MDE Requirements for Use of In-Situ Biological Stream Data

Intent and Purpose

The purpose of this document is to outline the requirements and specifications relating to the use of biological stream data in Maryland's regulatory framework. Specifically, this document was created to serve as a reference for those organizations providing the Maryland Department of the Environment (MDE) with biomonitoring data for regulatory decision making. Examples of the types of regulatory decisions that may utilize biological data include, but are not limited to, decisions regarding water quality criteria development, Integrated Report (305(*b*)/303(*d*)) assessments, TMDL development, Tier II high-quality water determinations, and measuring NPDES permit or 401 certification compliance. MDE also uses biological data for other non-regulatory purposes including trend analysis, restoration targeting, and measuring restoration progress. This document does not address Whole Effluent Toxicology (WET) testing, or other laboratory-based biological monitoring protocols, as they are covered under other programs. This document will instead address in-situ biological stream monitoring with a focus on data collected using Maryland Biological Stream Survey (MBSS) or similar protocols. The biological data quality guidelines provided within this document serve as supplementary information for the Biological Assessment Methodology for Non-tidal Streams[1] and as the guidelines in force for entities collecting MBSS-comparable data in response to permit requirements or conditions. In addition, all data submitted for Tier II high quality waters evaluations must also meet these minimum guidelines in order to be considered for Tier II designation or for evaluating assimilative capacity.

Biological Data Collection Methods

The paragraphs below provide brief summaries of some of the biological stream sampling methods used in Maryland. This is not an exhaustive compilation. There are other valid methods that could be used in a regulatory context. However, the methods discussed below have the longest history of use in Maryland for various Clean Water Act directives. As new methods and protocols are developed and utilized, this list may be expanded.

DNR's Maryland Biological Stream Survey (MBSS) Protocols

For Maryland's wadeable streams (1st through 4th order), MBSS protocols are used more often than any other set of biological monitoring protocols. This method, adapted from EPA's Rapid Bioassessment Protocols, samples not only the in-situ biological

[1] http://www.mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Biological_Listing_Methodology-non-tidalwadeablestreams_2014_Final%20(New%20links).pdf

community (fish and benthic macroinvertebrates[2]) but also water chemistry and in-stream habitat. Benthic macroinvertebrates are collected using a multi-habitat approach and a d-frame dip net while fish are collected by conducting two-pass electrofishing. MBSS data have been collected in Maryland since 1995 and to date include over 3000 sites. As part of this sampling methodology, fish and benthic macroinvertebrate community data are used to calculate separate indices of biotic integrity (IBI) that rate streams in comparison to reference conditions (minimally-impacted). These methods and the scoring methodology used in the IBIs are well-established and are considered quite robust (Southerland et al. 2005). The data collected using MBSS methods is used by the Department for a number of different regulatory applications including water quality standards development, Integrated Report assessment, Tier II high quality water designation, TMDL development, measuring NPDES permit compliance, restoration targeting, and measuring restoration progress. Several Maryland counties have adopted sampling methods similar to the MBSS with varying differences in protocols and analysis.

DNR's Stream Waders Protocols

The Stream Waders sampling protocols, used in Maryland since 2000, are similar to that of the MBSS methods. Benthic macroinvertebrates and habitat information are collected and a benthic IBI is calculated. However, one of the major differences from MBSS is that Stream Waders identifies benthic macroinvertebrates to the family level instead of genus. Stream Waders protocols also do not entail fish sampling. Though considered not as rigorous as the MBSS protocols, Stream Waders protocols have the benefits of being less costly and time intensive for sample collection and analysis. Additionally, Stream Waders data are collected by trained volunteers, something that cannot be done for MBSS protocols. Stream Waders protocols have helped provide the state with a low cost method for filling in stream monitoring gaps and have been used extensively for restoration targeting purposes.

