

**Bay Area Macroinvertebrate Bioassessment Information Network (BAMBI)*****Issue Paper # 1:******Standardization of Benthic Macroinvertebrate Rapid  
Bioassessment Field and Laboratory Protocols*****General Background Information**

The implementation of standardized benthic macroinvertebrate (BMI) rapid bioassessment field and laboratory protocols on a regional basis is critical for establishing the Bay Area Macroinvertebrate Bioassessment Information Network (BAMBI). Throughout the San Francisco Bay Area, municipal stormwater programs (Marin, Contra Costa, Alameda, Santa Clara and San Mateo Counties, and the City of Vallejo) and the Regional Water Quality Control Board (Regional Board) have designed water quality monitoring and watershed assessment programs to include rapid bioassessment techniques. A majority of these programs have used or are currently using the California Stream Bioassessment Procedure (CSBP), a standardized protocol for assessing biological and physical habitat conditions of wadeable streams in California. This protocol has been used by a variety of public agencies, consultants and citizen groups with varying levels of experience and training. As a result, there are uncertainties related to the consistency, usefulness and accuracy of the methods being used among the various programs. Implementing a standardized approach to conduct bioassessments increases the comparability of data sets collected from the various programs and enhances opportunities to perform data analysis on a regional basis. Therefore, standardization of field and laboratory protocols should be considered a high priority to Bay Area agencies that wish to compare BMI data collected from various locations.

**Objectives**

The purpose of this paper is to begin identifying and reviewing issues regarding the standardization of field and laboratory protocols used in macroinvertebrate bioassessment projects in the Bay Area. Descriptions of these issues will aid in reaching a goal of developing guidance on standardized field and laboratory protocols for those Bay Area agencies collecting BMI data. Due to the current use of the CSBP in a large majority of Bay Area bioassessment projects, this paper provides a description and generally refers to the CSBP, as opposed to other field and laboratory protocols (e.g., EMAP, RIVPACS). However, most discussion points identified in the paper are general in scope and may have relevance to the standardization of any rapid bioassessment protocol.

The following is a list of objectives for this issue paper:

1. Review the typical bioassessment field and laboratory protocols used in the Bay Area (i.e., CSBP);
2. Identify elements of bioassessment field and laboratory protocols that could potentially become standardized in Bay Area projects; and,

3. Suggest next steps to BAMBI participants in standardizing elements identified in objective #2, potentially creating comparable data for use in regional analyses.

**The California Stream Bioassessment Procedure (*Excerpt from the CDFG's Aquatic Bioassessment Laboratory QAPP*):**

In 1993 California initiated the first step in developing a state-wide bioassessment program by introducing the California Stream Bioassessment Procedure (CSBP). The CSBP is a standardized protocol for assessing biological and physical/habitat conditions of wadeable streams in California, and is a regional adaptation of the national Rapid Bioassessment Protocols outlined by the U.S. Environmental Protection Agency (EPA 841-D-97-002). The CSBP is a cost-effective tool that utilizes measures of a stream's benthic macroinvertebrate (BMI) community and its physical/habitat characteristics to determine the stream's biological and physical integrity. Biological and physical assessment measures integrate the effects of water quality over time, are sensitive to multiple aspects of water and habitat quality and can provide the public with a familiar expression of ecological health. A large majority of agencies in the Bay Area are using, or have used the CSBP when conducting rapid bioassessments.

Now in its third edition, the CSBP is recognized as California's standard protocol for conducting rapid bioassessments and forms the basis of California's effort to develop a statewide bioassessment program. The CSBP can be used to detect aquatic impacts from point and non-point sources of pollution and for assessing ambient biological condition. The sampling unit is an individual riffle or riffles within a reach of stream depending on the type of sampling design used. The CSBP should only be used when sampling wadeable, running water streams with available riffle habitats. It is important that BMI's are collected when streams are at base flow, as high flows can dramatically alter local community composition and can thus produce unrepresentative results. There are approved modifications of this procedure for narrow (< 1m) streams, wadeable streams with sand or mud bottoms and channelized streams. There are also procedures for lentic or still water environments. Additional information on the CSBP can be found at [www.dfg.ca.gov/cabw/cabw/csbp.html](http://www.dfg.ca.gov/cabw/cabw/csbp.html) or by contacting the California Department of Fish and Game's Aquatic Bioassessment Laboratory at (916) 358-0316.

**CSBP Field Protocols**

Point Source Sampling Design

Point source sampling design is used when discernable perturbations, impacting structures or discharges into the stream with point sources of pollution are apparent. The sampling units are individual riffles within the affected section of stream and an upstream unaffected section. At least one riffle in the unaffected section should be sampled and one or more riffles in the affected section, depending on the amount of detail that is required on downstream recovery. The riffles used for sampling BMIs should have relatively similar gradient, substrate and physical/habitat characteristics and quality. One sample will be collected from three (3) randomly chosen transects in each riffle selected.

