

**U.S. GEOLOGICAL SURVEY
NATIONAL WATER QUALITY LABORATORY
SOP — Laboratory Analytical Method or Procedure**

SOP # BS0335.0	EFFECTIVE DATE: April 7, 2000	TAXONOMIC IDENTIFICATION OF BENTHIC MACROINVERTEBRATES
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WRITTEN BY: S.R. Moulton, II and J.P. Slusark	APPROVED BY: Merle W. Shockey	

1. Scope, Application and Summary

- 1.1. Summary of procedure—The following procedures are suitable to standardized performing taxonomic identifications of benthic macroinvertebrates (BMIs). These procedures can be applied to any BMI sample submitted to the NWQL for analysis. Taxonomic identification of BMIs requires experienced personnel trained in zoological taxonomic principles and possessing a broad knowledge of all aquatic macroinvertebrate groups. Typically, dichotomous keys, which are used to identify organisms, offer a formal, stepwise method for arriving at the name of an organism based primarily on its morphological characteristics. Progression through the dichotomous key results in classification of the organism according to a nomenclatural hierarchy (for example, order→family→genus→species) of increasing morphological similarity. Identifying BMIs can require viewing the whole organism at the low magnification of a dissecting microscope or clearing and mounting the entire organism (or its parts) on a microscope slide for the viewing at higher magnification of a compound microscope.
- 1.2. Lab codes covered by this method—2172, 2174, 2175, 2176
- 1.3. Reporting units and levels—Standard Taxonomic Assessment and Rapid Taxonomic Assessment (as defined in this SOP)
- 1.4. Detection limits—not applicable.
- 1.5. Interference
 - 1.5.1. Identification to a recommended level (for example, genus or species) may not be possible if the organism is immature or damaged. In this case, identify the organism to the most reliable level, usually family or order, and note why the recommended level could not be achieved.
 - 1.5.2. Dirt and debris can obscure diagnostic morphological structures (for example, setae), which are necessary for identification. Debris can often be removed by using a sable brush or forceps, or placing the organism(s) in a sonicator for several minutes.

2. Reasons for Revision and Summary of Changes—This is a new SOP.

3. Health and Safety Warnings

- 3.1. Personal Safety
 - 3.1.1. Wear long pants and closed-toed shoes at all times when working in the laboratory.
 - 3.1.2. Wear an apron, rubber gloves, and protective eyewear during sample preparation.
 - 3.1.3. Know the location of the nearest eyewash and shower stations.
 - 3.1.4. Do not eat or drink in the laboratory.
 - 3.1.5. Maintain an erect sitting posture while working at a microscope.
 - 3.1.6. Follow other safety procedures described in the USGS Occupational Hazards and Safety Procedures Handbook (September 1999).
- 3.2. Chemical Safety

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- 3.2.1. Only work in the laboratory when the room ventilation system and fume hoods are working properly. Leave the laboratory and contact the BG supervisor if the ventilation systems are not working properly.
- 3.2.2. Use the preservative waste pump system to transfer preservative waste from the fume hood to the storage barrel. Contact the BG Supervisor if the system is not functioning properly. Contact the BG Safety Committee representative when the storage barrel is full and needs to be replaced.
- 3.2.3. Know the location of and be familiar with the Material Safety Data Sheets (MSDS) for each chemical used in the laboratory.
- 3.2.4. Know how to report and handle chemical and sample spills using procedures described in the NWQL Chemical Hygiene Plan (available from the Safety Program).
- 3.3. Follow other standard safety guidelines as describe in National Research Council (1995).
- 4. Sample Preservation, Handling, Containers, Analytical Processing/Holding Times, Cautions and Disposal**
- 4.1. Refer to SOP No. BS0333.0.
- 5. Preparation of Reagents/Standards/Solvents**
- 5.1. 70-percent ethanol
 - 5.1.1. Prepared by the BG Production Coordinator in 55-gallon batches according to the procedure in SOP No. BS0331.0.
 - 5.1.2. Taxonomists are responsible for filling their own squirt-bottle supply as needed. All squirt bottles must be labeled with "70% Ethanol".
- 5.2. Glycerin
 - 5.2.1. Stock supply kept in BG laboratory. Taxonomists may keep small quantities at their workstations in eyedropper bottles.
 - 5.2.2. There are no hazard warnings for this chemical.
- 5.3. Aqueous potassium hydroxide
 - 5.3.1. Stock supply in pellet form located in the chemical storage locker located beneath the fume hood in the BG laboratory.
 - 5.3.2. Preparation of KOH solution for clearing BMI tissues:
 - 5.3.2.1. Dissolve 3 to 5 pellets in about 10 ml of tap or distilled water.
 - 5.3.2.2. Label container (for example, a scintillation vial) with "KOH" if clearing overnight at room temperature.
 - 5.3.3. Wear safety glasses and rubber gloves when preparing KOH solution.
- 6. Apparatus**

