Long Term Resource Monitoring Program

Program Report

95-P002-1

Long Term Resource Monitoring Program Procedures:

Fish Monitoring

July 1995

Long Term Resource Monitoring Program Procedures: Fish Monitoring

by

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July 1995

The Environmental Management Technical Center issues LTRMP Program Reports to provide Long Term Resource Monitoring Program partners with programmatic documentation, procedures manuals, training manuals, and geospatial applications.

Cover graphic by Mi Ae Lipe-Butterbrodt

*The National Biological Service . . . gathering, analyzing,
and sharing the biological information necessary to support the wise
stewardship of the Nation's natural resources.*

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Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' (Corps) Environmental Management Program. The original authorization for the LTRMP was for 10 years, starting in 1987. Authorization has since been extended for an additional 5 years (to 2002) by Section 405 of the Water Resources Act of 1990 (Public Law 101-640).

The LTRMP is being implemented by the Environmental Management Technical Center, a National Biological Service Science Center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The Corps provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information to maintain the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.

Goal 2 of the LTRMP Operating Plan (USFWS 1992) is simply stated: *Monitor Resource Change*. Strategies for monitoring resource components are listed under this goal.

This report should be cited as:

Gutreuter, S., R. Burkhardt, and K. Lubinski. 1995. Long Term Resource Monitoring Program Procedures: Fish Monitoring. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95-P002-1. 42 pp. + Appendixes A-J

Contents

Tables

Page

Figures

1. Monitoring Rationale

Fishes are one of the most diverse and abundant natural resources of the Upper Mississippi River System (UMRS) (Carlander 1954; Rasmussen 1979; Van Vooren 1983; Fremling et al. 1989). Several features contribute to the great amount of interest fishes receive from the general public, fishery managers, and aquatic ecologists:

a. UMRS fishes support multimillion-dollar commercial and sport fisheries.

b. Fishes respond to a variety of hydrologic, water quality, and habitat variables.

c. Scientists and fishery managers recognize fish communities as an integrative index to a complex set of physical and biological conditions on the UMRS; that is, fish are indicators of the biotic integrity of the UMRS. In addition, impacts of sedimentation, increased navigation, and altered water levels in the UMRS are often perceived by the general public in terms of changes in the fish community or fish habitat.

d. Recent research demonstrates that fishes often have major controlling effects on other organisms, including vegetation, aquatic macroinvertebrates, zooplankton, and phytoplankton, and even on nutrient cycling and sediment resuspension (Northcote 1988). Therefore, information on fish is often required to understand other organisms and some physical/chemical processes.

The value of fishery data collected using standardized methods was clearly recognized in the planning documents that preceded the Environmental Management Program (Jackson et al. 1981), and there have been few disagreements about including fish as a major resource component for trend analysis. The following procedures address these concerns by standardizing collections based on commonly accepted methods and stratifying collections over space, season, and flow.

The basic unit of measurement related to the fishery component is the fish collection. A fish collection is defined as all of the fishes collected during a single deployment of a sampling gear at a defined place and time.

Trend analysis under the Long Term Resource Monitoring Program (LTRMP) emphasizes two attributes of the UMRS fishery resource: community and population structure. Sampling methods for these attributes are equivalent, but hypotheses related to the attributes require different analytical approaches; therefore, they are discussed in separate sections.

2. Acknowledgments

This document is the result of contributions of ideas from many individuals. It incorporates substantial material from the earliest LTRMP Procedures Manual (Burkhardt et al. 1988). The LTRMP planned for self-evaluation and change early in the program. This document reflects changes and refinements to the original LTRMP fish monitoring program identified through experience and analysis of preliminary data. Adoption of these changes was the result of group efforts within the LTRMP. We particularly thank the many LTRMP Field Station staff who have worked tirelessly for the success of this program: Minnesota Department of Natural Resources - Walter Popp and Mark Stopyro; Wisconsin Department of Natural

Resources - Terry Dukerschein, Andy Bartels, and Steve Skemp; Iowa Department of Natural Resources-Russ Gent, Mike Griffin, and Scott Gritters; Illinois Natural History Survey - Doug Blodgett, Chuck Theiling, Paul Raibley, Matt O'Hara, Kevin Irons, Fred Cronin, Dirk Soergel, and Rob Maher; and Missouri Department of Conservation - Bob Hrabik, Mike Petersen, and Dave Herzog. We also thank all current and former members of the LTRMP Analysis Team, Minnesota Department of Natural Resources, Wisconsin Department of Natural Resources, Iowa Department of Natural Resources, Illinois Department of Conservation, Illinois Natural History Survey, Missouri Department of Conservation, U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service.

3. Attributes

3.1 Community Structure

3.1.1 Definition and Importance

Fish community structure refers to the relative abundance of fishes of each species within a multi-species assemblage of fishes (Carline 1986). Relative abundance is traditionally measured by catch in numbers per unit of sampling effort, but measures based on weight are also commonly used. A "fish community" theoretically includes all of the fish that use a defined area over a given period of time. The best overall method for measuring fish community structure is the one that is most effective (samples the largest number of specimens) and least selective (captures species in proportion to their occurrence in the sampled area). Given commonly available levels of time and personnel, no single method routinely satisfies both criteria (Starrett and Barnikol 1955; Funk 1957; Hayes 1983; Hubert 1983). For this reason, the trend analysis procedure for fish community structure in a given aquatic area includes use of several sampling gears. Comparisons of collections between habitat categories are made with caution and with the full understanding that results are probably affected by habitat-related differences in gear efficiency.

3.1.2 Relative Abundance

Relative abundance can be assessed for all specimens regardless of size or it can be assessed separately for adults and young-of-the-year by using appropriate length categories defined for each fish species. Relative abundance is measured in units appropriate to the method used, and it is always paired with a taxonomic identification code applicable to the taxon or group it describes.

Relative abundance is one of the most common variables used by biologists to assess community structure. It is called relative abundance to stress the fact that virtually every sampling method is somewhat selective and therefore produces a biased view of true abundance. In trend analysis, this bias is minimized by the development of standardized methods and reliance on multiple sampling gears.

Species relative abundances often are grouped to demonstrate trends in the sport or commercial fishery or in functional (e.g., reproductive, feeding, habitat) guilds. For instance, Pitlo (1987), in a synthesis of UMRS standing stock estimates, indicated that "rough" and "forage" fish species commonly made up approximately 69% of the backwater fish community. "Panfish," predators, "game fish," and catfishes comprised 14%, 6%, 6%, and 5%, respectively, of this community. Percentages of these fish groups in channel border habitats, as determined by sampling using Primacord, were "rough" fish, 79; catfishes, 16; "forage fish," 4; combined "panfish," "game" fish, and predators, < 1.

Certain fish species in the UMRS were tentatively described at the outset of the Long Term Resource Monitoring Program as being adversely affected by high or prolonged levels of suspended sediment and habitat changes associated with high sedimentation rates. Sediment-associated physical factors can inhibit the reproduction, growth, behavior, or competitive ability of these species directly or indirectly via impacts on aquatic vegetation. We refer to these species as being "sediment-sensitive." Another categorization that may partially overlap sediment sensitivity is degree of dependence on backwaters. Some species require backwaters, especially to avoid the extreme physiological stress imposed by the combination of current and very low temperatures in channels during winter.

3.1.3 Species Richness

Species richness refers to the total number of species taken in a collection or during a defined unit of effort. It does not include hybrids or higher taxonomic categories that may be listed on data sheets (e.g., carp x goldfish hybrid, *Ictiobus* sp.). Species richness is a component of the overall diversity of the fish community. Because the sample species richness increases with increasing sampling effort, comparison of species richness estimates requires either constant sampling effort or formal estimation methods. Estimation of species richness is an important but difficult (Bunge and Fitzpatrick 1993) task.

3.2 Population Structure

3.2.1 Definition and Importance

Population structure refers to the distribution of individuals of a single species among size or age groups. Fishery biologists often recommend that analyses of population structure be based on large numbers ($\geq$200) of specimens. Data on population structure are obtained from routine LTRMP sampling efforts.

The target fish species for annual population structure evaluations are black crappie (*Pomoxis nigromaculatus*), channel catfish (*Ictalurus punctatus*), highfin carpsucker (*Carpiodes velifer*), and sauger (*Stizostedion canadense*). These species were selected for evaluation in the LTRMP because they are suspected of being susceptible to impacts associated with the three resource problems addressed by the program: (1) they represent different feeding, habitat-use, and reproductive guilds; (2) they are distributed throughout the UMRS at densities that enable reliable population structure evaluations; and (3) most are important components of either the UMRS sport or commercial fisheries.

Standard LTRMP collection methods often yield enough individuals of other closely associated species (e.g., northern pike [*Esox lucius*], walleye [*Stizostedion vitreum*], and white crappie [*Pomoxis annularis*]) to permit additional population structure evaluations. Such evaluations are encouraged by the Environmental Management Technical Center (EMTC).

3.2.2 Size Distribution

The size distribution for a given species is the vector (list) of the numbers of specimens taken in a collection or a unit of effort that fall into selected size categories. The size distribution of a species is a valuable index to a variety of population characteristics, including growth, recruitment, and mortality rates.

Evaluation of size distribution requires the establishment of standard total length categories (TLCs). During measurement, specimens are categorized based on their recorded total length (TL; see Section 5.2, Fish Identification and Measurement). Standard TLCs for size groups ≤400 mm TL are 1 cm. TLCs for size groups ≥400 mm TL are 2 cm. TLCs are labeled by their lower length boundary. For instance, fish in TLC 9 are between 90 and 99 mm TL, and fish in TLC 40 are between 400 and 420 mm TL.

4. Description of Sampling Methods and Gears

4.1 Electrofishing

Standardized electrofishing is conducted in aquatic areas where depth ranges from approximately 0.5 to 3.0 m. The standard unit of reporting electrofishing effort is time measured in hours, but electro-fishing effort is recorded in minutes.

To maximize standardization among electrofishing collections, the boats and shocking equipment used by each field crew have been assembled by field station and EMTC staff according to the specifications given below and in Appendix A. Electrofishing boats are 5.5-m (18-ft) flatbottomed aluminum boats. They are powered by 45- to 110-hp outboard motors and should be equipped with a small backup motor for safety and for running in shallow water.

The power supply is a 5-kW or higher capacity AC generator (Models MAB5036E-2 or GGB55-62ERC, T&J Manufacturing, Oshkosh, WI, or equivalent) equipped with a manual remote start/stop switch for safety. With attached circuitry, the generator is capable of producing AC, DC, and pulsed-DC output. The two forward booms hold anodes located 2.44 m (8 ft) from the front of the boat and spaced 3.05 m (10 ft) apart. Each anode consists of a stainless steel circular ring 0.91 m (3 ft) in diameter with four 30-cm (12-inch)-long, 2.54-cm (1-inch) outer-diameter stainless steel droppers attached. The droppers are attached to the ring with 35.6-cm (14-inch) lengths of wire so that the anode dropper units have a total length of 66 cm (26 inches). The boat hull serves as the cathode. Metering equipment permits the monitoring of output voltage and amperage. Two independent "deadman" safety foot switches are located on the front deck near the dip-netting stations, and two hand-operated safety switches are located at the rear of each dip-netting station. A fourth safety switch is located on the control box console, and a fifth switch is attached to the driver. Forward-mounted floodlights permit night sampling.

Diagnostic checking must be conducted annually and after service and replacement of any electrical components. This procedure includes inspection of all electrical contacts, excluding circuits internal to the control box and generator, for corrosion. The contact points between the stainless steel hoops and droppers of the anodes must be checked monthly. It is also desirable to map the electrical field annually. Appendix B contains specifications for the electrical field.

A pulsed-DC field is used for relative abundance samples because many fish caught in the electrical field are entrained to the anodes by an electrotactic physiological response (Reynolds 1983). In theory, this electrotactic response should reduce sampling variability caused by differences in visibility of fish caused by varying turbidity. The primary objective is to create an electromagnetic field that induces a constant power drop across a fixed length of fish tissue under different conditions of water temperature and conductivity (Burkhardt and Gutreuter 1995). For this reason, voltage and amperage are adjusted to achieve a uniform base power of 3,000 W. This adjustment is accomplished using LTRMP standardized electrofishing power settings (Appendix A). Power goals (W) are listed for various combinations of conductivity (µ S/cm) and temperature (°C). Pulse frequency is set to 60 Hz and duty-cycle is set to 25%. This configuration is effective for many species over a broad range of water quality conditions. **Note: Because power output affects catch rates of fishes differently, it is critical that power output from all LTRMP electrofishing samples is as close as possible to the power goal and does not deviate from the power goal by more than 20%.**

The electrofishing boat is operated by a pilot and two persons operating dip nets. Because electrofishing requires potentially hazardous equipment, special qualifications are required of crew members. The designated Crew Leader is required to pass an EMTC fisheries training course that includes a session on electrofishing techniques and safety and a course in cardiopulmonary resuscitation. All crew members should pass this training course, when offered. The Fisheries Specialist or Crew Leader is responsible for providing interim training for crew members who have not been able to take the LTRMP training course. All crew members also are required to have passed a course in cardiopulmonary resuscitation at the earliest possible opportunity.

Dip netters use 30-cm (12-inch)-deep, 3-mm (1/8-inch)-diameter mesh dip nets (Model ELECTRO REGULAR D, Duraframe Dipnet, Viola, WI) on 2.4-m (8-ft) fiberglass handles. Dip netters collect each fish as it appears, regardless of size or species. Fish are placed in a holding box until the run is terminated. Unusual species or specimens that are observed but not collected during the run are noted by the crew and reported as comments on the data sheet. However, these observations are not entered into the collection data set.

Beginning with 1993 and continuing to the present, daytime electrofishing is conducted from 1 h after sunrise to 1 h before sunset. Night electrofishing is conducted from 1 h after sunset to 1 h before sunrise. **Note: Prior to 1993, daytime electrofishing was conducted between the hours of 0700 and 1130 CST, and nighttime electrofishing was conducted from 30 min after sunset to 30 min before sunrise.**

Before starting an electrofishing run, the crew reviews the description of the area to be shocked and the collection site boundaries. Surface conductivity and water temperature are measured and used to identify the proper electrical settings. Individual electrofishing runs have a duration of 15 min and are approximately 200 m (220 yd) long and 30 m (33 yd) wide. The pilot uses a timer to measure the actual time required for each collection. During the run, the pilot operates the boat at a speed and along a path such that 15 min of effort allows coverage of the approximate sampling area. Banks, submerged logs, and any other structure within the sampling area are shocked thoroughly until they no longer yield fish. The pilot is free to modify the forward and backward movement of the boat to permit the most effective collection of fish only to the extent that such movement does not interfere with the objective of obtaining 100% area coverage with a single 15-min pass. Chase boats may be used in high water velocity conditions to recover incapacitated fish. Figure 1 illustrates how to electrofish in various habitats.

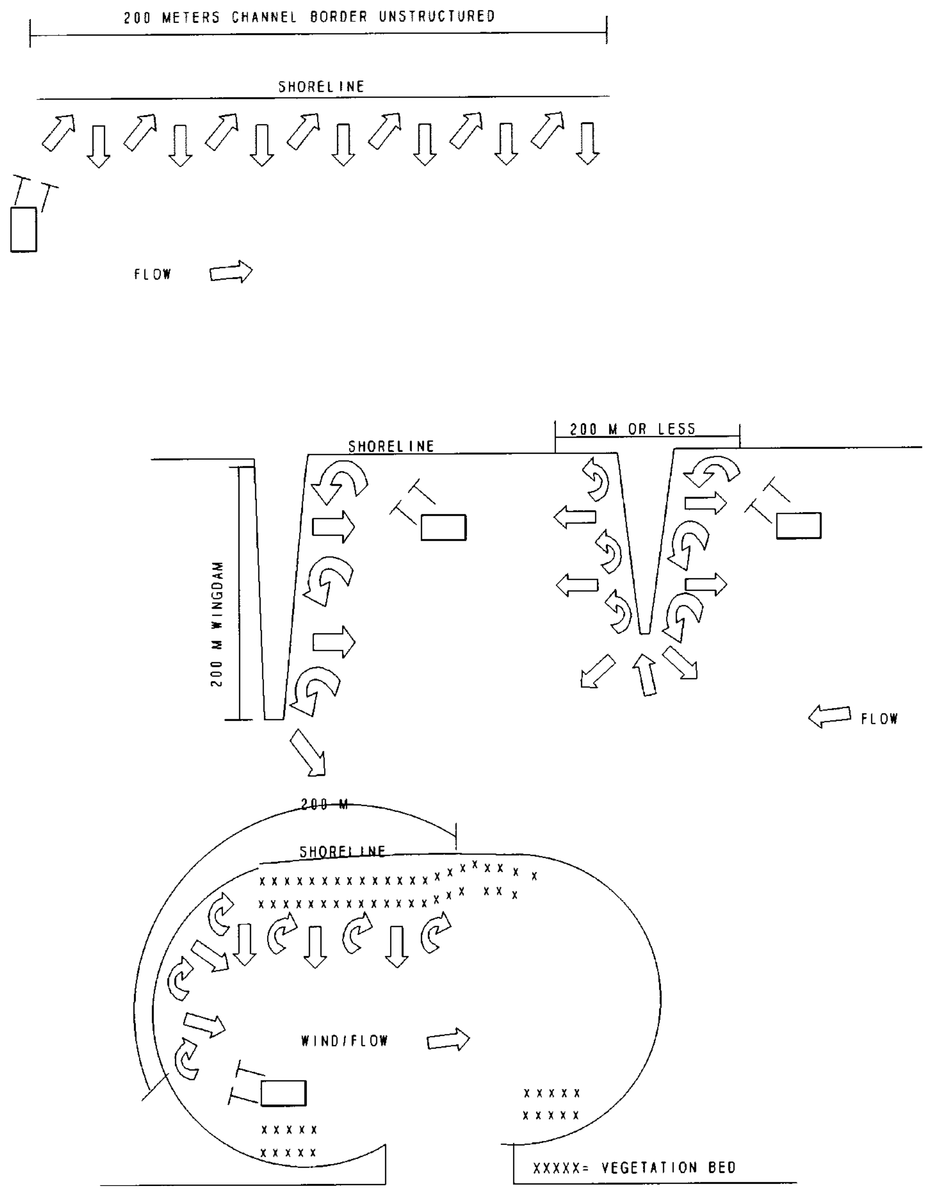


Figure 1. Boat maneuvers during electrofishing in various habitat types

Accessory physical and water quality measurements made near the center of the sampling site *before* electrofishing are water temperature, current velocity (20 cm below the water surface), average water depth in the sampled area, Secchi transparency (daytime only), conductivity, and qualitative appraisals of substrate composition, vegetation, and other proximate structures.

