2009-2010 Middle Fork Willamette River and Coast Fork Willamette River Watersheds Macroinvertebrate Survey

Sample Processing and Data Analysis

SUMMARY REPORT

Prepared for

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INTRODUCTION

ABR, Inc. was contracted in 2009 by the Middle Fork Willamette River Watershed Council to perform freshwater benthic macroinvertebrate sample processing and analysis services. Between fall 2009 and fall 2010, ABR received 15 benthic samples from the Council. Sample processing included subsampling and identification of samples by following standard laboratory protocols and adhering to a thorough quality control plan, as described herein. Taxonomic data were then analyzed using the Oregon Marine Western Coastal Forest (MWCF) and Western Cordillera and Columbia Plateau (WCCP) predictive models and the western Oregon multimetric index. This report details the laboratory methods and analyses used and the results of the data analyses of these 15 samples.

METHODS

LABORATORY PROTOCOLS

Upon arrival at our laboratory, we ensured that all samples were properly labeled and preserved. Each sample was assigned a unique internal tracking number (09-621-XX for 2009 and 10-651-XX for 2010 samples) that accompanied the project and sample information provided by the client. All of this information was entered into the project's sample log that was maintained in the laboratory.

ABR used trained and tested laboratory technicians, Nick Haxton and Matt Apling, to sort macroinvertebrates from raw field samples for this project. Each sample was processed using strict laboratory sample handling and labeling protocols (Cole, M. B. 2010. Macroinvertebrate Sample Handling and Sorting Procedures. Unpublished internal ABR training and reference document). A Caton gridded tray was used to subsample approximately 525 organisms from each sample. Using this subsampling procedure, each sample was distributed evenly across a 30-square wire-mesh tray. Individual squares were randomly selected and the contents removed and placed into a Petri dish. Macroinvertebrates were removed from the sample material under a dissecting microscope. This process was repeated until a total count of 525-550 organisms was achieved. The remainder of the sample (the unsorted fraction) was then inspected for large or rare taxa that were not encountered during subsampling; these "large/rare" taxa were recorded on the laboratory bench sheet as such and placed in a separate vial. All macroinvertebrate samples will be saved by ABR for a minimum of two years. Two sample residues (13% of sample lot) were inspected by the laboratory manager, Nick Haxton, to determine whether macroinvertebrate sorts were attaining 95% efficacy.

Macroinvertebrate identification also followed standard protocols (Cole, M. B. 2010. Macroinvertebrate Sample Identification Standard Operating Procedures, Unpublished ABR training and reference manual). Macroinvertebrates were identified to standard levels of resolution used for Level III bioassessments in Oregon (WQIQ 1999). Specimens identified for this project but not previously encountered during processing of western Oregon samples were added to ABR's master reference specimen collection.

DATA ANALYSIS

Predictive Models

All raw data were entered into an Excel spreadsheet and crosschecked against paper copies of the data for errors and omissions before the data were analyzed. Electronic data were also checked for outliers and other errors using summary statistics and graphic analyses. Data from each sample were analyzed using one of two predictive models developed for use in Oregon: Eight samples were analyzed using the MWCF model and 7 samples were analyzed using the WCCP. Choice of model for each sample was determined by the location of each site, as the MWCF model is applied to samples collection in the Willamette Valley ecoregions, while the WCCP model is applied to samples collected in the Oregon Cascade Mountains ecoregions.

These predictive models evaluate the biological condition of a site based on a comparison of observed (O) to expected (E) taxa. The observed taxa are those that occurred at the site, whereas the expected taxa are those predicted to occur at the site in the absence of disturbance. Impairment is determined by comparing the O/E score to the distribution of reference site O/E scores (Hawkins et al. 2000). Using the scoring criteria derived from the distribution of reference site scores for western Oregon, O/E scores of less than 0.75 (>95th percentile of reference site scores) were classified as “poor” (severely impaired), between 0.75 and 0.90 (90–95th percentile of reference site scores) as “fair” (or slightly impaired), and greater than 0.90 (<90th percentile of reference site scores) as “good” (unimpaired).

Two data files – one containing a taxa-by-site matrix and another file containing predictor variables for each site – were assembled for input into each model. The taxon-by-site matrix was created from a three-column text file using the program matrify.exe. Detailed descriptions of the procedures used to generate these files and run the model can be found at:

Multimetric Analysis

Data were also analyzed using the western Oregon multimetric index, developed by the Oregon Department of Environmental Quality. Multimetric analysis employs a set of metrics, each of which describes an attribute of the macroinvertebrate community that is known to be responsive to one or more types of pollution or habitat degradation. Each community metric is converted to a standardized score; standardized scores of all metrics are then summed to produce a single multimetric score that is an index of overall biological integrity. Reference condition data are required to develop and use this type of assessment tool. Metric sets and standardized metric scoring criteria are developed and calibrated for specific community types, based on both geographic location and stream/habitat type. DEQ has developed and currently employs a 10-metric set for use with riffle samples from higher-gradient streams in western Oregon (WQIW 1999).

