Methods for Sampling Benthic Macroinvertebrate Communities in Wadeable Waters

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Energy and Environment Cabinet
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Document Revision History

Date of Revision	Page(s) Revised	Revision Explanation
March 6, 2015	Section 1.B. (pg. 6), Section 1.G.2 (pg.8), Section 1.G.3. (pg. 9), Section 1.G.4.1., Section 1.G.4.2.	**Methods for Sampling Benthic Macroinvertebrate Communities in Wadeable Waters** Riffle, run and pool are defined in the Definitions section. Sample Reach section moved. Sampling periods were updated with more specific directions on prioritization of streams that around the 5 square mile catchment area size. More details on high-gradient and low-gradient stream collection are provided. General format changes were made. Table 2 was added for clarification.
January 24, 2011	Section 1.G.2. (pg. 7), Section 1.G.3. (pgs. 7-12).	**Methods for Sampling Benthic Macroinvertebrate Communities in Wadeable Waters** Sampling periods were updated to reflect index periods used to create MBI. High-gradient stream sampling and low-gradient stream sampling methodology was revised and reorganized for general content. Table 1-1 and Table 1-2 from 2009 SOP were used to create Table 1. Probabilistic and TMDL Monitoring sections were updated for general content and sampling protocols.
March, 2009	Section 7. Macroinvertebrates	**Standard Methods for Assessing Biological Integrity of Surface Waters in Kentucky** Collection Methods for Benthic Macroinvertebrates in Wadeable Waters was separated from preceding document and revised/updated for general content regarding macroinvertebrate field collection methods.
March 13, 2008		**Standard Methods for Assessing Biological Integrity of Surface Waters in Kentucky** General Content Document was re-formatted for maintaining headers, section titles, etc in a consistent style.All references to detailed water chemistry sampling were removed, and a reference inserted directing the reader to the 'Standard Operating Procedures for Sampling and Monitoring Surface Waters for Kentucky', in draft

July, 2002		**Methods for Assessing Biological Integrity of Surface Waters in Kentucky** original document

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1. Procedures

1.A. Scope and Applicability

This manual has been developed by the Kentucky Division of Water (KDOW) as guidance for the uniform and accurate collection, field processing, field handling, and quality assurance/quality control (QA/QC) of benthic macroinvertebrate samples collected from the wadeable waters of Kentucky. The methods defined herein are required for all benthic macroinvertebrate sampling, field processing, field handling, and QA/QC activities resulting in information that could be used for 305(b) water quality assessments. Any data submitted to KDOW for review will undergo QA/QC and those identified as not following the methods set forth in this document will be flagged and discarded.

1.B. Definitions

Aufwuchs - The plants and animals adhering to parts of rooted aquatic plants and other open surfaces. Also organisms and detritus coating rocks and plants in an aquatic environment often fed on by fish specialized as scrapers.

Benthic Macroinvertebrate - KDOW defines benthic macroinvertebrates as organisms large enough to be seen by the unaided eye, retained by a U.S. Standard No. 30 sieve (28 mesh/inch, 600μm openings) and live at least part of their life cycle within or upon available substrates of a water body.

Pool – An area of a stream characterized by deep (usually > 0.5 m), slow velocity and a variety of substrate types. Because of slower velocities, sediment deposition can occur over pool substrate. Pools may have a higher diversity of permanent microhabitat types.

Riffle – An area of a stream with an observable decrease in gradient characterized by shallow (<0.5 m), fast velocity and **stable, layered** rock substrate. The surfaces of some substrate could be exposed above the waterline.

Run – An area of a stream characterized by deep (usually > 0.5 m), fast velocity and a variety of substrate types. Runs are commonly found below riffles. In low-gradient streams, runs (also called glides) are the dominant habitat where velocity is faster than the surrounding habitats.

Thalweg – Path of deepest thread of water.