Surber Device Sampling Methods

Surber sampling devices have a 0.3 m by 0.3 m size frame with attached net designed to capture dislodged benthic organisms from a 0.09 m^2 area of stream bottom (Barbour et al. 1999). There are many different versions of protocols dictating where (e.g. mid riffle, beginning of riffle, etc) and how many surber samples should be gathered from a single monitoring location. However, DNR's Core Trend monitoring program, the largest known user of surber sampling methods in the state, uses three replicate samples collected in a riffle: one at midstream and at two points equidistant from each bank (Friedman 2009). The Core Trend program has been using surber sampling methods since 1976 to characterize local benthic communities and for detecting long term changes in water quality. Data collected by the Core Trend program using surber sampling methods has been used for TMDL development in nutrient and sediment impaired watersheds.

Artificial Substrate Sampling Methods

[2] MBSS sampling also now incorporates mussel and herpetofauna sampling as part of their standard protocols although these are not typically used for regulatory decisions.

Artificial substrate methods of biological sampling have also been used in Maryland to gather information on benthic macroinvertebrate communities. The most prominent user of artificial substrate methods, the Core Trend monitoring program, uses Hester-Dendy multiplate samplers to collect benthos in shallow streams without riffles and in slow deep streams/rivers (Friedman 2009). Since 1976, the Core Trend program has used this method at sites not appropriate for surber sampling. Data collected using multiplate samplers is also used for long term trend detection and for TMDL development.

Electrofishing for Fisheries Surveys

Electrofishing has supported fisheries management decisions in Maryland for several decades. Surveys typically determine overall fish community structure or measuring recruitment success as part of a balanced age structure. Stream fishery surveys tend to be more qualitative without strict rules for block net usage and the segment length (to be sampled). Generally, state biologists look for the presence and abundance of certain keystone or gamefish species to determine appropriate management actions. Although fishery surveys are of relatively limited use for water quality regulatory purposes, they have been used to correct stream use classification for a number of cold water streams. In addition, fisheries surveys can provide valuable information for measuring restoration success following the implementation of a restoration project.

How MDE Uses Biological Data

Both Federal and State regulations drive the utilization of biological data in Maryland. Specifically, 40 CFR section 130.7(b)(5) requires that as states assess their waters in accordance with Sections 303(*d*) and 305(*b*) of the Clean Water Act that "Each State shall assemble and evaluate all existing and readily available water quality related data and information to develop the list[3]." The Code of Maryland Regulations (COMAR) 26.08.02.03-4 provides further detail in identifying the criteria for using biological water quality data to make water quality-related assessments and decisions.[4] These criteria specify the basic requirements to be included as part of the biological assessment methodology and include items such as having a documented and repeatable process, consideration of natural variability, and the use of best professional judgment in scenarios where statistical methods may provide inappropriate results.

In general, MDE's primary use of biological data is for assessing aquatic life use attainment as required by Clean Water Act (CWA) Sections 303(*d*) and 305(*b*). To conduct these assessments, MDE makes use of a biological assessment methodology specifically designed for non-tidal wade-able streams.[5] This assessment methodology[6], though not considered a water quality standard, provides the statistical methods and

[3] The 'list' being the 303(d) List or list of impaired waters, also known as the Integrated Report.
[4] http://www.dsd.state.md.us/comar/getfile.aspx?file=26.08.02.03-4.htm
[5] The Department also uses a Biological Assessment Methodology for the Chesapeake Bay and all tidal tributaries. However, this document only addresses non-tidal biological monitoring.
[6] http://www.mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Biological_Listing_Methodology-non-tidalwadeablestreams_2014_Final%20(New%20links).pdf

decision process that Maryland uses for making impairment determinations. The assessment methodology does this by evaluating randomly sampled sites as part of a probabilistic survey to provide assessments at the 8-digit watershed scale. The Department reports the results of these assessments on a bi-annual basis as part of the Integrated Report of Surface Water Quality (IR). Historically, the non-tidal biological assessment methodology has utilized biological data collected using MBSS or MBSS-comparable protocols. Utilization of biological data collected using other protocols is possible in the Integrated Report but will require additional resources to reconcile differences and to ensure non-contradictory results.