The DEQ 10-metric set includes six positive metrics that score higher with better biological conditions, and four negative metrics that score lower with improved conditions (Table 1). The Modified Hilsenhoff Biotic Index (HBI), originally developed by Hilsenhoff (1982), computes an index to organic enrichment pollution based on the relative abundance of various taxa at a site. Values of the index range from 1 to 10; higher scores are interpreted as an indication of a more pollution tolerant macroinvertebrate community. Sensitive taxa are those that are intolerant of warm water temperatures, high sediment loads, and organic enrichment; tolerant taxa are adapted to persist under such adverse conditions. We used DEQ's taxa attribute coding system to assign these classifications to taxa in the data set (DEQ, unpublished information).

Metric values first were calculated for each sample and then were converted to standardized scores using DEQ scoring criteria for riffle samples from western Oregon streams (Table 1). The standardized scores were summed to produce a multimetric score ranging between 10 and 50. Sites were then assigned a level of impairment based on these total scores (Table 2).

Table 1. Metric set and scoring criteria (WQIW 1999) used to assess condition of macroinvertebrate communities in the Middle Fork Willamette River and Coast Fork Willamette River watersheds, Oregon.

	Scoring Criteria		
Metric	5	3	1
POSITIVE METRICS			
Taxa richness	>35	19-35	<19
Mayfly richness	>8	4-8	<4
Stonefly richness	>5	3-5	<3
Caddisfly richness	>8	4-8	<4
Number sensitive taxa	>4	2-4	<2
# Sediment sensitive taxa	≥2	1	0
NEGATIVE METRICS			
Modified HBI[1]	<4.0	4.0-5.0	>5.0
% Tolerant taxa	<15	15-45	>45
% Sediment tolerant taxa	<10	10-25	>25
% Dominant	<20	20-40	>40

[1] Modified HBI = Modified Hilsenhoff Biotic Index

Table 2. Multimetric score ranges for assignment of macroinvertebrate community condition levels (WQIW 1999).

Level of Impairment	Score Range (scale of 10 - 50)
None	>39
Slight	30 – 39
Moderate	20 – 29
Severe	<20

RESULTS

QUALITY CONTROL

Two of the 15 samples (13%) were checked for sorting efficacy; both samples passed with a greater than 95% sorting efficacy. ABR's senior scientist and taxonomist, Dr. Michael Cole, encountered no unusual or rare taxa that were difficult to identify. As such, no specimens were sent to outside specialists.

PREDICTIVE MODEL SCORES

Predictive model observed-versus-expected (O/E) scores varied widely among the 15 samples (Table 3). Based on O/E scores, benthic biological conditions from 5 samples was classified as least disturbed (>25^{th} to 95% percentile of reference site scores), from 1 sample as moderately disturbed (>10^{th} to 25% percentile of reference site scores), and from 9 samples as "most disturbed" (<10^{th} percentile of reference site scores; Hubler 2008).

MULTIMETRIC SCORES

Multimetric scores also varied widely among sampled sites (Table 3). Six samples scored in the no-disturbance ("none") class, 4 samples scored as slightly disturbed, 4 samples scored as moderately disturbed, and 1 scored as severely disturbed.

There was general agreement between MM scores and O/E scores, as the correlation between the two sets of scores received a correlation coefficient of 0.41 (Figure 2). In a few cases, sites received disparate MM scores relative to their O/E scores. Most notably, sample 10-651-07 (WFMCMO) received a multimetric score of 42 (no disturbance), but received an O/E score of only 0.656 (most disturbed). Similarly, samples 10-651-08 and 10-651-09 received "most disturbed" condition ratings based on O/E scores, but only "slightly disturbed" condition ratings based on multimetric scores. These disparities result from the difference conceptual approach each tool uses in assessing macroinvertebrate community conditions. Each tool is therefore better able to detect some types of changes than is the other. As such, we recommend the use of both predictive model and multimetric analysis approaches when determining macroinvertebrate community conditions in Oregon rivers and streams.