1.C. Health & Safety Warning

During high flow or runoff events, biological sampling should be postponed until baseline conditions exist. When these specific events are targeted, field crews shall use best professional judgment to obtain samples (i.e., postponement, high flow equipment,

etc.). Waders and specialized wading boots should be utilized when conducting in-stream biological sampling to remain dry, but also to provide a barrier from potential in-stream contaminants, and natural irritants (i.e., biting insects, poison ivy). It is recommended that a wading belt be used to reduce the chances of water filling waders during a fall. Boots should have studded soles to reduce the chances of slipping or falling. Investigators should exhibit caution around stream bank mud, boulders, bedrock or large woody debris to reduce the threat of a falling injury.

1.D. General Cautions

The sampling procedures herein require specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting benthic macroinvertebrate collections should train with KDOW staff (via workshops and/or participating in field sampling) to demonstrate competence.

When performing impact assessment in a stream, the contaminant plume from a point source or tributary may flow along one bank of the stream for some distance. Make sure benthic macroinvertebrates are sampled within the influence of the plume.

For special studies, any deviation from the procedures in this document will be noted in study documentation approved by KDOW biologists prior to sampling.

1.E. Personnel Qualifications / Responsibilities

All biologists will meet minimum job classification requirements as specified by the Department of Personnel. Biologists will be certified in first aid, CPR, blood borne pathogens and HAZWOPER (OSHA 1910.120) and recertification will be completed as required. Biologists continue training by reviewing numerous peer reviewed journals and attending professional conferences. In order to stay current with changing biological methods and taxonomy it strongly benefits each biologist to attend a minimum of one professional conference annually as funds allow. As available, workshops in biological methods and taxonomy should be attended. A macroinvertebrate biologist will instruct any other personnel in sample protocol before sampling. At least one macroinvertebrate biologist will be present on all sampling events. New training requirements that are identified will be discussed with the Monitoring Section Supervisor, TMDL Section Supervisor, and/or Water Quality Branch Manager.

1.F. Equipment and Supplies

- High or Low Gradient Stream Data Sheet
- Chain of Custody
- Sample Labels
- 600µm mesh, 0.25 meter wide rectangular net or kick seine
- 800 x 500-600 µm D-frame dip net
- U.S. Number 10 sieve

- U.S. Number 30 sieve
- 2- 600µm mesh wash buckets
- Medium-sized bucket
- 300µm nitex sampler/mesh
- Fine-tipped forceps
- 95% ethyl alcohol
- White picking pans
- Sample jars

1.G. Methods

1.G.1. Type of Collections

KDOW samples macroinvertebrate communities to establish reference conditions within the state to assess aquatic life use-support and gain understanding of trends for streams in each basin management unit (BMU). In addition, samples are acquired for comparative purposes for total maximum daily loads (TMDL) and best management practice (BMP) implementation evaluation. Standardized, semi-quantitative collections are made at all sampling locations. However, more precise quantitative data may be collected on a case-by-case basis or if biological monitoring requires more rigorous statistical analyses. Qualitative multi-habitat sweep collections are also made at most sites. In general, collection methods used by KDOW are similar to those discussed in Lenat (1988), Plafkin et al. (1989), Klemm et al. (1990), Eaton and Lenat (1991), U.S. EPA (1997b) and Barbour et al. (1999).

1.G.2. Sampling Periods

Collection of benthic macroinvertebrate samples within the designated index periods is critical for accurate assessments. Headwater streams (<5mi^2 drainage area), should be sampled between March 1 to May 31, while wadeable streams (>5mi^2 drainage area) are sampled from May 1 to September 30. It is imperative that biologists monitor rainfall and flow conditions of streams within basins that will be sampled during a monitoring season. While preparing for the monitoring season, biologists will prioritize when certain streams will be sampled based upon catchment size, flow, rainfall and geology. It is suggested that headwater streams be sampled in March and April with the smallest streams sampled first. Streams with catchment areas between 5-10 square miles should be sampled in May. Wadeable streams with catchment areas larger than 10 square miles can be sampled anytime within the May to September index period. Each program coordinator will specify this prioritization process in the yearly monitoring study plan.

In some cases, sampling outside these index periods is permissible to assess immediate impacts (e.g., chemical spills, leaks, etc.). For routine assessments or baseline data collection, samples collected outside of these index periods are considered unacceptable. Also, benthic macroinvertebrate samples should not be collected during periods of excessively high or low flows or within two weeks of a known scouring flow event.