4.2 Hoop Netting

An LTRMP hoop net set consists of paired deployment of a large baited hoop net and a small baited hoop net. The standard unit of hoop netting effort is the net-day, where days are 24.0 h and each hoop net cab counts as one net. Therefore, a 48-h deployment of a pair of hoop nets produces an effort of 4.0 net-days.

Large hoop nets (Model H25F, Memphis Net and Twine, Co., Inc., Memphis, TN, or exact equivalent) have seven fiberglass hoops and are 4.8 m (16 ft) long. The first hoop is 1.2 m (4 ft) in diameter; successive hoops decrease incrementally in diameter by 2.5 cm (1 inch) toward the cod end of the net. The #8 nylon netting, 3.7-cm (1.5-inch)-diameter bar mesh, is protected with a black asphalt-type coating (Netcoat, Memphis Net and Twine Co., Inc. or equivalent). Two finger-style throats are attached, one to the second hoop and one to the fourth hoop. The throat on the second hoop is 15.5 meshes long and has an aperture circumference of 35 meshes. The throat on the fourth hoop is 13.5 meshes long and has an aperture circumference of 26 meshes. The cod end has a 2.4-m (8-ft)-long drawstring made of 0.63-cm (0.25-inch)-diameter asphalt-coated nylon cord.

Small hoop nets (specially ordered from Memphis Net and Twine Co., Inc. or exact equivalent) have seven fiberglass hoops and are 3 m (10 ft) long. The first hoop is 0.6 m (2 ft) in diameter; successive hoops decrease incrementally in diameter by 2.5 cm (1 inch) toward the cod end of the net. The nets are constructed from #9 nylon netting with 1.8-cm (0.75-inch)-diameter bar mesh and are protected with a black asphalt-type coating (Netcoat, Memphis Net and Twine Co., Inc. or equivalent). Two finger-style throats are attached to the second and fourth hoops. The throat on the second hoop is 14 meshes long and has an aperture circumference of 28 meshes. The throat on the fourth hoop is 12.5 meshes long and has an aperture circumference of 22 meshes.

Both nets are baited with 3 kg of soybean cake, 1 kg placed in a 1.9-cm (0.75-inch)-diameter mesh bag attached to the rear of the net, and 2 kg placed loosely in the rear of the net (where current velocity is high this bag may consist of 0.6-cm [0.25-inch] mesh and all bait may be placed in this bag).

Hoop nets are deployed in pairs, with both members placed in the same habitat stratum. Hoop nets are fished with the open end of the net facing downstream. Depth must be sufficient to submerge all throats of hoop nets.

Beginning in 1993 and continuing to the present, the two hoop nets are deployed in parallel sets, with the smaller net nearer shore (Fig. 2). The nets do not have to be placed adjacent to each other but may be displaced longitudinally when doing so will help satisfy depth requirements. Hoop nets may be deployed in sites where depth is sufficient to submerge the throats of nets. Each hoop net is anchored using a 15-61-m (50-200-ft)-long lead rope tied to a stake or a net anchor, whichever works best given substrate composition, depth, and velocity conditions at the sample location. Wherever current is sufficient to hold the nets open, the lower end is not bridled. Where current speed is insufficient to hold a hoop net open, a 15-m (50-ft)-long line is tied to a two-strand bridle at the mouth of the net and is tied to an anchor or stake to hold the net open. A visible float and rope may be attached to the mouth of the

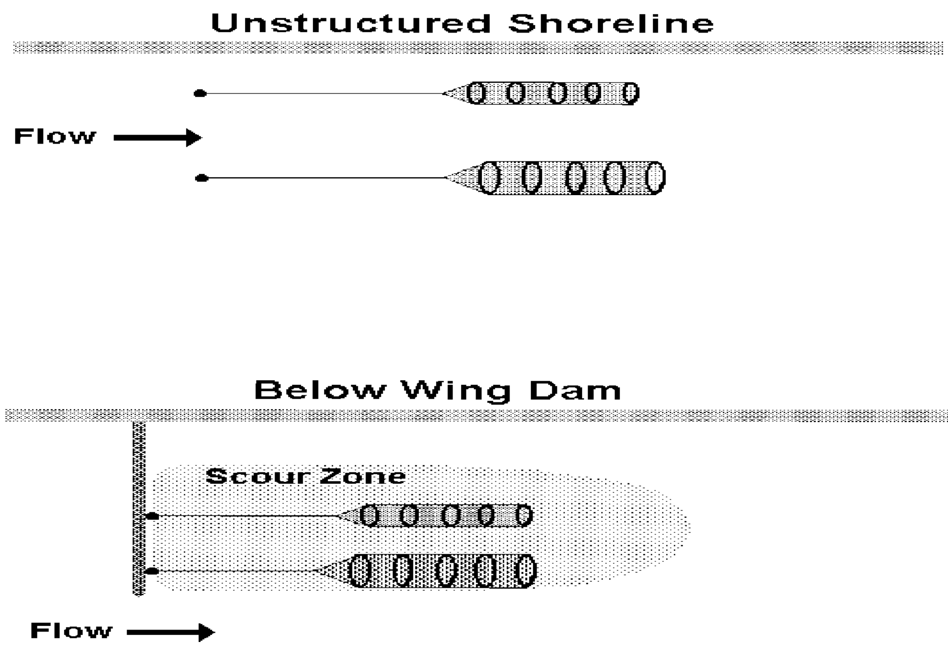


Figure 2. Placement of large and small hoop nets along unstructured shoreline and downstream from wing dams

net to aid retrieval. However, this float line must not lift the net from the bottom. At wing dam sites, hoop nets (cabs) are set within 100 m below the wing dam and within the scour hole (if present). The large net is placed near the tip of the wing dam and the small net is placed approximately halfway between the shoreline and the tip of the wing dam. Separate Collection and Measurement Sheets (Appendixes C and D) are completed for each net.

Note: Prior to 1993, hoop nets were deployed differently; the two nets were connected in series, and the pair was treated entirely as a single net (Appendix E). The larger hoop net was positioned upstream of the smaller hoop net. It was anchored with a 15-m (50-ft) rope tied to a stob or a net anchor, whichever worked best given substrate composition, depth, and velocity conditions at the sample location. A 15-m (50-ft) rope connected a two-strand bridle at the mouth of the larger hoop net to the tail of the smaller hoop net. A 15-m (50-ft)-long line was tied to a two-strand bridle at the mouth of the small hoop net to anchor the downstream end of the net if current velocity was insufficient to hold the nets open. Where current was sufficient to hold the nets open, the lower end was usually not bridled. Catches were not recorded separately for each net prior to 1993. This

method of deployment was abandoned in 1993 because results of a study sponsored by the Open River Field Station indicated this set was inferior to each of several detached deployments.

A standard net-set has a duration of 48 h. The net is retrieved by towing a grappling hook to snare the lead line or by lifting the optional float attached to the mouth of the net.

Accessory physical and water quality measurements made near the center of the sampling site when the nets are set are water temperature, current velocity (20 cm below the water surface), depth of net set (for each net), Secchi transparency (daytime only), and qualitative appraisals of substrate composition, vegetation, and other proximate structures.

4.3 Seining

Seining is used to collect small fishes in shallow areas. The standard unit of seining effort is the net haul. The time duration of seining effort is not recorded.

Seines are made of "Ace"-type nylon netting with a mesh size of 3 mm (1/8 inch). Seines are 10.7 m (35 ft) long and 1.8 m (6 ft) high, with a square bag measuring 0.9-m (3-ft) on each side located at the center of the net. The Open River Field Station uses a seine having a mudline and 5-mm (3/16-inch) mesh to accommodate soft sediments and high current velocities. Seines may be coated with a preservative as long as the mesh remains flexible and is not plugged; preservatives may have to be thinned using a suitable solvent.

Seines are fished along banks in water not exceeding 1.2 m (4 ft) in depth. One end (the downstream end in flowing water habitats) of the seine is anchored to the bank; the other end is deployed perpendicular to the bank and is swept, fully extended, around a 90-degree arc (quarter haul) to the shoreline in the downstream direction. This motion will sweep a quadrant approximately 4.6 to 5.2 m (15 to 17 ft) in radius. The seine haul is made slowly to ensure that the lead line remains in contact with the river bottom and that the float line remains on the surface of the water at all times.

Seining at a site consists of a minimum of two hauls, with the first haul the farthest downstream and the last haul the farthest upstream. Optionally, as many as four hauls may be made at one site. Data from each haul are recorded separately; see Section 6.2.3 for instructions.

In areas where snags are anticipated, a third person patrols the back of the seine, clears the lead line as necessary to keep it in contact with the bottom substrate, and attempts to minimize disturbance to fish in front of the seine. If the haul is interrupted by two or more snags that in the judgment of the Crew Leader require an excessive amount of clearing time, the seine haul is terminated and a new haul is initiated in undisturbed water.

Accessory physical and water quality measurements made near the center of the sampling site area *before* seining are Secchi transparency, water temperature, current velocity (20 cm below the water surface), depth, and qualitative appraisals of substrate composition, vegetation, and other proximate structures.

4.4 Fyke Netting

Fyke nets are deployed with leads fully extended and without respect to maximum depth in areas where depth is at least sufficient to submerge the throats of nets, with two exceptions. The first exception is where bed slope along the length of the lead is steeper than approximately 30 degrees (i.e., where the cabs of shoreline sets would lie in depths greater than approximately 7.6 m [25 ft]). The second exception is in tailwaters where full extension of a lead would put the cab in an eddy current that could roll the net. Where either exception occurs, leads may be shortened to no less than 40% of their extended length (i.e., no less than 6.1 m or 20 ft) to place the top of the cab at or above the water surface. If this minimum lead length is not sufficient to remedy either exception, an alternate sampling site must be used. When leads are shortened, a Summary Code value of 6 is recorded for otherwise normally completed samples. The leads are extended from the bank, a densely vegetated "edge," or the lead of another fyke net (paired off-shore deployment). The standard unit of fyke netting effort is the net-day, where a day is 24.0 h and each cab counts as one net. Thus, a tandem set (see below) deployed for 27 h is an effort of 2.25 net-days.

The LTRMP uses Wisconsin-type fyke nets (trap nets) that contain three sections: the lead, the frame, and the cab. All netting material is #12 nylon, 1.8-cm (0.75-inch)-diameter bar mesh, with a black asphalt-type coating (Netcoat, Memphis Net and Twine Co., Inc., or equivalent). The lead is 15 m (50 ft) long and 1.3 m (4.5 ft) high. The frame and the cab are covered with nylon mesh. Together, the frame and the cab are 6 m (20 ft) long when fully extended. The frame section is formed by two rectangular spring-steel (6.3-mm [0.25-inch] black-oil-tempered rod) frames that are 0.9 m (3 ft) high and 1.8 m (6 ft) wide and have 0.9-m high vertical crosspieces in the centers. Two mesh wings extend from the sides of the first frame toward the middle of the second frame such that there is a 5.1-cm (2-inch) vertical gap between each wing and an extension of the lead that is tied between the vertical crosspieces and bisects the frame section. The cab is constructed of six 0.9-m (3-ft)-diameter spring-steel hoops. Two throats are attached to the first (from the frame) and third hoops. The square-style throat on the first hoop is 20 meshes long and has an aperture circumference of 40 meshes. The crow-foot throat on the third hoop is 28 meshes long and has an aperture circumference of 32 meshes. The cod end has a 2.4-m (8-ft)-long drawstring made of 6.3-mm (0.25-inch)-diameter asphalt-coated nylon cord.

In nonvegetated backwater and impounded habitats with open shorelines, fyke nets are fished with the lead anchored to shore or other structure in low velocity, shallow water habitats. The net and lead are positioned perpendicular to shore (Fig. 3).

In densely vegetated backwater contiguous and impounded habitats where vegetation creates a false or pseudo-shoreline, fyke nets are fished perpendicular to the vegetation bed (Fig. 3). The lead must be set 1 m (3.2 ft) inside the outer edge of the weed bed.

In offshore impounded or backwater sites, two fyke nets are fished end-to-end (tandem set), with the leads tied together (Fig. 3). The fyke nets are anchored at both ends in low velocity, shallow water habitat. The end-to-end fyke net sets require a different gear code than traditional sets (Table 1).

Accessory physical and water quality measurements made near the cab mouth when the net is set are water temperature, current velocity (20 cm below the water surface), depth, Secchi transparency, and qualitative appraisals of substrate composition, vegetation, and other proximate structures.

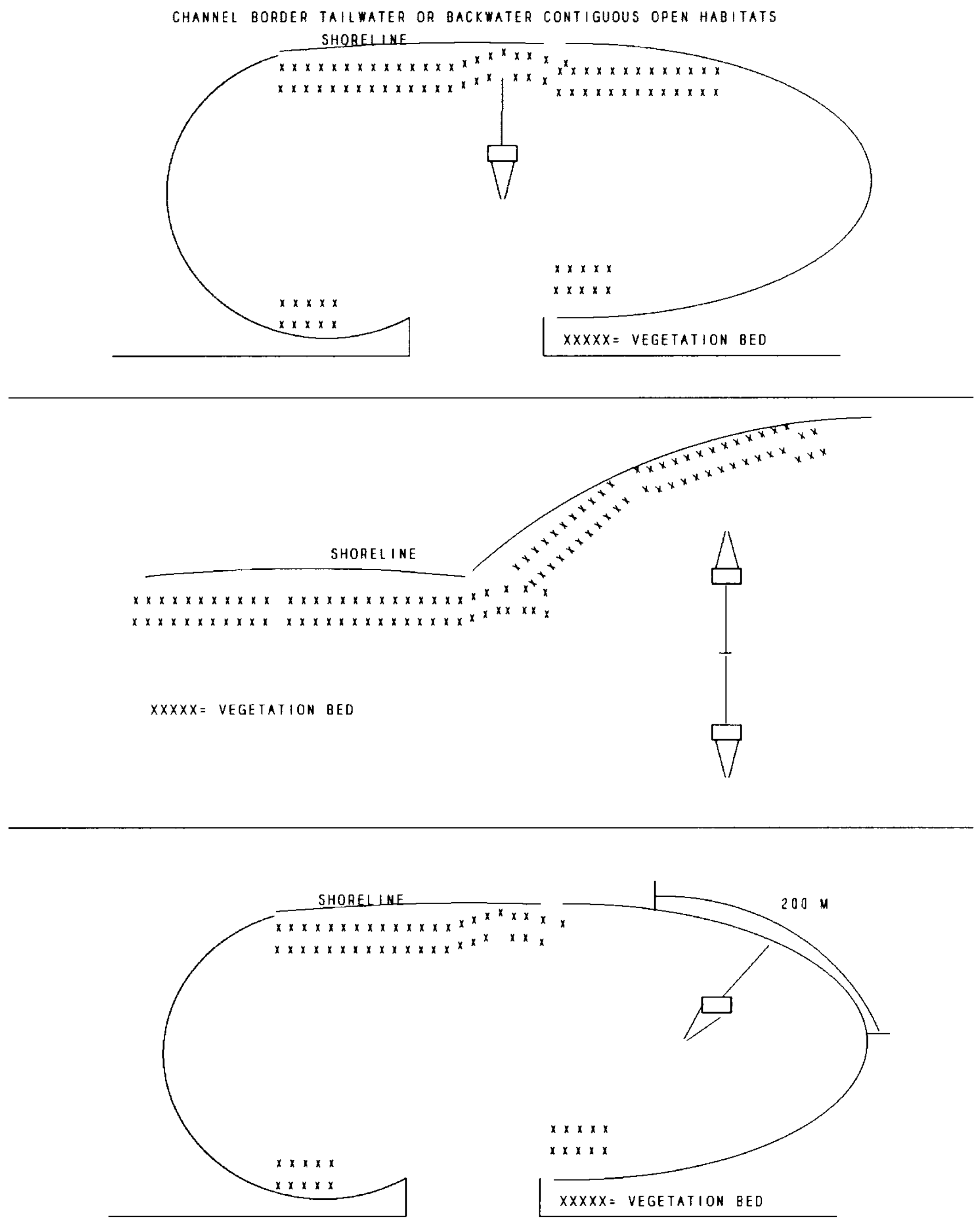


Figure 3. Placement of fyke and mini fyke nets in various habitats

Table 1. Long Term Resource Monitoring Program fish sampling gear codes

Code	Gear type
D	Day electrofishing
N	Night electrofishing
F	Fyke net
X	Tandem fyke nets
M	Mini fyke net
Y	Tandem mini fyke net
GL	Gill net - set parallel to shoreline (experimental option)
GR	Gill net - set perpendicular to shoreline (experimental option)
H	Tandem (connected) hoop nets (obsolete)
HS	Small hoop net
HL	Large hoop net
P	Tandem hoop nets for population sampling (obsolete)
S	Seine net
B*	Seine net pulled by boat (experimental and obsolete)
T	Trawl
TA	Trammel net, anchored set
TD	Trammel net, floating and drifting

*Seine pulled by boat over soft sediments or offshore. This method was used experimentally and is obsolete.

4.5 Mini Fyke Netting

In tailwater border aquatic areas, mini fyke nets are set so that the tops of the cabs are at or above the water surface. To achieve such placement in tailwater borders, leads may be shortened to no less than 1.8 m (6 ft). In all aquatic areas other than tailwater borders, mini fyke nets are deployed according to the criteria for extension of leads used for fyke nets (see Section 4.4). Where shortening of leads on mini fyke nets is permitted, these leads may be shortened to no less than 1.8 m (6 ft). The standard effort unit is as per fyke nets (see Section 4.4).

