STATE OF TENNESSEE

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Division of Water Pollution Control

Quality System Standard Operating Procedure

for

MACROINVERTEBRATE STREAM SURVEYS

Revised October 2006

This SOP is an intra-departmental document intended to govern the internal management of the Tennessee Department of Environment and Conservation and to meet requirements of the U.S. Environmental Protection Agency for a quality system. It is not intended to affect rights, privileges, or procedures available to the public.

DIVISION OF WATER POLLUTION CONTROL
QUALITY SYSTEMS STANDARD OPERATING PROCEDURES
FOR MACROINVERTEBRATE STREAM SURVEYS

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DIVISION OF WATER POLLUTION CONTROL

QUALITY SYSTEM STANDARD OPERATING PROCEDURE FOR MACROINVERTEBRATE STREAM SURVEYS

TITLE AND APPROVAL PAGE

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PLAN COVERAGE	General instructions for macroinvertebrate stream surveys in Tennessee

APPROVALS AND CONCURRENCES

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Revision 2
Effective Date: March 2002
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REVISIONS AND ANNUAL REVIEW PROCEDURE: QS-SOP FOR MACROINVERTEBRATE STREAM SURVEYS

1. This document shall be reviewed annually to reconfirm the suitability and effectiveness of the program components described in this document.

2. A report of the evaluation of effectiveness of this document shall be developed at the time of review and submitted to appropriate stakeholders. Peer Reviews shall be conducted, if necessary and appropriate. It shall be reconfirmed that the document is suitable and effective. It shall include, if necessary, clarification of roles and responsibilities, response to problem areas and acknowledgement of successes. Progress toward meeting TDEC–BOE mission, program goals and objectives shall be documented. Plans shall be made for the upcoming cycle and communicated to appropriate stakeholders.

3. The record identified as "Revisions" shall be used to document all changes.

4. A copy of any document revisions made during the year shall be sent to all appropriate stakeholders. A report shall be made to the Assistant Commissioner and Quality Assurance Manager of any changes that occur. Other stakeholders shall be notified, as appropriate and documented on the "Document Distribution" list.

NOTICE OF REVISION(S) RECORD

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
10-1-03	xii	Minor	Replace MEAC recipient
10-01-03	II/B/1	Minor	Clarify Station Naming Protocol
10-01-03	II/D/4	Minor	Additional Information for Habitat Assessments
10-01-03	II/D/5 Table 1	Major	Revised Regional Habitat Guidelines
10-01-03	II/F/5	Major	Provide Biorecon Scoring Guidelines for 73a
10-01-03	II/F/6 Table 2	Major	Revised family level biorecon assessment guidelines
10-01-03	II/F/8 Table 3	Major	Revised Genus level biorecon assessment guidelines
10-01-03	II/G/1	Minor	Add online assessment database as source for determinig ecoregions.
10-01-03	II/G/2	Minor	Clarify procedures for additional SQKICK sampling to insure 200 organisms sample.
10-01-03	II/G/4	Minor	Clarify procedures for additional modified SQKICK sampling to insure 200 organism sample
10-01-03	II/G/5	Minor	Clarify procedures for additional SQBANK sampling to insure 200 organism sample.
10-01-03	Appendix A 2-7	Major	Updated biocriteria tables.
10-01-03	Appendix A 8-14	Major	Added location and status to ecoregion reference stream table. Added new reference streams.
10-01-03	Appendix A 15-16	Major	Added Table of regional expectations for individual habitat parameters.
10-01-03	Appendix B 4-7	Minor	Revised header information on habitat assessment sheets.
03-03-03	Appendix B 12	Minor	Revised macroinvertebrate assessment report sheet.

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
10-01-03	Appendix C 2	Major	Added Peltoperlidae to list of intolerant macroinvertebrate families for biorecons.
10-01-03	Appendix C 3-6	Major	Updated intolerant macroinvertebrate genera for biorecons.
10-01-03	Appendix C 7-21	Major	Updated NCBI scores for Tennessee Taxa.
10-01-03	Appendix C 22-25	Major	Added taxa to list of clinger organims.
10-01-03	Appendix E	Major	Added taxa to verified taxa list.
10-12-06	V	Minor	Change Commissione'rs name
10-12-06	V	Minor	Change QA manager's name.
10-12-06	VIII	Minor	Update reviewers
10-12-06	X	Minor	Update notice of revisions.
10-12-06	Section 1.1, Prtocol B, Page 2	Minor	Add naming scheme of UT to UT
10-12-06	Section 1.1, Protocol C, Page 1	Minor	Update meter specifications to match chemical QSSOP.
10-12-06	Section 1.1, Prtocol F, page 4	Minor	Clarify how chironomids are counted in richness metric for biorecons.
10-12-06	Section 1.1, Protocol F, Page 6 and 7	Major	Tables 2 and 3 updated based on reference data.
10-12-06	Section 1.1, Protocol J Page 2	Minor	Clarification of Slide labeling procedure.
10-12-06	Section II, Protocl K Page 2 Item f	Major	%NUTOL replaced %Dominant

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
10-12-06	Appendix A	Major	Biocriteria tables updated based on new reference data. Tables separated by season, metric ranges and target scores adjusted. Bioregion 66f combined with 66deg.
10-12-06	Appendix A	Major	Update ecoregion reference stream list.
10-12-06	Appendix B	Minor	Revised header information on habitat assessment sheets, stream survey form and biorecon field form.
10-12-06	Appendix B	Minor	Macroinvertebrate Assessment report revised.
10-12-06	Appendix C	Minor	Added additional taxa to NCBI score list.
10-12-06	Appendix C	Minor	Added Nymphoridae to list of clingers.
10-12-06	Appendix E	Minor	Added taxa to the verified taxa list.

This revision(s) has been reviewed and approved. It becomes effective on: 10 – 23 - 2006

Paul E. Davis — 10/24/06

Paul Davis
Director
Division of Water Pollution Control

Date

Charles L. Head — 10-23-06

Charles Head
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EVALUATION PROCEDURE:
QS-SOP FOR MACROINVERTEBRATE STREAM SURVEYS

As this document is used, needed changes or improvements will be apparent. Specific recommendations for improvements or changes are solicited as well as information concerning typographical or formatting errors.

1. Copy this page and complete all questions. Electronic versions of this are encouraged especially if comments are significant.

2. Send specific recommendations for improvements or changes, along with the following information, to:

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Document Effective Date _____
Section(s) and Page Number(s) to which your comments apply _____
Comments _____

QS-SOP DOCUMENT DISTRIBUTION LIST

Copies of this document were distributed to the following individuals in TDEC and TDH

Additional copies were distributed to non-TDEC agencies and individuals upon request (including other state and federal agencies, consultants, universities etc.). An updated distribution list is maintained in the Planning and Standards Section.

The system for document distribution is described in TDEC-BOE Quality Manual, Chapters 5 and 10.

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PREFACE

The U.S. EPA requires that a centrally planned, directed and coordinated quality assurance and quality control program be applied to efforts supported by them through grants, contracts or other formalized agreements. This includes the implementation of a Quality Management Plan as written by the contract holder with Data Quality Objectives (DQOs) set in Quality Assurance Project Plans (QAPPs) for specific projects. The organization may elect to support portions of the QAPP through technical or administrative standard operating procedures (SOPs), as specified by the quality system. As a contract holder and through memoranda of agreement, the Tennessee Department of Environment and Conservation is required to maintain such a system.

This quality system technical Standard Operating Procedure (QS-SOP) was prepared, reviewed and distributed in accordance with TDEC's Quality Management Plan and other quality system documents in response to U.S. EPA's requirements for a Quality Management Program. QS-SOPs are integral parts of successful quality systems as they provide staff with the information to perform a job properly and facilitate consistency in the quality and integrity of the process.

This QS-SOP is specific to the Division of Water Pollution Control and is intended to assist the division in maintaining their quality control and quality assurance processes and ensure compliance with government regulations. It provides specific operational direction for the division's Quality Assurance Project Plan for Macroinvertebrate Stream Surveys.

I. PROCEDURES

I.A SCOPE, APPLICABILITY AND REGULATORY REQUIREMENTS

The purpose of this Quality Systems Standard Operating Procedure (QS-SOP) is to support the Quality Assurance Program. The document provides a consolidated reference document for use in training and orientation of employees. This guide will also be a reference tool for more experienced employees. It establishes an approach that can be recommended to sister agencies that monitor Tennessee water or stipulated to members of the regulated community given monitoring requirements in receiving streams. This SOP describes the macroinvertebrate stream survey process and will delineate all steps in the process, including habitat assessments, field collections, sample analysis, data reduction and reporting. This SOP is only intended to describe routine conditions encountered during a macroinvertebrate stream survey.

Federal Statutory Authority

Federal Water Pollution Control Act (amended through P.L. 106-308, October 13,2000) as Amended by the Clean Water Act of 1977 enacted by Public Law 92-500, October 18, 1972, 86 Stat. 816; 33 U.S.C. 1251 et. seq.
Title III, Sec. 302: Water Quality Related Effluent Limitations
Title III, Sec. 303: Water Quality Standards and Implementation Plans
Title III, Sec. 304: Information and Guidelines
Title III, Sec. 305: Water Quality Inventory

Tennessee Statutory Authority

Tennessee Water Quality Control Act of 1977 (Acts 1971, ch. 164, § 1; 1977 ch. 366, § 1; T.C.A., § 69-3-101 et seq.

Tennessee Regulatory Authority

General Water Quality Criteria and the Antidegradation Statement: Rule 1200-4-3
(specifically 1200-4-3-.03(3) j: Biological Integrity and 1200-4-3-.06 Tennessee Antidegradation Statement)
Use Classification for Surface Waters: Rule 1200-4-4

I.B METHOD SUMMARY

This document describes procedures for performing two types of macroinvertebrate surveys approved by the Division of Water Pollution Control for assessing biological integrity of streams. The entire procedure is described including protocols for sample collection, habitat assessment, sample analysis, data reduction and reporting.

Macroinvertebrates are used by the Division as indicator organisms to determine if a stream supports fish and aquatic life. Two types of surveys (biorecons and semi-quantitative single habitat) are used depending on the purpose of the survey.

Biorecons (BR) will be used as a screening or reconnaissance tool to provide a quick evaluation of the relative health of the biological community. The biorecon will be used primarily for general watershed assessments and for determining where more intensive monitoring is needed. This method is not comparable to the proposed biocriteria.

Semi-quantitative single habitat surveys (SQKICK or SQBANK) will be conducted whenever a more defensible and/or definable assessment is needed. This method is directly comparable to the proposed biocriteria. The semi-quantitative biological survey is preferred in situations where the use attainment status of a stream is not obvious from the results of a biorecon. Tier evaluations under the Antidegradation Policy, enforcement actions and TMDL studies are additional examples of occasions when biorecons may provide inadequate amounts of information and a semi-quantitative sample would be preferable. It is recommended that this method be used by any outside agency or private organization submitting biological data to the Division for review.

Habitat assessments (high gradient and low gradient) are also described in this document. Habitat assessments are to be conducted in conjunction with all types of biological surveys since habitat is often a limiting factor to the complexity of the benthic community. By following this assessment procedure, habitat can either be confirmed or eliminated as a cause of stress to the macroinvertebrate community.

I.C DEFINITIONS AND ACRONYMS

Ambient Monitoring: Routine sampling and evaluation of receiving waters not necessarily associated with periodic disturbance.

Benthic Community: Animals living on the bottom of the stream.

Biocriteria: Numerical values or narrative expressions that describe the reference biological condition of aquatic communities inhabiting waters of a given designated aquatic life use. Biocriteria are benchmarks for water resources evaluation and management decisions.

Biometric: A calculated value representing some aspect of the biological population's structure, function or other measurable characteristic that changes in a predictable way with increased human influence.

Bioregion: An ecological subregion, or group of ecological subregions, with similar aquatic macroinvertebrate communities that have been grouped for assessment purposes. Tennessee has defined 15 bioregions.

Ecoregion: A relatively homogenous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables. There are eight (Level III) ecoregions in Tennessee.

Ecological Subregion (or subecoregion): A smaller area that has been delineated within an ecoregion that has even more homogenous characteristics than does the original ecoregion. There are 25 (Level IV) ecological subregions in Tennessee.

Ecoregion Reference: Least impacted waters within an ecoregion that have been monitored to establish a baseline to which alterations of other waters can be compared.

Habitat: The instream and riparian features that influence the structure and function of the aquatic community in a stream.

Macroinvertebrate: Animals without backbones that are large enough to be seen by the unaided eye and which can be retained by a U.S. Standard No. 30 sieve (28 meshes/inch, 0.595 mm).

Reference database: Biological and chemical data from ecoregion reference sites.

Riparian Zone: An area that borders a waterbody (approximately 18 meters wide).

Watershed: The area that drains to a particular body of water or common point.

Acronyms

BR	Biorecon
D.O.	Dissolved Oxygen
D/S	Downstream
EAC	Environmental Assistance Center
EPT	Ephemeroptera Plecoptera Trichoptera
ES	Environmental Specialist
GPS	Global Positioning System
IT	Intolerant Taxa
LDB	Left Descending Bank
NCBI	North Carolina Biotic Index
OC	Oligochaeta and Chironomidae
PAS	Planning and Standards Section
QA/QC	Quality Assurance/Quality Control
RDB	Right Descending Bank
SQBANK	Semi-Quantitative Bank Sample
SQKICK	Semi-Quantitative Kick Sample
TDEC	Tennessee Department of Environment and Conservation
TMDL	Total Maximum Daily Loading
TOPO	Topographic Map
TR	Taxa Richness
U/S	Upstream
WPC	Water Pollution Control

I.D HEALTH AND SAFETY WARNINGS

(Adopted from Klemm et al., 1990)

1. Know how to swim. Always wear waders with a belt to prevent them from filling with water in case of a fall. A life jacket at dangerous wading stations is advisable. Life jackets are required when operating a boat.

2. Avoid broken glass or other sharp objects that may lie out of sight at the bottom of streams.

3. Keep first aid supplies in the lab and in the field at all times. Training in basic first aid and cardio-pulmonary resuscitation is strongly recommended. Any person allergic to bee stings or other insect bites should have needed medications.

4. Always perform lab work involving ethanol or CMC-10 in a room containing a properly installed and operating hood.

5. Carry communication equipment in the field in case of emergency. Carry a list of emergency contact numbers for the sample area.

6. Consider all surface waters potential health hazards due to toxic substances or pathogens and minimize exposure as much as possible. Avoid splashing face and clean exposed body parts (hands and arms) immediately after contact with these waters. Carry soap and an adequate supply of clean water for this purpose. (Ethanol can also be used.)

7. If working in water known or suspected to contain human wastes, get immunized against tetanus, hepatitis, typhoid fever and polio.

8. Never work alone in the field.

9. MSDS sheets for ethanol and CMC-10 are to be kept in the lab. Everyone working with these agents should be familiar with the location and content of the MSDS sheets.

10. Obtain permission from land-owners before crossing private property.

I.E CAUTIONS

1. Avoid cross contamination of samples. Thoroughly rinse all nets and sieves and inspect for clinging organisms before leaving the sample site. Inspect nets and sieves again immediately before sampling the next site. Use new sample bottles whenever possible, otherwise thoroughly rinse bottles and inspect before use.

2. Avoid sampling bias by following these procedures exactly. Take care not to over sample, especially on biorecons.

3. Biocriteria metrics can only be applied to SQKICK or SQBANK samples. Never calculate quantitative metrics or apply biocriteria to biorecons.

4. Use the standardized station ID naming protocol for all samples. Make sure the station ID is included on all paperwork associated with the sample.

5. To avoid errors, calibrate all meters at the beginning of each sampling run (preferably each morning). Perform a drift check at the end of each day. If the meter calibration is off by more than 0.2 for pH, D.O. or temperature or off by more than 10% for conductivity, proceed all readings between the initial calibration and the drift check with an N (uncertainty in result) on the stream survey sheet and on any chemical request forms turned in at the lab. If lab forms have already been submitted, notify the Planning and Standards section of questionable readings in writing (e-mail or fax).

6. Express all time on a 24-hour clock.

7. Express all measurements except flow in meters. Flow is expressed in cfs.

8. Express temperature readings in degrees centigrade.

I.F INTERFERENCES

1. Document all deviations from protocol.

2. Semi-quantitative bank samples collected in 65j, 66d, 66e, 66f, 66g, 67f, 67g, 67h, 67i, 68a, 68b, 68c, 69d, 71e, 71f, 71g, 71h, and 74a cannot be compared to biocriteria. If sampling in a non-riffle stream in these regions, an upstream or offsite reference must be collected.

3. Semi-quantitative kick samples collected in 65a, 65b, 65e, 65i, 73a and 74b cannot be compared to biocriteria. An upstream or offsite reference must be collected.

4. Additional samples (of the same habitat) should be collected if it appears that fewer than 200 organisms were found in the standard collection (document).

5. Avoid sampling in flooded conditions or immediately after a flood.

6. Do not sample if stream is reduced to isolated pools. If stream channel naturally goes dry, only sample if there has been flow for longer than 30 days. Only compare to biocriteria or biorecon guidelines for those regions where reference streams routinely went dry (68b, 68c, 69d, and 71i).

7. Flag dissolved oxygen, pH, temperature and conductivity readings with an N (Questionable data) if post-trip drift checks show meter calibrations to be off by more than 0.2 units (or 10% for conductivity).

8. Organisms that are not on the verified taxa list must be verified by an approved expert.

9. Sampling stations should be located in areas where the benthic community is not influenced by atypical conditions, such as those created by bridges or dams unless judging the effects of atypical conditions is a component of the study objectives.

I.G PERSONNEL QUALIFICATIONS

Tennessee Civil Service Titles: Biologist or Environmental Specialist (state employees only). For the purpose of this report, both position titles will be referred to as biologist.

Minimum Education Requirements: B.S. in a biological science. Coursework in stream ecology and macroinvertebrate taxonomy is desirable. A graduate level degree in stream ecology or similar field is preferable.

Minimum experience: one year (specific class-work involving biological stream surveys can be substituted for experience)

Expertise: Macroinvertebrate taxonomy (must be able to consistently pass quality control checks), computation of basic statistics, use of standard water quality monitoring meters, habitat evaluations and general water quality assessments.

Training: Protocols outlined in this SOP
- Quality System Requirements
- Quality Assurance Project Plan

I.H.. EQUIPMENT AND SUPPLIES

Prior to any sampling trip, gather and inspect all necessary gear. Replace or repair any damaged equipment. Calibrate all meters the morning of the sampling trip with a drift check at the end of the day (or the end of the trip for overnight stays). Upon return from a trip, take care of any equipment repairs or replacements immediately. Necessary equipment will vary per project, but the following is a standardized list.

Field Equipment

Waders
Forceps
Ethanol
External sample tags
Internal sample tags
Habitat Assessment Sheet (High gradient for riffles, Low gradient for glide-pool)
Stream Survey Sheet
Biorecon Sheet (Biorecons only)
Biological Analysis Request Sheet (for Chain of Custody and/or samples sent to lab)
Topographic maps (USGS quadrangle maps) may also be referred to as topos or quads.
Tennessee Atlas and Gazetteer
½ gallon wide mouth plastic sample bottles for Semi-Quantitative samples
Small wide mouth plastic bottles for biorecons
Calibrated GPS unit
Calibrated Dissolved Oxygen meter and replacement membrane kit
Calibrated pH meter
Calibrated conductivity meter
Calibrated temperature meter or thermometer in ^{o}C
Spare batteries for all meters
Camera (preferably digital) with memory cards, floppy discs or film
Triangular dip net with 500-micron mesh (Biorecons and SQBANK samples only)
One meter square kick net with 500 micron mesh (SQKICK samples only)
Rectangular net (18”) with 500 micron mesh (SQKICK in streams less than 1 meter wide only)
White enamel or plastic pans for sorting debris (biorecons only)
Magnifying lens
Waterproof marking pens (Sharpies), pencils and black ballpoint ink pens (not roller-ball)
Flashlights
Duct Tape
First Aid Kit
Watch
Spherical densiometer (for canopy measurements)
Map Wheel (for calculating stream miles)

Laboratory Equipment

The following equipment is needed to perform sample analysis (semi-quantitative samples only).

Dissecting Microscope
Compound Microscope
Jewelers Forceps
Microscope slides
Round 12 mm coverslips
Square 22 mm coverslips
Gridded Tray with subsampling insert
Small Gridded dish (36 grids)
Ethanol
CMC-10 or equivalent permanent mounting media
Random number jar
Bench Sheet
Turkey baster (or equivalent suction device)
Transfer pipette (or equivalent suction device)
Slide storage box
Glass vials with rubber or Teflon line lid (for reference specimens)

I.I PROCEDURES

Protocol A - Selection of Survey Type and Station Location

Biologist or Environmental Specialist from EAC
Central Office Coordinator

1. Determine biological sampling needs.

   The central office will coordinate biological sampling needs with the environmental assistance centers. The location and type of biological assessments are included in the annual water quality monitoring workplan.

   The following guidelines will be used in determining the level of monitoring needed.

   a. **Biorecons** (BR) will be used for

      - Routine watershed assessments
      - Screening sites
      - Ambient monitoring

   b. **Semi-Quantitative Single Habitat** (SQKICK or SQBANK) will be used for clarification of ambiguous biorecons where use attainment status of stream is not obvious. Examples include:

      - Tier evaluations
      - TMDL studies
      - Permit compliance and enforcement

   c. **Both** Biorecons and Semi-Quantitative Single Habitat Samples will be collected at Ecoregion Reference Sites.

2. Select sites.

   Site selection is dependent on the study objectives. After determining the specific objectives of the study and clearly defining what information is needed, select sampling sites on specific reaches of the stream. Reconnaissance of the waterway is very important. Note possible sources of pollution, access points, substrate types, flow characteristics, and other physical characteristics that will need to be considered in selecting the sampling sites. Although the number and location of sampling stations will vary with each individual study, the following basic rules should be applied:

a. Determine whether an upstream or watershed **reference site** is needed or if the study site can be compared to biocriteria (Appendix A) or biorecon guidelines (Tables 2 and 3) derived from the ecoregion reference database. In order to compare to biocriteria, the watershed upstream of the test site must:

   1. Be at least 80% within the specified bioregion
   2. Be of the appropriate stream order (estimated using topographic maps)
   3. Be collected using the collection method designated for that bioregion (SQKICK or SQBANK).

   This information can be found in Appendix A. Compare all appropriate semi-quantitative samples to biocriteria. Depending on study purposes or if the study stream does not meet requirements for the reference database, an upstream sample or an appropriate watershed reference may need to be collected.

   Compare biorecons on streams whose upstream drainage is at least 80% within a bioregion to guidelines developed from the ecoregion reference database (Tables 2 and 3). If the test stream lies within a bioregion and ecoregion reference data are not available, biorecons at the ecoregion reference sites for that bioregion should be collected at the same time. Information on the location of designated ecoregion reference sites can be found in Appendix A. If the test stream crosses multiple bioregions upstream of the test site, select an appropriate upstream or watershed reference. (An alternative is to compare the site to guidelines for each appropriate bioregion, however if assessments differ another reference must be used).

b. For **watershed screenings**, locate sites near the mouth of each tributary. If impairment is observed, locate additional sites upstream of the impaired stream reach to try to define how far the impairment extends.

c. For monitoring **point source** pollution, establish a station downstream of the source of pollution in the stream after mixing has occurred. If complete mixing of the discharge does not occur immediately, left bank, mid-channel and right bank stations may need to be established to determine the extent of possible impact. Establish stations at various distances downstream from the discharge. Space the collecting stations exponentially farther apart going downstream from the pollution source to determine the extent of the recovery zone.

d. For **site specific** sampling, locations immediately above, or below the confluence of two streams, or immediately below point/nonpoint source discharges should be avoided if mixing does not immediately occur. Unless the stream is extremely small or extremely turbulent, an in-flow will usually hug the stream bank with little lateral mixing for some distance. This may result in two very different biological populations and an inaccurate assessment of stream conditions. This can be avoided by sampling after mixing has occurred.

e. All sampling stations under comparison during a study should have **similar habitat** unless the object of the study is to determine the effects of habitat degradation.

f. Sampling stations for macroinvertebrates should be located within the same reach (200 meters or yards) of where sampling for **chemical and physical parameters** will be located. If the macroinvertebrates are collected more than 200 meters from the chemical sampling, consider it a separate station and assign it a different station ID number.

g. Sampling stations should be located in areas where the benthic community is not influenced by **atypical conditions**, such as those created by bridges or dams unless judging the effects of atypical conditions is a component of the study objectives.

Protocol B – Assigning Station Numbers

Biologist/Environmental Specialist

Assign station numbers to each site using the following protocol. The station number will be used to identify the sample and must be included on all associated paperwork, results, tags etc. This number is to be used to identify this site every time it is sampled for any parameter (benthic, fish, bacteria, chemical). If new stations are set up that will have chemical or bacteriological monitoring, send the new station information to Planning and Standards as soon as the station location is finalized and before the lab sends results.

1. Before assigning a new station number, check the Water Quality Monitoring database to make sure a number hasn't already been assigned to that site. Contact the Planning and Standards section if there is any question. Unless the sites are located upstream and downstream of a point source discharge, tributary confluence or some other factor that would affect the stream, stations collected within 200 meters (yards) of each other are considered the same site**.** (So, if chemical samples were taken off the bridge and biological samples were collected up to 200 meters (yards) upstream, they are still the same station.)

The only exception to this naming scheme is sites that have been designated as Ecoregion reference sites. These sites are always identified with their ECO designation no matter what the purpose of sampling. If new ecoregion reference sites are added, contact Planning and Standards (PAS) to determine the appropriate station name.

2. If a number does <u>not</u> already exist for the site, create a 12-character identification number. All letters in the station name are capitalized. Do not use more than 12 characters including the decimal.

   a. The first five digits will be the first five letters of the stream name (capitalized). If the stream name has more than one word, use the first letter of each word finishing out the five letters with the last word. For example, South Fork Forked Deer River would be SFFDE. Do not use the words River, Creek Branch etc. (Fork is only used if the stream is also designated river, creek, branch etc.) For example, Dry Fork would be DRY but Dry Fork Creek would be DFORK.

   b. The next five characters designate the river mile. This will be written as three whole numbers, a decimal and a tenth space. For example, river mile 1.2 would be written as 001.2.

   c. The last two characters designate the county. Use the County Identification table in Appendix B to determine the appropriate county designation. The county is expressed with two letters; do not use the numeric state code.

Example 1: A station located at river mile 1.5 on Puncheoncamp Creek in Greene County would be PUNCH001.5GE

Example 2: A station located at river mile 25 on the North Fork Forked Deer River in Gibson County would be NFFDE025.0GI.

3. Unnamed Tributaries will be named in the following manner.

   a. Use the first five letters of the receiving stream the tributary enters.

   b. Use 1T for the first unnamed tributary station sampled, 2T for the second unnamed tributary sampled etc.

   c. Use a 3-character stream mile including one whole number, the decimal and a tenth space.

   d. Use the two letter county designation from Appendix A.

      Example 1: A station located a river mile 0.2 on an unnamed tributary that entered the North Fork Forked Deer river in Gibson County would be NFFDE1T0.2GI.

      Example 2: A second station located at mile 5.5 on the same unnamed tributary would be NFFDE1T5.5GI.

      Example 3: A site at river mile 8.5 on a different unnamed tributary to the North Fork Forked Deer would be NFFDE2T8.5GI.

   e. When naming an unnamed tributary to an unnamed tributary, use the first three letters of the main stem followed by the 1T1T, the river mile and the county. For example, a station at river mile 0.5 on an unnamed tributary to an unnamed tributary to Turkey Creek in Gibson County would be called TUR1T1T0.5GI.

Protocol C – Field Parameters

BIOLOGIST/ENVIRONMENTAL SPECIALIST

Dissolved Oxygen, pH, temperature and conductivity readings are taken at each biological monitoring site. Multi-probe or individual meters meeting the following specifications can be used.

Parameter	Range	Accuracy	Resolution
Temperature	-5°C to 40 ^{o}C	+/- 0.15 ^{o}C	0.01 ^{o}C
Specific Conductivity	0 to 1000 umhos/cm*	+/- 1% of reading	4 digits
pH	0 to 14 units	+/- 0.2 units	0.01 units
Dissolved Oxygen	0 to 20 mg/l	+/- 0.2 mg/l	0.01 mg/l

* For mining or other high conductivity/low pH siturations a higher range may be necessary.

1. Calibrate meters are calibrated following manufacturer's directions at the beginning of each day. (For multi-day surveys, meters may be calibrated at the beginning of each sampling period not to exceed 5 days). Maintain calibration SOPs for each type and/or brand of meter. Keep all calibration records in a bound logbook (Figure 1). Information must include the date, meter being calibrated, project name/number, initials of person performing the calibration, parameter, standards used, meter reading, adjustments and any problems. A record of routine maintenance is also kept in this log. Give each meter a distinct identifying name (i.e. meter A, meter B) for calibration and maintenance records. Mark the meter with this designation.

Date	Meter	Project	Init.	Parameter	Standard	Reading	Adj	Comments
3/6/02	YSI-A	Davis Ck	JEB	Conductivity	142	120	142	Cleaned contacts
3/6/02	YSI-A	Davis Ck	JEB	Conductivity	142	140	NA	Drift Check

Figure 1: Example of Meter Calibration Log

2. Take meter readings mid-stream immediately prior to collecting macroinvertebrate samples. Suspend probes in the water column so they do not touch the bottom. If the water is too shallow to suspend the meter, carefully lay the probe on its side on a firm substrate (preferably rock). Do not allow the probe to sink into soft substrate. Stand downstream of the probe, being careful not to disturb the substrate in the area of the probe. Allow enough time for each reading to stabilize before it is recorded. This may take a minute or longer for dissolved oxygen. When taking dissolved oxygen readings, make sure that the stirrer is activated.

3. Take duplicate readings at each site. If time is a constraint, duplicate readings may be reduced to the first and last site each day. To make a duplicate reading, lift the probe completely out of the water, than place it in another location upstream of the original reading. If the readings are off by more than 0.2 units (or 10% for conductivity), repeat the procedure until reproducible results are obtained.

4. Record field parameters in the appropriate boxes on the stream survey sheet (Appendix B). If chemical samples are being collected, the field parameters should also be entered on the sample request form (Appendix B).