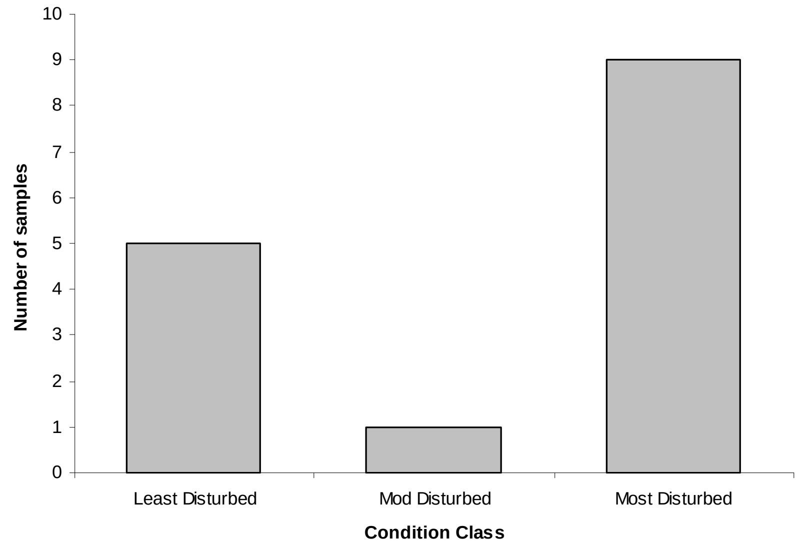

Figure 1. Distribution of 2009-2010 predictive model scores from Middle Fork Willamette River and Coast Fork Willamette River watersheds macroinvertebrate samples (n = 15 samples).

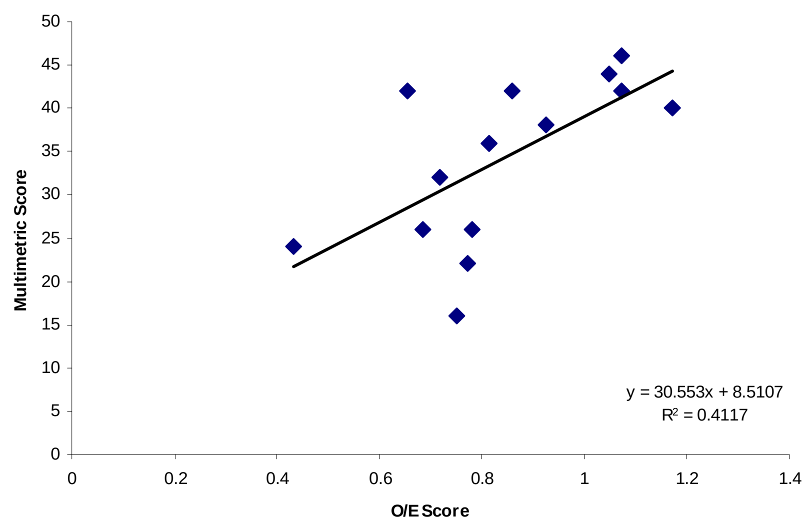

Figure 2. Relationship between O/E scores and multimetric scores calculated from 15 macroinvertebrate samples collected from the Middle Fork Willamette River and Coast Fork Willamette River watersheds, Oregon, in 2009 and 2010.

Table 3. Predictive model O/E scores (P > 0.5) of macroinvertebrate samples collected from 15 stream reaches in the Middle Fork Willamette River and Coast Fork Willamette River watersheds, Oregon, 2009 and 2010.

ABR Sample ID	Sample Code	Sample Date	Model	O/E	Impairment Class	MMS	Disturbance Class
09-621-01	CGSKMO	27-May-09	MWCF	0.771208	Most Disturbed	22	Moderate
09-621-02	CGSKUP	17-Jul-09	MWCF	0.752483	Most Disturbed	16	Severe
09-621-03	CGCFDW	17-Sep-09	MWCF	0.78199	Most Disturbed	26	Moderate
09-621-04	CGCFUP	17-Sep-09	MWCF	0.684684	Most Disturbed	26	Moderate
09-621-05	LCMO	19-Aug-09	MWCF	0.814093	Most Disturbed	36	Slight
09-621-06	LCUP	19-Aug-09	MWCF	0.860588	Mod disturbed	42	None
10-651-01	OAKSTCMO	23-Sep-10	WCCP	1.049459	Least Disturbed	44	None
10-651-02	OAKSCMO	23-Sep-10	WCCP	1.172925	Least Disturbed	40	None
10-651-03	OAKMFWUP	27-Sep-10	WCCP	0.43213	Most Disturbed	24	Moderate
10-651-04	OAKMFWDW	27-Sep-10	WCCP	1.072979	Least Disturbed	46	None
10-651-05	WFNFUP	22-Sep-10	WCCP	0.925993	Least Disturbed	38	Slight
10-651-06	WFNFMO	22-Sep-10	WCCP	1.072979	Least Disturbed	42	None
10-651-07	WFMCMO	29-Jul-10	WCCP	0.655709	Most Disturbed	42	None
10-651-08	MCUP	2-Sep-10	MWCF	0.813705	Most Disturbed	36	Slight
10-651-09	MCMO	2-Sep-10	MWCF	0.718462	Most Disturbed	32	Slight

LITERATURE CITED

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