The LTRMP uses Wisconsin-type mini fyke nets (trap nets) that contain three sections: the lead, the frame, and the cab. All netting material is 3-mm (0.125-inch) "Ace"-type nylon mesh coated with green latex net dip. The lead is 4.5 m (15 ft) long and 0.6 m (2 ft) high. The frame and cab are covered with nylon mesh. Together the frame and the cab are 3 m (10 ft) long when fully extended. The frame section is formed by two rectangular spring-steel (0.63-cm [0.25-inch] black-oil-tempered rod) frames that are 0.6 m (2 ft) high and 1.2 m (4 ft) wide. Two mesh wings extend from the sides of the first frame toward the middle of the second frame so that there is a 5.1-cm (2-inch) vertical gap between each wing and an extension of the lead that bisects the frames. The cab is constructed of two 0.6-m (2-ft)-diameter spring-steel hoops. One throat is attached to the first (from the frame) hoop and has an aperture diameter of 5 cm (2 inch) that is fixed using a stainless-steel ring. The cod end has a 1.8-m (6-ft)-long drawstring made of 4.4-mm (0.187-inch)-diameter asphalt-coated nylon cord.

The same procedures used for setting the large fyke nets apply to mini fyke nets (see Section 4.4). Mini fyke nets are used in backwater, channel border, side channel, and impounded habitats. Samples collected using mini fyke nets require a different gear code than regular fyke nets (Table 1). Accessory measurements are as per fyke nets.

4.6 Trawling

Trawling is conducted at permanently fixed sampling sites in tailwater zones and unstructured channel borders. The LTRMP trawls primarily collect small fishes. The standard unit of trawling effort is the 350-m-long haul.

Two-seam, 4.8-m (16-ft)-wide and 4.5-m (15-ft)-long slingshot balloon trawls (TRL16BC, Memphis Net and Twine Co., Inc., or equivalent) are used. The body of the trawl is made of #9 nylon with 18-mm (0.75-inch)-diameter stretch mesh. The bag of the trawl is made of #18 nylon with 18-mm (0.75-inch)-diameter stretch mesh. The bag contains a 1.8-m (6-ft) liner consisting of 3-mm (0.125-inch)-diameter mesh. Floats are spaced every 0.91 m (3 ft) along the top line and 4.8-mm (0.1875-inch) chain is tied to the bottom line. The trawl is operated with 37-cm-high by 75-cm-long (15- x 30-inch) otter boards (Memphis Net and Twine BD2 or equivalent) pulled with 30-m (100-ft) tow lines.

Trawls are made in the downstream direction at a speed that keeps the lead line of the net in close contact with the river bottom. Nominal trawl lengths are 350 m (1,148 ft). The amount of time required to cover this distance is reported as sample time in minutes.

Trawling at a site consists of a minimum of six hauls if the site is in main or side channel border areas and four hauls if the site is in a tailwater zone. Data from each haul are recorded separately; see Section 6.2.3 for recording instructions.

Accessory physical and water quality measurements made *before* trawling are water temperature, current velocity (20 cm below the water surface), depth, Secchi transparency, and qualitative appraisals of substrate composition and other proximate structures.

4.7 Gill Netting

Beginning in 1993, gill nets are an *optional* experimental sampling gear. This option was included to improve monitoring capabilities for some large riverine species. The standard unit of gill netting effort is the net-day, where a day is 24 h.

Gill nets are 91.44 m (300 ft) long and consist of four 22.86-m (75-ft) panels of monofilament mesh. The panels are 2.44 m (8 ft) deep. Each panel consists of a different size mesh. Mesh sizes are 10.2, 15.2, 20.3, and 25.4 cm (4, 6, 8, and 10 inch) stretch measure. The 10.2- and 15.2-cm (4- and 6-inch) mesh is woven from #8 (9.07-kg [20-lb] test) transparent nylon monofilament, and the other meshes are woven from #12 (13.61-kg [30-lb] test) transparent nylon monofilament. The top line consists of floating foam core rope and the bottom line is 13.61-kg (30-lb) lead core rope. Additional lead may be added to the lead line as needed to sink gill nets.

Gill nets may be set either perpendicular or parallel to the shoreline. Perpendicular sets caught nearly four times as many fish as the parallel sets during limited experimental use by the Open River Field Station. Perpendicular sets are preferred but may be impractical where current velocity is substantial. Gear codes are *GR* for **G**ill net-perpendicula**R** and *GL* for **G**ill net-paralle**L**.

Record count and lengths of captured fishes separately for each panel. Mesh size is recorded in User-Defined Field 12 on the LTRMP *Fish Measurement Sheet* (see Section 6.2.3). If no fish are caught in a particular mesh size, record the mesh size, a species code of NFSH (no fish caught) and a count of zero.

Accessory chemical and physical measurements, as per fyke netting, are made near the center of the gill net set when the net is set.

4.8 Trammel Netting

Beginning in 1994, trammel nets are an *optional* experimental sampling gear. Experimental use of trammel nets was adopted to explore improvement of detection of large riverine species.

Experimental trammel nets are 274 m (300 ft) long and 1.8 m (6 ft) deep. The interior panel consists of 7.6-m (3-inch) bar mesh. The wall panels are 34-cm (14-inch) bar mesh. All netting is constructed of #208 multifilament nylon. Trammel nets have a poly-core float line and 30-lb lead-core lead line.

Because use of trammel nets is experimental within the LTRMP, there are currently no requirements for sampling. Trammel nets may be used to explore fish communities in any aquatic area. Trammel nets may be anchored (Gear Code TA) or drifted with current (Gear Code TD).

5. Sampling Requirements

5.1 Sampling Design

5.1.1 General Aspects

Beginning in 1993, the LTRMP fish monitoring effort is based on a stratified random sampling design (Gutreuter 1993) augmented with relatively few subjectively chosen permanently fixed sampling stations (restricted to tailwaters below dams and a few backwaters and other areas of special interest) within six LTRMP study reaches. The stratified random sampling design enables unbiased design-based estimation of relative abundance and other statistics (Cochran 1977), and supports interpretation of model-based hypothesis tests. Prior to 1992, all LTRMP fish sampling was conducted at subjectively chosen permanently fixed sampling sites (see Appendix F for a description).

5.1.2 LTRMP Fish Sampling Strata

LTRMP fish sampling is conducted in nine strata. The strata are based on enduring geomorphic and physical features, called aquatic areas (Wilcox 1993), that help define important habitat types for fishes (Gutreuter 1992). The terminology used here is consistent with that in Wilcox (1993) except where noted below. Transient features such as vegetation create important habitats for many species but have proven to be too ephemeral to serve as sampling strata. Important transient features are recorded at the time of sampling. The LTRMP fish sampling strata are defined as follows:

a. *Main channel border-unstructured area* (MCB-U). An unstructured main (navigation) channel border area is that aquatic area between the margins of the main navigation channel and the nearest natural shoreline areas (island or mainland). A natural shoreline area is any shoreline, excluding dams, lock walls, and wing dams (see definition below). Revetted shoreline, although human-made, is included in MCB-U. An unstructured channel border area is important because it is a large stratum and supports many riverine species.

b. *Main channel border-wing dam area* (MCB-W). A main (navigation) channel border-wing dam area is a localized portion of main navigation channel border area in which a wing dam is the predominant physical feature. Wing dams are artificial structures that act to restrict flow to the navigation channel and are usually constructed of rock (see also Wilcox 1993). Wing dams protrude from the shoreline and may be totally submerged or emergent, depending on water elevation and construction height. Fish sampling by the LTRMP is restricted to those wing dams that are at least 50 m long (from shore to tip). Because wing dams create eddy currents and areas of low flow speed, LTRMP sampling is further restricted to those wing dams that have an exploitable hydraulic effect. Therefore, wing dams submerged under more than 2 m of water are not sampled, and wing dams submerged under 1-2 m of water may not be sampled if current velocity over the top exceeds 0.5 m/s. Wing dams are important because they concentrate some fishes.

c. *Side channel border* (SCB). A side channel border is the border of all secondary and tertiary channels (Wilcox 1993) that have terrestrial margins and carry flow downstream through the floodplain (and hence have measurable current velocities) at normal water elevations. For the purpose of LTRMP fish sampling, fully submerged secondary or tertiary channels that do not have terrestrial margins (such as may occur in impounded areas above dams) are not distinguished as side channels. Shallow narrow side channels may not have a well defined trough or thalweg, in which case the borders extend to mid-channel. Side channels are important because they are lotic areas that are relatively unaltered and isolated from navigation traffic.

d. *Tailwater zone* (TWZ). For the purpose of LTRMP fish sampling, the tailwater zone is defined as the area immediately downstream from a lock and dam and includes the plunge-pool (scour hole) created by the dam. The tailwater border is defined as the first 500 m of shoreline below a lock and dam. Tailwater zones provide unique conditions that act to concentrate many fishes, including important large riverine species such as shovelnose sturgeon. Because tailwaters are small and are of special interest, LTRMP fish sampling is conducted at permanently fixed sites within tailwaters. Sampling site locations are not randomly selected within tailwaters.

e. *Backwater, contiguous-offshore* (BWC-O). Contiguous backwaters are aquatic areas that have some contiguous aquatic link to the main navigation channel but are separated from the main channel by a terrestrial area. Additionally, for the purpose of fish sampling within the LTRMP, backwaters are further defined as lacustrine areas; they do not carry flow at normal river elevations. Backwaters may consist of floodplain depression lakes, sloughs (contiguous abandoned-channel lakes), lateral levee lakes, contiguous scour channel lakes, and artificial lacustrine areas (Wilcox 1993). Contiguous backwater-offshore areas are contiguous backwaters more than 50 m from the nearest shoreline. Small backwaters may not have such an offshore area.

f. *Backwater, contiguous-shoreline* (BWC-S). Contiguous backwater-shoreline areas are those areas of backwaters, as described in (e) above, that are within 50 m of the nearest shoreline.

g. *Impounded-offshore* (IMP-O). Impounded areas are usually large, mostly open-water areas located immediately upriver from locks and dams. Water elevations are held above pre-impoundment levels by the dams. Impounded areas may contain submerged channels and areas that were terrestrial before impoundment. An offshore impounded area is that portion of the impounded area more than 50 m from the nearest shoreline.

h. *Impounded-shoreline* (IMP-S). Impounded shoreline areas are those portions of impounded areas (as per *h* above) within 50 m of the nearest shoreline.

i. *Main channel trough* (CTR). The main channel trough is the thalweg or navigation channel within the main channel. This channel is usually identified as the area between the navigation buoys. From 1990 through 1992, trawling was conducted in the main channel trough. Trawling in the main channel trough was suspended in 1993 for lack of efficacy, and experimental evaluations of replacement methods were initiated.

j. *Tributary mouth* (TRI). The tributary mouth is the portion of a tributary stream that is within the floodplain of a large river. The LTRMP does not conduct routine monitoring in tributary mouths, but this aquatic area is sampled as part of specialized LTRMP projects.

k. *Tributary delta lakes*. Lake Pepin, a tributary delta lake (Wilcox 1993) in Pool 4 of the Mississippi River, contains unique habitats, nonexistent in other reaches of the Mississippi and Illinois Rivers, and requires specialized sampling. Because Minnesota Department of Natural Resources fisheries personnel conduct ongoing monitoring in Lake Pepin, the LTRMP does not conduct fish monitoring in Lake Pepin.

5.1.3 Allocation of Sampling Effort

Sampling gears are deployed independently within strata. That is, separate lists of randomly selected sampling sites are generated for each gear type. Because some gears cannot be deployed under certain conditions, not all gears are deployed in each stratum; however, there are at least three mandatory gears for each stratum. Because the proportions of various strata vary among study reaches, gear effort is allocated on a reach-specific basis. The mandatory and optional gears and general guidelines for effort allocation during each sampling time period are given in Table 2.

Table 2. General gear effort allocation guidelines. Because the proportions of strata vary dramatically among Long Term Resource Monitoring Program study reaches, actual effort allocations may be different.

	Strata												
	MCB-	**MCB-**		**BWC-O**		**BWC-S**			**IMP-O**		**IMP-S**	
Gear	**U**	**W**	**SCB**	**u**	**v**	**u**	**v**	**TWZ**	**u**	**v**	**u**	**v**
D	+	+	+	o	+	+	+	o	o	+	+	+
N	o	o	o	o	o	o	o	+	o	o	o	o
F	o	o	o		+	+	+	o		+	+	+
M	+	+	+		+	+	+	o		+	+	+
S	o		o			o					o	
T	o		o					+				
H	+	+	+	+	o	o	o		+	o	o	o
G	o	o	o	o	o	o	o		o	o	o	o
X				+					+			
Y				+					+			
% Effort	12	12	26	5		25		10	5		5	

MCB-U = Main channel border-unstructured area; MCB-W = Main channel border-wing dam habitat; SCB = Side channel border; TWZ = Tailwater zone; BWC-O = Backwater, contiguous-offshore; BWC-S = Backwater, contiguous-shoreline; IMP-O = Impounded-offshore; IMP-S = Impounded-shoreline; u = Unvegetated; v = Vegetated

D = Day electrofishing; N = Night electrofishing; F = Fyke net; M = Mini fyke; S = Seine net; T = Trawl; H = Tandem (connected) hoop nets (obsolete); G = Gill nets; X = Tandem fyke nets; Y = Tandem fyke nets

+ = Mandatory; o = Optional

Effort allocation among strata does not compromise unbiased estimation in stratified random sampling. However, effort allocation does influence the precision of estimates. The approximate sampling allocation (Table 2) was based on subjective appraisals of the ecological importance of strata to river fishes, approximate size, and the objectives of the LTRMP. Optimal allocation schemes were considered but were abandoned because minimization of variance required allocation of the preponderance of samples to the impounded stratum and neglected ecologically important strata such as side channels and backwaters. Sample allocation affects precision of estimates within and across strata but does not affect the unbiasedness of stratified random sampling. Therefore, allocations of sampling effort among strata need not remain constant through time or among study reaches.

5.1.4 Seasonal Distribution of Fish Collections

Full sets of collections are made in all strata during each of three time periods: June 15 to July 30, August 1 to September 15, and September 16 to October 30. Prior to 1991, time allocations were different (Appendix F). The primary purpose of this seasonal allocation of samples is to ensure data are collected that represent warm season conditions.

5.1.5 Random Selection of Collection Sites

Prior to the sampling season, lists of primary and alternate sample collection sites are generated. Collection sites are represented by a 50- × 50-m grid in a geographic information system (GIS) database. Grids are indexed and referenced by Universal Transverse Mercator (UTM) coordinates. The GIS database includes delineations of the known extent of sampling strata. Areas known to be inaccessible, either for lack of legal access or due to physical conditions that preclude boat travel, are deleted from the sampling frame. Within each study reach, the grids are classified as to whether they represent areas in the upper or lower half (segment) of the study reach. Within each stratum, grids are selected at random, with uniform probability, to produce a list of primary collection sites for each sampling gear. For each primary collection site, the set of all grids within the stratum that occur within a 1-km radius of the center of the collection site is identified, and a second random selection of grids is made from this set. This second random selection process produces a list of alternate collection sites. The lists of primary and alternate collection sites are sent to field stations prior to sampling.

5.1.6 Location of Collection Sites During Sampling Operations

The centers of collection sites can usually be located to within 100 m by comparison of actual physical features with a corresponding base map. Sites that are in off-shore impounded areas or complex mazes of channels may be difficult to locate in this way and a Global Positioning System (GPS) receiver may have to be used. Accuracy of the Magellan (Magellan Systems Corporation, Monrovia, CA) GPS units used by the LTRMP is 100 m under good conditions.

During a particular sampling venture, the primary site is located in the field and a determination is made as to whether or not the particular gear can be deployed. This determination is based on a simple assessment of whether or not the sampling gear can be physically deployed at the site. The primary consideration is whether depth is sufficient to permit access to the area and to deploy the gear. If it is determined that the primary site could not be sampled (1) the header box of an LTRMP *Fish Collection Sheet* is completed (except for finish date and time) with a Summary Code of *2*, (2) depth is recorded and a "Comment" is entered explaining the condition that prevents sampling, and (3) the nearest alternate site is located. This process may be repeated until an alternate site is found that can be sampled; however, LTRMP *Fish Collection Sheets* are not required for alternate sites that could not be sampled. If a site can be sampled with a particular gear, the gear is deployed according to procedures for that gear.

Field station staff schedule sampling operations. Sampling efforts using the various gear must be interspersed, as must visitation to collection sites in different segments of study reaches. For example, all of the electrofishing must not be conducted within a single 1-week period, nor must sampling proceed systematically from one end of the study reach to the other. Field Station Team Leaders and Fisheries Specialists are responsible for ensuring that use of various sampling gears and sampling within upper, middle, and lower segments of study reaches are interspersed though each time period.

5.2 Fish Identification and Measurement

5.2.1 General Information

This section contains guidelines for collection and recording of fish data. The data collected during fish sampling consist of (1) an unambiguous description of the sample in space and time, (2) site-specific observations and measurements of habitat characteristics, (3) quality control information, and (4) enumerations and measurements of fish catches. Instructions for coding data sheets are given in Section 6. Appendix G contains suggested references to be used as keys in the identification of fish.

5.2.2 Identifying, Measuring, Weighing, and Enumerating Fish

For LTRMP routine monitoring collections, fish must be identified to species to the extent reasonably possible. Fish that cannot be identified to species must be preserved and returned to the lab for identification and enumeration (see Section 5.2.7). Scientific and common names are those most recently established by the American Fisheries Society. Four-character fish codes (Appendix H) established by the EMTC are used for reporting species on data sheets. For comparative purposes, the LTRMP also maintains and provides a reference file of species identification codes used by other fish collection agencies. Counts by species and length category are required.

Prior to 1992, individual measurements of lengths and weights were required for all species in all collections. Beginning with the 1992 field season, *individual* lengths and weights are required only from subsamples of black crappie, channel catfish, common carp, highfin carpsucker, sauger, and walleye captured during the last time period. These subsamples consist of haphazard (approximately random) selection of at least two (2) individuals per length group. Additional individual length and weight measurements may be recorded, but this should be done only to satisfy specific objectives. One scenario where additional individual length measurements are useful is providing data for formal length frequency analysis to estimate growth and mortality parameters. Obviously, such special objectives should be carefully considered on a case-by-case basis and must be coordinated with the EMTC Fisheries Component Specialist. Length group counts are required for all species.

Whenever possible, the maximum total length (MTL) of an individual fish is measured to the nearest 1 mm. Maximum total length is the greatest possible length of the fish with mouth closed and caudal rays squeezed together to give the maximum overall measurement (Anderson and Gutreuter 1983). Standard length (SL; the maximum distance from the front tip of the fish to the posterior margin of the hypural bone as manifested by the "notch" created by flexing the caudal peduncle; Anderson and Gutreuter 1983) is recorded for specimens that have damaged or deformed caudal fins, but these individuals are not included in population structure analyses. Fork length (FL; the maximum distance from the front tip of the fish to the posterior edge of the median caudal fin rays; Anderson and Gutreuter 1983) may be used for fish such as paddlefish and sturgeon that have rigid upper caudal lobes or variable caudal filaments. All individual length measurements are reported in millimeters on fish data sheets.

