Measurement Quality Objectives for Benthic Macroinvertebrate (BMI) Taxonomy

MQOs developed specifically for field-based BMI collections including sample handling and preservation, lab quality control and corrective actions. Following Surface Water Ambient Monitoring Program (SWAMP) standard operating procedures and measurement quality objectives (MQOs) are requirements for all SWAMP projects. If standard methods are modified for biological assessments, they may not be comparable to statewide projects. It is recommended that projects collecting BMI data utilize these requirements for comparability with SWAMP and utilization of the California Stream Calculation Index (CSCI) scoring tools for habitat and stream health determinations.

Table 1. MQOs for Field Sample Collection, Handling and Preservation of Benthic Macroinvertebrates

Analyte	Bottle Type/Size	Preservative	Maximum Holding Time
Benthic macroinvertebrate field samples	Plastic wide-mouth bottles with screw top lids, 0.5 L (minimum). Additional containers can be used as needed.	95% ethanol, diluted to a final concentration of no less than 70% ethanol	Not applicable
Benthic macroinvertebrates (identified)	Glass or shell vials	70% ethanol	Not applicable

Effective Date: January 6, 2020

Table 2a. Lab MQOs: Benthic Macroinvertebrate Taxonomic Analysis
Definitions: OR = Original lab, QC = Quality Control (external) lab
External QC Assessment MQOs. Samples are re-evaluated by an external (QC) lab

Lab Quality Control	Frequency of Analysis	Measurement Quality Objective	Purpose
Absolute recount error rate	10% of samples in project	$\sum \frac{\lvert QC\ lab\ count - OR\ lab\ count \rvert}{QC\ lab\ count} < 10\%$	Precision
Taxa ID error rate	10% of samples in project	$\frac{Number\ of\ FinalIDs\ misidentified\ by\ OR}{Number\ of\ FinalIDs\ identified\ by\ QC} < 10\%$	Accuracy
Individual ID error rate	10% of samples in project	$\frac{Number\ of\ individuals\ misidentified\ by\ QC\ lab}{Number\ of\ individuals\ identified\ by\ QC\ lab} < 10\%$	Accuracy
Lower taxonomic resolution individual error rate	10% of samples in project	$\frac{Number\ of\ specimens\ where\ QC\ lab\ FinalID\ achieved\ higher\ resolution\ than\ OR\ lab\ FinalID}{Total\ number\ of\ specimens\ in\ sample\ by\ QC\ lab} < 10\%$	Sensitivity
Lower taxonomic resolution count error rate	10% of samples in project	$\frac{Number\ of\ FinalIDs\ where\ the\ QC\ lab\ acheived\ higher\ resolution\ than\ the\ OR\ lab}{Number\ of\ FinalIDs\ identified\ by\ QC\ lab} < 10\%$	Sensitivity

Table 2b. Lab MQOs: Benthic Macroinvertebrate Taxonomic Analysis
Definitions: OR= Original lab, QC = Quality Control (external) lab
External QC Descriptive MQOs (no thresholds). Samples are re-evaluated by an external (QC) lab

Lab Quality Control	Frequency of Analysis	Measurement Quality Objective	Purpose
Recount accuracy	10% of samples in project	$\frac{Number\ of\ specimens\ in\ smaller\ count}{Number\ of\ specimens\ in\ larger\ count}$	Precision
Taxa count error rate	10% of samples in project	$\frac{\lvert Number\ of\ FinalIDs\ per\ QC\ lab\ -\ Number\ of\ FinalIDs\ per\ OR\ lab\rvert}{Number\ of\ FinalIDs\ per\ QC\ lab}$	Accuracy
Higher taxonomic resolution individual error rate	10% of samples in project	$\frac{Number\ of\ individuals\ where\ the\ QC\ lab\ acheived\ lower\ resolution\ than\ the\ OR\ lab}{Number\ of\ individuals\ identified\ by\ QC\ lab}$	Sensitivity
Higher taxonomic resolution count error rate	10% of samples in project	$\frac{Number\ of\ FinalIDs\ where\ the\ QC\ lab\ acheived\ lower\ resolution\ than\ the\ OR\ lab}{Number\ of\ FinalIDs\ identified\ by\ QC\ lab}$	Sensitivity

Table 2c. Lab MQOs: Benthic Macroinvertebrate Taxonomic Analysis
Taxonomy-Internal Quality Control. Samples are re-evaluated by a second practitioner in the lab