The Department also uses biological monitoring data to designate and re-evaluate high quality or Tier II waters. For Tier II waters, biological sites are evaluated on a site by site basis instead of being assessed as part of a larger assessment unit. Sites having both a fish and benthic IBI score of 4.00 or greater are designated as Tier II and then afforded the additional protections described in COMAR Section 26.08.02.04-1. At the time of this document, Tier II waters have only been designated on the basis of data collected using MBSS protocols. Until and unless other criteria for defining Tier II waters can be proposed and accepted, future monitoring (and the identification of new Tier II locations) must be done using the same (MBSS) or comparable protocols in order to make valid assimilative capacity determinations.

Additionally, biological data have been used in water quality standards development and for TMDL development. In both cases, MBSS-comparable biological data are the predominant type used, although other methods have been incorporated in the past (e.g. artificial substrate and surber sampling for TMDL purposes). Most often, biological data used in the context of water quality standards or TMDL development serves as a reference dataset to determine the appropriate pollution threshold(s) that preserves a healthy aquatic community.

Another regulatory use of biological data is for measuring NPDES permit compliance. Generally speaking, NPDES permits require WET testing as a permit condition more frequently than any other type of biological monitoring. However, an increasing number of permits are also incorporating in-situ biological monitoring to determine if permitted discharges are causing shifts in nearfield aquatic communities. In similar fashion, the Department can require the collection of biological data for granting 401 certifications for particular Non-tidal Wetlands and Waterways permits. These data can then be used to inform future management decisions as a project proceeds with development. The type of biological monitoring used in these circumstances is tailored to the discharge/pollutant of concern and may or may not require MBSS-comparable monitoring.

MDE also uses DNR's Core/Trend benthic macroinvertebrate data for non-regulatory trend analyses. These data, collected with surber or multiplate sampling devices, have been sampled at fixed locations over varying frequencies since 1976. Using this long data record facilitates temporal comparisons and longer term trend analyses. Trend analyses developed from these data have been used to gauge restoration progress and to describe the overall health of larger order flowing waters.

The last two major uses of in-situ biological monitoring data by MDE are for restoration targeting, and for measuring restoration progress. These analyses, like Tier II and NPDES compliance analyses, evaluate data on a more site-specific basis to help guide local water quality management practices. Both of these monitoring objectives rely heavily on MBSS data due to in-house familiarity and the robustness of the IBIs. The Department may use other protocols with lower costs and where a high density of sampling sites is needed, to help determine the highest priority areas for restoration.

Appropriateness of Biological Sampling Protocols for Certain Monitoring Purposes

Biological data collected using MBSS protocols has been the predominant biological sampling method used by MDE for various monitoring and analyses purposes. It should be noted however, that the Department does not exclusively require MBSS protocols in all cases. As stated previously, the Department is required to consider all readily available data to support water quality assessments in Maryland. Where appropriate, the Department will attempt to incorporate other forms of biological data. Still, MBSS or MBSS-comparable data can more easily be assessed due to the size of the dataset and in-house familiarity. Full utilization of other established protocols[7] that differ from MBSS can and does occur, pending resources.

Each monitoring method has its strengths. MBSS-comparable monitoring is a comprehensive community assessment and is especially suited to those scenarios where a one-time sample is needed. Data analysts are able to leverage a large historical MBSS dataset for comparison work and it is possible to account for interannual variability after IBI scores are calculated. Biological monitoring methods involving the use of artificial substrates (multiplate samplers) and surber sampling devices essentially standardize the habitat sampled according to substrate area provided or cleaned, respectively. Both of these methods are particularly useful for trend analysis when long term sampling is conducted. Additionally, the multiplate samplers, can be used in large rivers and streams that may be unsampleable by other methods. Stream Waders sampling provides only a family-level benthic macroinvertebrate community assessment but can be accomplished at a much lower cost than other protocols. Also, because Stream Waders uses similar metrics and scoring methods to the MBSS methods, it allows for more intuitive data integration to help fill monitoring gaps left by the MBSS. Finally, even though biological sampling conducted for the purpose of fisheries surveys is not broadly applicable to many of MDE's regulatory or other data analysis goals, it can supply much needed information for identifying and correcting Maryland's water use classifications.

