

CHAPTER 11

QUALITY ASSURANCE AND QUALITY CONTROL

Biological monitoring programs that contribute data to the TCEQ must conform to all QA measures outlined in this chapter and all QC 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 (TSAs), in both the field and the laboratory, and by a TCEQ-approved QAPP.

All TCEQ regional biological-monitoring projects will require a separate QAP that details the unique aspects of the project. A QAP shell document appears in the SWQM QAPP. Types of biological-monitoring projects are detailed in Chapter 2.

Technical Systems Audits

The TCEQ conducts TSAs on agency regional SWQM personnel conducting biological monitoring and on contracted organizations collecting biological data as resources allow. If the TCEQ determines that a TSA is needed, it will conduct the TSA separately from a TSA on other monitoring activities, such as routine monitoring. If the TCEQ determines that a TSA is needed for a CRP partner or other cooperator, a TSA is performed during that organization'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 organization 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 the sampling station location and number, date and time of collection, details of collections including the area and duration of sampling, raw counts of specimens collected, and photographs of any large specimens released after identification.
- A sample-tracking logbook that details the event and sample information. Assign each sample a unique sample tracking number, such as *BM 020 14* for 'benthic macroinvertebrate number 020, year 2014.'
- Laboratory identification notes and bench sheets. Each sheet must contain the label information, unique sample tracking number from the logbook, the date of identification, the name of the identifier, the scientific name for each taxon, the number of individuals in each taxon, and other comments that may pertain to identification.
- Appropriately labeled sample 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 takes place every few years and will be available to TCEQ personnel and other cooperators furnishing biological or habitat data to the TCEQ. These trainings are a significant part of the QA for the biological monitoring program and will be required regardless of level of expertise. Even experienced field biologists will be required to attend periodic trainings to ensure they are practicing current methodologies. In place of a major training event, employees or contractors may participate in a biological-monitoring event with experienced personnel.

Approval of Deviation from Methods

Biological collection methods for wadable streams are documented in this manual and any variation from those sampling protocols must be approved in advance by the TCEQ and detailed in a QAPP or QAP. It is imperative that monitoring initiatives on water bodies without prescribed protocols, such as reservoirs or tidal streams, be discussed at the beginning of study plan development with either the TCEQ SWQM Team or WQSG 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 TSAs of personnel involved in the collection of biological data.

Tracking Samples

Proper sample custody is a joint effort of the sampling crew, the sample transporter, and the laboratory staff (including sorters, pickers, and those performing taxa identification). The sampling crew places biological samples and the identifying labels in jars with screw-top lids. This label is the main sample documentation and is written in waterproof ink or pencil and placed in the jar. The laboratory staff is responsible for keeping this label with the sample and replacing it if damaged. The sample label includes the following information.

- county
- river basin
- stream name

- station ID or location of nearest landmark (for example, a road crossing)
- time and date of collection
- name of each collector
- collection methods
- type of preservative used

Sample-Tracking Log

Maintain a *sample-tracking logbook* that contains the following for each sample. Log this information immediately upon returning to the lab.

- unique sample tracking number
- name of person logging information
- name of each collector
- location of collection
- date of collection
- date entered in log
- date identification and enumeration began

After completing the log entries, inspect the sample label to ensure that it is in good condition and legible, and includes the following information.

- name of each collector
- station location
- station number, if applicable
- date and time of collection
- collection method
- preservative

Note: Replace the label if deterioration is obvious.

Laboratory Bench Sheet

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

- sample number from tracking log
- name of identifier
- location of collection
- date of collection

- date entered in log
- date identification and enumeration began
- date identification and enumeration ended
- scientific name for each taxon in sample
- number of individuals in each taxon
- ID qualifiers (difficulties)

Voucher-Specimen Vials

Consistent with guidelines for voucher specimens found in previous chapters, maintain a **separate vial** for each taxon in the sample. Each vial may contain multiple specimens of the same taxon. Preserve specimens in 70 percent ethanol or isopropyl alcohol. Each vial must contain a label that includes the following information.

- name of each collector
- name of each identifier
- station location
- station number, if applicable
- date and time of collection
- collection method
- preservative
- scientific name of taxon contained in vial

When slide mounts of specimens (or parts of specimens) are needed to complete identification using a compound microscope, the slides must be labeled with the scientific name of the taxon, the initials of the identifier, and the sample tracking log number.

General Quality Assurance

To minimize misidentification of biological samples, the following steps are mandatory:

Vouchers

Retain voucher specimens of all species of fishes, benthic macroinvertebrates, algae samples, and permanent diatom slides for a minimum of five years or until the applicable regulatory decision is made (whichever is longer).

Voucher specimens serve as long-term physical proof that confirm 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.

Voucher Storage

Consider the following 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 experienced in the specific area of taxonomy required

The organization maintaining voucher specimens must have a history that demonstrates the ability to preserve the specimens into the future (USGS 2000). This could include in-house provisions for sample maintenance or archiving in a university or museum natural-history collection.