1.G.3. Sample Reach

A representative reach of stream should be selected for sampling. The stream reach to be assessed should be no less than 100 meters and no more than 300 meters. Large tributaries have the potential to greatly influence the biological communities of a sampling reach, therefore, it is desirable to either sample above or below the confluence of large tributaries to the reach.

1.G.4. Sampling Methods

The methods described in this section are modifications of the single and multi-habitat approaches outlined by Barbour *et al*. (1999). These methods vary somewhat among stream sizes and gradients because of differences in habitat types present. KDOW must approve any deviation from the methods described below.

It is important to keep in-stream habitat intended for benthic macroinvertebrate sampling intact and undisturbed until samples have been collected. Therefore, field personnel should avoid walking through areas designated for collection of benthic macroinvertebrates until sampling has been completed. Failure to use caution could result in sample degradation.

1.G.4.1. High-Gradient Streams

High gradient streams are defined as streams that have velocities greater than 0.013m/sec (0.5ft/sec), exhibit rapid changes in stream gradient and have a high frequency of riffle habitat. These streams are commonly found in the Mountain, Bluegrass and Pennyroyal Bioregions of Kentucky.

In high-gradient streams, riffle habitat predominates and is the primary targeted habitat. A collection consists of two types of samples: 1) a composited semi-quantitative riffle sample and 2) a composited multi-habitat sample. These two sample types must be kept separate. A summary of these collection techniques is shown in Table 1.

There may be situations in which high gradient streams lack true riffle habitat. Under these circumstances, it is appropriate to use best professional judgment to identify where a riffle might be as determined by changes in stream bed slope and/or stream flow. For example, if the stream is dominated by sediment, a riffle can be defined as the area in which shallow water is moving quickly over an area that may have unstable gravel/cobble substrate. In streams dominated by bedrock, a riffle can be defined as the area in which a noticeable change in slope causes turbulence of the water surface.

Table 1. Summary of sampling methods for headwater and wadeable high-gradient streams.				
Technique	Sampling Device	Habitat	Replicates (composited)	
			Headwater	**Wadeable**
1m^2 kicknet/seine[1]	Kicknet/seine and wash bucket	Riffle	4 – 0.25m^2	4 – 0.25m^2
Multi-habitat				
Undercut Banks/Roots	D-frame dip net and washbucket	Riffle-Run-Pool	3 each	3
Sticks/Wood	D-frame dip net and washbucket	Riffle-Run-Pool	3	N/A
Leaf Packs	D-frame dip net and washbucket	Riffle-Run-Pool	3	3
Headwater Depositional Areas	D-frame dip net and washbucket or US No. 10 Sieve	Margins	6	N/A
Wadeable Depositional Areas	US No. 10 Sieve	Margins	N/A	3
Aufwuchs Sample	D-frame dip net and washbucket	Riffle-Run-Pool	N/A	3
Emergent Vegetation	D-frame dip net and washbucket	Riffle-Run-Pool	N/A	3
Bedrock/Slabrock	D-frame dip net and washbucket	Run-Pool	N/A	3
Water Willow Beds	D-frame dip net and washbucket	Riffle-Run-Pool	N/A	3
Rock Pick	Fine-tipped forceps and wash bucket	Riffle-Run-Pool As Applicable	5 small boulders (pool only)	15 total (5 from each Riffle-Run-Pool)
Edge Habitat	D-frame dip net, fine-tipped forceps and wash bucket	Margins	3	3
Wood Sample	Fine-tipped forceps and wash bucket	Riffle-Run-Pool	2 linear meters	3-6 linear meters
[1]Sample contents kept separate from other habitats.				