5. Perform a drift check on each meter at the end of the day (or at the end of the trip on multiple night trips). If the meter calibration is off by more than 0.2 for pH, D.O. or temperature or is off by more than 10% for conductivity, all readings between the initial calibration and the drift check should be preceded with an N (uncertainty in result) on the stream survey sheet and on any chemical request forms turned into the lab. If chemical request forms have already been submitted to the lab, the central office should be notified of questionable readings in writing (e-mail or fax).

Protocol D – Habitat Assessment

Biologist/Environmental Specialist

Conduct a habitat assessment any time a biological sample is collected. Use habitat data sheets finalized in *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (Barbour et. al., 1999) to evaluate the integrity of the habitat at each site (Appendix B). When possible, two or more investigators should collaborate on habitat assessments to reduce the potential for individual bias.

Two different habitat assessment sheets will be used dependent on the ecoregion and/or stream type. (For habitat assessments, it does not matter if the upstream watershed is contained in the same bioregion). In order for the site to be compared to the habitat guidelines (Table 9), the assessment sheet used will depend on the ecoregion. Information on ecoregion boundaries can be found in the *Tennessee Ecoregion Project* (Arnwine et al, 2000). Each Environmental Assistance Center should have copies of ecoregion maps for their area. The Planning and Standards section should be contacted if there is uncertainty about what ecoregion a stream is located in.

In ecoregions 65j, 66d, 66e, 66f, 66g, 67f, 67g, 67h, 67i, 68a, 68b, 68c, 69d, 71e, 71f, 71g, 71h, and 74a as well as riffle streams in 71i, use the High Gradient Stream (formerly Riffle-Run) assessment sheet to evaluate habitat based on the guidelines in Table 9. Note that the guidelines cannot be used in non-riffle streams in these ecoregions. Therefore, a suitable upstream or watershed reference must be selected for comparison in non-riffle streams.

In ecoregions 65a, 65b, 65e, 65i, 73a, and 74b as well as non-riffle steams in 71i, use the Low Gradient (formerly Glide-Pool) assessment sheet. Copies of these sheets are located in Appendix B.

Evaluate all ten habitat parameters. Base score on a scale of 0 to 20 for each parameter, with 20 being the highest attainable score. Scores are divided into four categories (optimal, suboptimal, marginal and poor) with a range of five scores possible in each category. Specific guidance for scoring is located on the habitat sheets (Appendix B). The parameters that are evaluated in each sample reach are:

1. Epifaunal Substrate/Available Cover (high and low gradient streams)

   Estimate the relative quantity and variety of natural structures in the stream such as cobble riffles, large rocks, fallen trees, logs and branches, and undercut banks that are available as refugia, feeding, spawning or nursery functions for macroinvertebrates and fish. Do not count “newly fallen trees and unstable habitats.

2a. Embeddedness (high gradient streams)

Estimate the percent that rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas.

2b. Pool Substrate Characterization (Low gradient)

Evaluate the type and condition of the bottom substrate in the pools. Firmer sediment such as gravel and sand, and rooted aquatic plants support a wider variety of organisms and should be scored higher than a pool substrate dominated by mud or bedrock with no plants. In addition, a stream that has a uniform substrate will support fewer types of organisms and should score lower than a stream that has a variety of substrate types.

3a. Velocity/Depth Combinations (high gradient)

Determine the patterns of velocity and depth. The four basic patterns are slow-deep, slow-shallow, fast-deep, and fast-shallow. The best streams will have all four patterns present. The general guidelines are 0.5 meter depth to separate shallow from deep and 0.3 m/sec to separate fast from slow.

3b Pool Variability (low gradient)

Rate the overall mixture of pool types found in the stream, according to size and depth. The four basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream having many different pool types will support a wider variety of aquatic species and should score higher. General guidelines are any pool dimension (length, width, oblique) greater than half the cross-section of the stream for separating large from small and 1 meter depth separating shallow and deep.

4. Sediment Deposition (high and low gradient)

Estimate the amount of sediment deposition. This is observable through the formation of islands, point bars (areas of increased deposition at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals. Determine whether pools and runs are filling in. Usually deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends or pools.

5. Channel Flow Status (high and low gradient)

   Estimate the degree to which the channel is filled with water. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited and the stream should score lower.

6. Channel Alteration (high and low gradient)

   Determine how much, if at all, the stream has been altered. Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams and bridges are present; when dredging or gravel removal is evident and when other such artificial changes have occurred. Scouring is often associated with channel alteration.

7a. Frequency of Riffles or Bends (high gradient)

   Determine the pattern of stream morphology by estimating the sequencing of riffles. In high gradient streams where distinct riffles are uncommon, a run/bend ratio can be used as a measure of meandering or sinuosity. In headwaters, riffles are usually continuous and the presence of cascades or boulders provides a form of sinuosity. To determine this parameter, a longer segment or reach than that designated for sampling should be incorporated into the evaluation.

7b. Channel Sinuosity (low gradient)

   Evaluate the meandering or sinuosity of the stream. A high degree of sinuosity provides diverse habitat for macroinvertebrates and the stream is better able to handle surges when the flow fluctuates due to rain events. To estimate this parameter, a longer segment or reach than that designated for sampling should be incorporated into the evaluation. (This will vary by site, but should include at least two bends).

8. Bank Stability (high and low gradient)

   Determine whether the stream banks are eroded or have the potential for erosion. Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks, and are therefore considered less stable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Each bank is evaluated separately on a scale of 0 to 10 and the cumulative score of both banks is used for this parameter. (This parameter should be evaluated within the 100-meter sample reach.)

9. Bank Vegetative Protection (high and low gradient)

   Determine the amount of vegetative protection afforded to the stream bank and near-stream portion of the riparian zone. The object is to determine the ability of the bank to resist erosion as well as the ability of the plants to uptake nutrients, control instream scouring, supply food to shredders and provide stream shading. Streams that have various types (shrubs, trees etc.) of native vegetation providing full natural plant growth will score highest. In some regions, the introduction of exotics, such as kudzu, has virtually replaced all native vegetation. The value of exotic vegetation to the quality of the habitat structure and contribution to the stream ecosystem should be evaluated, generally resulting in a lower score. Each bank is evaluated separately on a scale of 0 to 10 and the cumulative score of both banks is used for this parameter. (This parameter should be evaluated within the 100-meter sample reach.)

10. Riparian Vegetative Zone Width (high and low gradient)

    Estimate the width of natural vegetation from the edge of the stream bank out through the riparian zone (approximately 18 meters). Disturbance to the riparian zone occurs when roads, parking lots, fields, lawns, bare soil, or buildings are near the stream bank. Residential developments, urban centers, golf courses, pastures and row crops are common causes of degradation of the riparian zone. However, the presence of old fields (previously grazed fields, not currently in use), paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores. Each bank is evaluated separately on a scale of 0 to 10 and the cumulative score of both banks is used for this parameter. (This parameter should be evaluated within the 100-meter sample reach.)

Total the 10 habitat parameters and compare the score to the Habitat Assessment Guidelines (Table 1) to determine whether the habitat is capable of supporting a healthy benthic community. Note that habitat scores in five ecoregions (68a, 68b, 68c, 69d and 71i) vary by season.

Sometimes it may be useful to evaluate individual parameters in addition to the total habitat score. For example even if the total habitat score meets regional guidelines, the indiviual parameters of embeddeness and sediment deposition may be low indicating a problem with sedimentation. Likewise, there may be a problem with riparaian removal even though habitat scores meet regional guidelines. On the other hand, a low total score may not indicate a habitat problem if the channel flow status and velocity depth regime score low in a region where reference streams have extremely reduced flow during the summer and fall. Appendix A provides ecoergion specific expectations for each parameter on the Habitat guidelines form.

Table 1: Habitat Assessment Guidelines

Ecoregion	Habitat Form	Season	Not Impaired	Moderately Impaired	Severely Impaired
65a	Low Grad.	Jan. – Dec.	≥ 62	48 – 61	≤ 47
65b	Low Grad.	Jan. – Dec.	≥ 92	72 – 91	≤ 71
65e	Low Grad.	Jan. – Dec.	≥ 115	90 – 114	≤ 89
65i	Low Grad.	Jan. – Dec.	≥ 98	77 – 97	≤ 76
65j	High Grad.	Jan. – Dec.	≥ 158	124-157	≤ 123
66d	High Grad.	Jan. – Dec.	≥ 146	114 – 145	≤ 113
66e	High Grad.	Jan. – Dec.	≥ 143	113 – 142	≤ 112
66f	High Grad.	Jan. – Dec.	≥ 138	108 – 137	≤ 107
66g	High Grad.	Jan. – Dec.	≥ 173	130 - 172	≤ 129
67f	High Grad.	Jan. – Dec.	≥ 130	103 – 129	≤ 102
67g	High Grad.	Jan. – Dec.	≥ 117	92 – 116	≤ 91
67h	High Grad.	Jan. – Dec.	≥ 126	99 – 125	≤ 98
67i	High Grad.	Jan. – Dec.	≥ 120	95 - 119	≤ 94
68a	High Grad.	Jan. – June	≥ 156	130 - 155	≤ 130
68a	High Grad.	July – Dec.	≥ 139	103 – 138	≤ 102
68b	High Grad.	Jan. – June	≥ 144	113-143	≤ 112
68b	High Grad.	July – Dec.	≥ 109	86 - 108	≤ 86
68c	High Grad.	Jan. – June	≥ 128	101 – 127	≤ 100
68c	High Grad.	July – Dec.	≥ 121	95 – 120	≤ 94
69d	High Grad.	Jan. – June	≥ 160	126-159	≤ 125
69d	High Grad.	July – Dec.	≥ 164	129-163	≤ 128
71e	High Grad.	Jan. – Dec.	≥ 116	91 – 115	≤ 90
71f	High Grad.	Jan. – Dec.	≥ 123	97 – 122	≤ 96
71g	High Grad.	Jan. – Dec.	≥ 123	97 – 122	≤ 96
71h	High Grad.	Jan. – Dec.	≥ 117	92 – 116	≤ 91
71i	High/Low Grad.	Jan. – June	≥ 98	77 – 97	≤ 76
71i	High/Low Grad.	July – Dec.	≥ 96	76 – 95	≤ 75
73a	Low Grad.	Jan. – Dec.	≥ 94	74 – 93	≤ 73
74a	High Grad.	Jan. – Dec.	≥ 88	70 – 87	≤ 69
74b	Low Grad.	Jan. – Dec.	≥ 98	77 – 97	≤ 76

Protocol E: Completion of the Stream Survey Sheet

Biologist/Environmental Specialist

Completely fill out the stream survey sheet (Appendix B). Add additional information, not included on the sheet, as needed. Only use the version provided in Appendix B. Earlier versions should no longer be used. Consult all personnel present during sampling for additional observations that may have been overlooked before leaving the site.

1. Stream Survey Information - Complete all information in this section at new sites (those not already in the water quality database). Note that latitude and longitude is recorded in decimal format. Only the station number, stream name, station location, assessors, date and time need to be completed on existing sites already in the water quality database. Record the time that the field measurements (D.O., pH, Cond., Temp) are taken. Use the 24-hour clock to designate time.

2. Samples Collected. - Indicate all types of samples that were collected. If benthic sample methods other than those listed were used, describe. Indicate whether macroinvertebrate samples were returned to the office (this includes biorecon vouchers).

3. Field Measurements – Use calibrated meters for all field measurements.

   Designate what type of meter (and which meter) was used to make readings. The readings for each parameter (including duplicates) are recorded in the appropriate boxes. All readings are recorded in the units specified on the sheet. List any other readings, such as percent oxygen saturation, that were taken at the time of sampling (include units). Also, record field readings on the chemical request forms if chemical samples are being collected at the same time. (Average duplicate readings on the chemical request forms since only one value can be entered in the laboratory's system). This ensures readings will be received by the Central Office and will be entered in the Water Quality Database.

   If, after the drift check, the meter was found to be off by more than 0.2 units for pH, temperature or dissolved oxygen (or more than 10% for conductivity), write an N before the reading on the field survey sheet for all sites visited between the initial calibration and the drift check. The N designates questionable readings. Also, put an N before readings on the chemical request form. If the chemical request form has already been turned into the laboratory, fax the field data sheet to the central office. This will insure the readings are flagged as questionable when they are entered into the water quality database.

   Circle the appropriate level of precipitation for the previous 48 hours (or circle unknown). Also, indicate the ambient weather and record air temperature.

4. Watershed Characteristics – Drive or walk as much of the upstream watershed as possible. Indicate the approximate percent of the watershed observed. Note the prevalent land-use in the watershed upstream of the sampling location in the spaces provided, estimating percentages. Record any other land uses that, although not dominant, may potentially affect water quality. Record possible causes of impact in this section using the table provided on the sheet. These direct observations can be supplemented by current land use information found in some of the recently developed TMDL/modeling tools and GIS systems.

5. Physical Stream Characteristics - Indicate the length of the stream reach sampled in meters. Observe and note the surrounding land use. The percent canopy cover can either be measured with a spherical densiometer or estimated. Note any sediment deposits and water turbidity. Record the estimated abundance and type of algae present. (Indicate if an algae survey was performed) Estimate the average depth, width and length (in meters) of a typical riffle, run and pool within the survey reach. (Indicate if actual measurements are taken.)

   If flow readings were taken, record flow in the space provided (indicate if this is estimated instead of measured flow). Flow measurements are not required for biological surveys. Record the total habitat assessment score in the appropriate space. Circle the appropriate stream gradient and stream width.

6. Perform either a particle count **or** estimate the percent contribution of each substrate type. For most assessments, a visual estimate of percent substrate for riffles, runs and pools will be adequate. Particle counts should be done at sites that will be repeatedly sampled, especially if sediment movement is of concern. This is an abbreviated particle count with 100 measurements across a single transect. The transect should be in a run area with substrate typical of runs in the stream reach.

7. Stream Use Support – (This part of the form may be completed in the office.) Record if the stream is used for water supply or navigation. Indicate if it has been classified as Tier II or Tier III. Indicate if it is a naturally reproducing trout stream. Also, note if the stream is posted. Indicate its current support status and if a change in support status is being recommended.

8. Photographs - A photographic record is to be kept on each sampling station. Digital photographs are preferred. Photographs of the general stream condition and potential pollution sources should be taken during the original sample visit. Photographs of any changes are taken during subsequent sampling trips. Document the picture identification and a brief description on the field sheet.

9. Stream Sketch - A station sketch is made at the time of sampling. This sketch should be detailed enough so that subsequent sampling teams or data reviewers can determine where samples were taken and what potential sources of impairment were present. Use a separate sheet of paper if necessary. At a minimum, the sketch should include a rough outline of stream sinuosity, direction of flow, location of riffles and pools, location of samples (benthic, chemical, probe), location of bridges or any other man-made structures (include distance from sampling point), location of tributaries, run-off ditches, discharges, livestock access, and any other potential pollution sources.

10. Additional Comments - Describe any other conditions observed at the time of sampling (additional pages are to be used if necessary). Include any changes observed from previous sampling efforts. Note directions to the site and any special permission or keys needed for access. Ask other team members for input.

Protocol F - Biorecon (Reconnaissance/Screening)

Biologist/Environmental Specialist with expertise in macroinvertebrate taxonomy

The Biorecon method is based on EPA's *Rapid Bioassessment for Use in Wadeable Streams and Rivers* (Barbour et. al., 1999).

This method is a standardized screening tool useful for problem identification and/or prioritizing sites for further assessment, monitoring or protection. It is useful in discriminating obviously impaired or non-impaired areas from potentially impaired areas requiring further investigation. Use of the biorecon allows rapid screening of a large number of sites. It is <u>not</u> useful in determining slight or moderate impairment or for measuring slow improvement over time. Biorecons cannot be compared to biocriteria or to semi-quantitative samples. However, test sites may be compared to the biorecon guidance derived from biorecons conducted at ecoregion reference sites (Tables 2 and 3).

NOTE: Because the biorecon involves limited data generation, its effectiveness depends largely on the experience of the biologist performing the assessment. The biologist should have stream assessment experience, knowledge of aquatic ecology and expertise in benthic macroinvertebrate taxonomy.

1. <u>Habitat Selection</u> - Select 1 to 4 productive habitats for sampling. Only consider habitats that comprise more than 5% of the stable habitat in the stream reach. Productive habitats include riffles, run or pool rocks, leaf packs, woody debris, rooted undercut banks, macrophyte beds, and fine sediment. Other productive habitats that constitute a major portion of the stream reach may also be selected. Estimate approximately 0.5 meters of sampling area for any habitat selected.

   Proportion the selected habitats into four portions based on percent contribution. For example, if the selected habitats are riffle (50%), leaf packs (30%) and undercut banks (20%), the sample would be comprised of two riffle kicks, one leaf jab and one bank jab. Never collect more than four portions. Record the percent contribution of each habitat and the number of jabs collected in each habitat on the Biorecon Field Sheet (Appendix B).

2. <u>Sample Collection</u> – Sample all habitats using a 500 micron mesh triangular net. Use a combination of kick and/or jab techniques depending on the type of habitat. A single jab consists of thrusting the net into a productive habitat for a linear distance of 0.5 meter (approximately two net widths). A kick is a stationary sample accomplished by positioning the net and disturbing the upstream substrate for a distance of 0.5 meter. Take care not to over-sample since this could skew results.

a. Riffle Kick:

Position the net on the bottom of the stream and disturb the substrate the width of the net and for a distance of 0.5 meter upstream of the net. Use hands to scrape clinging organisms off rocks.

b. Non-Riffle Rock:

Select several rocks of various sizes equaling approximately 0.5 square meters of surface area in run and/or pool areas. Avoid rocks that are imbedded.

c. Leaf Packs:

Collect three handfuls of leaf packs by positioning the net downstream or under the leaf pack, then scooping the leaves into the net by hand. Select leaf packs from various locations (riffle, run, and pool if possible). The leaves should be submerged and show evidence of being consumed by benthic macroinvertebrates (50% decomposition is optimal). Avoid collecting recently deposited or fully decomposed leaf litter.

d. Snags/Woody debris:

Select snags and other woody debris that have been submerged for a relatively long period (not recent deadfall). Sample submerged woody debris by jabbing in medium-sized snag material (sticks and branches). The snag habitat may be kicked first to help dislodge organisms, after placing the net downstream of the snag. Accumulated woody material in pool areas are also considered snag habitat. A single jab is approximately two net widths or three handfuls of loose material.

e. Rooted Banks

Select bank habitat that is undercut with submerged hanging roots or plants. If undercut banks are not available, submerged tree roots may be substituted. Thrust the net vigorously under the bank to dislodge clinging organisms. A single jab is approximately two net widths. Avoid digging into the sediment, as this constitutes another habitat type.

f. Macrophytes

In deep water, sample aquatic plants that are rooted on the bottom of the stream by drawing the net through the vegetation from the bottom to the surface of the water. In shallow water, bump or jab the net along the bottom in the rooted area. Avoid collecting sediment if possible. Either type of macrophyte jab should not exceed 0.5 linear meters (two net widths).

g. Fine sediment

Sediment is found in quiet areas of the stream. Select fine silt, sand or muck with minimal gravel. Seek areas with evidence of tunneling by burrowing macroinvertebrates. Gently scoop the net through the sediment for 0.5 meters length and approximately 4 cm deep.

3. Sample Sorting/Preliminary Identification – Composite the four jabs in a 500-micron sieve (or the net). Examine large materials (rocks, leaves, sticks) for organisms and then discard. Rinse the remainder of the debris using sieved water in the sieve (or swish the net in the creek). Transfer small amounts of debris to a white pan with a little sieved water for field sorting. Scan the debris and water for organisms. Record a preliminary field identification or description of each distinct taxon on the biorecon sheet (so that you can recognize it back at the office). Also, record the relative abundance of each taxon.

If available, have a second biologist scan the debris for unrecorded taxa before discarding. If a second biologist is not present, preserve debris from 10% of the stations in 80% ethanol and return to the office for QC. Create an internal tag on waterproof paper by recording (in pencil) the station number, date, sampler's initials and sample type (Figure 2). Place the internal tag inside the container with the debris. Complete an external tag (Standard external tag provided by the state lab) and attach to the outside of the container (Figure 3).

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BIORECON

Figure 2: Example of internal tag.

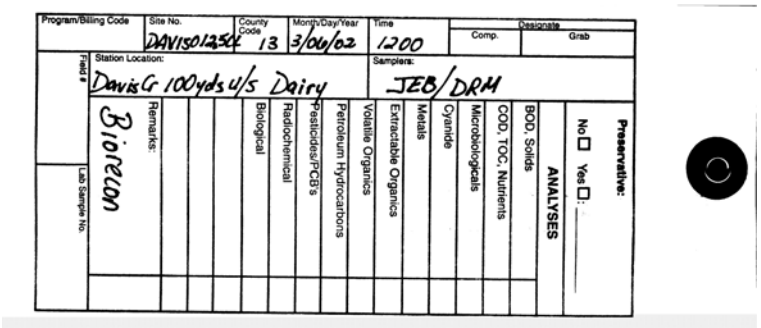

Figure 3: External tag

3. Voucher Specimens Place one or more representatives of each taxon in a small bottle containing 80% ethanol. If identifying to genus level, preserve six or more individuals of

families that commonly have multiple genera that are difficult to differentiate in the field. This includes Heptageniidae, Hydropsychidae, and many stonefly families. Include individuals that vary in color and/or size. Place an internal tag with the station number, date, sampler's initials and sample type inside the bottle (Figure 2). Attach an external sample tag to the outside of the bottle (Figure 3).

4. Final Sample Identification At the office, check the voucher organisms using a dissecting scope for accuracy in field identification. If possible, identify all taxa to genus except chironomids, oligochaetes, acarina, nematodes, and nematomorphs. (If the biologist is not competent at genus level or is under a time constraint, all taxa can be identified to family.) Whichever taxonomic level is selected, be consistent throughout the study. For example, do not identify EPT to genus if other organisms are only identified to family. Record appropriate changes for field misidentifications on the biorecon sheet. Retain voucher animals for a minimum of five years for QC purposes or in case further identification is needed at a later date. Add the name of the taxonomist, log number and date identified to the existing internal and external field tags (Figure 4).

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COL: JEB 3/6/02
BIORECON
ID: JEB 3/7/02
K0203001

Figure 4: Example of internal tag after sample identification

5. Biometric Calculation – After confirming field identifications, calculate three qualitative biometrics (that do not rely on relative abundance).

   a. **Taxa Richness (TR)** – The total number of distinct taxa found at a site. When counting chironomid taxa for family level biorecons, all chironomids are counted as a single family, when counting chironomids at genus level, red midges, non midges and tanypodinae are counted separately for a maximum total of three genera).

   b. **EPT** – The total number of distinct EPT taxa found at the site.

   c. **Intolerant Taxa (IT)** – The number of intolerant taxa (defined as having an NCBI value between 0.00 and 3.00) found at the test site. Be aware that North Carolina has updated family values since 1996. Appendix C contains a list of families and genera that should be counted as intolerant. For statewide consistency and comparability to the reference database, DO NOT count any animals intolerant that are not on this list.

   NOTE: Although the biorecon procedure calls for relative abundance to be estimated in the field, these numbers cannot be used for any metric calculations since they are not

quantitative. This information can be used less formally to evaluate the health of the macroinvertebrate community. For example, if the number of EPT taxa is high, but only a few individuals were found, it may be indicative of stress in the community.

7. Assessment Guidelines – Once the biometrics are calculated, use the guidelines in Table 2 for families or Table 3 for genera to help make an assessment. Do not use the family table if organisms were identified to genus level. The genus level provides a more accurate assessment and may not agree with the family level guidance. Keep the following information in mind when assessing biorecon data:

   a. Biorecons are most useful in areas of obvious impairment or in areas that are obviously not impaired. Sites that fall in the middle range may be too ambiguous to make assessments using the biorecon technique. These sites may require a more intensive assessment method. A Semi-Quantitative Single Habitat Sample (SQKICK or SQBANK) can be collected for clarification of use support (Protocol G). Chemical and habitat data may also help clarify assessment decisions.

   b. Biorecon data for ecoregion reference stations are not available in some bioregions. If test sites are collected in any of these bioregions, biorecons should be collected at all established ecoregion reference sites in that bioregion. (All ecoregion reference stream biorecon data should be submitted to the Planning and Standards Section so bioregion guidelines can be calculated or adjusted if already established.)

   c. Comparisons to the ecoregion reference guidelines are not appropriate at sites whose upstream watershed has drainage of more than 20% in another bioregion. Caution should be used when assessing test sites that are outside the size range of those monitored as reference sites since they may not be directly comparable.

8. Determine the value (1, 3, or 5) for each metric based on ranges at either the family (Table 2) and/or genus (Table 3) level. Add the three values together. Determine the assessment based on the total score:

   For all ecoregions except 73a11-15 = Non-impaired (Supporting)
   6-10 = Ambiguous (Need Additional Data)
   ≤ 5 = Severely Impaired (Partially or Not-Supporting)

   For ecoregion 73a:
   7-10 = Non-impaired (Supporting)
   3-6 = Ambiguous (Need Additional Data)
   ≤ 2 = Severely Impaired (Partially or Not Supporting

Table 2: Assessment Guidance for Family Level Biorecons

Bio-region	Season	Order *	Taxa Richness (TR)			EPT			Intolerant Taxa (IT)		
Score			**5**	**3**	**1**	**5**	**3**	**1**	**5**	**3**	**1**
65abei-74b	Jan-Dec	2,3,4	> 15	8-15	< 8	> 5	3-5	< 3	> 2	1-2	< 1
65j	Jan-Dec	2,3,4	> 14	7-14	< 7	> 6	4-6	< 4	> 4	2-4	< 2
66defg	Jan-Dec	2,3,4	> 20	10-20	<10	>10	6-10	< 6	> 7	4-7	< 4
67fghi	Jan-Dec	1,2,3,4,5	> 18	9-18	< 9	> 7	4-7	< 4	> 4	3-4	< 3
68a	Jan-June	3,4,5	> 11	6-11	< 6	> 6	3-6	< 3	> 5	3-5	< 3
68a	July-Dec	3,4,5	> 22	11-22	< 11	> 10	5-10	< 5	> 5	3-5	< 3
68b	Jan-June	3	> 10	5-10	< 5	> 5	3-5	< 3	> 3	2-3	< 2
68b	July-Dec	3	NA	NA	NA	NA	NA	NA	NA	NA	NA
68c	Jan-June	1,2,3	> 12	7-12	< 7	> 6	3-6	< 3	> 3	2-3	< 2
68c	July-Dec	1,2,3	> 13	7-13	< 7	> 5	3-5	< 3	> 4	3-4	< 3
69d	Jan-June	2,3,4	> 19	10-19	< 10	> 9	5-9	< 5	> 6	4-6	< 4
69d	July-Dec	2,3,4	> 12	6-12	< 6	> 3	2-3	< 2	> 2	2	< 2
71e	Jan-Dec	2,3	> 18	10-18	< 10	> 8	4-8	< 4	> 4	2-4	< 2
71fgh	Jan-Dec	2,3,4,5	> 18	10-18	< 11	> 9	5-9	< 5	> 6	3-6	< 3
71i	Jan-Dec	3,4	> 17	9-17	< 9	> 4	3-4	< 3	> 2	1-2	0
73a	Jan-June	3,4	> 12	6-12	< 6	> 1	1	0	NA	NA	NA
73a	July-Dec	3,4	> 13	7-13	< 7	> 1	1	0	NA	NA	NA
74a	Jan-June	3	> 11	6-11	< 6	> 3	2-3	< 2	> 1	1	0
74a	July-Dec	3	> 12	7-12	< 7	> 3	2-3	< 2	> 1	1	0
74b (see 65abei-74b)											

For all ecoregions except 73a:

11-15 = Non-impaired (Supporting)
6-10 = Ambiguous (Need Additional Data)
≤ 5 = Severely Impaired (Partially or Not-Supporting)

For ecoregion 73a:

7-10 = Non-impaired (Supporting)
3-6 = Ambiguous (Need Additional Data)
≤ 2 = Severely Impaired (Partially or Not Supporting)

*** Drainage area can be substituted for stream order, see Biocriteria tables in Appendix A**

Table 3: Assessment Guidance for Genus Level Biorecons

Bio-region	Season	Order *	Taxa Richness (TR)			EPT			Intolerant Taxa (IT)		
Score			**5**	**3**	**1**	**5**	**3**	**1**	**5**	**3**	**1**
65abei -74b	Jan-Dec	2,3,4	> 16	9-16	< 9	> 5	3-5	< 3	> 1	1	0
65j	Jan-Dec	2,3,4	> 14	8-14	< 8	> 7	4-7	< 4	> 4	2-4	< 2
66defg	Jan-Dec	2,3,4	> 30	16-30	< 16	> 16	9-16	< 9	> 14	8-14	< 8
67fghi	Jan-Dec	1,2,3,4,5	> 25	13-25	< 13	> 11	6-11	< 6	> 7	4-7	< 4
68a	Jan-June	3,4,5	> 14	8-14	< 8	> 9	5-9	< 5	> 6	3-6	< 3
68a	July-Dec	3,4,5	> 36	18-36	<18	> 16	9-16	< 9	> 10	5-10	< 5
68b	Jan-June	3	> 13	7-13	< 7	> 8	4-8	< 4	> 3	2-3	< 2
68b	July-Dec	3	NA	NA	NA	NA	NA	NA	NA	NA	NA
68c	Jan-June	1,2,3	> 13	7-13	< 7	> 6	4-6	< 4	> 5	3-5	< 3
68c	July-Dec	1,2,3	> 16	8-16	< 8	> 6	3-6	< 3	> 5	3-5	< 3
69d	Jan-June	2,3,4	> 27	14-27	< 14	> 13	7-13	< 7	> 10	6-10	< 6
69d	July-Dec	2,3,4	> 15	8-15	< 8	> 5	3-5	< 3	> 4	3-4	< 3
71e	Jan-Dec	2,3	> 20	10-20	< 10	> 7	4-7	< 4	> 3	2-3	< 2
71fgh	Jan-Dec	2,3,4,5	> 25	13-25	< 13	> 13	7-13	< 7	> 8	5-8	< 5
71i	Jan-Dec	3,4	> 21	11-21	< 11	> 6	3-6	< 3	> 2	2	< 2
73a	Jan-June	3,4	> 10	5-10	< 5	> 1	1	0	NA	NA	NA
73a	July-Dec	3,4	> 9	5-9	< 5	> 1	1	0	NA	NA	NA
74a	Jan-June	3	> 14	7-14	< 7	> 2	2	< 2	> 1	1	0
74a	July-Dec	3	> 13	7-13	< 7	> 3	2-3	< 2	> 1	1	0
74b (see 65abei-74b)											

For all ecoregions except 73a:

11-15 = Non-impaired (Supporting)
6-10 = Ambiguous (Need Additional Data)
≤ 5 = Severely Impaired (Partially or Not-Supporting)

For ecoregion 73a:

7-10 = Non-impaired (Supporting)
3-6 = Ambiguous (Need Additional Data)
≤ 2 = Severely Impaired (Partially or Not Supporting)

*** Drainage area can be substituted for stream order, see Biocriteria tables in Appendix A**

Protocol G – Field Collection Techniques for Semi-Quantitative Single Habitat Sample (SQKICK or SQBANK))

Biologist or Environmental Specialist

Collect a semi-quantitative single habitat sample (SQKICK or SQBANK) when a quantifiable assessment of the benthic community is needed. This method is directly comparable to the Division's proposed numeric biocriteria. This is a more defensible and sensitive method than the biorecon. When both sample types have been collected, semi-quantitative sample results will always take precedence over biorecon results.