Table 1 has been provided below to illustrate the relationship between the Department's uses of in-situ biological stream data and the appropriate biological monitoring protocols for those uses. As a general rule, the Department will continue to use the same monitoring protocols previously used at a site or for a certain purpose so as to facilitate

[7] Other established protocols include any other generally accepted in-situ biological sampling and evaluation protocols that incorporate QAQC and have QAPP-type documentation.

interannual comparisons and to allow for more rigorous trend analyses. Some monitoring scenarios may dictate particular biological monitoring methods. In the case of Tier II sampling, MBSS or MBSS-comparable protocols must be used until other definitions of Tier II waters are proposed and accepted. For other situations, the Department has the discretion to incorporate biomonitoring data collected with other protocols. Generally, MBSS protocols will work for many applications. However, there are circumstances where less costly and time-intensive sampling protocols will be used to fulfill the same purpose. In summary, Table 1 is meant to serve as a general guideline and not meant to limit the type of data acceptable to one protocol, format, or methodology.

Table 1: General Guidelines for the appropriate uses of specific in-situ biological stream monitoring protocols. Shown are regulatory and non-regulatory uses. Note: This table does not cover all situations. MDE retains the ability to exercise professional judgment when deciding the suitability of collected data.

Protocols	Regulatory Uses					Non-Regulatory Uses		
	Water Quality Standards Development	Integrated Report Assessments (impairment determinations)	Tier II High Quality Waters Determinations and Re-evaluation	TMDL Development	NPDES Permit Compliance and 401 Certification Requirements	Trend Detection	Restoration Targeting	Restoration Progress
MBSS or MBSS Comparable	✓	✓	✓	✓	✓	✓	✓	✓
Stream Waders (Benthos Family level taxonomy)				✓	✓	✓	✓	✓
Artificial Substrate Methods (e.g. Hester-Dendy multiplate sampler)	✓			✓	✓	✓	✓	✓
Surber Sampler	✓			✓	✓	✓	✓	✓
Electrofishing - Fishery Surveys	✓					✓	✓	✓

Minimum Data Quality Requirements for Data Acceptance

General Data Quality Requirements

This document does not seek to limit acceptable methods, but to establish the minimum data quality requirements to ensure that biological data submitted to MDE is of good quality. The document establishes minimum requirements for those who collect, analyze, or report the results of biological monitoring data to MDE for use in regulatory decision making.

Data providers must be proficient in the areas necessary to accomplish these tasks through related education or work experience. In certain cases, completion of training or other certification programs are also expected in order to meet the minimum qualifications for data use.[8] It is the responsibility of the data provider to be familiar with these requirements as well as any others that may be imposed as part of a special permitting condition (for NPDES permits or 401 certifications).

When submitting biomonitoring data for regulatory purposes, parties must provide adequate documentation to establish that field, laboratory, analysis, and protocol methods used to generate the data are within the established standard operating procedures (SOPs) and QA/QC plan for that type of monitoring. This documentation must, at a minimum, answer the questions of *who, what, where, when, why, and how* before MDE can consider it in the regulatory process. Data provided that does not provide all of this information can still be utilized by MDE for other purposes such as a general water quality indicator, for restoration targeting or for presence/absence comparisons. Such information can also be used to prioritize streams for future follow-up monitoring with more rigorous methods.

Specific Data Quality Requirements

MDE recognizes the following three roles as those generally necessary to conduct biological monitoring with the purpose of providing data to MDE for regulatory or non-regulatory uses.