1.G.4.1.A. Riffle (Semi-Quantitative) Sample

The semi-quantitative, riffle sample is comprised of four samples collected from four 0.25 m^2 quadrat kick net samples stratified within the thalweg of riffle habitat. This habitat is targeted to ensure the highest species richness and abundance of benthic macroinvertebrates. The thalweg of a riffle also guarantees the most flow permanence and substrate stability. Two kick net samples are allocated to each of two distinct riffles (at minimum) that are separated by at least one pool or run. This is done to help reduce between-riffle variability. If there are several riffles located within the reach, the sampling effort should be spread across the reach to give a comprehensive evaluation of the entire community (i.e. if four riffles are present then each riffle is to receive one 0.25 m^2 sample). The four samples are composited into a 600µm mesh wash bucket to yield a 1m^2 semi-quantitative sample. Large stones, leaves and sticks are individually rinsed and inspected for organisms and then discarded. Small stones and sediment are removed by elutriation using the wash bucket and U.S. No. 30 sieve.

1.G.4.1.B. Multi-Habitat (Qualitative) Sample

The qualitative sample is collected from various habitats that are present within the stream reach. The types of habitats targeted for multi-habitat sampling vary depending on stream size. Table 1 provides the sampling guidelines that should be followed when collecting qualitative samples in headwater and wadeable streams. If certain habitats are not available at a reach, these absences shall be noted in the field notes. Descriptions of the habitats that are targeted are found below.

1. Undercut Banks/Root Mats

Undercut banks and root mats from riffles, runs, and pools are sampled in both headwater and wadeable streams. The D-frame dip net is placed under the root wad or undercut bank, jabbed for approximately 1m, and then swept through the area to collect dislodged organisms. If large root wads are available, then place the root wad into the dip net and shaking vigorously. The contents are removed from the dip net and placed into a mesh wash bucket. At least three replicates are sampled within the reach. If undercut banks/root wads are present in more than one macrohabitat (i.e. riffle), then each is sampled separately with three (3) replicates.

2. Sticks/Wood

Sticks and wood are to be sampled from riffles, runs, and pools of headwater streams only. This habitat is sampled by kicking and/or stirring up loose emerged wood piles where present and then sweeping through the area to collect dislodged organisms. Material is then rinsed in the wash bucket and any sticks or wood are thoroughly washed and inspected before discarding. A total of three replicates will be sampled.

3. Leaf Packs

Leaf packs are to be sampled from riffles, runs, and pools of both headwater and wadeable streams. Leaf packs are preferably collected from "conditioned" (i.e., not new-fall material) material when possible. Samples are placed into the wash bucket and the material thoroughly rinsed to dislodge organisms. The washbucket is inspected and cleaned of organisms, which are placed in the collecting jar. After inspection, the leaf material discarded. Three leaf packs will be sampled for each sampling reach.

4. Headwater Stream Depositional Areas

Depositional areas within streams provide a unique habitat that specific macroinvertebrate taxa require in order to be productive. These habitats, most commonly associated with stream margins, are sampled by kicking and/or stirring up silt, sand, and fine gravel and then sweeping through the area to collect dislodged organisms or by using a U.S. No. 10 sieve as described in the next section. Six replicates will be collected in order to capture a variety of depositional areas with different proportions of silt, sand, and fine gravel substrate types.

5. Wadeable Stream Depositional Areas

Replicate samples are collected from three different depositional areas in wadeable streams. A U.S. No. 10 sieve is used to sort larger invertebrates (e.g., mussels, burrowing mayflies, dragonfly larvae) from silt, sand, and fine gravel by scooping the substrate to an approximate depth of 5cm for approximately 0.5 meter. All organisms are placed in the collecting jar and any coarse material discarded.

6. *Aufwuchs* Sample

***Aufwuchs* is sampled from riffles, runs, and pools from wadeable streams only.** This habitat is sampled by kicking and/or stirring approximately 1 meter of attached filamentous algae, moss, or small plants and then sweeping through the area to collect dislodged organisms. The material is rinsed and inspected for macroinvertebrates. All organisms are placed in the collecting jar and the material discarded. A total of three replicates are sampled within the reach.

7. Marginal Emergent Vegetation (exclusive of *Justicia americana* beds)

Marginal emergent vegetation, exclusive of water willow, *Justicia americana*, will be sampled in riffles, runs, and pools of wadeable streams only. This habitat is sampled by thrusting (i.e., "jabbing") the dip net into the vegetation for approximately 1 m, and then sweeping through the area to collect dislodged organisms. Material is then rinsed in the wash bucket and any sticks, leaves and vegetation are thoroughly washed and inspected before discarding. Remaining macroinvertebrates are placed in the collecting jar. A total of three replicates are sampled within the reach.