The semi-quantitative single habitat sample will generally be used for:

a. 303(d) list removal or addition (a biorecon can be used if it shows the site clearly supporting or non-supporting)
b. TMDLs
c. Permit compliance and enforcement
d. Any study that has the potential of being used by the Water Quality Control Board.

In order for the data to be compared to the reference database:

a. Samples must be collected in the exact manner outlined in this section.
b. The upstream watershed must be 80% within the bioregion.
c. The stream size must be comparable to those in the reference database for that bioregion (Appendix A).

There are three methods of semi-quantitative sample collection:

a. SQKICK (Riffle streams larger than 1 meter wide)
b. Modified SQKICK (Riffle streams less than 1 meter wide)
c. SQBANK (Non-riffle streams)

The type of sample collected will depend on the stream type and/or ecological subregion. Information on ecoregion boundaries can be found in *Tennessee Ecoregion Project* (Arnwine et al, 2000) and in *Development of Regionally-Based Numeric Interpretations of Tennessee's Narrative Biological Integrity Criterion* (Arnwine and Denton, 2001). Ecoregions can also be determined for specific stream segements by using Tennessee's Online Water Quality Assessment Database (www.state.tn.us/environment/water). Each Environmental Assistance Center should have copies of ecoregion maps for their area. Contact the Planning and Standards section if there is uncertainty about what ecoregion a stream is located in.

a. **Semi-quantitative Riffle Kick (SQKICK)**

Collect a semi-quantitative riffle kick (SQKICK) in ecological subregions 65j, 66d, 66e, 66f, 66g, 67f, 67g, 67h, 67i, 68a, 68b, 68c, 69d, 71e, 71f, 71g, 71h, 74a, and riffle streams in 71i. If a riffle is not present, a semi-quantitative bank sample can be collected, but will not be directly comparable to the reference criteria. Therefore, an upstream or off-site reference SQBANK will also need to be collected (this can be a bank sample collected at one or more of the established ecoregion reference sites). If riffles have been compromised by sedimentation or are embedded, they should still be sampled since impacts are being measured.

1. Use a (two-person) one square meter kick net with a 500-micron mesh to sample the riffle. If necessary, use rocks to weight the bottom edge to prevent the flow of water beneath the net. At each site, collect two kicks: one from an area of fast current velocity and one from an area of slower current velocity. Always collect the downstream sample first to avoid organism drift. Avoid areas with large leaf packs caught on the rocks if possible. If the stream is too small to do two riffle kicks in a single riffle, sample two separate riffles. (In extremely small streams, less than 1 meter wide, sample 4 riffles using the modified SQKICK for small streams – method b.)

2. One biologist holds the net at an angle that allows the current to flow into it. making sure the bottom is in contact with the substrate and the top of the net is above the surface of the water. The second biologist disturbs the substrate for approximately one-meter distance and the width of the net (one meter) upstream of the net by kicking and shuffling the substrate. This causes organisms and debris to flow into the net. Larger rocks may be lifted and rubbed with the hands to remove clinging organisms.

3. Once the kick is completed, allow time for the lighter debris to finish floating into the net. The biologist who performed the kick then grabs the two pole ends at the bottom of the net and carefully lifts the net out of the water while the other biologist continues to hold the upper end making sure the top of the net does not dip below the water surface, thereby allowing organisms to escape. If the top of the net dips under the water and debris flows out, discard the sample and collect another kick. Carry the net horizontally to the bank for processing.

4. Composite the debris from both kicks. Using forceps, remove all organisms clinging to the net and add them to the sample. Thoroughly rinse the sample using sieved water to remove fine sediment. Large rocks or organic material such as whole leaves or twigs, are discarded after rinsing and removing clinging organisms. If upon cursory examination of the debris, it does not appear that a minimum of 200 organisms have been collected after 2 kicks, perform additional kicks in the same reach until at least 200 organisms are assured. Document the number and location of kicks on the field survey form and write the number of kicks on the sample tag.

5. Place the composited debris in a wide mouth plastic container and preserve with 80% ethanol. Include an internal tag (written in pencil on water-proof paper) with the station number, date, sampler's initials and sample type inside the container with the debris (Figure 2). Attach an external sample tag to the outside of the container. Standard external tags for both biological and chemical samples are obtained from the state lab (Figure 3). Instead of an external tag, the site information can be printed in indelible ink (i.e. Sharpie) on the sample lid. The external tag information must include the Station ID, Stream name, location, sampler's initials, date sampled time sampled and sample type (Figure 5). If samples are going to be sent to the central lab for analysis, a biological sample request form including chain of custody must be completed (Appendix B).

Figure 5: Example of external tag information (on sample lid)

b. Modified SQKICK (small streams)

1. In extremely small streams, where riffles are less than one meter wide, collect a one person stationary kick using an 18-inch single handle rectangular net with a 500-micron mesh.

2. Sample four separate riffles. Starting with a downstream riffle, hold the net perpendicular to the flow making certain the bottom of the net is in contact with the substrate at all time. Disturb the substrate upstream of the net for an area approximately 18 inches long and the width of the net. Do not allow the net to move during the kick as it might cause organisms to drift under the net. Once the kick is complete, allow time for all debris to finish flowing into the net.

3. Composite the debris from all four kicks. Use forceps, to remove all organisms clinging to the net and add them to the debris. Thoroughly rinse the sample using sieved water to remove fine sediment. Large rocks or organic material such as whole leaves or twigs, are discarded after rinsing and removing clinging organisms. If upon cursory examination of the debris, it does not appear that 200 organisms are in the composited sample, collect additional kicks and add them to the composite. Document the total number of kicks on the sample tag and on the field survey form.

4. Place the composited debris in a wide mouth plastic container and preserve with 80% ethanol. Include an internal tag with the station number, date, sampler's initials and sample type inside the container with the debris (Figure 2). Attach an external sample tag to the outside of the container. Standard external tags for both biological and chemical samples are obtained from the state lab (Figure 3). Instead of an external tag, the site information can be written in indelible ink (i.e. Sharpie) on the sample lid. The external tag information must include the Station ID, Stream name, location, sampler's initials, date sampled time sampled and sample type (Figure 5). If samples are going to be sent to the central lab for analysis, a biological sample request form including chain of custody must be completed (Appendix B).

b. Semi-Quantitative Bank Sample (SQBANK)

In ecoregions 65a, 65b, 65e, 65i, 73a, 74b, collect a semi-quantitative bank sample (SQBANK) (even if riffles are present) for comparison to the reference criteria. Also, use the SQBANK method in 71i streams without riffle areas.

1. Use a triangular dip net with a 500-micron mesh to sample the rooted undercut bank. Collect the samples by jabbing the net below the surface of the water using an upward/forward thrusting motion designed to dislodge macroinvertebrates from the roots. Sample three separate areas of the reach including at least one sample from each bank. Collect samples from different velocities and different bank types (i.e. overhanging tree roots, undercut grass banks) if possible. Sample approximately one linear meter at each of the three sampling locations.

2. Thoroughly rinse the sample by gently swishing the net through the water. Do not let the net opening dip below the surface of the water. Visually inspect any large organic matter such as whole leaves and sticks. Remove any organisms clinging to these materials and add to the smaller debris, before discarding the large material. Using forceps, remove any organisms clinging to the net and add to the sample. Composite the debris from all three bank samples. If upon cursory examination of the debris, it does not appear that 200 organims have been collected, additional bank samples may be collected. Document the total number and location of bank jabs on the stream survey form and the number of bank jabs on the sample tag.

3. Place the composited debris in a wide mouth plastic container and preserve with 80% ethanol. Include an internal tag with the station number, date, sampler's initials and sample type inside the container with the debris (Figure 2). Attach an external sample tag to the outside of the container. Standard external tags for both biological and chemical samples are obtained from the state lab (Figure 3). Instead of an external tag, the site information can be written in indelible ink (i.e. Sharpie) on the sample lid. The external tag information must include the Station ID, Stream name, location, sampler's initials, date sampled time sampled and sample type (Figure 5). If samples are going to be sent to the central lab for analysis, a biological sample request form including chain of custody must be completed (Appendix B).

Protocol H:. Sample Logging

Any staff member

Samples must be logged to allow complete reconstruction, from initial field records, through data storage and system retrieval. Assign a discrete log number to each individual macroinvertebrate sample (including biorecons). This will be an eight digit number determined in the following manner:

N0105001

Where:

The first digit (N) determines which office the sample is from:

C = Chattanooga EAC	K = Knoxville EAC
L = Columbia EAC	M = Memphis EAC
V = Cookeville EAC	N = Nashville EAC
H = Johnson City EAC	S = Surface Mining
J = Jackson EAC	B = Lab Services, TDH

The second and third digit represent the year sampled (02 = 2002)

The fourth and fifth digit represent the month sampled (03 = March)

The last three digits represent a consecutive number for the number of samples collected that month (001 = the first sample collected in March).

The log numbers (along with the station number) will be used to identify the sample on paperwork, tags, bench sheets, logbooks, QC records, or any other place this sample is documented.

All samples are logged in a bound logbook. Make entries in black ballpoint pen. (Note: a computer can be used to log samples, however, a hard copy printout in a bound logbook should also be maintained.) The log entry must include the log number, station number, date collected, time collected, collector's initials, sample source, station location, type of sample, sorters initials, sorting date, taxonomist's initials and ID date.

Log #	**Station ID**	**Source**	**Location**	**Date Col.**	**Time Col.**	**Init. Col.**	**Type**	**Sort By**	**Sort Date**	**ID By**	**ID Date**
K0203001	DAVIS012.5CL	Davis Ck	100 yds u/s Dairy	3/6/02	1200	JEB/DRM	SQKICK	JEB	3/7/02	JEB	3/8/02
K0203002	DAVIS001.3CL	Davis Ck	Hwy Z	3/6/02	1500	JEB/DRM	BR	NA	NA	JEB	3/8/02

Figure 6: Macroinvertebrate Sample Log

Protocol I - Subsampling Procedures for Semi-Quantitative Samples

Biologist/Environmental Specialist with demonstrated expertise in sorting.

The majority of semi-quantitative samples are to be sent to the central lab for analysis. This is to be coordinated through the Planning and Standards Section.

All semi-quantitative samples are to be reduced to a 200+/- 20% (160-240) organism subsample using the following technique. This method comes directly from section 7.3 (pages 7-9) of the 1999 guidance, Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (EPA 841-B-99-002).

1. Thoroughly rinse the sample in a 500-micron mesh sieve to remove preservative and fine sediment. Large organic material (whole leaves, twigs, etc.) not removed in the field should be rinsed, visually inspected and discarded. It may be necessary to soak the sample contents in water for about 15 minutes to hydrate the benthic organisms, which will prevent them from floating on the water surface during sorting. If the sample was stored in more than one container, the contents of all containers for a given sample should be combined at this time. Gently mix the sample by hand while rinsing to make it homogenous.

2. Transfer the cleaned sample to a gridded pick subsampler (or similar apparatus). The subsampler is a white plastic cutting tray that measures approximately 18" x 12½" x 2¼." The tray is divided into 28, 2"x2" grids and marked with indelible ink. Note: it is preferable that a sieve insert or raised grid divider be used to separate the grids. Remove the animals and debris using a combination of scoop and transfer pipette.

3. If the debris will not fit in one tray, use two or more trays. Thoroughly mix the debris and divide equally between the trays. Sort the same grids for both trays. For example, if grid # 5 is randomly selected, both # 5 grids are picked. This will count as one grid out of 28.

4. Add enough water (or ethanol) to evenly distribute the debris. Gently shake and swirl the tray until the organisms are evenly distributed within the tray. Remove the excess water with a suction device (i.e. turkey baster with a 500 micron or smaller screen over the aperture), to the point where the sample is settled onto the bottom of the tray. If a raised grid insert is not being used, care should be taken not to pull organisms towards the area of suction.

5. Randomly select four numbers corresponding to squares (grids) within the gridded subsampling pan. Remove all material (organisms and debris) from the four grids and place the material into a dish or jar with a small amount of water. Use a magnifying light to make sure all organisms and debris were removed from the grids. Any organism that is lying over a line separating two grids is considered to be on the grid containing its head. If it is not possible to determine the location of the head (i.e. oligochaetes), the organism is considered to be in the grid containing most of the body.

6. If there appears to be 160-240 organisms (cumulative of the four grids) then subsampling is completed. If there appears to be fewer than 160 organisms, continue selecting grids one at a time until between 160 and 240 organisms are selected. If more than 240 organisms are contained in the first four grids, transfer the contents of the four grids to a second gridded pan. Randomly select grids for this second subsampling as was done for the first, sorting grids four (and then one) at a time until the second subsample contains 160-240 organisms. If it is estimated that the first four grids of the second subsample contain more than 240 organisms, transfer the four grids to another pan and conduct a third subsample. Continue creating subsamples until there are 160-240 organisms.

7. Transfer the subsample, a small amount at a time to a petris dish for sorting (removing organisms). Complete all sorting under a dissecting scope, removing and preserving all organisms in 80% ethanol. If the number of organisms from the four-grid subsample does not equal the specified number of 160-240, randomly choose a fifth grid and pick out all organisms in that grid. If the addition of the fifth grid fulfills the quota, than the subsampling is complete. If not, choose additional grids (one at a time) until the quota is reached or surpassed. All the organisms from the final grid that is randomly selected are removed even if the quota is reached midway through the picking of the grid.

   If, after microscopic sorting, more than 240 organisms are found, transfer all organisms to a small gridded dish (36 grids). Subsample by groups of first four and then one random grid until the target of 160-240 organisms is achieved.

8. Place the sorted debris in a separate container and preserve in 80% ethanol. Include both external and internal tags (Figures 2 and 3). Add the words “sorted debris” to the standard information on the tag. Save the remaining unsorted sample debris residue in a separate container labeled “sample residue”. This container should include the original sample label and internal tag.

9. Place the sorted 160-240 organism subsample into a glass vial and preserve in 80% ethanol. Place an internal tag written in pencil on waterproof paper citing the log number, station number, date collected and taxonomist inside each vial (Figure 4). Position the label so it can be read through the vial.

   Chironomids and oligochaetes are mounted on slides in a permanent mounting media (i.e. CMC-10). Slides are labeled with the station id, date collected and initials of the taxonomist and slide box number.

10. After sorting is completed, record the appropriate information (log number, station ID, sorters initials, date sorted and the number of organisms found) in the QC logbook (Figure 8, Section II-C).

11. All organisms and debris shall be retained as separately preserved samples for at least 5 years.

Protocol J - Taxonomy of Semi-Quantitative Samples

Biologist/Environmental Specialist with demonstrated expertise in macroinvertebrate taxonomy

The majority of semi-quantitative samples are to be sent to the central lab for analysis. This is to be coordinated through the Planning and Standards Section.

1. Identify all organisms to genus except Acari, Nematoda, Hydra, Brachiobdellida, immature Tubificidae, Lumbriculidae and Nematomorpha using the primary taxonomic keys listed in Appendix D. (Secondary keys will only be used to assist with difficult specimens and will not be available in all offices.) Calculate all biometrics at the specified level only. The primary keys will be updated as new literature is available. It is important that all taxonomists use the same primary keys for consistency in identification and nomenclature.

2. Record taxonomic nomenclature and number of organisms on a bench sheet. Header information that must be provided includes the log number, station ID number, date collected, time collected, samplers, sample source location, ecoregion, sample type, taxonomist and analysis date. Taxonomic information should include order, family and genus. An example is provided in Figure 7 (format can vary as long as all the information is provided).

STATION ID: HOHUM012.3SE	**LOG NUMBER:** C0203007
SOURCE: Hohum Creek	**COL. BY:** ABC/DEF
LOCATION: 100 yds u/s Hwy Q	**DATE COL:** 03/07/02
SAMPLE TYPE: SQKICK	**TIME:** 1700
ECOREGION: 68b (drains 68c)	**TAXONOMIST:** ABC **DATE:** 03/08/02

Order	Family	Genus	Count
Ephemeroptera	Heptageniidae	Epeorus	20
Ephemeroptera	Heptageniidae	Stenacron	30
Ephemeroptera	Leptophlebiidae	Paraleptophlebia	2
Plecoptera	Leuctridae	Leuctra	9
Trichoptera	Hydropsychidae	Cheumatopsyche	32

Figure 7: Example of Taxonomic Bench Sheet

3. After identifying all taxa in the subsample, return them to the vial and add fresh preservative (80% ethanol). Initial, date and add the log number to the internal tag (Figure 5). Store the sample for a minimum of five years.

4. Mount chironomids, oligochaetes and other small organisms on slides for identification. Use a permanent mounting media such as CMC10. CMC10 clears the mount so a separate clearing agent is not necessary. Use round coverslips (12 mm) for small specimens. Place one organism under each coverslip. A maximum of 10 coverslips can be placed on each slide. Square coverslips (22mm) can be used to mount larger specimens. Place one to three organisms are placed under each coverslip with a maximum of 3 coverslips per slide.

   Mount chironomid larvae so that their bodies are viewed laterally and their heads are viewed ventrally. Apply enough pressure to the coverslip so that the mandibles are opened exposing the mentum. The S1 setae, premandibles and pectin epipharyngis should also be visible. Mount oligochaetes laterally with minimal pressure. The mounting media should extend past the edges of the coverslip to allow for shrinkage during drying. Allow the slides to air-dry at least 24 hours before attempting identification. (A slide dryer can be used to dry mounts faster if desired). Label slides with the log number, station ID, date, taxonomist inititals and slide box slot number. Keep labeled slides in a slide box a minimum of five years after completion of the study.

   Note: Do not subsample chironomids and oligochaetes further. Identify each chironomid and oligochaete in the 160-240 organism subsample.

Protocol K - Data Reduction of Semi-Quantitative Samples

Biologist/Environmental Specialist with experience in macroinvertebrate taxonomy

A macroinvertebrate index, based on seven biometrics, has been developed by the Division for use in semi-quantitative macroinvertebrate surveys (Arnwine and Denton, 2001). This index is based on ecoregional reference data and calibrated by bioregion. The calibrated scoring criteria can be used in all streams that fit the sample criteria for that region (habita*t* sampled, sampling protocol, stream size) and have at least 80% of their upstream drainage in the same bioregion.

For streams that do not meet the profile (for instance non-riffle streams in bioregions that are calibrated to a SQKICK sample or streams that have more than 20% of their upstream drainage in other bioregions), calculate the same seven biometrics. However, the index tables cannot be used for assessment since these samples are not comparable to streams in the ecoregion reference database. Compare the biometrics to an appropriate upstream or watershed reference.

1. Using the raw benthic data from the semi-quantitative subsample (kick or bank), calculate a numerical value for each of the seven biometrics. Calculate all biometrics using taxa identified to the genus level except for specified taxa (Acari, Branchiobdellida, Nematomorpha, Nematoda, Hydra, immature Tubificidae, Lumbriculidae) or those too young or too damaged to identify to this level. Species identification is not to be used. .

   a. **EPT** (Ephemeroptera Plecoptera Trichoptera Richness)

      Total the number of genera within the orders Ephemeroptera, Plecoptera and Trichoptera. Taxa that could only be identified to family are included only if they are the only taxon found in that family or it is probable that they are distinct from other taxa identified to genus within the family.

   b. **TR** (Taxa Richness)

      Total the number of distinct genera found in the subsample. Taxa that could only be identified to family are included only if it is probable that they are distinct from other taxa identified to genus within the family.

   c. **%OC** (Percent oligochaetes and chironomids)

      $$\%OC = \frac{\text{Total number of Oligochaeta + Chironomidae}}{\text{Total number of individuals in the subsample}} \times 100$$

   d. **% EPT** (EPT Abundance)

$$\% \text{ EPT} = \frac{\text{Number of Ephemeroptera + Plecoptera + Trichoptera}}{\text{Total number of individuals in the subsample}} \times 100$$

e. **NCBI** (North Carolina Biotic Index)

$$\text{NCBI} = \Sigma \frac{x_i t_i}{n}$$

where: x_i = number of individuals within a taxon
t_i = tolerance value of a taxon (Appendix C)
n = total number of individuals in the subsample

f. **% NUTOL (% Nutrient Tolerant Organimsms)**

$$\% \text{ NUTOL} = \frac{\text{Total number of Cheumatopsyche, Lirceus, Physella, Baetis, Psephenus, Stenelmis, Simulium, Elimia, Oligochaeta, Polypedilum, Rheotanytarsus, Stenacron, Criotopus and Chironomus}}{\text{Total individuals in the sample}} \times 100$$

g. **% Clingers** (Percent contribution of organisms that build fixed retreats or have adaptations to attach to surfaces in flowing water)

A list of taxa designated as clingers is located in Appendix C.

$$\% \text{ Clingers} = \frac{\text{Total number of clinger individuals}}{\text{Total individuals in the sample}} \times 100$$

2. After calculating values for the seven biometrics, equalize the data by assigning a score of 0, 2, 4 or 6 based on comparison to the ecoregion reference database for the bioregion (Appendix A). Total the seven scores. Determine biological condition using Table 4 (if test sites meet the protocol for the bioregion). The Non-impaired category is equal to or greater than the proposed biocriteria.

Table 4: Determination of Biological Condition Based on Index Scores by Bioregion and Season

Bioregion	**Season**	**Sample Type**	**Index Score Rating**			
			Non-impaired	**Slightly Impaired**	**Moderately Impaired**	**Severely Impaired**
			(Supporting)	**(Partially Supporting)**		**(Non-Supporting)**
65abei-74b	Jan-Dec	SQBANK	≥ 32	21-31	10-20	< 10
65j	Jan-Dec	SQKICK	≥ 32	21-31	10-20	< 10
66defg	Jan-Dec	SQKICK	≥ 32	21-31	10-20	< 10
67fghi	Jan-Dec	SQKICK	≥ 32	21-31	10-20	< 10
68a	Jan-Dec	SQKICK	≥ 32	21-31	10-20	< 10
68b	Jan-June	SQKICK	≥ 32	21-31	10-20	< 10
68b	July-Dec	SQKICK	≥ 32	21-31	10-20	< 10
68c	Jan-June	SQKICK	≥ 32	21-31	10-20	< 10
68c	July-Dec	SQKICK	≥ 32	21-31	10-20	< 10
69d	Jan-June	SQKICK	≥ 32	21-31	10-20	< 10
69d	July-Dec	SQKICK	≥ 32	21-31	10-20	< 10
71e	Jan-Dec	SQKICK	≥ 32	21-31	10-20	< 10
71fgh	Jan-Dec	SQKICK	≥ 32	21-31	10-20	< 10
71i	Jan-Dec	SQKICK	≥ 32	21-31	10-20	< 10
71i	Jan-Dec	SQBANK	≥ 32	21-31	10-20	< 10
73a	Jan-June	SQBANK	≥ 22	13-21	7-12	< 7
73a	July-Dec	SQBANK	≥ 22	13-21	7-12	< 7
74a	Jan-June	SQKICK	≥ 32	21-31	10-20	< 10
74a	July-Dec	SQKICK	≥ 32	21-31	10-20	< 10

Protocol L: Report Preparation

Submit an assessment report to the Planning and Standards Section for each surveyed site. Minimally, this report should include a macroinvertebrate assessment sheet (Appendix B), taxonomic lists (Figure 7), habitat assessment sheets (Appendix B), stream survey sheets (Appendix B), map of sample location and photographs.

I.J - DATA AND RECORDS MANAGEMENT

Biorecon and semi-quantitative stations are established in the same Water Quality Database as chemical monitoring stations. The master database is kept on the H drive at the central office. The Planning and Standards Section is responsible for maintaining this database. The database will be sent to the EACs at the beginning of each quarter. For Access 2000 users, this is file WQ2000CO-EAC#(most current date). For Access 1997 users, this is file WQ1997CO-EAC#(most current date). The Quality Team member or their designee in each EAC should check that all biological stations for their area have been entered with complete information. Biorecon results are entered in the biorecon form of this database. Biological and chemical stations collected within 200 meters (yards) of each other are considered the same station and should be given the same station ID. This database is to be sent to the Planning and Standards section at the completion of each sample project with the upload date blank. (Note, if new stations are set up that will also have chemical monitoring, the station information should be sent to the Planning and Standards Section before chemical results are received.)

Results from semi-quantitative samples (including taxa lists) are entered by the Aquatic Biology Section, Lab Services, TDH in a 2000 Access file called SQDATA (date). Copies of taxa lists and habitat forms from any semi-quantitative samples identified by WPC Environmental Assistance Centers are to be sent to the Aquatic Biology Section for data entry. This database will be sent by the Aquatic Biology Section to the Planning and Standards Section at the completion of each project.

Assessment information for each stream segment will be entered in the Access 2000 Assessment Database (ADB) by the Planning and Standards Section (PAS). PAS staff will meet with WPC managers and biologists in each EAC before assessments are finalized. This database will eventually be accessible on the web for public access.

The original field sheets and taxa lists are to be kept in files at the sampling agency (Environmental Assistance Center or Aquatic Biology Section). Copies of the Stream Survey Sheet, Habitat Assessment Sheet and taxa lists along with Macroinvertebrate Assessment Report (Appendix B) are to be sent to the Planning and Standards Section. .These copies will be kept in the watershed files for five years before being transferred to the water quality library. The Aquatic Biology Section will also send copies of all paperwork to the appropriate Environmental Assistance Center

II. QUALITY ASSURANCE /QUALITY CONTROL

The U.S. EPA requires that a centrally planned, directed and coordinated quality assurance and quality control program be applied to efforts supported by them through grants, contracts or other formalized agreements. This time allocation is an essential component of biological sampling and analysis and will be included in annual work plans. This is not an optional or "as time allows" activity. The goal is to demonstrate the accuracy and precision of the biologists, as well as the reproducibility of the methodology, and to ensure unbiased treatment of all samples.

A. General QC Practices

1. Quality Team Leader (QC Coordinator) - A centralized biological QC coordinator will be designated with the responsibility to ensure that all QC protocols are met. This person will be an experienced water quality biologist. Major responsibilities will include monitoring QC activities to determine conformance, distributing quality related information, training personnel on QC requirements and procedures, reviewing QA/QC plans for completeness, noting inconsistencies, and signing off on the QA plan and reports.

2. Quality Team Member (In-house QC officer) - One WPC biologist/environmental specialist in each EAC will be designated as the Quality Team Member (in-house QC officer.) This person will be responsible for performing and/or ensuring that quality control is maintained and for coordinating activities with the central Quality Team Leader (QC coordinator).

3. Training - Unless prohibited by budgetary travel restrictions, training will be conducted at least once a year through workshops, seminars and/or field demonstrations in an effort to maintain consistency, repeatability and precision between biologists/environmental specialists conducting macroinvertebrate surveys. This will also be an opportunity for personnel to discuss problems they have encountered with the methodologies and to suggest SOP revisions prior to the annual SOP review. Note: topics of discussion should be submitted to the central Quality Team Leader (QC coordinator) before the meeting so that a planned agenda can be followed, thus making the best use of limited time.

B. Field Quality Control – Habitat Assessment and Biological Sampling Methodology

1. Habitat Assessments - At minimally 10% of sites, two trained biologists/environmental specialists will complete habitat assessment forms independently. Scores are compared for each parameter with discrepancies arbitrated while in the field.

2. Biorecon Collection A second biorecon will be collected at a minimum of 10% of the sites by a separate biologist/environmental specialist. This should be conducted at the same time, or at least within two weeks of the original survey.

3. Semi-quantitative Sample - A second semi-quantitative sample will be collected at 10% of the sites. Since this sampling method requires two people, it will not be possible in most offices for an independent team to conduct the sampling. Therefore, the same team can collect the samples with each investigator independently selecting the sample spot and performing the kick. At least once a year, a team from another EAC or the state lab should collect the QC sample.

4. Chain of Custody Chain of custody is required by the TDEC Office of General Counsel for samples that have the potential of being used in court, reviewed by state boards, or involved in state hearings. Chain of custody must also accompany any contract samples (semi-quantitative samples being sent to the lab). Chain of custody is the far right column of the biological analysis form. (Appendix B) The entire form must be filled out completely..

   The chain of custody follows the sample through collection, transfer, storage, taxonomic identification, quality assurance and disposal. The biologist who collected the sample must sign (not print) their name in full (not initial) in the Collected By space with the date and time (24-hour clock). If the sample is given to anyone else before it is delivered to the lab (or returned to the office), each person responsible for the sample must sign their full name on the Received By space with the date and time. The person in the laboratory (or office) who receives the sample will sign line four. The person who logs the sample in signs the last line.