1. The Principal Investigator (PI)
2. Research Assistant (RA)
    a. Field Research Assistant (Field-RA)
    b. Laboratory Research Assistant (Lab-RA)

Principal Investigator (PI)

The PI is the individual(s) primarily responsible for the coordination, development, and completion of the biological monitoring study, and oversight of all related data management. The responsibilities of this position may be shared between qualified individuals.

[8] Since MBSS sampling is a more rigorous method requiring a variety of sampling and taxonomic skills, experience and/or additional training and certifications are required.

The PI role is further defined as follows:

- The central point of contact regarding all aspects of the survey work and MDE
- Directly responsible for ensuring that the survey work is completed in a satisfactory fashion that complies with all applicable protocols, procedures, and methodologies
- Maintains current relevant working experience, including where available, any training or certifications. The PI may not be performing all aspects of the survey work, but must ensure that there is an adequate number of qualified biologists available for data collection and analysis, including field taxonomic identifications, laboratory taxonomic identifications, and for other laboratory processing and analysis
- Develops the monitoring plan and associated technical reports for the survey activity and provides this documentation to MDE, including related analysis such as IBI generation. For data intended for regulatory uses these documents must meet the conditions referenced above (See: General Data Quality Requirements).
- Responsible for leading, directing, and organizing the overall surveys and RAs and other staff throughout the survey process
- Ensures that all monitoring equipment are calibrated and in proper working order prior to the sampling event
- Ensures that all necessary permits, permissions, and other necessary approvals have been granted prior to the survey

Research Assistants (RA)

The RA is any individual(s) that operates under the supervision and/or direction of the PI, and as such performs duties as assigned provided they are qualified to do so which may require additional testing, training, or certifications.

The Field-RA role is further defined as follows:

- Conducts the field work necessary to complete the biological monitoring study, related research and analysis, or other duties associated with study completion.

The Laboratory-RA role is further defined as follows:

- Conducts laboratory analysis, data processing/entry, sorting and/or taxonomy work, QA/QC, and chemical analysis to meet biological monitoring study objectives.

The purpose of the following table is to help ensure that there is no significant delay in the use of, or disqualification of biological data provided to MDE for either regulatory or non-regulatory uses.

Table 2: Biomonitoring Roles and the Qualifications Required.

PIs must possess or meet the following:	Field-RAs must possess or meet the following:	Lab-RAs must possess or meet the following:
✓ Formal education with a background in relevant areas of study enabling them to lead appropriate staff, conduct biological monitoring, and accurately generate all necessary technical reports. Five years of related current work experience may be substituted for education. ✓ MDE protocol qualifications including current documented formal training and certification as related to specific biological monitoring protocols (i.e. MBSS, etc.). ✓ An understanding of the process of data management to ensure the coordination of all members of the biological monitoring study team in order to meet all regulatory conditions for quality data submissions to MDE.	✓ No experience is necessary, but must be able to adequately follow the direction of the PI to ensure that proper technique and protocols are followed. ✓ For MBSS sampling only, one year of documented formal training related to the specific biological monitoring protocols (for Stream Waders training required every year). ✓ Specifically for MBSS sampling, those Field-RAs identified as lead (field) fish taxonomic experts responsible for fish identification during field surveys should provide documentation that the MBSS laboratory fish taxonomy test was passed for the current sampling year.[9]	✓ Formal education with a background in relevant areas of study enabling them to perform taxonomic and related laboratory duties. Five years of related current work experience may be substituted for education. ✓ The minimum standards set by the appropriate laboratory governing body (i.e. for chemical analyses). ✓ Specifically for sorting and identifying benthic macroinvertebrate samples for MBSS style sampling, one year of documented formal training in the laboratory protocols ✓ To identify benthic macroinvertebrates to the genus level, Society for Freshwater Science (SFS) certification in Group 2 (Eastern EPT taxa) and Group 3 (Eastern Chironomidae) genera[10] **OR** Must send 10% of total samples (voucher) to an independent laboratory that is SFS certified. Voucher subsamples must meet acceptable error agreement during QAQC.

