Chapter 11 Quality Assurance and Quality Control

Biological monitoring programs that contribute data to the TCEQ must conform to all quality assurance measures outlined in this chapter and all quality control measures outlined in the biological monitoring chapters of this document. These measures were developed with freshwater streams and rivers in mind, but may be modified to address other systems. Quality assurance of biological monitoring programs is accomplished through a number of measures, including a program's participation in technical systems audits (TSA), both in the field and laboratory and by a TCEQ-approved Quality Assurance Project Plan (QAPP).

Technical Systems Audits

TSAs are conducted on entities collecting biological data as resources allow. If it is determined that a TSA is needed for a TCEQ regional office, the TSA will be conducted separately from a TSA on other monitoring activities, such as routine monitoring. If it is determined that a TSA is needed for a CRP partner or other cooperator, a TSA is performed during that entity's contract period and may or may not be separate from other TSAs. TSAs consist of both field and laboratory audits and include inspection of records kept on file at the offices of the entity submitting biological data.

Biological Sample Records

Records that must be maintained and that must be kept available for inspection during a TSA include:

- Field notes containing sampling station location and number, date and time of collection, details of collection efforts including area and duration of sampling, raw counts of specimens collected, and photographs of any large specimens released after identification.
- Sample tracking log that details the event and sample information. Assign each sample a unique sample tracking number, such as BM 020 04—Benthic Macroinvertebrate, #020, year 2004.
- Laboratory identification notes and bench sheets. The laboratory bench sheet must contain the label information, unique sample tracking number from the sample logbook, date of identification, name of identifier, scientific name for each taxon, number of individuals in each taxon, and other comments that may pertain to identification.
- Appropriately labeled sample jars and voucher specimen jars. The sample label must contain the information required in the appropriate chapter of this manual for a biological specimen type.

- Final counts of organisms reported on the basis of individuals per unit area, volume, or sampling effort.
- Raw data used to produce final counts that serve as evidence of the method of calculation. These records include:
  - Sampling station location and number
  - Date and time of day of collection
  - Information on volume, area, effort and duration of the sampling
  - Raw counts used in the calculation of reported values
  - Verification that the data have been entered into a database or sent to the TCEQ SWQM Team

Training

Training in all aspects of biological monitoring are held every few years and will be available to TCEQ staff and other cooperators furnishing biological or habitat data to the TCEQ. These trainings will be a significant part of the QA for the biological monitoring program and will be required regardless of level of expertise. In other words, even experienced field biologists will be required to attend periodic trainings to ensure they are practicing current methodologies.

Approval of Deviation of Methods

Biological collection methods for wadeable streams are currently documented in this manual and any variation from those sampling protocols must be approved in advance. It is imperative that monitoring initiatives on water bodies that do not have prescribed protocols, such as reservoirs or tidal streams, be discussed at the beginning of study plan development with either TCEQ SWQM Team or WQST staff or with the TPWD. To ensure rigorous and skillful implementation of the procedures in this manual, the TCEQ (with assistance from the TPWD) will conduct a series of TSAs of personnel involved in the collection of biological data.

Sample Tracking Procedures

Proper sample custody is a joint effort of the sampling crew, sample transporter, and the laboratory staff (may include sorters and those performing taxa identification). The main sample documentation is an identifying data label, that includes:

- County
- River basin
- Stream name
- Station ID or location of nearest landmark (for example: a road crossing)
- Time and date of collection
- Collector names
- Collection methods used

- Type of preservative used

Place biological samples in jars with screw-top lids. Place the identifying data labels, written in either waterproof ink or pencil, in the sample jar.

Maintain a *sample tracking log* that contains the following for each sample:

- Unique sample tracking number
- Name of person entering information in sample tracking log
- Name of sample collector(s)
- Location of collection
- Date of collection
- Date entered in log
- Date identification and enumeration began
- Date identification and enumeration completed

For each sample, enter this information in the sample tracking log immediately upon returning to the lab. After completing the sample tracking log entries, inspect the sample label to ensure that the label is in good shape, legible, and includes the following information:

- Collector(s) name(s)
- Station location
- Station number if applicable
- Date and time of collection
- Collection method
- Preservative

Note: Replace the label if deterioration is apparent.

