref	Dec-04	15	393	5	81.93	-2.11	0.15
4	GE	ref	Dec-04	17	305	5	82.95	-2.12	0.15
5	GE	ref	Dec-04	13	228	4	78.51	-1.96	0.17
1	GE	ref	Feb-07	11	1300	1	92.31	-0.40	0.85
2	GE	ref	Feb-07	12	1021	1	93.24	-0.36	0.87
3	GE	ref	Feb-07	11	955	1	94.87	-0.30	0.90
4	GE	ref	Feb-07	10	1068	1	95.51	-0.27	0.91
5	GE	ref	Feb-07	11	1536	1	94.27	-0.33	0.89
1	GE	ref	Nov-07	14	181	2	81.77	-1.43	0.34
2	GE	ref	Nov-07	14	176	2	76.14	-1.56	0.33
3	GE	ref	Nov-07	7	87	2	91.95	-1.01	0.45
4	GE	ref	Nov-07	10	137	2	76.64	-1.45	0.31
5	GE	ref	Nov-07	11	155	2	76.13	-1.51	0.34
1	GE	ref	Oct-04	5	48	2	81.25	-1.16	0.39
2	GE	ref	Oct-04	7	32	3	87.50	-1.50	0.27
3	GE	ref	Oct-04	6	25	3	80.00	-1.30	0.40
4	GE	ref	Oct-04	8	67	3	86.57	-1.52	0.27
5	GE	ref	Oct-04	7	58	3	79.31	-1.51	0.28
1	BB	ref	Aug-06	8	266	1	83.08	-0.70	0.70
2	BB	ref	Aug-06	7	295	1	89.49	-0.45	0.81
3	BB	ref	Aug-06	9	377	1	89.39	-0.49	0.80
4	BB	ref	Aug-06	8	333	1	90.99	-0.43	0.83
5	BB	ref	Aug-06	8	264	1	89.02	-0.50	0.80
1	BB	ref	Dec-04	13	204	2	81.37	-1.43	0.35
2	BB	ref	Dec-04	15	171	2	84.80	-1.32	0.39
3	BB	ref	Dec-04	7	70	2	82.86	-1.26	0.36
4	BB	ref	Dec-04	11	170	2	88.24	-1.18	0.40
5	BB	ref	Dec-04	10	191	2	87.96	-1.20	0.39
1	BB	ref	Jan-07	10	86	2	77.91	-1.20	0.50
2	BB	ref	Jan-07	11	105	1	77.14	-1.01	0.60
3	BB	ref	Jan-07	12	89	3	75.28	-1.59	0.35
4	BB	ref	Jan-07	14	205	2	79.51	-1.18	0.52
5	BB	ref	Jan-07	11	73	4	79.45	-1.57	0.37
1	BB	ref	Nov-07	11	109	3	80.73	-1.61	0.28
2	BB	ref	Nov-07	10	138	2	86.23	-1.12	0.47
3	BB	ref	Nov-07	13	191	2	85.86	-1.23	0.43
4	BB	ref	Nov-07	10	152	2	84.21	-1.30	0.37
5	BB	ref	Nov-07	9	296	1	78.72	-0.75	0.64
1	BB	ref	Oct-04	6	27	2	81.48	-1.29	0.34
2	BB	ref	Oct-04	11	104	3	76.92	-1.67	0.26
3	BB	ref	Oct-04	10	70	2	77.14	-1.35	0.40
4	BB	ref	Oct-04	6	73	2	78.08	-1.21	0.42
5	BB	ref	Oct-04	7	51	2	78.43	-1.26	0.41
1	GE	ref	Aug-06	12	260	2	79.23	-1.15	0.53
2	GE	ref	Aug-06	8	201	1	78.61	-0.81	0.64

Table A3-2: (Cont) Summary Measures, Including SDI, H' and 1-D for All Sample Locations, Dates and Treatments for a Each Replicate Sample

Rep	location	Treatment	Date	Taxon	Total	SDI	SDI level	H-prime	1-D
3	GE	ref	Aug-06	11	260	1	86.54	-0.66	0.75
4	GE	ref	Aug-06	10	135	1	83.70	-0.73	0.71
5	GE	ref	Aug-06	12	166	1	83.73	-0.80	0.70
1	GE	ref	Dec-04	13	185	5	76.22	-2.12	0.15
2	GE	ref	Dec-04	17	265	5	77.74	-2.18	0.15
3	GE	ref	Dec-04	15	254	6	81.10	-2.18	0.15
4	GE	ref	Dec-04	16	209	5	82.30	-2.15	0.15
5	GE	ref	Dec-04	14	211	5	77.25	-2.18	0.14
1	GE	ref	Jan-07	9	89	1	76.40	-0.97	0.60
2	GE	ref	Jan-07	7	104	2	83.65	-1.13	0.43
3	GE	ref	Jan-07	8	63	1	77.78	-0.92	0.62
4	GE	ref	Jan-07	8	99	2	86.87	-0.98	0.56
5	GE	ref	Jan-07	8	100	2	83.00	-1.11	0.49
1	GE	ref	Nov-07	3	34	2	97.06	-0.73	0.54
2	GE	ref	Nov-07	2	34	1	91.18	-0.30	0.84
3	GE	ref	Nov-07	6	18	2	77.78	-1.34	0.34
4	GE	ref	Nov-07	4	14	2	85.71	-0.90	0.54
5	GE	ref	Nov-07	5	52	2	94.23	-0.93	0.45
1	GE	ref	Oct-04	9	39	5	82.05	-1.97	0.16
2	GE	ref	Oct-04	8	47	4	85.11	-1.74	0.21
3	GE	ref	Oct-04	8	41	4	80.49	-1.75	0.22
4	GE	ref	Oct-04	8	34	4	79.41	-1.84	0.19
5	GE	ref	Oct-04	9	73	3	83.56	-1.57	0.27
1	BB	ref	Aug-06	8	116	1	81.90	-0.80	0.68
2	BB	ref	Aug-06	8	109	1	86.24	-0.62	0.75
3	BB	ref	Aug-06	5	110	1	85.45	-0.61	0.74
4	BB	ref	Aug-06	7	107	2	84.11	-1.23	0.39
5	BB	ref	Aug-06	8	69	2	84.06	-1.00	0.56
1	BB	ref	Dec-04	16	205	4	76.10	-1.91	0.23
2	BB	ref	Dec-04	18	271	6	79.34	-2.22	0.15
3	BB	ref	Dec-04	15	224	4	76.34	-1.95	0.20
4	BB	ref	Dec-04	19	325	6	79.08	-2.25	0.15
5	BB	ref	Dec-04	15	262	4	78.24	-1.88	0.23
1	BB	ref	Jan-07	11	114	2	78.95	-1.12	0.56
2	BB	ref	Jan-07	8	31	3	77.42	-1.32	0.44
3	BB	ref	Jan-07	9	50	2	78.00	-1.19	0.50
4	BB	ref	Jan-07	9	99	3	84.85	-1.40	0.35
5	BB	ref	Jan-07	8	62	3	82.26	-1.39	0.37
1	BB	ref	Nov-07	10	69	3	76.81	-1.67	0.27
2	BB	ref	Nov-07	9	39	4	82.05	-1.72	0.25
3	BB	ref	Nov-07	10	69	5	78.26	-2.04	0.15
4	BB	ref	Nov-07	9	76	3	82.89	-1.47	0.33
5	BB	ref	Nov-07	11	64	4	76.56	-1.91	0.20
1	BB	ref	Oct-04	11	90	3	80.00	-1.60	0.28
2	BB	ref	Oct-04	12	65	4	76.92	-1.95	0.20
3	BB	ref	Oct-04	8	48	3	81.25	-1.56	0.28
4	BB	ref	Oct-04	8	62	3	75.81	-1.66	0.23
5	BB	ref	Oct-04	9	74	1	77.03	-0.94	0.61
1	GE	ref	Aug-06	11	158	2	83.54	-1.25	0.44
2	GE	ref	Aug-06	16	245	2	79.59	-1.31	0.44
3	GE	ref	Aug-06	10	256	3	79.30	-1.52	0.31
4	GE	ref	Aug-06	14	214	2	78.50	-1.37	0.41
5	GE	ref	Aug-06	10	113	2	83.19	-1.12	0.53
1	GE	ref	Dec-04	15	293	4	75.09	-2.10	0.16
2	GE	ref	Dec-04	14	291	5	81.79	-2.00	0.17
3	GE	ref	Dec-04	15	203	5	76.35	-2.20	0.15
4	GE	ref	Dec-04	17	229	4	75.55	-2.14	0.15
5	GE	ref	Dec-04	15	281	5	75.80	-2.24	0.13
1	GE	ref	Jan-07	13	125	2	78.40	-1.29	0.49
2	GE	ref	Jan-07	12	272	1	77.94	-1.00	0.61
3	GE	ref	Jan-07	12	274	3	76.28	-1.51	0.38
4	GE	ref	Jan-07	12	223	3	76.23	-1.60	0.34
5	GE	ref	Jan-07	10	102	3	77.45	-1.35	0.46
1	GE	ref	Nov-07	5	69	2	94.20	-0.89	0.48
2	GE	ref	Nov-07	4	28	2	89.29	-0.94	0.48
3	GE	ref	Nov-07	4	23	2	82.61	-0.98	0.47
4	GE	ref	Nov-07	6	33	2	87.88	-1.10	0.43
5	GE	ref	Nov-07	5	51	2	84.31	-1.12	0.41
1	GE	ref	Oct-04	10	69	4	81.16	-1.91	0.18

Table A3-2: (Cont) Summary Measures, Including SDI, H' and 1-D for All Sample Locations, Dates and Treatments for a Each Replicate Sample

Rep	location	Treatment	Date	Taxon	Total	SDI	SDI level	H-prime	1-D
2	GE	ref	Oct-04	9	49	2	79.59	-1.37	0.36
3	GE	ref	Oct-04	12	31	5	77.42	-2.08	0.17
4	GE	ref	Oct-04	9	51	3	76.47	-1.68	0.25
5	GE	ref	Oct-04	8	40	2	77.50	-1.40	0.35
1	BB	scalp	Aug-06	11	295	2	80.34	-1.20	0.41
2	BB	scalp	Aug-06	7	182	2	75.82	-1.29	0.36
3	BB	scalp	Aug-06	11	333	2	81.68	-1.08	0.49
4	BB	scalp	Aug-06	10	408	2	79.90	-1.14	0.48
5	BB	scalp	Aug-06	8	443	1	79.68	-0.77	0.65
1	BB	scalp	Dec-04	20	464	5	83.41	-1.98	0.21
2	BB	scalp	Dec-04	14	492	5	82.93	-1.99	0.18
3	BB	scalp	Dec-04	16	439	5	82.46	-2.01	0.18
4	BB	scalp	Dec-04	17	342	4	79.24	-1.95	0.19
5	BB	scalp	Dec-04	14	396	4	75.76	-1.91	0.20
1	BB	scalp	Jan-07	10	180	4	79.44	-1.79	0.21
2	BB	scalp	Jan-07	10	210	2	80.95	-1.30	0.40
3	BB	scalp	Jan-07	8	69	3	81.16	-1.54	0.28
4	BB	scalp	Jan-07	11	208	3	79.33	-1.59	0.28
5	BB	scalp	Jan-07	13	154	3	80.52	-1.58	0.30
1	BB	scalp	Nov-07	9	89	3	79.78	-1.59	0.29
2	BB	scalp	Nov-07	8	73	2	76.71	-1.22	0.45
3	BB	scalp	Nov-07	9	102	3	81.37	-1.42	0.39
4	BB	scalp	Nov-07	9	98	4	81.63	-1.62	0.30
5	BB	scalp	Nov-07	10	129	4	77.52	-1.66	0.30
1	BB	scalp	Oct-04	12	236	3	76.27	-1.76	0.23
2	BB	scalp	Oct-04	12	117	3	75.21	-1.80	0.23
3	BB	scalp	Oct-04	12	275	3	77.45	-1.61	0.31
4	BB	scalp	Oct-04	11	171	3	80.70	-1.66	0.26
5	BB	scalp	Oct-04	8	84	2	77.38	-1.31	0.41
1	GE	scalp	Aug-06	5	63	1	80.95	-0.67	0.67
2	GE	scalp	Aug-06	4	72	1	90.28	-0.40	0.82
3	GE	scalp	Aug-06	8	91	1	86.81	-0.62	0.76
4	GE	scalp	Aug-06	9	101	1	80.20	-0.85	0.65
5	GE	scalp	Aug-06	10	146	1	86.99	-0.62	0.76
1	GE	scalp	Dec-04	14	332	2	80.72	-1.30	0.43
2	GE	scalp	Dec-04	15	364	2	78.57	-1.41	0.39
3	GE	scalp	Dec-04	13	293	2	78.84	-1.39	0.38
4	GE	scalp	Dec-04	16	578	2	80.62	-1.29	0.44
5	GE	scalp	Dec-04	15	367	3	82.83	-1.46	0.37
1	GE	scalp	Feb-07	12	569	1	78.21	-0.66	0.65
2	GE	scalp	Feb-07	8	374	1	87.97	-0.52	0.78
3	GE	scalp	Feb-07	9	585	1	87.01	-0.49	0.77
4	GE	scalp	Feb-07	9	481	1	88.98	-0.48	0.80
5	GE	scalp	Feb-07	5	531	1	90.40	-0.37	0.82
1	GE	scalp	Nov-07	9	92	3	84.78	-1.47	0.31
2	GE	scalp	Nov-07	7	38	3	81.58	-1.60	0.24
3	GE	scalp	Nov-07	5	24	2	79.17	-1.25	0.34
4	GE	scalp	Nov-07	5	35	2	80.00	-1.21	0.36
5	GE	scalp	Nov-07	4	31	2	93.55	-0.93	0.44
1	GE	scalp	Oct-04	10	137	2	81.02	-1.27	0.39
2	GE	scalp	Oct-04	5	118	2	87.29	-1.04	0.43
3	GE	scalp	Oct-04	7	96	2	92.71	-1.01	0.43
4	GE	scalp	Oct-04	8	45	3	88.89	-1.48	0.28
5	GE	scalp	Oct-04	9	87	2	75.86	-1.33	0.36
1	T	ref	Dec-07	17	230	3	77.39	-1.68	0.32
2	T	ref	Dec-07	12	114	3	77.19	-1.81	0.22
3	T	ref	Dec-07	10	106	4	81.13	-1.84	0.21
4	T	ref	Dec-07	11	79	4	82.28	-1.88	0.19
5	T	ref	Dec-07	7	29	3	79.31	-1.62	0.24
1	T	ref	Dec-07	13	67	3	76.12	-1.79	0.26
2	T	ref	Dec-07	11	42	5	80.95	-2.04	0.17
3	T	ref	Dec-07	13	116	4	82.76	-1.86	0.22
4	T	ref	Dec-07	13	44	5	79.55	-2.03	0.19
5	T	ref	Dec-07	13	68	5	76.47	-2.08	0.18
1	T	ref	Dec-07	2	5	1	80.00	-0.50	0.68
2	T	ref	Dec-07	2	6	2	100.00	-0.64	0.56
3	T	ref	Dec-07	6	12	4	83.33	-1.70	0.19
4	T	ref	Dec-07	5	17	3	82.35	-1.31	0.34
5	T	ref	Dec-07	5	10	3	80.00	-1.42	0.28

Table A3-2: (Cont) Summary Measures, Including SDI, H' and 1-D for All Sample Locations, Dates and Treatments for a Each Replicate Sample

Rep	location	Treatment	Date	Taxon	Total	SDI	SDI level	H-prime	1-D
1	T	scalp	Dec-07	11	37	4	75.68	-1.93	0.20
2	T	scalp	Dec-07	9	38	3	81.58	-1.44	0.37
3	T	scalp	Dec-07	12	56	5	82.14	-1.90	0.22
4	T	scalp	Dec-07	10	38	5	81.58	-1.95	0.18
5	T	scalp	Dec-07	6	26	3	80.77	-1.39	0.34

Table A3-3: Means and Standard Deviations for Sample Locations, Dates and Treatments

Reps	Location	Treatment	Date	Season	Avg Taxon	StDev Taxon	Avg Total	StDev Total	Precision	Avg Fish	Avg Fish Fry	Avg Gastropoda	Avg Hirudinea	Avg Acarina	Avg Amphipoda	Avg Coleoptera	Avg Diptera	Avg Ephameroptera	Avg Homoptera	Avg Plecoptera	Avg Trichoptera	Avg Nemata	Avg Nematoda	Avg Oligochaeta	Avg Zooplankton
5	GC	scalp	Aug-06	summer-06	6.4	2.1	157.0	98.4	31%	1.2	0	0	0	0	0	0.2	142.8	2.6	0	0.8	1	0.2	0	8	0.2
5	GC	scalp	Dec-04	winter-04	11.0	1.9	113.2	21.9	10%	0	0	0	0	1.6	0	0	10.4	64.8	0	9.8	15.8	0.4	0	10.4	0
5	GC	scalp	Feb-07	winter-07	3.8	0.8	40.6	33.4	41%	0	0	0	0	0	0	0	21.6	0	0	0	0	0.4	0	16.2	2.4
5	GC	scalp	Mar-05	spring-05	2.8	1.6	5.4	4.4	41%	0	0	0	0	0.2	0	0	3.4	0.6	0	0.4	0.2	0	0	0.4	0.2
5	GC	scalp	Nov-07	winter-07	1.6	1.5	3.8	4.4	58%	0	0	0	0	0	0	0	2.4	0	0	0	0	0.2	0	1.2	0
5	GW	ref	Aug-05	summer-06	5.4	1.7	81.4	27.4	17%	0	0.2	0	0	0	0.2	1	74.4	3.2	0.6	0.4	0.8	0	0.2	0.2	0.2
5	GW	ref	Dec-04	winter-04	10.0	1.0	86.6	5.5	3%	0	0	0	0	0	0.4	0	20.6	11.4	0	19.4	1	0	2	31.8	0
5	GW	ref	Dec-05	winter-05	8.8	1.6	45.4	16.4	18%	0	0	0	0	0	0	0	28.6	5.4	0	2.4	3	0	1.4	4.6	0
5	GW	ref	Mar-05	spring-05	3.0	1.7	3.8	1.8	24%	0	0.2	0	0	0	0	0	1	1.4	0	0.6	0.4	0	0.2	0	0
5	GW	ref	Aug-05	summer-06	7.0	2.2	149.0	30.7	10%	0	0	0	0	0.2	0	0	122.2	22.8	0	1	1.4	0	0	1.2	0.2
5	GW	ref	Dec-04	winter-04	12.6	1.5	174.6	42.4	12%	0	0	0	0	0	1	0.2	35.2	41.8	0	63.4	5.8	0	2.8	24.4	0
5	GW	ref	Dec-05	winter-05	9.8	1.9	58.4	26.0	22%	0	0	0	0	0	0	0	11.6	36.6	0	5	0.8	0	0.8	3.6	0
4	GW	ref	Mar-05	spring-05	1.5	0.6	3.5	2.4	39%	0	0	0	0	0	0	0	2.5	1	0	0	0	0	0	0	0
5	GW	ref	Aug-05	summer-06	9.4	1.8	153.4	49.1	16%	0	0	0	0	0	0	0	140.2	7.4	0	2.2	0.6	0	0.6	1.8	0.6
5	GW	ref	Dec-04	winter-04	5.4	1.7	23.8	6.5	14%	0	0	0	0	0	0	0	1.2	12.8	0	8.8	0.4	0	0	0.6	0
4	GW	ref	Mar-05	spring-05	2.0	1.2	3.0	1.8	35%	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0
5	GW	scalp	Aug-05	summer-06	8.6	0.9	361.8	53.6	7%	0	0	0	0	0.2	0	0	298.2	49.6	0	0.8	5	0	0	7.2	0.8
5	GW	scalp	Dec-04	winter-04	12.8	0.8	95.4	14.0	7%	0.2	0	0	0	0.8	0.2	0.6	32.4	19.4	0	12.2	2.2	0	3	24.4	0
5	GW	scalp	Dec-05	winter-05	9.4	0.5	50.2	14.0	14%	0	0	0	0	0	0	0	24.4	12.4	0	2.6	2.8	0	1	6.8	0.2
5	GW	scalp	Mar-05	spring-05	2.4	1.3	6.2	5.8	47%	0	0	0	0	0	1	0	0	3.8	0.2	1.2	0	0	0	0	0
5	GW	scalp	Nov-07	winter-07	5.8	1.1	34.6	8.1	12%	0	0	0	0	0	0	0	22.4	5	0	1	0	0	0.2	6	0
5	H	ref	Dec-07	winter-07	9.2	3.3	12.4	4.6	18%	0	0	0.4	0	0	0.4	0	1.2	4.4	0	4.4	1.2	0.4	0	0	0
5	H	ref	Dec-07	winter-07	10.4	2.6	31.2	17.4	28%	0	0	0.4	0	0	0	0	2.4	20	0	5.6	2	0	0	0.8	0
5	H	ref	Dec-07	winter-07	6.8	2.3	7.2	3.0	21%	0	0	0	0	0	0	0	2	1.6	0	2.4	0.8	0.4	0	0	0
3	H	scalp	Dec-07	winter-07	2.7	1.2	3.3	1.2	24%	0	0	0	0	0	0	0	3.33333	0	0	0	0	0	0	0	0
4	H	scalp	Dec-07	winter-07	4.5	2.5	5.0	3.5	40%	0	0	0	0	0	0	0	1.5	2	0	0.5	1	0	0	0	0
5	H	scalp	Dec-07	winter-07	2.4	0.9	5.2	2.7	26%	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1.2	0
5	BB	ref	Aug-06	summer-06	7.8	1.9	168.0	48.0	14%	0	0	0	0	0.2	0	0	146.2	9	0	0.8	4.8	0.2	0	6.6	0.2
5	BB	ref	Dec-04	winter-04	14.8	1.1	265.0	68.6	13%	0	0	0	0.2	2.4	0	0	116.8	55.8	0	50.2	16.6	5.2	0	17.8	0
5	BB	ref	Jan-07	winter-07	11.8	1.5	182.6	47.4	13%	0	0	0	0	0	0	0	144.2	18	0	3.8	14.6	1.2	0	0.8	0
5	BB	ref	Nov-07	winter-07	11.4	2.4	107.6	15.4	7%	0	0	0	0	1	0	0	57.6	14	0	7	1.2	5	0	21.8	0
5	BB	ref	Oct-04	fall-04	7.0	2.0	26.2	14.8	28%	0	0	0	0	0	0	0	8.4	4.4	0	2.6	1.2	1	0	8.6	0
5	GE	ref	Aug-06	summer-06	7.4	1.8	182.4	36.3	10%	0.2	0	0	0	0.2	0	0.4	120.8	52.2	0	0.4	1.4	0.6	0	6.2	0
5	GE	ref	Dec-04	winter-04	15.0	1.4	305.0	58.6	10%	0	0	0	0.2	2.6	0	0	54.6	107.8	0	83	18.2	4.2	0	34.4	0
5	GE	ref	Feb-07	winter-07	11.0	0.7	1176.0	239.5	10%	0	0	0	0	0.2	2.6	0	1105.6	42	0	6.6	6	4.2	0	8.6	0.2
5	GE	ref	Nov-07	winter-07	11.2	2.9	147.2	37.9	13%	0	0	0	0	0.4	0	0.6	69.6	18.8	0	7.2	1.2	1	0	48.2	0.2
5	GE	ref	Oct-04	fall-04	6.6	1.1	46.0	17.5	19%	0	0	0	0	0.2	0	0.2	12.6	8	0	6	1.4	0	0	17.6	0
5	BB	ref	Aug-06	summer-06	8.0	0.7	307.0	48.1	8%	0	0	0	0	0.2	0	0	272.6	14.8	0	0.4	1.6	0.8	0	16.4	0.2
5	BB	ref	Dec-04	winter-04	11.2	3.0	161.2	52.9	16%	0	0	0	0.2	0.2	0	0.2	67	11.8	0	3.2	1.8	1.6	0	75.2	0
5	BB	ref	Jan-07	winter-07	11.6	1.5	111.6	53.4	24%	0	0.2	0	0.2	0.2	0	0.4	80.8	8.6	0	2.4	9.4	2.2	0	7.2	0
5	BB	ref	Nov-07	winter-07	10.6	1.5	177.2	72.7	21%	0	0	0	0	0.4	0	0	43.4	15.4	0	3.6	1	2.4	0	111	0
5	BB	ref	Oct-04	fall-04	8.0	2.3	65.0	28.5	22%	0	0	0	0	0	0	1.8	34.8	9	0	1.6	1.6	2.4	0	13.8	0
5	GE	ref	Aug-06	summer-06	10.6	1.7	204.4	55.9	14%	0	0	0	0	0	0	0.6	165.6	14.6	0	1.8	8.4	1.4	0	11.8	0.2
5	GE	ref	Dec-04	winter-04	15.0	1.6	224.8	33.5	7%	0.2	0	0	0.2	1.8	0	0	29.6	90.8	0	62	15.8	3.4	0	20.8	0.2
5	GE	ref	Jan-07	winter-07	8.0	0.7	91.0	16.6	9%	0	0	0	0	0	0.2	0	64.6	7.8	0	0.2	5.8	0.6	0	11.8	0
5	GE	ref	Nov-07	winter-07	4.0	1.6	30.4	15.1	25%	0	0	0	0	0	0.2	0	10.8	1.6	0	0.2	0.2	0	0	17.2	0.2
5	GE	ref	Oct-04	fall-04	8.4	0.5	46.8	15.4	16%	0	0	0	0.2	0	0	0.2	14	13.8	0	6.6	0.4	1	0	10.6	0
5	BB	ref	Aug-06	summer-06	7.2	1.3	102.2	18.9	9%	0	0	0	0	0	0	0.2	78.8	14.8	0	0.4	1.2	2.2	0	4.6	0
5	BB	ref	Dec-04	winter-04	16.6	1.8	257.4	46.5	9%	0	0	0	0.2	1.6	0	0.8	84.6	88	0.2	41.6	18.4	2.6	0	19.4	0
5	BB	ref	Jan-07	winter-07	9.0	1.2	71.2	34.5	24%	0	0	0	0	0	0	0.2	51.8	4.4	0	2	7	2	0	3.8	0
5	BB	ref	Nov-07	winter-07	9.8	0.8	63.4	14.3	11%	0	0	0	0	0.2	0	0.8	22.2	16.2	0	4	0.2	2	0	17.8	0
5	BB	ref	Oct-04	fall-04	9.6	1.8	67.8	15.5	11%	0	0	0	0	0.6	0.2	0.4	19.4	13.2	0	4.4	0.8	0.8	0	27.8	0.2
5	GE	ref	Aug-06	summer-06	12.2	2.7	197.2	60.5	15%	0.2	0	0	0	1.4	0	1.2	119	46.4	0	2.8	16.4	1	0	8.8	0
5	GE	ref	Dec-04	winter-04	15.2	1.1	259.4	40.9	8%	0	0	0	0.4	3.4	0.2	0	59.6	84.4	0	60	22.6	6	0	22.8	0
5	GE	ref	Jan-07	winter-07	11.8	1.1	199.2	81.3	20%	0	0	0	0	0	0	0	135.2	29.4	0	3.4	15.2	6	0	10	0
5	GE	ref	Nov-07	winter-07	4.8	0.8	40.8	19.0	23%	0	0	0	0	0	0	0	25.6	2.6	0	0.2	0	0.8	0	11.4	0.2
5	GE	ref	Oct-04	fall-04	9.6	1.5	48.0	14.2	15%	0	0	0	0.2	0	0	0.6	13.2	10.4	0	3	2	1.6	0	17	0
5	BB	scalp	Aug-06	summer-06	9.4	1.8	332.2	102.4	15%	0.2	0	0	0	0.4	0	0.2	225	85.2	0	2.2	8.8	0.4	0	9.6	0.2
5	BB	scalp	Dec-04	winter-04	16.2	2.5	426.6	59.0	7%	0.2	0	0	0	1.4	0	0.6	156.4	112.2	0.2	88	2.6	10.6	0	54.4	0
5	BB	scalp	Jan-07	winter-07	10.4	1.8	164.2	57.9	18%	0	0	0	0	0	0	0.4	13	82.8	0	46.2	6.8	0	0	15	0
5	BB	scalp	Nov-07	winter-07	9.0	0.7	98.2	20.5	10%	0	0	0	0	0.6	0	0	53.8	25	0	8	0	2.4	0	8.2	0.2
5	BB	scalp	Oct-04	fall-04	11.0	1.7	176.6	79.6	23%	0	0	0	0	0.6	0	1.2	37	42.2	0	9.6	3.8	3.4	0	78.8	0
5	GE	scalp	Aug-06	summer-06	7.2	2.6	94.6	32.4	17%	0	0.2	0	0.2	0.2	0	0.2	80.8	6.8	0	0	1.8	0.6	0	3.6	0.2
5	GE	scalp	Dec-04	winter-04	14.6	1.1	386.8	111.0	14%	0	0.2	0	0.2	2.6	0	1.2	83.8	52.6	0	5.2	2.2	6.2	0	232.6	0
5	GE	scalp	Feb-07	winter-07	8.6	2.5	508.0	84.9	8%	0	0	0	0	0	0.2	0.2	439.2	7.6	0.4	0.8	0.8	1.2	0	55	2.6
5	GE	scalp	Nov-07	winter-07	6.0	2.0	44.0	27.3	31%	0.2	0	0	0	0	0	0	14.4	7.2	0	2.6	0	0.6	0	19	0
5	GE	scalp	Oct-04	fall-04	7.8	1.9	96.6	34.8	18%	0	0	0	0.6	0.2	0	0.4	33.8	16.4	0.4	0.8	0.4	0.4	0	43	0.2
5	T	ref	Dec-07	winter-07	11.4	3.6	111.6	74.1	33%	0	0	0	0	0.4	0	0	53	14.4	0	18	4.4	1.4	0	19.8	0.2
5	T	ref	Dec-07	winter-07	12.6	0.9	67.4	29.8	22%	0	0	0	0	0.6	0	0.4	24.6	14	0	15.4	6.2	1	0	5.2	0
5	T	ref	Dec-07	winter-07	4.0	1.9	10.0	4.8	24%	0	0	0	0	0	0	0	2.2	2.4	0	5.2	0.2	0	0	0	0
5	T	scalp	Dec-07	winter-07	9.6	2.3	39.0	10.8	14%	0	0	0	0	0.6	0	0	16.8	10	0	9	1.4	0.6	0	0.6	0