C. QC Log

A list of all samples sorted and/or identified by each biologist/environmental specialist will be kept in a bound log so that QC requirements and results can be documented (Figure 8). The QC log must contain the following information:

1. Sample log number
2. Station number
3. Sample type
4. Initials of taxonomist and sorter
5. Number of organisms picked in subsample (semi-quantitative samples only)
6. Date completed
7. Initials of person performing QC
8. Number of organisms found in re-pick (semi-quantitative samples only)
9. Percent sorting efficiency (semi-quantitative samples only).
10. Date of QC identification
11. Initials of QC taxonomist
12. Results of taxonomic QC (satisfactory/unsatisfactory)

Log #	Station ID	Sample Type	Sort By	Sort Date	# org.	Sort QC	QC Date	QC # org.	Sort Eff.	S/U	ID By	ID Date	QC ID	QC Date	S/U
J0201001	BIFFL003.0DY	SQKICK													
J0201002	BIGGS000.7WY	SQKICK	AJF	3/11/02	190	PDS	3/20/02	10	95%	S	AJF	3/11/02	PDS	3/20/02	S
J0201003	BMHOL002.0OB	SQKICK													
J0201004	CANE001.8WY	SQKICK													
J0201005	CGROU001.2WY	SQKICK													
J0201006	CLEAR001.2HN	SQKICK													
J0201007	CLOVE001.4OB	SQKICK													
J0201008	CSPRI002.4DY	SQKICK													
J0202001	CYPRE00.6WY	SQKICK													
J0202002	CYPRE000.6OB	SQKICK													
J0202003	DAVID002.6OB	SQKICK													
J0202004	GRASS000.8OB	SQKICK													
J0203001	HFORK006.8OB	SQKICK													
J0203002	HOOSI000.5OB	SQKICK													
J0203003	HURRI002.6WY	SQKICK													
J0203004	HURRI003.9WY	SQKICK													
J0203005	HURRI1T1.1WY	SQKICK													
J0203006	MILL004.0OB	SQKICK													
J0203007	NFOBI005.9OB	SQKICK	AJF	3/15/02	220	PDS	3/20/02	14	94%	S	AJF	3/15/02	PDS	3/20/02	S
J0203008	NFOBI018.0WY	SQKICK													
J0203009	NFOBI026.5WY	BR													
J0203010	NFOBI040.6HN	BR	NA	NA	NA	NA	NA	NA	NA	NA	AJF	3/16/02	PDS	3/20/02	S
J0203011	OBION020.9DY	BR													
J0203012	OBION044.3DY	BR													

Figure 8: Example of macroinvertebrate QC log

D. Sorting Efficiency (Semi-Quantitative samples only)

1. Each biologist/ES responsible for sample sorting, regardless of previous experience, will have every sample QC'ed by a second biologist/ES who has already achieved 90% sorting efficiency (documented) until the original biologist/ES has passed 90% sorting efficiency on a sample. A record of this is kept in the QC log. Once a biologist/ES has passed their first QC, they are QC'ed on 10% of subsequent samples (randomly selected).

2. Each biologist/ES involved in sorting of semi-quantitative benthic macroinvertebrate samples will have 10% of their subsamples (debris) resorted by a second experienced biologist/ES. The sample to be QC'ed is randomly chosen by the person performing the QC after every group of 10 samples has been completed. A sorting efficiency of 90% must be maintained. If fewer than 90% of the organisms are recovered, every sample prior to that one in the same group of 10 is resorted until a sample that has met the 90% requirement is found. The next group of 10 starts after the unsatisfactory sample.

   The sorting efficiency is calculated by:

   $$\text{Sorting efficiency} = \frac{\text{\# organisms found in initial pick}}{\text{Total \# organisms, both picks}} \times 100$$

3. Log results in the QC log.

4. All sorting QC must be completed before the data are released to ensure accuracy of results. If, for any reason, a report is released prior to QC completion, an addendum will be sent to all report recipients with any corrected information after QC is complete.

5. All subsample debris is preserved in 80% ethanol and kept in a labeled container for a minimum of 5 years. The original sample, from which the subsample was taken, is kept in a separate labeled container for the same period.

E. Taxonomic Verification

1. All biologists/ES are to be trained and show proficiency for genus level identification of each group of organisms. (Except Acari, Nematoda, Nematomorpha, Branchiobdellida, Enchytraeidae and Lumbriculidae). If the biologist/ES will only be performing family level biorecons, they need only demonstrate proficiency at the family level.

2. The same taxonomic keys for each group will be used by all taxonomists. Consistency in taxonomic keys is essential because couplets in different keys can result in identification discrepancies through differences in nomenclature or inconsistency of characters used for separation of taxa. This is particularly true where genera may exhibit great variability due to regionalization. Approved keys are listed in appendix D. Each EAC will have a copy of

the primary key for each taxa group. Supplemental keys, which may prove useful in some areas, are also listed. The supplemental keys will not be provided to EACs unless they are needed. Keys will be updated continually as new literature is made available. However, biologists/ES should not utilize new keys for anything other than supplemental information until they are approved by the central QC coordinator and incorporated into the SOP to be used by all Division biologists/ES. New literature will be discussed at the annual training meetings. If new keys are approved for use as primary keys, taxa from reference stations will be reviewed to ensure that the most recent nomenclature is being used for reference information.

3. Each new biologist/ES, regardless of previous experience, will have every sample QC'ed by another biologist/ES (who has passed QC) until they have satisfactorily completed taxonomic QC on a sample. A record of this is kept in the QC log. Once a biologist/ES has satisfactorily completed their first QC, 10% of their identified samples will be randomly checked by another biologist/ES. The sample to be QC'ed is randomly chosen by the QC'er after every 10th sample is completed. The biologist/ES performing the QC will identify every organism in the sample without consulting the original taxonomist's list. Once the second identification is complete, the two biologists/ES will go over any discrepancies together.

4. To satisfy QC requirements for Semi-Quantitative samples, the two taxa lists must not show a significant difference as measured by a chi-square test utilizing a contingency table at alpha 0.05. If a sample shows a significant difference, every sample prior to that one in the same group of 10 will be checked until a sample that has met the QC requirement has been found. The next group of 10 will start after the unsatisfactory sample. For biorecons, assessment results must be the same (supporting, ambiguous or non-supporting) to pass QC.

5. Log results in the QC logbook.

6. Complete all taxonomic QC before releasing results ensure accuracy of results. If, for any reason, results are released prior to QC completion, send an addendum to all report recipients with any adjusted information after QC is complete.

F. Reference Collections

1. The designated QC officer (quality team member) for each EAC will maintain a permanent reference collection consisting of all taxa identified by that office. In addition, a master collection of all taxa identified in the state will be kept in the central laboratory. The organisms in the centralized master reference collection will be verified by outside experts recognized for expertise in a particular taxonomic group. A list of verified organisms found in the state will be provided to each regional office (Appendix E). If new organisms, not on the verified state taxa list are found by the EAC, the quality team member will send a representative of that taxon to the central laboratory. The laboratory will have the new

taxon verified by an outside expert, will add the organism to the central reference collection and will notify all regional offices of its addition to the verified taxa list for Tennessee.

2. Each EAC and central laboratory reference collection will be catalogued with discrete collection numbers assigned to each taxon in each facility. Assign sequential numbers to specimens as they are added into the collection. For example, N0001 would be the first specimen in the Nashville EAC collection. Maintain an accession catalog of all reference material in a permanently bound log and on disk. Each entry must contain the following information:

   Accession number (This must be unique for each group of organisms in each collection)
   Complete name (genus, authority, date)
   Higher taxa (family, order, class)
   Locality data (Waterbody, site, county, ecoregion, station number)
   Sample type
   Name of collector/date of collection
   Name of taxonomist
   Name of verifier if appropriate
   Number of specimens

3. Arrange specimens for ease of use, (according to accession number or in phylogenetic order). Retain wet specimens in 80% ethanol in small screw cap vials with rubber or Teflon lined caps. Retain large specimens in appropriate size specimen jars sealed with electrical tape to reduce evaporation. Inspect vials monthly for evaporation adding 80% ethanol as needed. Keep permanently mounted microscope slides in a slide storage box. Seal the edges of the coverslips to prevent shrinkage of media over time (clear nail polish works well).

4. Clearly label all reference vials and slides. Place the labels in the vial with wet specimens or attach to slides for mounted specimens. Label information at a minimum must include:

   Full name of the organism (Order, family, genus)
   Accession number (reference number)
   Station ID number
   Ecoregion
   Collection date
   Collector
   Taxonomist
   Verifier.

G. Data Reduction QC

1. Store raw data (non-manipulated) in one or more separate locations and in an electronic database with backup.

2. A second staff member checks all computer data entry correctness by direct comparison with the field or laboratory handwritten data sheets. The person performing the data entry QC initial and dates each page of the checked printout in red ink

3. A second staff member checks ten percent of all biometrics that were hand calculated. If an error is found, all of the calculations for that biometric in that sample set are checked. The person performing the QC initials and dates each checked metric in red ink.

4. Keep QC information in a file with the other information for that project a minimum of five years.

5. Complete all data reduction QC before results are released.

III. REFERENCES

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APPENDIX A

ECOREGION REFERENCE INFORMATION

BIOCRITERIA TABLES
ECOREGION REFERENCE STREAMS
REGIONAL EXPECTATIONS FOR INDIVIDUAL HABITAT PARAMETERS

Bioregion: 65abei - 74b Season: January – December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQBANK Stream Order = 2, 3, 4 or 1st order drainage ≥ 1 sq mile (includes non-wadeable)	
Metric	6	4	2	0
Taxa Richness (TR)	> 36	24 - 36	12 – 23	< 12
EPT Richness (EPT)	> 9	6 – 9	3 – 5	< 3
% EPT	> 35.5	23.7 – 35.5	11.8 – 23.6	< 11.8
% OC	< 43.3	43.3 – 62.2	62.3 – 81.1	> 81.1
NCBI	< 6.23	6.23 – 7.48	7.49 – 8.74	> 8.74
% Clingers	> 27.7	18.5 – 27.7	9.2 – 18.4	< 9.2
% Nutol	< 28.5	28.5 - 52.3	52.4 - 76.2	> 76.2

Bioregion 65j Season: January – December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Stream Order = 2, 3, 4 or 1st order drainage ≥ 1 sq mile	
Metric	6	4	2	0
Taxa Richness (TR)	> 29	19 - 29	9 - 18	< 9
EPT Richness (EPT)	> 10	8 – 10	4 – 7	< 4
% EPT	> 46.4	31.0 – 46.4	15.5 – 30.9	< 15.5
% OC	< 36.5	36.5 – 57.6	57.7 – 78.8	> 78.8
NCBI	< 4.71	4.71 – 6.47	6.48 – 8.24	> 8.24
% Clingers	> 51.2	34.2 – 51.2	17.1 – 34.1	< 17.1
% Nutol	< 35.1	35.1 – 56.6	56.7 – 78.2	> 78.2

Bioregion 66defg Season: January – December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Stream Order = 2,3,4 or 1st order drainage ≥ 1 sq mile	
Metric	6	4	2	0
Taxa Richness (TR)	> 31	21 – 31	11 – 20	< 11
EPT Richness (EPT)	> 14	10 – 14	5 – 9	< 5
% EPT	> 58.3	38.9 – 58.3	19.4 – 38.8	< 19.4
% OC	< 30.1	30.1 – 53.3	53.4 – 76.6	> 76.6
NCBI	< 4.02	4.02 – 6.01	6.02 – 8.00	> 8.00
% Clingers	> 59.1	39.4 – 59.1	19.6 – 39.3	< 19.6
% Nutol	< 28.6	28.6 – 52.3	52.4 – 76.1	> 76.1

Bioregion 67fghi Season: January – December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 1, 2, 3, 4, 5	
Metric	6	4	2	0
Taxa Richness (TR)	> 28	20 – 28	10 – 19	< 10
EPT Richness (EPT)	> 10	7 – 10	4 – 6	< 4
% EPT	> 47.1	31.4 – 47.1	15.6 – 31.3	< 15.6
% OC	< 27.3	27.3 – 51.5	51. – 75.8	> 75.8
NCBI	< 4.70	4.71 – 6.46	6.47 – 8.23	> 8.23
% Clingers	> 53.9	36.0 – 53.9	18.0 – 35.9	< 18.0
% Nutol	< 36.5	36.5 – 57.6	57.7 – 78.8	> 78.8

Bioregion 68a Season: January – June Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 3, 4, 5 or 1st – 2nd order drainage ≥ 5 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 31	21 – 31	11 – 20	< 11
EPT Richness (EPT)	> 11	8 – 11	4 – 7	< 4
% EPT	> 35.8	23.9 – 35.8	11.9 – 23.9	< 11.9
% OC	< 39.5	39.5 – 59.6	59.7 – 79.8	> 79.8
NCBI	< 4.80	4.80 – 6.53	6.54 – 8.27	> 8.27
% Clingers	> 45.1	302 – 45.1	15.2 – 30.1	< 15.2
% Nutol	< 29.9	29.9 – 53.2	53.3 – 76.6	> 76.6

Bioregion 68a Season: July - December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 3, 4, 5 or 1st – 2nd order drainage ≥ 5 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 34	23 – 34	12 – 22	< 12
EPT Richness (EPT)	> 13	9 – 13	4 – 8	< 4
% EPT	> 48.9	32.6 – 48.9	16.2 – 32.5	< 16.2
% OC	< 32.6	32.6 – 55.0	55.1 – 77.5	> 77.5
NCBI	< 4.78	4.78 – 6.51	6.52 – 8.26	> 8.26
% Clingers	> 55.1	36.8 – 55.1	18.4 – 36.7	< 18.4
% Nutol	< 33.9	33.9 – 55.9	56.0 – 78.0	> 78.0

Bioregion 68b Season: January - June Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 3 or 1st – 2nd order drainage ≥ 5 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 30	21 – 30	10 – 20	< 10
EPT Richness (EPT)	> 10	7 – 10	4 – 6	< 4
% EPT	> 54.9	36.6 – 54.9	18.2 – 36.5	< 18.2
% OC	< 29.7	29.7 – 53.0	53.1 – 76.4	> 76.4
NCBI	< 5.28	5.28 – 6.85	6.86 – 8.42	> 8.42
% Clingers	> 37.3	25.0 – 37.3	12.6 – 24.9	< 12.4
% Nutol	< 39.4	39.4 – 59.6	59.7 – 79.8	> 79.8

Bioregion 68b Season: July - December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 3 or 1st – 2nd order drainage ≥ 5 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 25	17 – 25	8 – 16	< 8
EPT Richness (EPT)	> 6	5 – 6	2 – 4	< 2
% EPT	> 21.8	14.6 – 21.8	7.3 – 14.5	< 7.3
% OC	< 62.7	62.7 – 75.0	75.1 – 87.5	> 87.5
NCBI	< 6.15	6.15 – 7.43	7.44 – 8.72	> 8.72
% Clingers	> 29.0	19.4 – 29.0	9.7 – 19.3	< 9.7
% Nutol	< 53.7	53.7 – 69.1	69.2 – 84.5	> 84.5

Subregion 68c Season: January - June Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 1, 2, 3	
Metric	6	4	2	0
Taxa Richness (TR)	> 26	18 – 26	9 – 17	< 9
EPT Richness (EPT)	> 9	7 – 9	3 – 6	< 3
% EPT	> 60.2	40.2 – 60.2	20.1 – 40.1	< 20.1
% OC	< 30.7	30.7 – 53.8	53.9 – 77.0	> 77.0
NCBI	< 4.58	4.58 – 6.38	6.39 – 8.19	> 8.19
% Clingers	> 43.6	29.1 – 43.6	14.5 – 29.0	< 14.5
% Nutol	< 32.5	32.5 – 54.9	55.0 – 77.4	> 77.4

Subregion 68c Season: July - December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 1, 2, 3	
Metric	6	4	2	0
Taxa Richness (TR)	> 23	16 – 23	8 - 15	< 8
EPT Richness (EPT)	> 6	5 – 6	2 - 4	< 2
% EPT	> 29.7	19.9 – 29.7	10.0 – 19.8	< 10.0
% OC	< 42.8	42.8 – 61.8	61.9 – 80.9	> 80.9
NCBI	< 5.28	5.28 – 6.85	6.86 – 8.42	> 8.42
% Clingers	> 44.4	29.6 – 44.4	14.8 – 29.5	< 14.8
% Nutol	< 41.1	41.1 – 60.6	60.7 – 80.2	> 80.2

Bioregion 69d Season: January - June Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 2, 3, 4 or 1st order drainage ≥ 2 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 31	22 - 31	11 – 21	< 11
EPT Richness (EPT)	> 15	10 – 15	5 – 9	< 5
% EPT	> 59.9	40.0 – 59.9	20.0 – 39.9	< 20.0
% OC	< 33.4	33.4 – 55.6	55.7 – 77.8	> 77.8
NCBI	< 3.78	3.78 – 5.85	5.86 – 7.92	> 7.92
% Clingers	> 54.3	36.2 – 54.3	18.1 – 36.2	< 18.1
% Nutol	< 27.9	27.9 – 51.9	52.0 – 76.0	> 76.0

Bioregion 69d Season: July - December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 2, 3, 4 or 1st order drainage ≥ 2 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 34	23 - 34	12 – 22	< 12
EPT Richness (EPT)	> 12	9 – 12	4 – 8	< 4
% EPT	> 57.6	38.4 – 57.6	19.2 – 38.3	< 19.2
% OC	< 32.5	32.5 – 55.0	55.1 – 77.5	> 77.5
NCBI	< 5.01	5.01 – 6.67	6.68 – 8.33	> 8.33
% Clingers	> 53.2	35.6 – 53.2	17.8 – 35.5	< 17.8
% Nutol	< 37.4	37.4 – 58.3	58.4 – 79.2	> 79.7

Bioregion 71e Season: January - December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 2, 3 or 1st order drainage ≥ 6 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 24	17 - 24	8 – 16	< 8
EPT Richness (EPT)	> 9	7 - 9	3 – 6	< 3
% EPT	> 51.0	34.0 – 51.0	17.0 – 33.9	< 17.0
% OC	< 28.3	28.3 – 52.1	52.2 – 76.0	> 76.0
NCBI	< 5.09	5.09 – 6.72	6.73 – 8.36	> 8.36
% Clingers	> 57.1	38.1 – 57.1	19.0 – 38.1	< 19.0
% Nutol	< 43.7	43.7 – 62.4	62.5 – 81.2	> 81.2

Bioregion 71fgh Season: January - December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 2, 3, 4, 5 1st order drainage ≥ 4 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19 – 27	10 - 18	< 10
EPT Richness (EPT)	> 9	7 - 9	4 - 6	< 4
% EPT	> 53.5	35.8 – 53.5	17.9 – 35.7	< 17.9
% OC	< 27.5	27.5 – 51.6	51.7 – 75.8	> 75.8
NCBI	< 4.69	4.69 – 6.45	6.46 – 8.23	> 8.23
% Clingers	> 55.4	37.0 – 55.4	18.5 – 36.9	< 18.5
% Nutol	< 34.5	34.5 – 56.2	56.3 – 78.1	> 78.1

Bioregion 71i Season: January - December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 3, 4 or 1st order drainage ≥ 5 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 25	17 – 25	8 – 16	< 8
EPT Richness (EPT)	> 7	5 – 7	2 – 4	< 2
% EPT	> 41.5	27.8 – 41.5	13.9 – 27.7	< 13.9
% OC	< 34.2	34.2 – 56.0	56.1 – 78.0	> 78.0
NCBI	< 5.49	5.49 – 6.99	7.00 – 8.49	> 8.49
% Clingers	> 41.8	28.0 – 41.8	14.0 – 27.9	< 14.0
% Nutol	< 45.0	45.0 – 63.2	63.3 – 81.6	> 81.6

Bioregion 71i Season: January - December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQBANK Order = 3, 4 or 1st order drainage ≥ 5 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 32	22 - 32	11 – 21	< 11
EPT Richness (EPT)	> 6	5 – 6	2 – 4	< 2
% EPT	> 33.1	22.1 – 33.1	11.0 – 22.0	< 11.0
% OC	< 32.5	32.5 – 54.9	55.0 – 77.4	> 77.4
NCBI	< 6.90	6.90 – 7.93	7.94 – 8.96	> 8.96
% Clingers	> 19.3	12.9 – 19.3	6.4 – 12.8	< 6.4
% Nutol	< 30.9	30.9 – 53.9	54.0 – 77.0	> 77.0

Bioregion 73a Season: January – June Target TMI = 22 Scoring calibrated to 160-240 organism sample			Method = SQBANK Order = 3, 4 or 1st – 2nd order drainage ≥ 2 sq miles (Includes non-wadeable)	
Metric	6	4	2	0
Taxa Richness (TR)	> 25	17 – 25	9 – 16	< 9
EPT Richness (EPT)	NA	NA	NA	NA
% EPT	> 8.2	5.6 – 8.2	2.8 – 5.5	< 2.8
% OC	< 26.6	26.6 – 51.0	51.1 – 75.5	> 75.5
NCBI	< 7.53	7.53 – 8.35	8.36 – 9.17	> 9.17
% Clingers	NA	NA	NA	NA
% Nutol	< 29.3	29.3 –52.8	52.9 – 76.4	> 76.4

Bioregion 73a Season: July – December Target TMI = 22 Scoring calibrated to 160-240 organism sample			Method = SQBANK Order = 3, 4 or 1st – 2nd order drainage ≥ 2 sq miles (Includes non-wadeable)	
Metric	6	4	2	0
Taxa Richness (TR)	> 26	18 – 26	9 – 17	< 9
EPT Richness (EPT)*	NA	NA	NA	NA
% EPT	> 27.1	18.2 – 27.1	9.1 – 18.1	< 9.1
% OC	< 43.2	43.2 – 62.0	62.1 – 81.0	> 81.0
NCBI	< 7.40	7.40 – 8.26	8.27 – 9.13	> 9.13
% Clingers*	NA	NA	NA	NA
% Nutol	< 31.3	31.3 – 54.2	54.3 – 77.1	> 77.1

Bioregion 74a Season: January – June Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 3 or 1st – 2nd order drainage ≥ 2 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 19	13 - 19	6 – 12	< 6
EPT Richness (EPT)	> 4	3 -4	2	< 2
% EPT	> 29.5	19.7 – 29.5	9.8 – 19.6	< 9.8
% OC	< 61.0	61.0 – 74.0	74.1 – 87.0	> 87.0
NCBI	< 6.00	6.00 – 7.33	7.34 – 8.66	> 8.66
% Clingers	> 20.1	13.5 – 20.1	6.8 – 13.4	< 6.8
% Nutol	< 30.3	30.3 – 53.4	53.5 – 76.7	> 76.7

Bioregion 74a Season: July - December Target TMI = 32 Scoring calibrated to 160-240 organism sample			Method = SQKICK Order = 3 or 1st – 2nd order drainage ≥ 2 sq miles	
Metric	6	4	2	0
Taxa Richness (TR)	> 22	15 - 22	8 – 14	< 8
EPT Richness (EPT)	> 5	4 – 5	2 – 3	< 2
% EPT	> 63.7	42.5 – 63.7	21.2 – 42.4	< 21.2
% OC	< 30.1	30.1 – 53.3	53.4 – 76.6	> 76.6
NCBI	< 5.14	5.14 – 6.75	6.76 – 8.38	> 8.38
% Clingers	> 52.0	34.8 – 52.0	17.4 – 34.7	< 17.4
% Nutol	<38.4	38.4 – 58.8	58.9 – 79.4	> 79.4

NOTE: ecoregion 74b is in bioregion 65abei-74b (first table)

ECOREGION REFERENCE STREAMS

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO65A01	Active	Unnamed Trib. to Muddy Creek	08010207 Upper Hatchie	RM 0.7 U/S Matt Dammonds Rd	McNairy	35.09583	-88.49944
ECO65A03	Active	Wardlow Creek	06040001 TN Western Valley	RM 4.6 Hamburg Rd	McNairy	35.02277	-88.44194
ECO65B04	Active	Cypress Creek	08010207 Upper Hatchie	RM 5.5 U/S Buster King Rd	Hardeman	35.0675	-88.86
ECO65E04	Active	Blunt Creek	06040005 TN Western Valley	RM 0.1 U/S McHee Levee Rd	Carroll	35.95916	-88.26805
ECO65E06	Active	Griffin Creek	08010204 S Fk Forked Deer	RM 5 U/S Stanford Lane Ford	Carroll	35.81861	-88.54055
ECO65E08	Active	Harris Creek	08010201 N Fk Forked Deer	RM 2.2 Potts Chapel Rd	Madison	35.62638	-88.69972
ECO65E10	Active	Marshall Creek	08010208 Lower Hatchie	RM 2.2 Van Buren Rd	Hardeman	35.1619	-89.0694
ECO65E11	Active	West Fork Spring Creek	08010208 Lower Hatchie	RM 1.7 U/S Van Buren Rd	Hardeman	35.10194	-89.08194
ECO65I02	Active	Battles Branch	06030005 TN Pickwick Lake	U/S Old Kendrix Rd	Hardin	35.03333	-88.29305
ECO65J04	Active	Pompeys Branch	06030005 TN Pickwick Lake	U/S Pompeys Branch Rd	Hardin	35.05388	-88.16805
ECO65J05	Active	Dry Creek	06030005 TN Pickwick Lake	RM 3.2 Dry Creek Rd	Hardin	35.035	-88.15222
ECO65J06	Active	Right Fork Whites Creek	06040001 TN Western Valley	RM 3.4 U/S Morris Lane	Hardin	35.05305	-88.04777
ECO65J11	Active	Unnamed Trib. Rt Fork Whites Cr	06040001 TN Western Valley	RM 0.1 U/S Morris Lane	Hardin	35.05225	-88.04825
ECO66D01	Active	Black Branch	06010103 Watauga	RM 2 Hwy 321 near Elk Mills	Carter	36.2825	-82.0275
ECO66D03	Active	Laurel Fork	06010103 Watauga	RM 6.7 U/S Big Branch Off Dennis Cove Rd	Carter	36.25694	-82.11111
ECO66D05	Active	Doe River	06010103 Watauga	RM 26 U/S Picnic Area Roan Mtn State Park	Carter	36.15888	-82.10583

ECOREGION REFERENCE STREAMS

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO66D06	Active	Tumbling Creek	06010108 Nolichucky	RM 1.5 Tumbling Creek Rd end	Carter	36.01805	-82.48194
ECO66D07	Active	Little Stoney Creek	06010103 Watauga	RM 2 Little Stony Rd 0.3 mi D/S Goodwin Field Br	Carter	36.28666	-82.06666
ECO66E04	Active	Gentry Creek	06010102 South Fork Holston	RM 2.1 Gentry Creek Rds end.	Johnson	36.54444	-81.72444
ECO66E09	Active	Clark Creek	06010108 Nolichucky	RM 1.8 National Forest property off Hwy 107 Clarks Creek Rd	Unicoi	36.15077	-82.52911
ECO66E11	Active	Lower Higgens Creek	06010108 Nolichucky	RM 1.7 Lower Higgins Cr Rd 1 mi NW Ernestville	Unicoi	36.08722	-82.52027
ECO66E17	Active	Double Branch	06010201 Fort Loudoun Lake	RM 0.1 U/S Millers Cove Rd	Blount	35.74378	-83.76631
ECO66E18	Active	Gee Creek	06020002 Hiwassee	RM 0.9 Near Gee Creek Wilderness Boundary	Polk	35.24444	-84.54388
ECO66F06	Active	Abrams Creek	06010204 Little Tennessee	RM 18.3 West end of Cades Cove, 0.6 mi U/S Mill Creek	Blount	35.59305	-83.84694
ECO66F07	Active	Beaverdam Creek	06010102 S Fork Holston	RM 5, 1 mi SW Backbone Rock Park	Johnson	36.58638	-81.8275
ECO66F08	Active	Stony Creek	06010103 Watauga	RM 12.5 U/S SR 91	Carter	36.46722	-81.99805
ECO66G04	Active	Middle Prong Little Pigeon R	06010107 Lower French Broad	RM 0.5 U/S restricted rd 0.2 mi east Greenbriar Cove	Sevier	35.70666	-83.37888
ECO66G05	Active	Little River	06010201 Ft Loudoun/Little R	RM 50.7 U/S last house Little River Trail above Elkmont	Sevier	35.65333	-83.57727
ECO66G07	Active	Citico Creek	06010204 Little Tennessee	RM 5.2, one mile U/S Jakes Creek	Monroe	35.50555	-84.10694
ECO66G09	Active	North River	06010204 Little Tennessee	RM 3, 500 meters U/S campground on North River Rd	Monroe	35.32777	-84.14583
ECO66G12	Active	Sheeds Creek	03150101 Conasauga	RM 1.8, 0.25 mi U/S Shheds Creek Rd	Polk	35.00305	-84.61222

ECOREGION REFERENCE STREAMS

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO67F06	Active	Clear Creek	06010207 Lower Clinch	RM 1, U/S Norris Municipal Park Road	Anderson	36.21361	-84.05972
ECO67F13	Active	White Creek	06010205 Upper Clinch	RM 2, D/S old USGS gaging station next to White Creek Rd	Union	36.34361	-83.89166
ECO67F14	Active	Powell River	06010206 Powell	RM 106.5 McDowell Shoal D/S Fourmile Creek	Hancock	36.55638	-83.37916
ECO67F16	Active	Hardy Creek	06010206 Powell	RM 0.5, U/S SR 660 Powell Valley Rd	Lee County, VA	36.65083	-83.24722
ECO67F17	Active	Big War Creek	06010205 Upper Clinch	RM 0.6 Pawpaw Rd	Hancock	36.42694	-83.34694
ECO67F23	Active	Martin Creek	06010206 Powell	RM 0.5 Powell Valley Rd just U/S Hopkins Rd	Hancock	36.59111	-83.335
ECO67F25	Active	Powell River	06010206 Powell	RM 65.5 River Rd	Claiborne	36.55638	-83.60194
ECO67G01	Dropped 3-5-04	Little Chucky	06010108 Nolichucky	RM 4, Hwy 349	Greene	36.12418	-83.05185
ECO67G05	Active	Bent Creek	06010108 Nolichucky	RM 1.9 East of Hwy 340	Hamblen	36.18793	-83.16414
ECO67G08	Active	Brymer Creek	06020002 Hiwassee	RM 1.3, U/S Spring Br off Roark Lane/Brymer Creek Rd	Bradley	35.12666	-84.96388
ECO67G09	Active	Harris Creek	06020002 Hiwassee	RM 4.8, U/S Bancroft Rd	Bradley	35.175	-84.97916
ECO67G10	Active (9/12/02)	Flat Creek	06010107 Lower French Broad	RM 12 D/S Muddy Hollow Rd	Sevier	35.9157	-83.4515
ECO67G11	Active (4/14/03)	North Prong Fishdam Creek	06010104 Holston	U/S Road to Little Oak Campground	Sullivan	36.5344	-82.0192
ECO67H04	Active	Blackburn Creek	06020002 Hiwassee	RM1.8, 0.24 mi U/S Blackburn Hollow Rd	Bradley	35.22472	-84.97055
ECO67H06	Active	Laurel Creek	06010204 Little Tennessee	RM 0.8, D/S Lurel Creek Rd	Monroe	35.44829	-84.28833
ECO67H08	Active	Parker Branch	06010104 Holston	RM 0.5, Holston Army Ammunition Property	Hawkins	36.5225	-82.65888