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6.1. Labware

- 6.1.1. Forceps
- 6.1.2. Probes (fine-tipped and blunt)
- 6.1.3. Petri dishes
- 6.1.4. Screw-cap vials (4–6 dram preferred) with polyseal caps
- 6.1.5. Scintillation vials
- 6.1.6. Vial racks
- 6.1.7. Shell vials (1/4 dram)
- 6.1.8. Genitalia microvials
- 6.1.9. Cotton
- 6.1.10. Squirt bottle
- 6.1.11. Taxonomic identification labels
- 6.1.12. BMI Identification and Enumeration Bench Data Sheet
- 6.1.13. Pigma pen (01 size), India ink pen, or pencil.
- 6.1.14. Fine sable-hair brush
- 6.1.15. Pipette
- 6.1.16. 0.5 cc syringe

6.2. Equipment

- 6.2.1. Compound microscope (40 to 1000X magnification)
- 6.2.2. Dissecting microscope (6 to 50X magnification)
- 6.2.3. Fiber-optic illuminators
- 6.2.4. Sonicator

7. Analysis

7.1. Taxonomic Information Resources

- 7.1.1. Confirm identifications by consulting descriptions, reviews and revisions of taxa, monographs of regional faunas, and distributional checklists.
- 7.1.2. Use taxonomic literature located in two lateral file cabinets and on bookshelves in the BG laboratory (room no. 2432).
- 7.1.3. Consult taxonomic information (for example, checklists) on the Internet as necessary.
- 7.1.4. Know the limitations of the taxonomic literature being used. Apply caution when using unpublished information or literature not subjected to peer-review.

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7.2. Reference Collection

- 7.2.1. A reference collection of organisms representing all life stages and taxa found to date in BMI samples is maintained in a designated area of the BG laboratory (room no. 2432).
- 7.2.2. When necessary, confirm identifications by comparing organisms to reference taxa.

7.3. Taxonomic Specialists

- 7.3.1. Consult external taxonomic specialists as necessary to assist with problematic taxonomic issues or to confirm identifications. This is required for all BMI taxa classified as state or federal threatened or endangered species.
- 7.3.2. Copy all correspondence with external taxonomic specialists to the BG Supervisor and the BG Quality Control (QC) Officer. Share final resolution of an external taxonomic inquiry with all BG taxonomists.
- 7.3.3. External taxonomic specialists must be recognized experts in their area of taxonomic interest and have a demonstrated record of peer-reviewed publications in taxonomy, systematics, and biogeography of BMIs.

7.4. Levels of Taxonomic Assessment

- 7.4.1. Identify organisms to the taxonomic levels specified in the lab code.
- 7.4.2. The taxonomist will identify organisms in a Standard Taxonomic Assessment (STA) to the following recommended levels provided the organisms are mature and undamaged.