Table A3-4: Summary Statistics Showing Averages of Sediment Characteristics

Reps	Location	Treatment	Date	Season	Habitat	% Left	% Lost	% Sand	% Shadow	Avg Stone Size (cm2)	D5 (mm)	D50 (mm)	D95 (mm)	No. Stones	Stones / m2
5	GC	scalp	Aug-06	summer-06	Side	83	16.3	8	7.75	3.25	9.25	21.5	47.5	779.25	3692.25
5	GC	scalp	Dec-04	winter-04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GC	scalp	Feb-07	winter-07	Side	46	76.5	76.5	0	4	11.5	26	65.5	274	2083
5	GC	scalp	Mar-05	spring-05	Side										
5	GC	scalp	Nov-07	winter-07	Side	46	76.5	76.5	0	4	11.5	26	65.5	274	2083
5	GW	ref	Aug-05	summer-06	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GW	ref	Dec-04	winter-04	main	90	9.4	2.3333	7.8	3.6	10.2	25.2	52	522.6	2297
5	GW	ref	Dec-05	winter-05	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GW	ref	Mar-05	spring-05	Side	84	15	9	6	3	9	20	49	738	3510
5	GW	ref	Aug-05	summer-06	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GW	ref	Dec-04	winter-04	main	90	9.4	2.3333	7.8	3.6	10.2	25.2	52	522.6	2297
5	GW	ref	Dec-05	winter-05											
4	GW	ref	Mar-05	spring-05	Side	84	15	9	6	3	9	20	49	738	3510
5	GW	ref	Aug-05	summer-06	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GW	ref	Dec-04	winter-04	main	90	9.4	2.3333	7.8	3.6	10.2	25.2	52	522.6	2297
4	GW	ref	Mar-05	spring-05	Side	84	15	9	6	3	9	20	49	738	3510
5	GW	scalp	Aug-05	summer-06	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GW	scalp	Dec-04	winter-04	Side	90	8.7	0	8.6	2.3	8	16.6	34	1329.5	5820.2
5	GW	scalp	Dec-05	winter-05	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GW	scalp	Mar-05	spring-05	Side	86	13	7	6	2	7	14.5	32	1596.5	7312
5	GW	scalp	Nov-07	winter-07	main	94	5	2.75	1.75	2.75	8.5	18.75	39.75	993.25	4199
5	H	ref	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	H	ref	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	H	ref	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	H	scalp	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	H	scalp	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	H	scalp	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	BB	ref	Aug-06	summer-06	main	67	32	18	13.25	3.5	10.5	23.5	58.75	447.75	2649.5
5	BB	ref	Dec-04	winter-04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	BB	ref	Jan-07	winter-07	main	66	33	31.25	1.25	5.5	16	35	90.75	184.75	1076.5
5	BB	ref	Nov-07	winter-07	main	66	33	31.25	1.25	5.5	16	35	90.75	184.75	1076.5
5	BB	ref	Oct-04	fall-04	main	51	48.3	46.25	2.6667	4.75	13	29.25	75	346.75	2811
5	GE	ref	Aug-06	summer-06	Side	88	11	3.25	7.25	6.25	14	38.75	78.5	208.25	942
5	GE	ref	Dec-04	winter-04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GE	ref	Feb-07	winter-07	main	87	11.8	10.75	0.5	5.75	15.75	34.25	88	241.75	1102
5	GE	ref	Nov-07	winter-07	main	87	11.8	10.75	0.5	5.75	15.75	34.25	88	241.75	1102
5	GE	ref	Oct-04	fall-04	Side	85	14.5	0	14.5	5	11.5	34	64.5	308.5	1442.5
5	BB	ref	Aug-06	summer-06	main	67	32	18	13.25	3.5	10.5	23.5	58.75	447.75	2649.5
5	BB	ref	Dec-04	winter-04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	BB	ref	Jan-07	winter-07	main	66	33	31.25	1.25	5.5	16	35	90.75	184.75	1076.5
5	BB	ref	Nov-07	winter-07	main	66	33	31.25	1.25	5.5	16	35	90.75	184.75	1076.5
5	BB	ref	Oct-04	fall-04	main	51	48.3	46.25	2.6667	4.75	13	29.25	75	346.75	2811
5	GE	ref	Aug-06	summer-06	Side	88	11	3.25	7.25	6.25	14	38.75	78.5	208.25	942
5	GE	ref	Dec-04	winter-04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GE	ref	Jan-07	winter-07	main	87	11.8	10.75	0.5	5.75	15.75	34.25	88	241.75	1102
5	GE	ref	Nov-07	winter-07	main	87	11.8	10.75	0.5	5.75	15.75	34.25	88	241.75	1102
5	GE	ref	Oct-04	fall-04	Side	85	14.5	0	14.5	5	11.5	34	64.5	308.5	1442.5
5	BB	ref	Aug-06	summer-06	main	67	32	18	13.25	3.5	10.5	23.5	58.75	447.75	2649.5
5	BB	ref	Dec-04	winter-04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	BB	ref	Jan-07	winter-07	main	66	33	31.25	1.25	5.5	16	35	90.75	184.75	1076.5
5	BB	ref	Nov-07	winter-07	main	66	33	31.25	1.25	5.5	16	35	90.75	184.75	1076.5
5	BB	ref	Oct-04	fall-04	main	51	48.3	46.25	2.6667	4.75	13	29.25	75	346.75	2811
5	GE	ref	Aug-06	summer-06	Side	88	11	3.25	7.25	6.25	14	38.75	78.5	208.25	942
5	GE	ref	Dec-04	winter-04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GE	ref	Jan-07	winter-07	main	87	11.8	10.75	0.5	5.75	15.75	34.25	88	241.75	1102
5	GE	ref	Nov-07	winter-07	main	87	11.8	10.75	0.5	5.75	15.75	34.25	88	241.75	1102
5	GE	ref	Oct-04	fall-04	Side	85	14.5	0	14.5	5	11.5	34	64.5	308.5	1442.5
5	BB	scalp	Aug-06	summer-06	Side	90	9	0.25	8	3	9	20.25	41.5	785	3455.5
5	BB	scalp	Dec-04	winter-04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	BB	scalp	Jan-07	winter-07	Side	95	4.25	1.5	2.5	3.75	10.25	26	50.5	522.25	2197.5
5	BB	scalp	Nov-07	winter-07	Side	95	4.25	1.5	2.5	3.75	10.25	26	50.5	522.25	2197.5
5	BB	scalp	Oct-04	fall-04	Side	47	51.8	41	27.667	4	11.5	25.5	61.25	298.5	2339.5
5	GE	scalp	Aug-06	summer-06	Side	82	17	11.667	5	3	9	20	44	889	4079.67
5	GE	scalp	Dec-04	winter-04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	GE	scalp	Feb-07	winter-07	main	66	32.8	32.25	0.3333	4	12	26.75	64.25	429.25	2182
5	GE	scalp	Nov-07	winter-07	main	66	32.8	32.25	0.3333	4	12	26.75	64.25	429.25	2182
5	GE	scalp	Oct-04	fall-04	Side	93	6.5	5	1	5	12	33	68.5	387	1686
5	T	ref	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	T	ref	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	T	ref	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	T	scalp	Dec-07	winter-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table A3-5: Summary Data for Fish Catches, SDI, H' and 1-D for Each Location, Replicate, Habitat Type, Date and Treatment Type

Station	Sample	SDI	SDI level	hprime	simps	Location Type	Season	Rep	Area Sampled (m2)	Total Abundance	Mean Abundance	SD	Taxa	Mean Taxa	StDev Taxa	CPUE	Mean CUPE	StDev CPUE
bbsep06barflat	1	1	96.30	-0.16	0.93	1	2	1	108	81	53.20	45.07	5	4.4	0.89	0.75	0.53	0.46
bbsep06barflat	2	2	84.62	-1.01	0.38	1	2	2	96	103			5			1.07		
bbsep06barflat	3	1	77.78	-0.60	0.65	1	2	3	100	7			5			0.07		
bbsep06barflat	4	2	85.45	-1.04	0.42	1	2	4	96	71			4			0.74		
bbsep06barflat	5	2	95.38	-0.89	0.46	1	2	5	96	4			3			0.04		
bbsep06bay	1	1	85.19	-0.61	0.73	1	2	1	64	26	211.20	329.2	1	3.8	2.59	0.41	1.51	2.26
bbsep06bay	2	2	92.23	-0.83	0.57	1	2	2	144	13			3			0.09		
bbsep06bay	3	4	85.71	-1.55	0.22	1	2	3	144	18			2			0.13		
bbsep06bay	4	2	76.06	-1.22	0.34	1	2	4	144	220			6			1.53		
bbsep06bay	5	3	100.00	-1.04	0.37	1	2	5	144	779			7			5.41		
gcaug06na	1	2	75.00	-1.06	0.36	2	2	1	144	120	41.00	44.8	3	2.2	1.3	0.83	0.3	0.3
gcaug06na	2	1	100.00	0.00	1.00	2	2	2	64	10			1			0.16		
gcaug06na	3	1	100.00	0.00	1.00	2	2	3	144	20			1			0.14		
gcaug06na	4	1	83.33	-0.45	0.72	2	2	4	144	24			2			0.17		
gcaug06na	5	1	80.65	-0.70	0.66	2	2	5	144	31			4			0.22		
geaug06barsteep	1	2	92.31	-0.91	0.48	3	2	1	7	26	31.20	7.3	4	2.8	0.8	0.36	0.63	0.37
geaug06barsteep	2	2	100.00	-0.60	0.59	3	2	2	7	28			2			0.39		
geaug06barsteep	3	1	83.33	-0.53	0.71	3	2	3	54	30			3			0.56		
geaug06barsteep	4	1	89.29	-0.34	0.81	3	2	4	48	28			2			0.58		
geaug06barsteep	5	2	79.55	-0.96	0.43	3	2	5	35	44			3			1.26		
geaug06rif	1	3	79.41	-1.44	0.31	3	2	1	108	34	29.40	17.2	6	5.4	0.7	0.31	0.19	0.11
geaug06rif	2	3	86.79	-1.29	0.36	3	2	2	200	53			6			0.27		
geaug06rif	3	3	85.71	-1.34	0.35	3	2	3	160	35			6			0.22		
geaug06rif	4	4	76.92	-1.82	0.18	3	2	4	160	13			7			0.08		
geaug06rif	5	3	83.33	-1.47	0.25	3	2	5	176	12			5			0.07		
gesep06nook	1	1	90.91	-0.37	0.83	3	2	1	96	22	54.40	48.2	3	4.2	1.6	0.23	0.466	0.43
gesep06nook	2	2	94.12	-0.91	0.47	3	2	2	96	102			5			1.06		
gesep06nook	3	2	85.32	-1.11	0.38	3	2	3	144	109			6			0.76		
gesep06nook	4	3	83.33	-1.45	0.26	3	2	4	144	36			5			0.25		
gesep06nook	5	2	100.00	-0.64	0.56	3	2	5	96	3			2			0.03		
gwaug05bf	1	1	76.47	-0.55	0.64	4	2	1	96	17	17.40	20.23	2	1.8	0.84	0.18	0.12	0.12
gwaug05bf	2	1	93.75	-0.23	0.88	4	2	2	120	16			2			0.13		
gwaug05bf	3	1	100.00	0.00	1.00	4	2	3	144	2			1			0.01		
gwaug05bf	4	1	100.00	0.00	1.00	4	2	4	168	1			1			0.01		
gwaug05bf	5	2	82.36	-1.12	0.37	4	2	5	180	51			3			0.28		
gwaug05bf2	1	3	87.50	-1.37	0.30	4	2	1	60	16	10.20	4.76	5	2.6	1.5	0.27	0.19	0.12
gwaug05bf2	2	2	85.71	-0.96	0.43	4	2	2	7	7			3			0.1		
gwaug05bf2	3	2	100.00	-0.67	0.57	4	2	3	36	13			2			0.36		
gwaug05bf2	4	1	100.00	0.00	1.00	4	2	4	48	4			1			0.08		
gwaug05bf2	5	1	81.82	-0.47	0.70	4	2	5	7	11			2			0.15		
gwmay05bf	1	2	80.00	-0.95	0.44	4	1	1	30	5	3.33	1.5	3	2.7	0.6	0.17	0.11	0.05
gwmay05bf	2	2	100.00	-0.69	0.50	4	1	2	30	2			2			0.07		
gwmay05bf	3	3	100.00	-1.10	0.33	4	1	3	30	3			3			0.1		
gwmay05bf2	1	2	80.00	-0.95	0.44	4	1	1	20	5	4.33	2.1	3	2.3	1.2	0.25	0.22	0.1
gwmay05bf2	2	1	100.00	0.00	1.00	4	1	2	20	2			1			0.1		
gwmay05bf2	3	2	83.33	-1.01	0.39	4	1	3	20	6			3			0.3		
gwmay05	1	3	75.86	-1.47	0.24	4	1	1	50	29	37.67	7.8	5	5	1.7	0.58	0.75	0.16
gwmay05	2	3	80.00	-1.48	0.34	4	1	2	50	40			8			0.8		
gwmay05	3	3	86.36	-1.39	0.27	4	1	3	50	44			5			0.88		
gwmay05	1	2	76.47	-1.24	0.32	4	1	1	50	34	24.00	8.7	4	3	0.6	0.68	0.48	0.17
gwmay05	2	3	85.00	-1.33	0.32	4	1	2	50	20			5			0.4		
gwmay05	3	2	77.78	-1.16	0.36	4	1	3	50	18			4			0.36		
hedec07na	1					5	4	1	40	0	1.20	1.6	0	1	1.2	0	0.01	0.01
hedec07na	2					5	4	2	45	0			0			0		
hedec07na	3			0.00	1.00	5	4	3	80	1			1			0.01		
hedec07na	4			0.00	1.00	5	4	4	140	1			1			0.01		
hedec07na	5			-1.04	0.38	5	4	5	125	4			3			0.03		
hedec07na2	1					5	4	1	240	0	6.60	7	0	0.8	0.4	0	0.02	0.02
hedec07na2	2			0.00	1.00	5	4	2	400	16			1			0.04		
hedec07na2	3			0.00	1.00	5	4	3	400	12			1			0.03		
hedec07na2	4			0.00	1.00	5	4	4	400	3			1			0.01		
hedec07na2	5			0.00	1.00	5	4	5	280	2			1			0.01		

Table A3-6: Means and SD's and Precision for SDI, H' and 1-D for Locations, Dates or Treatments and Substrate Factors

Station	Location	Season & Year	Mean CPUE	StDev CPUE	Precision	Mean Taxa	StDev Taxa	Replicates
bbsep06bay	bb	summer-06	1.51	2.25	74%	4.00	2.35	5
bbsep06bf	bb	summer-06	0.53	0.46	43%	4.40	0.89	5
geaug06barsteep	ge	summer-06	0.63	0.36	29%	2.80	0.84	5
geaug06na	ge	summer-06	0.30	0.30	49%	2.20	1.30	5
geaug06rif	ge	summer-06	0.19	0.11	29%	6.00	0.71	5
gesep06nook	ge	summer-06	0.47	0.43	46%	4.20	1.64	5
gwaug05bf	gw	summer-05	0.12	0.12	47%	2.00	1.22	5
gwaug05bf2	gw	summer-05	0.19	0.12	31%	2.60	1.52	5
gwmay05bf	gw	spring-05	0.11	0.05	32%	2.67	0.58	3
gwmay05bf2	gw	spring-05	0.22	0.10	34%	2.33	1.15	3
gwmay05on	gw	spring-05	0.75	0.16	15%	6.00	1.73	3
gwmay05on2	gw	spring-05	0.48	0.17	26%	4.33	0.58	3
hedec07na	he	winter-07	0.01	0.01	64%	1.00	1.22	5
hedec07na2	he	winter-07	0.02	0.02	51%	0.80	0.45	5

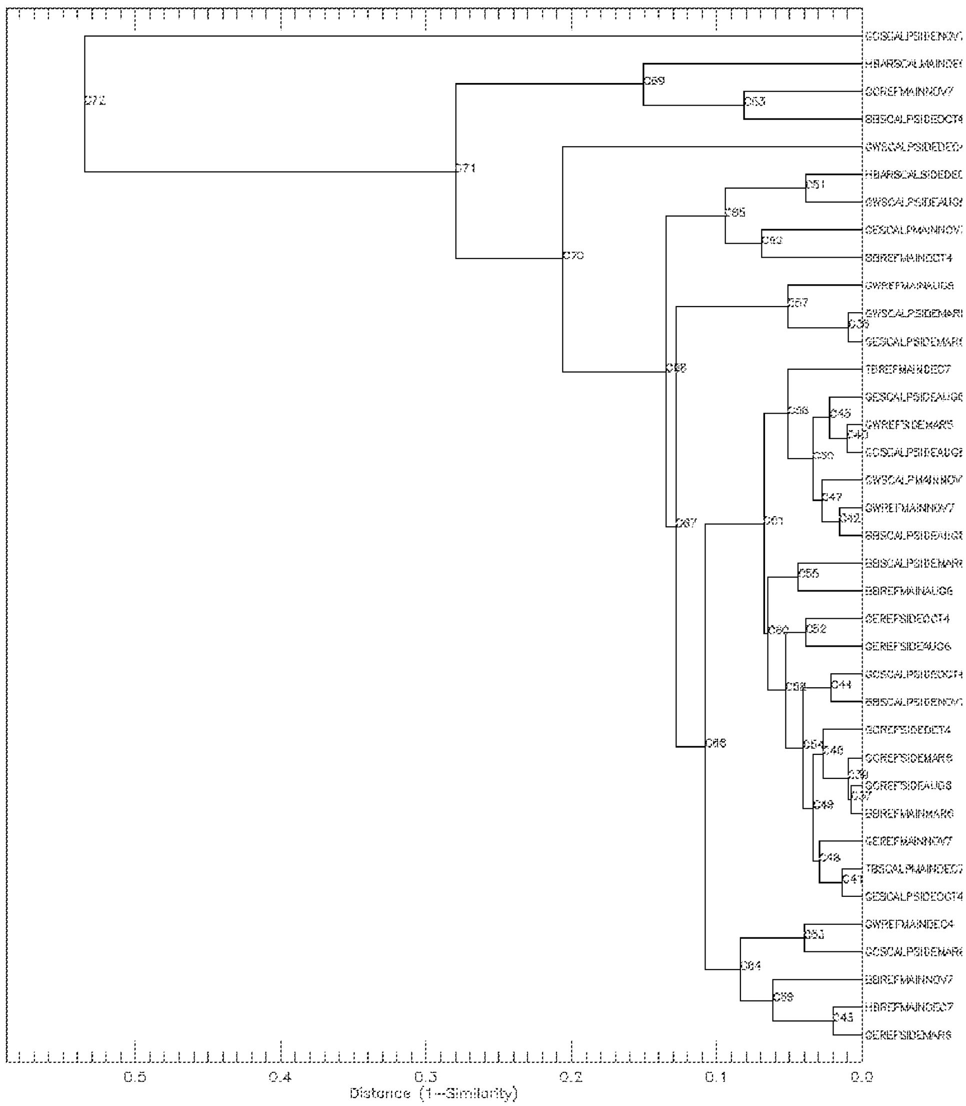
Appendix 4

SIGTREE Dendrograms of Cluster Analysis

Key to Coded Terms
BB = Site Location (e.g. Big Bar)
sc = Scalp Site
ref = Reference Site
# After sc/R = Sample Replicate Number
Nov07 = Date (e.g. November 2007)
Examples:
1) GCscNov07 = Gill Central, Scalp Site, November 2007
2) R1BBDec04 = Big Bar, Reference Site, Replicate 1, December 2004

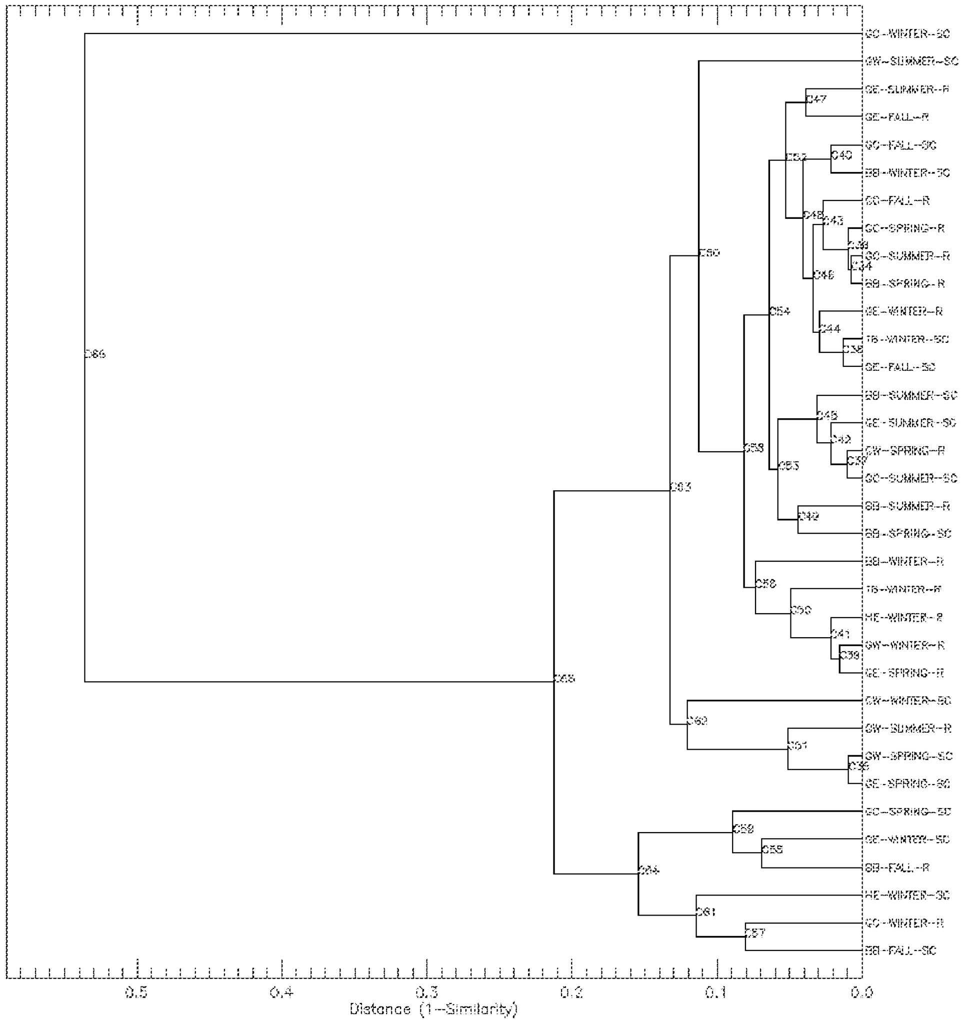
Legend Key
GW = Gill West
GC = Gill Central
GE = Gill East
BB = Big Bar
H = Herrling
T = Tranmer

Figure A4-1: SIGTREE Analysis of Substrate Factors (using Pearson Correlation) for Locations, Dates and Treatments



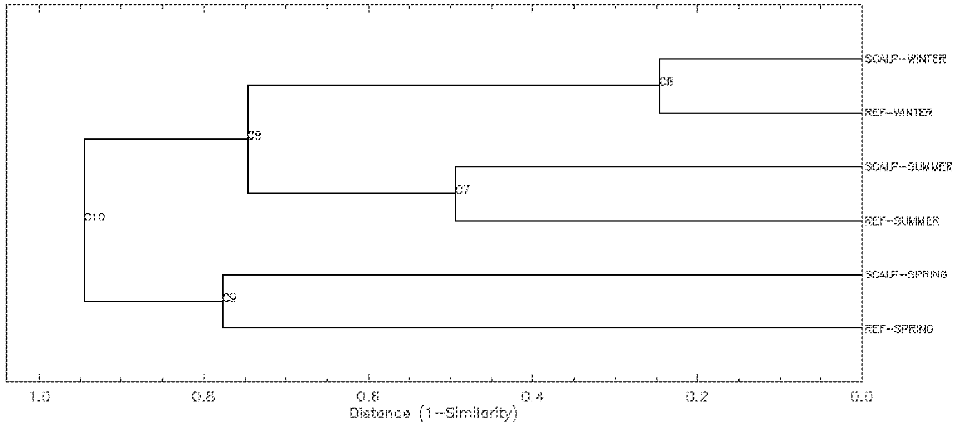
No Significant Linkages at p<0.005

Figure A4-2: SIGTREE Analysis for Selected Substrate Factors for Locations, Seasons (Regardless of Date) and Treatments

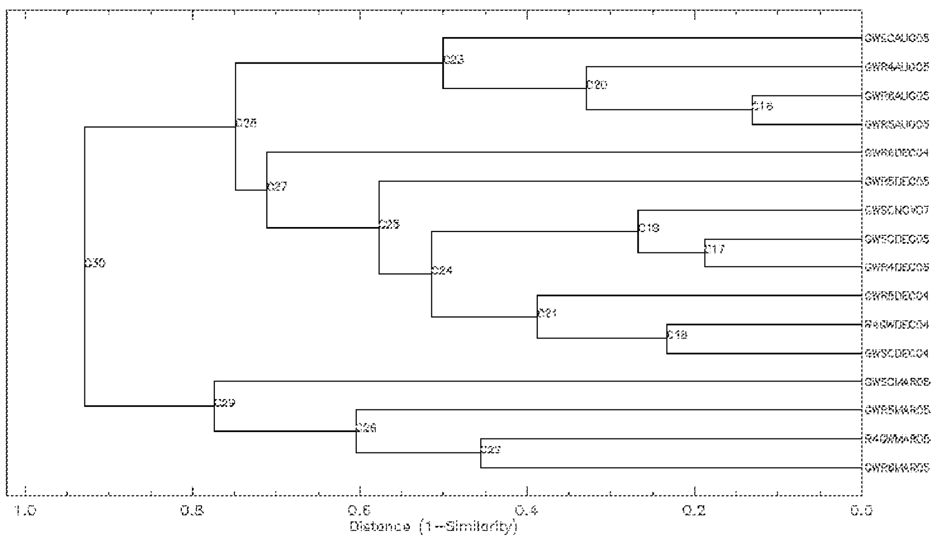


No Significant linkages at p<0.005

Figure A4-3: SIGTREE Analysis for Benthos for Each Location: Gill West Cluster Analysis



Significant linkages at p<0.03 = C7-C10



Significant linkages at p<0.01 = C18, C20, C21, C23-25, C27-30

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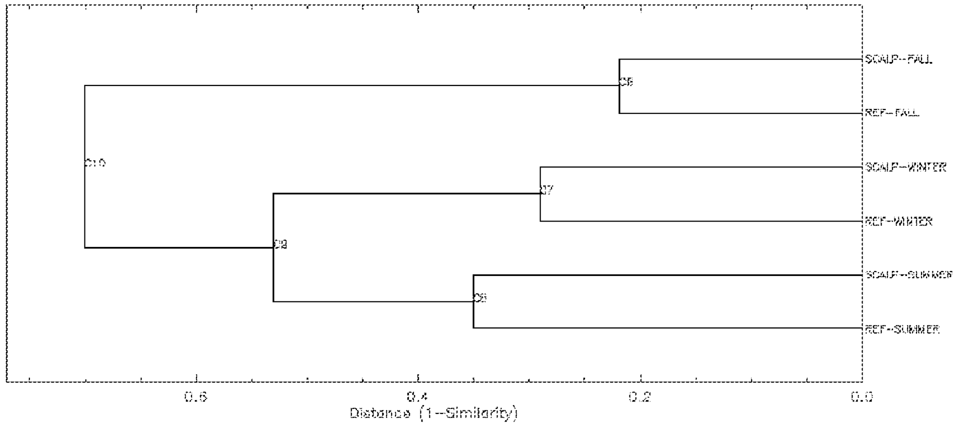
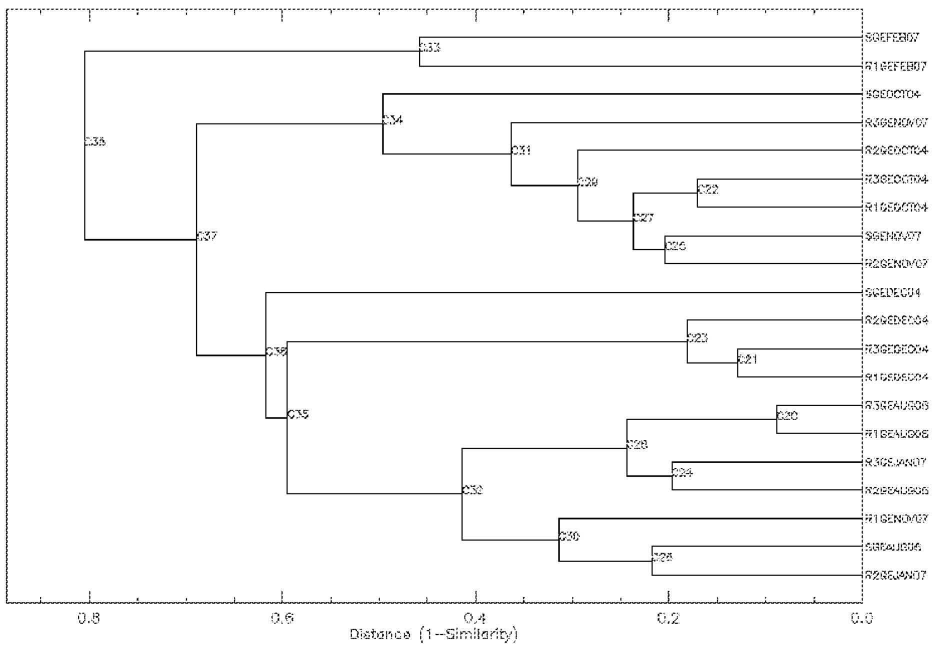
s\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERAT
IONAL LIAISON\HCM\copy of shared drive Jan 26 2010
\1. Pacific\7. Reports\Fraser River Sed Removal Su
rveys - FINAL.pdf