Confirmation Checks

Confirmation checks 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 the known range where it would be expected to occur, then the collection should be reviewed and rechecked for other similar species. Where a species' identification is in question, the collecting organization may send specimens to agency experts at either the TCEQ or the TPWD for confirmation.

Fish

Identification of Fish-Assemblage Samples

Fish-assemblage samples must be identified and counted by personnel trained in taxonomy and familiar with appropriate keys and literature. The validity of identifications affects the quality of community analyses and, frequently, the ALU designated for a stream.

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 identifying Texas freshwater fishes, the primary reference is Hubbs et al. (1991), with supplemental sources as needed.

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. 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. Each field container must include an internal label that includes the date, collection locality, the name of each collector, and the sampling method. This paper must be of high rag content and notations must be in pencil or waterproof ink.

Equipment Requirements

Before identification and counting, specimens are transferred to 70 percent ethanol or 45 percent isopropyl alcohol in the laboratory. See Chapters 3 and 4 for details of laboratory samples. Proper identification and counting of fish requires, at a minimum, the following equipment.

- stereo dissecting microscope, total magnification variable 7× to 30×; recommended 7× to 110×
- jeweler's forceps
- petri dishes
- preservative—70 percent ethanol or 45 percent isopropyl alcohol
- ruler

Taxonomic Keys

Required References

The following taxonomic references are required for identifying fish.

Freshwater

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.

Saltwater

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

Supplemental References

The following taxonomic references are recommended supplements.

Freshwater

Douglas, N.H. 1974. Freshwater Fishes of Louisiana. Baton Rouge, LA: Claitor's Publishing Division.

Hubbs, C., et al., eds. 1994. Freshwater and Marine Fishes of Texas and the Northwestern Gulf of Mexico. Austin: Texas System of Natural Laboratories.

Kuehne, R.A. and R.W. Barbour. 1983. The American Darters. University Press of Kentucky.

Lee, D.S., et al. 1980. Atlas of North American Fresh Water Fishes. North Carolina Biological Survey publication no. 1980-12. Raleigh: North Carolina State Museum of Natural History.

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

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

- Nelson, J.S., et al. 2004. Common and Scientific Names of Fishes from the United States, Canada, and Mexico. Special Publication 29. Bethesda, MD: American Fisheries Society.
- Page, L.M., and B.M. Burr. 1991. A Field Guide to Freshwater Fishes. Peterson Field Guide Series. Boston: Houghton Mifflin.
- Pflieger, W.L. 1975. The Fishes of Missouri. Jefferson City: Missouri Department of Conservation.
- Robison, H.W., and T.M. Buchanan. 1988. Fishes of Arkansas. Fayetteville: University of Arkansas Press.
- Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. Albuquerque: University of New Mexico Press.
- Thomas, C., T.H. Bonner, and B.G. Whiteside, 2007. Freshwater Fishes of Texas. College Station: Texas A&M University Press.
- Tomelleri, J.R., and M.E. Eberle. 1990. Fishes of the Central United States. Lawrence: University Press of Kansas.

Saltwater

- Hubbs, C., et al. 1994. Freshwater and Marine Fishes of Texas and the Northwestern Gulf of Mexico. Austin: Texas System of Natural Laboratories.
- Murdy, E.O. 1995. Saltwater Fishes of Texas. A Dichotomous Key. TAMU-SG-83-607. College Station: Texas A&M University Sea Grant College Program.
- Shipp, R.L. 1999. Dr. Bob Shipp's Guide to the Fishes of the Gulf of Mexico. Mobile, AL: KME Seabooks.

Benthic Macroinvertebrates

Benthic macroinvertebrates must be identified and counted by persons with appropriate expertise, training, and knowledge of the literature.

Identifying and counting benthic macroinvertebrates must be consistent among samples. The taxonomic expertise of the identifier must, at a minimum, be adequate to allow identification of all specimens to the appropriate taxonomic level identified in Chapter 5.

Equipment Requirements

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

- stereo dissecting microscope, total magnification variable 7× to 30×; recommended 7× to 110×
- stereo compound microscope, total magnification 400×
- jeweler's forceps
- petri dishes

- preservative: 70 percent ethanol or 70 percent isopropyl alcohol
- microscope slides

Taxonomic Keys

Required References

The following taxonomic references are required for identifying benthic macroinvertebrates.

Freshwater

Merritt, R.W., and K.W. Cummins, eds. 2008. *An Introduction to the Aquatic Insects of North America*. 4th ed. Dubuque, IA: Kendall/Hunt.

Pennak, R.W. 1989. *Freshwater Invertebrates of the United States: Protozoa to Mollusca*. 3rd ed. New York: John Wiley and Sons.

Thorpe, J.H., and A.P. Covich, eds. 1991. *Ecology and Classification of North American Freshwater Invertebrates*. New York: Academic Press.

U.S. EPA. 1982. *Freshwater Snails (Mollusca: Gastropoda) of North America*. EPA-600/3/82/026. Washington: U.S. Environmental Protection Agency.