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Taxon	Level of identification
Porifera	Family
Cnidaria	Family
Platyhelminthes	Class
Nematoda	Phylum
Nemertea	Genus
Nematomorpha	Phylum
Bryozoa	Phylum
Gastropoda	Genus
Bivalvia	Genus
Polychaeta	Family
Aphanoneura	Family
Oligochaeta	Family
Hirudinea	Family
Hydrachnidia	Order
Amphipoda	Genus
Isopoda	Genus
Decapoda	Genus
Collembola	Order
Ephemeroptera	
Acanthametropodidae	Genus/Species
Ameletidae	Genus
Ametropodidae	Genus/Species
Arthropleidae	Genus/Species
Baetidae	Genus/Species
Baetiscidae	Genus/Species
Behningiidae	Genus/Species
Caenidae	Genus/Species
Ephemeridae	Genus/Species
Ephemerellidae	Genus/Species
Heptageniidae	Genus/Species
Isonychiidae	Genus
Leptohyphidae	Genus/Species
Leptophlebiidae	Genus/Species
Metretopodidae	Genus/Species
Neophemeridae	Genus/Species
Oligoneuriidae	Genus/Species
Polymitarcyidae	Genus/Species
Potamanthidae	Genus/Species
Pseudironidae	Genus/Species
Siphonuridae	Genus/Species
Odonata	
Calopterygidae	Genus/Species

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Taxon	Level of identification
Coenagrionidae	Genus/Species
Lestidae	Genus/Species
Protoneuridae	Genus/Species
Aeshnidae	Genus/Species
Cordulegastridae	Genus
Corduliidae	Genus/Species
Gomphidae	Genus/Species
Libellulidae	Genus/Species
Macromiidae	Genus/Species
Petaluridae	Genus/Species
Plecoptera	
Capniidae	Genus
Chloroperlidae	Genus
Leuctridae	Genus
Nemouridae	Genus
Peltoperlidae	Genus
Perlidae	Genus/Species
Perlodidae	Genus/Species
Pteronarcyidae	Genus/Species
Taeniopterygidae	Genus
Heteroptera	
Belostomatidae	Genus/Species
Corixidae	Genus
Gelastocoridae	Genus
Gerridae	Genus/Species
Hebridae	Genus
Hydrometridae	Genus
Macroveliidae	Species
Mesoveliidae	Genus
Naucoridae	Genus
Nepidae	Genus/Species
Notonectidae	Genus
Ochteridae	Genus
Pleidae	Genus
Saldidae	Genus
Veliidae	Genus
Megaloptera	
Corydalidae	Genus/Species
Sialidae	Genus

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Taxon	Level of identification
Neuroptera	
Sisyridae	Genus
Trichoptera	
Apataniidae	Genus/Species
Beraeidae	Genus
Brachycentridae	Genus/Species
Calamoceratidae	Genus/Species
Dipseudopsidae	Genus
Ecnomidae	Genus/Species
Glossosomatidae	Genus/Species
Goeridae	Genus/Species
Helicopsychidae	Genus/Species
Hydrobiosidae	Genus/Species
Hydropsychidae	Genus/Species
Hydroptilidae	Genus/Species
Lepidostomatidae	Genus
Leptoceridae	Genus/Species
Limnephilidae	Genus/Species
Molannidae	Genus/Species
Odontoceridae	Genus/Species
Philopotamidae	Genus
Phryganeidae	Genus/Species
Polycentropodidae	Genus/Species
Psychomyiidae	Genus/Species
Rhyacophilidae	Genus/Species
Rossianidae	Genus/Species
Sericostomatidae	Genus/Species
Uenoidae	Genus/Species
Xiphocentronidae	Genus/Species
Lepidoptera	
Arctiidae	Genus
Cosmopterigidae	Genus
Nepticulidae	Genus
Noctuidae	Genus
Pyralidae	Genus
Tortricidae	Genus
Coleoptera	
Amphizoidae	Genus
Anthicidae	Family
Carabidae	Family
Chrysomelidae	Family