Figure A4-4: SIGTREE Analysis for Benthos for Each Location: Gill East Cluster Analysis

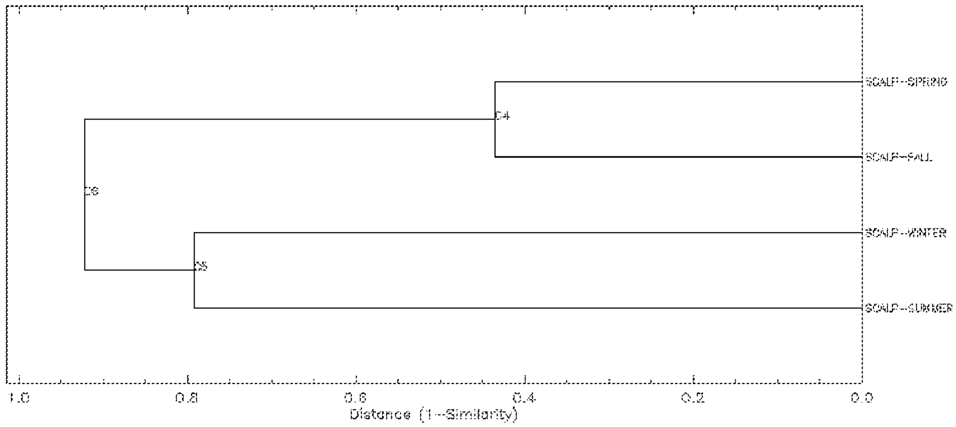


Significant linkages at p<0.02 = C8, C9, C10

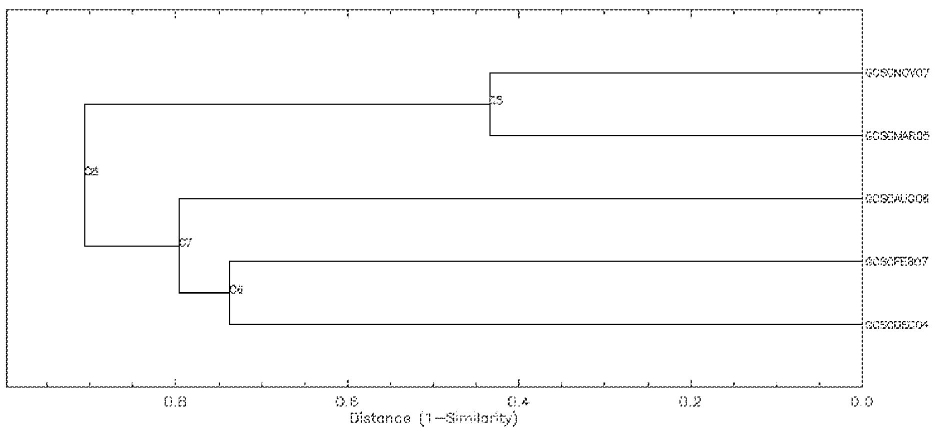


Significant linkages = C30, C32-38

Figure A4-5: SIGTREE Analysis for Benthos for Each Location:
Gill Central Cluster Analysis

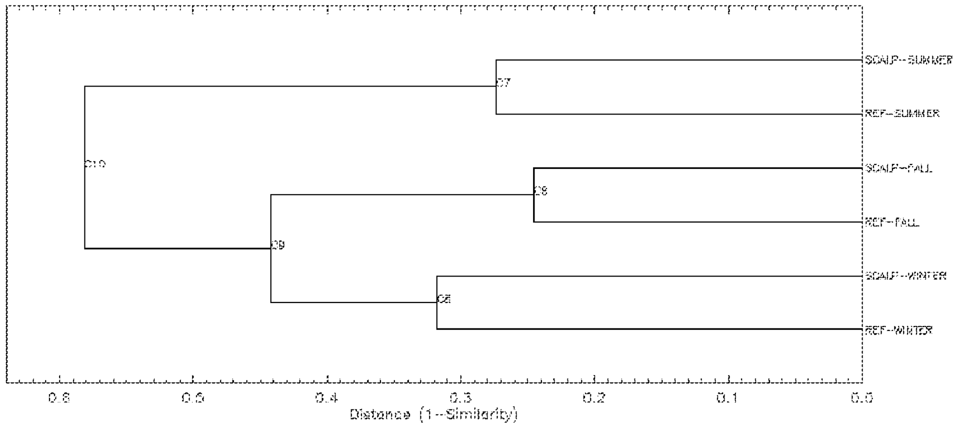


Significant linkages at p<0.05 = C5, C6

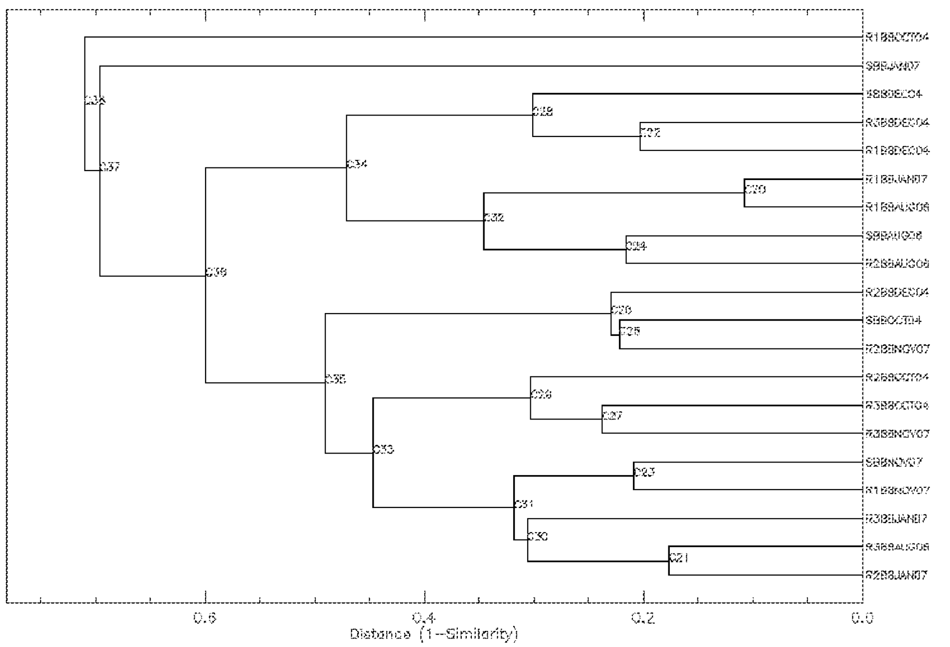


Significant linkages at p<0.05 = C6, C7, C8

Figure A4-6: SIGTREE Analysis for Benthos for Each Location: Big Bar Cluster Analysis



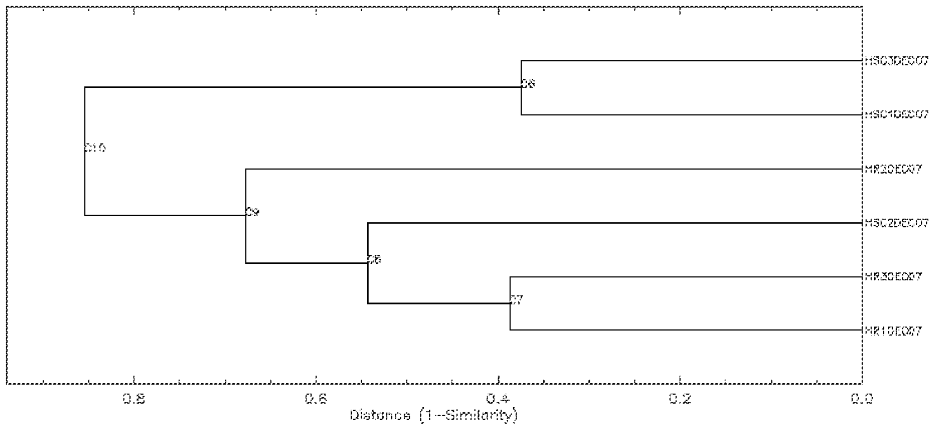
Significant clusters at p<0.03 = C8, C9, C10



Significant clusters at p<0.015 = C28, C33-38

Figure A4-7: SIGTREE Analysis for Benthos for Each Location: Herrling Bar Cluster Analysis

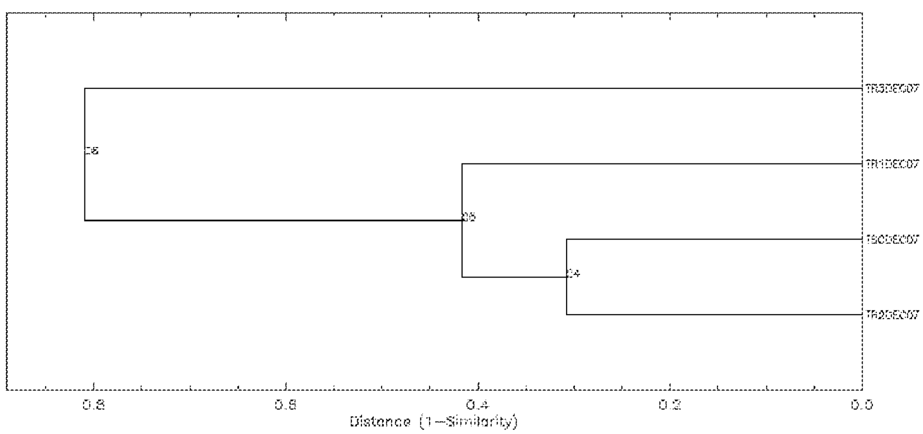
No dendrogram generated: HS (n=24) vs HR (n=30) for December, 2007; Similarity = 0.23, p<0.001 (power >99.9%)



Significant linkages at p<0.03 = C10

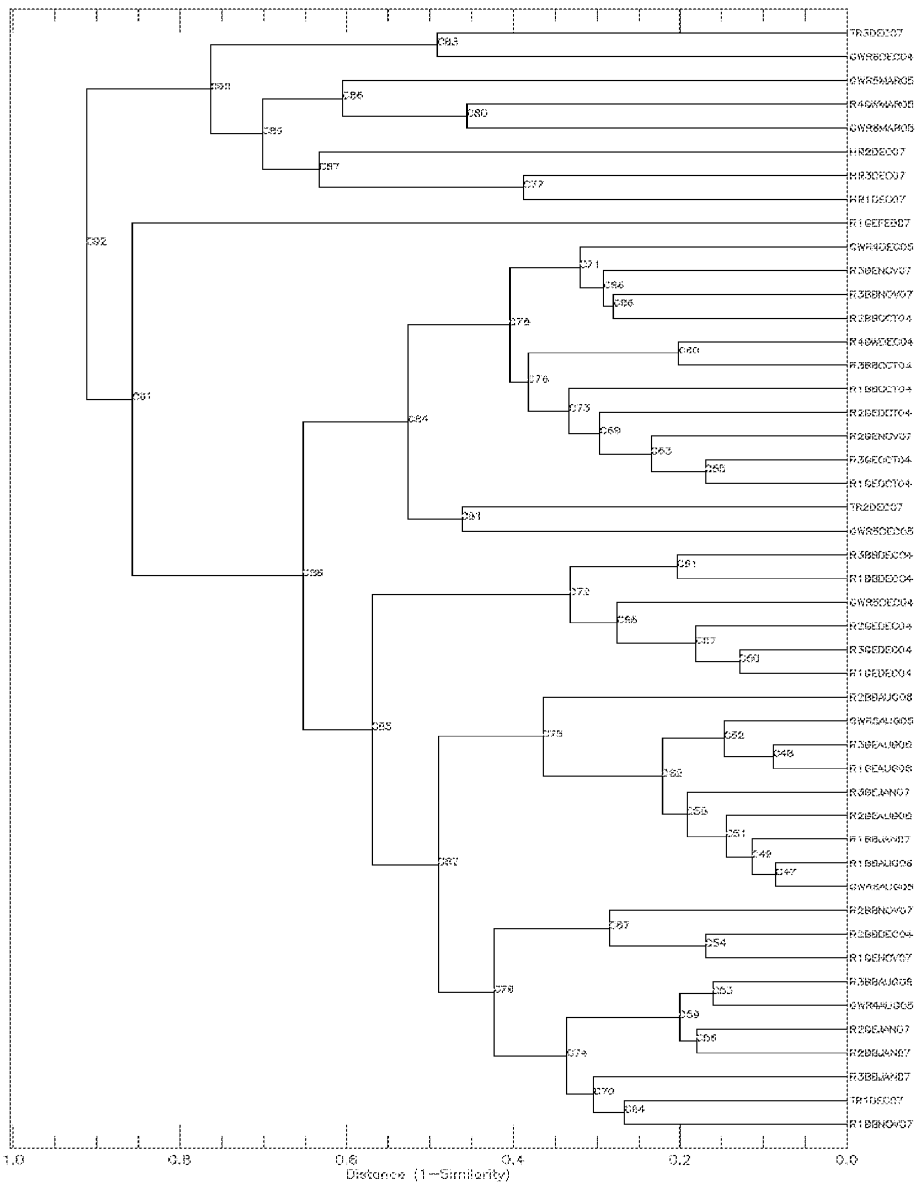
Figure A4-8: SIGTREE Analysis for Benthos for Each Location: Tranmer Bar Cluster Analysis

No dendrogram generated for T ref (n=15) vs T scalp (n= 5). Similarity is 0.74, p>0.3.



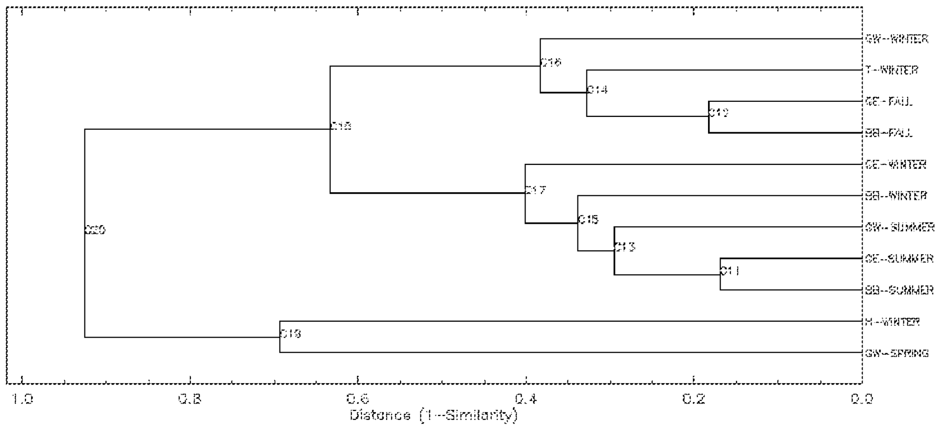
Significant linkages for p<0.05 = C5 and C6

Figure A4-9: SIGTREE Analyses for Benthos for Reference Sites: Cluster Analysis of All Locations and Dates



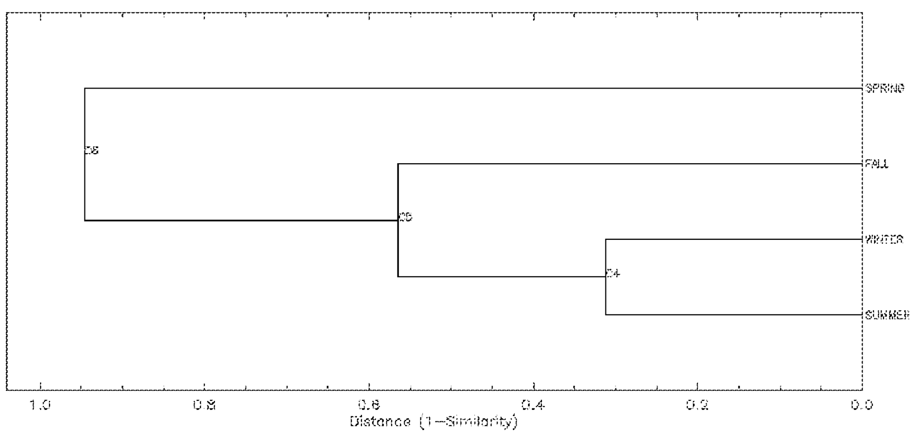
Significant linkages at p<0.004%=C72, C75, C81, C84, C85, C91, C92

Figure A4-10: SIGTREE Analysis for Benthos for Reference Sites: Cluster Analysis of All Locations and Seasons (Regardless of Date)



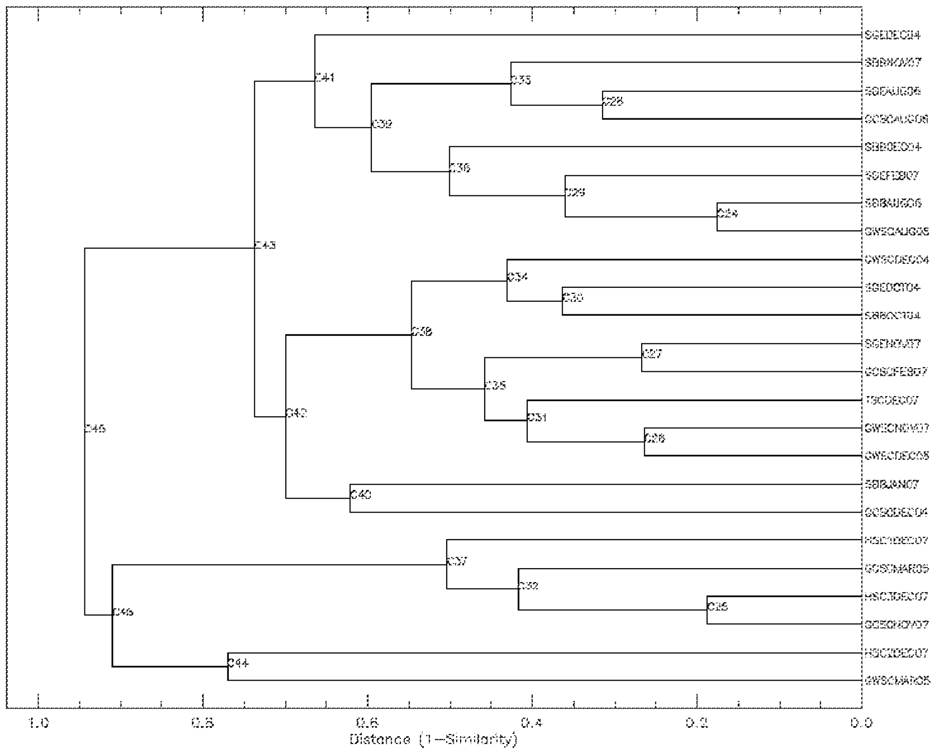
Significant linkages at p<0.015 = C13-C16, C18-C20

Figure A4-11: SIGTREE Analysis for Benthos for Reference Sites: Cluster Analysis of All Locations Grouped for Each Season



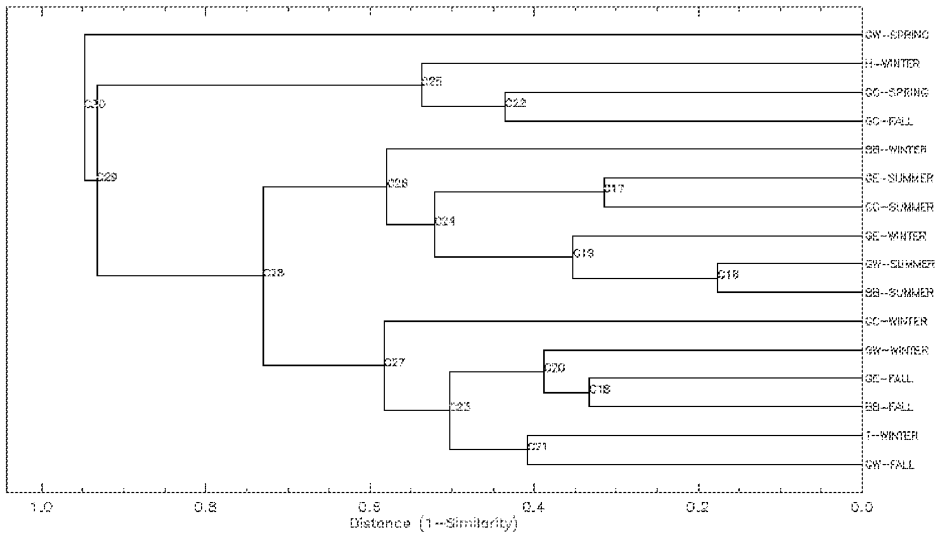
Significant linkages at p<0.05 = C4, C5, C6

Figure A4-12: SIGTREE Analysis for Benthos for Scalped Sites: Cluster Analysis of All Locations and Dates



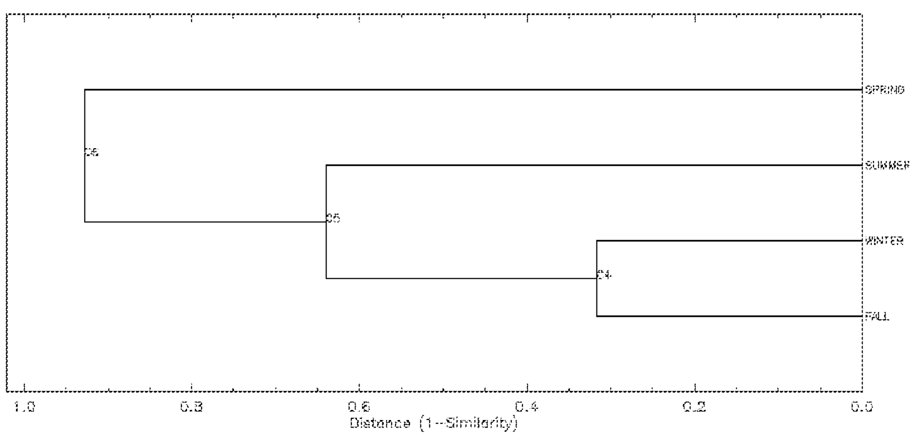
Significant linkages at p<0.005 = C29, C31, C34, C36, C40-43, C45

Figure A4-13: SIGTREE Analysis for Benthos for Scalped Sites: Cluster Analysis of All Locations Grouped for Each Season



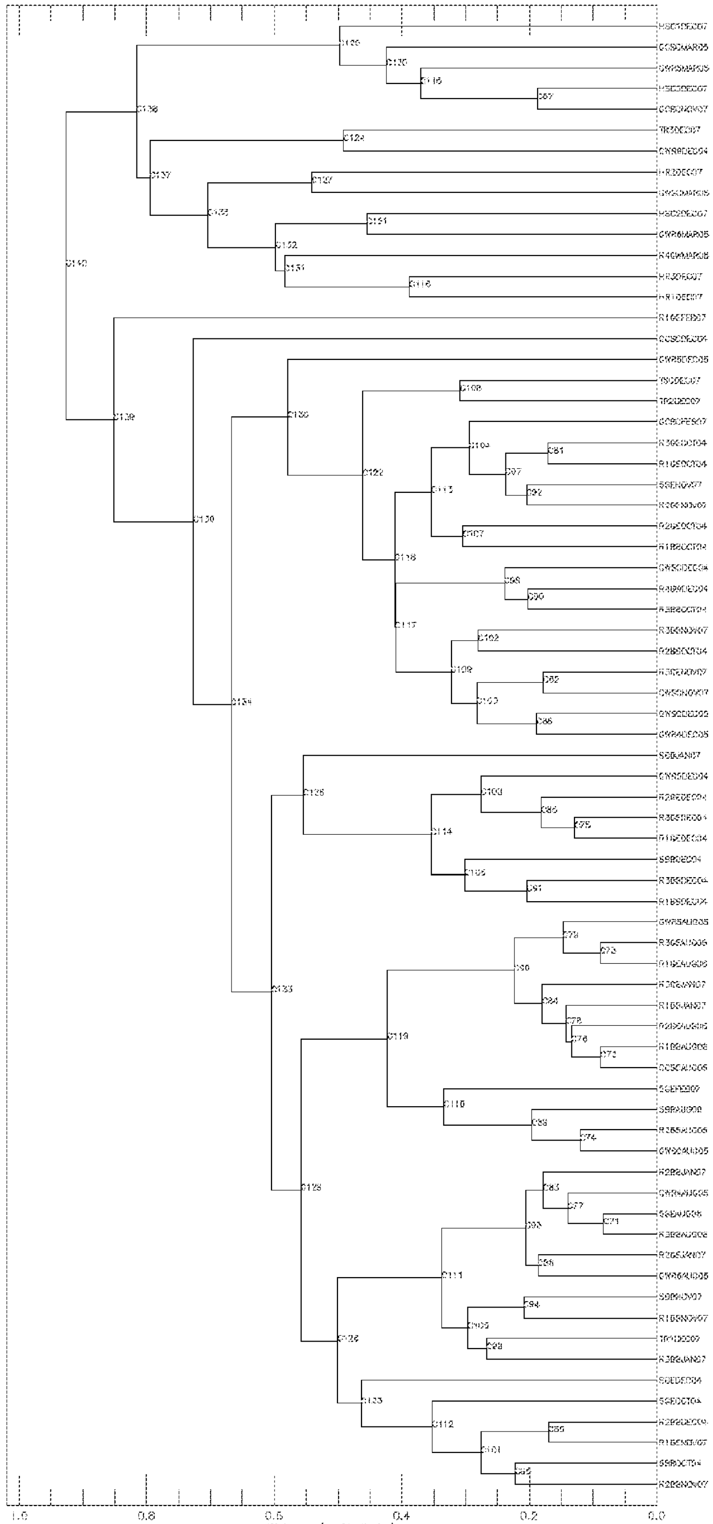
Significant linkages at p<0.01 = C20, C21, C23, C26-30

Figure A4-14: SIGTREE Analysis for Benthos for Scalped Sites: Cluster Analysis of All Samples Grouped by Season (Regardless of Location or Date)



Significant linkages at p<0.05 = C5 and C6

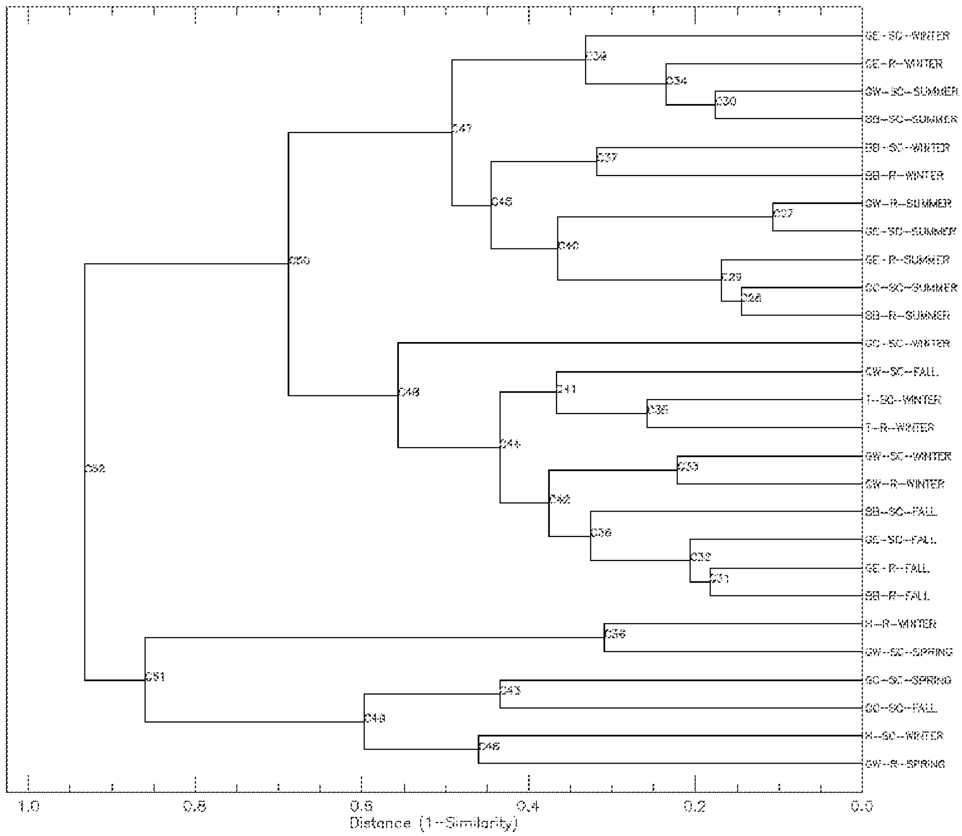
Figure A4-15: SIGTREE Analysis for Benthos Comparing Scalped and Reference Samples for All Locations: All Locations, Treatments and Dates



Significant linkages at P<0.002 = C100, C110, C119, C122, C123, C128, C130, C133, C136, C139

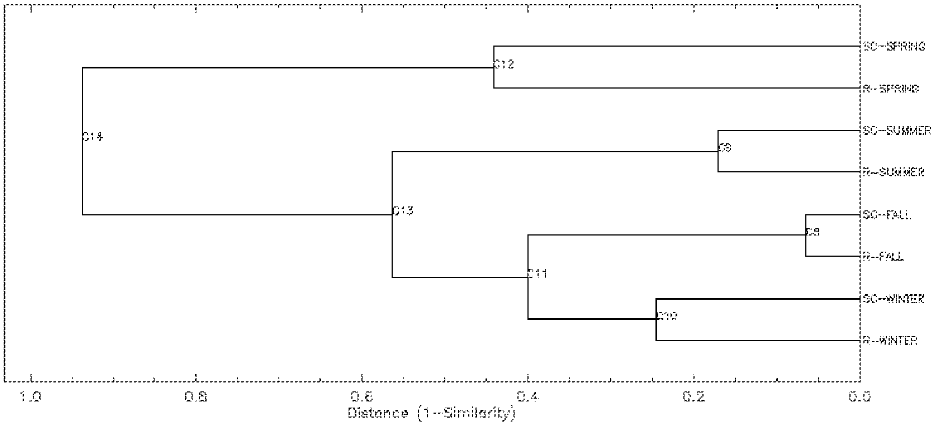
\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drives\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010\1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