### Non-point Source Sampling Design

Non-point sources sampling design is used when no obvious perturbations or discharges into the stream with non-point sources of pollution are apparent. This sampling design is appropriate for assessing an entire stream or large section of stream. The sampling units are riffles within a reach of stream. The stream reach must contain at least five (5) riffles within the same stream order and relative gradient. One sample will be collected from each upstream third of three (3) randomly chosen riffles.

### **CSBP Laboratory Protocols**

The CSBP utilizes a single standardized laboratory procedure for both point and non-point sampling. In brief, sample contents are rinsed in a 0.5 mesh sieve and placed into a gridded tray where they are spread evenly. Grids are then randomly selected and BMIs are picked from the debris and identified to a standard taxonomic level. BMIs from additional grids are identified until 300 organisms have been identified.

The CSBP laboratory methods are described in the California Department of Fish and Game Aquatic Bioassessment Laboratory's (ABL) Quality Assurance Project Plan (QAPP). In addition, the California Aquatic Bioassessment Laboratory Network (CAMLnet), and group of laboratories devoted to developing consistent laboratory procedures, developed a standard of taxonomic effort (STE) and Standard Taxonomic List (STL) for bioassessment projects using the CSBP. In Fall 2002 significant changes in STE for chironomids and oligochaetes were proposed by the ABL (August 22, 2002 version) and were approved, along with other minor changes, by CAMLNet members at their October meeting. The new STE and also flags for different levels of certainty in identification will be the recommended CSBP standard for samples collected in 2003.

### **Current Issues with CSBP Field and Laboratory Protocols**

The following is a list of key elements that BAMBI may chose to discuss and provide guidance to participants. The items are related to the standardization of CSBP field and laboratory protocols. Following the list of topic areas, a brief discussion of each element is provided, along with topics/issues for discussion.

- Field Crew Training
- Sampling Reach Selection
- Standardization of Field Methods;
- Selection of Laboratory; and,
- Standardization of Laboratory Methods

### Field Crew Training

Personnel properly trained in appropriate methods provide a foundation for all field sampling. In California only one entity, The Sustainable Land Stewardship International Institute (SLSII), consistently trains field personnel in the CSBP. SLSII has developed a training program, derived from the ABL's Standard Operating Procedures (SOPs) and has produced a methods manual

designed for agency staff and citizen monitoring groups to implement the CSBP protocols (SLSII 1999). The SLSII program includes a variety of training modules. These include:

- Overview of Freshwater Bioassessment Concepts and Techniques;
- Designing Freshwater Ecological Assessments - Rapid and Fully Integrated Approach;
- Sampling Biotic Communities in California Rivers and Streams;
- Physical/Habitat Assessments for Water Quality Projects;
- Taxonomic Identification of Freshwater Invertebrates Following the CSBP;
- Insuring Quality Data and Interpreting Information from Freshwater Ecological Assessments;
- Scientifically Sound Environmental Activism; and,
- Stakeholder Involvement in Ecological Assessment and Water Quality Monitoring; Current Topics in the Use of Freshwater Ecological Assessments in Water Quality Regulation

The following are issues related to training in the application of rapid bioassessment field protocols:

- Type and extent of field crew training;
- Length of training;
- Frequency of training; and,
- Training and trainer availability.

### Sample Reach Selection

Sampling site/reach locations depend on a variety of factors. Depending on the objectives of your project, one may choose to select reaches upstream and downstream of point source discharges or where changes in land use are evident. However, the primary goal in selecting sampling sites when conducting Rapid Bioassessments is to select a reach that “represents” the watershed/subwatershed of interest.

Factors that may limit the number of study reaches include accessibility (physical and legal) and suitable riffle habitat. Land ownership throughout the watershed can limit site selection to areas where written permission is granted. Land owners bordering potential sampling sites can be identified through the local county assessors office. In addition, sample site selection should include input from the Watershed Advisory Group and any public land agency located in the watershed.

Sample reach length depends on the frequency of riffle/run habitat units and uniformity of channel type. A critical component of the current CSBP is to establish reaches that contain at least five riffle/run habitat units within the same channel type. If the reach length is limited by private land, at least three riffle/run habitat units should be delineated. Once selected, a global positioning system (GPS) should be used, when available, to determine the coordinates of sites whenever possible.

The following are issues related to site selection that BAMBI may choose to address:

- Factors to consider in site selection (e.g. accessibility, study objectives, gradient, stream order, elevation, etc.);
- Participation in site selection; and,
- Documentation of sites (e.g. photo documentation and illustrations).

### Field Methods

The California Department of Fish and Game Aquatic Bioassessment Laboratory (ABL) have published standardized field methods in the CSBP (CDFG 1999). In addition, ABL staff have identified standard operating procedures (SOPs) for both field and laboratory (see below) work, which is included in their Quality Assurance Procedure Plan (QAPP).