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Taxon	Level of identification
Curculionidae	Family
Dryopidae	Genus/Species
Dytiscidae	Subfamily/Tribe/Genus
Elmidae	Genus/Species
Epimetopidae	Genus
Georyssidae	Genus
Gyrinidae	Genus/Species
Halplidae	Genus
Helophoridae	Genus
Heteroceridae	Family
Histeridae	Family
Hydraenidae	Genus
Hydrochidae	Genus
Hydrophilidae	Genus
Hydroscaphidae	Species
Lampyridae	Family
Limnichidae	Genus
Lutrochidae	Genus/Species
Melyridae	Family
Microsporidae	Genus
Noteridae	Genus
Ptilidae	Family
Psephenidae	Genus
Ptilodactylidae	Species
Salpingidae	Family
Scirtidae	Family
Staphylinidae	Family
Tenebrionidae	Family
Diptera	(pupae to Suborder/Family)
Athericidae	Genus
Blephariceridae	Genus
Canacidae	Genus
Ceratopogonidae	Genus (pupae to Family)
Chaoboridae	Genus
Chironomidae	Subfamily/Tribe/Genus (pupae to Subfamily; adults to Family)
Corethrellidae	Genus
Culicidae	Genus
Deuterophlebiidae	Genus
Dixidae	Genus
Dolichopodidae	Family
Dryomyzidae	Genus
Empididae	Genus
Ephydriidae	Family

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Taxon	Level of identification
Muscidae	Family
Nymphomyiidae	Genus
Pelecorhynchidae	Genus
Phoridae	Family
Psychodidae	Genus
Ptychopteridae	Genus
Sarcophagidae	Family
Scathophagidae	Family
Sciomyzidae	Genus
Simuliidae	Genus
Stratiomyidae	Genus
Syrphidae	Family
Tabanidae	Genus
Tanyderidae	Family
Thaumaleidae	Family
Tipulidae	Family/Genus

7.4.3. A taxonomist will identify organisms in a Rapid Taxonomic Assessment (RTA) to the following recommended levels provided the organisms are undamaged.

Taxon	Level of Identification
Porifera	Family
Cnidaria	Family
Platyhelminthes	Class
Nematoda	Phylum
Nemertea	Genus
Nematomorpha	Phylum
Bryozoa	Phylum
Gastropoda	Family
Bivalvia	Family
Polychaeta	Family
Aphanoneura	Family
Oligochaeta	Family
Hirudinea	Family
Hydrachnidia	Order
Amphipoda	Family
Isopoda	Family
Decapoda	Family
Insecta (except Collembola)	Family
Collembola	Order

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7.5. General Procedures

- 7.5.1. Refer to vendor's manual for information on the operation and maintenance of microscopes.
- 7.5.2. Transfer organisms from a vial into a petri dish containing 70-percent ethanol (does not apply to organisms mounted on microscope slides).
- 7.5.3. Identify and enumerate each organism.
 - 7.5.3.1. Identify organisms to the level of taxonomic assessment specified by the project or customer (for example, all NAWQA samples are identified using the STA)
 - 7.5.3.2. If necessary, clear organisms in KOH.
 - 7.5.3.2.1. Wear safety glasses and rubber gloves.
 - 7.5.3.2.2. Place the whole organism or a dissected part of an organism (for example, abdomen from a caddisfly pupa or adult) into about 10-ml KOH solution in a 50-ml beaker.
 - 7.5.3.2.3. Warm KOH solution gently on a hot plate for several minutes. Avoid boiling the KOH solution. Clearing time will vary depending on the size of the organism or structure being cleared (for example, a small hydroptilid caddisfly may require 2 to 3 minutes; a large limnephilid caddisfly abdomen may take 5 to 10 minutes to clear).
 - 7.5.3.2.4. Alternatively, clearing can be performed overnight by placing a specimen in a sealed vial of KOH at room temperature.
 - 7.5.3.2.5. Check the organism to determine whether additional clearing time is required.
 - 7.5.3.2.6. Remove the organism or structure from the KOH using forceps and place in a petri dish of 70-percent ethanol.
 - 7.5.3.2.7. Flush dissolved body tissues from dissected insect abdomens by inserting a 0.5 cc syringe filled with 70-percent ethanol. Inject ethanol into the open end of the abdomen to flush out dissolved tissues.
 - 7.5.3.3. Identify and enumerate all complete BMI's. Fragmented BMIs are identified and enumerated if the head is present.
 - 7.5.3.3.1. Do not identify and enumerate BMI fragments. BMI's without heads are not identified and enumerated except for insect pupae and adults with some portion of the thorax present.
 - 7.5.3.3.2. In quantitatively processed samples, identify and enumerate mollusks only if both the shell and soft body parts are present.