Figure A4-16: SIGTREE Analysis for Benthos Comparing Scalped and Reference Samples for All Locations: All Locations, Treatments Grouped by Season (Regardless of Date)



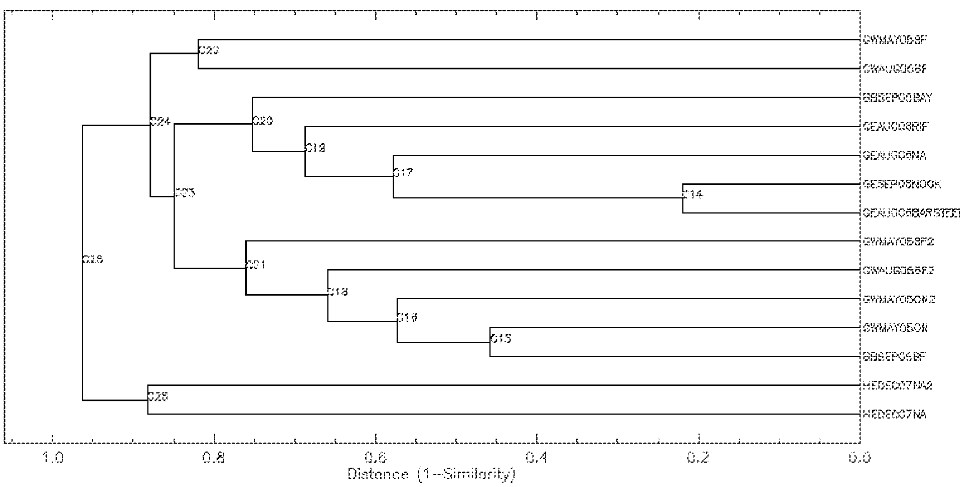
Significant linkages at $p<0.005$ = C37, C42, C45, C48-52

Figure A4-17: SIGTREE Analysis for Benthos Comparing Scalped and Reference Samples for All Locations: Samples Grouped by Season and Treatment (Regardless of Location or Date)



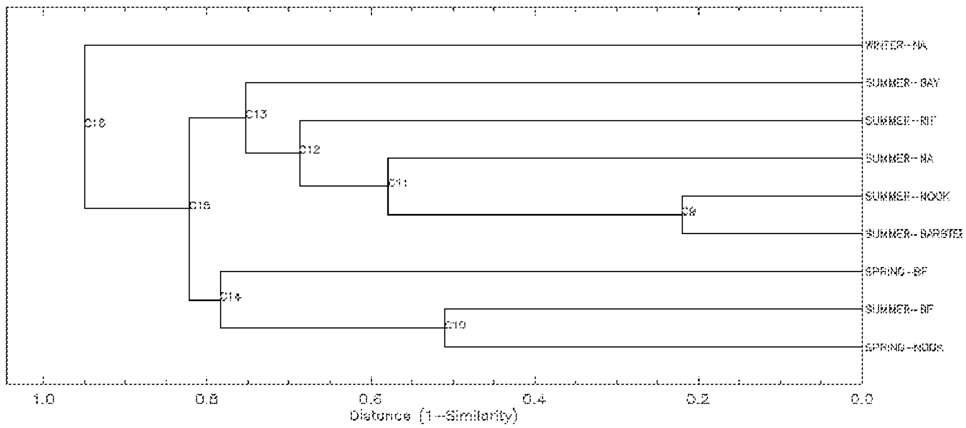
Significant linkages at p<0.02 = C11, C13, C14 (note power was 0.98, 1.00 and 1.00 respectively)

Figure A4-18: SIGTREE Analysis for Fish Community Analysis: All Locations and Dates



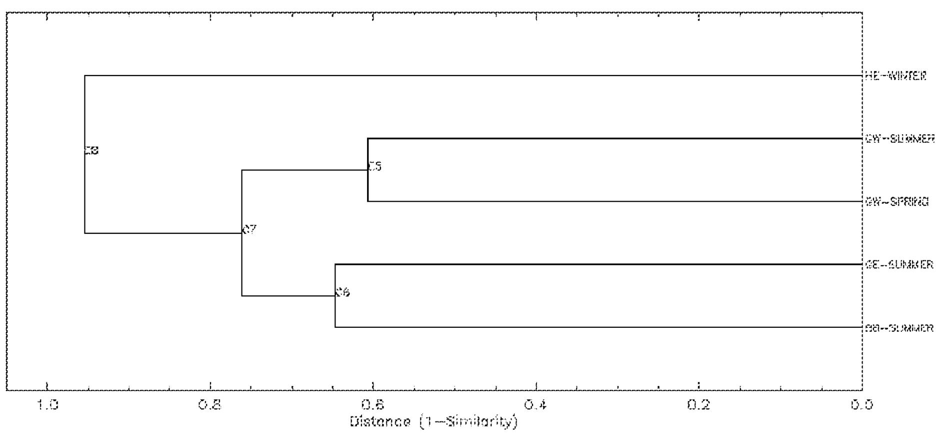
Significant linkages at p<0.01 = C26

Figure A4-19: SIGTREE Analysis for Different Habitat Types and Seasons (All Locations Combined)



Significant linkages at p<0.02 = C12, C14-16

Figure A4-20: SIGTREE Analysis for All Sample Locations and Habitats Combined for Each Season



Significant linkages at p<0.02 = C5, C7, C8

Appendix 5

Standardized Raw Data Tables

Table A5-1 Benthos Raw Data

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 1
Episode	1	1	1	1	1	Totals
Date	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)	5	2	11	11	4	33
F. Baetidae (ny)	1	1	6	2		10
F. Ephemerellidae (ny)	25	9	13	8	2	57
F. Heptageniidae (ny)	38	21	16	30	6	111
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)	5	5	9	6	4	29
F. Chloroperlidae (ny)						
F. Nemouridae (ny)						
F. Perlidae (ny)						
F. Perlodidae (ny)	1	1			2	4
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)			13	2		15
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)						
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)	6	3	3	1		13
F. Leptoceridae (L)						
F. Hydropsychidae (L)	3		1	2		6
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)						
F. Chironomidae (L)	57	20	57	37	14	185
F. Ceratopogonidae (L)						
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)						
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)						
O. Coleoptera (l)						
F. Dytiscidae (ad)	3	3				6
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina		1	1	1		3
Bivalva						
Gastropoda (snails)						
P. Nemata	7	4	5		1	17
P. Nematoda						
S-C. Oligochaeta	85	47	140	71	51	394
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	236	117	275	171	84	883
Total Organisms per m2	2540.36598	1259.41873	2960.17223	1840.68891	904.198062	9504.84392
Mean # organisms per m2	1900.968784					
Standard Deviation	857.2503606					
Total # species	12	12	12	11	8	14
Mean # species	11					
Standard Deviation	1.732050808					

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 2
Episode	2	2	2	2	2	Totals
Date	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)	9	10	8	2	5	34
F. Baetidae (ny)	15	13	12	9	7	56
F. Ephemerellidae (ny)	18	56	30	16	44	164
F. Heptageniidae (ny)	72	90	59	42	44	307
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)	51	47	50	50	29	227
F. Chloroperlidae (ny)						
F. Nemouridae (ny)		1				1
F. Perlidae (ny)						
F. Perlodidae (ny)		3	1	4	1	9
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)	43	57	42	25	36	203
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)	1					1
F. Hydroptilidae (L)						
F. Limnephilidae (L)	1			1		2
F. Lepidostomatidae (L)	1			1		2
F. Leptoceridae (L)						
F. Hydropsychidae (L)	4	1	1	1	1	8
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)						
F. Chironomidae (L)	181	158	150	115	140	744
F. Ceratopogonidae (L)	1		1			2
F. Dixidae (L)	2					2
F. Dolichopodidae (L)						
F. Empididae (L)	3	10	6	2	6	27
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)	1		3	2	1	7
O. Coleoptera (l)						
F. Dytiscidae (ad)	1		1	1		3
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina	2	2	2		1	7
Bivalva						
Gastropoda (snails)						
P. Nemata	17	9	12	6	9	53
P. Nematoda						
S-C. Oligochaeta	40	35	61	64	72	272
O. Homoptera						
F. Corixidae (ad)	1					1
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish				1		1
Fish Fry						
Total # of Organisms	464	492	439	342	396	2133
Total Organisms per m2	4994.61787	5296.01722	4725.5113	3681.37783	4262.64801	22960.1722
Mean # organisms per m2	4592.034446					
Standard Deviation	635.0732515					
Total # species	20	14	16	17	14	23
Mean # species	16.2					
Standard Deviation	2.48997992					

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 3
Episode	3	3	3	3	3	Totals
Date	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)						
F. Baetidae (ny)	41	41	46	51	39	218
F. Ephemerellidae (ny)		2	1	4	3	10
F. Heptageniidae (ny)	65	28	36	35	33	197
F. Leptophlebiidae (ny)					1	1
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)						
F. Chloroperlidae (ny)						
F. Nemouridae (ny)						
F. Perlidae (ny)	1					1
F. Perlodidae (ny)	3	3	1	2	1	10
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)						
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)				1		1
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)			1	1		2
F. Leptoceridae (L)						
F. Hydropsychidae (L)	4	5	8	19	5	41
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)						
F. Chironomidae (L)	172	97	226	275	353	1123
F. Ceratopogonidae (L)						
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)			1	1		2
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)						
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)	1					1
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina	1		1			2
Bivalva						
Gastropoda (snails)						
P. Nemata	2					2
P. Nematoda						
S-C. Oligochaeta	4	6	11	19	8	48
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton	1					1
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish			1			1
Fish Fry						
Total # of Organisms	295	182	333	408	443	1661
Total Organisms per m2	3175.45748	1959.0958	3584.49946	4391.81916	4768.56835	17879.4403
Mean # organisms per m2	3575.888052					
Standard Deviation	1102.572657					
Total # species	11	7	11	10	8	17
Mean # species	9.4					
Standard Deviation	1.816590212					

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 3
Episode	4	4	4	4	4	Totals
Date	25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)	16	12	6	12	8	54
F. Baetidae (ny)				1		1
F. Ephemerellidae (ny)	4	1		5	2	12
F. Heptageniidae (ny)	67	122	29	93	36	347
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)	29	48	19	53	74	223
F. Chloroperlidae (ny)	1			1	1	3
F. Nemouridae (ny)					1	1
F. Perlidae (ny)						
F. Perlodidae (ny)						
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)		2		1	1	4
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)		2		1		3
F. Hydroptilidae (L)						
F. Limnephilidae (L)					1	1
F. Lepidostomatidae (L)						
F. Leptoceridae (L)						
F. Hydropsychidae (L)	13	4	3	9	1	30
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)						
F. Chironomidae (L)	24	7	2	13	11	57
F. Ceratopogonidae (L)	2		1		1	4
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)			1		3	4
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)						
O. Coleoptera (l)						
F. Dytiscidae (ad)	1	1				2
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina						
Bivalva						
Gastropoda (snails)						
P. Nemata						
P. Nematoda						
S-C. Oligochaeta	23	11	8	19	14	75
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	180	210	69	208	154	821
Total Organisms per m2	1937.56728	2260.49516	742.734123	2238.96663	1657.69645	8837.45963
Mean # organisms per m2	1767.491927					
Standard Deviation	623.7887883					
Total # species	10	10	8	11	13	16
Mean # species	10.4					
Standard Deviation	1.816590212					

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 5
Episode	5	5	5	5	5	Totals
Date	22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)	17	9	12	13	17	68
F. Baetidae (ny)	2		10	5	5	22
F. Ephemerellidae (ny)	5	2	2	7	7	23
F. Heptageniidae (ny)	2		2	2	6	12
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)	6	4	6	3	8	27
F. Chloroperlidae (ny)						
F. Nemouridae (ny)						
F. Perlidae (ny)						
F. Perlodidae (ny)						
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)			3	2	8	13
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)						
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)						
F. Leptoceridae (L)						
F. Hydropsychidae (L)						
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)	1					1
F. Chironomidae (L)	42	47	61	50	67	267
F. Ceratopogonidae (L)						
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)						
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)					1	1
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina		1	2			3
Bivalva						
Gastropoda (snails)						
P. Nemata	2	1		6	3	12
P. Nematoda						
S-C. Oligochaeta	12	8	4	10	7	41
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton		1				1
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	89	73	102	98	129	491
Total Organisms per m2	958.019376	785.791173	1097.95479	1054.89774	1388.58988	5285.25296
Mean # organisms per m2	1057.050592					
Standard Deviation	220.785497					
Total # species	9	8	9	9	10	13
Mean # species	9					
Standard Deviation	0.707106781					

Unclear of sampling device
Grab sampler used

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 1
Episode	1	1	1	1	1	Totals
Date	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)	1	1	2			4
F. Baetidae (ny)	1			1		2
F. Ephemerellidae (ny)	1					1
F. Heptageniidae (ny)	8	2	2	2	1	15
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)	2		3	1		6
F. Chloroperlidae (ny)						
F. Nemouridae (ny)						
F. Perlidae (ny)						
F. Perlodidae (ny)						
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)	5		1	1		7
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)				1		1
F. Glossosomatidae (L)					1	1
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)		1				1
F. Leptoceridae (L)						
F. Hydropsychidae (L)	1	2				3
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)						
F. Chironomidae (L)	13	9	3	12	5	42
F. Ceratopogonidae (L)						
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)						
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)						
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina						
Bivalva						
Gastropoda (snails)						
P. Nemata	1			3	1	5
P. Nematoda						
S-C. Oligochaeta	18	12	7	1	5	43
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	51	27	18	22	13	131
Total Organisms per m2	548.977395	290.635091	193.756728	236.813778	139.935414	1410.11841
Mean # organisms per m2	282.0236814					
Standard Deviation	159.1873956					
Total # species	10	6	6	8	5	13
Mean # species	7					
Standard Deviation	2					

Treatment	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 2
Episode	2	2	2	2	2	Totals
Date	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)			1			1
F. Baetidae (ny)	5	2	7	5	6	25
F. Ephemerellidae (ny)	17	15	6	14	27	79
F. Heptageniidae (ny)	38	26	53	26	30	173
F. Leptophlebiidae (ny)					1	1
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)	26	12	19	9	15	81
F. Chloroperlidae (ny)			1			1
F. Nemouridae (ny)				1		1
F. Perlidae (ny)						
F. Perlodidae (ny)	1	1	1	1	1	5
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)	45	11	38	20	49	163
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)						
F. Hydroptilidae (L)				1	1	2
F. Limnephilidae (L)		1				1
F. Lepidostomatidae (L)	5	7	7	8	10	37
F. Leptoceridae (L)						
F. Hydropsychidae (L)	8	3	5	1	26	43
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)						
F. Chironomidae (L)	92	84	138	96	149	559
F. Ceratopogonidae (L)						
F. Dixidae (L)	4	7	2	6	5	24
F. Dolichopodidae (L)						
F. Empididae (L)						
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)		1				1
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina	2	1	2	1	6	12
Bivalva						
Gastropoda (snails)						
P. Nemata	4	5	10	5	2	26
P. Nematoda						
S-C. Oligochaeta	9	11	23	20	26	89
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea		1				1
Fish						
Fish Fry						
Total # of Organisms	256	188	313	214	354	1325
Total Organisms per m2	2755.65124	2023.68138	3369.21421	2303.55221	3810.54898	14262.648
Mean # organisms per m2	2852.529602					
Standard Deviation	738.6668876					
Total # species	13	16	15	15	15	21
Mean # species	14.8					
Standard Deviation	1.095445115					

Treatment	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 3
Episode	3	3	3	3	3	Totals
Date	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)						
F. Baetidae (ny)	4	2	1	4	3	14
F. Ephemerellidae (ny)	1	4	1	4		10
F. Heptageniidae (ny)	11	3		2	4	20
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)				1		1
O. Plecoptera (ny)						
F. Capniidae (ny)						
F. Chloroperlidae (ny)						
F. Nemouridae (ny)						
F. Perlidae (ny)						
F. Perlodidae (ny)		2			2	4
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)						
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)						
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)	4	2		2		8
F. Leptoceridae (L)						
F. Hydropsychidae (L)	5	2	3	3	3	16
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)						
F. Chironomidae (L)	160	106	115	210	138	729
F. Ceratopogonidae (L)						
F. Dixidae (L)		1		1		2
F. Dolichopodidae (L)						
F. Empididae (L)						
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)						
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina					1	1
Bivalva						
Gastropoda (snails)						
P. Nemata				1		1
P. Nematoda						
S-C. Oligochaeta	4	3	6	11	9	33
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton	1					1
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	190	125	126	239	160	840
Total Organisms per m2	2045.2099	1345.53283	1356.29709	2572.65877	1722.28202	9041.98062
Mean # organisms per m2	1808.396125					
Standard Deviation	516.2920109					
Total # species	8	9	5	10	7	15
Mean # species	7.8					
Standard Deviation	1.923538406					

Treatment	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 4
Episode	4	4	4	4	4	Totals
Date	25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)	3	1	3	2		9
F. Baetidae (ny)	1	4	4	4	1	14
F. Ephemerellidae (ny)	5	9	5	10	6	35
F. Heptageniidae (ny)	4	7	9	5	6	31
F. Leptophlebiidae (ny)				1		1
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)	2		2	2	2	8
F. Chloroperlidae (ny)						
F. Nemouridae (ny)		1		1		2
F. Perlidae (ny)						
F. Perlodidae (ny)						
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)	1	2	2	2	2	9
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)		2	1	1		4
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)	1		1		2	4
F. Leptoceridae (L)						
F. Hydropsychidae (L)	10	25	10	8	12	65
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)						
F. Chironomidae (L)	228	91	129	121	142	711
F. Ceratopogonidae (L)	1					1
F. Dixidae (L)	2			2	3	7
F. Dolichopodidae (L)						
F. Empididae (L)						
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)	1		1			2
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina						
Bivalva						
Gastropoda (snails)						
P. Nemata	2	1	1		2	6
P. Nematoda						
S-C. Oligochaeta	3				1	4
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	264	143	168	159	179	913
Total Organisms per m2	2841.76534	1539.28956	1808.39612	1711.51776	1926.80301	[illegible]
Mean # organisms per m2	1965.55436					
Standard Deviation	509.9466472					
Total # species	14	10	12	12	11	17
Mean # species	11.8					
Standard Deviation	1.483239697					

Treatment	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 5
Episode	5	5	5	5	5	Totals
Date	22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)	5	1		1	1	8
F. Baetidae (ny)	7	7	5	6	12	37
F. Ephemerellidae (ny)	1	3		2	3	9
F. Heptageniidae (ny)	3		2	5	6	16
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)	2	3	7	4	3	19
F. Chloroperlidae (ny)						
F. Nemouridae (ny)				1		1
F. Perlidae (ny)						
F. Perlodidae (ny)		1				1
F. Leuctridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)	1	2	4	5	2	14
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)						
F. Hydroptilidae (L)					1	1
F. Limnephilidae (L)						
F. Lepidostomatidae (L)		1				1
F. Leptoceridae (L)						
F. Hydropsychidae (L)		1		2	1	4
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (l)						
F. Chironomidae (L)	55	49	66	69	43	282
F. Ceratopogonidae (L)						
F. Dixidae (L)			1	2	1	4
F. Dolichopodidae (L)						
F. Empididae (L)						
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)				1	1	2
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina	3	1		1		5
Bivalva						
Gastropoda (snails)						
P. Nemata	2	2	6	9	6	25
P. Nematoda						
S-C. Oligochaeta	31	28	15	24	11	109
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	110	99	106	132	91	538
Total Organisms per m2	1184.06889	1065.662	1141.01184	1420.88267	979.547901	[illegible]
Mean # organisms per m2	1158.234661					
Standard Deviation	166.1675847					
Total # species	10	12	8	14	13	17
Mean # species	11.4					
Standard Deviation	2.408318916					

Unclear of sampling device
Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drive s\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010 \1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode 1	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode 2	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode 3	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode 4	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode 5
Episode	1	1	1	1	1	Totals	2	2	2	2	2	Totals	3	3	3	3	3	Totals	4	4	4	4	4	Totals	5	5	5	5	5	Totals
Date	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04		9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04		16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06		25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07		22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar		Big Bar	Big Bar	Big Bar	Big Bar	Big Bar		Big Bar	Big Bar	Big Bar	Big Bar	Big Bar		Big Bar	Big Bar	Big Bar	Big Bar	Big Bar		Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)																														
Substrate																														
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)	1	1				2	2	1	6	2	2	13							1			1	4	6	9	7	3	8	5	32
F. Baetidae (ny)							2		2			4	2	1	3	3	2	11			1			1	2	4	3	3	1	13
F. Ephemerellidae (ny)	1	11	5	7	3	27	10	8	2	9	7	36	4				2	6	5	2	8	8	2	25	2	1	3	2		8
F. Heptageniidae (ny)		7	5	2	2	16	2	1	1	1	1	6	18	6	12	8	9	53	1	1	3	2	2	9	6	3	5	5	4	23
F. Leptophlebiidae (ny)																						2		2						
F. Tricorythidae (ny)													1		2		1	4							1					1
O. Plecoptera (ny)																														
F. Capniidae (ny)		1	1	4		6	5	1			2	8							1		1	1	1	4	6	1	2	1	4	14
F. Chloroperlidae (ny)																						1		1						
F. Nemouridae (ny)														1	1			2										1		1
F. Perlidae (ny)																														
F. Perlodidae (ny)								1	1			2																		
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)		1	1			2	3	1		2										1	4		2	7	1	1	1			3
O. Trichoptera (L)																														
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)			1			1									1	1		2					2	2						
F. Hydroptilidae (L)										1		1																		
F. Limnephilidae (L)																						1		1						
F. Lepidostomatidae (L)		1	1		1	3	1	1		1	2	5	2	2				4		1		1		2			1			1
F. Leptoceridae (L)																														
F. Hydropsychidae (L)	2		1		1	4	2	1				3	2					2	7	5	8	17	5	42	2		1		1	4
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)																														
F. Chironomidae (L)	11	44	42	45	31	173	65	53	26	82	85	311	221	264	337	303	235	1360	60	81	51	146	43	381	37	29	48	54	45	213
F. Ceratopogonidae (L)								1				1																		
F. Dixidae (L)																														
F. Dolichopididae (L)																														
F. Empididae (L)		1				1	6	4		2	6	18			1	1	1	3	3	4	2	7	5	21			1			1
F. Simuliidae (L)								1				1																		
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)								3		1		4								2				2				2	1	3
O. Coleoptera (l)																														
F. Dytiscidae (ad)		8				8					1	1										1		1						
F. Dytiscidae (ny)																														
F. Elmidae (l)	1					1													1					1						
F. Hydraenidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)																														
O. Mysidacae																														
O. Acarina										1		1				1		1			1			1		1	1			2
Bivalva																														
Gastropoda (snails)																														
P. Nemata		4	1	3	4	12	4	2			2	8			1	2	1	4	2	1	3	3	2	11	1	1	6	2	2	12
P. Nematoda																														
S-C. Oligochaeta	11	25	12	12	9	69	101	92	32	68	83	376	16	20	19	14	13	82	5	6	6	14	5	36	42	90	116	74	233	555
O. Homoptera																														
F. Corixidae (ad)																														
F. Corixidae (ny)																														
Zooplankton														1				1												
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea							1					1								1				1						
Fish																														
Fish Fry																					1			1						
Total # of Organisms	27	104	70	73	51	325	204	171	70	170	191	800	266	295	377	333	264	1535	86	105	89	205	73	558	109	138	191	152	296	886
Total Organisms per m2	290.635091	1119.48332	753.498385	785.791173	548.977395	3498.38536	2195.90958	1840.68891	753.498385	1829.92465	2055.97417	8675.99569	2863.29386	3175.45748	4058.12702	3584.49946	2841.76534	16523.1432	925.726588	1130.24758	958.019376	2206.67384	785.791173	6006.45856	1173.30463	1485.46825	2055.97417	1636.16792	3186.22174	9537.13671
Mean # organisms per m2	699.6770721						1735.199139						3304.628633						1201.291712						1907.427341					
Standard Deviation	306.8286935						569.8657984						517.6368154						575.2388119						782.2960742					
Total # species	6	11	10	6	7	14	13	15	7	11	10	19	8	7	9	8	8	14	10	11	12	14	11	22	11	10	13	10	9	18
Mean # species	8						11.2						8						11.6						10.6					
Standard Deviation	2.34520788						3.033150178						0.707106781						1.516575089						1.516575089					

Unclear of sampling device
Grab sampler used

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Table A5-1 Benthos Raw Data (con't)

Treatment	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Episode 1	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Episode 2	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Episode 3	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Episode 4	Ref 3	Ref 3	Ref 3	Ref	3 Ref 3	Episode 5
Episode	1	1	1	1	1	Totals	2	2	2	2	2	Totals	3	3	3	3	3	Totals	4	4	4	4	4	Totals	5	5	5	5	5	Totals
Date	28-Oct-04	28-Oct-04	28-Oct-04	28-Oct-04	28-Oct-04		9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04		16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06		25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07		22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07	
Site	Big Bar	Big Bar	Big Bar	Big Bar	Big Bar		Big Bar	Big Bar	Big Bar	Big Bar	Big Bar		Big Bar	Big Bar	Big Bar	Big Bar	Big Bar		Big Bar	Big Bar	Big Bar	Big Bar	Big Bar		Big Bar	Big Bar	Big Bar	Big Bar	Big Bar	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)																														
Substrate																														
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)	1	2	1	2		6	1	1	1	1		4							3	1	2	3	1	10	6	6	7	6	7	32
F. Baetidae (ny)	1	3	1			5	2	5	7	5	8	27	4	2	4	5	3	18		1	1		2	4	4		8	4	4	20
F. Ephemerellidae (ny)	7	3	3	8	1	22	12	22	16	38	13	101	1	2		2	1	6		1		1		2		1	8	3	3	15
F. Heptageniidae (ny)	7	10	6	9	1	33	25	81	78	53	62	299	3	1	5	33	7	49	4		1		1	6	2	1	7	2	2	14
F. Leptophlebiidae (ny)								4	2	3		9																		
F. Tricorythidae (ny)														1				1												
O. Plecoptera (ny)																														
F. Capniidae (ny)	3	4	3		3	13	9	25	11	28	18	91							2	2			4	8	2	2		2	1	7
F. Chloroperlidae (ny)										1		1																		
F. Nemouridae (ny)							1			1		2				1		1											2	2
F. Perlidae (ny)																														
F. Perlodidae (ny)							1	1			3	5					1	1												
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)	3	2		2	2	9	18	21	20	26	24	109							2					2	4		3	1	3	11
O. Trichoptera (L)																														
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)								2		2	1	5										2		2						
F. Hydroptilidae (L)																														
F. Limnephilidae (L)							1					1																		
F. Lepidostomatidae (L)					1	1	7	21	1	19	5	53																		
F. Leptoceridae (L)																														
F. Hydropsychidae (L)	1	2				3	1	11	4	15	2	33				5	1	6	2	2	3	19	7	33			1			1
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)																														
F. Chironomidae (L)	38	14	21	17	7	97	89	45	54	92	101	381	95	94	94	57	51	391	85	20	35	54	36	230	16	17	15	39	20	107
F. Ceratopogonidae (L)																			1					1						
F. Dixidae (L)																														
F. Dolichopodidae (L)																														
F. Empididae (L)							11	8	6	10	5	40	2	1				3	5	2	4	7	8	26	1	1	2			4
F. Simuliidae (L)																														
F. Psychodidae (L)										1		1																		
F. Tanyderidae (L)																														
F. Tipulidae (L)											1	1							1		1			2						
O. Coleoptera (l)																														
F. Dytiscidae (ad)	1				1	2		2	1	1		4														3			1	4
F. Dytiscidae (ny)													1					1												
F. Elmidae (l)																						1		1						
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)		1				1																								
O. Mysidacae																														
O. Acarina		1		2		3		1	2	3	2	8													1					1
Bivalva																														
Gastropoda (snails)																														
P. Nemata	1	1	1	1		4	2	2	2	6	1	13	4	1	2		4	11	4		2	1	3	10	2	2	2	1	3	10
P. Nematoda																														
S-C. Oligochaeta	27	22	12	21	57	139	24	18	19	20	16	97	6	7	5	4	1	23	5	2	1	11		19	31	6	16	18	18	89
O. Homoptera																														
F. Corixidae (ad)							1					1																		
F. Corixidae (ny)																														
Zooplankton					1	1																								
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea								1				1																		
Fish																														
Fish Fry																														
Total # of Organisms	90	65	48	62	74	339	205	271	224	325	262	1287	116	109	110	107	69	511	114	31	50	99	62	356	69	39	69	76	64	317
Total Organisms per m2	968.783638	699.677072	516.684607	667.384284	796.555436	3649.08504	2206.67384	2917.11518	2411.19483	3498.38536	2820.23681	13853.606	1248.65447	1173.30463	1184.06889	1151.7761	742.734123	5500.53821	1227.12594	333.692142	538.213132	1065.662	667.384284	3832.0775	742.734123	419.806243	742.734123	818.083961	688.912809	3412.27126
Mean # organisms per m2			729.8170075						2770.721206						1100.107643						766.4155005						682.4542519			
Standard Deviation			167.1756182						500.1966496						203.0141077						371.1251767						153.8574284			
Total # species	11	12	8	8	9	15	16	18	15	19	15	24	8	8	5	7	8	12	11	8	9	9	8	15	10	9	10	9	11	14
Mean # species			9.6						16.6						7.2						9						9.8			
Standard Deviation			1.816590212						1.816590212						1.303840481						1.224744871						0.836660027			