ECOREGION REFERENCE STREAMS

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO67I12	Active	Mill Creek	06010207 Lower Clinch	RM 1.2, Below confluence of 2 tribs off Tuskegee Drive	Anderson	35.98833	-84.28888
ECO6701	Active	Big Creek	06010104 Holston	RM 9.8, D/S Fisher Creek West of Surgoinsville on Stanley Valley Rd	Hawkins	36.4778	-82.9387
ECO6702	Active	Fisher Creek	06010104 Holston	RM 0.6, U/S Bray Road	Hawkins	36.49	-82.94027
ECO6707	Probation	Possum Creek	06010102 South Fork Holston	RM 1.5, Weaver Pike Bridge, Bluff City	Sullivan	36.48	-82.19944
ECO68A01	Active	Rock Creek	05130104 S Fork Cumberland	RM 24.8, Pickett State Park	Pickett	36.57833	-84.79472
ECO68A03	Active	Laurel Fork of Station Camp Cr	05130104 S Fork Cumberland	RM 4, Big South Fork NRA	Fentress/ Scott	36.51611	-84.69805
ECO68A08	Active	Clear Creek	06010208 Emory	RM 4, Genesis Rd (HWY 298)	Morgan	36.11916	-84.7425
ECO68A13	Active	Piney Creek	06010201 Watts Bar Lake	RM 8.1, U/S Wash Pelfrey Rd, U/S Polecat Branch	Rhea	35.62083	-84.96944
ECO68A20	Active	Mullens Creek	06020001 Tennessee	RM 5, U/S Jeep Trail	Marion	35.12472	-85.44388
ECO68A26	Active	Daddy's Creek	06010208 Emory	RM 2.3, U/S Hebbertsburg Rd, Catoosa	Cumberland	36.05861	-84.79138
ECO68A27	Active	Island Creek	06010208 Emory	RM 2.3, U/S Noah Hambrey Rd, Catoosa	Morgan	36.05138	-84.66805
ECO68A28	Active	Rock Creek	06010208 Emory	RM 1.8, Off Hwy 62 approx 1 mi NE Lancing	Morgan	36.13277	-84.64166
ECO68B01	Active	Crystal Creek	06020004 Sequatchie	RM 1.2, Approx 0.25 mi D/S Lower East Valley Rd	Bledsoe	35.54083	-85.21694
ECO68B02	Active	McWilliams Creek	06020004 Sequatchie	RM 1.9, D/S Smith Rd	Sequatchie	35.4175	-85.32083
ECO68B09	Active	Mill Branch	06020004 Sequatchie	RM 0.4, U/S Upper East Valley Rd	Bledsoe	35.67444	-85.08888
ECO68C12	Active	Ellis Gap Branch	06020001 Tennessee	RM 0.4, U/S Mullens Cove Rd, Prentice Cooper State Forest	Marion	35.04916	-85.47277

ECOREGION REFERENCE STREAMS

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO68C13	Active	Mud Creek	06030003 Upper Elk	RM 5.6, U/S E Roarks Cove Rd	Franklin	35.23055	-85.91722
ECO68C15	Active	Crow Creek	06030001 Guntersville Lake	RM 34.7, Off Ford Spring Rd below UT in Tom Pack Hollow	Franklin	35.1138	-85.9128
ECO68C20	Active	Crow Creek	06030001 Guntersville Lake	RM 35, Off Ford Spring Rd upstream UT in Tom Pack Hollow	Franklin	35.1155	-85.9110
ECO69D01	Active	No Business Branch	05130101 Upper Cumberland	RM 0.2, U/S Hwy 25	Campbell	36.55277	-84.06861
ECO69D03	Active	Flat Fork	06010208 Emory	RM 5, U/S Flat Fork Rd, U/S Rock Fork Branch	Morgan	36.1235	-84.5122
ECO69D04	Active	Stinking Creek	05130101 Upper Cumberland	RM 15.1, Approx 0.5 mi south of Stinking Creek Rd near power line	Campbell	36.4258	-84.2618
ECO69D05	Active	New River	05140104 S Fork Cumberland	RM 55.4, approx 0.5 mi U/S HWY 116, 0.3 mi U/S Morgan/Anderson Co. line	Morgan	36.12444	-84.43130
ECO69D06	Active	Round Rock Creek	05130104 S Fork Cumberland	RM 1, U/S ford off Norma Rd	Campbell	36.24722	-84.28444
ECO71E09	Active	Buzzard Creek	05130206 Red	RM 1.3, Buzzard Creek Rd	Robertson	36.60583	-86.98361
ECO71E14	Active	Passenger Creek	05130206 Red	RM 1.6, HWY 76	Montgomery	36.53444	-87.19583
ECO71E17	Probation (9-7-06)	Santee Creek	05130206 Red	Stroudville Rd	Robertson	36.481389	-87.089722
ECO71E18	Active (9-7-06)	Calebs Creek	05130206 Red	Sprouse Rd	Robertson	36.49778	-86.778333
ECO71E19	Active (9-7-06)	South Harpeth Creek	05130206 Red	U/S Maxie/Carr Rd	Robertson	36.49237	-87.0066
ECO71F12	Active	South Harpeth River	05130204 Harpeth	RM 16.9, South Harpeth and Pewitt Rd, U/S Kelley Creek	Williamson	35.925	-87.0929
ECO71F16	Active	Wolf Creek	06040003 Lower Duck	RM 0.8, U/S Wolf Creek Rd	Hickman	35.81805	-87.68527
ECO71F19	Active	Brush Creek	06040004 Buffalo	RM 2.1, Paul Reed Rd, U/S Little Brush Creek	Lewis/Lawrence	35.41972	-87.53416

ECOREGION REFERENCE STREAMS

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO71F27	Active	Swanegan Branch	06030005 Pickwick Lake	RM 0.5, Off Thomas Woodard Rd	Wayne	35.06916	-87.6375
ECO71F28	Active	Little Swan Creek	06040003 Lower Duck	RM 5.6, Meriwether Lewis National Monument	Lewis	35.52888	-87.45361
ECO71F29	Active (2/27/03)	Hurricane Creek	06040003 Lower Duck	RM 6.6, Hwy 13	Humphreys	35.980556	-87.761389
ECO71G03	Active	Flat Creek	05130106 Upper Cumberland	RM 1.8, HWY 136	Putnam	36.35944	-85.43138
ECO71G04	Active	Spring Creek	05130106 Upper Cumberland	RM 16.2, Boatman Rd	Overton	36.27277	-85.42333
ECO71G10	Active	Hurricane Creek	06030003 Upper Elk	RM 9.4, Hurricane Creek Rd	Moore	35.32083	-86.29944
ECO71G14	Active (5-7-04)	Blackburn Fork	05130106 Upper Cumberland	Cummins Mill Rd	Jackson	36.2506	-85.5647
ECO71G15	Active (6-20-05)	Long Creek	05110002 Barren	Wilson Rd Ford , off Beech Grove Rd, off Hwy 261	Macon	36.615278	-85.92916
ECO71H03	Active	Flynn Creek	05130106 Upper Cumberland	RM 10.2, Flynn Creek Rd, 3 mi NE Nameless TN	Jackson	36.2792	-85.66444
ECO71H06	Active	Clear Fork	05130108 Caney Fork	RM 6.8, Off Big Hill Rd	Dekalb/Cannon	35.92416	-85.99083
ECO71H09	Active	Carson Fork	05130203 Stones	RM 4.2, Burt-Burgen Rd, 2 mi NE Bradyville	Cannon	35.76495	-86.13263
ECO71I03	Dropped 9/8/03	Stewart Creek	05130203 Stones	RM 16.7, End of West North Creek Rd	Rutherford	35.89805	-86.55777
ECO71I09	Dropped 5/13/03	West Fork Stones River	05130203 Stones	RM 32.3, U/S Rock Springs Rd	Rutherford	35.019722	-86.46663
ECO71I10	Active	Flat Creek	06040002 Upper Duck	RM 6.4, U/S Hazelwood Rd	Marshall	35.68583	-86.80166
ECO71I12	Active	Cedar Creek	05130201 Cumberland	RM 4.6, Centerville Rd	Wilson	36.28425	-86.20339
ECO71I13	Dropped 4/30/03	Fall Creek	05130203 Stones	RM 3.6, U/S Mona Rd	Rutherford	36.0205	-86.41602

ECOREGION REFERENCE STREAMS

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO71I14	Active	Little Flat Creek	06040002 Upper Duck	RM 3.6, U/S Will Brown Rd	Maury	35.69903	-86.83872
ECO71I15	Active	Harpeth River	05130204 Harpeth	RM 105.7, D/S McDaniel Rd	Williamson	35.8325	-86.70019
ECO71I16	Active (4/10/03)	West Fork Stones River	05130203 Stones	RM 30.4, Walnut Grove Rd	Rutherford	35.7225	-86.4451
ECO73A01	Active	Cold Creek	08010100 Mississippi	RM 14.4, U/S Long Hole Rd	Lauderdale	35.7425	-89.6994
ECO73A02	Active	Middle Fork Forked Deer	08010100 Mississippi	RM 3.3, 0.5 miles upstream Watkins Rd	Lauderdale	35.81777	-89.65611
ECO73A03	Active	Cold Creek	08010100 Mississippi	RM 2.3, Approx 1.4 mi u/s Crutcher Lake Rd, U/S Adams Bayou	Lauderdale	35.66305	-89.81222
ECO73A04	Active	Bayou du Chien	08010202 Obion	RM 3.2, Approx 1.5 mi U/S boat ramp on Walnut Log Rd and 0.75 mi U/S last cabin	Lake	36.475	-89.30916
ECO74A06	Active	Sugar Creek	08010100 Mississippi	RM 2.3, U/S Copper Rd	Tipton	35.49944	-89.91914
ECO74A08	Active	Pawpaw Creek	08010202 Obion	RM 3.1, U/S Upper Crossing of Putnam Hill Rd	Obion	36.30527	-89.35666
ECO74B01	Active	Terrapin Creek	08010202 Obion	RM 1.6, Terrapin Creek Rd	Henry	36.48666	-88.48583
ECO74B04	Active	Powell Creek	08010202 Obion	RM 2.2, McClains Levee Rd	Weakley	36.48027	-88.64
ECO74B12	Active	Wolf River	08010210 Wolf	RM 72.7, U/S Yager Rd	Fayette	35.0325	-89.24583

Regional Expectations for Individual Habitat Parameters

	Epifaunal Substrate		Embedded-ness		Pool Substrate		Velocity Depth		Pool Variability		Sediment Deposition		Flow Status		Channel Alteration		Riffle Frequency		Channel Sinuosity		Bank Stability		Vegetative Protection		Riparian Vegetation	
Eco	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75 %
65a	5	4	NA	NA	7	5	NA	NA	11	8	12	9	11	8	12	9	NA	NA	5	4	8	6	14	10	4	3
65b	15	11	NA	NA	10	7	NA	NA	10	8	9	7	10	8	16	12	NA	NA	12	9	13	10	19	14	20	15
65e	15	11	NA	NA	11	8	NA	NA	11	8	15	11	18	14	18	14	NA	NA	15	11	16	12	20	15	18	14
65i	15	11	14	10	10	8	NA	NA	12	9	12	9	8	6	18	14	8	6	11	8	10	8	18	14	20	15
65j	17	13	18	14	NA	NA	17	13	NA	NA	16	12	15	11	19	14	18	14	NA	NA	18	14	20	15	20	15
66d	20	15	20	15	NA	NA	20	15	NA	NA	18	14	19	14	20	15	20	15	NA	NA	20	15	20	15	20	15
66e	19	14	18	14	NA	NA	20	15	NA	NA	18	14	18	14	20	15	20	15	NA	NA	20	15	20	15	20	15
66f	18	14	19	14	NA	NA	16	12	NA	NA	19	14	19	14	20	15	18	14	NA	NA	20	15	20	15	18	14
66g	19	14	19	14	NA	NA	18	14	NA	NA	19	14	18	14	20	15	20	15	NA	NA	20	15	20	15	19	14
67f	18	13	18	14	NA	NA	17	13	NA	NA	15	11	18	14	20	15	19	14	NA	NA	18	14	19	14	20	15
67g	16	12	15	11	NA	NA	16	11	NA	NA	15	11	17	13	15	11	16	12	NA	NA	12	9	16	12	12	9
67h	13	10	17	13	NA	NA	16	12	NA	NA	15	11	15	11	18	13	18	14	NA	NA	18	14	19	14	19	14
67i	13	10	16	12	NA	NA	11	8	NA	NA	15	11	17	13	16	12	13	10	NA	NA	18	14	19	14	16	12
68a Jan-Jun	18	14	18	14	NA	NA	17	13	NA	NA	19	14	19	14	19	14	18	14	NA	NA	20	15	20	15	20	15
68a Jul-Dec	18	13	17	13	NA	NA	15	11	NA	NA	18	14	15	11	19	14	14	11	NA	NA	20	15	20	15	20	15
68b Jan-Jun	15	11	16	12	NA	NA	15	12	NA	NA	13	10	17	13	18	13	16	12	NA	NA	14	10	16	12	13	10
68b Jul-Dec	14	10	12	9	NA	NA	12	9	NA	NA	10	7	15	11	16	12	16	12	NA	NA	14	11	13	10	11	8
68c Jan-Jun	17	13	16	12	NA	NA	15	11	NA	NA	17	13	18	14	19	14	18	14	NA	NA	17	13	19	14	18	14
68c Jul-Dec	16	12	16	12	NA	NA	14	10	NA	NA	16	12	12	9	20	15	18	13	NA	NA	16	12	18	14	18	13

	Epifaunal Substrate		Embedded-ness		Pool Substrate		Velocity Depth		Pool Variability		Sediment Deposition		Flow Status		Channel Alteration		Riffle Frequency		Channel Sinuosity		Bank Stability		Vegetative Protection		Riparian Vegetation	
Eco	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	Eco	REF	75%	REF	75%	REF	75%	REF	75%	REF	75%	REF	75 %
69d Jan-Jun	17	13	18	14	NA	NA	18	14	NA	NA	18	13	16	12	20	15	19	14	NA	NA	19	14	20	15	20	15
69d Jul-Dec	16	12	17	13	NA	NA	15	11	NA	NA	17	13	9	7	20	15	18	14	NA	NA	18	14	20	15	20	15
71e	16	12	15	11	NA	NA	16	12	NA	NA	13	10	16	12	17	13	16	12	NA	NA	13	10	14	11	13	10
71f	16	12	17	13	NA	NA	16	12	NA	NA	15	11	15	11	18	14	17	13	NA	NA	16	12	18	14	16	12
71g	15	11	16	12	NA	NA	16	12	NA	NA	16	12	17	13	18	14	17	13	NA	NA	18	14	18	14	16	12
71h	15	11	17	13	NA	NA	16	12	NA	NA	15	11	16	12	16	12	17	13	NA	NA	17	13	15	11	12	9
71i Jan-Jun	12	9	14	10	15	11	14	10	13	10	14	10	16	12	17	12	11	8	16	12	16	12	16	12	14	10
71i Jul-Dec	13	10	13	10	11	8	10	8	8	6	13	10	12	9	18	14	8	6	9	7	16	12	16	12	13	9
71I Jul-Dec	13	10	13	10	11	8	10	8	8	6	13	10	12	9	18	14	8	6	9	7	16	12	16	12	13	9
73a	11	8	NA	NA	8	6	NA	NA	6	5	9	7	15	11	17	13	NA	NA	10	8	10	8	17	13	18	14
74a	10	8	13	10	NA	NA	13	10	NA	NA	9	8	8	6	15	11	14	10	NA	NA	11	8	12	9	13	10
74b	12	9	NA	NA	11	8	NA	NA	10	8	10	7	15	11	16	12	NA	NA	10	8	13	10	20	15	20	15

APPENDIX B

FORMS AND DATA SHEETS

COUNTY ABBREVIATIONS AND CODE NUMBERS
HABITAT ASSESSMENT DATA SHEETS
STREAM SURVEY SHEET
BIORECON FIELD SHEET
BIOLOGICAL SAMPLE REQUEST INCLUDING CHAIN OF CUSTODY FORM
MACROINVERTEBRATE ASSESSMENT REPORT

COUNTIES – Abbreviations and Code Numbers

COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS	COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS
ANDERSON	**AN**	01	001	LAUDERDALE	**LE**	49	097
BEDFORD	**BE**	02	003	LAWRENCE	**LW**	50	099
BENTON	**BN**	03	005	LEWIS	**LS**	51	101
BLEDSOE	**BL**	04	007	LINCOLN	**LI**	52	103
BLOUNT	**BT**	05	009	LOUDON	**LO**	53	105
BRADLEY	**BR**	06	011	MCMINN	**MM**	54	107
CAMPBELL	**CA**	07	013	MCNAIRY	**MC**	55	109
CANNON	**CN**	08	015	MACON	**MA**	56	111
CARROLL	**CR**	09	017	MADISON	**MN**	57	113
CARTER	**CT**	10	019	MARION	**MI**	58	115
CHEATHAM	**CH**	11	021	MARSHALL	**ML**	59	117
CHESTER	**CS**	12	023	MAURY	**MY**	60	119
CLAIBORNE	**CL**	13	025	MEIGS	**ME**	61	121
CLAY	**CY**	14	027	MONROE	**MO**	62	123
COCKE	**CO**	15	029	MONTGOMERY	**MT**	63	125
COFFEE	**CE**	16	031	MOORE	**MR**	64	127
CROCKETT	**CK**	17	033	MORGAN	**MG**	65	129
CUMBERLAND	**CU**	18	035	OBION	**OB**	66	131
DAVIDSON	**DA**	19	037	OVERTON	**OV**	67	133
DECATUR	**DE**	20	039	PERRY	**PE**	68	135
DE KALB	**DB**	21	041	PICKETT	**PI**	69	137
DICKSON	**DI**	22	043	POLK	**PO**	70	139
DYER	**DY**	23	045	PUTNAM	**PU**	71	141
FAYETTE	**FA**	24	047	RHEA	**RH**	72	143
FENTRESS	**FE**	25	049	ROANE	**RO**	73	145
FRANKLIN	**FR**	26	051	ROBERTSON	**RN**	74	147
GIBSON	**GI**	27	053	RUTHERFORD	**RU**	75	149
GILES	**GS**	28	055	SCOTT	**SC**	76	151
GRAINGER	**GR**	29	057	SEQUATCHIE	**SE**	77	153
GREENE	**GE**	30	059	SEVIER	**SV**	78	155
GRUNDY	**GY**	31	061	SHELBY	**SH**	79	157
HAMBLEN	**HA**	32	063	SMITH	**SM**	80	159
HAMILTON	**HM**	33	065	STEWART	**ST**	81	161
HANCOCK	**HK**	34	067	SULLIVAN	**SU**	82	163
HARDEMAN	**HR**	35	069	SUMNER	**SR**	83	165
HARDIN	**HD**	36	071	TIPTON	**TI**	84	167
HAWKINS	**HS**	37	073	TROUSDALE	**TR**	85	169

COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS	COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS
HAYWOOD	**HY**	38	075	UNICOI	**UC**	86	171
HENDERSON	**HE**	39	077	UNION	**UN**	87	173
HENRY	**HN**	40	079	VAN BUREN	**VA**	88	175
HICKMAN	**HI**	41	081	WARREN	**WA**	89	177
HOUSTON	**HO**	42	083	WASHINGTON	**WN**	90	179
HUMPHREYS	**HU**	43	085	WAYNE	**WE**	91	181
JACKSON	**JA**	44	087	WEAKLEY	**WY**	92	183
JEFFERSON	**JE**	45	089	WHITE	**WH**	93	185
JOHNSON	**JO**	46	091	WILLIAMSON	**WI**	94	187
KNOX	**KN**	47	093	WILSON	**WS**	95	189
LAKE	**LA**	48	095				

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION
STATION #_____	ECOREGION
LAT_____ LONG_____	WATERSHED GROUP
WBID/HUC	INVESTIGATORS
FORM COMPLETED BY	DATE_____ TIME_____ AM PM

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the from of newfall, but not yet prepared for colonization (may rate at high end of scale)	20-40% mix of stable habitat; availability less than desirable; substrate frequently disturbed or removed	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 76% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow) (Slow is<0.3m/s deep is >0.5m)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower than regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime (usually slow-deep)
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low – gradient streams) of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased far development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills> 75% of the available channel; or 25 % of channel substrate is exposed.	Waters fills 25-75 % of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (BACK)

Station ID_____ Date_____

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present	Channelization may be extensive; embankments or shoring structures, present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5-7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >35.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank) **Note: determine left or right side by facing downstream.**	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods	Unstable; many eroded area; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars
SCORE____(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE____(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protective (score each bank) **Note: determine left or right side by facing downstream**	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height
SCORE____(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE____(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone > 18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE____(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE____(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

TOTAL SCORE _____

HABITAT ASSESSMENT DATA SHEET- LOW GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION
STATION #_____	ECOREGION
LAT_____ LONG_____	WATERSHED GROUP
WBID/HUC	INVESTIGATORS
FORM COMPLETED BY	DATE_____ TIME_____ AM PM

Habitat Parameter	Section 1: Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the from of newfall, but not yet prepared for colonization (may rate at high end of scale)	10-30% mix of stable habitat; availability less than desirable; substrate frequently disturbed or removed	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation present.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low – gradient streams) of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased far development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills> 75% of the available channel; or 25 % of channel substrate is exposed.	Waters fills 25-75 % of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

HABITAT ASSESSMENT DATA SHEET- LOW GRADIENT STREAMS (BACK)

Station ID _____ **Date** _____

Habitat Parameter	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present	Channelization may be extensive; embankments or shoring structures, present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Channel Sinuosity	The bends in the stream increase the stream length 3-4 times longer than if it was in a straight line. (Note – channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2-3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods	Unstable; many eroded area; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars
SCORE____(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE____(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protective (score each bank) Note: determine left or right side by facing downstream.	More than 90% of streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height
SCORE____(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE____(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone > 18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE____(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE____(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

TOTAL SCORE _____

STREAM SURVEY FORM

STREAM SURVEY INFORMATION

STATION NUMBER:		ASSESSORS:	
STREAM NAME:		DATE:	
STATION LOCATION:		TIME:	
COUNTY:		STREAM MILE:	
WBID#/HUC:		STREAM ORDER:	
WATERSHED GROUP #		DRAINAGE AREA	
LATITUDE DEC/DEG		ELEVATION (ft):	
LONGITUDE DEC/DEG		GAZETTEER PAGE	
ECOLOGICAL SUBREGION:		USGS QUAD	
PROJECT/PURPOSE:			

SAMPLES COLLECTED

Aquatic Life Assessed: Macroinvertebrates Fish Algae Other:

Type of benthic sample: BIORECON SQ KICK SQ BANK DENDY SURBER OTHER _____

CHEMICALS Y or N

FIELD MEASUREMENTS

METERS USED: _____

pH	SU	DISSOLVED OXYGEN	PPM
CONDUCTIVITY	UMHOS	TIME	
TEMPERATURE	°C	OTHERS	

Previous 48 hours Precip: UNKNOWN NONE LITTLE MODERATE HEAVY FLOODING

Ambient Weather: SUNNY CLOUDY BREEZY RAIN SNOW AIR TEMP: _____

WATERSHED CHARACTERISTICS App. % of watershed observed: _____

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE		URBAN		RESID	
CROPS		INDUSTRY		OTHER	
FOREST		MINING			

IMPACTS: rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES			SOURCES		
	Flow Alter.	(1500)		Unknown	(9000)
Pesticides (0200)	Habitat Alt.	(1600)	Point Source: Indust (0100)	Municipal	(2000)
Metals (0500)	Thermal Alt.	(1400)	Logging (2000)	Mining	(5000)
Ammonia (0600)	Pathogens	(1700)	Construction;Land Devel (3200)	Road /bridge	(3100)
Chlorine (0700)	Oil & grease	(1900)	U/S Dam (8800)	Urban Runoff	(4000)
Nutrients (0900)	Unknown	(0000)	Riparian loss (7600)	Bank destabilization	(7700)
pH (1000)	Siltation	(1100)	Agriculture: Row crop (1000)	Intensive Feedlot	(1600)
Organic Enrichment / Low D.O.		(1200)	Livestock grazing-riparian (1410)	Dredging	(7200)
Other:			Other:		

PHYSICAL STREAM CHARACTERISTICS LENGTH OF STREAM AREA ASSESSED (m): _____

SURROUNDING LAND USE :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE			URBAN			RESID.		
CROPS			INDUSTRY			OTHER		
FOREST			MINING					

% CANOPY COVER: Estimated: _____ Open(0-10) Partly Shaded(11-45) Mostly Shaded(46-80) Shaded(>80)

Measured: _____ U/S_____ D/S_____ LB_____ RB_____

BANK HEIGHT (m): **HIGH WATER MARK** (m):

SEDIMENT DEPOSITS: NONE SLIGHT MODERATE EXCESSIVE BLANKET

TYPE: SLUDGE MUD SAND SILT NONE OTHER_____ Contaminated Y or N

TURBIDITY CLEAR SLIGHT MODERATE HIGH OPAQUE

ALGAE PRESENT? NONE SLIGHT MODERATE CHOKING TYPE _____

AQUATIC VEGET. ROOTED FLOATING TYPE _____

ADDITIONAL COMMENTS: (oil sheen, odor, colors) _____

STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)			
WIDTH (m)			
REACH LENGTH (m)			

Staff Gauge/Bench Ht: _____
VELOCITY (FS) _____
FLOW (CFS) _____
HABITAT ASSESSMENT SCORE #:
RR # _____ GP # _____

Gradient (sample reach): Flat Low Mode. High Cascade
Size (stream width) : V. Small (<1.5m) Small (1.5-3m) Med (3-10m) Large (10-25m) Very Lrg (>25m)

SUBSTRATE (Complete either particle count or estimate substate (%)

Particle Count - 100 measured particles (mm). **Circle one: RIFFLE RUN**

size (mm)	description	abbreviation	Record measured particle size. Use abbrev. below for smaller sizes.						
<0.062	silt/clay	cl	1-10						
0.062-0.125	very fine sand	vfs	11-20						
0.125-.250	fine sand	fs	21-30						
0.25-0.50	med sand	ms	31-40						
0.5-1.0	coarse sand	cs	41-50						
1.0-2.0	very coarse sand	(use actual size)	51-60						
2.0-64.0	gravel	(use actual size)	61-70						
64-256	cobble	(use actual size)	71-80						
256-4096	boulder	(use actual size)	81-90						
---	bedrock	bdrx	91-100						
---	woody debris	wood							

SUBSTRATE (%) **(Visual estimates)**

	RIFFLE	RUN	POOL		RIFFLE	RUN	POOL
BOULDER (> 10")	%	%	%	CLAY (slick)	%	%	%
COBBLE (2.5-10")	%	%	%	SILT	%	%	%
GRAVEL (0.1-2.5")	%	%	%	DETRITUS (CPOM)	%	%	%
BEDROCK	%	%	%	MUCK-MUD (FPOM)	%	%	%
SAND (gritty)	%	%	%	MARL (shell frags.)	%	%	%

STREAM USE SUPPORT: WATER WITHDRAWL NOTED

CLASSIFIED FOR:
Dom. H2O Supply — Ind. H2O Supply
TIER II/TIER III — Navigation
Trout >> — Nat. Repr?

POSTED FOR:
Bacteriological Advis.
Do Not Consume
Precautionary
Fish Tissue Advis.:

SUPPORT STATUS;
FULLY SUPPORTING (FS) PARTIALLY SUPPORTING (PS) SUPPORTING, BUT THREATENED (TH) NONSUPPORTING (NS)

Photos ? Y or N **Roll/Disc #** **Photo #ID** #/ID
#/ID #/ID

STREAM SKETCH (include flow direction, reach distance, distance from bridge, sampling points, tribs, outfalls, livestock access, riparian area etc.)