[9] Currently, the Maryland Department of Natural Resources' MBSS program offers this test annually in May.
[10] You must contact the Society of Freshwater Science to arrange genus-level benthic macroinvertebrate taxonomic certification.

The information contained in table 2 sets the minimum standard. It is within the purview of the specific MDE administration, program, or group issuing an individual permit to establish more rigorous data standards, as necessary. The Department has the discretion to make case-by-case decisions on whether to utilize a biological dataset for regulatory purposes. To help data providers understand MDE's requirements for biological data submission (for use in regulatory purposes) this document includes Appendices A and B which cover MBSS-comparable data submissions and other biological data submissions. Please refer to these checklists when submitting data to MDE.

Data used for regulatory purposes will be held to a high standard due to the wide-reaching impact that such decisions may have. In all cases, it is the Department's goal to enhance the credibility of decision-making through the use of high quality environmental data.

Sampling Protocol Documents

The documents below provide method-specific documentation for each set of biomonitoring protocols. Some of these documents include results and other ancillary information that may or may not be useful to a data collector. Electrofishing protocols for fisheries studies are not provided as the methods vary depending on the fishery study's purpose.

MBSS

Field Protocols

Stranko,S. , D. Boward, J. Killian, A. Becker, M. Ashton, M. Southerland, B. Franks, W. Harbold, and J. Cessna. 2017. *Maryland Biological Stream Survey: Round Four Field Sampling Manual.* Columbia, MD: Versar, Inc. and Frostburg, MD: University of Maryland Appalachian Laboratory, with Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs; Annapolis, MD. 12 Resource Assessment Service-3142014-700. Also available at http://dnr.maryland.gov/streams/Publications/R4Manual.pdf

Laboratory, Field, and Analytical Methods

Roth, N.E., J. Volstad, L. Erb, E. Weber, P. Kazyak, S. Stranko, D. Boward. 2005. *Maryland Biological Stream Survey 2000-2004, Volume 6: Laboratory, Field, and Analytical Methods*. Columbia, MD: Versar Inc. with Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. DNR 12-0305-0108 EA-05-3.

IBI Calculation Procedures

Southerland, M. T., G. M. Rogers, R. J. Kline, R. P. Morgan, D. M. Boward, P. F. Kazyak, R. J. Klauda and S. A. Stranko. 2005. *New biological indicators to better assess the condition of Maryland Streams*. Prepared by Versar, Inc., Columbia, MD, with Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. CBWP-MANTA-EA-05-13. Also Available at http://dnr.maryland.gov/streams/Publications/ea-05-13_new_ibi.pdf

Stream Waders

Protocol Manual

Boward, D., R. Bruckler, S. Weglein, and L. Roberson. 2015. *Maryland Stream Waders Volunteer Stream Monitoring Manual.* Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs; Annapolis, MD. DNR 12-1212011-491. Also available at http://dnr.maryland.gov/streams/Publications/SWManual2015.pdf

Surber and Multiplate Sampling

General Description of Sampling Methods

Friedman, E. 2009. *Benthic Macroinvertebrate Communities at Maryland's Core/Trend Monitoring Stations: Water Quality Status and Trends*. Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs; Annapolis, MD. CBWP-MANTA-MN-09-1.

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Friedman, E. 2009. Benthic Macroinvertebrate Communities at Maryland's Core/Trend Monitoring Stations: Water Quality Status and Trends. DNR CBWP-MANTA-MN-09-1. Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs; Annapolis, MD.

Southerland, M.T., G.M. Rogers, M.J. Kline, R.P. Morgan, D.M. Boward, P.F. Kayzak, R.J. Klauda, and S.A. Stranko. 2005. New Biological Indicators to Better Assess the Condition of Maryland Streams. DNR CBWP-MANTA-EA-05-13. Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs; Annapolis, MD.

Appendix A

Appendix B