When identification and sorting begins, handle the collections individually, working only on a single sample at a time. Maintain a *laboratory bench sheet* for each sample that contains, at a minimum, the following information:

- Sample number from sample tracking log
- Name of identifier
- Location of collection
- Date of collection
- Date entered in log
- Date identification and enumeration began
- Date identification and enumeration completed
- Scientific name for each taxon in sample
- Number of individuals in each taxon

- ID qualifiers (difficulties)

Consistent with voucher specimen guidelines, maintain *separate specimen vials* for each taxon in the sample. Preserve specimens in 70 percent ethanol or isopropyl alcohol. Each vial must contain a label that includes the following information:

- Collector(s) name(s)
- Name of identifier(s)
- Station location
- Station number if applicable
- Date and time of collection
- Collection method
- Preservative
- Scientific name of taxon contained in vial

If it is necessary to make slide mounts of specimens (or parts of specimens) to examine them at higher magnification using the compound microscope in order to complete the identification, the slides must be labeled with the scientific name of the taxon, the initials of the identifier, and the sample number from the sample tracking log.

General Quality Assurance

To minimize misidentification of biological samples, the following steps will be taken:

Vouchers

Retain voucher specimens of all species of fishes and invertebrates as well as any algae samples and permanent diatom slides for a minimum of five years or until the conclusion of applicable regulatory decision (whichever is longer).

Voucher specimens serve as long-term physical representations that substantiate the names applied to organisms collected as part of the TCEQ SWQM Program. Voucher specimens ensure the credibility of TCEQ bioassessment data by documenting the identity of the organisms and making them available for review by the general scientific community.

Take the following into consideration when storing voucher specimens:

- Long-term maintenance of wet (alcohol-preserved) and mounted specimens
- Adequate quantity and quality of space to store specimens
- An effective mechanism for locating and retrieving specimens upon request
- Personnel experience in the specific area of taxonomy required

The organization maintaining voucher specimens must have a history that indicates it will be able to preserve the specimens into the future (USGS 2000). This could include in-house provisions for maintenance of samples or archiving at a natural history collection at a university.

Confirmation Checks

Confirmation of species identification and distribution may be performed as an aspect of biological QA. If samples checked against known distributional information determine that the species in question was collected outside of the known range where it would be expected to occur, then the collection should be reviewed and re-checked for other similar species. Where a species identification is in question, the collecting entity may send the specimen(s) to agency experts at either TCEQ or TPWD for confirmation.

Fish

Identification of Fish Assemblage Samples

The identification of fish assemblage samples to the species level requires taxonomic training and a familiarity with appropriate keys and literature. The validity of identifications affects the quality of community analyses and, frequently, the ALU designated for a stream. Consequently, only those with appropriate taxonomic training may perform species identifications.

Appropriate equipment must be available for laboratory determinations of biological specimens, including a dissecting microscope, an assortment of probes, dividers, a ruler, forceps, and appropriate taxonomic references. For the purposes of identifying Texas freshwater fishes, the primary reference is Hubbs et al. (1991), with complementary sources used as required.

Retention and Preservation of Fishes

Large, easily identified fishes may be counted in the field after all collection activity at a sampling location has been completed. This will necessitate maintaining the fishes in some type of holding bucket or tank with adequate aeration. Retain small fishes for positive identification in the laboratory. The standard preservative is 10 percent formalin (one part full-strength formalin to nine parts water). Place specimens in this preservative while still alive; those that die before preservation normally do not retain distinctive markings. Do not crowd fishes into bottles as the preservation will not be adequate. Slit larger specimens on the right side of the abdominal cavity to allow proper preservation.

Take care to avoid breathing or contact with formalin. Each field container must include an internal label that includes the date, collection locality, names of collector(s), and sampling method. This paper must be of a high rag content and notations must be in pencil or waterproof ink.

Equipment Requirements

Proper identification and enumeration of fish requires, at a minimum, the following equipment:

- Stereo dissecting microscope, total magnification variable 7x to 30x; recommended 7x to 110x
- Jeweler's forceps

- Petri dishes
- Preservative: 70 percent ethanol
- Ruler

Taxonomic Keys

(FW = Freshwater, SW = Salt water)

Required:

FW: Hubbs, C., R.J. Edwards, and G.P. Garrett. 1991. An annotated checklist of the freshwater fishes of Texas, with keys to identification of species. Tex J of Sci 43(4):1-56.

SW: Hoese H.D. and R.H. Moore. 1998. Fishes of the Gulf of Mexico—Texas, Louisiana, and Adjacent Waters. Texas A&M University Press. College Station, Texas.

Other recommended keys include:

FW: Douglas, N.H. 1974. *Freshwater Fishes of Louisiana*. Claitor's Publishing Division, Baton Rouge, Louisiana. 443 pp.

FW/SW: Hubbs, C., J.D. McEachran, C.R. Smith, and N.T. Travis, eds. 1994. *Freshwater and Marine Fishes of Texas and the Northwestern Gulf of Mexico*. xviii+ 270 pp., 3 maps. Texas System of Natural Laboratories, Inc., Austin, Texas.

FW: Kuehne, R.A. and R.W. Barbour. 1983. *The American Darters*. The University Press of Kentucky. 177 pp.