A Pathogenic Code (Table 3) is recorded for individual fish showing visible external injury, disease, anomaly, or parasite burden. This code is recorded in the "PC" field.

Table 3. Fish health and pathogen codes for Long Term Resource Monitoring Program fisheries component

Code	Abnormality
0	None
1	Parasite
2	Skeletal abnormality
3	Tumors
4	Injury
5	Skin/fin/eye
6	Other

A Summary Code is assigned to the collection to document the overall status of important conditions that can affect proper interpretation of the data (see Table 4). Therefore, the correct selection of this Summary Code value is a critical task. Crew Leaders are responsible for selection of the most accurate Summary Code. Crew Leaders must not be pressured by participating agencies to select inappropriate Summary Codes. Any suggestion of incentives to choose inaccurate Summary Codes must be reported to the EMTC Fisheries Component Specialist. Summary Codes of 1-2 describe unsuccessful sampling attempts, and Summary Codes 3-8 describe various degrees of sampling success. A Summary Code of 5 is reserved for ideally completed samples. In general, data from collections having Summary Codes ≥3 may be used in analyses and reports. Exceptions to this rule apply to specific data. For example, weight data from collections having a Summary Code of 4 (weighing equipment probably in error) should not be used to construct weight-length equations.

5.2.3 Subsampling

If the number of specimens collected prevents timely identification and measurement in the field, specimens may be preserved in formalin or a subsample may be selected for measurement followed by enumeration or estimation of the remaining sample. Subsampling is defined as dividing an unmanageable collection of one species of fish into a representative manageable sample in which lengths and weights are recorded along with the total number of fishes in the collection. Subsampling is necessary to keep fish alive and to keep sampling time manageable. The Crew Leader determines whether or not the sample is too large to efficiently work up. A subsample must not consist of fewer than 100 fish of a species. Where practical, fish in the total sample should be counted. For large catches, the count may be estimated by weighing and counting a subsample of approximately 100 fish, weighing the total sample, and then calculating the total count, $\hat{n}_t$, as

$$\hat{n}_t = n_s w_t / w_s,$$

where n_s and w_s are the count and weight, respectively, of the subsample, and w_t is the weight of the total sample. Because the density of fish flesh is nearly constant (to achieve neutral buoyancy), volume is proportional to weight. Therefore, volumetric measures may be used rather than weight measures in the equation above.

Table 4. Sampling Summary Codes, which range from 1 to 8 and document the success or failure of a sampling attempt. Codes of 1 and 2 describe unsuccessful sampling attempts. Codes 3-8 describe successful sampling attempts.

Summary code	Description
	Unsuccessful collection attempts:
1	Sampling gear failed. The site may be resampled, within the current time period, as time permits. Explain gear failure in Comments.
2	Habitat cannot be sampled due to environmental conditions (e.g., a dry or inaccessible site). Explain in Comments if site is a primary sampling site.
	Successfully completed collection attempts:
3	Sampling completed under unusual environmental conditions that may have influenced gear efficiency. Explain conditions in Comments.
4	Weighing equipment may be in error (e.g., due to windy conditions, waves).
5	Signifies that: a. The data were collected at the identified time and place. b. All methods followed the LTRMP Procedures Manual. c. All equipment and gear were functional. d. No unusual environmental conditions existed that could prohibit interpretation of the data as being representative of those in the sampled habitat type at that time.
6	Non-critical gear modification (e.g., fyke net lead shortened). Explain modification in Comments.
7	A gear that is normally deployed along a shoreline was deployed along a pseudo-shoreline formed by dense aquatic vegetation or flooded terrestrial vegetation.
8	Minor gear damage or alteration noted at completion of sample. The extent of the alteration or damage was almost certainly insufficient to cause major changes in efficiency. Explain damage or alteration in Comments.

Large fish and species that do not dominate the collection are processed normally. Fish to be subsampled are assumed to be randomly located by size throughout the live well. The field crew mixes the holding tank and then scoops out fish with a standardized scoop net and measures the bulk weight of these fish. **(These fish should also be enumerated if their numbers are not excessive.)** This process is repeated until at least 200 fish of a species remain. These remaining fish are processed normally and weighed in aggregate. **The estimated or enumerated total count of fish not measured is recorded on the data sheet by entering the species code, leaving length blank, and recording the count (bulk weight is optional). Mean lengths from the subsample are no longer recorded for the unmeasured fish in the residual whole sample**.

Specimens that cannot be identified in the field are preserved in suitable plastic containers labeled with the Location Code, Pool/Reach Code, Project Code, Start Date and Time, Gear Code, and Stratum Code. All preserved specimens, with the exception of those sent to an identification expert (see 5.2.8), are identified and measured at the lab as time permits.

5.2.4 Measurements from Key Species During the Last Time Period

Key species are black crappie, channel catfish, common carp, highfin carpsucker, sauger, walleye, and any others as determined by study objectives. During the last time period, individual length and weight measurements may be taken from a subsample of these species from each sampling site where they are captured. These subsamples consist of haphazard (approximately random) selection of at least two (2) individuals per length group. These fish are measured to the nearest 1 mm and are weighed (in grams) to the nearest 1%. **Note: Do not record weights of fish that are <10% of the minimum scale capacity (100 g for a 1,000-g scale) whenever spring-loaded mechanical scales are used; spring-loaded scales are too insensitive for weighing such small fish** (Gutreuter and Krzoska 1994). These subsamples should be made approximately random by using a dip net to take a random sweep and working through all captured fish in the sweep before repeating this process (if necessary).

5.2.5 Collecting Specialized Data: Tagging, Aging Structures, and Food Use

Special objectives may require collection of specialized data. These objectives must be coordinated with the EMTC Fisheries Component Specialist. Currently, the LTRMP collects specialized data to monitor the potential effects of the invasion of zebra mussels on freshwater drum, a molluscivorous fish, and to test certain predictions of the flood-pulse hypothesis. Procedures for these efforts are provided in annual memoranda, which become addenda to this Procedures Manual.

These special objectives require collection of subsample specimens, which may include sagittae (the largest of the three otoliths), scales from below the lateral line and under the tips of pelvic fins when depressed in natural position, stomachs, and stomach contents. Otoliths and scales are placed in small coin envelopes to which a unique barcoded specimen number has been attached. Stomachs and stomach contents are placed in "whirl-pack" bags and preserved with ethanol or other non-acidic alcohol. These bags must either contain a barcoded waterproof label or must be marked with a bar-coded sticker label. The bar code numbers are recorded on LTRMP *Fish Measurement Sheets* (see *Specimen numbers* under User-Defined Fields in Section 6.2.3).

The LTRMP Fish Collection and Measurement Sheets were designed to be adaptable to record specialized data. See Section 6 for procedures for recording specialized data.

5.2.6 Measurements from All Species

The minimal data required for all species are counts by total length class (TLC). Where catches are large, subsampling (Section 5.2.3) may be implemented. Standard TLCs for fish ≤400 mm maximum total length (MTL) are 1-cm intervals and for fish ≥400 mm MTL TLCs are 2-cm intervals. All TLCs are labeled using their lower length boundaries. For instance, fish in TLC 9 are between 90 and 99 mm TL, and fish in TLC 40 are between 400 and 420 mm TL.

5.2.7 Training

The first level of quality assurance associated with the process of data collection for the LTRMP occurs when a data sheet is completed in the field. The person who initials a data sheet testifies that the recorded data are representative of the location being sampled and that the data have been collected according to the procedures described in this manual and demonstrated during LTRMP training courses. Therefore, at least one person in the fish sampling crew is a designated LTRMP Crew Leader, qualified to initial field data sheets by having passed the fish sampling course conducted by the EMTC. This course includes, but is not limited to, fish identification and measurement, gear operation and maintenance, UMRS aquatic areas identification, LTRMP procedures and quality assurance guidelines, and fish population analyses.

Additional safety and first aid training associated with electrofishing is described in Section 4.1, Electrofishing.

5.2.8 Expert Identification and Reference Collections

The EMTC fish training course is designed to provide staff with the ability to readily identify 95% of the fish collected in the field. Recently published identification keys are carried in the field to facilitate field identification. When a specimen cannot be identified to the Crew Leader's satisfaction, it is hardened in formalin and preserved in alcohol in a container labeled with the field station number, location code, date, time, and gear code. The fish is later identified at the field station or is sent to an expert in the field of fish identification. A list of recognized experts in the field of fish identification and their addresses is updated regularly by the EMTC. This list is maintained at each field station (Appendix I).

Reference fish collections are maintained, as needed, at the field stations to assist in identification of rare or unusual species. Collection containers are clearly labeled with scientific and common names of the specimen(s), the date, UTM coordinates and zone, gear type associated with the collection, and the name of the person making the identification.

5.2.9 Investigating Fish Kills

Field personnel will investigate all fish kills in accordance with the *Field Manual for the Investigation of Fish Kills*, U.S. Department of the Interior, Fish and Wildlife Service Resource Publication 177, Fred P. Meyer and Lee A. Barclay, editors.

6. Fish Data Sheets and Coding Instructions

6.1 Overview

Correct and complete recording of data is absolutely essential to the success of all LTRMP efforts. Conversely, failure to comply with data recording procedures compromises the mission of the LTRMP and results in unrecoverable waste of sampling effort. Procedures for recording data are driven by the need for correct information and documentation of quality assurance and chain-of-custody information. Because information critical to future resource management decisions is the primary product of the LTRMP, it is essential that all data are properly recorded. **All LTRMP field staff who collect fish data are expected to understand and comply with data recording procedures**.

Data collected during fish sampling excursions are recorded on two data sheets: the *Fish Collection Sheet* and the *Fish Measurement Sheet*. A collection is defined as a sampling venture consisting of a *unique* combination of location, time, and sampling gear. One *Fish Collection Sheet* (Appendix C; EMTC 03/24/95) is completed for each collection. This sheet is used to document gear-specific sampling effort, detailed spatial data, key physical and chemical measurements, qualitative observations on local habitat characteristics, comments, and quality assurance data. One or more Fish Measurement Sheet (Appendix D; EMTC 03/24/95) is used to record fish catch data from each collection. These data sheets serve as the sole means of recording fish collection and catch data obtained from routine monitoring efforts, biological response monitoring at Habitat Rehabilitation and Enhancement Projects, special research projects, and any ad hoc experimental excursions. Both data sheets were designed to optimize the mix of flexibility, capture of essential data, simplicity, visual clarity, and quality assurance objectives.

6.2 Coding Instructions

6.2.1 General

Record data using waterproof ink. A Number 2 pencil may be used only if weather is inclement, in which case this must be noted in the "Comment" field. Write legibly so that others who are unfamiliar with your handwriting can read it. Record all data accurately. Site definition data in the top portions of the data sheets must accurately represent the place and time a collection was made and must be identical on all sheets for any particular collection. **Erasure of information is absolutely prohibited.** If a recording error is made, draw a single line through the error, write the correction above or adjacent to the error, and sign and circle your initials next to the correction or error. Sampling Crew Leaders are responsible for ensuring that data sheets are complete and accurate. Completion of all fields is mandatory except where noted below.

Only data described in Sections 6.2.2 and 6.2.3 are to be recorded on the LTRMP data sheets described in those sections, and **ALL DATA MUST BE RECORDED IN THE APPROPRIATE SPACES (AND ONLY IN THE APPROPRIATE SPACES, EXCEPT FOR CORRECTIONS)**. *Never* record ancillary data in any field (except for preapproved use of the user-defined fields). These requirements are crucial because data entry operators cannot interpret non-standard data and because the data sheets must contain an unambiguous record that can withstand legal challenge. The presence of recording irregularities (e.g., recording count tallies in the space provided for weight measurements) compromises the record by opening an opportunity to claim that other records may contain misrepresentative data and are therefore suspect.

6.2.2 Fish Collection Sheet (EMTC 03/24/95)

All fields (recording spaces) on each *Fish Collection Sheet* (Appendix C) are recorded in the field at the time specific measurements are taken except for application of bar code stickers, total number of fish collected, certification, and perhaps number of fish measurement data sheets and Universal Transverse Mercator (UTM) or latitude/longitude coordinates (N/S and E/W) (see below), which are recorded when logging data sheets and performing the final QA/QC checks (see Section 7 below). The content of *Fish Collection Sheets* is as follows:

Field name	Description and coding instructions
Site Alias *(Optional)*	Space is provided to record an optional site alias for field station use.
Place Bar Code Here	Affix bar code sticker in the space provided in the upper right margin upon return to office (see Section 7.2, Pre-Submission QA/QC Procedures). **Note: Application of the bar code sticker is mandatory; data sheets lacking bar codes will be returned to the field station without being keyed.**

1. Header Data

Field name	Description and coding instructions
Field Station Number	One-digit numeric field station number: **1 = Lake City, MN** **2 = Onalaska, WI** **3 = Bellevue, IA** **4 = Wood River, IL** **5 = Cape Girardeau, MO** **6 = Havana, IL**
Location Code	Five-digit alphanumeric code for LTRMP Location Code having the format nnnnn.nnnnn. For randomly selected sites enter *nnnn*.RS, where *nnnn* is the site number from the sampling map or site list. For permanently fixed sites record *rmmm.ma*, where *r* designates the river (M = Mississippi and I = Illinois), *mmm.m* is the river mile (recorded to the nearest 0.1 mi), and *a* is an alphabetic code for the relative lateral position across the floodplain.
Pool/Reach	Two-digit alphanumeric code for the LTRMP study reach or pool number: **04 = Pool 4, UMR** **08 = Pool 8, UMR** **13 = Pool 13, UMR** **26 = Pool 26, UMR** **LG = La Grange Pool, Illinois River** **OR = Open Mississippi River**
Project Code	Four-digit alphanumeric LTRMP project code. Format is *A-nnn*, where *A* is a letter describing project type and *nnn* is a special project number. Project types are as follows:

Field name	Description and coding instructions
	M = RTA standardized resource monitoring **B = HREP biological response monitoring** **E = Ad hoc exploratory sampling** **R = Special research project**
	Note: A three-digit project number *nnn* is not recorded for RTA standardized resource monitoring (M); however, the EMTC will assign project numbers for all other project types. To ensure the integrity of the data, all project numbers must be obtained from the EMTC.
Start Date	Date on which a gear collection was initiated (e.g., the date on which a net was set). Six-digit numeric *mmddyy* format wherein April 1, 1995, is recorded as 040195.
Start Time	Four-digit 2400-h (military) Central Standard Time (CST) at which a gear sample begins (e.g., the time a net was set or an electrofishing run was begun). When a gear sample is begun, immediately obtain the time value from a watch. Record time of sample initiation to the nearest minute. Examples: 1:45 p.m. is recorded as 13:45 and midnight is 00:00 of the new day.
Finish Date	Date on which a gear sample was completed (e.g., the date on which a net was lifted). Format is the same as "Start Date."
Finish Time	Four-digit 2400-h Central Standard Time (CST) at which a gear sample is completed (e.g., the time that a net is lifted or an electrofishing run [actual shocking time] is completed). Format and accuracy requirements are the same as "Start Time." Leave this field blank for seine samples.
Site Type	One-digit code identifying the type of sampling site, as follows: **0 = Primary randomly selected sampling site** **1 = Alternate randomly selected sampling site** **2 = Subjectively chosen permanently fixed site**
Stratum (Habitat Class)	Four-digit alphabetic LTRMP habitat class description: **BWC-O = Backwater, offshore** **BWC-S = Backwater, shoreline** **MCB-U = Main channel border, unstructured** **MCB-W = Main channel border, wing dam** **IMP-O = Impounded, offshore** **IMP-S = Impounded, shoreline** **SCB = Side channel border** **TWZ = Tailwater zone (permanently fixed sampling sites)** **CTR = Main channel trough (optional sampling only)**
Gear	One-digit alphabetic gear code as described in Table 1 and summarized below:

Field name	Description and coding instructions
	D = Day (1 h after sunrise to 1 h before sunset) electrofishing **F = Fyke netting** **GR = Gill netting, perpendicular (to shore) set** **GL = Gill netting, parallel (to shore) set** **HS = Hoop netting, small LTRMP net** **HL = Hoop netting, large LTRMP net** **M = Mini fyke netting** **N = Night (1 h after sunset to 1 h before sunrise) electrofishing** **S = Seining** **T = Trawling** **TP = Plankton trawling** **X = Tandem fyke netting** **Y = Tandem mini fyke netting** **TA = Trammel netting, anchored set** **TD = Trammel netting, floating and drifting**
	(**Gill nets:** *Record mesh size of gill net panels in User-Defined Field 12 on the Fish Measurement Sheet; see User-Defined Fields in Section 6.2.3 below*.)
Time Period	One-digit numeric LTRMP Sampling Time Period code. Example: The first sampling time period is coded as *1*.
Summary Code	One-digit numeric code documenting the overall quality of a sample collection as described in Table 4 and summarized below: **1 = Gear failure; site may be resampled within time period** **2 = Site cannot be sampled (i.e., site is dry or inaccessible)** **3 = Sample collected under unusual environmental conditions** **4 = Weighing equipment may be in error due to wind and waves** **5 = Normally completed sample; all LTRMP procedures followed** **6 = Non-critical gear modification (e.g., fyke net lead shortened)** **7 = Pseudo-shoreline used for shoreline gear** **8 = Minor gear damage or noncritical gear failure**

2. Location Data

Field name	Description and coding instructions
Zone	Two-digit numeric field to record Global Positioning System (GPS) zone. For most LTRMP reaches, there is just one value for *Zone*.
Accuracy	Four-digit numeric field to record a measure of positioning accuracy. Record Percent Dilution of Precision (PDOP) from GPS devices and the following codes for base map cross-reference and revisits to marked fixed sites: **000.1 = Almost certain accuracy within 100 m because of immediate proximity to uniquely identifiable features (undisturbed marker, wing dam, day mark, etc.)** **000.2 = High confidence of accuracy within 100 m because of agreement between general site appearance and identifiable features on a base map** **000.3 = Other than above**

Field name	Description and coding instructions
N/S Coordinates	Six-digit field to record latitudinal (north/south) coordinates of the collection location. Units are specific to location method; Universal Transverse Mercator (UTM) Northing for Magellan and degrees-minutes-seconds north latitude for Loran. For fixed sampling sites, this value should be measured using a GPS device at least once when each site is marked and recorded in the *Sites Table*. On subsequent visits, most fixed sites can be relocated from a base map with acceptable accuracy (100 m) or from site markers. For revisits to marked fixed sites, record the UTM Northing from the current *Sites Table*. Unmarked open water sites may have to be relocated using a Magellan or other GPS device.
Method	One-digit numeric code specifying the method used to locate the collection site, as follows: **1 = UTMs recorded from cross-reference between base map and site features** **2 = UTMs recorded from GPS device (Magellan)** **3 = Latitude (N/S coordinates; degrees, minutes, seconds) and longitude (E/W coordinates; degrees, minutes, seconds) recorded from GPS (Loran)** **4 = Latitude and longitude recorded from cross-reference between base map and site features**
E/W Coordinates	Seven-digit field to record the longitudinal (east/west) coordinates of the collection location. Units are specific to location method; UTM Easting for Magellan and degrees-minutes-seconds west latitude for Loran. For fixed sampling sites, this value should be measured using a GPS device at least once when each site is marked, and it should be recorded in the *Sites Table*. On subsequent visits, most fixed sites can be relocated from a base map with acceptable accuracy (100 m) or from site markers. For revisits to marked fixed sites, record the UTM Easting from the current *Sites Table*. Unmarked open water sites may have to be relocated using a Magellan or other GPS device.