Unclear of sampling device
Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drive s\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010 \1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

Table A5-1 Benthos Raw Data (con't)

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 1	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 2	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 3	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 4	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 5
Episode	1	1	1	1	1	Totals	2	2	2	2	2	Totals	3	3	3	3	3	Totals	4	4	4	4	4	Totals	5	5	5	5	5	Totals
Date	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04		9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04		16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06		26-Feb-07	26-Feb-07	26-Feb-07	26-Feb-07	26-Feb-07		19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	
Site	Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)																														
Substrate																														
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)	35	11	3	9	13	71	13	12	14	20	19	78							2	5	6	5	7	25	11	7	1	4	1	24
F. Baetidae (ny)								3		1		4		1	3	2		6				1		1	1	1	1			3
F. Ephemerellidae (ny)	3	2		1	1	7	19	28	20	44	29	140			1	1	1	3	1		1			2	6	2				8
F. Heptageniidae (ny)	2				2	4	7	9	4	12	8	40	8	5	4	6	1	24	1	3		6		10				1		1
F. Leptophlebiidae (ny)											1	1				1		1												
F. Tricorythidae (ny)																														
O. Plecoptera (ny)																														
F. Capniidae (ny)			1	1	2	4	2	4	2	3	1	12							1		1		1	3	4	2	3	2	1	12
F. Chloroperlidae (ny)																						1		1						
F. Nemouridae (ny)																														
F. Perlidae (ny)																														
F. Perlodidae (ny)									1			1													1					1
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)							1	3	2	4	3	13																		
O. Trichoptera (L)													1					1												
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)																1	1	2												
F. Hydroptilidae (L)																														
F. Limnephilidae (L)								1				1																		
F. Lepidostomatidae (L)	1					1				3	1	4				1	1	2	1		1	2		4						
F. Leptoceridae (L)																														
F. Hydropsychidae (L)			1			1	1		1	4		6				2	2	4												
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)											1	1																		
F. Chironomidae (L)	15	68	46	17	19	165	61	75	63	100	64	363	51	65	79	81	127	403	445	329	509	428	480	2191	24	12	11	10	15	72
F. Ceratopogonidae (L)	1		1			2	1	2		1	2	6																		
F. Dixidae (L)																														
F. Dolichopodidae (L)																														
F. Empididae (L)							7	8	7	9	16	47					1	1	2	1		2		5						
F. Simuliidae (L)																														
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)							1		1			2																		
O. Coleoptera (l)																														
F. Dytiscidae (ad)	2					2	1	2		1	2	6							1					1						
F. Dytiscidae (ny)															1			1												
F. Elmidae (l)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)																				1				1						
O. Mysidacae																														
O. Acarina				1		1	1	1	5	4	2	13					1	1												
Bivalva																														
Gastropoda (snails)																														
P. Nemata				1	1	2	10	4	5	5	7	31					3	3	3	1	1		1	6	1	2				3
P. Nematoda																														
S-C. Oligochaeta	76	35	43	14	47	215	207	211	168	366	211	1163	2	1	1	6	8	18	110	26	62	35	42	275	43	12	8	18	14	95
O. Homoptera																														
F. Corixidae (ad)		2				2													1		1			2						
F. Corixidae (ny)																														
Zooplankton	1					1									1			1	1	8	3	1		13						
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea	1		1		1	3				1		1			1			1												
Fish																									1					1
Fish Fry								1				1	1					1												
Total # of Organisms	137	118	96	44	86	481	332	364	293	578	367	1934	63	72	91	101	146	473	569	374	585	481	531	2540	92	38	24	35	31	220
Total Organisms per m2	1474.70398	1270.18299	1033.36921	473.627557	925.726588	5177.61033	3573.7352	3918.1916	3153.92896	6221.74381	3950.48439	20818.084	678.148547	775.026911	979.547901	1087.19053	1571.58235	5091.49623	6124.86545	4025.83423	6297.09365	5177.61033	5715.82347	27341.2271	990.312164	409.041981	258.342304	376.749193	333.692142	2368.13778
Mean # organisms per m2			1035.522067						4163.616792						1018.299247						5468.245425						473.6275565			
Standard Deviation			379.3849061						1194.673134						349.0178334						914.3922748						294.2997441			
Total # species	10	5	7	7	8	15	14	15	13	16	15	22	5	4	8	9	10	17	12	8	9	9	5	15	9	7	5	5	4	10
Mean # species			7.4						14.6						7.2						8.6						6			
Standard Deviation			1.816590212						1.140175425						2.588435821						2.50998008						2			

Unclear of sampling device
Grab sampler used

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 1	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 2	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 3	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 4	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Episode 5
Episode	1	1	1	1	1	Totals	2	2	2	2	2	Totals	3	3	3	3	3	Totals	4	4	4	4	4	Totals	5	5	5	5	5	Totals
Date	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04		9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04		16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06		26-Feb-07	26-Feb-07	26-Feb-07	26-Feb-07	26-Feb-07		19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	
Site	Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)																														
Substrate																														
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)		1	2	3		6	1	1		1	2	5							7	1	1	4	2	15	2	4	1	1	3	11
F. Baetidae (ny)					1	1	6	11	6	5	3	31	13	6	15	24	17	75	9	10	13	4	23	59	1	5		4	8	18
F. Ephemerellidae (ny)				1	1	2	42	51	50	47	23	213		3	3			6		2	1			3	10	9	2	13	8	42
F. Heptageniidae (ny)	3	1	2	14	11	31	43	55	82	66	42	288	35	34	36	19	54	178	48	33	12	17	22	132	3	8	2	8	2	23
F. Leptophlebiidae (ny)									1	1		2									1			1						
F. Tricorythidae (ny)															1	1		2												
O. Plecoptera (ny)																														
F. Capniidae (ny)	5	10	3	2	7	27	9	9	21	6	4	49							8	4	1	2	4	19	4	5	1	2	4	16
F. Chloroperlidae (ny)																														
F. Nemouridae (ny)	1					1				1		1							1	1				2						
F. Perlidae (ny)																														
F. Perlodidae (ny)							1	2	2	2		7	2					2							2	1				3
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)		1	1			2	75	77	92	55	59	358							3	5		2	2	12	5	4		2	6	17
O. Trichoptera (L)																														
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)							1		1			2													1					1
F. Hydroptilidae (L)										1	1	2																		
F. Limnephilidae (L)																										1				1
F. Lepidostomatidae (L)			2	2	3	7	3	2	4	5	4	18	1	2	1	1	2	7	1	2		1		4	1	1		1		3
F. Leptoceridae (L)																														
F. Hydropsychidae (L)							12	22	13	14	8	69							9		4	4	9	26	1					1
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)																														
F. Chironomidae (L)	12	7		18	26	63	53	38	49	60	41	241	159	103	126	83	133	604	1200	952	906	1020	1448	5526	80	89	50	45	80	344
F. Ceratopogonidae (L)																														
F. Dixidae (L)																														
F. Dolichopididae (L)																														
F. Empididae (L)							6	4	10	9	2	31									2			2		1		1		2
F. Simuliidae (L)							1					1																		
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)																													2	2
O. Coleoptera (l)																														
F. Dytiscidae (ad)		1				1									1			1								2	1			3
F. Dytiscidae (ny)																1		1												
F. Elmidae (l)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)																							13	13						
O. Mysidacae																														
O. Acarina				1		1		3	3	5	2	13		1				1		1				1					2	2
Bivalva																														
Gastropoda (snails)																														
P. Nemata							8	1	10	2		21		1	1	1		3	3	1	7	4	6	21	2	1			2	5
P. Nematoda																														
S-C. Oligochaeta	27	11	15	26	9	88	35	26	49	25	37	172	7	1	5	8	10	31	11	9	7	10	6	43	68	45	30	60	38	241
O. Homoptera																														
F. Corixidae (ad)																														
F. Corixidae (ny)																														
Zooplankton																							1	1	1					1
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea								1				1																		
Fish														1				1												
Fish Fry																														
Total # of Organisms	48	32	25	67	58	230	296	303	393	305	228	1525	217	152	189	138	216	912	1300	1021	955	1068	1536	5880	181	176	87	137	155	736
Total Organisms per m2	516.684607	344.456405	269.106566	721.205597	624.327234	2475.78041	3186.22174	3261.57158	4230.35522	3283.10011	2454.25188	16415.5005	2335.84499	1636.16792	2034.44564	1485.46825	2325.08073	9817.00753	13993.5414	10990.3122	10279.8708	11496.2325	16533.9074	63293.8644	1948.33154	1894.51023	936.49085	1474.70398	1668.46071	7922.49731
Mean # organisms per m2			495.1560818						3283.100108						1963.401507						12658.77287						1584.499462			
Standard Deviation			188.4514682						631.2944088						390.5365871						2578.406054						408.5034129			
Total # species	5	7	6	8	7	12	15	15	15	17	13	20	6	9	9	8	5	13	11	12	11	10	11	17	14	14	7	10	11	19
Mean # species			6.6						15						7.4						11						11.2			
Standard Deviation			1.140175425						1.414213562						1.816590212						0.707106781						2.949576241			

Unclear of sampling device
Grab sampler used

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode Totals	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode 2 Totals	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode 3 Totals	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode 4 Totals	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Episode 5 Totals
Episode	1	1	1	1	1		2	2	2	2	2		3	3	3	3	3		4	4	4	4	4		5	5	5	5	5	
Date	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04		9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04		16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-	6	25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07		19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	
Site	Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)																														
Substrate																														
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)	4	3	4	1		12	1	5	12	2	4	24							7	5	2	4	4	22			1	1	1	3
F. Baetidae (ny)			2			2	13	9	18	4	10	54	14		1	1	2	18			1			1			1			1
F. Ephemerellidae (ny)	1	1	1	1	4	8	19	33	36	30	28	146	3	4		3		10	1	1	1	3	1	7			1	2	1	4
F. Heptageniidae (ny)	6	11	6	5	19	47	24	66	46	50	43	229	20	5	11	2	4	42	2	1	1	2	3	9						
F. Leptophlebiidae (ny)							1					1																		
F. Tricorythidae (ny)															1		2	3												
O. Plecoptera (ny)																														
F. Capniidae (ny)	4	2	1	5	4	16	12	13	11	6	10	52																		
F. Chloroperlidae (ny)																														
F. Nemouridae (ny)									1			1																		
F. Perlidae (ny)																														
F. Perlodidae (ny)								1		1		2	3	2	1		3	9												
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)	3	6	4	3	1	17	53	51	69	35	47	255											1	1				1		1
O. Trichoptera (L)																	2	2												
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)								2	1	2	3	8	1	1	2			4	1					1						
F. Hydroptilidae (L)								1		1		2																		
F. Limnephilidae (L)											1	1										1		1						
F. Lepidostomatidae (L)	1					1		4	7	3	8	22	2		2	1	2	7	1	1				2			1			1
F. Leptoceridae (L)																														
F. Hydropsychidae (L)					1	1	8	17	8	5	8	46	16	5	5	1	2	29	5	9	2	2	7	25						
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)																														
F. Chironomidae (L)	10	15	8	7	30	70	25	29	17	35	30	136	186	158	225	113	139	821	68	63	49	73	68	321	10	3	9	10	22	54
F. Ceratopogonidae (L)																														
F. Dixidae (L)																														
F. Dolichopodidae (L)																														
F. Empididae (L)							4	1	2	5		12	3	1		1		5	2					2						
F. Simuliidae (L)																														
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)															2			2												
O. Coleoptera (l)																														
F. Dytiscidae (ad)		1				1											1	1												
F. Dytiscidae (ny)													1				1	2												
F. Elmidae (l)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)																							1	1					1	1
O. Mysidacae																														
O. Acarina								2	5	1	1	9																		
Bivalve																														
Gastropoda (snails)																														
P. Nemata	2			2	1	5	4	3		7	3	17	2		2	2	1	7			2	1		3						
P. Nematoda																														
S.C. Oligochaeta	8	8	15	10	12	53	20	27	20	22	15	104	9	25	8	10	7	59	2	24	5	13	15	59	23	31	5		27	86
O. Hemiptera																														
F. Corixidae (ad)																														
F. Corixidae (ny)																														
Zooplankton									1			1				1		1							1					1
Invertebrate (term)																														
Invertebrate Eggs																														
Hirudinea					1	1		1				1																		
Fish							1					1																		
Fish Fry																														
Total # of Organisms	39	47	41	34	73	234	185	265	254	209	211	1124	260	201	260	135	166	1022	89	104	63	99	100	455	34	34	18	14	52	152
Total Organisms per m2	419.806243	505.920344	441.334769	365.98493	785.791173	2518.83746	1991.38859	2852.5296	2734.12271	2249.73089	2271.25942	12099.0312	2798.70829	2163.61679	2798.70829	1453.17546	1786.8676	11001.0764	958.019376	1119.48332	678.148547	1065.662	1076.42626	4897.7395	365.98493	365.98493	193.756728	150.699677	559.741658	1636.16792
Mean # organisms per m2	503.7674919						2419.806243						2200.215285						979.547901						327.2335845					
Standard Deviation	165.4337951						360.755394						601.3842393						178.6673054						162.8217042					
Total # Species	9	8	8	8	9	13	13	17	15	16	14	22	12	8	11	10	12	17	9	7	8	8	8	14	3	2	6	4	5	9
Mean # Species	8.4						15						10.6						8						4					
Standard Deviation	0.547722558						1.58113883						1.673320053						0.707106781						1.58113883					

Unclear of sampling device
Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drives\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010\1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Episode 1	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Episode 2	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Episode 3	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Episode 4	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Episode 5
Episode	1	1	1	1	1	Totals	2	2	2	2	2	Totals	3	3	3	3	3	Totals	4	4	4	4	4	Totals	5	5	5	5	5	Totals
Date	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04		9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04		16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06		25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07	25-Jan-07		19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	
Site	Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East		Gill East	Gill East	Gill East	Gill East	Gill East	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)																														
Substrate																														
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)			4	2		6			1	3		4							5	3	2	6	3	19	2		4	1	4	11
F. Baetidae (ny)							5	2	3	5	5	20	8	12	21	4	1	46										1		1
F. Ephemerellidae (ny)	17	1	1	3	1	23	43	46	23	42	52	206		1		2	1	4	4	11	26	25	4	70				1		1
F. Heptageniidae (ny)	12	4	3	2	2	23	54	15	50	35	34	188	34	38	52	38	13	175	4	10	16	21	4	55						
F. Leptophlebiidae (ny)							4					4		1				1	1		1			2						
F. Tricorythidae (ny)													2	3		1		6				1		1						
O. Plecoptera (ny)																														
F. Capniidae (ny)	1	1		4	1	7	16	2	5	13	14	50							2	4	6	1	4	17						
F. Chloroperlidae (ny)							1					1																		
F. Nemouridae (ny)										1		1			1			1												
F. Perlidae (ny)																1		1												
F. Perlodidae (ny)								2	1	1	1	5		2	4	3	3	12												
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)	4		1	2	1	8	79	26	41	52	45	243														1				1
O. Trichoptera (L)														1				1												
O. Trichoptera (P)																			1					1						
F. Brachycentridae (L)																														
F. Glossosomatidae (L)							1	3	3		4	11	2			2		4	1			4	2	7						
F. Hydroptilidae (L)			1			1				1		1																		
F. Limnephilidae (L)										1		1								1	1			2						
F. Lepidostomatidae (L)	3		1	2		6	6	1	4	2	5	18	2	1	6	4	4	17	2	3	6	2		13						
F. Leptoceridae (L)																														
F. Hydropsychidae (L)	1	1		1		3	18	23	8	10	23	82	4	9	25	19	3	60	12	7	15	14	5	53						
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)																														
F. Chironomidae (L)	13	13	8	19	10	63	44	71	29	44	59	247	98	157	126	130	81	592	86	212	163	124	68	653	42	18	15	19	29	123
F. Ceratopogonidae (L)																														
F. Dixidae (L)																														
F. Dolichopididae (L)																														
F. Empididae (L)	1	1	1			3	3	23	12	6	7	51		1	1	1		3		5	6	7	3	21	1					1
F. Simuliidae (L)																														
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)																			1	1				2			1		3	4
O. Coleoptera (l)																														
F. Dytiscidae (ad)		1	1		1	3																								
F. Dytiscidae (ny)													3	1			2	6												
F. Elmidae (l)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)								1				1																		
O. Mysidacae																														
O. Acarina							4		7	2	4	17	2	1	1	1	2	7												
Bivalva																														
Gastropoda (snails)																														
P. Nemata	3	1	1		3	8	6	4	5	4	11	30	1	1		3		5	1	2	12	9	6	30	1	2		1		4
P. Nematoda																														
S-C. Oligochaeta	14	26	8	16	21	85	9	72	11	7	15	114	2	15	19	5	3	44	5	13	20	9	3	50	23	7	3	10	14	57
O. Homoptera																														
F. Corixidae (ad)																														
F. Corixidae (ny)																														
Zooplankton																													1	1
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea			1			1					2	2																		
Fish														1				1												
Fish Fry																														
Total # of Organisms	69	49	31	51	40	240	293	291	203	229	281	1297	158	245	256	214	113	986	125	272	274	223	102	996	69	28	23	33	51	204
Total Organisms per m2	742.734123	527.44887	333.692142	548.977395	430.570506	2583.42304	3153.92896	3132.40043	2185.14532	2465.01615	3024.7578	13961.2487	1700.7535	2637.24435	2755.65124	2303.55221	1216.36168	10613.563	1345.53283	2927.87944	2949.40797	2400.43057	1097.95479	10721.2056	742.734123	301.399354	247.578041	355.220667	548.977395	2195.90958
Mean # organisms per m2			516.6846071						2792.249731						2122.712594						2144.241119						439.181916			
Standard Deviation			152.6097619						440.5201335						651.4558078						874.7379201						204.2942486			
Total # species	10	9	12	9	8	14	15	14	15	17	15	22	11	16	10	14	10	19	13	12	12	12	10	16	5	4	4	6	5	10
Mean # species			9.6						15.2						12.2						11.8						4.8			
Standard Deviation			1.516575089						1.095445115						2.683281573						1.095445115						0.836660027			

Unclear of sampling device
Grab sampler used

Table A5-1 Benthos Raw Data (con't)

Treatment	REF 4	REF 4	REF 4	REF 4	REF 4	Episode 1 Totals	REF 4	REF 4	REF 4	REF 4	REF 4	Episode 2 Totals	REF 4	REF 4	REF 4	REF 4	REF 4	Episode 3 Totals	REF 4	REF 4	REF 4	REF 4	REF 4	Episode 4 Totals	REF 5	REF 5	REF 5	REF 5	REF 5	Episode 1 Totals
Episode	1	1	1	1	1		2	2	2	2	2		3	3	3	3	3		4	4	4	4	4		1	1	1	1	1	
Date	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04		16-Mar-05	16-Mar-05	16-Mar-05	16-Mar-05	16-Mar-05		16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05		19-Dec-05	19-Dec-05	19-Dec-05	19-Dec-05	19-Dec-05		9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	
Site	Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (m/s)	<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		1m/sec	1m/sec	1m/sec	1m/sec	1m/sec		<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		1m/sec	1m/sec	1m/sec	1m/sec	1m/sec	
Substrate	Course Gravel	Course Gravel	Course Gravel	Course Gravel	Course Gravel		Course Gravel	Course Gravel	Course Gravel	Course Gravel	Course Gravel		course gravel and cobble	course gravel and cobble	course gravel and cobble	course gravel and cobble	course gravel and cobble		course gravel and cobble	course gravel and cobble	course gravel and cobble	course gravel and cobble	course gravel and cobble		course gravel small cobble	course gravel small cobble	course gravel small cobble	course gravel small cobble	course gravel small cobble	
O. Ephemeroptera (ny)																										1				1
F. Ameletidae (ny)							1		1			2	3	1			1	5								2			1	3
F. Baetidae (ny)		1	5	2	2	10													2		2	2	1	7	9	10	14	10	10	53
F. Ephemerellidae (ny)	2	3	5	3	3	16		1				1			1		1	2	2	1		3	2	8	20	19	38	14	20	111
F. Heptageniidae (ny)	6	3	10	6	6	31			1		3	4		2	3	2	2	9	4	2	2		4	12	14	7	9	9	3	42
F. Leptophlebiidae (ny)																														
F. Tricorythidae (ny)																														
O. Plecoptera (ny)																									1		3	1		5
F. Capniidae (ny)	4	5	8	18	7	42	1				1	2										3	1	4	3	4	11	8	5	31
F. Chloroperlidae (ny)																1		1												
F. Nemouridae (ny)																			1					1						
F. Perlidae (ny)																														
F. Perlodidae (ny)	1					1							1					1							1			2		3
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)	8	12	8	14	12	54			1			1							1	2	1	2	1	7	73	58	60	51	36	278
O. Trichoptera (L)																														
O. Trichoptera (P)																							1	1			1		1	2
F. Brachycentridae (L)																														
F. Glossosomatidae (L)					1	1													1	1			1	3		1				1
F. Hydroptilidae (L)																														
F. Limnephilidae (L)																														
F. Lepidostomatidae (L)				1	1	2			1			1	4					4	1				1	2	1	1	3			5
F. Leptoceridae (L)																														
F. Hydropsychidae (L)	1		1			2		1				1								4	1	2	2	9	5	5	8	3		21
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (P)																														
F. Chironomidae (L)	21	24	17	18	11	91	3		1			4	115	77	69	56	54	371	20	14	21	54	33	142	24	31	53	28	30	166
F. Ceratopogonidae (L)																														
F. Dixidae (L)																														
F. Dolichopodidae (L)																	1	1												
F. Empididae (L)		2	2	1	7	12			1			1													1	1	2	3	3	10
F. Simuliidae (L)																														
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)																			1					1						
O. Coleoptera (l)																														
F. Dytiscidae (ad)																														
F. Dytiscidae (ny)													1	1			3	5									1			1
F. Elmidae (l)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)			1	1		2										1		1									1		4	5
O. Mysidacae																														
O. Acarina																														
Bivalva																														
Gastropoda (snails)																														
P. Nemata																														
P. Nematoda	2	2		2	4	10				1		1		1				1	3	1	1	2		7		6	4	4		14
S-C. Oligochaeta	42	35	38	14	30	159											1	1	3	1	16	3		23	15	26	39	13	29	122
O. Homoptera																														
F. Corixidae (ad)																														
F. Corixidae (ny)													3					3												
Zooplankton																1		1												
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea																														
Fish																														
Fish Fry										1		1	1					1												
Total # of Organisms	87	87	95	80	84	433	5	2	6	2	4	19	128	82	73	61	63	407	39	26	44	71	47	227	167	172	247	146	142	874
Total Organisms per m2	936.49085	936.49085	1022.60495	861.141012	904.198062	4660.92573	53.8213132	21.5285253	64.5855759	21.5285253	43.0570506	204.52099	1377.82562	882.669537	785.791173	656.620022	678.148547	4381.0549	419.806243	279.870829	473.627557	764.262648	505.920344	2443.48762	1797.63186	1851.45318	2658.77287	1571.58235	1528.5253	9407.96555
Mean # organisms per m2	932.1851453						40.90419806						876.2109795						488.6975242						1881.593111					
Standard Deviation	59.25235283						19.25569841						294.6538719						176.645453						456.2701632					
Total # species	9	9	10	11	11	14	3	2	6	2	2	11	7	5	3	5	7	15	11	8	7	8	10	14	12	14	15	12	11	19
Mean # species	10						3						5.4						8.8						12.8					
Standard Deviation	1						1.732050808						1.673320053						1.643167673						1.643167673					

Unclear of sampling device
Grab sampler used

Table A5-1 Benthos Raw Data (con't)

Treatment	REF 5	REF 5	REF 5	REF 5	REF 5	Episode 2	REF 5	REF 5	REF 5	REF 5	REF 5	Episode 3	REF 5	REF 5	REF 5	REF 5	REF 5	Episode 4	REF 6	REF 6	REF 6	REF 6	REF 6	Episode 1	REF 6	REF 6	REF 6	REF 6	REF 6	Episode 2
Episode	2	2	2	2	2	Totals	3	3	3	3	3	Totals	4	4	4	4	4	Totals	1	1	1	1	1	Totals	2	2	2	2	2	Totals
Date	16-Mar-05	16-Mar-05	16-Mar-05	16-Mar-05	16-Mar-05		16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05		19-Dec-05	19-Dec-05	19-Dec-05	19-Dec-05	19-Dec-05		9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04		16-Mar-05	16-Mar-05	16-Mar-05	16-Mar-05	16-Mar-05	
Site	Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (m/s)	>1m/sec	>1m/sec	>1m/sec	>1m/sec	>1m/sec		<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		>1m/sec	>1m/sec	>1m/sec	>1m/sec	>1m/sec	
Substrate	course gravel	course gravel	course gravel	course gravel	course gravel		course gravel	course gravel	course gravel	course gravel	course gravel		course gravel	course gravel	course gravel	course gravel	course gravel		gravel	gravel	gravel	gravel	gravel		gravel	gravel	gravel	gravel	gravel	
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)		2			2	4	1			1		2	14	5	6	6	5	36					1	1		2	1		2	5
F. Baetidae (ny)							6	5	5	10	16	42	1	2		4	1	8	4	3	1	1	2	11						
F. Ephemerellidae (ny)							1	2	3	2	3	11	7	28	20	13	8	76		2				2						
F. Heptageniidae (ny)							7	11	5	19	17	59	14	31	3	11	4	63	11	10	13	7	9	50			2	1		3
F. Leptophlebiidae (ny)																														
F. Tricorythidae (ny)																														
O. Plecoptera (ny)																														
F. Capniidae (ny)													3	7	5	2	4	21	1	1	3		1	6						
F. Chloroperlidae (ny)															1			1												
F. Nemouridae (ny)											1	1																		
F. Perlidae (ny)																														
F. Perlodidae (ny)							1		2		1	4	1					1												
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)													1		1			2	10	6	3	6	13	38						
O. Trichoptera (L)																														
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)																														
F. Hydroptilidae (L)																														
F. Limnephilidae (L)																														
F. Lepidostomatidae (L)									1	4	1	6																		
F. Leptoceridae (L)																														
F. Hydropsychidae (L)											1	1	1	1	1		1	4	1	1				2						
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (L)																														
F. Chironomidae (L)	2	1	2		5	10	172	124	91	114	109	610	1	12	16	6	3	38		4	1			5		2				2
F. Ceratopogonidae (L)															4			4												
F. Dixidae (L)																														
F. Dolichopodidae (L)																														
F. Empididae (L)							1					1		1	8	2	4	15	1					1		1	1			2
F. Simuliidae (L)																														
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)															1			1												
O. Coleoptera (L)																														
F. Dytiscidae (ad)																														
F. Dytiscidae (ny)																														
F. Elmidae (L)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (L)																														
O. Amphipoda (Scud)																														
O. Mysidacae																														
O. Acarina											1	1																		
Bivalva																														
Gastropoda (snails)																														
P. Nemata																														
P. Nematoda														2	2			4												
S-C. Oligochaeta							5				1	6		6	7	4	1	18	3					3						
O. Homoptera																														
F. Corixidae (ad)																														
F. Corixidae (ny)																														
Zooplankton									1			1																		
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea																														
Fish																														
Fish Fry																														
Total # of Organisms	2	3	2	0	7	14	194	142	108	150	151	745	43	95	75	48	31	292	31	27	21	14	26	119	0	5	4	1	2	12
Total Organisms per m2	21.5285253	32.2927879	21.5285253	0	75.3498385	150.699677	2088.26695	1528.5253	1162.54037	1614.6394	1625.40366	8019.37567	462.863294	1022.60495	807.319699	516.684607	333.692142	3143.16469	333.692142	290.635091	226.049516	150.699677	279.870829	1280.94726	0	53.8213132	43.0570506	10.7642626	21.5285253	129.171152
Mean # organisms per m2			30.13993541						1603.875135						628.6329386						256.189451						25.83423036			
Standard Deviation			27.86260303						330.0260434						280.2431902						70.3393294						22.32125011			
Total # Species	1	2	1	0	2	2	8	4	7	6	10	13	9	10	13	8	9	15	7	7	5	3	5	10	0	3	3	1	1	4
Mean # Species			1.2						7						9.8						5.4						1.6			
Standard Deviation			0.836660027						2.236067977						1.923538406						1.673320053						1.341640786			

Unclear of sampling device
Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drive s\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERAT IONAL LIAISON\HCM\copy of shared drive Jan 26 2010 \1. Pacific\7. Reports\Fraser River Sed Removal Su rveys - FINAL.pdf

Table A5-1 Benthos Raw Data (con't)