FW: Lee, D.S., C.R. Gilbert., C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr. 1980. *Atlas of North American Fresh Water Fishes.* North Carolina State Museum of Natural History, Publication #1980-12 of the North Carolina Biological Survey. Raleigh, North Carolina. 854 pp.

FW: McGowan, N., R.J. Kemp, Jr. and R. McCune. 1971. *Freshwater Fishes of Texas*. Texas Parks and Wildlife Department, Austin, Texas. Bulletin 5-A. 40 pp.

FW: Miller, R.J. and H.W. Robinson. 1973. *The Fishes of Oklahoma*. Oklahoma State University Press, Stillwater, Oklahoma.

SW: Murdy, E.O. 1995. *Saltwater Fishes of Texas. A Dichotomous Key*. TAMU-SG-83-607. Texas A & M University Sea Grant College Program. College Station, Texas. 158 pp.

FW: Nelson, J. S., E. J. Crossman, H. Espinosa-Pérez, L. T. Findley, C. R. Gilbert, R. N. Lea, and J.D. Williams. 2004. *Common and Scientific Names of Fishes from the United States, Canada, and Mexico*. American Fisheries Society, Special Publication 29, Bethesda, Maryland.

FW: Page, L.M. and B.M. Burr. 1991. *A Field Guide to Freshwater Fishes*. The Peterson Field Guide Series. Houghton Mifflin Company. Boston, Massachusetts. 432 pp.

FW: Pflieger, W.L. 1975. *The Fishes of Missouri*. Missouri Department of Conservation, Jefferson City, Missouri. 343 pp.

FW: Robison, H.W. and T.M. Buchanan. 1988. *Fishes of Arkansas*. The University of Arkansas Press, Fayetteville, Arkansas. 536 pp.

SW: Shipp, R.L. 1999. *Dr. Bob Shipp's Guide to the Fishes of the Gulf of Mexico*. KME Seabooks. Mobile, Alabama. 256 pp.
FW: Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. *The Fishes of New Mexico*. University of New Mexico Press, Albuquerque, New Mexico. 393 pp.
FW: Thomas, C., T.H. Bonner, and B.G. Whiteside, 2007. *Freshwater Fishes of Texas*. Texas A&M Press, College Station, Texas.
FW: Tomelleri, J.R. and M.E. Eberle. 1990. *Fishes of the Central United States*. University Press of Kansas, Lawrence, Kansas. 226 pp.

Benthic Macroinvertebrates

Identification and enumeration of benthic macroinvertebrates must be conducted by individuals with appropriate expertise, training, and knowledge of the literature.

Identification and enumeration of benthic macroinvertebrates must be done consistently among samples and the taxonomic expertise of the identifier must, at a minimum, be adequate to allow identification of all specimens for each sample according to the appropriate taxonomic level identified on pages 5-9 in Chapter 5: Freshwater Benthic Macroinvertebrates.

Equipment Requirements

Proper identification and enumeration of benthic macroinvertebrates requires, at a minimum, the following equipment:

- Stereo dissecting microscope, total magnification variable 7x to 30x; recommended 7x to 110x
- Stereo compound microscope, total magnification 400x
- Jeweler's forceps
- Petri dishes
- Preservative: 70 percent ethanol or 70 percent isopropyl alcohol
- Microscope slides

Taxonomic Keys

(FW = Freshwater, SW = Salt water)

Required:

FW: Merrit, R.W. and K.W. Cummins (eds). 2008. An Introduction to the Aquatic Insects of North America, 4th Edition. Kendall/Hunt Publishing Co., Dubuque, Iowa.
FW: Pennak, R.W. 1989. *Freshwater Invertebrates of the United States: Protozoa to Mollusca,* 3rd Edition. John Wiley and Sons, New York.
FW: Thorpe, J.H. and A.P. Covich (eds). 1991. *Ecology and Classification of North American Freshwater Invertebrates*. Academic Press Inc., New York, New York.
FW: US EPA. 1982. *Freshwater Snails (Mollusca:Gastropoda) of North America*. EPA-600/3/82/026. U.S. Environmental Protection Agency, Washington D.C.
SW: Andrews, J. 1977. *Shells and Shores of Texas*. University of Texas Press. 365 pp.

SW: Fauchald, K. 1977. *The Polychaete Worms*. Definitions and Keys to the Orders, Families, and Genera. Natural History Museum of Los Angeles Science Series # 28. Los Angeles, California.
SW: Gosner, K.L. 1971. *Guide to the Identification of Marine and Estuarine Invertebrates*. Wiley- Interscience, New York, New York.
SW: Uebelaker, J.M. and P.G. Johnson (eds). 1984. *Taxonomic Guide to the Polychaetes of the Northern Gulf of Mexico*. 7 volumes. Mineral Management Services, Metairie, Louisiana.
SW: Williams, A.B. 1984. *Shrimps, Lobsters and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida*. Smithsonian Inst. Press, Washington, D.C.