BIORECON FIELD SHEET

STATION NUMBER _____ **ASSESSORS:** _____

STREAM NAME: _____ **DATE:** _____ **TIME** _____

STREAM LOCATION: _____ **ECOREGION:** _____ **ORDER:** _____ **DRAINAGE AREA:** _____

HUC_____ **WATERSHED GROUP** _____ **LOG #:**

FIELD OBSERVATION OF MACROBENTHOS

Indicate estimated abundance (EA):

1 = rare (1-3 organisms) 3 = abundant (10-49 organisms)

2 = common (4-9 organisms) 4 = dominant (>50 organisms)

Habitats Sampled:	**Riffle**	**Macrophytes**	**Pool/Run Rock**	**Woody debris/snag**	**Leaf Packs**	**Sediment**	**Undercut Banks**	**Other**_____
Percent habitat in reach	_____	_____	_____	_____	_____	_____	_____	_____
# Jabs per habitat	_____	_____	_____	_____	_____	_____	_____	_____

TAXA	EA
Ephemeroptera	
Plecoptera	
Trichoptera	

TAXA	EA
Oligochaeta	
Amphipoda	
Decapoda	
Isopoda	
Acarina	
Odonata	
Anisoptera	
Zygoptera	
Hemiptera	
Megaloptera	
Coleoptera	

TAXA	EA
Diptera	
Chironomidae	
Red	
Non-red	
Tanypodinae	
Athericidae	
Blephaceridae	
Ceratopogonidae	
Culicidae	
Simuliidae	
Tipulidae	
Mollusca	
Bivalvia	
Corbiculidae	
Spaheriidae	
Gastropoda	
Pleuroceridae	
Other	

TAXA RICHNESS _____

OF EPT _____

OF INTOLERANTS (0-3) _____

Score _____

STATE OF NESSEE - ENVIRONMENTAL LABORATORIES

Biological Analysis

Please Print Legibly

****Schedule must be arranged in advance for all tests (615) 262-6327**

Project/Site No.	
Project Name	
Station No.	County
Description	
Stream Mile	Depth
Collection Date	Time
Sampler's name (Print)	
Sampling Agency	
Billing Code	
If Priority, Date Needed	
Send Report to	
Contact Hazard	
Date Reported	By
Reviewed By	
Reviewed by	

BIOLOGICAL SURVEYS

- ☐ Macroinvertebrate Recon
- ☐ Rapid Bioassessment (State SOP)
- ☐ Intensive Survey - Surber
- ☐ Intensive Survey - Dendy
- ☐ Fish Population Recon
- ☐ Fish Population Intensive
- ☐ Fish Tissue Collection
- ☐ Chlorophyll Analysis
  - Log Number
  - Chlorophyll a
  - Pheophyton
- ☐ SPECIAL STUDIES
  - (Please Specify)

Screening Bioassays

(Cannot be used for permitting)

48 hr Static Screening Cd
- Log Number
- LC50 @ 24 hrs
- LC50 @ 48 hrs

48 hr Static Screening Pp
- Log Number
- LC50 @ 24 hrs
- LC50 @ 48 hrs

Acute Bioassays

48 hr Static Definitive Cd
- Log Number
- LC50 @ 24 hrs
- LC50 @ 48 hrs
- NOAEC
- LOAEC

48 hr Static Definitive Pp
- Log Number
- LC50 @ 24 hrs
- LC50 @ 48 hrs
- NOAEC
- LOAEC

96 hr Static Definitive Cd
- Log Number
- LC50 @ 24 hrs
- LC50 @ 48 hrs
- LC50 @ 72 hrs
- LC50 @ 96 hrs
- NOAEC
- LOAEC

96 hr Static Definitive Pp
- Log Number
- LC50 @ 24 hrs
- LC50 @ 48 hrs
- LC50 @ 72 hrs
- LC50 @ 96 hrs
- NOAEC
- LOAEC

Chronic Bioassays

Chronic Cd
- Log Number
- LC50 @ 24 hrs
- LC50 @ 48 hrs
- LC50 @ 72 hrs
- LC50 @ 96 hrs
- Survival
  - NOAEC
  - LOAEC
- Reproduction
  - NOAEC
  - LOAEC
  - IC25

Chronic Pp
- Log Number
- LC50 @ 24 hrs
- LC50 @ 48 hrs
- LC50 @ 72 hrs
- LC50 @ 96 hrs
- LC50 @ 120 hrs
- LC50 @ 144 hrs
- LC50 @ 168 hrs
- Survival
  - NOAEC
  - LOAEC
- Growth
  - NOAEC
  - LOAEC
  - IC25

Chlorine Residual

Lab Parameters
- pH
- Cond.
- D.O.
- Temp.

Branch Lab Number	

Chain of Custody (sign full name)

1. Collected by	
Date	Time
Delivered to	
Date	Time
2. Received by	
Date	Time
Delivered to	
Date	Time
3. Received by	
Date	Time
Delivered to	
Date	Time
4. Rec'd in Lab by	
Date	Time
Logged in by	
Date	Time

Additional Information

1. Approx. volume of sample
2. Nearest town or city
3. Others present at collection
4. Number of other samples collected at same time at this point
5. Field collection procedure, handling and/or preservation of this sample
6. Mode of transportation to lab
7. Sample/cooler sealed by
8. Date sample/cooler sealed
9. Remarks

PH-3010 (rev 1/96)

RDA 1527

MACROINVERTEBRATE ASSESSMENT REPORT (Revised 10-06)

STATION NUMBER:	**LOG NUMBER**	
STREAM:	**ECOREGION(s)**	
LOCATION:	**DATE:**	
HUC/ADB SEGMENT	**WATERSHED GROUP:**	
STREAM ORDER:	**DRAINAGE AREA:**	
SAMPLED BY:	**ID BY**	**SCORED BY:**

If new station send additional information requested on header of stream survey form to PAS

SAMPLE TYPE (circle one) BIORECON SQBANK SQKICK

BIORECON

METRIC	FAMILY LEVEL		GENUS LEVEL	
	Value	Score	Value	Score
Taxa Richness				
EPT Richness				
Intolerant Taxa				

BR INDEX SCORE: _____

COMMENTS :

SEMIQUANTITATIVE SAMPLE

Total number of individuals in subsample = _____

METRIC	VALUE	SCORE
Taxa Richness		
EPT Richness		
% EPT		
% OC		
NCBI		
% Clingers		
% NUTOL		

TMI SCORE _____

COMMENTS :

HABITAT ASSESSMENT SCORE _____RR/HIGH GRAD. (or) _____GP/LOW GRAD.

HABITAT GUIDELINES FOR SUBREGION (Circle one) ABOVE BELOW

APPENDIX C

BIOMETRIC INFORMATION

INTOLERANT MACROINVERTEBRATE FAMILIES FOR BIORECONS
INTOLERANT MACROINVERTEBRATE GENERA FOR BIORECONS
NCBI SCORES FOR TENNESSEE TAXA
LIST OF CLINGER ORGANISMS

Intolerant Macroinvertebrate Families for Biorecons

(Based on average genus NCBI scores for Tennessee taxa within families)

Ephemeroptera
- Ameletidae
- Ephemerellidae
- Leptophlebiidae
- Neoephemeridae
- Polymitarcyidae

Plecoptera
- Capniidae
- Chloroperlidae
- Leuctridae
- Peltoperlidae
- Perlidae
- Perlodidae
- Pteronarcyidae

Trichoptera
- Brachycentridae
- Calamoceratidae
- Glossosomatidae
- Helicopsychidae
- Lepidostomatidae
- Limnephilidae
- Odontoceridae
- Philopotamidae
- Rhyacophilidae
- Sericostomatidae
- Uenoidae

Coleoptera
- Psephenidae

Diptera
- Athericidae
- Blephariceridae
- Dixidae
- Sciomyzidae

Intolerant Macroinvertebrate Genera for Biorecons

(Based on NCBI scores of 0.00 – 3.00)

List excludes intolerant Oligochaeta and Chironomidae (which are not identified for biorecons). A complete listing of NCBI Scores is in a separate table.

Intolerant Genera - Biorecons		
Order	**Genera**	**NCBI**
Coleoptera	Hydrobiomorpha	0
Coleoptera	Helocombus	2
Coleoptera	Hydrophilus	2
Coleoptera	Microcylloepus	2.11
Coleoptera	Optioservus	2.36
Coleoptera	Oulimnius	1.8
Coleoptera	Promoresia	2.35
Coleoptera	Psephenus	2.35
Decapoda	Orconectes	2.6
Diptera	Atherix	2
Diptera	Blepharicera	0
Diptera	Dicranota	0
Diptera	Dixa	2.55
Diptera	Dixella	2.55
Diptera	Ectemnia	0
Diptera	Limnoophila	3
Diptera	Pedicia	2
Diptera	Sciomyzidae	2
Ephemeroptera	Ameletus	2.38
Ephemeroptera	Attenella	1.56
Ephemeroptera	Brachycercus	3.01
Ephemeroptera	Choroterpes	0
Ephemeroptera	Cinygmula	0
Ephemeroptera	Diphetor	1.2
Ephemeroptera	Drunella	0.26
Ephemeroptera	Epeorus	1.27
Ephemeroptera	Ephemera	1.12
Ephemeroptera	Ephemerella	2.04
Ephemeroptera	Ephoron	1.32
Ephemeroptera	Fallceon	1.2
Ephemeroptera	Habrophlebia	0

Intolerant Genera - Biorecons		
Order	**Genera**	**NCBI**
Ephemeroptera	Habrophlebiodes	2
Ephemeroptera	Heptagenia	2.57
Ephemeroptera	Leucrocuta	2.4
Ephemeroptera	Neochoroterpes	2
Ephemeroptera	Neoephemera	0.81
Ephemeroptera	Nixe	0
Ephemeroptera	Paraleptophlebia	0.94
Ephemeroptera	Rithrogena	0.3
Ephemeroptera	Serratella	1.57
Lepidoptera	Petrophila	2.09
Mesogastropoda	Elimia	2.46
Mesogastropoda	Leptoxis	1.79
Odonata	Chromagrion	2
Odonata	Didymops	2.36
Odonata	Lanthus	1.77
Plecoptera	Acroneuria	1.47
Plecoptera	Agnetina	0
Plecoptera	Allocapnia	2.52
Plecoptera	Alloperla	1.22
Plecoptera	Attaneuria	0
Plecoptera	Beloneuria	0
Plecoptera	Cultus	1.57
Plecoptera	Diploperla	2.06
Plecoptera	Diura	2
Plecoptera	Haploperla	0.98
Plecoptera	Helopicus	0.41
Plecoptera	Hydroperla	1.6
Plecoptera	Isogenoides	0.54
Plecoptera	Isoperla	1.5
Plecoptera	Leuctra	0.67
Plecoptera	Malirakus	1.15
Plecoptera	Neoperla	1.49
Plecoptera	Oemopteryx	1
Plecoptera	Paracapnia	0.12
Plecoptera	Paragnetina	1.54
Plecoptera	Paraleuctra	0.67
Plecoptera	Perlinella	0.63
Plecoptera	Pteronarcys	1.67
Plecoptera	Rasvena	1.0

Intolerant Genera - Biorecons		
Order	**Genera**	**NCBI**
Plecoptera	Remenus	0.2
Plecoptera	Soyedina	0
Plecoptera	Sweltsa	0
Plecoptera	Tallaperla	1.18
Plecoptera	Taenionema	2.0
Plecoptera	Viehoperla	2.7
Plecoptera	Yugus	0
Trichoptera	Agapetus	0
Trichoptera	Agarodes	0.69
Trichoptera	Agraylea	2
Trichoptera	Anisocentropus	0.85
Trichoptera	Apatania	0.64
Trichoptera	Arctopsyche	0
Trichoptera	Brachycentrus	2.08
Trichoptera	Ceraclea	2.01
Trichoptera	Chimarra	2.76
Trichoptera	Diplectrona	2.21
Trichoptera	Dolophilodes	0.81
Trichoptera	Glossosoma	1.55
Trichoptera	Goera	0.13
Trichoptera	Goerita	0
Trichoptera	Helicopsyche	0
Trichoptera	Hydatophylax	2.17
Trichoptera	Lepidostoma	0.9
Trichoptera	Limnephilus	2.0
Trichoptera	Matrioptila	0
Trichoptera	Mayatrichia	0
Trichoptera	Micrasema	0.56
Trichoptera	Mystacides	2.69
Trichoptera	Nectopsyche	2.94
Trichoptera	Neophylax	2.2
Trichoptera	Neotrichia	0
Trichoptera	Oxyethira	2.22
Trichoptera	Parapsyche	0
Trichoptera	Psilotreta	0
Trichoptera	Psychomyia	2.44
Trichoptera	Pycnopsyche	2.52
Trichoptera	Rhyacophila	0.73
Trichoptera	Setodes	0

Intolerant Genera - Biorecons		
Order	**Genera**	**NCBI**
Trichoptera	Theliopsyche	0
Trichoptera	Wormaldia	0.65

NCBI SCORES FOR TENNESSEE TAXA

Order	Family	Genus	NCBI
Acarina	Acarina	Acarina	5.53
Aelosomatida	Aelosomatidae	Aelosoma	4
Aelosomatida	Aelosomatidae	Und. spp.	4
Amphipoda	Crangonyctidae	Crangonyx	7.87
Amphipoda	Gammaridae	Gammarus	9.1
Amphipoda	Hyalellidae	Hyalella	7.75
Amphipoda		Und. spp.	7.4
Branchiobdellida		Und. spp.	6
Coleoptera	Cabaridae	Und. spp.	4
Coleoptera	Chrysomelidae	Und. spp.	4
Coleoptera	Curculionidae	Tanysphyrus	4
Coleoptera	Curculionidae	Und. spp.	4
Coleoptera	Dryopidae	Helichus	4.63
Coleoptera	Dytiscidae	Acilius	4
Coleoptera	Dytiscidae	Agabetes	5.5
Coleoptera	Dytiscidae	Agabus	8.9
Coleoptera	Dytiscidae	Copelatus	10
Coleoptera	Dytiscidae	Coptotomus	9.26
Coleoptera	Dytiscidae	Desmopachria	4
Coleoptera	Dytiscidae	Hydaticus	9.1
Coleoptera	Dytiscidae	Hydroporus	8.62
Coleoptera	Dytiscidae	Hydrovatus	4.6
Coleoptera	Dytiscidae	Hygrotus	4
Coleoptera	Dytiscidae	Laccodytes	10
Coleoptera	Dytiscidae	Laccophilus	10
Coleoptera	Dytiscidae	Liodessus	5.5
Coleoptera	Dytiscidae	Lioporus	5.5
Coleoptera	Dytiscidae	Neoporus	8.52
Coleoptera	Dytiscidae	Rhantus	3.61
Coleoptera	Dytiscidae	Uvarus	8
Coleoptera	Dytisicidae	Und. spp.	5.5
Coleoptera	Elmidae	Ancyronyx	6.49
Coleoptera	Elmidae	Dubiraphia	5.93
Coleoptera	Elmidae	Macronychus	4.58
Coleoptera	Elmidae	Microcylloepus	2.11
Coleoptera	Elmidae	Optioservus	2.36
Coleoptera	Elmidae	Oulimnius	1.8
Coleoptera	Elmidae	Promoresia	2.35
Coleoptera	Elmidae	Stenelmis	5.1
Coleoptera	Elmidae	Und. Spp.	6

Order	Family	Genus	NCBI
Coleoptera	Gyrinidae	Dineutus	5.54
Coleoptera	Gyrinidae	Gyrinus	6.17
Coleoptera	Gyrinidae	Und. spp.	5.8
Coleoptera	Haliplidae	Haliplus	8.71
Coleoptera	Haliplidae	Peltodytes	8.73
Coleoptera	Haliplidae	Und. spp.	8.7
Coleoptera	Helophoridae	Helophorus	7.57
Coleoptera	Hydraenidae	Hydraena	4
Coleoptera	Hydrophilidae	Berosus	8.43
Coleoptera	Hydrophilidae	Dibolocelus	4.6
Coleoptera	Hydrophilidae	Helochares	4
Coleoptera	Hydrophilidae	Helocombus	2
Coleoptera	Hydrophilidae	Hydrobiomorpha	5
Coleoptera	Hydrophilidae	Hydrobius	5
Coleoptera	Hydrophilidae	Hydrochus	6.55
Coleoptera	Hydrophilidae	Hydrophilus	2
Coleoptera	Hydrophilidae	Laccobius	7.32
Coleoptera	Hydrophilidae	Paracymus	4
Coleoptera	Hydrophilidae	Sperchopsis	6.13
Coleoptera	Hydrophilidae	Tropisternus	9.68
Coleoptera	Hydrophilidae	Und. spp.	4.6
Coleoptera	Hydroptilidae	Enochrus	8.75
Coleoptera	Noteridae	Hydrocanthus	7.14
Coleoptera	Noteridae	Suphisellus	4
Coleoptera	Psephenidae	Ectopria	4.16
Coleoptera	Psephenidae	Psephenus	2.35
Coleoptera	Ptilodactylidae	Anchytarsus	3.64
Coleoptera	Scirtidae	Cyphon	6.8
Coleoptera	Scirtidae	Elodes	6.8
Coleoptera	Scirtidae	Pryonocyphon	7
Coleoptera	Scirtidae	Scirtes	6.8
Coleoptera	Scirtidae	Und. spp.	6.8
Coleoptera	Staphylinidae	Bledius	8
Coleoptera	Staphylinidae	Carpelimus	8
Coleoptera	Staphylinidae	Psephidonus	8
Coleoptera	Staphylinidae	Stenus	8
Coleoptera	Staphylinidae	Thinobius	8
Coleoptera	Staphylinidae	Und. spp.	8
Decapoda	Cambaridae	Cambarus	7.62
Decapoda	Cambaridae	Orconectes	2.6
Decapoda	Cambaridae	Procambarus	9.49
Decapoda	Cambaridae	Und. spp.	7.5

Order	Family	Genus	NCBI
Decapoda	Palaemonidae	Palamontes	7.1
Diptera	Athericidae	Atherix	2
Diptera	Blephariceridae	Blepharicera	0
Diptera	Ceratopogonidae	Alluaudomyia	5.99
Diptera	Ceratopogonidae	Atrichopogon	6.49
Diptera	Ceratopogonidae	Bezzia	6
Diptera	Ceratopogonidae	Bezzia/Palpomyia	6
Diptera	Ceratopogonidae	Ceratopogon	7.7
Diptera	Ceratopogonidae	Culicoides	7.7
Diptera	Ceratopogonidae	Dasyhelea	4
Diptera	Ceratopogonidae	Forcipomyia	4
Diptera	Ceratopogonidae	Mallochohelea	6
Diptera	Ceratopogonidae	Monohelea	5.7
Diptera	Ceratopogonidae	Probezzia	6
Diptera	Ceratopogonidae	Serromyia	5.7
Diptera	Ceratopogonidae	Sphaeromias	5.9
Diptera	Ceratopogonidae	Stilobezzia	6
Diptera	Ceratopogonidae	Und. spp.	5.9
Diptera	Chaoboridae	Mochlonyx	8.5
Diptera	Chaoboridae	Und. spp.	8.5
Diptera	Chironomidae	Ablabesmyia	7.2
Diptera	Chironomidae	Acricotopus	10
Diptera	Chironomidae	Apedilum	5.69
Diptera	Chironomidae	Apsectrotanypus	0.1
Diptera	Chironomidae	Axarus	2
Diptera	Chironomidae	Brillia	5.18
Diptera	Chironomidae	Brundiniella	1.71
Diptera	Chironomidae	Cardiocladius	5.87
Diptera	Chironomidae	Chaetocladius	4
Diptera	Chironomidae	Chernovkiia	6
Diptera	Chironomidae	Chironomus	9.63
Diptera	Chironomidae	Cladopelma	3.49
Diptera	Chironomidae	Cladotanytarsus	4.09
Diptera	Chironomidae	Clinotanypus	8.74
Diptera	Chironomidae	Coelotanypus	8
Diptera	Chironomidae	Conchapelopia	4.5
Diptera	Chironomidae	Constempellina	0
Diptera	Chironomidae	Corynoneura	6.01
Diptera	Chironomidae	Crico./Ortho.	4.86
Diptera	Chironomidae	Cricotopus	5.78
Diptera	Chironomidae	Cryptochironomus	6.4
Diptera	Chironomidae	Cryptotendipes	6.19

Order	Family	Genus	NCBI
Diptera	Chironomidae	Demicryptochironomus	2.12
Diptera	Chironomidae	Diamesa	8.12
Diptera	Chironomidae	Dicrotendipes	8.1
Diptera	Chironomidae	Diplocladius	7.41
Diptera	Chironomidae	Djalmabatista	4
Diptera	Chironomidae	Einfeldia	7.08
Diptera	Chironomidae	Endochironomus	7.79
Diptera	Chironomidae	Epoicocladius	0
Diptera	Chironomidae	Eukiefferiella	3.43
Diptera	Chironomidae	Glyptotendipes	9.47
Diptera	Chironomidae	Goeldichironomus	10
Diptera	Chironomidae	Harnischia	9.07
Diptera	Chironomidae	Hayesomyia	4.6
Diptera	Chironomidae	Heleniella	0
Diptera	Chironomidae	Helopelopia	6.2
Diptera	Chironomidae	Heterotrissocladius	5.23
Diptera	Chironomidae	Hydrobaenus	9.54
Diptera	Chironomidae	Kiefferulus	10
Diptera	Chironomidae	Krenosmittia	0
Diptera	Chironomidae	Labrundinia	5.9
Diptera	Chironomidae	Larsia	9.3
Diptera	Chironomidae	Limnophyes	7.43
Diptera	Chironomidae	Lopescladius	1.67
Diptera	Chironomidae	Meropelopia	2.7
Diptera	Chironomidae	Metriocnemus	0
Diptera	Chironomidae	Micropsectra	1.52
Diptera	Chironomidae	Microtendipes	5.53
Diptera	Chironomidae	Nanocladius	7.07
Diptera	Chironomidae	Natarsia	9.95
Diptera	Chironomidae	Nilotanypus	3.9
Diptera	Chironomidae	Nilothauma	5.03
Diptera	Chironomidae	Omisus	4
Diptera	Chironomidae	Orthocladius	5.95
Diptera	Chironomidae	Pagastia	1.77
Diptera	Chironomidae	Parachaetocladius	0
Diptera	Chironomidae	Parachironomus	9.42
Diptera	Chironomidae	Paracladopelma	5.51
Diptera	Chironomidae	Paracricotopus	10
Diptera	Chironomidae	Parakiefferiella	5.4
Diptera	Chironomidae	Paralauterborniella	4.77
Diptera	Chironomidae	Paramerina	4.29
Diptera	Chironomidae	Parametriocnemus	3.65

Order	Family	Genus	NCBI
Diptera	Chironomidae	Paraphaenocladius	3.33
Diptera	Chironomidae	Parapsectra	1.52
Diptera	Chironomidae	Paratanytarsus	8.45
Diptera	Chironomidae	Paratendipes	5.11
Diptera	Chironomidae	Pentaneura	4.7
Diptera	Chironomidae	Phaenopsectra	6.5
Diptera	Chironomidae	Polypedilum	5.69
Diptera	Chironomidae	Potthastia	6.4
Diptera	Chironomidae	Procladius	9.1
Diptera	Chironomidae	Psectrocladius	3.59
Diptera	Chironomidae	Pseudochironomus	5.36
Diptera	Chironomidae	Pseudorthocladius	1.51
Diptera	Chironomidae	Pseudosmittia	2
Diptera	Chironomidae	Psilometriocnemus	2.8
Diptera	Chironomidae	Rheocricotopus	7.3
Diptera	Chironomidae	Rheopelopia	2
Diptera	Chironomidae	Rheosmittia	7
Diptera	Chironomidae	Rheotanytarsus	5.89
Diptera	Chironomidae	Robackia	2.95
Diptera	Chironomidae	Saetheria	7.07
Diptera	Chironomidae	Smittia	2
Diptera	Chironomidae	Stelechomyia	5
Diptera	Chironomidae	Stempellina	0
Diptera	Chironomidae	Stempellinella	4.62
Diptera	Chironomidae	Stenochironomus	6.45
Diptera	Chironomidae	Stictochironomus	6.52
Diptera	Chironomidae	Stilocladius	0.98
Diptera	Chironomidae	Sublettea	1.6
Diptera	Chironomidae	Symbiocladius	5.4
Diptera	Chironomidae	Symposiocladius	5.34
Diptera	Chironomidae	Synorthocladius	4.36
Diptera	Chironomidae	Tanypus	9.19
Diptera	Chironomidae	Tanytarsus	6.76
Diptera	Chironomidae	Thienemanniella	5.86
Diptera	Chironomidae	Thienemannimyia	6.2
Diptera	Chironomidae	Tribelos	6.31
Diptera	Chironomidae	Trissopelopia	0
Diptera	Chironomidae	Tvetenia	3.65
Diptera	Chironomidae	Unniella	0
Diptera	Chironomidae	Xenochironomus	7.1
Diptera	Chironomidae	Xestochironomus	2
Diptera	Chironomidae	Xylotopus	5.99

Order	Family	Genus	NCBI
Diptera	Chironomidae	Zavrelia	5.3
Diptera	Chironomidae	Zavrelimyia	9.11
Diptera	Chrironomidae	Limnophyes	7.43
Diptera	Culicidae	Aedes	8
Diptera	Culicidae	Anopheles	8.58
Diptera	Culicidae	Culex	10
Diptera	Culicidae	Und. sp.	8.1
Diptera	Dixidae	Dixa	2.55
Diptera	Dixidae	Dixella	2.55
Diptera	Dolichopodidae	Und. spp.	7
Diptera	Empididae	Chelifera	7.57
Diptera	Empididae	Clinocera	7.57
Diptera	Empididae	Hemerodromia	7.57
Diptera	Empididae	Trichoclinocera	7.57
Diptera	Ephydridae	Notiphila	6
Diptera	Empididae	Und. spp.	7.6
Diptera	Ephydridae	Und. spp.	6
Diptera	Muscidae	Und. spp.	8.4
Diptera	Psychodidae	Pericoma/Telmatoscopus	4.2
Diptera	Psychodidae	Psychoda	9.64
Diptera	Psychodidae	Und. spp.	6.9
Diptera	Ptychopteridae	Bittacomorpha	8
Diptera	Sciomyzidae	Und. spp.	2
Diptera	Simuliidae	Cnephia	6
Diptera	Simuliidae	Ectemnia	0
Diptera	Simuliidae	Prosimulium	4.01
Diptera	Simuliidae	Simulium	4
Diptera	Simuliidae	Und. spp.	3.5
Diptera	Stratiomyidae	Allognosta	5.2
Diptera	Stratiomyidae	Caloparyphus	5.2
Diptera	Stratiomyidae	Myxosargus	6
Diptera	Stratiomyidae	Nemotelus	4
Diptera	Stratiomyidae	Odontomyia	8
Diptera	Stratiomyidae	Stratiomys	8.08
Diptera	Stratiomyidae	Und. spp.	5.2
Diptera	Syrphidae	Neoascia	9.7
Diptera	Syrphidae	Und. spp.	9.69
Diptera	Tabanidae	Chlorotabanus	8
Diptera	Tabanidae	Chrysops	6.73
Diptera	Tabanidae	Diachlorus	8
Diptera	Tabanidae	Hybomitra	8
Diptera	Tabanidae	Tabanus	9.22

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Diptera	Tanyderidae	Protoplasa	4.33
Diptera	Tipulidae	Antocha	4.25
Diptera	Tipulidae	Cryptolabis	4.9
Diptera	Tipulidae	Dactylolabis	6
Diptera	Tipulidae	Dicranota	0
Diptera	Tipulidae	Epiphragma	4.9
Diptera	Tipulidae	Erioptera	4.62
Diptera	Tipulidae	Gonomyia	6
Diptera	Tipulidae	Hexatoma	4.31
Diptera	Tipulidae	Limnophila	3
Diptera	Tipulidae	Limonia	9.64
Diptera	Tipulidae	Molophilus	6
Diptera	Tipulidae	Ormosia	6.27
Diptera	Tipulidae	Pedicia	2
Diptera	Tipulidae	Pilaria	7
Diptera	Tipulidae	Pseudolimnophila	7.22
Diptera	Tipulidae	Rhabdomastix	8
Diptera	Tipulidae	Tipula	7.33
Diptera	Tipulidae	Und. spp.	4.9
Ephemeroptera	Leptophlebiidae	Leptophlebia	6.23
Ephemeroptera	Ameletidae	Ameletus	2.38
Ephemeroptera	Baetidae	Acentrella	3.6
Ephemeroptera	Baetidae	Acerpenna	3.7
Ephemeroptera	Baetidae	Baetis	4.51
Ephemeroptera	Baetidae	Centroptilum	6.6
Ephemeroptera	Baetidae	Diphetor	1.2
Ephemeroptera	Baetidae	Fallceon	1.2
Ephemeroptera	Baetidae	Heterocloeon	3.48
Ephemeroptera	Baetidae	Labiobaetis	6
Ephemeroptera	Baetidae	Paracloeodes	7.4
Ephemeroptera	Baetidae	Plauditus	4.51
Ephemeroptera	Baetidae	Procloeon	6.6
Ephemeroptera	Baetidae	Und. spp.	6.1
Ephemeroptera	Baetiscidae	Baetisca	3.4
Ephemeroptera	Caenidae	Brachycercus	3.01
Ephemeroptera	Caenidae	Caenis	7.41
Ephemeroptera	Ephemerellidae	Attenella	1.56
Ephemeroptera	Ephemerellidae	Drunella	0.26
Ephemeroptera	Ephemerellidae	Ephemerella	2.04
Ephemeroptera	Ephemerellidae	Eurylophella	4.34
Ephemeroptera	Ephemerellidae	Serratella	1.57
Ephemeroptera	Ephemerellidae	Timpanoga	4.34

Order	Family	Genus	NCBI
Ephemeroptera	Ephemerellidae	Und. spp.	1.9
Ephemeroptera	Ephemeridae	Ephemera	1.12
Ephemeroptera	Ephemeridae	Hexagenia	4.9
Ephemeroptera	Heptageniidae	Cinygmula	0
Ephemeroptera	Heptageniidae	Epeorus	1.27
Ephemeroptera	Heptageniidae	Heptagenia	2.57
Ephemeroptera	Heptageniidae	Leucrocuta	2.4
Ephemeroptera	Heptageniidae	Maccaffertium	3.45
Ephemeroptera	Heptageniidae	Nixe	0
Ephemeroptera	Heptageniidae	Rithrogena	0.3
Ephemeroptera	Heptageniidae	Stenacron	3.58
Ephemeroptera	Heptageniidae	Stenonema	3.45
Ephemeroptera	Heptageniidae	Und. spp.	4
Ephemeroptera	Isonychiidae	Isonychia	3.45
Ephemeroptera	Leptophyphidae	Tricorythodes	5.06
Ephemeroptera	Leptophyphidae	Und. Spp	5.1
Ephemeroptera	Leotophlebiidae	Choroterpes	0
Ephemeroptera	Leptophlebiidae	Habrophlebia	0
Ephemeroptera	Leptophlebiidae	Habrophlebiodes	2
Ephemeroptera	Leptophlebiidae	Neochoroterpes	2
Ephemeroptera	Leptophlebiidae	Paraleptophlebia	0.94
Ephemeroptera	Leptophlebiidae	Und. spp.	1.8
Ephemeroptera	Metropodidae	Siphloplecton	3.31
Ephemeroptera	Neoephemeridae	Neoephemera	0.81
Ephemeroptera	Polymitarcyidae	Ephoron	1.32
Ephemeroptera	Polymitarcyidae	Und. spp.	0.7
Ephemeroptera	Potamanthidae	Anthopotamus	4
Ephemeroptera	Siphlonuridae	Siphlonurus	5.81
Ephemeroptera	Siphlonuridae	Und. spp.	4.1
Ephemeroptera	Tricorythidae	Tricorythodes	5.06
Ephemeroptera	Tricorythidae	Und. spp.	5.1
Gordiida	Gordiidae	Gordius	6
Haplonemertea	Tertastemmatidae	Prostoma	6.1
Hemiptera	Belostomatidae	Belostoma	9.8
Hemiptera	Belostomatidae	Lethocerus	4
Hemiptera	Belostomatidae	Und. spp.	6.9
Hemiptera	Corixidae	Palmacorixa	6
Hemiptera	Corixidae	Sigara	9.06
Hemiptera	Corixidae	Trichocorixa	6
Hemiptera	Corixidae	Und. spp.	9
Hemiptera	Gerridae	Aquarius	5
Hemiptera	Gerridae	Gerris	6