Treatment	REF 6	REF 6	REF 6	REF 6	REF 6	Episode 3	REF 6	REF 6	REF 6	REF 6	REF 6	Episode 4	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 1	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 2	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 3
Episode	3	3	3	3	3	Totals	4	4	4	4	4	Totals	1	1	1	1	1	Totals	2	2	2	2	2	Totals	3	3	3	3	3	Totals
Date	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05		16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05		9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04		15-Mar-05	16-Mar-05	17-Mar-05	18-Mar-05	19-Mar-05		16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	
Site	Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)	<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		1m/sec	1m/sec	1m/sec	1m/sec	1m/sec		<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec	<
Substrate	gravel	gravel	gravel	gravel	gravel		gravel	gravel	gravel	gravel	gravel																			
O. Ephameroptera (ny)																														
F. Ameletidae (ny)							1					1	2		1	3		6	3	1	2	2	10	18						
F. Baetidae (ny)	6		1	4	3	14		4	4	3	4	15	1	1	3	6	1	12							32	52	36	22	37	179
F. Ephemerellidae (ny)		1	1			2							10	11	12	14	7	54				1		1					1	1
F. Heptageniidae (ny)		1	1		2	4				1		1	2	4	6	7	5	24							10	12	17	5	24	68
F. Leptophlebiidae (ny)																	1	1												
F. Tricorythidae (ny)																														
O. Plecoptera (ny)																														
F. Capniidae (ny)										2	1	3	4	6	4	6	4	24			2	1	3	6						
F. Chloroperlidae (ny)																														
F. Nemouridae (ny)																														
F. Perlidae (ny)																	2	2												
F. Perlodidae (ny)	1	1			1	3										1		1							1	1	1	1		4
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)							2	1	1	1		5	4	7	11	8	4	34												
O. Trichoptera (L)													1					1												
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)																									2	1		1	1	5
F. Hydroptilidae (L)																														
F. Limnephilidae (L)																														
F. Lepidostomatidae (L)														2				2							2	2	1		1	6
F. Leptoceridae (L)																														
F. Hydropsychidae (L)			1	1	1	3			1			1	2		3	2	1	8							5	1	3	4	1	14
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)																														
F. Chironomidae (L)	104	98	127	155	208	692		2	2	2	1	7	31	29	18	22	22	122							284	363	239	285	319	1490
F. Ceratopogonidae (L)																														
F. Dixidae (L)																														
F. Dolichopodidae (L)	1					1																								
F. Empididae (L)													13	8	8	7	4	40												
F. Simuliidae (L)				1		1																						1		1
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)																														
O. Coleoptera (l)																														
F. Dytiscidae (ad)																2	1	3												
F. Dytiscidae (ny)																														
F. Elmidae (l)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)															1			1				2	3	5						
O. Mysidacae																														
O. Acarina														1	1		2	4							1					1
Bivalva																														
Gastropoda (snails)																														
P. Nemata																														
P. Nematoda	1		1	1		3	1					1	3	4	3	2	3	15												
S-C. Oligochaeta		1	1	2	4	8					1	1	43	22	13	20	24	122							4	4	4	15	9	36
O. Homoptera																														
F. Corixidae (ad)																					1			1						
F. Corixidae (ny)																														
Zooplankton					3	3																				1		2	1	4
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea																														
Fish														1				1												
Fish Fry																														
Total # of Organisms	113	102	133	164	222	734	4	7	8	9	7	35	116	96	84	100	81	477	3	1	5	6	16	31	341	437	301	336	394	1809
Total Organisms per m2	1216.36168	1097.95479	1431.64693	1765.33907	2389.66631	7900.96878	43.0570506	75.3498385	86.1141012	96.8783638	75.3498385	376.749193	1248.65447	1033.36921	904.198062	1076.42626	871.905274	5134.55328	32.2927879	10.7642626	53.8213132	64.5855759	172.228202	333.692142	3670.61356	4703.98278	3240.04306	3616.79225	4241.11948	19472.5511
Mean # organisms per m2			1580.193757						75.34983854						1026.910657						66.73842842						3894.510226			
Standard Deviation			518.7771584						20.13809143						150.6227699						62.48837577						576.8379438			
Total # species	5	5	7	6	7	11	3	3	4	5	4	9	12	12	13	13	14	20	1	1	3	4	3	5	9	9	7	9	9	12
Mean # species			6						3.8						12.8						2.4						8.6			
Standard Deviation			1						0.836660027						0.836660027						1.341640786						0.894427191			

Unclear of sampling device

Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drives\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010\1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

Table A5-1 Benthos Raw Data (con't)

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 4	Scalp	Scalp	Scalp	Scalp	Scalp	Episode 5
Episode	4	4	4	4	4	Totals	5	5	5	5	5	Totals
Date	19-Dec-05	19-Dec-05	19-Dec-05	19-Dec-05	19-Dec-05		19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	
Site	Gill West	Gill West	Gill West	Gill West	Gill West		Gill West	Gill West	Gill West	Gill West	Gill West	
Sample #	1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)	1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec		<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec	<1m/sec
Substrate												
O. Ephameroptera (ny)												
F. Ameletidae (ny)		1	1		2	4	3	2	3	2	6	16
F. Baetidae (ny)	1	1	10	2	3	17	1	1	2		2	6
F. Ephemerellidae (ny)	3		6	2	1	12	1		1			2
F. Heptageniidae (ny)	3	7	2	7	10	29		1				1
F. Leptophlebiidae (ny)												
F. Tricorythidae (ny)												
O. Plecoptera (ny)												
F. Capniidae (ny)				2		2	1				1	2
F. Chloroperlidae (ny)												
F. Nemouridae (ny)												
F. Perlidae (ny)												
F. Perlodidae (ny)	1					1						
F. Leuctridae (ny)												
F. Polycentropodidae (ny)												
F. Pteronarcyidae (ny)												
F. Taeniopterygidae (ny)			3	2	5	10				3		3
O. Trichoptera (L)												
O. Trichoptera (P)												
F. Brachycentridae (L)												
F. Glossosomatidae (L)	1		1		1	3						
F. Hydroptilidae (L)												
F. Limnephilidae (L)												
F. Lepidostomatidae (L)												
F. Leptoceridae (L)												
F. Hydropsychidae (L)	3	1	1	5	1	11						
F. Rhyacophilidae (L)												
F. Athericidae (L)												
F. Blephariceridae (L)												
O. Diptera (l)												
F. Chironomidae (L)	24	25	43	10	16	118	22	22	29	11	23	107
F. Ceratopogonidae (L)												
F. Dixidae (L)												
F. Dolichopodidae (L)									1			1
F. Empididae (L)	1	1	1	1		4						
F. Simuliidae (L)												
F. Psychodidae (L)												
F. Tanyderidae (L)												
F. Tipulidae (L)									3	1		4
O. Coleoptera (l)												
F. Dytiscidae (ad)												
F. Dytiscidae (ny)												
F. Elmidae (l)												
F. Hydrochidae												
F. Hydrophilidae												
O. Lepidoptera (l)												
O. Amphipoda (Scud)												
O. Mysidacae												
O. Acarina												
Bivalva												
Gastropoda (snails)												
P. Nemata												
P. Nematoda	2	2		1		5	1					1
S-C. Oligochaeta	23	2		4	5	34	3	6	8	8	5	30
O. Homoptera												
F. Corixidae (ad)												
F. Corixidae (ny)												
Zooplankton		1				1						
Invertebrate (imm)												
Invertebrate Eggs												
Hirudinea												
Fish												
Fish Fry												
Total # of Organisms	62	41	68	36	44	251	32	32	47	25	37	173
Total Organisms per m2	667.384284	441.334769	731.96986	387.513455	473.627557	2701.82992	344.456405	344.456405	505.920344	269.106566	398.277718	1862.21744
Mean # organisms per m2			540.3659849						372.4434876			
Standard Deviation			150.3918122						87.64780618			7.7
Total # species	10	9	9	10	9	14	7	5	7	5	5	11
Mean # species			9.4						5.8			
Standard Deviation			0.547722558						1.095445115			

Treatment	Scalp 1	Scalp 1	Scalp 1	Scalp 1	Scalp 1	Scalp 1	Scalp 2	Scalp 2	Scalp 2	Scalp 2	Scalp 2	Scalp 2	Scalp 3	Scalp 3	Scalp 3	Scalp 3	Scalp 3	Scalp 2
Episode						Totals						Totals						Totals
Date	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07		13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07		13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07	
Site	Herrling	Herrling	Herrling	Herrling	Herrling		Herrling	Herrling	Herrling	Herrling	Herrling		Herrling	Herrling	Herrling	Herrling	Herrling	
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)																		
Substrate																		
O. Ephameroptera (ny)																		
F. Ameletidae (ny)								1	1	1	1	4						
F. Baetidae (ny)																		
F. Ephemerellidae (ny)																		
F. Heptageniidae (ny)																		
F. Leptophlebiidae (ny)																		
F. Tricorythidae (ny)																		
O. Plecoptera (ny)									1			1						
F. Capniidae (ny)																		
F. Chloroperlidae (ny)																		
F. Nemouridae (ny)																		
F. Perlidae (ny)																		
F. Perlodidae (ny)																		
F. Leuctridae (ny)																		
F. Polycentropodidae (ny)																		
F. Pteronarcyidae (ny)																		
F. Taeniopterygidae (ny)																		
O. Trichoptera (L)																		
O. Trichoptera (P)																		
F. Brachycentridae (L)																		
F. Glossosomatidae (L)																		
F. Hydroptilidae (L)																		
F. Limnephilidae (L)								2				2						
F. Lepidostomatidae (L)																		
F. Leptoceridae (L)																		
F. Hydropsychidae (L)																		
F. Rhyacophilidae (L)																		
F. Athericidae (L)																		
F. Blephariceridae (L)																		
O. Diptera (l)																		
F. Chironomidae (L)	1		1		2	4		1			1	2	2	4		1	3	10
F. Ceratopogonidae (L)								1				1						
F. Dixidae (L)																		
F. Dolichopodidae (L)																		
F. Empididae (L)																		
F. Simuliidae (L)																		
F. Psychodidae (L)																		
F. Tanyderidae (L)																		
F. Tipulidae (L)	1					1												
O. Coleoptera (l)																		
F. Dytiscidae (ad)																		
F. Dytiscidae (ny)																		
F. Elmidae (l)																		
F. Hydrochidae																		
F. Hydrophilidae																		
O. Lepidoptera (l)																		
O. Amphipoda (Scud)																		
O. Mysidacae																		
O. Acarina																		
Bivalva																		
Gastropoda (snails)																		
P. Nemata																		
P. Nematoda																		
S-C. Oligochaeta															2		1	3
O. Homoptera																		
F. Corixidae (ad)																		
F. Corixidae (ny)																		
Zooplankton																		
Invertebrate (imm)																		
Invertebrate Eggs																		
Hirudinea																		
Fish																		
Fish Fry																		
Total # of Organisms	2	0	1	0	2	5	0	5	2	1	2	10	2	4	2	1	4	13
Total Organisms per m2	86.565097	0	432.825485	0	865.65097	1385.04155	0	53.8213132	21.5285253	10.7642626	21.5285253	107.642626	86.565097	173.130194	86.565097	43.2825485	173.130194	562.67313
Mean # organisms per m2			277.0083102						21.5285253						112.534626			
Standard Deviation			374.3377478						20.13809143			1.9			58.06963238			
Total # species	2	0	1	0	1	2	0	4	2	1	2	5	1	1	1	1	2	2
Mean # species			0.8						1.8						1.2			
Standard Deviation			0.836660027						1.483239697						0.447213595			

Unclear of sampling device
Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drives\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010\1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

Table A5-1 Benthos Raw Data (con't)

Treatment	Reference 1	Reference 1	Reference 1	Reference 1	Reference 1	Reference 1	Reference 2	Reference 2	Reference 2	Reference 2	Reference 2	Reference 2	Reference 3	Reference 3	Reference 3	Reference 3	Reference 3	Reference 3	Scalp	Scalp	Scalp	Scalp	Scalp	Scalp	Ref 1	Ref 2	Ref 3	Ref 4	Ref 5	Reference
Episode						Totals						Totals						Totals						Totals						Totals
Date	13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07		13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07		13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07		14-Dec-07	14-Dec-07	14-Dec-07	14-Dec-07	14-Dec-07		14-Dec-07	14-Dec-07	14-Dec-07	14-Dec-07	14-Dec-07	
Site	Herrling	Herrling	Herrling	Herrling	Herrling		Herrling	Herrling	Herrling	Herrling	Herrling		Herrling	Herrling	Herrling	Herrling	Herrling		Tranmer	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer
Sample #	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
Velocity (cm/s)																														
Substrate																														
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)		1	1	1	3	6	14	18		9	5	46			1	1	1	3	3		4	3	3	13	9	5	2	13	2	31
F. Baetidae (ny)	1			2		3	1		1	1		3							3		1	3		7	2	1	2	1	1	7
F. Ephemerellidae (ny)	2					2		1				1					1	1		3	5	11		19	11	4	5	2	2	24
F. Heptageniidae (ny)																			1	1	4	2	2	10	2	2	5			9
F. Leptophlebiidae (ny)																					1			1		1				1
F. Tricorythidae (ny)																														
O. Plecoptera (ny)																														
F. Capniidae (ny)	1			4	1	6	5	3	1	3	1	13	1	1	1	1	2	6	12	6	10	4	4	36	22	27	22	9	6	86
F. Chloroperlidae (ny)																														
F. Nemouridae (ny)		1				1															1			1	1					1
F. Perlidae (ny)																														
F. Perlodidae (ny)																				1				1	2					2
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)	2		1		1	4	1					1							2	2	3			7				1		1
O. Trichoptera (L)																														
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)																														
F. Hydroptilidae (L)																														
F. Limnephilidae (L)	1				1	2		2	1		1	4	1					1				1		1	1	1				2
F. Lepidostomatidae (L)																			1	1				2						
F. Leptoceridae (L)																														
F. Hydropsychidae (L)					1	1			1			1					1	1		1	2	1		4	7	4	5	3	1	20
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)																														
F. Chironomidae (L)	1	1	1			3					2	2			1	1		2	10	22	23	10	14	79	122	41	36	23	11	233
F. Ceratopogonidae (L)							1					1	1	1			1	3							1		1			2
F. Dixidae (L)																									1					1
F. Dolichopodidae (L)																														
F. Empididae (L)							1				1	2							1			2		3	10	6	9	3		28
F. Simuliidae (L)																														
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)								1				1													1					1
O. Coleoptera (l)																														
F. Dytiscidae (ad)																														
F. Dytiscidae (ny)																														
F. Elmidae (l)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)		1				1																								
O. Mysidacae																														
O. Acarina																			1	1	1			3	2					2
Bivalva																														
Gastropoda (snails)	1					1					1	1																		
P. Nemata		1				1									1			1	1		1		1	3	2	2		3		7
P. Nematoda																														
S.C. Oligochaeta								1	1			2							2			1		3	34	20	19	20	6	99
O. Homoptera																														
F. Corixidae (ad)																														
F. Corixidae (ny)																														
Zooplankton																												1		1
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea																														
Fish																														
Fish Fry																														
Total # of Organisms	9	5	3	7	7	31	23	26	5	13	11	78	3	2	4	3	6	18	37	38	56	38	24	193	230	114	106	79	29	558
Total Organisms per m2	96.8783638	53.8213132	32.2927879	75.3498385	75.3498385	333.692142	247.578041	279.870829	53.8213132	139.935414	118.406889	839.612487	32.2927879	21.5285253	43.0570506	32.2927879	64.5855759	193.756728	398.277718	409.041981	602.798708	409.041981	258.342304	2077.50269	2475.78041	1227.12594	1141.01184	850.376749	312.163617	6006.45856
Mean # organisms per m2	66.73842842						167.9224973						38.75134553						415.5005382						1201.291712					
Standard Deviation	24.54629548						93.71711027						16.32481258						122.6370322						797.231552					
Total # species	7	5	3	3	5	12	6	6	5	3	6	13	3	2	4	3	5	8	11	9	12	10	5	17	17	12	10	11	7	20
Mean # species	4.6						5.2						3.4						9.4						11.4					
Standard Deviation	1.673320053						1.303840481						1.140175425						2.701851217						3.646916506					

Unclear of sampling device
Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drive s\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERAT IONAL LIAISON\HCM\copy of shared drive Jan 26 2010 \1. Pacific\7. Reports\Fraser River Sed Removal Su rveys - FINAL.pdf

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref 2	Ref 3	Ref 4	Ref 5	Ref 6	Reference
Episode						Totals
Date	14-Dec-07	14-Dec-07	14-Dec-07	14-Dec-07	14-Dec-07	
Site	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)	1	4	3	2	3	13
F. Baetidae (ny)	1					1
F. Ephemerellidae (ny)	11	6	14	8	4	43
F. Heptageniidae (ny)	2	5	1	1	3	12
F. Leptophlebiidae (ny)					1	1
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)	10	2	43	5	12	72
F. Chloroperlidae (ny)						
F. Nemouridae (ny)				1		1
F. Perlidae (ny)						
F. Perlodidae (ny)	1				1	2
F. Leutridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)	1		1			2
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)				1		1
F. Glossosomatidae (L)					1	1
F. Hydroptilidae (L)						
F. Limnephilidae (L)		1			1	2
F. Lepidostomatidae (L)		1	3	1		5
F. Leptoceridae (L)						
F. Hydropsychidae (L)	1	2	14	1	4	22
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (P)						
F. Chironomidae (L)	30	13	25	16	23	107
F. Ceratopogonidae (L)	1			1		2
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)	4		1	2	6	13
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)	1					1
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)			2			2
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina		1	2			3
Bivalva						
Gastropoda (snails)						
P. Nemata		1	1	1	2	5
P. Nematoda						
S-C. Oligochaeta	3	6	6	4	7	26
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	67	42	116	44	68	337
Total Organisms per m2	721.205597	452.099031	1248.65447	473.627557	731.96986	3627.55651
Mean # organisms per m2	725.5113025					
Standard Deviation	320.91226					
Total # species	13	11	13	13	13	22
Mean # species	12.6					
Standard Deviation	0.894427191					

Treatment	Ref 3	Ref 4	Ref 5	Ref 6	Ref 7	Reference
Episode						Totals
Date	14-Dec-07	14-Dec-07	14-Dec-07	14-Dec-07	14-Dec-07	
Site	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer	Tranmer
Sample #	1	2	3	4	5	
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)						
F. Baetidae (ny)		2		2		4
F. Ephemerellidae (ny)						
F. Heptageniidae (ny)			2	3	3	8
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)			2	2	4	8
F. Chloroperlidae (ny)						
F. Nemouridae (ny)						
F. Perlidae (ny)						
F. Perlodidae (ny)						
F. Leutridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)	1	4	3	9	1	18
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)						
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)						
F. Leptoceridae (L)						
F. Hydropsychidae (L)					1	1
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (P)						
F. Chironomidae (L)	4		3	1	1	9
F. Ceratopogonidae (L)						
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)			1			1
F. Simuliidae (L)			1			1
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)						
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina						
Bivalva						
Gastropoda (snails)						
P. Nemata						
P. Nematoda						
S-C. Oligochaeta						
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	5	6	12	17	10	50
Total Organisms per m2	53.8213132	64.5855759	129.171152	182.992465	107.642626	538.213132
Mean # organisms per m2	107.6426265					
Standard Deviation	52.18169922					
Total # species	2	2	6	5	5	8
Mean # species	4					
Standard Deviation	1.870828693					

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Totals
Episode	5	5	5	5	5	5
Date	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07
Site	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central
Sample #	1	2	3	4	5	Totals
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)						
F. Baetidae (ny)						
F. Ephemerellidae (ny)						
F. Heptageniidae (ny)						
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)						
F. Chloroperlidae (ny)						
F. Nemouridae (ny)						
F. Perlidae (ny)						
F. Perlodidae (ny)						
F. Leutridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)						
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)						
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)						
F. Leptoceridae (L)						
F. Hydropsychidae (L)						
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (P)			1			1
F. Chironomidae (L)	6		2	1	2	11
F. Ceratopogonidae (L)						
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)						
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)						
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina						
Bivalva						
Gastropoda (snails)						
P. Nemata			1			1
P. Nematoda						
S-C. Oligochaeta	5		1			6
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton						
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	11	0	5	1	2	19
Total Organisms per m2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mean # organisms per m2	[illegible]					
Standard Deviation	192.1082152					
Total # species	2	0	4	1	1	4
Mean # species	1.6					
Standard Deviation	1.516575089					

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Totals
Episode	3	3	3	3	3	3
Date	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06
Site	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central
Sample #	1	2	3	4	5	Totals
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)						
F. Baetidae (ny)						
F. Ephemerellidae (ny)	2	3	3	3		11
F. Heptageniidae (ny)						
F. Leptophlebiidae (ny)			1			1
F. Tricorythidae (ny)		1				1
O. Plecoptera (ny)			3	1		4
F. Capniidae (ny)						
F. Chloroperlidae (ny)						
F. Nemouridae (ny)						
F. Perlidae (ny)						
F. Perlodidae (ny)						
F. Leutridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)						
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)						
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)	4		1			5
F. Leptoceridae (L)						
F. Hydropsychidae (L)						
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (P)						
F. Chironomidae (L)	137	100	292	114	47	690
F. Ceratopogonidae (L)						
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)	3	2	8	6	5	24
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)						
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)	1					1
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina						
Bivalva						
Gastropoda (snails)						
P. Nemata				1		1
P. Nematoda						
S-C. Oligochaeta	12	11	7	9	1	40
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton	1					1
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish	1	1	3	1		6
Fish Fry						
Total # of Organisms	161	118	318	135	53	785
Total Organisms per m2	1733.04629	1270.18299	3423.03552	1453.17546	570.50592	8449.94618
Mean # organisms per m2	1689.989236					
Standard Deviation	1059.58297					
Total # species	8	6	8	7	3	12
Mean # species	6.4					
Standard Deviation	2.073644135					

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Totals
Episode	4	4	4	4	4	4
Date	26-Feb-07	26-Feb-07	26-Feb-07	26-Feb-07	26-Feb-07	26-Feb-07
Site	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central
Sample #	1	2	3	4	5	Totals
Velocity (cm/s)						
Substrate						
O. Ephemeroptera (ny)						
F. Ameletidae (ny)						
F. Baetidae (ny)						
F. Ephemerellidae (ny)						
F. Heptageniidae (ny)						
F. Leptophlebiidae (ny)						
F. Tricorythidae (ny)						
O. Plecoptera (ny)						
F. Capniidae (ny)						
F. Chloroperlidae (ny)						
F. Nemouridae (ny)						
F. Perlidae (ny)						
F. Perlodidae (ny)						
F. Leutridae (ny)						
F. Polycentropodidae (ny)						
F. Pteronarcyidae (ny)						
F. Taeniopterygidae (ny)						
O. Trichoptera (L)						
O. Trichoptera (P)						
F. Brachycentridae (L)						
F. Glossosomatidae (L)						
F. Hydroptilidae (L)						
F. Limnephilidae (L)						
F. Lepidostomatidae (L)						
F. Leptoceridae (L)						
F. Hydropsychidae (L)						
F. Rhyacophilidae (L)						
F. Athericidae (L)						
F. Blephariceridae (L)						
O. Diptera (P)						
F. Chironomidae (L)	7	19	17	14	24	81
F. Ceratopogonidae (L)	1	6	2	12	6	27
F. Dixidae (L)						
F. Dolichopodidae (L)						
F. Empididae (L)						
F. Simuliidae (L)						
F. Psychodidae (L)						
F. Tanyderidae (L)						
F. Tipulidae (L)						
O. Coleoptera (l)						
F. Dytiscidae (ad)						
F. Dytiscidae (ny)						
F. Elmidae (l)						
F. Hydrochidae						
F. Hydrophilidae						
O. Lepidoptera (l)						
O. Amphipoda (Scud)						
O. Mysidacae						
O. Acarina						
Bivalva						
Gastropoda (snails)						
P. Nemata					2	2
P. Nematoda						
S-C. Oligochaeta	2	5	3	14	57	81
O. Homoptera						
F. Corixidae (ad)						
F. Corixidae (ny)						
Zooplankton		1		4	7	12
Invertebrate (imm)						
Invertebrate Eggs						
Hirudinea						
Fish						
Fish Fry						
Total # of Organisms	10	31	22	44	96	203
Total Organisms per m2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mean # organisms per m2	[illegible]					
Standard Deviation	1444.49629					
Total # species	3	4	3	4	5	5
Mean # species	3.8					
Standard Deviation	0.836660027					

Legend: Unclear of sampling device; Grab sampler used

Table A5-1 Benthos Raw Data (con't)

Treatment	Scalp	Scalp	Scalp	Scalp	Scalp	Totals	Scalp	Scalp	Scalp	Scalp	Scalp	Totals	Ref	Ref	Ref	Totals	Scalp	Scalp	Scalp	Scalp	Scalp	Totals	Ref	Ref	Ref	Ref	Ref	Totals
Episode	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
Date	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	16-Mar-05	16-Mar-05	16-Mar-05	16-Mar-05	16-Mar-05	16-Mar-05	14-Aug-08	14-Aug-08	14-Aug-08	16-Mar-05	14-Aug-08	14-Aug-08	14-Aug-08	14-Aug-08	14-Aug-08	16-Mar-05	18-Aug-08	18-Aug-08	18-Aug-08	18-Aug-08	18-Aug-08	16-Mar-05
Site	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Gill Central	Foster Top	Foster Top	Foster Top	Foster Top	Foster	Foster	Foster	Foster	Foster	Foster	Minto	Minto	Minto	Minto	Minto	Minto
Sample #	1	2	3	4	5	Totals	1	2	3	4	5	Totals	A	B	C	Totals	A	B	C	D	E	Totals	A	B	C	D	E	Totals
Velocity (cm/s)																												
Substrate																												
O. Ephameroptera (ny)																												
F. Ameletidae (ny)														1														
F. Baetidae (ny)	1	2	4	4	3	14					3	3				3				3	4	3				6	1	3
F. Ephemerellidae (ny)	4	3	11	4	8	30																				2		
F. Heptageniidae (ny)	20	18	35	34	24	131														1	2					2	1	
F. Leptophlebiidae (ny)	28	32	27	24	37	148																						
F. Tricorythidae (ny)	1					1																						
O. Plecoptera (ny)																												
F. Capniidae (ny)																												
F. Chloroperlidae (ny)	15	2	17	6	9	49					1	1				1						1						1
F. Nemouridae (ny)																												
F. Perlidae (ny)										1		1				1						1						1
F. Perlodidae (ny)																		1		1								
F. Leuctridae (ny)																												
F. Polycentropodidae (ny)																												
F. Pteronarcyidae (ny)																												
F. Taeniopterygidae (ny)																												
O. Trichoptera (L)	12	9	18	13	11	63																						
O. Trichoptera (P)																												
F. Brachycentridae (L)																												
F. Glossosomatidae (L)																												
F. Hydroptilidae (L)			1			1																						
F. Limnephilidae (L)																												
F. Lepidostomatidae (L)			2			2			1			1				1						1						1
F. Leptoceridae (L)																												
F. Hydropsychidae (L)			10	1	2	13																				1		
F. Rhyacophilidae (L)																												
F. Athericidae (L)																												
F. Blephariceridae (L)																												
O. Diptera (l)																												
F. Chironomidae (L)	14	11	14	2	6	47		2	2	4	7	15		1		15				25	33	15			1	30	25	15
F. Ceratopogonidae (L)																												
F. Dixidae (L)																												
F. Dolichopididae (L)																												
F. Empididae (L)	1		2		1	4		1		1		2				2						2						2
F. Simuliidae (L)																												
F. Psychodidae (L)			1			1								2														
F. Tanyderidae (L)																												
F. Tipulidae (L)																												
O. Coleoptera (l)																									1			
F. Dytiscidae (ad)														1														
F. Dytiscidae (ny)															1													
F. Elmidae (l)																												
F. Hydrochidae																												
F. Hydrophilidae																												
O. Lepidoptera (l)																												
O. Amphipoda (Scud)																												
O. Mysidacae																												
O. Acarina		2	1	2	3	8				1		1				1						1						1
Bivalva																												
Gastropoda (snails)																												
P. Nemata				2		2											1							1				
P. Nematoda																												
S.C. Oligochaeta	20	10	5	11	6	52		1			1	2				2	1				1	2				3	4	2
O. Homoptera																												
F. Corixidae (ad)													1															
F. Corixidae (ny)																												
Zooplankton									1			1	1			1						1						1
Invertebrate (imm)																												
Invertebrate Eggs																												
Hirudinea																												
Fish																												
Fish Fry																												
Total # of Organisms	116	89	148	103	110	566	0	4	4	7	12	27	2	5	1	8	2	1	0	30	40	70	0	1	2	44	31	77
Total Organisms per m2	1248.65447	958.019376	1593.11087	1108.71905	1184.06889	6092.57266	0	43.0570506	43.0570506	75.3498385	129.171152	290.635091																
Mean # organisms per m2	1218.514532						58.1270183																					
Standard Deviation	235.7594693						47.89794502																					
Total # species	10	9	14	11	11	16	0	3	3	4	4	9	2	4	1	9	2	1	0	4	4	9	0	1	2	6	4	9
Mean # species	11						2.8						2.333333333				2.2						2.6					
Standard Deviation	1.870828693						1.643167673						1.527525232				1.788854382						2.408318916					