Other recommended keys include:

FW: Brigham, A.R., W.U. Brigham, and A. Gnilka. 1983. *Aquatic Insects and Oligochaetes of North and South Carolina*. Midwest Aquatic Enterprises, Mahomet, Illinois.
FW: Edmondson, W.T. ed. 1959. *Ward and Whipple Freshwater Biology 2nd Edition*. John Wiley and Sons, Inc., New York, New York. 1248 pp.
FW: McCafferty, W.P. 1983. *Aquatic Entomology*. Jones and Bartlett Publishers, Inc., Boston, Massachusetts.
FW: Usinger, R.L. (ed). 1968. *Aquatic Insects of California*. University of California Press, Berkley, California.
SW: Abbott, R.T. 1974. *American Seashells*, 2nd edition. Van Nostrand Reinhold Co., New York, New York.
SW: Barnes, R.D. 1987. *Invertebrate Zoology*, Fifth edition. CBS College Publishing, New York, New York.
SW: Farfante, I.P. 1988. *Illustrated Key to Penaeoid Shrimps of Commerce in the Americas*. National Oceanic and Atmospheric Association Report. NMFS 64. 32 pp.
SW: Williams, Austin B. 1965. *Marine decapod crustaceans of the Carolinas*. United States Fish and Wildlife Service, Fishery Bulletin 65(1): 1-298.
SW: Wood, Carl E. 1974. *Key to the natantia (crustacean, decapoda) of the coastal waters on the Texas coast*. Contributions in Marine Science 18: 35-56.

Benthic Algae and Plankton

Identification of algae and plankton samples must be conducted by individuals with proper expertise, training, and knowledge of the literature. Identification must include, at a minimum, genus-level for non-diatom algae, and species level for diatoms.

Equipment Requirements

Proper identification and enumeration of benthic algae or plankton requires, at a minimum, the following equipment:

- Binocular compound microscope; 10x oculars with 10x to 100x (oil immersion) objectives
- Microscope slides and cover slips
- Mounting media for permanent diatom slides

- Hot plate for preparing permanent diatom slides
- Diatom pencil for circling taxa on slides for vouchers

Taxonomic Keys

(FW = Freshwater, SW = Salt water)

Required:

FW: Prescott, G. W. 1978. *How to Know the Freshwater Algae*. 3rd edition. Wm. C. Brown Co., Dubuque, Iowa.

FW: Patrick, R. and C. W. Reimer. 1966 and 1975. *The Diatoms of the United States, exclusive of Alaska and Hawaii*. Monograph No. 13, Vols. 1 and 2. Acad. Nat. Sci., Phila., Philadelphia, Pennsylvania.

SW: Tomas, C. R. 1997. *Identifying Marine Phytoplankton*. Academic Press. San Diego, California. 858 pp.

Other recommended keys include:

FW: Dillard, G. E. 1989-1993. Freshwater Algae of the Southeastern United States. Parts 1-6. Bibliotheca Phycologica.

FW: Krammer, K. and H. Lange-Bertalot. 1986-1991. Susswasserflora von Mitteleuropa. Band 2. Parts 1-5. Bacillariophycea. Gustav Fischer Verlag. Stuttgart, Germany.

FW: Prescott, G. W. 1962. The Algae of the Western Great Lakes Area. Wm. C. Brown Co., Dubuque, Iowa.

FW: Whitford, L. A. and G. J. Schumacher. 1973. A Manual of Fresh-Water Algae. Sparks Press, Raleigh, North Carolina.

Aquatic Macrophytes

Taxonomic Keys

(FW = Freshwater, SW = Salt water)

Recommended references include:

FW: Prescott, G.W. 1969. *How to Know the Aquatic Plants*. Wm. C. Brown Co., Dubque, Iowa. 171 pp.

FW: Riemer, D.N. 1984. *Introduction to Freshwater Vegetation*. Van Nostrand and Reinhold Co., New York. 207 pp.

SW: Hotchkiss, N. 1972. *Common Marsh Plants of the United States and Canada*. Dover Publications, Inc., New York. 124 pp.

SW: Stutzenbaker, C. D. 1999. *Aquatic and Wetland Plants of the Western Gulf Coast*. University of Texas Press, Austin, Texas. 465 pp.

FW/SW: Tarver, D.P., J.A. Rodgers, M.J. Mahler, and R.L. Lazor. 1986. *Aquatic and Wetland Plants of Florida,* 3rd edition. Bureau of Aquatic Plant Research and Control, Florida Department of Natural Resources, Tallahassee, Florida