3. Gear Effort

Time	Four-digit numeric field to document actual elapsed time required to capture a sample of fish (actual duration of gear deployment). Format is 2400-h (military) time, *hh:mm*, where a fyke net set fished for 25 h and 15 min is recorded as 25:15. Effort (time) values must be accurate to the nearest minute and must equal the difference between finish date and time and start date and time. Leave this field blank for seine samples.
Distance	Three-digit numeric field for recording the length (in meters) of an electrofishing run or trawl haul. Completion of this field is required only for electrofishing, trawling, and trammel net drifting.

Field name	Description and coding instructions

4. Electrofishing Settings
(Electrofishing Only)

Power Goal	Four-digit field to record the predetermined electrofishing power goal (in watts). **Note: For electrofishing only**.
Power Used	Four-digit field to record the actual average electrofishing power (in watts) consumption.
Volts and QF	Three-digit numeric field to record DC volts. The Quality Factor (QF) is a one-digit numeric field: **Blank = Normal operation/acceptable measurement** **0 = Voltage meter inoperative** **1 = Unstable voltage readings (varies by > 70 V); equipment questionable**
Amps and QF	Three-digit numeric field to record DC current (in amperes). The Quality Factor (QF) is a one-digit numeric field: **Blank = Normal operation/acceptable current determination** **0 = Ammeter inoperative** **1 = Unstable current readings (varies by > 10 amps)**
Pulse (Hz)	Three-digit numeric field to record pulse frequency (Hertz [=cycles/sec]).
Duty Cycle	Three-digit numeric field to record electrofishing duty cycle (percentage of time current is flowing).
5. Water Data	*Measurements of physical and chemical characteristics follow procedures documented in the LTRMP water quality monitoring procedures, except as noted below.*
Secchi and QF	Three-digit numeric field for recording measurement of water transparency (in centimeters) using a Secchi disk. Quality Factor codes are printed on the data sheets: **Blank = Normal measurement/no problems** **0 = Equipment inoperative** **1 = Equipment in question (e.g., paint discolored)** **3 = Reading off scale (high)** **4 = Used proximate measurement - no measurement at this site** **5 = No sample taken** **9 = Non-standard method used**
Conductivity and QF	Four-digit numeric field to record conductivity to the nearest 1 μS/cm. Quality Factor codes are printed on the data sheets: **Blank = Normal measurement/no problems** **0 = Equipment inoperative**

Field name	Description and coding instructions
	1 = Equipment in question **3 = Reading off scale (high)** **4 = Used proximate measurement - no measurement at this site** **5 = No sample taken** **9 = Non-standard method used**
Water Velocity and QF	Three-digit numeric field to record water velocity to the nearest 0.1 m/s. Quality Factor codes are printed on the data sheets: **Blank = Normal measurement/no problems** **0 = Equipment inoperative** **1 = Equipment in question** **3 = Reading off scale (high)** **5 = No sample taken** **9 = Non-standard method used** Three lines are provided to record intermediate measurements.
Water Temp and QF	Three-digit numeric field to record water temperature measurement to the nearest 0.1 °C. Quality Factor codes are printed on the data sheets: **Blank = Normal measurement/no problems** **0 = Equipment inoperative** **1 = Equipment in question** **4 = Used proximate measurement - no measurement at this site** **5 = No reading taken** **9 = Non-standard method used**
D.O. and QF	Three-digit numeric field to record dissolved oxygen concentration to the nearest 0.1 mg/L. This field is optional. Quality Factor codes are printed on the data sheets: **Blank = Normal measurement/no problems** **0 = Equipment inoperative** **1 = Equipment in question** **3 = Reading off scale (high)** **4 = Used proximate measurement - no measurement at this site** **5 = No sample taken** **9 = Non-standard method used**
Depth and QF	Three-digit numeric field to record water depth to the nearest 0.1 m. Quality Factor codes are printed on the data sheets: **Blank = Normal measurement/no problems** **0 = Equipment inoperative** **1 = Equipment in question** **5 = No sample taken** **9 = Non-standard method used**
Stage Height	Water elevation measurement obtained from local stage height gauge. Record gauge location as "G = *name*" in the Comments field. This is an optional field. Quality Factor codes are:

Field name	Description and coding instructions
	1 = Feet relative (local) measure **2 = Feet above mean sea level (AMSL)** **3 = Meters relative (local) measure** **4 = Meters above mean sea level (AMSL)**
6. Structure	
Emergent and Submersed Aquatic Vegetation (Percent Coverage)	One-digit numeric field to record qualitative estimate of percent of area within a 100-m radius in which there is emergent and/or submersed aquatic vegetation, based on visual observation. Values are as follows: **0 = 0% (no emergent/submersed aquatic vegetation apparent)** **1 = 1%-19% coverage** **2 = 20%-49% coverage** **3 = ≥50% coverage**
Density	One-digit numeric field to record qualitative estimate of density of both emergent and submersed aquatic vegetation within a 100-m radius, based on visual observation. Make and record this estimate only if emergent or submersed aquatic vegetation is present. Values are as follows: **1 = Prevailing vegetation is sparse (probably <10 stems/m^2) and does not create an "edge" at its perimeter** **2 = Prevailing vegetation is dense (probably ≥10 stems/m^2 and creates a distinct "edge" at its perimeter**
Predominant Substrate	One-digit numeric field to record qualitative observation of sediments based on visual and tactile observation. Values are as follows: **1 = Silt (very fine and very soft sediments that may contain highly hydrated [very soft] clay; sand lacking)** **2 = Silt/Clay/Little Sand (fine and soft sediments dominated by silt but usually containing little fine sand, with perhaps dehydrated [firm] clay pellets or moderately hydrated clay with little fine sand)** **3 = Sand/Mostly Sand (firm to very firm, fine to coarse sediments with sand dominant, or entirely sand)** **4 = Gravel/Rock/Hard Clay (hard substrate consisting of dehydrated [firm] clay, gravel, rock, bedrock, or concrete)**
Other Structure	Eight check-off boxes to record presence of other habitat structure within a 100-m radius. To record presence of one or more of the features listed on the data sheet, write *X* in the appropriate box. Describe important features that are not listed on the data sheet in the "Comments" field.
7. Comments *(Bottom of Sheet)*	Eighty-character field to record miscellaneous comments and observations. Only the first 80 characters are keyed. **Print one character per box.** Abbreviate to capture key ideas. If more space is needed, write in bottom margin of data; however, any writing outside the boxes will not be keyed.

Field name	Description and coding instructions
8. Other Information	*Accurate QA/QC data are essential components of a good sampling program. Recording of the following information is mandatory.*
Number of containers returned to lab for identification	Two-digit field to record the number of individual containers (whirl-pacs, vials, etc.) containing specimens that were returned to the field station or lab for identification or measurement. This field must always be completed. If no fish were returned to the field station or lab, record "0" (zero).
Number of fish measurement data sheets	Two-digit numeric field to record the total number of *Fish Measurement Sheets* (recorded in the field and lab) completed for the sample collection.
Total number of fish collected	Five-digit numeric field to record the total number of fish (of all species, whether enumerated in the field or lab) captured in the sample collection. This number is to be obtained from a manual tally of fish counts on the corresponding *Fish Measurement Sheets*.
9. Certification	
Are header blocks on this sheet and the fish measurement data sheet complete and do they match?	Verify that header data on the *Fish Collection Sheet* and all associated *Fish Measurement Sheets* are complete and identical, then check (✓) *Yes*. This information is required but is not keyed.
Are the data sheets complete?	Verify that the *Fish Collection Sheet* and all associated *Fish Measurement Sheets* are properly completed and correct, then check (✓) *Yes*. This information is required but is not keyed.
Crew Leader Code	Four-digit alphanumeric field to record the LTRMP Crew Identification Code. These codes are permanently assigned to LTRMP staff at each station. Record the code that was assigned to the crew member who is responsible for direction of the particular sample collection.
Crew Leader's Signature	Space where the designated Crew Leader for the sample collection must sign (legal signature) the statement of compliance with current LTRMP procedures. There must be a designated Crew Leader (the person who is responsible for decisions in difficult situations). This information is required but is not keyed.

6.2.3 Fish Measurement Sheet (EMTC 03/24/95)

Fish Measurement Sheets (Appendix D) are used in the field and lab, depending on circumstances. For fish that can be identified and enumerated in the field, all data (except for the *Fish Collection Sheet* bar code number, and [optionally] the number of fish recorded on the sheet [see below]) are recorded at the collection site. At times, it might be necessary to preserve specimens and return them to the lab for positive identification and/or enumeration, and for this purpose and *only* this purpose, measurements are made and recorded on *Fish Measurement Sheets* in the lab. When preserving fish at the collection site, the page number and header block of an otherwise blank *Fish Measurement Sheet* must be completed and returned to the lab with the preserved specimens. When recording fish measurements in the lab, verify that the *Fish Measurement Sheet* header information, including the bar code number, matches the corresponding *Fish Collection Sheet* EXACTLY, and that the page numbers are in proper sequence.

<u>Field name</u>	<u>Description and coding instructions</u>
Fish Collection Sheet Bar Code Number	Print the bar code number of the corresponding *Fish Collection Sheet* in the boxes provided in the top margin upon return to office (see Section 1.7.2, Pre-Submission QA/QC Procedures). Verify that the number recorded is correct before sending data sheets to the data entry contractor. **Note: Recording of collection sheet bar code numbers on all *Fish Measurement Sheets* is required; data sheets lacking bar code numbers will be returned to the field station.**
Page Number	Two-digit numeric field to record the page number of the *Fish Measurement Sheet*. Number multiple sheets consecutively. The page number of the last *Fish Measurement Sheet* for a sample collection must equal the entry for Number of Fish Measurement Data Sheets on the corresponding *Fish Collection Sheet*.
Header Data	Record header information according to the corresponding instructions for the *Fish Collection Sheet*. There is only one additional field, Recording Site, below.
Recording Site	One-digit numeric field to record the site at which fish on the particular *Fish Measurement Sheet* were identified, enumerated, and measured. Record *1* on *Fish Measurement Sheets* completed in the field and *2* on sheets completed in the lab or office. **Note: Never record data from the field and lab on the same data sheet; use separate *Fish Measurement Data Sheets* for field and lab recording**.
Measurement Block	
Species Name	Space for noting species common names. This QA field is not keyed. Record an identifiable common name or abbreviation (other than the LTRMP fish code) of a common name, even if the species code is known, to preclude loss of data due to mistaken codes. This value does not have to be written on each row where multiple rows of a species occur. The first occurrence of a species' common name in a contiguous block should be recorded, but subsequent rows can be identified by a vertical line.
Species Code	Four-digit alphabetic field to record LTRMP species code identifiers. These species codes are cross-referenced to American Fisheries Society-accepted common and scientific names in Appendix H. **A SPE-**

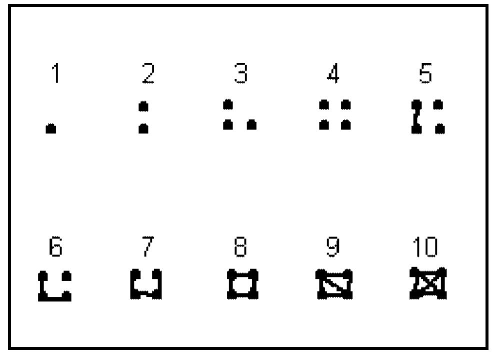
Field name	Description and coding instructions
	CIES CODE MUST BE ENTERED FOR EACH AND EVERY COMPLETED ROW. *Never* indicate continued measurements from a species on successive rows by vertical line drawn below the first occurrence of a code. Species codes may be completed in the lab if species common names were identified on the data sheets.
Length (min)	Four-digit numeric field to record individual length measurements or lower bounds (minima) of length groups. Record all measurements of individual lengths to the nearest 1 mm. Record lower bounds of length groups to the nearest 1 mm. This field is left blank only to designate unmeasured fish; otherwise, it must be completed.
TFS	One-digit alphabetic field to record system used for length measurement: **T or Blank = Maximum total length measurement; distance from anterior-most extreme of head (jaw closed) to most distant lobe of caudal fin (lobes compressed to achieve maximum length)** **F = Fork length; distance from anterior-most extreme of head (jaw closed) to fork of caudal fin (tip of median fin rays)** **S = Standard length; distance from anterior-most extreme of head (jaw closed) to caudal peduncle (posterior margin of hypural bone)** Use standard length for fish with damaged caudal fins. Use fork length for fishes such as paddlefish or sturgeon that have rigid caudal fins or variable-length caudal filaments.
Group Width (GRP WTH)	One-digit numeric field to record the width, to the nearest 1 cm of a length group from within which fish were enumerated or bulk-weighed. For example, to record counts from fish in the 1-cm length interval from 290 to 299.9 mm, the Group Minimum is 290 and the Group Width is 1. **RECORD GROUP WIDTHS FOR ALL ROWS THAT CONTAIN COUNTS OR BULK WEIGHTS FOR A SPECIFIED LENGTH GROUP.** Leave this field blank for fish that are unmeasured or individually measured to the nearest 1 mm. Presence of group width values distinguishes individual measurements from bulk values.
Weight (g)	Five-digit numeric field to record individual or aggregate weights (in grams). Individual weights are distinguished by the presence of a Group Width value and should be measured to the nearest 1%. Measurement of weight with > 1% measurement error defeats any purpose for measuring weight. Weights should be measured only for special purposes.
Fish Count	Five-digit numeric field to record counts of fish represented by the row of data. Fish Count is *1* for all individually measured lengths and weights and ≥1 for bulk counts. For example, if a particular fish was measured to the nearest 1 mm, then Fish Count is *1* f; if just one fish of a particular length group is encountered during length group enumeration, then Fish

Field name | Description and coding instructions

Count is also *1* for that length group. However, if 10 fish of a length group are encountered during group enumeration, then Fish Count is 10.

Working Tally

Space in which to tally fish during enumeration of fish by species or length group. This field is not keyed and is provided for scratch intermediate recording. Tally fish counts using the decimal enumeration scheme composed of dots and lines shown to the right. This scheme is efficient in that 10 can be recorded in the same amount of space required to record 5 using the traditional system of four vertical lines crossed by one diagonal line. This scheme allows more than 100 fish to be recorded in a single Working Tally field.



Efficient decimal tally scheme (credit to M. Stopyro, Minnesota Department of Natural Resources).

Pathogen Code (PC)

One-digit field to record LTRMP fish health/pathogen codes (Table 3), as follows:

0 or blank = No visible abnormality
1 = Parasite
2 = Skeletal abnormality
3 = Tumors
4 = Injury
5 = Skin/fin/eye
6 = Other

Subproject

Two-digit field to record data needed to interpret User-Defined Fields (UDFs), as follows:

First Box

1 = Aging structures (otoliths, scales, etc.) collected, specimen bar code
2 = Stomach contents collected
3 = Both aging structures and stomach contents collected
0 = Continued from previous line

Note: When the above codes are used, the specimen bar code number must be recorded in UDFs 1-10.

Second Box

0 = Tag implanted, number follows in UDFs 1-11, fish released
1 = Tag recovered, number follows in UDFs 1-11, fish released
2 = Tag recovered, number follows in UDFs 1-11, fish not released
3 = Tag scar visible, fish released

Field name	Description and coding instructions
	4 = Tag scar visible, fish not released **5 = Fin clipped, fin position follows in UDF 11** **6 = Fin clip recovered, position follows in UDF 11, released** **7 = Fin clip recovered, position follows in UDF 11, not released**
	Note: It may be rarely necessary to collect aging structures or stomachs *and* record a tag number. When this need arises, record the specimen (aging structure or stomach) information first, skip to the next line number on the data sheet, leaving everything to the left of the first Subproject box, record a zero in the first Subproject box, and then record tagging information as per above. This is necessary only if a tag number must be recorded; fin positions and specimens can be recorded on one line.
User-Defined Fields	Twelve one-digit alphanumeric fields to record special information not routinely collected during standardized monitoring activities. The identities of UDFs are specific to particular project codes. If you need to record data in these fields, obtain a special Project Code from the EMTC. The descriptions of all UDFs are permanently recorded in a Project Detail File and can be referenced using the Project Code.

Gill Nets: Record the mesh size code for the panel from which fish were extracted in UDF 12 as follows:

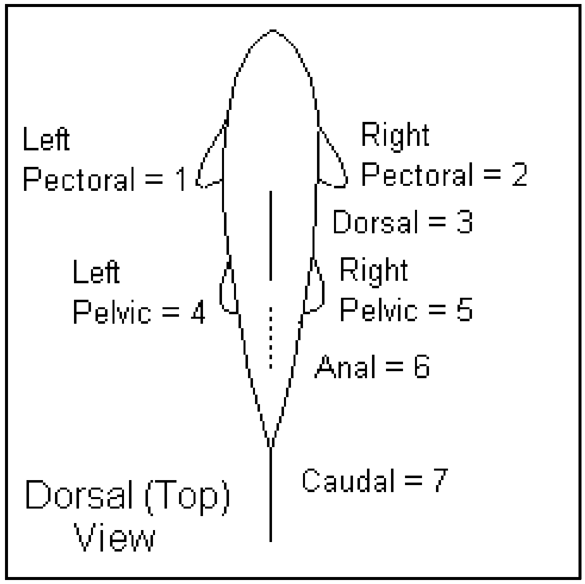
Mesh size code	*Mesh size (stretch)*
1	**4"**
2	**6"**
3	**8"**
4	**10"**

When no fish are caught in a particular mesh size, record the mesh size code, a species code value of "NFSH" (no fish caught), and a count of "0" (zero).