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- 7.5.3.3.3. In qualitatively processed samples, identify mollusks on the basis of the entire organism or empty shell. If identification is based solely on the shell, then record "artifact" in the notes field on the bench data sheet.
- 7.5.3.3.4. In qualitatively processed samples, identify Bryozoa using the entire organism or stalk fragments (missing zooids). If fragment, record as "artifact".
- 7.5.3.4. When necessary, use morphological characters located in the terminal abdominal segments (for example, genitalia) of insects to identify pupae and adults. In most cases, these segments must be present to achieve low-level taxonomic resolution. For this reason, insect pupae and adults are identified and enumerated provided that at least the terminal abdominal segments and some portion of the thorax are present. To avoid a potentially redundant record, head and thorax combinations from pupae and adult insects are only enumerated if at least some of the anterior abdominal segments are present as well. Do not match fragments with the remainder of the body.
- 7.5.3.5. Place organism parts that are cleared, dissected or inadvertently fragmented during identification in a ¼ dram shell vial or genitalia microvial containing 70-percent ethanol and plug with cotton. Place the shell vial or microvial inside the primary taxon vial. Place larval sclerites from pupal metamorphotypes in either the puparium or in a microvial.
- 7.5.4. Where appropriate, use a standardized conditional or provisional designation listed below to convey as much taxonomic information as possible.

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Designation	Description
sp.	<ul style="list-style-type: none"> • Species place holder for identifications to Genus-level only • Denotes both singular and plural forms of species • Example: <i>Hydropsyche</i> sp.
sp. nr.	<ul style="list-style-type: none"> • Means “species near” • Refers to a potentially undescribed species nearest to the species/authority following the designation • Example: <i>Hydropsyche</i> sp. nr. <i>simulans</i> Ross
cf.	<ul style="list-style-type: none"> • Means “confer” • Refers to a species that closely matches the species/authority following the designation but differs morphologically in some minor ways or the description in the literature is too vague or incomplete to be certain • Example: <i>Hydropsyche</i> cf. <i>simulans</i> Ross
/ “slash”	<ul style="list-style-type: none"> • Used to denote two or more taxa that are unresolvable or where only two species are known in a monophyletic group • Placed between the taxa in question • Taxa are ordered alphabetically • If Species, authorities are included • Example: <i>Hydropsyche rossi</i> Flint, Voshell, and Parker/<i>simulans</i> Ross
sp. 1 or sp. A genus A	<ul style="list-style-type: none"> • Refers to provisional taxa reported in the literature where their specific identity remains unknown; also known as “operational taxonomic units” or “OTUs” • Provisional designation is reported exactly as it appears in the literature • Provisional designation is followed parenthetically by the author(s) and year of the publication • Example: <i>Oecetis</i> sp. A (Floyd, 1995)
group	<ul style="list-style-type: none"> • Denotes a group of more than two closely related species that cannot be separated or organisms that can be reliably placed in a species group where determination to species is unsupported • If only two species in the group, then use “/” or slash designation • Is formally recognized in the literature • Example: <i>Hydropsyche scalaris</i> group
complex	<ul style="list-style-type: none"> • Denotes a species for which there may be considerable variation suggesting two or more cryptic species • Is formally recognized in the literature • Example: <i>Oecetis inconspicua</i> complex
n. sp.	<ul style="list-style-type: none"> • Means “new species” • Represents a species new to science that has been verified by a recognized authority or one that appears in the literature as such • If the designation appears in the literature, the designation must be followed parenthetically by the authors and year of the publication • Example: <i>Hydroptila</i> n. sp. (Moulton and Stewart, 1997)
Other conditional or provisional designations	<ul style="list-style-type: none"> • Reported exactly as they appear in the reference from which they were obtained • The designation is followed parenthetically by the author(s) and year of the publication • Example: <i>Stilocladius?</i> sp. (Epler, 1995)