Saltwater

Andrews, J. 1977. *Shells and Shores of Texas*. Austin: University of Texas Press.

Fauchald, K. 1977. *The Polychaete Worms: Definitions and Keys to the Orders, Families, and Genera*. Science Series no. 28. Natural History Museum of Los Angeles.

Gosner, K.L. 1971. *Guide to the Identification of Marine and Estuarine Invertebrates*. New York: Wiley-Interscience.

Uebelaker, J.M., and P.G. Johnson, eds. 1984. *Taxonomic Guide to the Polychaetes of the Northern Gulf of Mexico*. 7 volumes. Metairie, LA: Mineral Management Services.

Williams, A.B. 1984. *Shrimps, Lobsters and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida*. Washington: Smithsonian Institution Press.

Supplemental References

The following taxonomic references are recommended as supplements.

Freshwater

Brigham, A.R., W.U. Brigham, and A. Gnilka. 1983. *Aquatic Insects and Oligochaetes of North and South Carolina*. Mahomet, IL: Midwest Aquatic Enterprises.

Edmondson, W.T., ed. 1959. *Ward and Whipple's Fresh-Water Biology*. 2nd ed. New York: John Wiley and Sons.

McCafferty, W.P. 1983. *Aquatic Entomology*. Boston: Jones and Bartlett.

Usinger, R.L., ed. 1968. Aquatic Insects of California. Berkeley and Los Angeles: University of California Press.

Saltwater

Abbott, R.T. 1974. American Seashells. 2nd ed. New York: Van Nostrand Reinhold.

Barnes, R.D. 1987. Invertebrate Zoology. 5th ed. New York: CBS College Publishing.

Farfante, I.P. 1988. Illustrated Key to Penaeoid Shrimps of Commerce in the Americas. NMFS 64. Springfield, VA: National Oceanic and Atmospheric Association Report.

Williams, Austin B. 1965. Marine Decapod Crustaceans of the Carolinas. *U.S. Fish and Wildlife Service Fishery Bulletin* 65(1): 1–298.

Wood, Carl E. 1974. Key to the Natantia (Crustacea, Decapoda) of the coastal waters on the Texas coast. *Contributions in Marine Science* 18: 35–56.

Benthic Algae and Plankton

Algae and plankton samples must be identified by persons with proper expertise, training, and knowledge of the literature. Identification must reach, at a minimum, the genus level for non-diatom algae and the 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; 10× oculars with 10× to 100× (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

Required References

The following taxonomic references are required for identifying benthic algae and plankton.

Freshwater

Prescott, G.W. 1978. How to Know the Freshwater Algae. 3rd ed. Dubuque, IA: Wm. C. Brown.

Patrick, R., and C.W. Reimer. 1966, 1975. The Diatoms of the United States, exclusive of Alaska and Hawaii. Monograph no. 13, vols. 1 and 2. Academy of Natural Sciences of Philadelphia.

Saltwater

Tomas, C.R. 1997. Identifying Marine Phytoplankton. San Diego: Academic Press.

Supplemental References

The following taxonomic references are recommended as supplements.

Freshwater

- Dillard, G.E. 1989–93. Freshwater Algae of the Southeastern United States. Parts 1–6. Bibliotheca Phycologica. Stuttgart, Germany: Cramer.
- Krammer, K., and H. Lange-Bertalot. 1986–91. Susswasserflora von Mitteleuropa. Band 2. Parts 1–5. Bacillariophyceae. Stuttgart, Germany: Gustav Fischer Verlag.
- Prescott, G.W. 1962. The Algae of the Western Great Lakes Area. Dubuque, IA: Wm. C. Brown.
- Wehr, J.D., and R.G. Sheath. 2002. Freshwater Algae of North America: Ecology and Classification. Waltham, MA: Academic Press.
- Whitford, L.A, and G.J. Schumacher. 1973. A Manual of Fresh-Water Algae. Raleigh, NC: Sparks Press.

Aquatic Macrophytes

Taxonomic Keys

Required References

The following taxonomic references are required for identifying aquatic macrophytes.

Freshwater

- Prescott, G.W. 1969. How to Know the Aquatic Plants. Dubuque, IA: Wm. C. Brown.
- Riener, D.N. 1984. Introduction to Freshwater Vegetation. New York: Van Nostrand Reinhold.
- Tarver, D.P., et al. 1986. Aquatic and Wetland Plants of Florida. 3rd ed. Tallahassee: Bureau of Aquatic Plant Research and Control, Florida Department of Natural Resources.

Saltwater

- Hotchkiss, N. 1972. Common Marsh Plants of the United States and Canada. New York: Dover Publications.
- Stutzenbaker, C. D. 1999. Aquatic and Wetland Plants of the Western Gulf Coast. Austin: University of Texas Press.
- Tarver, D.P., et al. 1986. Aquatic and Wetland Plants of Florida. 3rd ed. Tallahassee: Bureau of Aquatic Plant Research and Control, Florida Department of Natural Resources.