Seines and Trawls: Record the haul number (seines 1-4; trawls 1-6) in UDF 12. If no fish are caught in a particular haul, record the haul number, a species code of "NFSH" (no fish caught), and a Fish Count of "0" (zero).

Fin Clipping: To record the positions of fin clips, record the fin position number, as shown in the diagram below, in UDF 11.

Field name	Description and coding instructions



Numeric codes for fin clip positions

Specimen numbers: Record specimen (aging structure and/or stomach contents) bar code numbers in UDFs 1-10. The *first* box of the Subproject field must contain an appropriate code.

Tag numbers: Record tag numbers in UDFs1-11. The *second* box of the Subproject field must contain an appropriate code.

QA/QC Block	*The Quality Assurance/Quality Control block is used to record abbreviated documentation of compliance with LTRMP procedures.*
Recorder Code	Three-digit numeric field to record the LTRMP Crew Identification Number. These numbers are permanently assigned to LTRMP staff at each station. Record the code that was assigned to the crew member who recorded data on the *Fish Measurement Sheet*.
Number of Fish on This Sheet	Four-digit field to record the total number of fish (sum of Fish Counts) recorded on this *Fish Measurement Sheet*.
Crew Leader Initials	Space for the designated Crew Leader (person responsible for decisions in difficult situations) to initial his or her first and last names.

6.3 Tips for Measuring and Recording Measurements

6.3.1 General

The *Fish Measurement Sheet* is flexible; it can be used to record data from several different enumeration and measurements tasks. One sheet may be used to record data from several species; when convenient (such as when catches are large), you may use separate (possibly several) data sheets to record measurements from each species. Suggestions for recording different types of measurements are provided in the following sections.

6.3.2 Recording Individual Measurements Without Regard to Subsampling Quotas

At times, it may be necessary to record individual lengths (and perhaps weights) from all fish of key species in small samples. This task is easy. Simply record measurements from individuals on successive lines. Group-width fields will be left blank, signifying individual measurement.

6.3.3 Recording Length Group Counts

Recording counts by length group is a frequently used method. Perhaps the easiest way to collect and record these data is to make an initial visual inspection of the catch. Approximate length ranges of abundant species are estimated from visual observation of the catch. The recorder can then write in TLC minima for length groups apparent in the catch. As fish are processed and categorized into length groups, counts are tallied in the Working Tally field. When the last fish is processed, tallies are added and final fish counts are recorded. As occasional fish are encountered that are outside the prerecorded set of length group minima, new length classes are added to the data sheet. It may be convenient to use one *Fish Measurement Sheet* for each species when catches are large.

6.3.4 Recording Subsampled Individual Measurements in the Quota Measurement Scheme

The most difficult processing task is obtaining and recording a quota of, say, the first k (usually $k = 3$) individual lengths and weights from a larger sample in which fish will be classified by length group. This task requires obtaining both individual measurements and counts by length group. This process can be managed using the *Fish Measurement Sheet*. Set up the range of expected length groups and begin measuring. For the first fish of a particular length group, write a tally mark in the working tally field, then record individual length and weight measurements and a fish count of one (*1*) on a *new* line. For convenience, you may want to record length group tallies on one sheet (for a species) and then record the successive individual lengths and weights beginning on a separate sheet. Repeat this process. After the k'th fish of a length group is processed, circle those first k tally marks in the working tally field. When the $(k + 1)$'th fish is encountered, begin tallying anew in the same working tally box. **After all fish are processed, count the uncircled tally marks in each working tally box and record this number in the fish count field corresponding to that length group. The sum of the fish counts from length group tallies and individual measurements must equal the total number of fish captured.**

7. QA/QC Procedures for Submission of Data for Entry

7.1 Overview

Properly completed data sheets are submitted to the data entry contractor on a weekly basis. This schedule ensures that the data are available for use on a timely basis and avoids development of a backlog. All complete sets of data sheets completed during a particular week should be submitted for entry during the same week or early the following week. A complete set of data sheets for a collection consists of the *Fish Collection Sheet* and all *Fish Measurement Sheets,* listing all fish caught for that collection. Only complete sets may be submitted to the data entry contractor. When, for any collection, fish are returned to the lab for identification, it will usually not be possible to complete all *Fish Measurement Sheets* during the same week the collection was made. When fish must be returned to the lab for identification, then the *Fish Collection Sheet* and any *Fish Measurement Sheets* recorded in the field are held at the field station until all *Fish Measurement Sheets* for that collection have been completed. It is only after the last lab-recorded *Fish Measurement Sheet* has been completed that the *Fish Collection Sheet* and all *Fish Measurement Sheets* are sent to the data entry contractor.

After data have been recorded in the field and all fish that were returned to the lab have been processed and recorded, some additional QA/QC actions are needed to document collection of the data and to check for discrepancies that would delay processing unless resolved prior to data entry. The Field Station Fisheries Component Specialists are responsible for proper performance of these QA/QC steps. The purposes of these steps are to (1) provide information to verify that all data sheets are keyed by the data entry contractor, (2) document the chain-of-custody of the data, and (3) provide an additional safeguard against dissociation of corresponding *Fish Collection Sheets* and *Fish Measurement Sheets* because of discrepant header information.

7.2 Pre-Submission QA/QC Procedures

As soon as possible after returning from a sampling venture, perform the following eight (8) steps:

1. Recheck all data sheets. Ensure that Header Block information from each *Fish Collection Sheet* and all corresponding *Fish Measurement Sheets* match exactly.

2. Affix one sticker from a pair of bar code stickers onto the space provided at the top of the first *Fish Collection Sheet*. **Use bar codes in numeric order.** Place the other sticker from this pair of stickers in the next available Collection Sheet Bar Code field on a *Fish Data Sheet Log* (*Revision EMTC 01/20/95*; example in Appendix J). These two bar codes must match.

3. Record the number of corresponding *Fish Collection Sheets* and *Fish Measurement Sheets* completed for this collection in the "Number of Sheets" field on the *Fish Data Sheet Log*. The number of *Fish Collection Sheets* is *1* if a *Fish Collection Sheet* is submitted to the data entry contractor. The number of *Fish Measurement Sheets* is the number being submitted to the data entry contractor with this batch. If no fish were caught, so that there are no corresponding *Fish Measurement Sheets*, record a zero (*0*).

4. On each and every *Fish Measurement Sheet* in the collection, write the bar code number of the corresponding *Fish Collection Sheet* (see item 2, above) into the boxes labeled "Fish Collection Sheet Bar Code Number" in the upper margin. Continue this until all *Fish Measurement Sheets* in the collection have received bar code numbers.

5. On the *Fish Data Sheet Log*, record the Date Logged, Crew Code (identification of the person performing the logging), and your initials in the last three columns to document completion of QA/QC steps 1-5, above.

6. Make one photocopy of all data sheets.

7. Continue as in Steps 1-5 for any additional collections.

8. When you are ready to submit data to the data entry contractor, check to see that Field Station Numbers and page numbers are recorded on the corresponding completed *Fish Data Sheet Logs*, record the *Date Mailed to Data Entry*[1] (bottom left corner of *Log*), and sign below. Then make two copies of the *Fish Data Sheet Log*(s). Place the original *Fish Data Sheet Log*(s) on the top of the batch of data sheets and mail this entire set to the data entry contractor. Keep one copy of the *Fish Data Sheet Log*(s) on file at the field station and immediately mail the other copy to the EMTC.

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[1]Field Station staff complete the box at the bottom of the *Fish Data Sheet Log* labeled *Date Mailed to Data Entry*, but not the three boxes to the right of this. The data entry contractor completes the boxes labeled *Date Received by Data Entry* and *Date Sent to EMTC.* EMTC staff sign for receipt of the log and data sheets in the box labeled *Date Received by EMTC.*

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Appendix A

Long Term Resource Monitoring Program Electrofishing Boats

Table A-1. Parts list for Long Term Resource Monitoring Program electrofishing boats, excluding major components

Qty	Part	Qty	Part
1	20º Bezel	1	3-Prong Straight Blade Female Plug
48	¼-20 x 1" SS Bolts		
1	Battery Box	1	3-Prong Male Household Plug
1	Chair	2	16' x ½" Chance Pole
1	Control Head	5	2-Prong Twist Lock Receptacle
1	Intake Screen	2	4-Prong Twist Lock Receptacle
1	Stern Light	1	3-Prong Twist Lock Receptacle
1	12-V Voltmeter	2	Momentary Closed Switch
1	Pedestal	40 ft	8# Wire - Color: Black
1	Water Pump	120 ft	12# Wire - Various Colors: Red, Yellow, Green, Blue, Black
20	8" x ¾" Metal Screw		
1	Overflow Tube	210 ft	16# Wire - Various Colors: Red, Yellow, Green, Blue, Black
40	¼" Lock Washers		
1	Steering Wheel	1	Amphenol Large Boot
2 box	Single Gang 4½" Outlet	1	5-amp Toggle Breaker
1 box	Single Gang Waterproof Hub Box	1	25-amp Toggle Breaker
4	Chance Pole Caps	1	10-amp Toggle Breaker
50 ft	¾" PVC Conduit	1	Amphenol Cord Grip
50 ft	½" Thinwall Conduit	1	Amphenol Plug Housing
10 ft	¾" Thinwall Conduit	12	Terminal Block Jumpers
90 ft	1" Thinwall Conduit	1	On-None-On Toggle Switch
2 ft	¾" Watertite Flex Conduit	1	12-Terminal Block
2	¾" Watertite Connector	2	4-Terminal Block
2	½" Box Connector	3	5-amp Toggle Breaker
11 ft	600-V 3-Way (12-3) Cord	2	Safety Mats (Electrical Disconnect)
4	½" Strain Relief Cord Grip		
5	Conduit Cord Grip	4	Halogen Deck Light
7	Waterproof Receptacle Cover	1	Console
2	Cover for Momentary Switch	1	Amphenol 3-Prong Female Insert
1	Single Gang Blank Cover	18 ft	½" Copper or Aluminum Tubing
1	3-Prong Twist Lock	20 ft	9/16" Stainless Steel Tubing
4	4-Prong Twist Lock	1	Bow Light

Table A-2. LTRMP standardized electrofishing power settings for various water conductivities and temperatures. Electrofishing at these power settings ensures potential transfer of 3,000 watts from water to fish (Burkhardt and Gutreuter 1995).

	Temperature								
Conduc-tivity	5	10	15	20	25	30	35	40	45
25	8859	7896	7164	6588	6125	5745	5427	5159	4929
35	6809	6130	5615	5212	4889	4626	4407	4224	4068
45	5684	5164	4772	4467	4225	4029	3867	3733	3620
55	4980	4563	4251	4010	3820	3668	3545	3444	3360
65	4501	4158	3902	3707	3556	3436	3340	3263	3202
75	4159	3870	3658	3498	3375	3280	3206	3148	3104
85	3904	3658	3480	3348	3249	3174	3117	3076	3045
95	3710	3499	3348	3239	3159	3101	3060	3032	3013
105	3558	3376	3249	3159	3096	3053	3025	3008	3001
115	3438	3281	3174	3102	3053	3023	3006	3000	3003
125	3343	3207	3118	3060	3025	3006	3000	3004	3015
135	3266	3150	3076	3032	3008	3000	3004	3016	3036
145	3203	3105	3046	3014	3001	3002	3015	3036	3063
155	3153	3070	3024	3003	3001	3012	3032	3061	3096
165	3113	3044	3010	3000	3007	3026	3055	3091	3134
175	3081	3025	3003	3002	3018	3045	3082	3125	3174
185	3056	3012	3000	3009	3033	3068	3112	3163	3218
195	3036	3004	3002	3020	3052	3095	3146	3203	3265
205	3021	3000	3008	3034	3074	3124	3182	3245	3314
215	3011	3000	3016	3051	3098	3155	3220	3290	3364
225	3004	3003	3028	3070	3125	3189	3260	3336	3417
235	3001	3009	3042	3092	3154	3224	3301	3384	3470
245	3000	3018	3059	3116	3184	3261	3345	3433	3525
255	3002	3028	3077	3141	3216	3299	3389	3483	3581
265	3006	3040	3097	3168	3250	3339	3435	3535	3638
275	3012	3054	3118	3196	3284	3380	3481	3587	3696
285	3019	3070	3141	3225	3320	3421	3529	3640	3755
295	3029	3087	3165	3256	3356	3464	3577	3694	3814
305	3039	3105	3190	3287	3394	3507	3626	3749	3874

	Temperature								
Condu c-tivity	5	10	15	20	35	30	35	40	45
535	3493	3703	3924	4152	4385	4622	4862	5105	5349
545	3518	3734	3960	4193	4431	4674	4919	5166	5415
555	3543	3764	3996	4234	4478	4725	4975	5228	5482
565	3568	3795	4032	4275	4524	4777	5032	5289	5548
575	3593	3826	4068	4317	4571	4828	5088	5351	5615
585	3619	3857	4104	4358	4617	4880	5145	5412	5682
595	3644	3888	4140	4400	4664	4932	5202	5474	5748
605	3670	3919	4177	4442	4711	4984	5259	5536	5815
615	3696	3950	4214	4484	4758	5036	5316	5598	5882
625	3723	3982	4251	4526	4805	5088	5373	5660	5949
635	3749	4014	4288	4568	4852	5140	5430	5722	6016
745	3775	4045	4325	4610	4899	5192	5487	5785	6083
655	3802	4077	4362	4652	4947	5245	5545	5847	6150
665	3829	4109	4399	4694	4994	5297	5602	5909	6218
675	3855	4142	4436	4737	5042	5349	5660	5971	6285
685	3882	4174	4474	4779	5089	5402	5717	6034	6352
695	3909	4206	4511	4822	5137	5455	5775	6096	6420
705	3937	4239	4549	4865	5185	5507	5832	6159	6487
715	3964	4271	4587	4908	5232	5560	5890	6222	6555
725	3991	4304	4624	4950	5280	5613	5948	6284	6622
735	4019	4337	4662	4993	5328	5666	6005	6347	6690
745	4046	4369	4700	5036	5376	5719	6063	6410	6757
755	4074	4402	4738	5079	5424	5772	6121	6472	6825
765	4102	4435	4776	5122	5472	5825	6179	6535	6893
775	4130	4468	4814	5165	5520	5878	6237	6598	6960
785	4158	4501	4852	5209	5568	5931	6295	6661	7028
795	4186	4534	4891	5252	5617	5984	6353	6724	7096
805	4214	4568	4929	5295	5665	6037	6411	6787	7164
815	4242	4601	4967	5338	5713	6090	6469	6850	7232

Table A-2. Continued

	Temperature										Temperature								
Conduc-tivity	5	10	15	20	25	30	35	40	45	Condu c-tivity	5	10	15	20	35	30	35	40	45
315	3051	3124	3216	3319	3432	3551	3676	3804	3935	825	4270	4634	5006	5382	5761	6143	6527	6913	7299
325	3064	3145	3243	3353	3471	3596	3726	3860	3996	835	4298	4668	5044	5425	5810	6197	6586	6976	7367
335	3079	3166	3270	3386	3511	3642	3777	3916	4058	845	4326	4701	5083	5469	5858	6250	6644	7039	7435
345	3094	3188	3299	3421	3551	3687	3828	3973	4120	855	4355	4735	5121	5512	5907	6303	6702	7102	7503
355	3110	3211	3328	3456	3592	3734	3880	4030	4182	865	4383	4768	5160	5556	5955	6357	6760	7165	7571
365	3127	3234	3357	3491	3633	3781	3932	4087	4245	875	4412	4802	5198	5599	6004	6410	6819	7228	7639
375	3144	3258	3388	3528	3675	3828	3985	4145	4308	885	4440	4835	5237	5643	6052	6464	6877	7292	7707
385	3162	3283	3419	3564	3717	3876	4038	4204	4372	895	4469	4869	5276	5687	6101	6517	6935	7355	7775
395	3181	3308	3450	3601	3760	3924	4091	4262	4436	905	4498	4903	5314	5730	6149	6571	6994	7418	7843
405	3201	3334	3482	3639	3803	3972	4145	4321	4500	915	4526	4937	5353	5774	6198	6624	7052	7481	7912
415	3221	3360	3514	3677	3846	4021	4199	4380	4564	925	4555	4970	5392	5818	6247	6678	7110	7545	7980
425	3242	3387	3546	3715	3890	4070	4253	4440	4628	935	4584	5004	5431	5862	6295	6731	7169	7608	8048
435	3263	3414	3579	3753	3934	4119	4308	4499	4693	945	4613	5038	5470	5905	6344	6785	7227	7671	8116
445	3284	3442	3613	3792	3978	4168	4362	4559	4758	955	4642	5072	5509	5949	6393	6839	7286	7735	8184
455	3306	3470	3646	3831	4022	4218	4417	4619	4823	965	4670	5106	5548	5993	6442	6892	7344	7798	8253
465	3328	3498	3680	3870	4067	4268	4472	4679	4888	975	4699	5140	5587	6037	6490	6946	7403	7861	8321
475	3351	3527	3714	3910	4112	4318	4527	4740	4954	985	4728	5174	5626	6081	6539	7000	7462	7925	8389
485	3374	3555	3749	3950	4157	4368	4583	4800	5019	995	4758	5208	5665	6125	6588	7053	7520	7988	8457
495	3397	3584	3783	3990	4202	4419	4639	4861	5085	1005	4787	5242	5704	6169	6637	7107	7579	8052	8526
505	3421	3614	3818	4030	4248	4469	4694	4922	5151	1015	4816	5276	5743	6213	6686	7161	7637	8115	8594
515	3445	3643	3853	4071	4293	4520	4750	4983	5217	1025	4845	5311	5782	6257	6735	7215	7696	8179	8662
525	3469	3673	3889	4111	4339	4571	4806	5044	5283	1035	4874	5345	5821	6301	6784	7268	7755	8242	8731