Order	Family	Genus	NCBI
Hemiptera	Gerridae	Limnoporus	6
Hemiptera	Gerridae	Metrobates	6
Hemiptera	Gerridae	Rheumatobates	6
Hemiptera	Gerridae	Trepobates	6
Hemiptera	Gerridae	Und. spp.	6
Hemiptera	Hebridae	Hebrus	6
Hemiptera	Hebridae	Lipogomphus	6
Hemiptera	Hydrometridae	Hydrometra	6
Hemiptera	Mesoveliidae	Mesovelia	6
Hemiptera	Nepidae	Ranatra	7.82
Hemiptera	Notonectidae	Bueno	4
Hemiptera	Notonectidae	Notonecta	8.71
Hemiptera	Notonectidae	Und. spp.	6.4
Hemiptera	Saldidae	Pentacora	10
Hemiptera	Saldidae	Und. spp.	10
Hemiptera	Veliidae	Microvelia	6
Hemiptera	Veliidae	Rhagovelia	6
Hemiptera	Veliidae	Und. spp.	6
Heterostropha	Valvatidae	Valvata	8
Hydroida	Hydridae	Hydra	6
Isopoda	Asellidae	Asellus	9.11
Isopoda	Asellidae	Caecidotea	9.11
Isopoda	Asellidae	Lirceus	7.85
Lepidoptera	Pyralidae	Acentria	5
Lepidoptera	Pyralidae	Crambus	4.6
Lepidoptera	Pyralidae	Munroessa/Syncllita	4.3
Lepidoptera	Pyralidae	Petrophila	2.09
Lepidoptera	Pyralidae	Synclita	5
Lepidoptera	Pyralidae	Und. spp.	4.3
Limnophila	Ancylidae	Ferrissia	6.55
Limnophila	Ancylidae	Laevapex	7.49
Limnophila	Ancylidae	Und. spp.	7
Limnophila	Lymnaeidae	Lymnaea	6.9
Limnophila	Lymnaeidae	Pseudosuccinea	7.65
Limnophila	Physidae	Physella	8.84
Limnophila	Planorbidae	Gyraulus	4.23
Limnophila	Planorbidae	Menetus	8.23
Limnophila	Planorbidae	Planorbella	6.82
Limnophila	Planorbidae	Planorbula	6.82
Limnophila	Planorbidae	Und. spp.	6.3
Lumbricida	Lumbricidae	Und. Spp.	10
Lumbriculida	Lumbriculidae	Eclipidrilus	7.03

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Lumbriculida	Lumbriculidae	Lumbriculus	7.03
Lumbriculida	Lumbriculidae	Und. spp.	7.03
Lymnophila	Lymnaeidae	Fossaria	6
Lymnophila	Lymnaeidae	Stagnicola	8.22
Megaloptera	Corydalidae	Chauliodes	8.98
Megaloptera	Corydalidae	Corydalus	5.16
Megaloptera	Corydalidae	Nigronia	5.25
Megaloptera	Corydalidae	Und. spp.	6.5
Megaloptera	Sialidae	Sialis	7.17
Mermithida	Mermithidae	Und. spp.	6.02
Mesogastropoda	Hydrobiidae	Und. spp.	5.78
Mesogastropoda	Pleuroceridae	Elimia	2.46
Mesogastropoda	Pleuroceridae	Leptoxis	1.79
Mesogastropoda	Pleuroceridae	Pleurocera	6
Mesogastropoda	Pleuroceridae	Und. spp.	3.4
Mesogastropoda	Viviparidae	Campeloma	6.8
Mesogastropoda	Viviparidae	Viviparus	6
Odonata	Aeshnidae	Basiaeschna	7.35
Odonata	Aeshnidae	Boyeria	5.97
Odonata	Aeshnidae	Nasiaeschna	8.14
Odonata	Aeshnidae	Und. spp.	5.6
Odonata	Calopterygidae	Calopteryx	7.78
Odonata	Calopterygidae	Hetaerina	5.61
Odonata	Coenagrionidae	Amphiagrion	5
Odonata	Coenagrionidae	Argia	8.17
Odonata	Coenagrionidae	Chromagrion	2
Odonata	Coenagrionidae	Enallagma	8.91
Odonata	Coenagrionidae	Ischnura	9.52
Odonata	Coenagrionidae	Und. spp.	6.1
Odonata	Cordulegastridae	Cordulegaster	5.73
Odonata	Corduliidae	Didymops	2.36
Odonata	Corduliidae	Epitheca	8.57
Odonata	Corduliidae	Helocordulia	4.83
Odonata	Corduliidae	Macromia	6.16
Odonata	Corduliidae	Neurocordulia	5.03
Odonata	Corduliidae	Somatochlora	9.15
Odonata	Corduliidae	Und. spp.	6.6
Odonata	Gomphidae	Dromogomphus	5.92
Odonata	Gomphidae	Gomphus	5.8
Odonata	Gomphidae	Hagenius	3.99
Odonata	Gomphidae	Lanthus	1.77
Odonata	Gomphidae	Ophiogomphus	5.54

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Odonata	Gomphidae	Progomphus	8.22
Odonata	Gomphidae	Stylogomphus	4.72
Odonata	Gomphidae	Stylurus	5.8
Odonata	Gomphidae	Und. spp.	5
Odonata	Lestidae	Lestes	9.42
Odonata	Libellulidae	Erythemis	9.72
Odonata	Libellulidae	Libellula	9.64
Odonata	Libellulidae	Nannothemis	9
Odonata	Libellulidae	Pachydiplax	9.86
Odonata	Libellulidae	Perithemis	9.85
Odonata	Libellulidae	Und. spp.	6.7
Plecoptera	Capniidae	Allocapnia	2.52
Plecoptera	Capniidae	Paracapnia	0.12
Plecoptera	Capniidae	Und. spp.	0.9
Plecoptera	Chloroperlidae	Alloperla	1.22
Plecoptera	Chloroperlidae	Haploperla	0.98
Plecoptera	Chloroperlidae	Rasvena	1
Plecoptera	Chloroperlidae	Sweltsa	0
Plecoptera	Chloroperlidae	Und. spp.	0.7
Plecoptera	Leuctridae	Leuctra	0.67
Plecoptera	Leuctridae	Paraleuctra	0.67
Plecoptera	Leuctridae	Und. spp.	0.2
Plecoptera	Nemouridae	Amphinemura	3.33
Plecoptera	Nemouridae	Soyedina	0
Plecoptera	Nemouridae	Und. spp.	1.2
Plecoptera	Peltoperlidae	Peltoperla	4.2
Plecoptera	Peltoperlidae	Tallaperla	1.18
Plecoptera	Peltoperlidae	Viehoperla	2.7
Plecoptera	Peltoperlidae	Und. spp.	3
Plecoptera	Perlidae	Acroneuria	1.47
Plecoptera	Perlidae	Agnetina	0
Plecoptera	Perlidae	Attaneuria	0
Plecoptera	Perlidae	Beloneuria	0
Plecoptera	Perlidae	Eccoptura	3.74
Plecoptera	Perlidae	Neoperla	1.49
Plecoptera	Perlidae	Paragnetina	1.54
Plecoptera	Perlidae	Perlesta	4.7
Plecoptera	Perlidae	Perlinella	0.63
Plecoptera	Perlidae	Und. spp.	1.5
Plecoptera	Perlodidae	Cultus	1.57
Plecoptera	Perlodidae	Diploperla	2.06
Plecoptera	Perlodidae	Diura	2

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Plecoptera	Perlodidae	Helopicus	0.41
Plecoptera	Perlodidae	Hydroperla	1.6
Plecoptera	Perlodidae	Isogenoides	0.54
Plecoptera	Perlodidae	Isoperla	1.5
Plecoptera	Perlodidae	Malirakus	1.15
Plecoptera	Perlodidae	Remenus	0.2
Plecoptera	Perlodidae	Yugus	0
Plecoptera	Perlodidae	Und. spp.	1.6
Plecoptera	Pteronarcyidae	Pteronarcys	1.67
Plecoptera	Taeniopterygidae	Oemopteryx	1
Plecoptera	Taeniopterygidae	Taenionema	2
Plecoptera	Taeniopterygidae	Taeniopteryx	5.37
Plecoptera	Taeniopterygidae	Und spp.	2.7
Rhynchobdellida	Glossiphoniidae	Helobdella	9.1
Rhynchobdellida	Glossiphoniidae	Mooreobdella	9.43
Rhynchobdellida	Glossiphoniidae	Placobdella	9
Trichoptera	Apataniidae	Apatania	0.64
Trichoptera	Brachycentridae	Brachycentrus	2.08
Trichoptera	Brachycentridae	Micrasema	0.56
Trichoptera	Calamoceratidae	Anisocentropus	0.85
Trichoptera	Calamoceratidae	Heteroplectron	3.23
Trichoptera	Dipseudopsidae	Phylocentropus	6.2
Trichoptera	Glossosomatidae	Agapetus	0
Trichoptera	Glossosomatidae	Glossosoma	1.55
Trichoptera	Glossosomatidae	Matrioptila	0
Trichoptera	Glossosomatidae	Und. spp.	1
Trichoptera	Goeridae	Goera	0.13
Trichoptera	Goeridae	Goerita	0
Trichoptera	Helicopsychidae	Helicopsyche	0
Trichoptera	Hydropsychidae	Arctopsyche	0
Trichoptera	Hydropsychidae	Ceratopsyche	3.11
Trichoptera	Hydropsychidae	Cheumatopsyche	6.22
Trichoptera	Hydropsychidae	Diplectrona	2.21
Trichoptera	Hydropsychidae	Hydropsyche	4.3
Trichoptera	Hydropsychidae	Macrostemum	3.52
Trichoptera	Hydropsychidae	Parapsyche	0
Trichoptera	Hydropsychidae	Und. spp.	4
Trichoptera	Hydroptilidae	Agraylea	2
Trichoptera	Hydroptilidae	Hydroptila	6.22
Trichoptera	Hydroptilidae	Leucotrichia	4.06
Trichoptera	Hydroptilidae	Mayatrichia	0
Trichoptera	Hydroptilidae	Neotrichia	0

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Trichoptera	Hydroptilidae	Ochrotrichia	3.95
Trichoptera	Hydroptilidae	Orthotrichia	8.29
Trichoptera	Hydroptilidae	Oxyethira	2.22
Trichoptera	Hydroptilidae	Und. spp.	4
Trichoptera	Lepidostomatidae	Lepidostoma	0.9
Trichoptera	Lepidostomatidae	Theliopsyche	0
Trichoptera	Lepidostomatidae	Und. spp.	0.9
Trichoptera	Leptoceridae	Ceraclea	2.01
Trichoptera	Leptoceridae	Mystacides	2.69
Trichoptera	Leptoceridae	Nectopsyche	2.94
Trichoptera	Leptoceridae	Oecetis	4.7
Trichoptera	Leptoceridae	Setodes	0
Trichoptera	Leptoceridae	Triaenodes	4.46
Trichoptera	Leptoceridae	Und. spp.	2.7
Trichoptera	Limnephilidae	Hesperophylax	5.0
Trichoptera	Limnephilidae	Hydatophylax	2.17
Trichoptera	Limnephilidae	Ironoquia	7.78
Trichoptera	Limnephilidae	Limnephilus	2
Trichoptera	Limnephilidae	Pycnopsyche	2.52
Trichoptera	Limnephilidae	Und. spp.	2
Trichoptera	Molannidae	Molanna	4.27
Trichoptera	Odontoceridae	Psilotreta	0
Trichoptera	Philopotamidae	Chimarra	2.76
Trichoptera	Philopotamidae	Dolophilodes	0.81
Trichoptera	Philopotamidae	Wormaldia	0.65
Trichoptera	Philopotamidae	Und. spp.	1.4
Trichoptera	Phryganeidae	Ptilostomis	6.37
Trichoptera	Polycentropodidae	Cernotina	4
Trichoptera	Polycentropodidae	Cyrnellus	7.34
Trichoptera	Polycentropodidae	Neureclipsis	4.19
Trichoptera	Polycentropodidae	Polycentropus	3.53
Trichoptera	Polycentropodidae	Und. spp.	4
Trichoptera	Psychomyiidae	Lype	4.05
Trichoptera	Psychomyiidae	Psychomyia	2.44
Trichoptera	Psychomyiidae	Und. spp.	3.2
Trichoptera	Rhyacophilidae	Rhyacophila	0.73
Trichoptera	Sericostomatidae	Agarodes	0.69
Trichoptera	Uenoidae	Neophylax	2.2
Tricladida	Planaridae	Cura	4.97
Tricladida	Planaridae	Dugesia	7.23
Tricladida	Planaridae	Und. spp.	6.1
Tubificida	Enchytraeidae	Und. spp.	9.84

Order	Family	Genus	NCBI
Tubificida	Naididae	Bratislavia	6
Tubificida	Naididae	Chaetogaster	4
Tubificida	Naididae	Dero	10
Tubificida	Naididae	Haemonais	4
Tubificida	Naididae	Nais	8.88
Tubificida	Naididae	Ophidonais	2
Tubificida	Naididae	Pristina	9.56
Tubificida	Naididae	Pristinella	7.74
Tubificida	Naididae	Slavina	7.06
Tubificida	Naididae	Specaria	4
Tubificida	Naididae	Stephensoniana	4
Tubificida	Naididae	Stylaria	9.38
Tubificida	Naididae	Und. spp.	6.1
Tubificida	Tubificidae	Aulodrilus	4.63
Tubificida	Tubificidae	Branchiura	8.28
Tubificida	Tubificidae	Ilyodrilus	9.26
Tubificida	Tubificidae	imm. w. cap. cht.	7.11
Tubificida	Tubificidae	imm. w/o cap. cht.	9.5
Tubificida	Tubificidae	Limnodrilus	9.5
Tubificida	Tubificidae	Quistadrilus	3.86
Tubificida	Tubificidae	Spirosperma	5.3
Tubificida	Tubificidae	Tubifex	10
Veneroida	Corbiculidae	Corbicula	6.12
Veneroida	Sphaeriidae	Eupera	5.73
Veneroida	Sphaeriidae	Pisidium	6.48
Veneroida	Sphaeriidae	Sphaerium	7.58
Veneroida	Sphaeriidae	Und. spp.	6.6

LIST OF CLINGER ORGANISMS

Order	Family	Genus
Coleoptera	Dryopidae	Helichus
Coleoptera	Elmidae	Ancyronyx
Coleoptera	Elmidae	Dubiraphia
Coleoptera	Elmidae	Macronychus
Coleoptera	Elmidae	Microcylloepus
Coleoptera	Elmidae	Optioservus
Coleoptera	Elmidae	Oulimnius
Coleoptera	Elmidae	Promoresia
Coleoptera	Elmidae	Stenelmis
Coleoptera	Hydrophilidae	Sperchopsis
Coleoptera	Psephenidae	Ectopria
Coleoptera	Psephenidae	Psephenus
Coleoptera	Ptilodactylidae	Anchytarsus
Coleoptera	Staphylinidae	Bledius
Coleoptera	Staphylinidae	Carpelimus
Diptera	Blephariceridae	Blepharicera
Diptera	Chironomidae	Cricotopus
Diptera	Chironomidae	Endochironomus
Diptera	Chironomidae	Microtendipes
Diptera	Chironomidae	Paralauterborniella
Diptera	Chironomidae	Phaenopsectra
Diptera	Chironomidae	Rheotanytarsus
Diptera	Empididae	Clinocera
Diptera	Nymphomyiidae	Nymphomyia
Diptera	Simuliidae	Cnephia
Diptera	Simuliidae	Prosimulium
Diptera	Simuliidae	Simulium
Diptera	Simuliidae	Und. spp.
Diptera	Tipulidae	Antocha
Ephemeroptera	Ephemerellidae	Attenella
Ephemeroptera	Ephemerellidae	Drunella
Ephemeroptera	Ephemerellidae	Ephemerella
Ephemeroptera	Ephemerellidae	Eurylophella
Ephemeroptera	Ephemerellidae	Serratella
Ephemeroptera	Ephemerellidae	Und. spp.

Order	Family	Genus
Ephemeroptera	Heptageniidae	Cinygmula
Ephemeroptera	Heptageniidae	Epeorus
Ephemeroptera	Heptageniidae	Heptagenia
Ephemeroptera	Heptageniidae	Leucrocuta
Ephemeroptera	Heptageniidae	Nixe
Ephemeroptera	Heptageniidae	Rithrogena
Ephemeroptera	Heptageniidae	Stenacron
Ephemeroptera	Heptageniidae	Stenonema
Ephemeroptera	Heptageniidae	Und. spp.
Ephemeroptera	Leptophlebiidae	Choroterpes
Lepidoptera	Pyralidae	Petrophila
Megaloptera	Corydalidae	Chauliodes
Megaloptera	Corydalidae	Corydalus
Megaloptera	Corydalidae	Nigronia
Odonata	Coenagrionidae	Argia
Plecoptera	Capniidae	Allocapnia
Plecoptera	Chloroperlidae	Alloperla
Plecoptera	Chloroperlidae	Haploperla
Plecoptera	Chloroperlidae	Sweltsa
Plecoptera	Leuctridae	Leuctra
Plecoptera	Peltoperlidae	Peltoperla
Plecoptera	Peltoperlidae	Tallaperla
Plecoptera	Peltoperlidae	Viehoperla
Plecoptera	Peltoperlidae	Und. spp.
Plecoptera	Perlidae	Acroneuria
Plecoptera	Perlidae	Agnetina
Plecoptera	Perlidae	Beloneuria
Plecoptera	Perlidae	Eccoptura
Plecoptera	Perlidae	Neoperla
Plecoptera	Perlidae	Paragnetina
Plecoptera	Perlidae	Perlesta
Plecoptera	Perlidae	Perlinella
Plecoptera	Perlidae	Und. spp.
Plecoptera	Perlodidae	Cultus
Plecoptera	Perlodidae	Diploperla
Plecoptera	Perlodidae	Diura
Plecoptera	Perlodidae	Helopicus

Order	Family	Genus
Plecoptera	Perlodidae	Hydroperla
Plecoptera	Perlodidae	Isogenoides
Plecoptera	Perlodidae	Isoperla
Plecoptera	Perlodidae	Remenus
Plecoptera	Perlodidae	Yugus
Plecoptera	Perlodidae	Und spp.
Plecoptera	Pteronarcyidae	Pteronarcys
Trichoptera	Apataniidae	Apatania
Trichoptera	Brachycentridae	Brachycentrus
Trichoptera	Brachycentridae	Micrasema
Trichoptera	Glossosomatidae	Agapetus
Trichoptera	Glossosomatidae	Glossosoma
Trichoptera	Glossosomatidae	Matrioptila
Trichoptera	Glossosomatidae	Und. spp.
Trichoptera	Goeridae	Goera
Trichoptera	Goeridae	Goerita
Trichoptera	Helicopsychidae	Helicopsyche
Trichoptera	Hydropsychidae	Arctopsyche
Trichoptera	Hydropsychidae	Ceratopsyche
Trichoptera	Hydropsychidae	Cheumatopsyche
Trichoptera	Hydropsychidae	Diplectrona
Trichoptera	Hydropsychidae	Hydropsyche
Trichoptera	Hydropsychidae	Macrostemum
Trichoptera	Hydropsychidae	Parapsyche
Trichoptera	Hydropsychidae	Und. spp.
Trichoptera	Hydroptilidae	Hydroptila
Trichoptera	Hydroptilidae	Leucotrichia
Trichoptera	Hydroptilidae	Mayatrichia
Trichoptera	Hydroptilidae	Neotrichia
Trichoptera	Hydroptilidae	Ochrotrichia
Trichoptera	Hydroptilidae	Orthotrichia
Trichoptera	Leptoceridae	Oecetis
Trichoptera	Leptoceridae	Setodes
Trichoptera	Philopotamidae	Chimarra
Trichoptera	Philopotamidae	Dolophilodes
Trichoptera	Philopotamidae	Wormaldia
Trichoptera	Philopotamidae	Und. spp.

Order	Family	Genus
Trichoptera	Polycentropodidae	Cernotina
Trichoptera	Polycentropodidae	Cyrnellus
Trichoptera	Polycentropodidae	Neureclipsis
Trichoptera	Polycentropodidae	Polycentropus
Trichoptera	Polycentropodidae	Und. spp.
Trichoptera	Psychomyiidae	Lype
Trichoptera	Psychomyiidae	Psychomyia
Trichoptera	Rhyacophilidae	Rhyacophila
Trichoptera	Uenoidae	Neophylax

APPENDIX D

TAXONOMIC INFORMATION

GENUS LEVEL TAXONOMIC KEYS
TAXONOMIC SPECIALISTS FOR REFERENCE VERIFICATION

GENUS LEVEL TAXONOMIC KEYS
(Primary Key for each group is listed first)

TURBELLARIA

Kenk, R. 1972. *Freshwater Planarians (Turbellaria) of North America*. EPA-WPCRS, 18050/ELD 02/72. Supt. Doc. No. 5501-0365. Washington, D.C.

MOLLUSCA

Gastropoda

Burch, J.B. 1982. *Freshwater Snails (Mollusca: Gastropoda) of North America*. Washington, D.C.: Government Printing Office, EPA Publications. Washington, D.C.

Thorp A.P. and A.P. Covich (eds.) 1991. *Ecology and Classification of North American Freshwater Invertebrates*. Academic Press, Inc., San Diego, Ca.

Bivalvia

Burch, J.B. 1972. *Freshwater Sphariacean clams (Mollusca: Pelecypoda) of North America*. EPA-WPCRS 18050, ELD03/72. Supt. Doc. No. 5501-0367. Washington, D.C.

Thorp A.P. and A.P. Covich (eds.) 1991. *Ecology and Classification of North American Freshwater Invertebrates*. Academic Press, Inc., San Diego, Ca

Starnes, L.B. and A.E. Bogan. 1988. *The Mussels (Mollusca: Bivalvia: Unionidae) of Tennessee*. Amer. Malacological Bull. 6:19-38.

ANNELIDA

Tubificidae and Naididae

Brinkhurst, R.O. 1986 *Guide to the Freshwater Aquatic Microdrile Oligochaetes of North America*. Buchanan Printers, Winnipeg, Man., Canada. 259 pp.

Other Oligochaetes & Branchiobdellida

Thorp, A.P. and A.P. Covich (eds.) 1991. *Ecology and Classification of North American Freshwater Invertebrates*. Academic Press, Inc., San Diego, Ca.

Hirudinea

Klemm, D. J. 1985. *A Guide to the Freshwater Annelida (Polychaeta, Naidid and Tubificid Oligocahaeta, and Hirudinea) of North America*. Kendall/Hunt Publ. Co., Dubuque, Ia.

CRUSTACEA

Amphipoda

Thorp, A.P. and A.P. Covich (eds.) 1991. *Ecology and Classification of North American Freshwater Invertebrates*. Academic Press, Inc., San Diego, Ca.

Decapoda

Hobbs, H.H., Jr. 1972 *Crayfishes (Astacidae) of North and Middle America*. EPA-WPCRS No. 18050, ELD05/72. Supt. Doc. No. 5501-0399, Washington, D.C. 173 pp.

Isopoda

Williams, W.D. 1972. *Freshwater Isopods (Asellidae) of North America*. EPA-WPCRS No. 18050 ELD05/72. Supt. Doc. No. 5501-0390. Washington, D.C. 45 pp.

INSECTA

Collembola

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia.

Ephemeroptera

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia.

McCafferty W.P. 1990. *Revisionary Synopsis of the Baetidae (Ephemeroptera of North and Middle America.* Trans. Amer. Entomol. Soc. 105(2):139-221

Brigham, A.R., W.V. Brigham and A. Gnilka (eds.). 1982. *Aquatic Insects and Oligochaetes of North and South Carolina*. Midwest Aquatic Enterprises, Mahomet, Ill.

Plecoptera

Stewart, K.W. and B.P. Stark. 1988. *Nymphs of North American Stonefly genera (Plecoptera)*. Monograph 12. Thomas Say Foundation. 460 pp.

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia.

Odonata

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia.

Louton, J. A. 1985. *Lotic Dragonfly (Anisoptera: Odonata) Nymphs of the Southeastern United States: Identification, Distribution and Historical Biogeography*. University Microfilms International. Ann Arbor, Me.

Needham, J. G. and M.J. Westfall, Jr. 1955. *A Manual of the Dragonflies of North America (Anisoptera)*. Univ. California Press, Berkeley. 615 pp.

Hemiptera

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia.

Brigham A.R., W.V. Brigham and A. Gnilka (eds.). 1982. *Aquatic Insects and Oligochaetes of North and South Carolina*. Midwest Aquatic Enterprises, Mahomet, Ill.

Megaloptera

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia.

Trichoptera

Wiggins, G. B. 1996. *Larvae of the North American Caddisfly Genera (Trichoptera)*. 2nd ed. Univ. Toronto Press, Canada.

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia.

Lepidoptera

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia.

Brigham A.R. and D.D. Herlong. Aquatic and Semi-Aquatic Lepidoptera. pp. 12.5-12.36 in in A.R. Brigham, W.V. Brigham, and A. Gnilka (eds.). Aquatic Insects and Oligochaetes of North and South Carolina. Midwest Aquatic Enterprises, Mahomet, Ill.

Coleoptera

White, D.S. and W.U. Brigham. 1996. "Aquatic Coleoptera" pp. 399-473 in Merritt, R.W. and K.W. Cummins (eds.). 3rd Edition. An Introduction to the Aquatic Insects of North America. Kendall and Hunt Publishing Co., Dubuque, Ia.

Brigham, A.R., W.V. Brigham and A. Gnilka (eds.). 1982. *Aquatic Insects and Oligochaetes of North and South Carolina*. Midwest Aquatic Enterprises, Mahomet, Ill.

Diptera

Chironomidae

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia.

Epler, J.H. 2001. *Identification Manual for the Larval Chironomidae (Diptera) of North and South Carolina.* North Carolina Department of Environment and Natural Resources, Raleigh, NC.

Epler, J.H. 1995 (Rev.). *Identification Manual for the Larval Chironomidae (Diptera) of Florida*. Florida Dept. Env. Prot., Tallahassee.

Wiederholm, T. (ed.) 1983. *Chironomidae of the Holarctic Region. Keys and Diagnoses. Part 1: Larvae*. Suppl. 19, Entomological Scandinavica. 457 pp.

Wiederholm, T. (ed.). 1986. *Chironomidae of the Holarctic Region. Keys and Diagnoses. Part 2: Pupae*. Suppl. 28. Entomologica Sandinavica. 457 pp.

Other Diptera Families

Merritt, R.W. and K.W. Cummins (eds.). 1996. 3rd Edition. *An Introduction to the Aquatic Insects of North America*. Kendall and Hunt Publishing Co., Dubuque, Ia

TAXONOMIC SPECIALISTS USED FOR REFERENCE VERIFICATIONS

Oligochaeta

Michael R. Milligan
Center for Systematics and Taxonomy
P.O. Box 37534
Sarasota, FL 34278
mydrilus@aol.com
941-365-5540
(Private Consulting)
Fee: $150 / 38 slides, Turnaround 60 days

Decapoda

Horton H. Hobbs, III, PhD
Wittenberg University Department of Biology
Springfield, OH 45501-0720
email: hhobbs@wittenberg.edu
(University professor, author USEPA identification manual)
No fee

Mollusca

Art Bogan, PhD
N.C. State Museum of Natural Sciences
102 N. Salisbury St.
Raleigh, NC 27626
919-733-7450
(State museum curator)
No fee

Odonata

Ken J. Tennessen, PhD
1949 Hickory Ave.
Florence, AL 35630
256-766-6970
(Private Consulting, Co-author of Odonata Key, Merritt and Cummins, 3rd.)
Fee: $40 / hr (26 specimens), Turnaround 11 days

Megaloptera

Don C. Tarter, PhD
Marshall University Department of Biological Science
400 Hal Greer Blvd.
Huntington, WV 25755-2510
304-696-5413
(University professor)
No fee, Turnaround 15 days

Hemiptera

Cecil L. Smith, PhD
Associate Curator, Entomology Collection
The University of Georgia Museum of Natural History
Natural History Building
Athens, GA 30602-1882
706-542-2407
(University museum curator)
No fee, Turnaround 60 days

Coleoptera

Paul J. Spangler, PhD
Dept. of Entomology
National Museum of Natural History, Smithsonian Institute
Washington, D.C. 20560-0169
202-357-2061
(Federal museum curator)
No fee

Paul K. Lago, PhD
The University of Mississippi
Biology Department
University, MS 38677
601-232-7203
` No fee, hydrophilids only (13 taxa), Turnaround 8 days

Ephemeroptera

Boris C. Kondratieff, PhD
Dept. of Bioagricultural Sciences and Pest Management
Colorado State University
Fort Collins, Co 80523
(University professor)
No fee, Turnaround 30 day

Plecoptera

Ken W. Stewart, PhD
University of North Texas
P.O. Box 305220
Denton, TX 76203-5220
stewart@unt.edu
940-565-3618
(University professor, co-author Plecoptera key, Merritt and Cummins, 3rd ed.)
Fee: $300 / 31 taxa, Turnaround 30 days

Trichoptera

John C. Morse, PhD
Department of Entomology, Clemson University
Long Hall
Box 340365
Clemson, SC 29634-0365
jmorse@clemson.edu
864-656-5049
(University professor, co-author Trichoptera key, Merritt and Cummins, 3rd ed.)
Fee from Grad. Student: $25 / hr.($125 for 58 taxa)
Turnaround 180 days

Lepidoptera

M. Alma Solis, John W. Brown, Michael G. Pogue
Systematic Entomology Laboratory, Communications & Taxonomic Services Unit
Bldg. 046, Rm. 101, BARC-West
10300 Baltimore Avenue
Beltsville, MD 20705-2350
301-504-7041
(Federal Entomology lab, USDA)
No fee within reason, Turnaround 100 days

Chironomidae

John H. Epler, PhD
461 Tiger Hammock Rd.
Crawfordville, FL 32327
johneplr@freenet.tlh.fl.us
850-926-3700
(Private consulting, author of Identification Manual for the Larval Chironomidae of Florida)
Fee: $85 - 100 /hr or $20 - 25 /taxon, Turnaround 35 days

Simuliidae

Robert V. Peterson (Ret.)
Systematic Entomology Laboratory CTSU
Bldg. 046, BARC-West
10300 Baltimore Ave
Beltsville, MD 20705-2350
301-504-7041
(Federal entomology lab, USDA, author of Simuliidae key, Merritt and Cummins, 3rd ed.)
No fee within reason, Turnaround 100 days

Ceratopogonidae

William L. Grogan, PhD
Salilsbury State College , MD
Cooperating Scientist for Systematic Entomology Lab., CTSU
Bldg. 046, BARC-West
10300 Baltimore Ave.
Beltsville, MD 20705-2350
(Federal entomology lab, USDA)
No fee within reason, Turnaround 120 days

Steve Murphee, PhD
Dept. of Biology, Belmont University
Nashville, TN 37212-3757
murphrees@belmont.edu
615-386-4400

Empididae and **Stratiommyidae**

Norman E. Woodley
Systematic Entomology Lab, CTSU
Bldg. 046, BARC-West
10300 Baltimore Ave.
Beltsville, MD 20705-2350
(Federal entomology lab, USDA)
No fee within reason, Turnaround 100 days

Athericidae, Blephariceridae, Dixidae, Ephydridae, Psychodidae, Sciomyzidae

No specialists available.