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7.5.5. When appropriate, use a standardized note listed below to justify an identification where the recommended level was not achieved.

Note	Description
imm.	<ul style="list-style-type: none"> • Means “immature” and includes all synonyms thereof • Identificaton to prescribed level not supported because the organism(s) is/are too immature • May be applied to larvae or pupae
dam.	<ul style="list-style-type: none"> • Means “damaged” and includes all synonyms thereof • Identification to prescribed level not supported because the organism(s) is/are damaged
mount	<ul style="list-style-type: none"> • Means “poor mount” and includes all synonyms thereof • Identification to targeted level not supported because slide mounted organism(s) is/are poorly oriented on slide
indet.	<ul style="list-style-type: none"> • Means “indeterminate” and includes all synonyms thereof • Identification to targeted level not supported for recently molted organisms, mayfly subimagos, mature and intact organisms because of undocumented variation or indistinct characters, required case is missing/damaged, or required habitat/ecological information is missing/unavailable • Unlikely that taxon is new to science
gender	<ul style="list-style-type: none"> • Includes males and females • Identification to targeted level not supported because of gender
retained	<ul style="list-style-type: none"> • Denotes unmounted/unidentified organisms retained in separate vial • For qualitatively processed samples only

7.5.6. When appropriate, use a standardized note listed below to convey additional information about an identification.

Note	Description
new state record	<ul style="list-style-type: none"> • Refers to a potential new state record for a taxon based on known distributional information in the published literature or other reliable source
new U.S. record	<ul style="list-style-type: none"> • Refers to a potential new United States record for a taxon based on known distributional information in the published literature or other reliable source
new species ?	<ul style="list-style-type: none"> • Represents a potentially undescribed species that cannot be linked to any closely related species • Used with Genus-level identification only
no. lost	<ul style="list-style-type: none"> • Refers to the number of organisms accidentally lost in handling • The number of organisms lost is indicated before “lost” • Example: 2 lost, ? lost, all lost
artifact	<ul style="list-style-type: none"> • Identification of a bryozoan fragment (missing zooids) or empty mollusk shell • Only used in qualitatively processed samples, when taxon is not represented by a complete organism
ref.	<ul style="list-style-type: none"> • Denotes an organism(s) suitable for placement in a reference collection