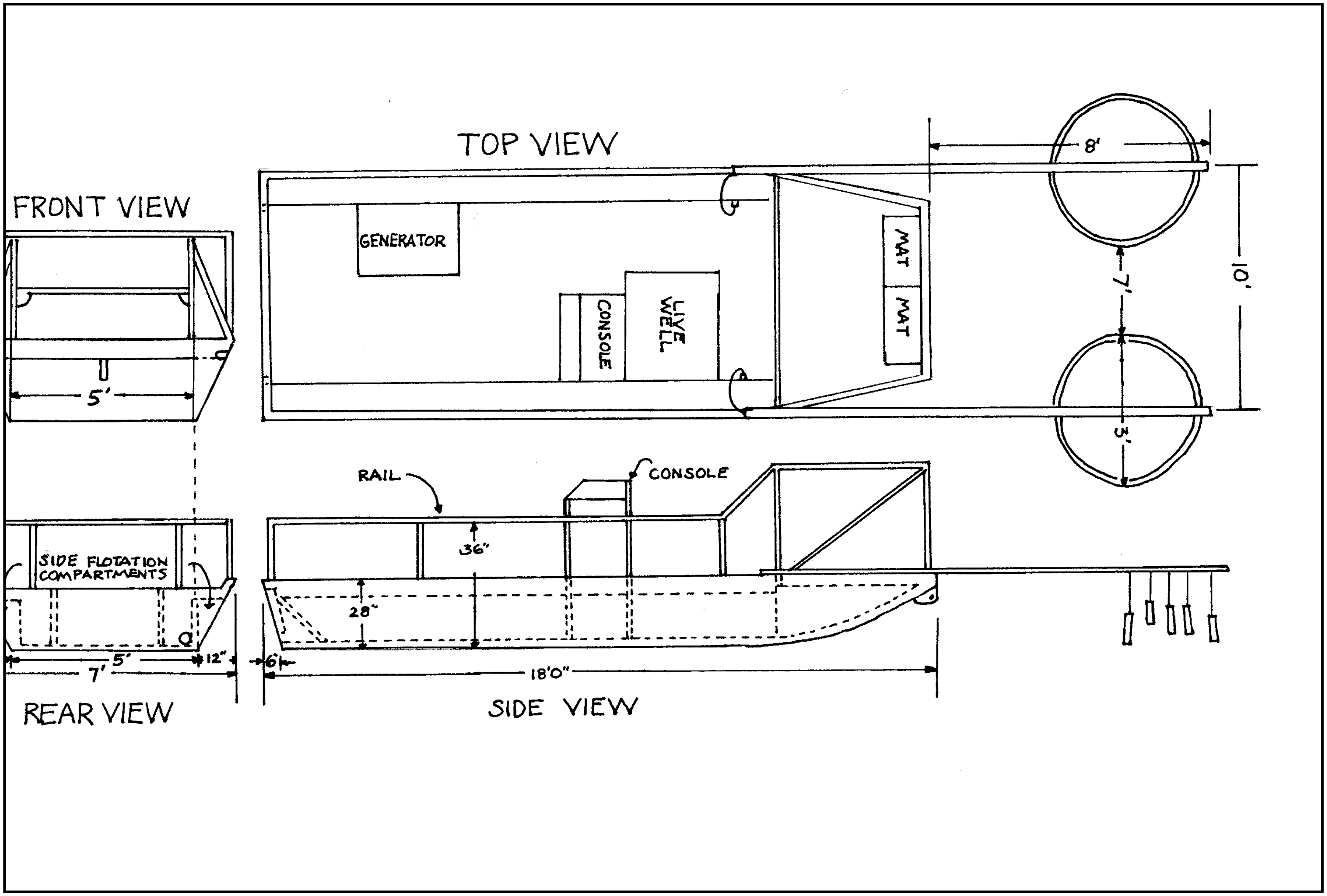


Figure A-1. External configuration of a Long Term Resource Monitoring Program pulsed-DC electrofishing boat

GAUGE	COLOR	ORIGINATES	DESTINATES		SYSTEM	LINE
12	GREEN	AFT GROUND STUD	PORT GROUND STUD		GENERATOR	
12	RED	GENERATOR 3-PRONG PLUG	4-PRONG OUTLET FOR CONTROL BOX		GENERATOR	
12	BLACK	GENERATOR 3-PRONG PLUG	4-PRONG OUTLET FOR CONTROL BOX		GENERATOR	
12	YELLOW	CONTROL BOX	AFT BOOM 4-PRONG OUTLET		GENERATOR	
12	BLUE	CONTROL BOX	PORT BOOM 4-PRONG OUTLET		GENERATOR	
8	BLACK	BATTERY (+ TERMINAL)	RELAY PANNEL IN CONSOLE		12 VOLT	
16	WHITE	PORT RAILING DEADMAN SWITCH	RELAY PANNEL IN CONSOLE		12 VOLT	
16	GREEN	STAR. RAILING DEADMAN SWITCH	STAR. RAILING DEADMAN SWITCH		12 VOLT	
16	GREEN	STAR. RAILING DEADMAN SWITCH	RELAY PANNEL IN CONSOLE	No. 4 TOGGLE	12 VOLT	
16	RED	STARBOARD MAT	RELAY PANNEL IN CONSOLE	No. 4 TOGGLE	12 VOLT	
16	YELLOW	PORT MAT	RELAY PANNEL IN CONSOLE	No. 4 TOGGLE	12 VOLT	
16	BLUE	PORT MAT	JOINS TO STAR. MAT THEN TO RELAY (CONSOLE)		12 VOLT	
12	RED	ALL 2-PRONG TWIST LOCK OUTLETS	RELAY PANNEL IN CONSOLE	No. 2 TOGGLE	12 VOLT	
12	YELLOW	PORT FLOOD LIGHTS	RELAY PANNEL IN CONSOLE	No. 5 TOGGLE	12 VOLT	
12	BLACK	STAR. FLOOD LIGHTS	RELAY PANNEL IN CONSOLE	No. 5 TOGGLE	12 VOLT	
16	RED	STERN AND BOW LIGHTS	RELAY PANNEL IN CONSOLE	No. 6 TOGGLE	12 VOLT	

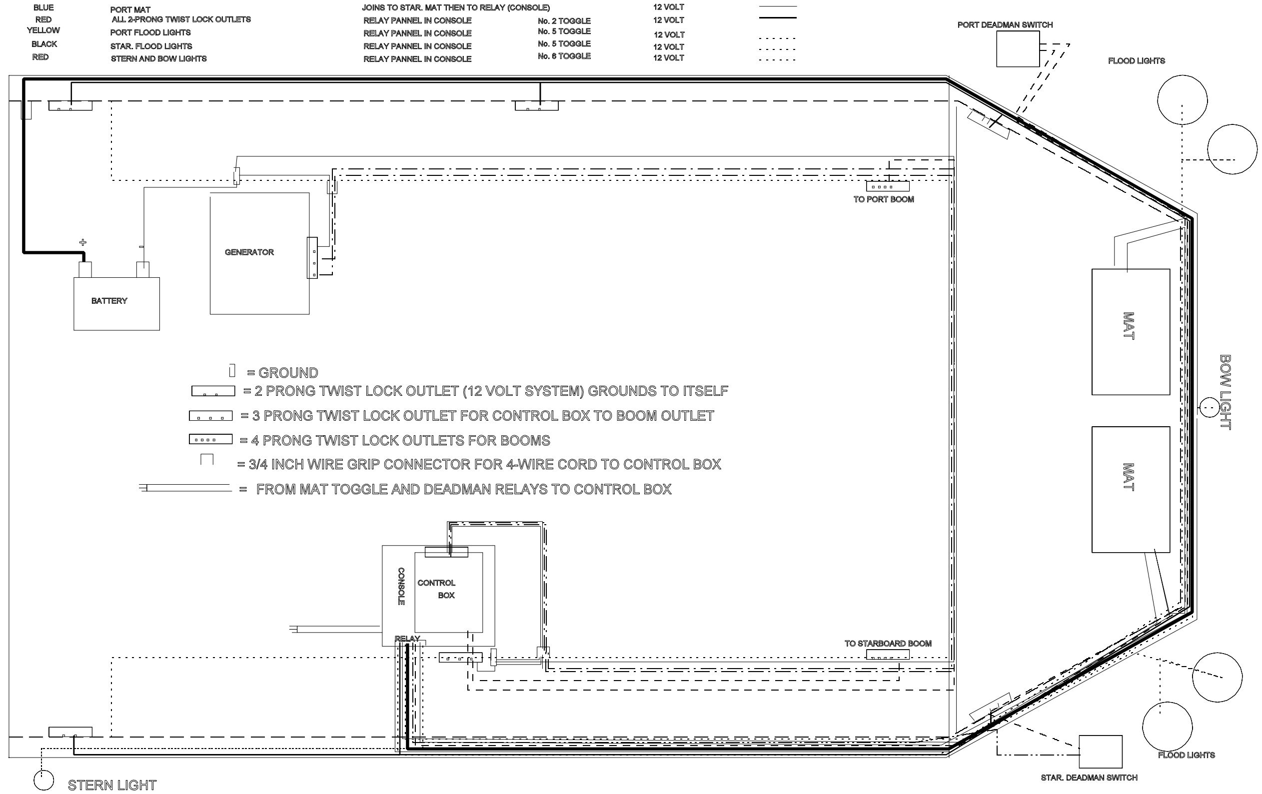


Figure A-2. Circuit diagram for a Long Term Resource Monitoring Program pulsed-DC electrofishing boat

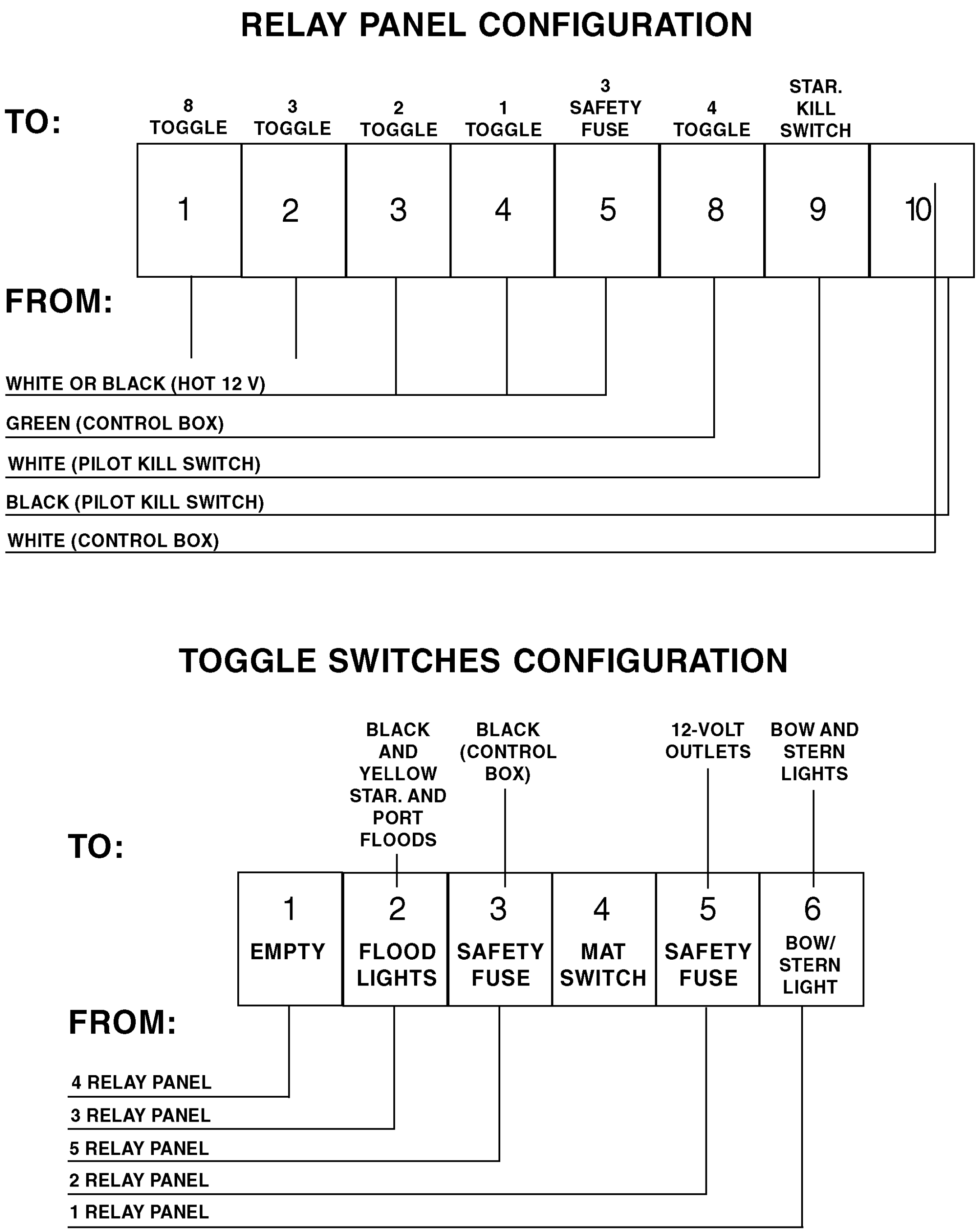


Figure A-3. Terminal block strip and toggle switch configuration for a Long Term Resource Monitoring Program electrofishing boat

Appendix B

Mapping Electrical Fields Surrounding Long Term Resource Monitoring Program Electrofishing Boats

The electrical field emanating from all Long Term Resource Monitoring Program (LTRMP) electrofishing boats should be mapped annually and after repair of electrical components to ensure standardization.

The effective voltage gradient for capture of fish ranges from 0.1 to 1.0 V/cm (Reynolds 1983). A voltage gradient of 0.1 to 1.0 V/cm is generally sufficient to produce a voltage drop of 2 to 20 V over the length of a 20-cm fish, enough to capture but not harm the fish.

The effective electrical field is measured with an oscilloscope and probe having two metal pins (electrodes) separated by a gap of 1 cm. The oscilloscope is used to measure the voltage gradient between the two pins. The voltage gradient in the electrical field must be at least 0.1 V/cm, as per the measurements shown in Figure B-1, below.

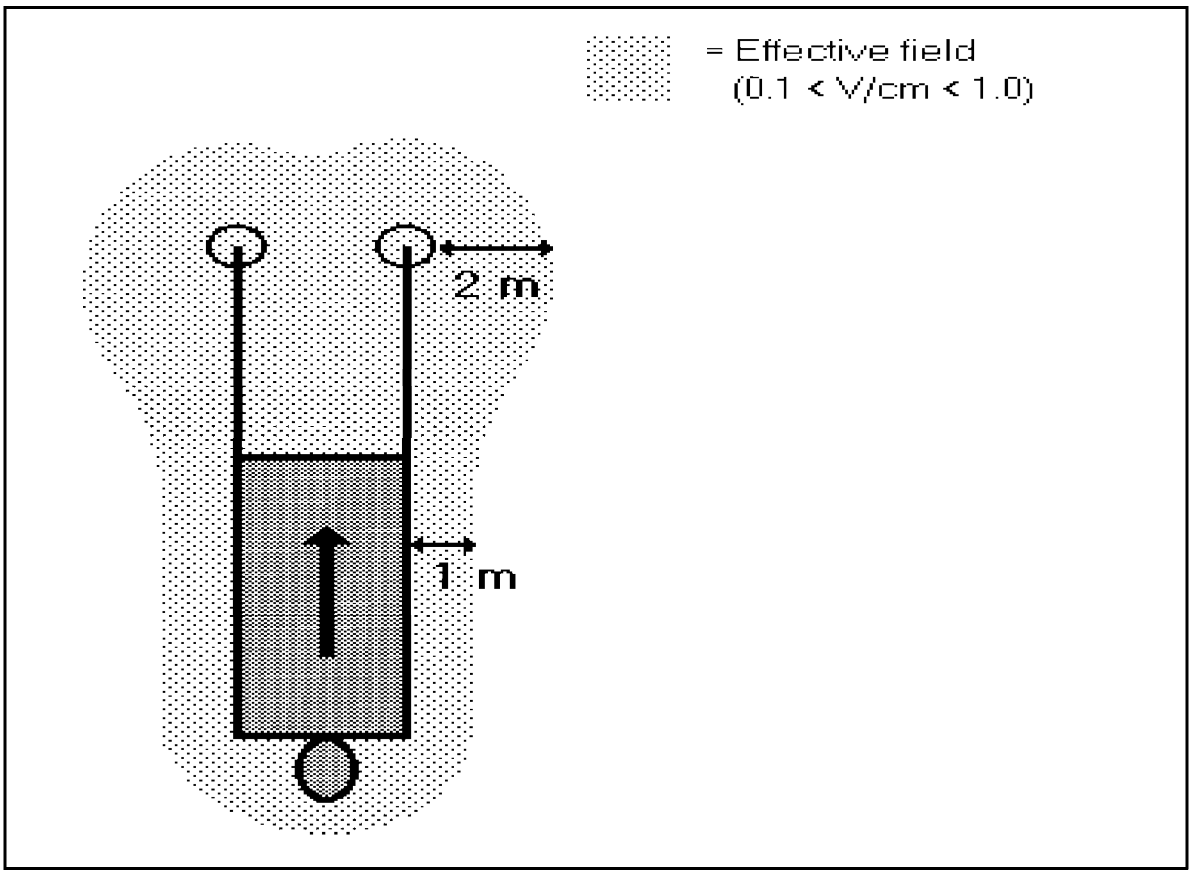


Figure B-1. Approximate shape of the effective (0.1 ≤ V/cm ≤1.0) electrical field around a Long Term Resource Monitoring Program electrofishing boat operating at the 3,000-W power goal. Shaded area is the effective field.