APPENDIX E

VERIFIED TAXA LIST

VERIFIED TAXA LIST

Order	Family	Genus
Acarina	Acarina	Acarina
Aelosomatida	Aelosomatidae	Aelosoma
Amphipoda	Crangonyctidae	Crangonyx
Amphipoda	Crangonyctidae	Stygobromus
Amphipoda	Gammaridae	Gammarus
Amphipoda	Hyalellidae	Hyalella
Branchiobdellida	Branchiobdellida	Branchiobdellida
Cladocera	Daphniidae	Simocephalus
Coleoptera	Anthicidae	Anthicidae
Coleoptera	Carabidae	Und. spp.
Coleoptera	Chrysomelidae	Und. spp.
Coleoptera	Curculionidae	Onychylis
Coleoptera	Curculionidae	Pnigodes
Coleoptera	Curculionidae	Tanysphyrus
Coleoptera	Dryopidae	Helichus
Coleoptera	Dryopidae	Pelonomus
Coleoptera	Dytiscidae	Acilius
Coleoptera	Dytiscidae	Agabetes
Coleoptera	Dytiscidae	Agabus
Coleoptera	Dytiscidae	Copelatus
Coleoptera	Dytiscidae	Coptotomus
Coleoptera	Dytiscidae	Desmopachria
Coleoptera	Dytiscidae	Hydaticus
Coleoptera	Dytiscidae	Hydroporus
Coleoptera	Dytiscidae	Hydrovatus
Coleoptera	Dytiscidae	Hygrotus
Coleoptera	Dytiscidae	Laccodytes
Coleoptera	Dytiscidae	Laccophilus
Coleoptera	Dytiscidae	Liodessus
Coleoptera	Dytiscidae	Lioporus
Coleoptera	Dytiscidae	Neoporus
Coleoptera	Dytiscidae	Rhantus
Coleoptera	Dytiscidae	Uvarus
Coleoptera	Elmidae	Ancyronyx
Coleoptera	Elmidae	Dubiraphia

Order	Family	Genus
Coleoptera	Elmidae	Gonielmis
Coleoptera	Elmidae	Macronychus
Coleoptera	Elmidae	Microcylloepus
Coleoptera	Elmidae	Optioservus
Coleoptera	Elmidae	Oulimnius
Coleoptera	Elmidae	Promoresia
Coleoptera	Elmidae	Stenelmis
Coleoptera	Gyrinidae	Dineutus
Coleoptera	Gyrinidae	Gyrinus
Coleoptera	Haliplidae	Haliplus
Coleoptera	Haliplidae	Peltodytes
Coleoptera	Helophoridae	Helophorus
Coleoptera	Hydraenidae	Hydraena
Coleoptera	Hydrophilidae	Berosus
Coleoptera	Hydrophilidae	Dibolocelus
Coleoptera	Hydrophilidae	Helochares
Coleoptera	Hydrophilidae	Helocombus
Coleoptera	Hydrophilidae	Hydrobiomorpha
Coleoptera	Hydrophilidae	Hydrobius
Coleoptera	Hydrophilidae	Hydrochus
Coleoptera	Hydrophilidae	Hydrophilus
Coleoptera	Hydrophilidae	Laccobius
Coleoptera	Hydrophilidae	Paracymus
Coleoptera	Hydrophilidae	Sperchopsis
Coleoptera	Hydrophilidae	Tropisternus
Coleoptera	Hydroptilidae	Enochrus
Coleoptera	Noteridae	Hydrocanthus
Coleoptera	Noteridae	Suphisellus
Coleoptera	Psephenidae	Ectopria
Coleoptera	Psephenidae	Psephenus
Coleoptera	Ptilodactylidae	Anchytarsus
Coleoptera	Scirtidae	Cyphon
Coleoptera	Scirtidae	Elodes
Coleoptera	Scirtidae	Prionocyphon
Coleoptera	Scirtidae	Scirtes
Coleoptera	Staphylinidae	Bledius
Coleoptera	Staphylinidae	Carpelimus

Order	Family	Genus
Coleoptera	Staphylinidae	Psephidonus
Coleoptera	Staphylinidae	Staphylinidae
Coleoptera	Staphylinidae	Stenus
Coleoptera	Staphylinidae	Thinobius
Collembola	Enromobryidae	Sinella
Collembola	Entomobryidae	Entomobrya
Collembola	Isotomatidae	Hydroistoma
Collembola	Isotomidae	Agrenia
Collembola	Isotomidae	Isotomurus
Collembola	Onychiuridae	Onychiurus
Collembola	Poduridae	Podura
Collembola	Sminthuridae	Dicyrtoma
Collembola	Sminthuridae	Sminthurides
Cyclopoida	Cyclopidae	Und. spp.
Decapoda	Cambaridae	Cambarus
Decapoda	Cambaridae	Orconectes
Decapoda	Cambaridae	Procambarus
Decapoda	Palaemonidae	Palamontes
Diptera	Athericidae	Atherix
Diptera	Blephariceridae	Blepharicera
Diptera	Ceratopogonidae	Alluaudomyia
Diptera	Ceratopogonidae	Atrichopogon
Diptera	Ceratopogonidae	Bezzia
Diptera	Ceratopogonidae	Bezzia/Palpomyia
Diptera	Ceratopogonidae	Ceratopogon
Diptera	Ceratopogonidae	Culicoides
Diptera	Ceratopogonidae	Dasyhelea
Diptera	Ceratopogonidae	Forcipomyia
Diptera	Ceratopogonidae	Mallochohelea
Diptera	Ceratopogonidae	Monohelea
Diptera	Ceratopogonidae	Probezzia
Diptera	Ceratopogonidae	Serromyia
Diptera	Ceratopogonidae	Sphaeromias
Diptera	Ceratopogonidae	Stilobezzia
Diptera	Chaoboridae	Mochlonyx
Diptera	Chironomidae	Ablabesmyia
Diptera	Chironomidae	Acampptocladius

Order	Family	Genus
Diptera	Chironomidae	Acricotopus
Diptera	Chironomidae	Alotanypus
Diptera	Chironomidae	Antillocladius
Diptera	Chironomidae	Apedilum
Diptera	Chironomidae	Apsectrotanypus
Diptera	Chironomidae	Axarus
Diptera	Chironomidae	Brillia
Diptera	Chironomidae	Brundiniella
Diptera	Chironomidae	Cardiocladius
Diptera	Chironomidae	Chaetocladius
Diptera	Chironomidae	Chernovkiia
Diptera	Chironomidae	Chironomus
Diptera	Chironomidae	Cladopelma
Diptera	Chironomidae	Cladotanytarsus
Diptera	Chironomidae	Clinotanypus
Diptera	Chironomidae	Coelotanypus
Diptera	Chironomidae	Conchapelopia
Diptera	Chironomidae	Constempellina
Diptera	Chironomidae	Corynoneura
Diptera	Chironomidae	Cricotopus/Orthocladius
Diptera	Chironomidae	Cricotopus
Diptera	Chironomidae	Cryptochironomus
Diptera	Chironomidae	Cryptotendipes
Diptera	Chironomidae	Demicryptochironomus
Diptera	Chironomidae	Diamesa
Diptera	Chironomidae	Dicrotendipes
Diptera	Chironomidae	Diplocladius
Diptera	Chironomidae	Djalmabatista
Diptera	Chironomidae	Doithrix
Diptera	Chironomidae	Einfeldia
Diptera	Chironomidae	Endochironomus
Diptera	Chironomidae	Endotribelos
Diptera	Chironomidae	Epoicocladius
Diptera	Chironomidae	Eukiefferiella
Diptera	Chironomidae	Euryhapsis
Diptera	Chironomidae	Glyptotendipes
Diptera	Chironomidae	Goeldichironomus

Order	Family	Genus
Diptera	Chironomidae	Harnischia
Diptera	Chironomidae	Hayesomyia
Diptera	Chironomidae	Heleniella
Diptera	Chironomidae	Helopelopia
Diptera	Chironomidae	Heterotrissocladius
Diptera	Chironomidae	Hydrobaenus
Diptera	Chironomidae	Kiefferulus
Diptera	Chironomidae	Krenopelopia
Diptera	Chironomidae	Krenosmittia
Diptera	Chironomidae	Labrundinia
Diptera	Chironomidae	Larsia
Diptera	Chironomidae	Lauterborniella
Diptera	Chironomidae	Lopescladius
Diptera	Chironomidae	Meropelopia
Diptera	Chironomidae	Mesosmittia
Diptera	Chironomidae	Metriocnemus
Diptera	Chironomidae	Micropsectra
Diptera	Chironomidae	Microtendipes
Diptera	Chironomidae	Nanocladius
Diptera	Chironomidae	Natarsia
Diptera	Chironomidae	Neozavrelia
Diptera	Chironomidae	Nilotanypus
Diptera	Chironomidae	Nilothauma
Diptera	Chironomidae	Omisus
Diptera	Chironomidae	Orthocladius
Diptera	Chironomidae	Pagastia
Diptera	Chironomidae	Parachaetocladius
Diptera	Chironomidae	Parachironomus
Diptera	Chironomidae	Paracladopelma
Diptera	Chironomidae	Paracricotopus
Diptera	Chironomidae	Parakiefferiella
Diptera	Chironomidae	Paralauterborniella
Diptera	Chironomidae	Paramerina
Diptera	Chironomidae	Parametriocnemus
Diptera	Chironomidae	Paraphaenocladius
Diptera	Chironomidae	Parapsectra
Diptera	Chironomidae	Paratanytarsus

Order	Family	Genus
Diptera	Chironomidae	Paratendipes
Diptera	Chironomidae	Parochlus
Diptera	Chironomidae	Pentaneura
Diptera	Chironomidae	Phaenopsectra
Diptera	Chironomidae	Platysmittia
Diptera	Chironomidae	Polypedilum
Diptera	Chironomidae	Potthastia
Diptera	Chironomidae	Procladius
Diptera	Chironomidae	Psectrocladius
Diptera	Chironomidae	Pseudochironomus
Diptera	Chironomidae	Pseudorthocladius
Diptera	Chironomidae	Pseudosmittia
Diptera	Chironomidae	Psilometriocnemus
Diptera	Chironomidae	Rheocricotopus
Diptera	Chironomidae	Rheopelopia
Diptera	Chironomidae	Rheosmittia
Diptera	Chironomidae	Rheotanytarsus
Diptera	Chironomidae	Robackia
Diptera	Chironomidae	Saetheria
Diptera	Chironomidae	Smittia
Diptera	Chironomidae	Stelechomyia
Diptera	Chironomidae	Stempellina
Diptera	Chironomidae	Stempellinella
Diptera	Chironomidae	Stenochironomus
Diptera	Chironomidae	Stictochironomus
Diptera	Chironomidae	Stilocladius
Diptera	Chironomidae	Sublettea
Diptera	Chironomidae	Symbiocladius
Diptera	Chironomidae	Symposiocladius
Diptera	Chironomidae	Synorthocladius
Diptera	Chironomidae	Tanypus
Diptera	Chironomidae	Tanytarsus
Diptera	Chironomidae	Thienemanniella
Diptera	Chironomidae	Thienemannimyia
Diptera	Chironomidae	Tribelos
Diptera	Chironomidae	Trissopelopia
Diptera	Chironomidae	Tvetenia

Order	Family	Genus
Diptera	Chironomidae	Unniella
Diptera	Chironomidae	Xenochironomus
Diptera	Chironomidae	Xestochironomus
Diptera	Chironomidae	Xylotopus
Diptera	Chironomidae	Zavrelia
Diptera	Chironomidae	Zavreliella
Diptera	Chironomidae	Zavrelimyia
Diptera	Chrironomidae	Limnophyes
Diptera	Culicidae	Aedes
Diptera	Culicidae	Anopheles
Diptera	Culicidae	Culex
Diptera	Dixidae	Dixa
Diptera	Dixidae	Dixella
Diptera	Dolichopodidae	
Diptera	Emphydridae	Scatella
Diptera	Empididae	Chelifera
Diptera	Empididae	Clinocera
Diptera	Empididae	Empididae
Diptera	Empididae	Hemerodromia
Diptera	Empididae	Trichoclinocera
Diptera	Ephydridae	Notiphila
Diptera	Muscidae	
Diptera	Nymphomyiidae	Nymphomyia
Diptera	Phoridae	Dohrniphora
Diptera	Phoridae	Phoridae
Diptera	Psychodidae	Pericoma/Telmatoscopus
Diptera	Psychodidae	Psychoda
Diptera	Ptychopteridae	Bittacomorpha
Diptera	Sciomyzidae	
Diptera	Simuliidae	Cnephia
Diptera	Simuliidae	Ectemnia
Diptera	Simuliidae	Prosimulium
Diptera	Simuliidae	Simulium
Diptera	Stratiomyidae	Allognosta
Diptera	Stratiomyidae	Caloparyphus
Diptera	Stratiomyidae	Myxosargus
Diptera	Stratiomyidae	Nemotelus

Order	Family	Genus
Diptera	Stratiomyidae	Odontomyia
Diptera	Stratiomyidae	Stratiomyidae
Diptera	Stratiomyidae	Stratiomys
Diptera	Syrphidae	Neoascia
Diptera	Tabanidae	Chlorotabanus
Diptera	Tabanidae	Chrysops
Diptera	Tabanidae	Diachlorus
Diptera	Tabanidae	Hybomitra
Diptera	Tabanidae	Tabanus
Diptera	Tanyderidae	Protoplasa
Diptera	Tipulidae	Antocha
Diptera	Tipulidae	Cryptolabis
Diptera	Tipulidae	Dactylolabis
Diptera	Tipulidae	Dicranota
Diptera	Tipulidae	Epiphragma
Diptera	Tipulidae	Erioptera
Diptera	Tipulidae	Gonomyia
Diptera	Tipulidae	Hexatoma
Diptera	Tipulidae	Limnophila
Diptera	Tipulidae	Limonia
Diptera	Tipulidae	Lipsothrix
Diptera	Tipulidae	Molophilus
Diptera	Tipulidae	Ormosia
Diptera	Tipulidae	Paradelphomyia
Diptera	Tipulidae	Pedicia
Diptera	Tipulidae	Pilaria
Diptera	Tipulidae	Pseudolimnophila
Diptera	Tipulidae	Rhabdomastix
Diptera	Tipulidae	Tipula
Entoprocta	Urnotellidae	Urnatella
Ephemeroptera	Ameletidae	Ameletus
Ephemeroptera	Baetidae	Acentrella
Ephemeroptera	Baetidae	Acerpenna
Ephemeroptera	Baetidae	Baetis
Ephemeroptera	Baetidae	Centroptilum
Ephemeroptera	Baetidae	Diphetor
Ephemeroptera	Baetidae	Fallceon

Order	Family	Genus
Ephemeroptera	Baetidae	Heterocloeon
Ephemeroptera	Baetidae	Labiobaetis
Ephemeroptera	Baetidae	Paracloeodes
Ephemeroptera	Baetidae	Plauditus
Ephemeroptera	Baetidae	Procloeon
Ephemeroptera	Baetiscidae	Baetisca
Ephemeroptera	Caenidae	Brachycercus
Ephemeroptera	Caenidae	Caenis
Ephemeroptera	Ephemerellidae	Attenella
Ephemeroptera	Ephemerellidae	Drunella
Ephemeroptera	Ephemerellidae	Ephemerella
Ephemeroptera	Ephemerellidae	Eurylophella
Ephemeroptera	Ephemerellidae	Serratella
Ephemeroptera	Ephemerellidae	Timpanoga
Ephemeroptera	Ephemeridae	Ephemera
Ephemeroptera	Ephemeridae	Hexagenia
Ephemeroptera	Heptageniidae	Cinygmula
Ephemeroptera	Heptageniidae	Epeorus
Ephemeroptera	Heptageniidae	Heptagenia
Ephemeroptera	Heptageniidae	Leucrocuta
Ephemeroptera	Heptageniidae	Nixe
Ephemeroptera	Heptageniidae	Rithrogena
Ephemeroptera	Heptageniidae	Stenacron
Ephemeroptera	Heptageniidae	Stenonema
Ephemeroptera	Isonychiidae	Isonychia
Ephemeroptera	Leotophlebiidae	Habrophlebia
Ephemeroptera	Leptophlebiidae	Choroterpes
Ephemeroptera	Leptophlebiidae	Habrophlebiodes
Ephemeroptera	Leptophlebiidae	Leptophlebia
Ephemeroptera	Leptophlebiidae	Neochoroterpes
Ephemeroptera	Leptophlebiidae	Paraleptophlebia
Ehemeroptera	Leptophyphidae	Tricorythodes
Ephemeroptera	Metropodidae	Siphloplecton
Ephemeroptera	Neoephemeridae	Neoephemera
Ephemeroptera	Polymitarcyidae	Ephoron
Ephemeroptera	Potamanthidae	Anthopotamus
Ephemeroptera	Siphlonuridae	Siphlonurus

Order	Family	Genus
Gordiida	Gordiidae	Gordius
Haplonemertea	Tertastemmatidae	Prostoma
Harpacticoida	Harpacticoida	Harpacticoida
Hemiptera	Belostomatidae	Belostoma
Hemiptera	Belostomatidae	Lethocerus
Hemiptera	Corixidae	Palmacorixa
Hemiptera	Corixidae	Sigara
Hemiptera	Corixidae	Trichocorixa
Hemiptera	Gelastocoridae	Gelastocoris
Hemiptera	Gerridae	Aquarius
Hemiptera	Gerridae	Gerris
Hemiptera	Gerridae	Limnoporus
Hemiptera	Gerridae	Metrobates
Hemiptera	Gerridae	Rheumatobates
Hemiptera	Gerridae	Trepobates
Hemiptera	Hebridae	Hebrus
Hemiptera	Hebridae	Lipogomphus
Hemiptera	Hydrometridae	Hydrometra
Hemiptera	Mesoveliidae	Mesovelia
Hemiptera	Nepidae	Ranatra
Hemiptera	Notonectidae	Bueno
Hemiptera	Notonectidae	Notonecta
Hemiptera	Pleidae	Neoplea
Hemiptera	Saldidae	Pentacora
Hemiptera	Veliidae	Microvelia
Hemiptera	Veliidae	Rhagovelia
Heterostropha	Valvatidae	Valvata
Hydroida	Hydridae	Hydra
Isopoda	Asellidae	Asellus
Isopoda	Asellidae	Caecidotea
Isopoda	Asellidae	Lirceus
Lepidoptera	Lepidoptera	Lepidoptera
Lepidoptera	Nepticulidae	
Lepidoptera	Noctuidae	Simyra
Lepidoptera	Noctuidae	
Lepidoptera	Pyralidae	Acentria
Lepidoptera	Pyralidae	Crambus

Order	Family	Genus
Lepidoptera	Pyralidae	Munroessa/Syncllita
Lepidoptera	Pyralidae	Petrophila
Lepidoptera	Pyralidae	Synclita
Lepidoptera	Tortricidae	Archips
Limnophila	Ancylidae	Ferrissia
Limnophila	Ancylidae	Laevapex
Limnophila	Lymnaeidae	Lymnaea
Limnophila	Lymnaeidae	Pseudosuccinea
Limnophila	Physidae	Physella
Limnophila	Planorbidae	Gyraulus
Limnophila	Planorbidae	Menetus
Limnophila	Planorbidae	Planorbella
Limnophila	Planorbidae	Planorbula
Lumbricida	Lumbricidae	
Lumbriculida	Lumbriculidae	Eclipidrilus
Lumbriculida	Lumbriculidae	Lumbriculus
Lymnophila	Lymnaeidae	Lymnaea
Lymnophila	Lymnaeidae	Stagnicola
Megaloptera	Corydalidae	Chauliodes
Megaloptera	Corydalidae	Corydalus
Megaloptera	Corydalidae	Nigronia
Megaloptera	Sialidae	Sialis
Mermithida	Mermithidae	Und. spp.
Mesogastropoda	Hydrobiidae	Und spp.
Mesogastropoda	Lymnaeidae	Fossaria
Mesogastropoda	Pleuroceridae	Elimia
Mesogastropoda	Pleuroceridae	Leptoxis
Mesogastropoda	Pleuroceridae	Pleurocera
Mesogastropoda	Valvatidae	Valvata
Mesogastropoda	Viviparidae	Campeloma
Mesogastropoda	Viviparidae	Viviparus
Mysidacea	Mysidae	Mysis
Neuroptera	Sisyridae	Sisyra
Odonata	Aeshnidae	Basiaeschna
Odonata	Aeshnidae	Boyeria
Odonata	Aeshnidae	Nasiaeschna
Odonata	Calopterygidae	Calopteryx

Order	Family	Genus
Odonata	Calopterygidae	Hetaerina
Odonata	Coenagrionidae	Amphiagrion
Odonata	Coenagrionidae	Argia
Chromagrion	Coenagrionidae	Chromagrion
Odonata	Coenagrionidae	Enallagma
Odonata	Coenagrionidae	Ischnura
Odonata	Cordulegastridae	Cordulegaster
Odonata	Corduliidae	Didymops
Odonata	Corduliidae	Epitheca
Odonata	Corduliidae	Helocordulia
Odonata	Corduliidae	Macromia
Odonata	Corduliidae	Neurocordulia
Odonata	Corduliidae	Somatochlora
Odonata	Gomphidae	Arigomphus
Odonata	Gomphidae	Dromogomphus
Odonata	Gomphidae	Gomphus
Odonata	Gomphidae	Hagenius
Odonata	Gomphidae	Lanthus
Odonata	Gomphidae	Ophiogomphus
Odonata	Gomphidae	Progomphus
Odonata	Gomphidae	Stylogomphus
Odonata	Gomphidae	Stylurus
Odonata	Lestidae	Lestes
Odonata	Libellulidae	Erythemis
Odonata	Libellulidae	Libellula
Odonata	Libellulidae	Nannothemis
Odonata	Libellulidae	Pachydiplax
Odonata	Libellulidae	Perithemis
Plecoptera	Capniidae	Allocapnia
Plecoptera	Capniidae	Paracapnia
Plecoptera	Chloroperlidae	Alloperla
Plecoptera	Chloroperlidae	Haploperla
Plecoptera	Chloroperlidae	Rasvena
Plecoptera	Chloroperlidae	Sweltsa
Plecoptera	Leuctridae	Leuctra
Plecoptera	Leuctridae	Paraleuctra
Plecoptera	Nemouridae	Amphinemura

Order	Family	Genus
Plecoptera	Nemouridae	Paranemoura
Plecoptera	Nemouridae	Soyedina
Plecoptera	Peltoperlidae	Peltoperla
Plecoptera	Peltoperlidae	Tallaperla
Plecoptera	Peltoperlidae	Viehoperla
Plecoptera	Perlidae	Acroneuria
Plecoptera	Perlidae	Agnetina
Plecoptera	Perlidae	Attaneuria
Plecoptera	Perlidae	Beloneuria
Plecoptera	Perlidae	Eccoptura
Plecoptera	Perlidae	Neoperla
Plecoptera	Perlidae	Paragnetina
Plecoptera	Perlidae	Perlesta
Plecoptera	Perlidae	Perlinella
Plecoptera	Perlodidae	Cultus
Plecoptera	Perlodidae	Diploperla
Plecoptera	Perlodidae	Diura
Plecoptera	Perlodidae	Helopicus
Plecoptera	Perlodidae	Hydroperla
Plecoptera	Perlodidae	Isogenoides
Plecoptera	Perlodidae	Isoperla
Plecoptera	Perlodidae	Malirakus
Plecoptera	Perlodidae	Perlodidae
Plecoptera	Perlodidae	Remenus
Plecoptera	Perlodidae	Yugus
Plecoptera	Pteronarcyidae	Pteronarcys
Plecoptera	Taeniopterygidae	Oemopteryx
Plecoptera	Taeniopterygidae	Taenionema
Plecoptera	Taeniopterygidae	Taeniopteryx
Podocopida	Podocopida	Podocopida
Rhynchobdellida	Glossiphoniidae	Helobdella
Rhynchobdellida	Glossiphoniidae	Mooreobdella
Rhynchobdellida	Glossiphoniidae	Placobdella
Trichoptera	Apataniidae	Apatania
Trichoptera	Beraeidae	Beraea
Trichoptera	Brachycentridae	Brachycentrus
Trichoptera	Brachycentridae	Micrasema

Order	Family	Genus
Trichoptera	Calamoceratidae	Anisocentropus
Trichoptera	Calamoceratidae	Heteroplectron
Trichoptera	Dipseudopsidae	Phylocentropus
Trichoptera	Glossosomatidae	Agapetus
Trichoptera	Glossosomatidae	Glossosoma
Trichoptera	Glossosomatidae	Matrioptila
Trichoptera	Goeridae	Goera
Trichoptera	Goeridae	Goerita
Trichoptera	Helicopsychidae	Helicopsyche
Trichoptera	Hydropsychidae	Arctopsyche
Trichoptera	Hydropsychidae	Ceratopsyche
Trichoptera	Hydropsychidae	Cheumatopsyche
Trichoptera	Hydropsychidae	Diplectrona
Trichoptera	Hydropsychidae	Hydropsyche
Trichoptera	Hydropsychidae	Macrostemum
Trichoptera	Hydropsychidae	Parapsyche
Trichoptera	Hydroptilidae	Agraylea
Trichoptera	Hydroptilidae	Hydroptila
Trichoptera	Hydroptilidae	Leucotrichia
Trichoptera	Hydroptilidae	Mayatrichia
Trichoptera	Hydroptilidae	Neotrichia
Trichoptera	Hydroptilidae	Ochrotrichia
Trichoptera	Hydroptilidae	Orthotrichia
Trichoptera	Hydroptilidae	Oxyethira
Trichoptera	Lepidostomatidae	Lepidostoma
Trichoptera	Lepidostomatidae	Theliopsyche
Trichoptera	Leptoceridae	Ceraclea
Trichoptera	Leptoceridae	Mystacides
Trichoptera	Leptoceridae	Nectopsyche
Trichoptera	Leptoceridae	Oecetis
Trichoptera	Leptoceridae	Setodes
Trichoptera	Leptoceridae	Triaenodes
Trichoptera	Limnephilidae	Hesperophylax
Trichoptera	Limnephilidae	Hydatophylax
Trichoptera	Limnephilidae	Ironoquia
Trichoptera	Limnephilidae	Limnephilus
Trichoptera	Limnephilidae	Pycnopsyche

Order	Family	Genus
Trichoptera	Molannidae	Molanna
Trichoptera	Odontoceridae	Psilotreta
Trichoptera	Philopotamidae	Chimarra
Trichoptera	Philopotamidae	Dolophilodes
Trichoptera	Philopotamidae	Wormaldia
Trichoptera	Phryganeidae	Ptilostomis
Trichoptera	Polycentropodidae	Cernotina
Trichoptera	Polycentropodidae	Cyrnellus
Trichoptera	Polycentropodidae	Neureclipsis
Trichoptera	Polycentropodidae	Paranyctiophylax
Trichoptera	Polycentropodidae	Polycentropus
Trichoptera	Psychomyiidae	Lype
Trichoptera	Psychomyiidae	Psychomyia
Trichoptera	Rhyacophilidae	Rhyacophila
Trichoptera	Sericostomatidae	Agarodes
Trichoptera	Sericostomatidae	Fattigia
Trichoptera	Uenoidae	Neophylax
Tricladida	Planaridae	Cura
Tricladida	Planaridae	Dugesia
Tricladida	Planaridae	Sphalloplana
Tubificida	Enchytraeidae	Und. spp.
Tubificida	Naididae	Bratislavia
Tubificida	Naididae	Chaetogaster
Tubificida	Naididae	Dero
Tubificida	Naididae	Haemonais
Tubificida	Naididae	Nais
Tubificida	Naididae	Ophidonais
Tubificida	Naididae	Piguetiella
Tubificida	Naididae	Pristina
Tubificida	Naididae	Pristinella
Tubificida	Naididae	Slavina
Tubificida	Naididae	Specaria
Tubificida	Naididae	Stephensoniana
Tubificida	Naididae	Stylaria
Tubificida	Tubificidae	Aulodrilus
Tubificida	Tubificidae	Branchiura
Tubificida	Tubificidae	Ilyodrilus

Order	Family	Genus
Tubificida	Tubificidae	Isochaetides
Tubificida	Tubificidae	Limnodrilus
Tubificida	Tubificidae	Quistadrilus
Tubificida	Tubificidae	Spirosperma
Tubificida	Tubificidae	Tubifex
Unionoida	Unionidae	Plectomerus
Urnatellida	Urnatellidae	Urnatella
Veneroida	Corbiculidae	Corbicula
Veneroida	Sphaeriidae	Eupera
Veneroida	Sphaeriidae	Pisidium
Veneroida	Sphaeriidae	Sphaerium
Veneroida	Unionidae	Alasmidonta