8. Bedrock or Slab-Rock Habitats

Bedrock and slab-rock surfaces are sampled from riffles, runs, and pools of wadeable streams only. These habitats are sampled by placing the edge of the dip net flush on the substrate, and disturbing approximately 0.1 m^2 of area to dislodge attached organisms. Material is emptied into a wash bucket, rinsed, inspected for organisms, and discarded. All remaining organisms are placed in the collecting jar. A total of three replicates are sampled within the reach.

9. Water Willow (*Justicia Americana)* Beds

Water willow is a very common aquatic plant associated with marginal areas in wadeable streams. **Sampling of this habitat type is conducted in riffles, runs, and pools of wadeable streams only.** These beds are sampled by working the net through a 1 m section in a jabbing motion. The material is then emptied into a wash bucket and any willow stems are thoroughly washed, inspected, and discarded. All organisms are placed in the collecting jar.

10. Rock Picking

Benthic macroinvertebrates are picked from small boulders in both headwater and wadeable streams. Selected rocks are washed in a bucket half filled with water and then carefully inspected to remove organisms. Individuals are picked from 5 small, pool boulders in headwater streams and 15 small boulders from each wadeable stream macrohabitat (5 each from riffles, runs and pools).

11. Edge Habitat

Edge habitats are stream margins often associated with either in-stream sediment deposits or floodplain/bank margin. Edge habitats are really good places to look for snails and beetles. Three 1 meter long areas are visually examined for additional macroinvertebrate taxa that might have been missed while utilizing other multi-habitat methods. Edges that have not been previously sampled for another habitat should be targeted.

12. Wood Sample

"Conditoned" submerged wood will be sampled in both headwater and wadeable streams. Smaller pieces of wood are individually rinsed into the wash bucket and inspected for burrowers and crevice dwellers. All macroinvertebrates on or in the wood are removed with fine-tipped forceps and placed in the collecting jar. Likewise, all dislodged organisms in the washbucket are removed and placed in the collecting jar. Large diameter, well-aged logs should be inspected and handpicked with fine-tipped forceps. Any individual picked from logs are placed in the collecting jar. In headwater streams, a minimum of 2 meters (6 linear feet) of wood ranging from 5-15 cm in diameter will be picked, while 3 to 6 meters (10 to 20 linear feet) of wood ranging from 5-15 cm in diameter will be picked in wadeable streams. In both headwater and wadeable streams, pieces of wood should range from 5-15 cm (2-6 inches) in diameter.

1.G.4.2. Low-Gradient Streams (MACS 20 Jab Method)

Low-gradient streams are defined as streams that have velocities less than 0.013m/sec (0.5ft/sec) and naturally lack riffle habitat with stable rocky substrate. The most productive habitats of these streams are typically root wads, woody snags, undercut banks and aquatic vegetation. These streams are found in the western parts of the state, particularly in the Mississippi Valley and Interior River Lowlands (MVIR) bioregion.

The sampling method follows the Mid-Atlantic Coastal Plain Streams Workgroup (MACS) protocol (US EPA 1997a) also detailed in Barbour et al. (1999). The technique is considered proportional sampling, where some predetermined number of sample units (20 in this case) is allocated among distinct microhabitats in relation to their proportion found within a stream reach. A sample unit is called a "jab" in which a D-frame dip net is thrust into the targeted habitat in a jabbing motion for approximately 0.5 meter and then swept with the net two or three times to collect the dislodged organisms. If a jab becomes heavily clogged with debris and sediment, then discard the material making sure that the net is free from any macroinvertebrates and repeat the jab. Under no

circumstances should more or less than 20 jabs be collected per sample. All material is composited into a wash bucket for further processing. Large leaves and twigs can be washed, inspected and discarded to reduce the volume of the debris in the sample. Sand and sediment should be elutriated using a bucket and 600 µm sieve. As an example, if the stream reach is determined to be half undercut banks/roots, a quarter cobble/gravel, and a quarter leaf packs, the biologist would complete 10 jabs in the undercut banks/root wads, 5 jabs in the cobble/gravel, and 5 jabs in leaf packs, achieving a total of 20 jabs that were completed in the appropriate proportion.