The ABL is considering adding an additional level to the non-point source protocol of the CSBP. The additional level would require sampling only a single riffle in a stream reach, as opposed to three riffles. This reduction in samples per reach would be coupled with a greater number of organisms identified per sample (i.e., 500 compared to 300) and a more precise level of taxonomic identification (i.e., species as opposed to family/genus) of those organisms. A decision by the ABL on whether to endorse this method is expected in the up and coming months.

The following are issues related to the standardization of field methods:

- Index period (i.e. season);
- Timing of sampling related to flow;
- Consistency in implementing field SOPs;
- Protocols for other habitat types (e.g. non-wadable streams & pool dominated systems);
- Field verification of appropriate methodology (i.e. field audits); and,
- Use of additional levels of the CSBP (i.e., less riffles).

### Laboratory Selection

To assure the highest data quality is achieved, rapid bioassessment project managers should select a laboratory with experience and demonstrated knowledge of not only aquatic macroinvertebrates, but also data objectives, standard taxonomic effort, and relative laboratory standard operating procedures. At this point, the ABL is not recommending an accreditation process for bioassessment labs. However, if your goal as project manager is to potentially compare your results to others, it is incredibly important that the laboratory(s) you select consistently follow documented protocols.

The following list of issues related to selection of a laboratory:

- Selection of laboratories who participate in the California Aquatic Macroinvertebrate Laboratory Network (CAMLnet);
- Selection of laboratories that implement ABL Standard Operating Procedures (SOPs), including the most recent version of ABL Standard Taxonomic Effort (STE);
- Questions to ask when selecting a laboratory; and,

- Adequate training of laboratory personnel.

### Standardization of Laboratory Methods

ABL staff has identified standard operating procedures (SOPs) for laboratory analysis, which is included in their Quality Assurance Procedure Plan (QAPP). CAMLNet has also developed a standard taxonomic list that is aimed at standardizing levels of taxonomic effort among labs using the CSBP, with a goal of maximizing the number of compatible datasets available for analysis at a statewide level. Taxonomic reference keys are also listed by CAMLNet.

Currently, there is a single taxonomic level (Level I CSBP) established by CAMLNet, where most organisms are identified to the family or genus level. However, CAMLNet has discussed developing an additional, more precise taxonomic level option (Level II CSBP), where many organisms are identified to species. Level II CSBP would follow the level of taxonomic effort the USEPA's Environmental Monitoring and Assessment Program (EMAP) currently implements. Laboratory costs associated with conducting a Level II CSBP are estimated to be 50% greater than Level I CSBP costs, and many small laboratories lack in-house expertise to provide full Level II identifications. Although no date has been set for implementation of the Level II CSBP, BAMBI may choose to monitor the development of this additional level and provide guidance to participants in up and coming months.

The following are issues related to the standardization of laboratory methods that BAMBI may choose to discuss:

- Use of Standard Operating Procedures (SOPs) by all laboratories;
- Involvement in CAMLNet by all laboratories;
- Standardization of level of taxonomic effort by all laboratories; and,
- Level I versus Level II CSBP.

### **Options for Improvement**

The previous section provided a brief overview of important elements related the standardization of field and laboratory protocols, and identified issues related to these elements. Although it is suggested that BAMBI continue to take direction from the ABL and CAMLNet regarding these issues, it is recommended that participants prioritize the these issues and focus future resources on providing guidance to BAMBI participants on selected topics. A discussion of resource allocation for the development of guidance information for BAMBI participants should take place at the next BAMBI workgroup meeting.

### **Future Steps to Improve Standardization**

1. Discussion and selection of high priority issues related to the standardization of rapid bioassessment field and laboratory protocols by BAMBI participants;

2. Guidance development by BAMBI on priority issues identified by BAMBI participants; and,
3. Consideration of using the additional level of CSBP field methods (i.e., single riffle) and the CSBP Level II taxonomic effort (i.e., species level identification) for monitoring ambient conditions in the future.

The Bay Area Macroinvertebrate Bioassessment Information Network (BAMBI) includes scientists, watershed managers and regulators interested in local applications of *bioassessment* --the use of biological community data for assessing the condition of waterbodies and watersheds. BAMBI's focus is on *benthic macroinvertebrates* (bottom-dwelling animals without backbones, visible to the naked eye) which are present in most aquatic environments and are useful indicators of ecosystem function because their community composition responds to a wide range of ecosystem variables. BAMBI Issue Papers provide background and discussion of technical areas important to the development and improvement of bioassessment in the Bay Area. These are provisional workproducts for BAMBI discussion in January 2003, contributed by members of the Bay Area Stormwater Management Agencies Association (BASMAA), and the SF Bay RWQCB. Forward comments or questions to BAMBI c/o watersheds@acpwa.org