Unclear of sampling device

Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drive s\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010 \1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref	Ref	Ref	Ref	Ref	Totals	Ref	Ref	Ref	Ref	Ref	Totals	Scalp	Scalp	Scalp	Scalp	Scalp	Totals	Ref 1	Ref 1	Ref 1	Ref 1	Ref 1	Totals	Ref 2	Ref 2	Ref 2	Ref 2	Ref 2	Totals
Episode	2	2	2	2	2	2	2	2	2	2	2	2																		
Date	18-Aug-08	18-Aug-08	18-Aug-08	18-Aug-08	18-Aug-08	16-Mar-05	18-Aug-08	18-Aug-08	18-Aug-08	18-Aug-08	18-Aug-08	16-Mar-05	11-Feb-08	11-Feb-08	11-Feb-08	11-Feb-08	11-Feb-08	16-Mar-05	11-Feb-08	11-Feb-08	11-Feb-08	11-Feb-08	11-Feb-08	16-Mar-05	11-Feb-08	11-Feb-08	11-Feb-08	11-Feb-08	11-Feb-08	16-Mar-05
Site	Jesperson	Jesperson	Jesperson	Jesperson	Jesperson	Jesperson	Calamity Bar	Calamity Bar	Calamity Bar	Calamity Bar	Calamity Bar	Calamity Bar	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton
Sample #	A	B	C	D	E	Totals	A	B	C	D	E	Totals	1	2	3	4	5	Totals	1	2	3	4	5	Totals	1	2	3	4	5	Totals
Velocity (cm/s)																														
Substrate																														
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)	1		1		1				1														1		2	7	6	17	6	
F. Baetidae (ny)	1	5	1	1		3				7	6	3	232	40	66	34	76	3	96	47	85	152	233	3	1			1	5	3
F. Ephemerellidae (ny)			1						1	2	2		1	13	2	3	4		3		2	1	3		5	8	7	10	6	
F. Heptageniidae (ny)		4	1		1					3	1		30	22	16	6	15		4	7	6	6	11			3	6	12	7	
F. Leptophlebiidae (ny)																												1		
F. Tricorythidae (ny)																														
O. Plecoptera (ny)																														
F. Capniidae (ny)													7	1		6	3		2	5	1	1	2		9	5	12	11	6	
F. Chloroperlidae (ny)						1						1						1						1						1
F. Nemouridae (ny)													1	19	4	2			3		2	4	5							
F. Perlidae (ny)						1						1						1						1						1
F. Perlodidae (ny)													2	1					2			1	1							
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)													9	11	2	2	13		8	7	8	10	15		1					
O. Trichoptera (L)								1																						
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)														1																
F. Hydroptilidae (L)																														
F. Limnephilidae (L)																														
F. Lepidostomatidae (L)						1						1		1				1						1	1					1
F. Leptoceridae (L)																														
F. Hydropsychidae (L)		1								5	1			1																
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)																														
F. Chironomidae (L)	30	76	52	10	21	15	19		14	85	62	15	9	29	3	5	4	15	48	14	100	31	78	15	241	881	500	368	248	15
F. Ceratopogonidae (L)											1															1			1	
F. Dixidae (L)																														
F. Dolichopodidae (L)		1			2																									
F. Empididae (L)						2					1	2	2					2				1		2	11	10	8	19	5	2
F. Simuliidae (L)							1			1																				
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)																														
O. Coleoptera (l)																														
F. Dytiscidae (ad)																									1					
F. Dytiscidae (ny)				2																										
F. Elmidae (l)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)																														
O. Mysidacae																														
O. Acarina						1						1						1						1			1			1
Bivalva																														
Gastropoda (snails)									1																					
P. Nemata			1																			1	1		5	5	2	4	1	
P. Nematoda																														
S-C. Oligochaeta	2	3	8			2		4	3	6	7	2	1	6	1	2	4	2	1		13	13	16	2	125	391	206	176	102	2
O. Homoptera																														
F. Corixidae (ad)																														
F. Corixidae (ny)																														
Zooplankton						1						1			1		1	1				2		1		2		3	1	1
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea																														
Fish																														
Fish Fry																														
Total # of Organisms	34	90	65	13	25	103	20	5	20	109	81	210	294	145	95	60	120	275	167	80	217	223	366	806	402	1313	748	622	388	1758
Total Organisms per m2																														
Mean # organisms per m2																														
Standard Deviation																														
Total # species	4	6	7	3	4	9	2	2	5	7	8	9	10	12	8	8	8	9	9	5	8	12	11	9	11	10	9	11	11	9
Mean # species			4.8						4.8						9.2						9						10.4			
Standard Deviation			1.643167673						2.774887385						1.788854382						2.738612788						0.894427191			

Unclear of sampling device
Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drives\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010\1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref 3	Ref 3	Ref 3	Ref 3	Ref 3	Totals	Scalp	Scalp	Scalp	Scalp	Scalp	Totals	Scalp	Scalp	Scalp	Scalp	Scalp	Totals
Episode																		
Date	11-Feb-08	11-Feb-08	11-Feb-08	11-Feb-08	11-Feb-08	16-Mar-05	16-Jan-08	16-Jan-08	16-Jan-08	16-Jan-08	16-Jan-08	16-Mar-05	16-Jan-08	16-Jan-08	16-Jan-08	16-Jan-08	16-Jan-08	16-Mar-05
Site	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Hamilton	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar D	Spring Bar D	Spring Bar D	Spring Bar D	Spring Bar D	Spring Bar D
Sample #	1	2	3	4	5	Totals	1	2	3	4	5	Totals	1	2	3	4	5	Totals
Velocity (cm/s)																		
Substrate																		
O. Ephemeroptera (ny)																		
F. Ameletidae (ny)							1	3	1	2			12	12	7	10	12	
F. Baetidae (ny)	6	6	16	14	7	3	15	6	11	12	8	3	23	11	12	8	13	3
F. Ephemerellidae (ny)	4		1					3	1	3	2		15	13	7	16	15	
F. Heptageniidae (ny)	5	2	7	12	6		2	6	1		5		22	18	15	28	23	
F. Leptophlebiidae (ny)																		
F. Tricorythidae (ny)																		
O. Plecoptera (ny)																		
F. Capniidae (ny)	7	1	10	9	9		3	4	3	7	5		39	24	21	39	18	
F. Chloroperlidae (ny)						1						1						1
F. Nemouridae (ny)			2					2	1	2					1	1	1	
F. Perlidae (ny)						1						1						1
F. Perlodidae (ny)													1		2		1	
F. Leuctridae (ny)																		
F. Polycentropodidae (ny)																		
F. Pteronarcyidae (ny)																		
F. Taeniopterygidae (ny)	1								1					1				
O. Trichoptera (L)																		
O. Trichoptera (P)																		
F. Brachycentridae (L)																		
F. Glossosomatidae (L)													1					
F. Hydroptilidae (L)																		
F. Limnephilidae (L)																		
F. Lepidostomatidae (L)						1						1	1			2		1
F. Leptoceridae (L)																		
F. Hydropsychidae (L)																1		
F. Rhyacophilidae (L)																		
F. Athericidae (L)																		
F. Blephariceridae (L)																		
O. Diptera (l)																		
F. Chironomidae (L)	5	19	4	6	1	15	69	45	71	46	39	15	144	113	125	77	197	15
F. Ceratopogonidae (L)																		
F. Dixidae (L)																		
F. Dolichopodidae (L)																		
F. Empididae (L)						2					2	2	2			1	1	2
F. Simuliidae (L)		3	3	4	4													
F. Psychodidae (L)																		
F. Tanyderidae (L)																		
F. Tipulidae (L)											1		1					
O. Coleoptera (l)																		
F. Dytiscidae (ad)																		
F. Dytiscidae (ny)																		
F. Elmidae (l)																		
F. Hydrochidae																		
F. Hydrophilidae																		
O. Lepidoptera (l)																		
O. Amphipoda (Scud)																		
O. Mysidacae																		
O. Acarina						1						1			1			1
Bivalva																		
Gastropoda (snails)																		
P. Nemata													1	1	4			
P. Nematoda																		
S-C. Oligochaeta		1			2	2				1	1	2		2				2
O. Homoptera																		
F. Corixidae (ad)																		
F. Corixidae (ny)																		
Zooplankton					1	1						1						1
Invertebrate (imm)																		
Invertebrate Eggs																		
Hirudinea																		
Fish																		
Fish Fry																		
Total # of Organisms	28	32	43	45	30	118	90	69	90	73	63	226	262	195	195	183	281	659
Total Organisms per m2																		
Mean # organisms per m2																		
Standard Deviation																		
Total # species	6	6	7	5	7	9	5	7	8	7	8	9	12	9	10	10	9	9
Mean # species			6.2						7						10			
Standard Deviation			0.836660027						1.224744871						1.224744871			

Treatment	* Ref	* Ref	* Ref	* Ref	* Ref	Totals	Ref	Ref	Ref	Ref	Ref	Totals
Episode												
Date	16-Jan-08	16-Jan-08	16-Jan-08	16-Jan-08	16-Jan-08	16-Mar-05	16-Jan-08	16-Jan-08	16-Jan-08	16-Jan-08	16-Jan-08	16-Mar-05
Site	Herrling	Herrling	Herrling	Herrling	Herrling	Herrling	Railway	Railway	Railway	Railway	Railway	Railway
Sample #	1	2	3	4	5	Totals	1	2	3	4	5	Totals
Velocity (cm/s)												
Substrate												
O. Ephemeroptera (ny)												
F. Ameletidae (ny)							1	3		2	2	
F. Baetidae (ny)	1					3	68	59	34	76	19	3
F. Ephemerellidae (ny)				1	1		45	34	13	29	20	
F. Heptageniidae (ny)							33	22	9	19	13	
F. Leptophlebiidae (ny)										1		
F. Tricorythidae (ny)												
O. Plecoptera (ny)												
F. Capniidae (ny)							22	27	11	15	17	
F. Chloroperlidae (ny)						1						1
F. Nemouridae (ny)							4	2	1	5	3	
F. Perlidae (ny)						1						1
F. Perlodidae (ny)							12	5	4	4		
F. Leuctridae (ny)												
F. Polycentropodidae (ny)												
F. Pteronarcyidae (ny)												
F. Taeniopterygidae (ny)							5		4	3	1	
O. Trichoptera (L)												
O. Trichoptera (P)												
F. Brachycentridae (L)												
F. Glossosomatidae (L)							1	1				
F. Hydroptilidae (L)												
F. Limnephilidae (L)												
F. Lepidostomatidae (L)						1		2		1	1	1
F. Leptoceridae (L)												
F. Hydropsychidae (L)							2	3		1	1	
F. Rhyacophilidae (L)												
F. Athericidae (L)												
F. Blephariceridae (L)												
O. Diptera (l)												
F. Chironomidae (L)	1	8	10	3	1	15	399	740	246	652	320	15
F. Ceratopogonidae (L)												
F. Dixidae (L)												
F. Dolichopodidae (L)												
F. Empididae (L)						2	1	7	4	2		2
F. Simuliidae (L)												
F. Psychodidae (L)												
F. Tanyderidae (L)												
F. Tipulidae (L)									1		1	
O. Coleoptera (l)												
F. Dytiscidae (ad)												
F. Dytiscidae (ny)												
F. Elmidae (l)												
F. Hydrochidae												
F. Hydrophilidae												
O. Lepidoptera (l)												
O. Amphipoda (Scud)												
O. Mysidacae												
O. Acarina						1	1			1		1
Bivalva												
Gastropoda (snails)												
P. Nemata								3				
P. Nematoda												
S-C. Oligochaeta						2	4	8	2	11	8	2
O. Homoptera												
F. Corixidae (ad)												
F. Corixidae (ny)												
Zooplankton						1						1
Invertebrate (imm)												
Invertebrate Eggs												
Hirudinea												
Fish												
Fish Fry												
Total # of Organisms	2	8	10	4	2	18	598	916	329	822	406	1557
Total Organisms per m2												
Mean # organisms per m2												
Standard Deviation												
Total # species	2	1	1	2	2	9	14	14	11	15	12	9
Mean # species			1.6						13.2			
Standard Deviation			0.547722558						1.643167673			

Unclear of sampling device
Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drive s\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010 \1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

CAN024231_0104

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref	Ref	Ref	Ref	Ref	Totals	Scalp	Scalp	Scalp	Scalp	Scalp	Totals	Scalp	Scalp	Scalp	Scalp	Scalp	Totals	Ref	Ref	Ref	Ref	Ref	Totals	Ref	Ref	Ref	Ref	Ref	Totals
Episode																														
Date	15-Jan-08	15-Jan-08	15-Jan-08	15-Jan-08	15-Jan-08	16-Mar-05	12-Feb-08	12-Feb-08	12-Feb-08	12-Feb-08	12-Feb-08	16-Mar-05	12-Feb-08	12-Feb-08	12-Feb-08	12-Feb-08	12-Feb-08	16-Mar-05	15-Feb-08	15-Feb-08	15-Feb-08	15-Feb-08	15-Feb-08	16-Mar-05	15-Feb-08	15-Feb-08	15-Feb-08	15-Feb-08	15-Feb-08	16-Mar-05
Site	Seabird	Seabird	Seabird	Seabird	Seabird	Seabird	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar D	Spring Bar D	Spring Bar D	Spring Bar D	Spring Bar D	Spring Bar D	Herrling	Herrling	Herrling	Herrling	Herrling	Herrling	Railway	Railway	Railway	Railway	Railway	Railway
Sample #	1	2	3	4	5	Totals	1	2	3	4	5	Totals	1	2	3	4	5	Totals	1	2	3	4	5	Totals	1	2	3	4	5	Totals
Velocity (cm/s)																														
Substrate																														
O. Ephemeroptera (ny)																														
F. Ameletidae (ny)	5	6	2	18	10				1	2			5	9	2	5	1				1							1		
F. Baetidae (ny)	8		1	1	3	3	5	6		7	6	3					3	3	1		1	1		3	1				1	3
F. Ephemerellidae (ny)	21	1	4	7	21		4	1		3	7		1	1	9	1											1		1	
F. Heptageniidae (ny)	4	1		1	2		4	3	3	4	9		1	1	4	1	3		11	11	16	8	6		10	2	4	8	5	
F. Leptophlebiidae (ny)																													1	
F. Tricorythidae (ny)																														
O. Plecoptera (ny)																														
F. Capniidae (ny)	7	4	1	13	5		4	14	1	15	2		1	1	2	2			12	5	23	20	17		18		7	15	17	
F. Chloroperlidae (ny)		1		1		1						1						1						1						1
F. Nemouridae (ny)	1		1																	1	1				1				1	
F. Perlidae (ny)						1						1						1						1					1	1
F. Perlodidae (ny)		1																												
F. Leuctridae (ny)																														
F. Polycentropodidae (ny)																														
F. Pteronarcyidae (ny)																														
F. Taeniopterygidae (ny)							1	1											1		2	3					1	2		
O. Trichoptera (L)																														
O. Trichoptera (P)																														
F. Brachycentridae (L)																														
F. Glossosomatidae (L)		1																												
F. Hydroptilidae (L)																														
F. Limnephilidae (L)																														
F. Lepidostomatidae (L)						1						1						1						1	1					1
F. Leptoceridae (L)																														
F. Hydropsychidae (L)		1		1						1																	1			
F. Rhyacophilidae (L)																														
F. Athericidae (L)																														
F. Blephariceridae (L)																														
O. Diptera (l)																														
F. Chironomidae (L)	109	19	66	69	39	15	67	74	25	85	136	15	3	18	19	16	3	15	6	10	21	23	34	15	7	9	4	5	12	15
F. Ceratopogonidae (L)	10	9	3	6	5																									
F. Dixidae (L)																														
F. Dolichopididae (L)																														
F. Empididae (L)		2		3	2	2				2	2	2		1				2						2						2
F. Simuliidae (L)																	2													
F. Psychodidae (L)																														
F. Tanyderidae (L)																														
F. Tipulidae (L)																														
O. Coleoptera (l)																														
F. Dytiscidae (ad)		1																												
F. Dytiscidae (ny)																														
F. Elmidae (l)																														
F. Hydrochidae																														
F. Hydrophilidae																														
O. Lepidoptera (l)																														
O. Amphipoda (Scud)																														
O. Mysidacae																														
O. Acarina						1						1						1						1						1
Bivalva																														
Gastropoda (snails)																														
P. Nemata	1				2											1	1													
P. Nematoda																														
S-C. Oligochaeta	89	70	42	106	50	2						2						2	1					2						2
O. Homoptera																														
F. Corixidae (ad)																														
F. Corixidae (ny)																														
Zooplankton						1						1		1				1						1						1
Invertebrate (imm)																														
Invertebrate Eggs																														
Hirudinea																														
Fish																														
Fish Fry																														
Total # of Organisms	255	117	120	226	139	485	85	99	30	119	162	311	11	32	36	26	13	75	32	27	65	55	57	177	38	11	18	31	39	38
Total Organisms per m2																														
Mean # organisms per m2																														
Standard Deviation																														
Total # Species	10	13	8	11	10	9	6	6	4	8	6	9	5	7	5	6	6	9	6	4	7	5	3	9	6	2	6	5	8	9
Mean # Species	10.4						6						5.8						5						5.4					
Standard Deviation	1.816590212						1.414213562						0.836660027						1.58113883						2.19089023					

Unclear of sampling device
Grab sampler used

Table A5-1 Benthos Raw Data (con't)

Treatment	Ref	Ref	Ref	Ref	Ref	Totals	Scalp	Scalp	Scalp	Scalp	Scalp	Totals
Episode												
Date	12-Feb-08	12-Feb-08	12-Feb-08	12-Feb-08	12-Feb-08	16-Mar-05	7-Mar-08	7-Mar-08	7-Mar-08	7-Mar-08	7-Mar-08	16-Mar-05
Site	Seabird	Seabird	Seabird	Seabird	Seabird	Seabird	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar C	Spring Bar C
Sample #	1	2	3	4	5	Totals	1	2	3	4	5	Totals
Velocity (cm/s)												
Substrate												
O. Ephemeroptera (ny)												
F. Ameletidae (ny)	2	12	1	7	7					2		
F. Baetidae (ny)	1				2	3	31	43	33	32	19	3
F. Ephemerellidae (ny)	1	3	2	6	17		21	10	27	12	12	
F. Heptageniidae (ny)	2	1	1	1	12		12	20	20	16	12	
F. Leptophlebiidae (ny)												
F. Tricorythidae (ny)												
O. Plecoptera (ny)												
F. Capniidae (ny)	5	5	4	7	5		9	11	3	10	3	
F. Chloroperlidae (ny)						1						1
F. Nemouridae (ny)							1		4	1	2	
F. Perlidae (ny)						1						1
F. Perlodidae (ny)								3		1		
F. Leuctridae (ny)												
F. Polycentropodidae (ny)												
F. Pteronarcyidae (ny)												
F. Taeniopterygidae (ny)			1	1			1					
O. Trichoptera (L)												
O. Trichoptera (P)												
F. Brachycentridae (L)												
F. Glossosomatidae (L)												
F. Hydroptilidae (L)												
F. Limnephilidae (L)												
F. Lepidostomatidae (L)						1	1	1	1	1	1	1
F. Leptoceridae (L)												
F. Hydropsychidae (L)		1		2			2			1		
F. Rhyacophilidae (L)												
F. Athericidae (L)												
F. Blephariceridae (L)												
O. Diptera (I)												
F. Chironomidae (L)	8	53	35	36	65	15	387	507	309	404	287	15
F. Ceratopogonidae (L)		1							1			
F. Dixidae (L)												
F. Dolichopodidae (L)												
F. Empididae (L)		1		2	1	2	2		3	3	3	2
F. Simuliidae (L)												
F. Psychodidae (L)												
F. Tanyderidae (L)												
F. Tipulidae (L)												
O. Coleoptera (I)												
F. Dytiscidae (ad)												
F. Dytiscidae (ny)												
F. Elmidae (I)												
F. Hydrochidae												
F. Hydrophilidae												
O. Lepidoptera (I)												
O. Amphipoda (Scud)												
O. Mysidacae												
O. Acarina						1			1	1	1	1
Bivalva												
Gastropoda (snails)												
P. Nemata		1					2	5	1	4	2	
P. Nematoda												
S-C. Oligochaeta		1		4	1	2	3	4	2	5		2
O. Homoptera												
F. Corixidae (ad)												
F. Corixidae (ny)												
Zooplankton						1						1
Invertebrate (non)												
Invertebrate Eggs												
Hirudinea												
Fish												
Fish Fry												
Total # of Organisms	19	79	44	66	110	220	472	604	405	493	342	1240
Total Organisms per m2												
Mean # organisms per m2												
Standard Deviation												
Total # species	6	10	6	9	8	9	12	9	12	14	10	9
Mean # species			7.8						11.4			
Standard Deviation			1.788854382						1.949358869			

Treatment	Scalp	Scalp	Scalp	Scalp	Excavation	Totals	Ref	Ref	Ref	Ref	Ref	Totals
Episode												
Date	7-Mar-08	7-Mar-08	7-Mar-08	7-Mar-08	7-Mar-08	16-Mar-05	13-Mar-08	13-Mar-08	13-Mar-08	13-Mar-08	13-Mar-08	16-Mar-05
Site	Spring Bar D	Spring Bar D	Spring Bar D	Spring Bar D	Spring Bar D	Spring Bar D	Herring	Herring	Herring	Herring	Herring	Herring
Sample #	1	2	3	4	5	Totals	1	2	3	4	5	Totals
Velocity (cm/s)												
Substrate												
O. Ephemeroptera (ny)												
F. Ameletidae (ny)		1										
F. Baetidae (ny)	18	6	12	35	3	3						3
F. Ephemerellidae (ny)	1	2	1	4	1						1	
F. Heptageniidae (ny)	3	2	8	14	3		18	19	2	38	4	
F. Leptophlebiidae (ny)												
F. Tricorythidae (ny)												
O. Plecoptera (ny)												
F. Capniidae (ny)	12	1	3	9	13		38	4	17	8	7	
F. Chloroperlidae (ny)						1						1
F. Nemouridae (ny)			1	1			1		1			
F. Perlidae (ny)						1						1
F. Perlodidae (ny)								1				
F. Leuctridae (ny)												
F. Polycentropodidae (ny)												
F. Pteronarcyidae (ny)												
F. Taeniopterygidae (ny)	1	4	5	6	8							
O. Trichoptera (L)												
O. Trichoptera (P)												
F. Brachycentridae (L)												
F. Glossosomatidae (L)												
F. Hydroptilidae (L)												
F. Limnephilidae (L)												
F. Lepidostomatidae (L)						1						1
F. Leptoceridae (L)												
F. Hydropsychidae (L)												
F. Rhyacophilidae (L)												
F. Athericidae (L)												
F. Blephariceridae (L)												
O. Diptera (I)												
F. Chironomidae (L)	251	89	112	296	139	15	31	40	61	56	98	15
F. Ceratopogonidae (L)	1		1	1								
F. Dixidae (L)												
F. Dolichopodidae (L)												
F. Empididae (L)					2	2	1	1				2
F. Simuliidae (L)												
F. Psychodidae (L)												
F. Tanyderidae (L)												
F. Tipulidae (L)										1		
O. Coleoptera (I)												
F. Dytiscidae (ad)												
F. Dytiscidae (ny)												
F. Elmidae (I)												
F. Hydrochidae												
F. Hydrophilidae												
O. Lepidoptera (I)												
O. Amphipoda (Scud)												
O. Mysidacae												
O. Acarina						1						1
Bivalva												
Gastropoda (snails)												
P. Nemata		1			2							
P. Nematoda												
S-C. Oligochaeta			1	1		2		1				2
O. Homoptera												
F. Corixidae (ad)												
F. Corixidae (ny)												
Zooplankton						1						1
Invertebrate (non)												
Invertebrate Eggs												
Hirudinea												
Fish												
Fish Fry												
Total # of Organisms	287	106	144	367	171	882	89	66	81	103	110	294
Total Organisms per m2												
Mean # organisms per m2												
Standard Deviation												
Total # species	7	8	9	9	8	9	5	6	4	4	4	9
Mean # species			8.2						4.6			
Standard Deviation			0.836660027						0.894427191			

Treatment	Ref	Ref	Ref	Ref	Ref	Totals	Ref	Ref	Ref	Ref	Ref	Totals
Episode												
Date	13-Mar-08	13-Mar-08	13-Mar-08	13-Mar-08	13-Mar-08	16-Mar-05	7-Mar-08	7-Mar-08	7-Mar-08	7-Mar-08	7-Mar-08	16-Mar-05
Site	Railway	Railway	Railway	Railway	Railway	Railway	Seabird	Seabird	Seabird	Seabird	Seabird	Seabird
Sample #	1	2	3	4	5	Totals	1	2	3	4	5	Totals
Velocity (cm/s)												
Substrate												
O. Ephemeroptera (ny)												
F. Ameletidae (ny)							3	5	2			
F. Baetidae (ny)	1	2				3	25	41	43	48	31	3
F. Ephemerellidae (ny)	1	1	6	1					4	2	10	
F. Heptageniidae (ny)	19	4	24	10	9			1	4	3	2	
F. Leptophlebiidae (ny)	2		2									
F. Tricorythidae (ny)												
O. Plecoptera (ny)												
F. Capniidae (ny)	15	13	10	17	4		22	34	3	8	1	
F. Chloroperlidae (ny)						1						1
F. Nemouridae (ny)	2		4	2	1		2	3	2			
F. Perlidae (ny)						1						1
F. Perlodidae (ny)											1	
F. Leuctridae (ny)												
F. Polycentropodidae (ny)												
F. Pteronarcyidae (ny)												
F. Taeniopterygidae (ny)								2				
O. Trichoptera (L)												
O. Trichoptera (P)												
F. Brachycentridae (L)												
F. Glossosomatidae (L)												
F. Hydroptilidae (L)												
F. Limnephilidae (L)												
F. Lepidostomatidae (L)						1						1
F. Leptoceridae (L)												
F. Hydropsychidae (L)				1				1			1	
F. Rhyacophilidae (L)												
F. Athericidae (L)												
F. Blephariceridae (L)												
O. Diptera (I)												
F. Chironomidae (L)	198	53	157	203	52	15	103	118	153	106	148	15
F. Ceratopogonidae (L)			1				1					
F. Dixidae (L)												
F. Dolichopodidae (L)												
F. Empididae (L)				2		2			1		1	2
F. Simuliidae (L)												
F. Psychodidae (L)												
F. Tanyderidae (L)												
F. Tipulidae (L)	1											
O. Coleoptera (I)												
F. Dytiscidae (ad)												
F. Dytiscidae (ny)												
F. Elmidae (I)												
F. Hydrochidae												
F. Hydrophilidae												
O. Lepidoptera (I)												
O. Amphipoda (Scud)												
O. Mysidacae												
O. Acarina						1						
Bivalva												
Gastropoda (snails)												
P. Nemata	2			1							2	2
P. Nematoda												
S-C. Oligochaeta						2		1	1			2
O. Homoptera												
F. Corixidae (ad)												
F. Corixidae (ny)												
Zooplankton						1						
Invertebrate (non)												
Invertebrate Eggs												
Hirudinea												
Fish												
Fish Fry												
Total # of Organisms	241	73	204	237	66	507	156	206	213	167	197	577
Total Organisms per m2												
Mean # organisms per m2												
Standard Deviation												
Total # species	9	5	7	8	4	9	6	9	9	5	9	8
Mean # species			6.6						7.6			
Standard Deviation			2.073644135						1.949358869			

Unclear of sampling device
Grab sampler used

\\nats01\NSD\CDCI NCR Inquiry\Network Shared Drives\Habitat\X HM & ES\HM&ES Directorate\HP&SD\OPERATIONAL LIAISON\HCM\copy of shared drive Jan 26 2010\1. Pacific\7. Reports\Fraser River Sed Removal Surveys - FINAL.pdf

Table A5-2: Fish Raw Data

Big Bar Fish Sampling September 8, 2006

Species	Bar edge flat 1 (108m2)	2 (96m2)	3 (100m2)	4 (96m2)	5 (96m2)	Total	Bay 1 (64m2)	2 (144m2)	3 (144m2)	4 (144m2)	5 (144m2)	Total
Coast Range Sculpin (Cottus aleuticus)										1		1
Mountain Whitefish (Prosopium williamsoni)			1			1	1 (mort)					
Longnose Dace (Rhinichthys cataractae)	1	3	1	9	1	15		2	4	28	6	40
Large Scale Sucker (Catostomus macrocheilus)		3	2			5						
Sucker Sp.											1	1
Northern Pike Minnow (Ptychocheilus oregonius)					2	2				1	22	23
Redside Shiner (Richardsonius balteatus)	69	75		20		164				2	3	5
Leopard Dace (Rhinichthys falcatus)	5	20	2	34	1	62	26	6	14	64	424	534
Peamouth Chub (Mylocheilus caurinus)	3					3					4	4
Pumpkinseed Sunfish (Lepomis gibbosus)												
Prickly Sculpin (Cottus asper)												
Rainbow Trout (Oncorhynchus mykiss)												
Chinook Fry and Smolts (Oncorhynchus tshawytscha)	3	2				5						
Coho Fry and Smolts (Oncorhynchus kisutch)			1			1						
Stickleback Sp.												
Mountain Sucker (Catostomusplatyrhynchus)												
Unidentified Sp.				8		8		5		124	319	448
Total Number Fish	81	103	7	71	4	266	26	13	18	220	779	1056
Mean Abundance	53.2						211.2					
SD	46.07						329.16					
Total Number Species	5	5	5	4	3	10	1	3	2	6	7	8
Mean Species Richness	4.4						3.8					
SD	0.89						2.59					
CPUE (fish per m2sampled)	0.75	1.07	0.07	0.74	0.04		0.41	0.09	0.13	1.53	5.41	
Mean CPUE	0.53						1.51					
SD	0.46						2.26					

Gill Central fish sampling (August 30, 2006) (Set number and area sampled) and **Gill East (August 30, 2006)** (Set number and area sampled - Bar Edge Steep)

Species	Gill Central 1 (144m2)	2 (64m2)	3 (144m2)	4 (144m2)	5 (144m2)	Total	Gill East Steep 1 (72m2)	2 (72m3)	3 (54m2)	4 (48m2)	5 (35m2)	Total
Coast Range Sculpin (Cottus aleuticus)												
Mountain Whitefish (Prosopium williamsoni)	56			4		60						
Longnose Dace (Rhinichthys cataractae)												
Large Scale Sucker (Catostomus macrocheilus)												
Sucker Sp.							8				9	17
Northern Pike Minnow (Ptychocheilus oregonius)					2	2	1					1
Redside Shiner (Richardsonius balteatus)												
Leopard Dace (Rhinichthys falcatus)									1			1
Peamouth Chub (Mylocheilus caurinus)					2	2	16	8	4	3	9	40
Pumpkinseed Sunfish (Lepomis gibbosus)												
Prickly Sculpin (Cottus asper)					2	2	1					1
Rainbow Trout (Oncorhynchus mykiss)												
Chinook Fry and Smolts (Oncorhynchus tshawytscha)	34					34						
Coho Fry and Smolts (Oncorhynchus kisutch)												
Stickleback Sp.												
Mountain Sucker (Catostomusplatyrhynchus)												
Unidentified Sp.	30	10	20	20	25	105		20	25	25	26	96
Total Number Fish	120	10	20	24	31	205	26	28	30	28	44	156
Mean Abundance	41						31.2					
SD	44.8						7.3					
Total Number Species	3	1	1	2	4	6	4	2	3	2	3	6
Mean Species Richness	2.2						2.8					
SD	1.3						0.8					
CPUE (fish per m2sampled)	0.83	0.16	0.14	0.17	0.22		0.36	0.39	0.56	0.58	1.26	
Mean CPUE	0.3						0.63					
SD	0.3						0.37					