Each of the following habitats will be targeted, if present within the sampling reach and are outlined in Table 2, while a more detailed description of each sample type is described thereafter.

Table 2 Summary of the proportional MACS 20 jab sampling method for low-gradient streams.

Sample Type	**Sampling Device**	**Habitat**
Proportional Jabs		
Undercut Banks/Roots	D-frame dip net and wash bucket	All Applicable
Emergent Vegetation	D-frame dip net and wash bucket	All Applicable
Snag/Woody Debris	D-frame dip net and wash bucket	All Applicable
Cobble/Gravel	D-frame dip net and wash bucket	All Applicable
Silt, Sand, Fine Gravel	D-frame dip net and wash bucket	Margins
Leaf Packs	D-frame dip net and wash bucket	Run-Pool
Edge Habitat	D-frame dip net and wash bucket	Margin
Wood Sample (5-15 cm in diameter)	Fine-tipped forceps and wash bucket	Run-Pool

Each available habitat is allotted a portion of the 20 jabs available (i.e. if 4 major habitats are equally represented, 5 jabs would be taken from each of the 4 habitats).

1. Undercut Banks/Roots

These are sampled by placing a large root wad into a D-frame dip net and shaking vigorously. The contents are removed from the dip net and placed into the mesh wash bucket. If undercut banks are present in both run and pool areas, each is allotted jabs separately.

2. Emergent Vegetation

In deep water, this habitat is sampled by drawing the dip net through the vegetation from the bottom to the surface (no more than 0.5m). In shallower water, jab the net along the bottom in the rooted area, then sweep through the area to collect dislodged organisms. Material is then rinsed in the wash bucket and any sticks, leaves and vegetation are thoroughly washed and inspected before discarding.

3. Snags/Woody Debris

Snag samples are preferably collected from "conditioned" (i.e., not new-fall) material. If possible, avoid large snags as they are difficult to sample. Medium sized snags can be kicked first to dislodge organisms, but only after the net has been placed downstream of the disturbance. Woody debris is sampled by jabbing and sweeping the submerged area. Large diameter, well-aged logs can be inspected and handpicked with fine-tipped forceps. Woody material is emptied into a wash bucket, rinsed, inspected for organisms, and discarded.

4. Cobble/Gravel

Shallow cobble/gravel areas are sampled by disturbing the substrate 0.5m above the net. The net must remain in close contact to the bottom of the stream for at least 30 seconds after kicking has stopped, sweep through a 1m section in a jabbing motion to collect dislodged macroinvertebrates. The material is then emptied into a wash bucket and thoroughly washed. The organisms in the sample can be elutriated away from the gravel, after which the gravel is inspected and discarded.

5. Silt, Sand, and Fine Gravel

This habitat is sampled with a bumping motion as opposed to jabbing, to reduce the amount of fines/debris in the net. The material collected is treated similarly to the cobble/gravel sample.

6. Leaf Packs

Leaf packs are collected from conditioned material, whenever possible. Samples are taken from runs and pools and placed into the wash bucket. Leaf material is thoroughly rinsed to dislodge organisms, inspected and discarded.

7. Edge Habitat

Edge habitats are stream margins often associated with either in-stream sediment deposits or floodplain/bank margin. Edge habitats are really good places to look for snails and beetles. Edges that have not been previously sampled for another habitat should be targeted.

8. Wood Sample

"Conditioned" submerged wood may be sampled as a jab in both headwater and wadeable low-gradient streams. Smaller pieces of wood are individually rinsed into the wash bucket and inspected for burrowers and crevice dwellers. All macroinvertebrates on or in the wood are removed with fine-tipped forceps and placed in the collecting jar. Likewise, all dislodged organisms in the washbucket are removed and placed in the collecting jar. Large diameter, well-aged logs should be inspected and handpicked with fine-tipped forceps. Any individual picked from logs are placed in the collecting jar. In headwater streams, a minimum of 2 meters (6 linear feet) of wood ranging from 5-15 cm in diameter equates to one jab, while 3 to 6 meters (10 to 20 linear feet) of wood ranging from 5-15 cm in diameter will represent one jab in wadeable streams.