Lab Quality Control	Frequency of Analysis	Measurement Quality Objective	Purpose
Recount accuracy	10% of samples in project	$\frac{Number\ of\ specimens\ in\ smaller\ count}{Number\ of\ specimens\ in\ larger\ count} \geq 95\%$	Precision
Taxa ID error rate	10% of samples in project	$\frac{Number\ of\ misidentified\ FinalIDs}{Number\ of\ FinalIDs} < 10\%$	Accuracy
Individual ID error rate	10% of samples in project	$\frac{Number\ of\ misidentified\ individuals}{Number\ of\ identified\ individuals} < 10\%$	Accuracy
Lower taxonomic resolution individual error rate	10% of samples in project	$\frac{Number\ of\ individuals\ with\ inadequate\ resolution}{Number\ of\ individuals\ adequate\ resolution} < 10\%$	Sensitivity
Lower taxonomic resolution count error rate	10% of samples in project	$\frac{Number\ of\ FinalIDs\ with\ inadequate\ resolution}{Number\ of\ FinalIDs\ with\ adequate\ resolution} < 10\%$	Sensitivity

Table 2d. Laboratory MQOs for Benthic Macroinvertebrate Taxonomic Analysis
Sample Processing

Lab Quality Control	Frequency of Analysis	Measurement Quality Objective	Purpose
Sample Integrity and Preservation Check	10% of samples in a project	Ensure that all sample jars are intact and have no more than 50% (by volume) of sample material. All hydrometer checked samples must contain a minimum of 70% ethanol.	Representativeness
Subsampling	100% of samples in a project	At least 3 grids analyzed, and up to 100% of sample volume analyzed if required to achieve target number of organisms (n = 600).	Representativeness
Picking and sorting efficiency	100% of samples in a project	$\frac{Number\ of\ specimes\ in\ inital\ sort}{Number\ of\ specimens\ after\ second\ sort} \geq 90\%$	Completeness
Taxonomic Identification	100% of samples in a project	100% of all sorted samples are processed.	Completeness
Sorting process	Every sample	Separate BMIs to taxonomic Order for later taxonomic identification. Identified BMIs are labeled and placed in a separate vial per taxonomic Order.	Accuracy

Table 3a. Laboratory Quality Control Corrective Actions for Benthic Macroinvertebrates Analysis Sample Processing

Lab Quality Control	Recommended Corrective Action
Sample Integrity and Preservation Check	If samples are found to not meet the minimum concentration of ethanol, then the entire batch must be checked. Any sample not meeting the requirement must have fresh preservative placed in the container immediately, and any associated data must be flagged by the laboratory. Project coordinator and field crew must be notified about inadequate preservation.
Subsampling	Corrective action for this MQO is to retrain and supervise pickers.
Sorting Process	Corrective action for this MQO is to retrain and supervise pickers
Remnant Jar Quality Control Check	Corrective action for this MQO is to increase training and supervision of sorter according to lab protocol, and to continue sorting residue until the MQO is achieved (that is, ≤5% of the total number organisms are discovered in the sorted residue). Because 100% of samples are subjected to these MQOs, data do not need to be qualified.
Processing Efficiency	Corrective action for this MQO is to locate missing samples and document failures.

Table 3b. Laboratory Quality Control Corrective Actions for Benthic Macroinvertebrates Analysis Taxonomy

Lab Quality Control	Recommended Corrective Action
Standard Taxonomic Effort	The Standard Taxonomic Effort for BMIs will be reviewed and updated as needed based on discovery of new taxa, published taxonomic revisions that result in nomenclatural changes, workshops that provide better understanding of existing taxonomic keys, etc. Typically, these changes and updates are presented and discussed at the annual meeting of SAFIT.
Taxonomic Identification and Enumeration (Internal and External QC)	Corrective action for these MQOs is to train and supervise taxonomists, and to update data for analysis based on the following process: In the case of MQO failures, the OR taxonomist goes back through all original samples from a given project and corrects identifications as necessary based on feedback from the QC taxonomist. The project coordinator then randomly selects another 10% of samples to submit for a second round of QC. Samples that underwent QC in Round 1 should not be selected for Round 2 and subsequent rounds. If an additional round of QC is needed, all steps in the process are performed again, including submittal of an Excel "BMI QC Submittal Data Template" with data from the second set of samples, except that Round would equal 2. Additional lots shall be submitted by the OR until a lot passes quality assurance checks or until all samples have been submitted to a QC lab for quality assurance checks. Enforcement of corrective actions is the responsibility of the project coordinator, not the QC lab. If the original lab disputes the QC lab identification, specimens can be sent to a third lab for verification at the discretion of the project coordinator.

References:

Ode, P.R., A.E., Fetscher, and L.B. Busse. 2016. Standard Operating Procedures for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 004

State Water Resources Control Board. 2019. Statewide Bioassessment Program: Quality Assurance Project Plan. Sacramento, CA: Surface Water Ambient Monitoring Program.