Gill East (August 30, 2006) (Set number and area sampled - Riffle) and **Gill East (September 8, 2006)** (Set number and area sampled - Nook)

Species	Riffle 1 (108m2)	2 (200m2)	3 (160m2)	4 (180m2)	5 (176m2)	Total	Nook 1 (96m2)	2 (96m3)	3 (144m2)	4 (144m2)	5 (96m2)	Total
Coast Range Sculpin (Cottus aleuticus)												
Mountain Whitefish (Prosopium williamsoni)												
Longnose Dace (Rhinichthys cataractae)	3	1				4						
Large Scale Sucker (Catostomus macrocheilus)												
Sucker Sp.			1			1			13			13
Northern Pike Minnow (Ptychocheilus oregonius)	1		6	2	4	13		1	1	4		6
Redside Shiner (Richardsonius balteatus)				2	1	3						
Leopard Dace (Rhinichthys falcatus)	3	9	5	2	3	22		2	1	2		5
Peamouth Chub (Mylocheilus caurinus)	5	29	19	1	1	55	1	36	43	11		91
Pumpkinseed Sunfish (Lepomis gibbosus)				1		1					1	1
Prickly Sculpin (Cottus asper)												
Rainbow Trout (Oncorhynchus mykiss)		1				1						
Chinook Fry and Smolts (Oncorhynchus tshawytscha)							1		1	7		9
Coho Fry and Smolts (Oncorhynchus kisutch)												
Stickleback Sp.	5	5	2	1		13						
Mountain Sucker (Catostomusplatyrhynchus)								3				3
Unidentified Sp.	17	8	2	4	3	34	20	60	50	12	2	144
Total Number Fish	34	53	35	13	12	147	22	102	109	36	3	272
Mean Abundance	29.4						54.4					
SD	17.2						48.2					
Total Number Species	6	6	6	7	5	10	3	5	6	5	2	8
Mean Species Richness	5.4						4.2					
SD	0.7						1.6					
CPUE (fish per m2sampled)	0.31	0.27	0.22	0.08	0.07		0.23	1.06	0.76	0.25	0.03	
Mean CPUE	0.19						0.466					
SD	0.11						0.43					

Table A5-2 (Con't): Fish Raw Data

Gill West Fish Sampling (May 30, 2005)

Species	Bar edge flat 1 (30m2)	2 (30m2)	3 (30m2)	Total	Open Nook 1 (50 m2)	2 (50 m2)	3 (50 m2)	Total	Bar Edge flat 1 (20 m2)	2 (20 m2)	3 (20 m2)	Total	Open Nook 1 (50 m2)	2 (50 m2)	3 (50 m2)	Total
Coast Range Sculpin (Cottus aleuticus)	1			1						2	2	4				
Mountain Whitefish (Prosopium williamsoni)	3			3												
Longnose Dace (Rhinichthys cataractae)		1	1	2		2	1	3			1	1		2	1	3
Large Scale Sucker (Catostomus macrocheilus)			1	1												
Sucker Sp.			1	1												
Northern Pike Minnow (Ptychocheilus oregonius)					6	4		10								
Redside Shiner (Richardsonius balteatus)					7	6	12	25					4	1		5
Leopard Dace (Rhinichthys falcatus)	1			1	1	2	16	19					13	9	9	31
Peamouth Chub (Mylocheilus caurinus)						1		1								
Pumpkinseed Sunfish (Lepomis gibbosus)																
Prickly Sculpin (Cottus asper)						1		1	1			1	4	6	3	13
Rainbow Trout (Oncorhynchus mykiss)																
Chinook Fry and Smolts (Oncorhynchus tshawytscha)		1		1	9	2	5	16	3		3	6	13	2	5	20
Coho Fry and Smolts (Oncorhynchus kisutch)																
Stickleback Sp.																
Mountain Sucker (Catostomusplatyrhynchus)									1			1				
Unidentified Sp.					6	22	10	38								
Total Number Fish	5	2	3	10	29	40	44	113	5	2	6	13	34	20	18	72
Mean Abundance	3.3				37.7				4.3				24.0			
SD	1.5				7.8				2.1				8.7			
Total Number Species	3	2	3	6	5	8	5	8	3	1	3	5	4	5	4	5
Mean Species Richness	2.7				5				2.3				3			
SD	0.6				1.7				1.2				0.6			
CPUE (fish per m2sampled)	0.17	0.07	0.1		0.58	0.8	0.88		0.25	0.1	0.3		0.68	0.4	0.36	
Mean CPUE	0.11				0.75				0.22				0.48			
SD	0.05				0.16				0.1				0.17			

Herrling Fish Sampling Scalp 2 (Dec 2007) (Set Number and Sample Area (m2)) and **Herrling Fish Sampling Scalp 3 (Dec 2007)** (Set number and sample area (m2))

Species	Scalp 2: 1 (40 m2)	2 (45 m2)	3 (80 m2)	4 (140 m2)	5 (125 m2)	Total	Scalp 3: 1 (240 m2)	2 (400 m2)	3 (400 m2)	4 (400 m2)	5 (280 m2)	Total
Coast Range Sculpin (Cottus aleuticus)												
Mountain Whitefish (Prosopium williamsoni)												
Longnose Dace (Rhinichthys cataractae)												
Large Scale Sucker (Catostomus macrocheilus)					2	2						
Sucker Sp.												
Northern Pike Minnow (Ptychocheilus oregonius)												
Redside Shiner (Richardsonius balteatus)												
Leopard Dace (Rhinichthys falcatus)												
Peamouth Chub (Mylocheilus caurinus)												
Pumpkinseed Sunfish (Lepomis gibbosus)												
Prickly Sculpin (Cottus asper)				1	1	2						
Rainbow Trout (Oncorhynchus mykiss)												
Chinook Fry and Smolts (Oncorhynchus tshawytscha)			1			1						
Coho Fry and Smolts (Oncorhynchus kisutch)												
Stickleback Sp.												
Mountain Sucker (Catostomusplatyrhynchus)												
Unidentified Sp.					1	1		16	12	3	2	33
Total Number Fish	0	0	1	1	4	6	0	16	12	3	2	33
Mean Abundance	1.2						6.6					
SD	1.6						7.0					
Total Number Species	0	0	1	1	3	4	0	1	1	1	1	1
Mean Species Richness	1						0.8					
SD	1.2						0.4					
CPUE (fish per m2sampled)	0	0	0.01	0.01	0.03	0.01	0	0.04	0.03	0.01	0.01	0.02
Mean CPUE	0.01						0.02					
SD	0.01						0.02					

Gill West Fish Sampling (August 2005) (Set number and area sampled - Bar Edge Flat (scalp); Set number and area sampled - Bar Edge Flat (reference))

Species	Scalp 1 (96m2)	2 (120m2)	3 (144m2)	4 (168m2)	5 (180m2)	Total	Reference 1 (60m2)	2 (72m2)	3 (36m2)	4 (48m2)	5 (72m2)	Total
Coast Range Sculpin (Cottus aleuticus)												
Mountain Whitefish (Prosopium williamsoni)												
Longnose Dace (Rhinichthys cataractae)							1					
Large Scale Sucker (Catostomus macrocheilus)							3					
Sucker Sp.	4	1				5						
Northern Pike Minnow (Ptychocheilus oregonius)	13	15	2	1	24	55	4	2				6
Redside Shiner (Richardsonius balteatus)					7	7	7	1	8	4	9	29
Leopard Dace (Rhinichthys falcatus)					18	18						
Peamouth Chub (Mylocheilus caurinus)												
Pumpkinseed Sunfish (Lepomis gibbosus)												
Prickly Sculpin (Cottus asper)												
Rainbow Trout (Oncorhynchus mykiss)												
Chinook Fry and Smolts (Oncorhynchus tshawytscha)							1	4	5		2	12
Coho Fry and Smolts (Oncorhynchus kisutch)					2	2						
Stickleback Sp.												
Mountain Sucker (Catostomusplatyrhynchus)												
Unidentified Sp.												
Total Number Fish	17	16	2	1	51	87	16	7	13	4	11	51
Mean Abundance	17.4						10.2					
SD	20.23						4.76					
Total Number Species	2	2	1	1	3	5	5	3	2	1	2	5
Mean Species Richness	1.8						2.6					
SD	0.84						1.52					
CPUE (fish per m2sampled)	0.18	0.13	0.01	0.01	0.28		0.27	0.1	0.36	0.08	0.15	
Mean CPUE	0.12						0.19					
SD	0.12						0.12					

Table A5-3: Sediment Raw Data

Site	Big Bar Scalp														
Channel	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side
Date	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	13-Mar-06	13-Mar-06	13-Mar-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07
Photo no.	4	1	2	3	2101a	2103b	2105c	3516a	3517b	3519c	3521d	6490	6492	6494	6491
No. Stones	43	279	689	183	393	569	711	728	894	732	786	607	486	446	550
% Sand	90.85	6.08	0	27.6	0.67	1.7	13.52	0.32	0.38	0.2	1.04	1.34	2.8	1.6	2.06
% Shadow	0	17.54	28.3	38.75	18.69	13.26	15.94	8.69	7.65	7.97	10.3	4.34	2	1.44	3.74
% lost	90.85	23.62	28.3	66.35	19.36	14.96	29.46	9.01	8.03	8.17	11.34	5.68	4.8	3.04	5.8
% left	9.15	76.38	71.7	33.65	80.64	85.04	70.54	90.99	91.97	91.83	88.66	94.32	95.2	96.96	94.2
Stones/quadrat	469.95	365.28	960.95	543.83	487.35	669.1	1007.94	800.09	972.06	797.13	886.53	643.55	510.5	459.98	583.86
Stones/m2	1879.78	1461.12	3843.79	2175.33	1949.4	2676.39	4031.76	3200.35	3888.22	3188.5	3546.13	2574.22	2042.02	1839.93	2335.46
D5 (mm)	12.47	14.01	9.23	11.66	11.08	10.18	8.78	9.7	9.2	9.71	9.43	10.28	10.95	11.26	10.56
D50 (mm)	27.1	30.43	20.01	25.34	27.72	23.81	19.08	21.85	19.9	21.89	20.8	24.26	27.11	28.5	25.42
D95 (mm)	67.72	76.62	39.7	63.05	53.52	46.56	46.6	43.03	39.5	43.1	41.13	47.36	52.44	54.9	49.43
Average Stone Size (cm2)	4.61	5.23	3.23	4.29	4.53	3.87	3.15	3.54	3.21	3.54	3.36	3.94	4.43	4.66	4.14

Site	Big Bar Reference														
Channel	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main
Date	27-Oct-04	27-Oct-04	27-Oct-04	27-Oct-04	11-Mar-06	11-Mar-06	11-Mar-06	16-Aug-06	16-Aug-06	16-Aug-06	16-Aug-06	22-Nov-07	22-Nov-07	22-Nov-07	22-Nov-07
Photo no.	1	2	3	1a	0233a	0235b	0237c	3499a	3500b	3501c	3502d	6456	6459	6458	6457
No. Stones	226	90	112	959	645	311	298	483	243	433	632	89	178	237	235
% Sand	33.09	36.2	77.42	39.75	0.28	25.13	7.26	23.93	16.88	26.42	7.72	44.75	38.05	19.6	24.15
% Shadow	0.3	0	1.24	7.15	8.3	6.8	8.06	15.76	16.2	13.44	9.79	1.3	0.28	3.45	1.4
% lost	33.39	36.2	78.66	46.9	8.58	31.93	15.32	39.69	33.08	39.86	17.51	46.05	38.33	23.05	25.55
% left	66.61	63.8	21.34	53.1	91.42	68.07	84.68	60.31	66.92	60.14	82.49	53.95	61.67	76.95	74.45
Stones/quadrat	339.29	141.07	524.84	1806.03	705.53	456.88	351.91	800.86	363.12	719.99	766.15	164.97	288.63	307.99	315.65
Stones/m2	1357.15	564.26	2099.34	7224.11	2822.14	1827.53	1407.65	3203.45	1452.48	2879.95	3064.61	659.87	1154.53	1231.97	1262.59
D5 (mm)	14.49	21.7	11.85	6.71	10.03	12.64	14.25	9.76	14.04	10.25	9.96	20.19	15.61	15.15	14.98
D50 (mm)	31.48	47.13	25.75	14.59	23.21	27.45	30.95	21.2	30.51	22.27	21.64	43.86	33.91	32.91	32.54
D95 (mm)	79.44	122.13	64.15	35.01	45.48	68.66	78.03	52.15	76.84	54.95	53.3	113.11	85.99	83.3	82.31
Average Stone Size (cm2)	5.43	8.42	4.37	2.35	3.76	4.68	5.33	3.53	5.25	3.73	3.61	7.79	5.89	5.7	5.63

Site	Gill Central Scalp Site													
Channel	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side
Date	27-Oct-04	27-Oct-04	6-Mar-06	6-Mar-06	6-Mar-06	6-Mar-06	18-Aug-06	18-Aug-06	18-Aug-06	18-Aug-06	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07
Photo no.	1b	1a	5	4	2	1	3586d	3585c	3581b	3578a	6366	6367	6369	6368
No. Stones	797	397	693	437	366	454	355	1463	530	769	84	0	464	0
% Sand	1.7	4.93	0	0	1.16	0.12	3.06	1.06	14.76	14.32	78.5	100	28.6	100
% Shadow	10.65	2.43	14.4	9.69	12.24	12.89	5.94	5.93	13.51	8.07	0	0	0.15	0
% lost	12.35	7.36	14.4	9.69	13.4	13.01	9	6.99	28.27	22.39	78.5	100	28.75	100
% left	87.65	92.64	85.6	90.31	86.6	86.99	91	93.01	71.73	77.61	21.5	0	71.25	0
Stones/quadrat	909.3	428.54	809.58	483.89	422.63	521.9	390.11	1572.95	738.88	990.85	390.7	0	651.23	0
Stones/m2	3637.19	1714.16	3238.32	1935.56	1690.53	2087.6	1560.44	6291.8	2955.53	3963.41	1562.79	0	2604.91	0
D5 (mm)	9.37	11.48	9.66	11.11	11.52	10.88	11.77	8.08	10.13	8.85	13.58	N/A	10.73	N/A
D50 (mm)	20.55	29.49	21.73	27.82	29.69	26.83	30.85	15.8	22.01	19.23	29.5	N/A	23.32	N/A
D95 (mm)	40.68	56.64	42.81	53.69	56.99	51.93	59.03	31.96	54.25	46.99	74.14	N/A	57.72	N/A
Average Stone Size (cm2)	3.32	4.83	3.51	4.55	4.86	4.38	5.06	2.52	3.68	3.18	5.06	N/A	3.92	N/A

Table A5-3 (Con't): Sediment Raw Data

Site	Gill Central Sediment Reference Site											
Channel	Side	Side	Side	Side	Side	Side	Side	Side	Main	Main	Main	Main
Date	27-Oct-04	27-Oct-04	7-Mar-06	7-Mar-06	7-Mar-06	18-Aug-06	18-Aug-06	18-Aug-06	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07
Photo no.	1 R a	1 R b	1	3	4	3595a	3593c	3597b	6431	6430	6429	6428
No. Stones	375	521	476	191	413	341	424	392	461	613	13	423
% Sand	22.25	7.33	18.67	10.98	1.62	12.4	11.31	7.4	72.3	24.05	96.8	43.1
% Shadow	2.23	6.93	6.65	5.17	9.67	7.59	8.82	11.69	0.12	0.94	0	0
% lost	24.48	14.26	25.32	16.15	11.29	19.99	20.13	19.09	72.42	24.99	96.8	43.1
% left	75.52	85.74	74.68	83.85	88.71	80.01	79.87	80.91	27.58	75.01	3.2	56.9
Stones/quadrat	496.56	607.65	637.39	227.79	465.56	426.2	530.86	484.49	1671.5	817.22	406.25	743.41
Stones/m2	1986.23	2430.6	2549.54	911.15	1862.25	1704.79	2123.45	1937.96	6686	3268.9	1625	2973.64
D5 (mm)	12.16	11.08	10.84	17.4	11.22	13.05	11.79	12.3	6.96	9.67	13.34	10.1
D50 (mm)	26.42	24.08	23.55	37.81	28.34	28.34	25.62	26.72	15.12	21.01	28.98	21.94
D95 (mm)	65.92	59.71	58.33	96.57	54.61	71.04	63.8	66.72	36.37	51.64	72.73	54.09
Average Stone Size (cm2)	4.49	4.06	3.96	6.63	4.63	4.84	4.34	4.54	2.45	3.5	4.96	3.67

Site	Gill East Scalp											
Channel	Side	Side	Side	Side	Side	Side	Side	Side	Main	Main	Main	Main
Date	27-Oct-04	27-Oct-04	22-Mar-06	22-Mar-06	22-Mar-06	18-Aug-06	18-Aug-06	18-Aug-06	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07
Photo no.	1	3	0013a	0018b	2252c	3605a	3606b	3607c	6407	6408	6409	6410
No. Stones	182	592	923	1851	1920	980	348	1339	321	34	680	682
% Sand	3.93	7.17	4.71	16.93	8.32	1.56	33.16	1.03	35.55	85.53	5.03	4.88
% Shadow	1.75	1.79	6.96	0.16	5.16	6.86	4.6	5.39	0	0.04	0.84	1.23
% lost	5.68	8.96	11.67	17.08	13.48	8.43	37.76	6.42	35.55	85.57	5.87	6.11
% left	94.32	91.04	88.33	82.92	86.52	91.57	62.24	93.58	64.45	14.43	94.13	93.89
Stones/quadrat	192.95	650.25	1044.91	2232.36	2219.12	1070.19	559.13	1430.81	498.06	235.62	722.41	726.38
Stones/m2	771.82	2601.01	4179.62	8929.45	8876.47	4280.74	2236.52	5723.24	1992.24	942.48	2889.62	2905.53
D5 (mm)	14.23	10.74	9.02	6.09	6.11	8.96	11.51	8.29	12.14	17.14	10.23	9.95
D50 (mm)	43.25	23.34	19.23	13.23	13.27	19.01	25.02	16.53	26.38	37.23	22.23	22.89
D95 (mm)	80.46	57.76	38.26	31.56	31.65	37.86	62.2	33.32	65.82	94.98	54.86	44.9
Average Stone Size (cm2)	7.2	3.92	3.09	2.12	2.12	3.06	4.23	2.64	4.48	6.51	3.72	3.71

Site	Gill East Reference													
Channel	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Main	Main	Main	Main
Date	27-Oct-04	27-Oct-04	22-Mar-06	22-Mar-06	22-Mar-06	22-Mar-06	18-Aug-06	18-Aug-06	18-Aug-06	18-Aug-06	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07
Photo no.	R1	R2	2238a	2240b	2243c	2245d	3614a	3615b	3619c	3620d	6392	6391	6393	6395
No. Stones	176	441	450	591	495	1052	210	234	165	224	239	212	205	311
% Sand	0.04	0.36	2.43	3.48	1.82	0	3.06	2.48	3.54	5.72	10.5	8.75	14.78	11.79
% Shadow	16.13	13.46	3.04	2.88	3.01	3.81	6.93	9.49	9.7	5.79	1.77	1.6	0.08	0.1
% lost	16.17	13.82	5.47	6.35	4.83	3.81	9.99	11.97	13.24	11.51	12.27	10.35	14.86	11.89
% left	83.83	86.18	94.53	93.65	95.17	96.19	90.01	88.03	86.76	88.49	87.73	89.65	85.14	88.11
Stones/quadrat	209.94	511.74	476.03	631.1	520.14	1093.7	233.31	265.81	190.18	253.14	272.43	236.48	240.78	352.97
Stones/m2	839.76	2046.95	1904.13	2524.4	2080.56	4374.79	933.23	1063.26	760.72	1012.55	1089.71	945.9	963.12	1411.87
D5 (mm)	13.91	10.94	11.15	10.34	10.89	8.91	13.52	13.06	14.29	16.58	16.03	17.11	16.97	14.23
D50 (mm)	41.54	27.08	28.04	24.49	26.87	18.81	39.48	37.09	43.55	36.02	34.82	37.16	36.86	30.91
D95 (mm)	77.53	52.38	54.08	47.77	52.01	37.5	74.01	69.88	80.98	91.71	88.46	94.82	93.98	77.92
Average Stone Size (cm2)	6.9	4.42	4.58	3.98	4.38	3.02	6.55	6.13	7.25	6.29	6.06	6.5	6.44	5.32

Table A5-3 (Con't): Sediment Raw Data

Site	Gill West Scalp																				
Channel	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Side	Main	Main	Main	Main
Date	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	17-Mar-05	17-Mar-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07
Photo no.	4A	5A	7A	6A	8A	9A	11A	12A	13A	10A	3A	4A	12A	13A	14A	15A	16A	6339	6340	6341	6342
No. Stones	1018	967	999	957	683	2414	1766	1198	1982	1311	1928	1265	824	878	949	776	716	1326	820	962	865
% Sand	0	0.6	0.9	0.6	0	0	0	0	0	0.2	3.25	11.9	2.7	4.1	0.2	0	3.8	1.7	1.6	8.33	1.16
% Shadow	5.8	7.1	4.35	16.3	14.2	6.55	9.1	15.2	4.6	6.5	1.1	11	20.15	17.35	19.15	25.4	22.25	1.57	2.55	1.51	3.38
% lost	5.8	7.7	5.25	16.9	14.2	6.55	9.1	15.2	4.6	6.7	4.35	22.9	22.85	21.45	19.35	25.4	26.05	3.27	4.15	9.84	4.54
% left	94.2	92.3	94.75	83.1	85.8	93.45	90.9	84.8	95.4	93.3	95.65	77.1	77.15	78.55	80.65	74.6	73.95	96.73	95.85	90.16	95.46
Stones/quadrat	1080.68	1047.67	1054.35	1151.62	796.04	2583.2	1942.79	1412.74	2077.57	1405.14	2015.68	1640.73	1068.05	1117.76	1176.69	1040.21	968.22	1370.83	855.5	1066.99	906.14
Stones/m2	4322.72	4190.68	4217.41	4606.5	3184.15	10332.8	7771.18	5650.94	8310.27	5620.58	8062.73	6562.91	4272.2	4471.04	4706.76	4160.86	3872.89	5483.3	3422.01	4267.97	3624.55
D5 (mm)	8.94	9.01	9	8.79	9.71	7.07	7.63	8.32	7.49	8.33	7.55	7.02	8.97	8.86	8.74	9.03	9.21	8.38	9.52	8.55	9.38
D50 (mm)	18.92	19.2	19.14	18.35	21.91	12.45	14.28	16.63	13.82	16.68	14.03	15.25	19.02	18.61	18.16	19.27	19.94	16.88	21.16	18.58	20.59
D95 (mm)	37.7	38.22	38.11	36.66	43.13	25.69	29.13	33.51	28.28	33.59	28.66	36.7	37.9	37.15	36.32	38.34	39.57	33.96	41.78	45.31	40.74
Average Stone Size (cm2)	3.04	3.09	3.08	2.95	3.54	1.97	2.27	2.66	2.19	2.67	2.23	2.47	3.06	2.99	2.92	3.1	3.21	2.7	3.42	3.06	3.32

Site	Gill West Reference																		
Channel	Main	Main	Main	Main	Main	Side	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main
Date	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	9-Dec-04	17-Mar-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	16-Aug-05	19-Nov-07	19-Nov-07	19-Nov-07	19-Nov-07
Photo no.	16A	18A	17A	19A	20A	13A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	6438	6437	6436	6435
No. Stones	583	590	337	436	667	738	1602	1523	1350	1450	1210	1039	1200	1105	1115	771	884	753	756	881
% Sand	5.15	2.1	0	0	0.4	9.9	6.5	6.8	2.1	1	1.8	5.1	10.8	1.2	5.2	1.8	0.68	2.92	0.54	2.26
% Shadow	3.1	4.2	15.5	15.85	2.9	6	4.6	6.35	8.6	13.55	16.45	16.25	15.8	15.2	17.2	19.95	3.49	1.92	2.03	2.41
% lost	8.25	6.3	15.5	15.85	3.3	15.9	11.1	13.15	10.7	14.55	18.25	21.35	26.6	16.4	22.4	21.75	4.17	4.84	2.57	4.67
% left	91.75	93.7	84.5	84.15	96.7	84.1	88.9	86.85	89.3	85.45	81.75	78.65	73.4	83.6	77.6	78.25	95.83	95.16	97.43	95.33
Stones/quadrat	635.42	629.67	398.82	518.12	689.76	877.53	1802.02	1753.6	1511.76	1696.9	1480.12	1321.04	1634.88	1321.77	1436.86	985.3	922.47	791.3	775.94	924.16
Stones/m2	2541.69	2518.68	1595.27	2072.49	2759.05	3510.11	7208.1	7014.39	6047.03	6787.6	5920.49	5284.17	6539.51	5287.08	5747.42	3941.21	3689.87	3165.2	3103.77	3696.63
D5 (mm)	10.86	10.34	11.7	10.9	10.09	9.36	6.72	6.81	8.17	7.91	8.21	7.75	7.03	8.47	7.46	9.17	9.33	9.72	9.78	9.33
D50 (mm)	23.59	24.52	30.53	26.92	23.47	20.33	14.6	14.79	16.1	15.23	16.27	16.84	15.27	17.17	16.21	19.77	20.41	21.97	22.18	20.39
D95 (mm)	58.42	47.82	58.46	52.1	45.94	49.87	35.05	35.52	32.52	30.91	32.83	40.81	36.76	34.5	39.17	39.27	40.42	43.24	43.62	40.39
Average Stone Size (cm2)	3.97	3.99	5.01	4.39	3.81	3.38	2.36	2.39	2.57	2.43	2.6	2.75	2.47	2.75	2.64	3.19	3.29	3.55	3.59	3.29

Table A5-3 (Con't): Sediment Raw Data

Site	Herrling Island Bar Scalp														
Channel	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Side	Side	Side	Side	Side
Date	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07
Photo no.	200049	200052	200051	200053	200050	200011	200012	200009	200013	200020	200061	200065	200064	200063	200060
No. Stones	772	446	749	278	347	66	95	116	273	140	450	452	582	571	597
% Sand	37	28.3	23.8	29.3	39.6	58.3	52.6	50.6	49.8	51.2	40.7	6.4	2.5	24.6	41.9
% Shadow	0	0	0.1	0.2	0.9	0	0.1	0	0	0	0	0.7	6.1	0.3	0.1
% lost	37	28.3	23.9	29.4	40.5	58.3	52.7	50.6	49.8	51.2	40.7	7.1	8.6	24.9	42
% left	63	71.7	76.2	70.6	59.5	41.7	47.3	49.5	50.3	48.8	59.3	92.9	91.4	75.1	58.1
Stones/quadrat	1224.8	621.9	983.6	393.8	583.2	158.3	200.8	234.6	543.3	286.9	759.2	486.6	636.9	760.5	1028.4
Stones/m2	4899.3	2487.8	3934.3	1575.3	2332.8	633.1	803.4	938.3	2173.1	1147.5	3036.9	1946.6	2547.6	3042.1	4113.7
D5 (mm)	8	11	8.9	13.5	11.3	20.6	18.4	17.2	11.7	15.7	10	12.3	10.3	10	8.7
D50 (mm)	17.4	23.8	19.3	29.4	24.5	44.7	40.1	37.3	25.3	34	21.7	26.7	24.4	21.7	18.9
D95 (mm)	42.4	59	47.2	73.8	60.9	115.4	102.7	95.2	63.1	86.3	53.5	66.6	47.6	53.5	46.1
Average Stone Size (cm2)	2.9	4	3.2	5	4.1	7.9	7.1	6.5	4.3	5.9	3.6	4.5	4	3.6	3.1

Site	Herrling Island Bar Referrence					Tranmer Bar Scalp					Tranmer Bar Refference				
Channel	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main	Main
Date	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	18-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07	13-Dec-07
Photo no.	200077	200076	200075	200070	200074	200007	200004	200005	200006	200001	6825	6815	6818	6821	6823
No. Stones	166	275	357	897	361	539	394	425	349	440	746	843	903	1080	965
% Sand	42.5	31.6	23.7	9.9	28.9	7.2	4.6	7.7	16.6	5.8	2.7	0.2	0	0.2	0.3
% Shadow	5.2	9.8	10.7	4.4	6.7	2.1	1.5	3	2.2	0.6	0.2	0.1	0.2	0.3	0.2
% lost	47.7	41.4	34.4	14.3	35.6	9.3	6.1	10.7	18.8	6.4	2.9	0.3	0.2	0.5	0.4
% left	52.3	58.6	65.6	85.7	64.4	90.7	93.9	89.3	81.2	93.6	97.1	99.7	99.8	99.6	99.6
Stones/quadrat	317.5	469	544.1	1046.3	560.3	594.1	419.7	476.1	429.8	469.9	768.2	845.4	904.4	1084.9	969.1
Stones/m2	1270.1	1875.9	2176.5	4185.2	2241.2	2376.5	1678.7	1904.5	1719.2	1879.5	3072.8	3381.5	3617.8	4339.5	3876.3
D5 (mm)	14.9	12.5	11.7	8.6	11.5	11.2	11.5	12.4	13	12.5	9.8	9.6	9.4	8.9	9.2
D50 (mm)	32.5	27.1	25.3	18.8	25	24.3	29.8	26.9	28.2	27.1	22.3	21.3	20.6	18.9	19.9
D95 (mm)	82.1	67.8	63	45.8	62.1	60.4	57.2	67.3	70.8	67.7	43.8	42	40.8	37.6	39.6
Average Stone Size (cm2)	5.6	4.6	4.3	3.1	4.2	4.1	4.9	4.6	4.8	4.6	3.6	3.4	3.3	3	3.2