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- 7.5.7. Place specimens of each identified taxon in a 4- or 6-dram screw-cap vial containing 70-percent ethanol and BG taxonomic identification label. Secure the vial with a polyseal screw cap.
- 7.5.8. Place different life stages for the same taxon in separate vials.
- 7.5.9. Designate identified organisms as reference taxa for inclusion in the reference collection. This should be done for each new project.
 - 7.5.9.1. Select organisms that are mature, intact, and, when possible, are available in a series (several organisms of a taxon in a single sample) from a particular sample. Organisms may be selected despite their condition if they represent the only verifiable record of a particular taxon.
 - 7.5.9.2. Place the organism(s) in a gray, stoppered vial, record "ref." in the notes field on the BMI Identification and Enumeration Bench Data Sheet. Have a second taxonomist verify the identification. The second taxonomist also places his/her own determination label in the vial.
- 7.5.10. Record identification results legibly on the BMI Identification and Enumeration Bench Data Sheet. The following information is recorded:
 - 7.5.10.1. Taxon name; if species, provide authority (for example, *Hydropsyche simulans* Ross). (Note: record the species epithet for a monotypic genus or one for which there is only one North American species.)
 - 7.5.10.2. Life stage, where **L** is larva(e); **P** is pupa(e); or **A** is adult(s). (Note: record multiple life stages for the same taxon on separate lines.)
 - 7.5.10.3. Supporting taxonomic note(s) where applicable. (Note: use a semi-colon to separate multiple notes for a single taxon.)
 - 7.5.10.4. Organism count; recorded in the appropriate correction factor column.
 - 7.5.10.4.1. In qualitatively processed samples (lab code 2176), record a "1" in the 1:1 correction factor column.
 - 7.5.10.4.2. In quantitatively processed samples (lab codes 2172, 2174, and 2175), record the actual number of organism is identified for each taxon. Organism counts from the large-rare scan are recorded in the 1:1 column. Organism counts from the grid subsamples are recorded in the subsampling-correction-factor column.
 - 7.5.11. Comparing the taxonomic names on the completed bench data sheet to the vials for the sample to ensure that a corresponding vial exists for each entry.
 - 7.5.12. Place the BMI Identification and Enumeration Bench Data Sheet for each sample in the "Big Bugs Complete" bin located in the BG laboratory (Room No. 2432).
- 7.6. Identification of organisms prepared on microscope slides.

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- 7.6.1. Obtain paperwork for each sample from the “Midge Mounting Complete” bin located in the BG laboratory (Room No. 2432).
- 7.6.2. Obtain microscope slides and the corresponding Slide Preparations — Identification and Enumeration Worksheet for each sample to be identified. Verify that sample identification codes for the slides and the worksheet match.
- 7.6.3. Place a slide on the compound microscope.
- 7.6.4. Locate the organism under the first cover slip using scanning magnification (usually 4X).
- 7.6.5. Identify each organism left to right as they appear under the cover slip.
- 7.6.6. Record each taxon name in the corresponding position number field on the Slide Preparations — Identification and Enumeration Worksheet.
- 7.6.7. Repeat these steps until all organisms on slides for each sample have been identified.
- 7.6.8. Record each taxon from the Slide Preparations — Identification and Enumeration Worksheet to the BMI Identification and Enumeration Bench Data Sheet along with life stage, notes (if applicable), and enumeration. To enumerate, count the number of occurrences for each taxon on the Slide Preparations — Identification and Enumeration Worksheet.
- 7.6.9. Place completed BMI Identification and Enumeration Bench Data Sheet and other related paperwork for each sample in the “Midges Complete” bin located in the BG laboratory (Room No. 2432).
- 7.6.10. Place completed slides with the identified organisms stored in vials for each sample.

8. Quality Control and Quality Assurance

8.1. General

- 8.1.1. Maintain a bound daily record book that describes work performed. Entries must include the full sample identification code as specified by the project.
- 8.1.2. Clean microscopes, objective lenses, and light sources as necessary.
- 8.1.3. Keep all paperwork in a folder at the workstation.
- 8.1.4. Return all literature to the proper filing cabinet or shelf.
- 8.1.5. Do not mix taxa from different samples in the same petri dish except for making side by side comparisons.
- 8.1.6. Use extreme care when handling reference taxa to prevent damage.
- 8.1.7. When identifying a taxon for the first time, consider all lines of morphological and distributional evidence available; use the reference collection and consult with other taxonomists in the laboratory to share discoveries with others.