1.G.4.3. Alternative Sampling Methods

The following are methods that may be used for special studies, as approved by KDOW:

1.G.4.3.A. Modified Traveling-Kick Method (TKM)

The TKM is an adaptation of Hornig and Pollard's (1978) method. A traveling kicknet is used to collect samples along horizontal transects across the width of the stream at mid-riffle in the thalweg. In the event that the riffle cannot be sampled using horizontal transects, samples will be collected diagonally in an upstream direction. A triangular or D-frame dip net is placed on small cobble sizes or smaller sized substrate and moved in an upstream direction disturbing an area in front of the dip net of 30 cm (1 ft). The distance covered in the Interior Plateau portion of the state is 1.5 m (5 ft) in 30 seconds, while the distance in the Eastern and Western Coal Fields and Jackson Purchase area is 3 m (10 ft) in one minute.

1.G.4.3.B. Surber Sampler

Three to four Surbers samples are taken along a transect across the stream at mid-riffle in the thalweg by methods outlined in Needham and Needham (1962) and Klemm et al. (1990). In the event that the Surbers cannot be taken on a transect, they will be collected diagonally in an upstream direction. The Surber samplers should be employed only when the riffles are shallow (20 cm or less) and the current is moderate.

1.G.4.3.C. Modified Hester-Dendy Multiplate Sampler

Three multiplates, as described by Fullner (1971), are attached by wire or cord to a flotation device and allowed to float 25–30 cm (1 ft) below the surface. The multiplates are collected at the end of three weeks during the summer in the Interior Plateau or six weeks in the spring or fall in the Interior Plateau and for six weeks in the rest of the state regardless of season.

1.G.4.3.D. Basket Sampler

These samplers, described by Mason et al. (1967), may be used in lieu of multiplates. The basket samplers should be filled with limestone rock of approximately 7.5 cm (3 in) in diameter or porcelain spheres of approximately the same diameter. Residence time is the same as the multiplates.

1.G.4.3.E. Drift Nets

These should be used in streams that have a current velocity of more than 0.5 m/sec (1.5 ft/sec). A minimum of two drift nets per station should be used. One net should be set 25 cm (10 in) from the surface of the river and one set 10 cm (4 in) below the surface of the water. The collection period should be from one to three hours. Data should be reported in number of organisms per 100 m^3 of flow. Additional information can be found in Klemm et al. (1990).

1.G.4.3.F. Dredges

These may be used in lentic-type environments in water depths greater than 1 m and collected along a transect. The number of samples collected on the transect will be dependent upon the goals of the study. All dredge samples are to be washed in a 600 µm mesh bucket.

1.G.5. Sample Processing

Large sticks and leaves are washed, inspected for organisms and discarded. Material should be elutriated and hand washed into a bucket and 600 µm sieve. This process is repeated until a manageable amount of debris and organisms (relative to the size of the sample container) can be preserved for laboratory processing.

While at the sampling location, all macroinvertebrate samples will receive a label. The label may be placed in the sample jar or written directly on the jar with a permanent marker. The label will include the site number, stream name, location, county, date sampled and the collector's initials.

After sampling has been completed, all sampling gear will be thoroughly cleaned to remove all benthic organisms so that specimens are not carried to the next site. The equipment shall be examined prior to sampling at the next site to ensure that no benthic macroinvertebrates are present.

2. Quality Assurance and Quality Control (QA/QC)

Quality assurance and quality control measures that will be utilized to demonstrate confidence in collection procedures may include, but are not limited to, field audits, annual recertification in collection methods, annual review of standard operating procedures and specified training for new personnel. If more specific QA/QC

requirements are needed for a project, the project coordinator will address those specific needs in the Quality Assurance Project Plan.

3. References

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