8.2. Taxonomic Identifications

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- 8.2.1. The QC Officer or a trained QC representative verifies identifications.
- 8.2.2. A QC sample-block includes all samples completed by taxonomists during a given week.
- 8.2.3. Every Monday morning obtain paperwork packets for each sample placed in the "Midges Complete" bin located in the BG laboratory. This represents the QC sample-block because slide mounted midges are the last part of a sample to be identified.
- 8.2.4. Obtain all vials and slides for a sample that are associated with each packet of paperwork.
- 8.2.5. Data for the block are entered by a QC representative into an electronic file (Microsoft™Excel™).
- 8.2.6. The file is checked electronically using a spell check program maintained by the QC officer to ensure that all taxonomic names are correct. Incorrect names are corrected. Monotypic genera that are not determined to the species level are automatically fixed. Taxa not previously determined by a BG taxonomist are temporarily listed as unverified.
- 8.2.7. Ten percent of the taxa for the block is randomly selected for QC check along with all unverified taxa.
- 8.2.8. Vials of all selected taxa are removed from the samples vial racks. The organisms in each vial are all checked to ensure that they were properly determined. In quantitatively processed samples, each vial of organisms are re-enumerated. Incorrect determinations and enumerations are recorded on the QC Identification/Enumeration Data Sheet.
- 8.2.9. QC verification labels are placed in each vial reviewed as part of the 10 percent taxa check.
- 8.2.10. Taxa mounted on microscope slides are removed from the slide box for the sample and the Slide Preparation and Identification Worksheet are referenced to determine the position of the organism(s) on the slide. Each taxon is checked for accuracy. In quantitatively processed samples, the organisms are re-counted. Incorrect determinations and enumerations for organisms on slides are recorded on the QC Identification/Enumeration Data Sheet.
- 8.2.11. The initials of the QC representative are placed in the cell of the QC Identification/Enumeration Data Sheet for each correct organism checked.
- 8.2.12. Results of the QC evaluation are communicated directly to each taxonomist and summarized to the BG during weekly staff meetings.
- 8.2.13. Problems with identification and enumeration in the data uncovered during the QC process are corrected by updating the electronic file for each sample and after consultation with the taxonomist.

9. Data Acquisition, Calculations and Data Evaluation/Reduction

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9.1. Data are electronically corrected for laboratory and field subsampling according to methods described in SOP No. BS0333.0.

10. Data Management and Records Management

10.1. Following QC and prior to data release, the original paperwork packets for each sample are filed in the QC workstation until all samples for a project are completed.

10.2. After all samples for a project have passed through QC, data are released to the customer.

10.3. Following data release, the original paperwork packet for each sample is stored in a lateral file organized by project and labeled with the name of the project. The lateral file is located outside the Production Coordinator's workstation.

10.4. All paperwork is maintained on file in the BG for a period of 3 years after data are released to the customer.

10.5. The taxonomists' laboratory record books are filed in the QC Officer's workstation. The file contains all full record books of current employees and all record books of former employees. The BG Supervisor, Production Coordinator, or QC Officer may inspect laboratory record books at any time.

10.6. The QC Officer routinely backs up BMI data in electronic form in net work directories and on zip disks. These disks are filed in the QC Officer's workstation.

11. Definitions—not applicable.

12. References

12.1. Moulton, S.R., II, Carter, J.L., Grotheer, S.A., Cuffney, T.F., and Short, T.M., 2000, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory — processing, taxonomy, and quality control of benthic macroinvertebrate samples. U.S. Geological Survey Open-File Report 00-212 (IN PRESS).

12.2. National Research Council, 1995, Prudent practices in the laboratory—Handling and disposal of chemicals: Washington, D.C., National Academy Press, 427 p.

12.3. U.S. Geological Survey, 1999, Occupational Hazards and Safety Procedures Handbook: Manual No. 445-2-h, available at <http://www.usgs.gov/usgs-manual/handbook/hb/445-2-h.html>

13. Key Words

benthic macroinvertebrate, taxonomic identification, enumeration, determination, reference collection, standard taxonomic assessment, rapid taxonomic assessment

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Attachments

1. Slide Preparations — Identification and Enumeration Worksheet
2. BMI Identification and Enumeration Bench Data Sheet