Appendix C

Fish Collection Sheet

Fish Collection Sheet

Long Term Resource Monitoring Program
Environmental Management Technical Center
575 Lester Avenue, Onalaska, Wisconsin 54650

Site Alias

Place Bar Code Here

1. Header Data

Field Station Number
Location Code ♦
Pool/Reach
Project Code ▬
M=RTA Monitoring, B=Bio Response, E=Experimental, R=Research
Start Date (MM/DD/YY)
Start Time (HH/MM)
Finish Date(MM/DD/YY)
Finish Time (HH/MM)
Site Type (0=Primary, 1=Alternate, 2=Fixed)
Stratum ▬
Gear
Time Period
Summary Code

2. Location Data

Zone
Accuracy
N/S Coordinates
Method
1=UTM (Map)
2=UTM (GPS)
3=L/L (GPS)
4=L/L (Map)
E/W Coordinates

3. Gear Effort

Time (HH/MM)
Distance m

4. Electrofishing Settings

Power Goal
Power Used
Volts QF
Amps QF
Pulse (Hz)
Duty Cycle

5. Water Data

Secchi cm QF
Conductivity µS/cm QF
Water Velocity ♦ m/s QF
Water Temp ♦ C QF
D.O. ♦ QF
Depth ♦ QF
Stage Height ♦ QF

QF Codes:
Blank=No Problems
0=Equipment Inoperative
1=Equipment in Question
2=Reading Off Scale (High)
3=Reading Off Scale (Low)
5=Sample Unusable/ Unobtained
9=Non-Standard Method Used

6. Structure

Check All That Apply Within Sample Area
(50x50m except 200x50m for electrofishing)

Emergent and Submersed Aquatic Vegetation

Percent Coverage
Codes: 0=0%, 1=1-19%, 2=20-49%, 3=>50%
Density
Codes: 1=Sparse, 2=Dense

6. Structure (continued)

Predominant Substrate
Substrate Codes: 1=Silt(Soft), 2=Silt/Clay/Little Sand, 3= Sand/Mostly Sand, 4=Gravel/Rock/Hard Clay (Hard)

Other Structure
(If present, place an X in the appropriate box)

Woody debris/snags
Wing Dam/Dyke
Tributary Mouth
Revetment
Inlet/Outlet Channel
Low-head Dam, Closing Structure, Weir
Flooded Terrestrial
Other (Describe in Comments)

8. Other Information

Number of containers returned to lab
Number of fish measurement data sheets
Total number of fish collected

9. Certification

Are header blocks on this sheet and the fish measurement data sheet complete and do they match? ( ) Yes

Are the data sheets complete? ( ) Yes

Crew Leader ID

Data recorded on this form and corresponding fish measurement data sheets were collected in accordance with current LTRMP procedures and are, to the best of my knowledge, complete and free of errors.

Crew Leader's Signature

7. Comments

Note: Only 80 characters may be used for comments.

EMTC 03/24/95

Appendix D

Fish Measurement Sheet

Fish Measurement Sheet

Long Term Resource Monitoring Program
Environmental Management Technical Center
575 Lester Avenue, Onalaska, Wisconsin 54650

Fish Collection Sheet Bar Code Number

Page Number

Field Station Number

Location Code ♦

Pool/Reach

Recording Site 1=Field 2=Lab

Start Date (MM/DD/YY)

Start Time (HH/MM)

Gear

Line	Species Name	Species Code	Length (min) (mm)	TFS	GRP (WTH) (cm)	Weight (g)	Fish Count	Working Tally	PC	Sub-Proj.		User Defined Fields 1	2	3	4	5	6	7	8	9	10	11	12
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							
13																							
14																							
15																							
16																							
17																							
18																							
19																							
20																							

Recorder Code

Number of Fish on This Sheet

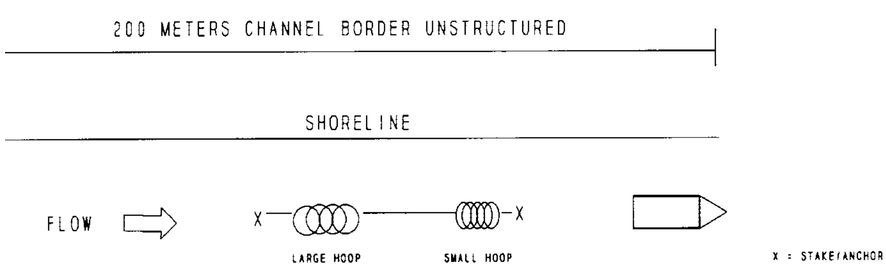
Is the collection sheet barcode number recorded above?

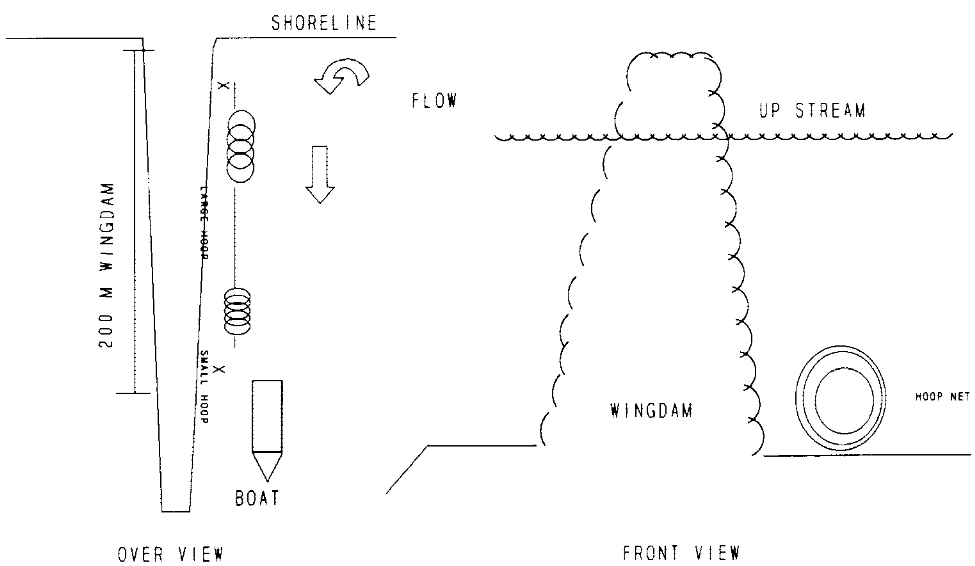
Crew Leader Initials: ________

EMTC 03/24/95

Appendix E

Placement of Serially Connected Tandem Hoop Nets Prior to 1993





Appendix F

Original Long Term Resource Monitoring Program Fish Monitoring Design

Overview. The original sampling design (1989 through 1992) for the fisheries component of the Long Term Resource Monitoring Program (LTRMP) was based on a fixed-point sampling program, wherein subjectively chosen permanent sampling stations were monitored through time. This appendix describes that original sampling design. Details of procedures used prior to 1991 were described by Burkhardt et al. (1988).

Fixed-point sampling is often used in biological and water quality field surveys, but is little used elsewhere. Fixed-point sampling is valid if interest is restricted only to the set of permanent sampling stations, and there is no interest in making inferences beyond those stations. Data from the LTRMP are needed to detect trends within whole habitat classes and study reaches; fixed-point sampling cannot satisfy that need.

Fixed-point sampling has important features that distinguish it from more common randomized (fixed, stratified, clustered, or systematic) sampling (Johnson and Nielson 1983). Because selection of the original sites is not random over LTRMP study reaches, it cannot be assumed that attributes or trends measured in the permanent sampling stations reflect attributes or trends in the larger LTRMP study reaches. Therefore, data collected from permanent sampling stations can be used as indices within sites but cannot be used to infer attributes or trends in the larger unit without assuming that the permanent stations are truly representative (Johnson and Nielson 1983). Critics of fixed-point sampling or the results of fixed-point sampling can always argue validly that the resultant data may be only artifacts of the initial site selection.

Sampling sites. Within LTRMP study reaches, permanent sampling sites were subjectively chosen to represent individual biologist's beliefs about each of seven target habitat types: channel border-unstructured, channel border-wing dam, side channel border, tailwater, main channel trough, contiguous backwater, and impounded. It should be noted that not all of the selected habitats exist in every study area. In cases where only some of the selected habitats are found, the amount of effort that would normally be applied to the nonexistent habitat is applied to existing target habitats or other habitats typical of the study area, depending on crew leader and EMTC discretion.

In the original LTRMP fish monitoring design, the permanent sampling sites were defined such that they contained two, but occasionally more, subareas that were treated as replicates (Fig. F-1). The replicate subareas were usually, but not always, contiguous (see *Sample replications*, below). In this scheme, replication is valid for estimation and testing of these composite sites. An alternative interpretation of this arrangement is that the replicates constitute different sites within the habitat class, although they were not selected independently.

Seasonal distribution of fish collections. Three full sets of collections, plus replicates, were expended annually in all habitats: two sets in each habitat type from June 15 to July 30, from August 1 to September 15, and from September 16 to October 30.

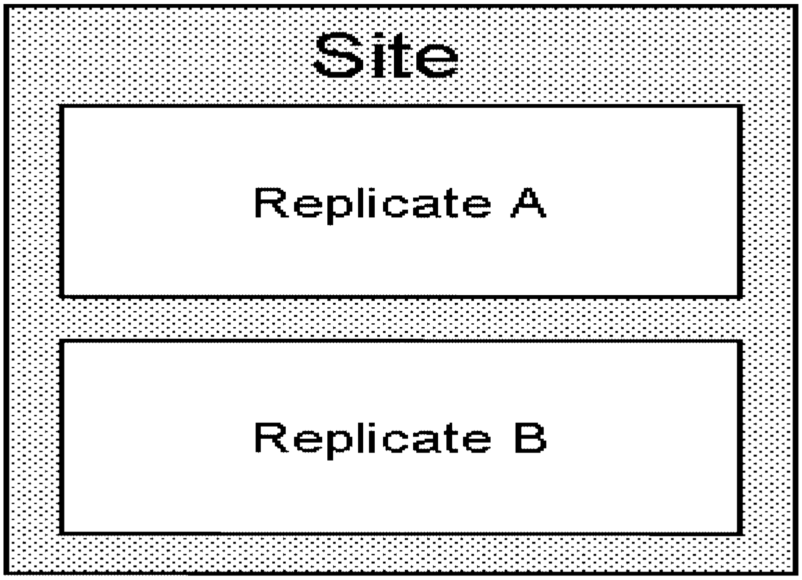


Figure F-1. Spatial replication within sampling sites in the original Long Term Resource Monitoring Program fixed-site sampling design.

Prior to 1991, two sets of "community" collections were made from June 15 through July 30 and from August 1 to September 15. Catches of all species were recorded during these first two time periods. Additionally, during 1989 and 1990 "population" sampling was directed at channel catfish (Time Period 3), black crappie (Time Period 4), and sauger (Time Period 5). Catches of all other species were not reliably recorded in these collections. These "population" collections were described by Burkhardt et al. (1988).

Spatial distribution of fish collections. (See Table F-1)

a. *Channel border-unstructured habitat*. A unit of effort in channel border-unstructured habitat consisted of two 200-m, 15-min night electrofishing runs starting 30 min after sunset (nn); two hoop net sets (hh); four seine hauls (ssss), and four trawls (tttt) each for the upper and lower reaches (includes replicates).

b. *Channel border-wing dam habitat*. A unit of effort in channel border-wing dam habitat consisted of two electrofishing runs that encompass the front and back of the wing dam (recording time and distance) starting at or near 0700 CST (dd); two hoop net sets (hh); and two mini fyke net sets (mm) each for the upper and lower reaches (includes replicates).

c. *Side channel border*. A unit of effort in side channel border-unstructured habitat consisted of two 200-m, 15-min night electrofishing runs starting 30 min after sunset (nn); two hoop net sets (hh); and four seine hauls (ssss) each for the upper and lower reaches (includes replicates).

d. *Tailwater*. A unit of effort in tailwater habitat consisted of two night electrofishing runs starting 30 min after sunset; two hoop net sets (hh); two fyke sets (ff); two mini fyke net sets (mm); and four trawls (tttt) for the upper reach only (includes replicates).

e. *Main channel trough*. A unit of effort in main channel trough habitat consisted of six trawls (tttttt) each for the upper and lower reaches (includes replicates).

f. *Nonvegetated, backwater-contiguous habitat*. A unit of effort in nonvegetated, backwater-contiguous habitat consisted of two 200-m, 15-min daytime electrofishing runs starting at or near 0700 CST (dd); two 200-m, 15-min night electrofishing runs starting 30 min after sunset (nn); two fyke net sets (ff); and two seine hauls (ss) each for the upper and lower reaches (includes replicates).

If a nonvegetated shoreline did not exist, two tandem fyke net sets (xx) and two mini fyke nets (mm) were used instead of ff and ss.

g. *Vegetated, backwater-contiguous habitat*. A unit of effort in vegetated, backwater-contiguous habitat consisted of two 200-m, 15-min daytime electrofishing runs starting at or near 0700 CST (dd); two fyke net sets (ff); and two mini fyke net sets (mm) (includes replicates).

h. *Nonvegetated, impounded habitat*. A unit of effort in nonvegetated, impounded habitat consisted of two 200-m, 15-min daytime electrofishing runs starting at or near 0700 CST (dd); two tandem fyke net sets (xx); and two tandem mini fyke net sets (yy) (deployed the same as the large tandem fyke net sets) for the lower reach only (includes replicates).

i. *Vegetated, impounded habitat*. A unit of effort in vegetated, impounded habitat consisted of two 200-m, 15-min daytime electrofishing runs starting at or near 0700 CST (dd); two fyke net sets (ff); and two mini fyke net sets (mm) for the lower reach only (includes replicates).

Sample replications. Under certain circumstances, fish collections were to be treated as replications. The criteria necessary for collections to be considered replications were that:

1. Collections were made within the same habitat area and water levels.
2. Collections were made using the same method.
3. Collections were made within the same time period.
4. Water conditions were similar for water depth, velocity, temperature, dissolved oxygen, turbidity, specific conductance, and cover.
5. Collection locations within the habitat area were considered random and independent. (However, locations were not, in fact, random.)

Duplicate sampling was necessary for evaluating sampling variance within habitat classes. A minimum of one duplicate per method was considered a standard requirement within all community units of effort. If time constraints did not permit a full sample effort, duplicate samples were sometimes omitted from regular sampling.

Design modification. During 1992 and early 1993, a review of this sampling design was completed. It was concluded that the original LTRMP fish sampling design was inadequate to obtain statistically valid and defensible estimates and tests of trends within habitat classes and study reaches. This conclusion was based on the limitations inherent in restriction of sampling to subjectively chosen permanent sampling sites and is a fundamental scientific and statistical principle that does not require empirical data for support. However, to assess the penalty in precision that might be incurred by incorporating stratified random sampling, an analysis of within- and among-site variance components was performed. The resulting analyses (Gutreuter 1993) suggested that adoption of stratified random sampling will not sacrifice precision. The LTRMP fish sampling design was modified during the winter and spring of 1993 to include stratified random sampling.

Table F-1. Annual fish collections, 1990-1992, and units of effort for one collection period per habitat by pool position and vegetation condition. Second letter indicates replicate sample and (no.) indicates collection code serial number.

	Upper reach				Lower reach			
Habitat category	**Open**		**Vegetated**		**Open**		**Vegetated**	
Channel border unstructured	**(01)**	dd nn hh ssss tttt			**(08)**	dd nn hh ssss tttt		
Channel border wing dam	**(02)**	dd hh mm			**(09)**	dd hh mm		
Side channel border unstructured	**(03)**	nn hh ssss			**(10)**	nn hh ssss		
Tailwater	**(04)**	nn hh ff mm tttt						
Channel trough	**(05)**	tttttt			**(11)**	tttttt		
Backwater-contiguous	**(06)**	dd nn ff ss yy	**(07)**	dd ff mm ss yy	**(12)**	dd nn ff	**(13)**	dd ff mm
Impounded					**(14)**	dd xx yy	**(15)**	dd ff mm

Units of effort/gear code:

dd = two 200-m day electrofishing collections (with duplicates); nn = two 200-m night electrofishing collections; hh = two 48-h hoop net collections; ssss = four seine collections; tttt = four trawl hauls; mm = two 24-h mini fyke net collections; ff = two 24-h fyke net collections; xx = two 24-h fyke nets set in tandem collections (may be interchanged with f in open water); and yy = two 24-h mini fyke nets set in tandem collections (interchanges with s in impounded open habitats).

Appendix G

References to be Used as Keys in the Identification of Fish

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison, Wisconsin. 1,052 pp.

Pflieger, W. L. 1975. Fishes of Missouri. Missouri Department of Conservation, Jefferson City, Missouri. 343 pp.

Robinson, H. W., and T. M. Buchanan. 1984. Fishes of Arkansas. The University of Arkansas Press, Fayetteville, Arkansas. 536 pp.

Appendix H

Long Term Resource Monitoring Program List of Fishes and Fish Codes

Table H-1. Long Term Resource Monitoring Program list of fishes and fish codes arranged alphabetically by common name. Nomenclature follows Robins et al. (1991).

Common name	Scientific name	Code
Age-0 fish (young-of-the-year)	Unidentified	YOYF
Alabama shad	*Alosa alabamae*	ALSD
Alewife	*A. pseudoharengus*	ALWF
Alligator gar	*Lepisosteus spatula*	ALGR
American brook lamprey	*Lampetra appendix*	ABLP
American eel	*Anguilla rostrata*	AMEL
Banded darter	*Etheostoma zonale*	BDDR
Banded killifish	*Fundulus diaphanus*	BDKF
Banded pygmy sunfish	*Elassoma zonatum*	BPSF
Banded sculpin	*Cottus carolinae*	BDSP
Bantam sunfish	*Lepomis symmetricus*	BTSF
Bigeye chub	*Notropis amblops*	BECB
Bigeye shiner	*N. boops*	BESN
Bighead carp	*Hypopthalmichthys nobilis*	BHCP
Bigmouth buffalo	*Ictiobus cyprinellus*	BMBF
Bigmouth shiner	*Notropis dorsalis*	BMSN
Black buffalo	*Ictiobus niger*	BKBF
Black bullhead	*Ameiurus melas*	BKBH
Black crappie	*Pomoxis nigromaculatus*	BKCP
Black redhorse	*Moxostoma duquesnei*	BKRH
Black x white crappie	*Pomoxis nigromaculatus* x *annularis*	BCWC
Blackchin shiner	*Notropis heterodon*	BCSN
Blacknose dace	*Rhinichthys atratulus*	BNDC
Blacknose shiner	*Notropis heterolepis*	BNSN
Blackside darter	*Percina maculata*	BSDR
Blackspotted topminnow	*Fundulus olivaceus*	BPTM
Blackstripe topminnow	*F. notatus*	BTTM
Blacktail shiner	*Cyprinella venusta*	BTSN
Bloater	*Coregonus hoyi*	BLTR
Blue catfish	*Ictalurus furcatus*	BLCF
Blue sucker	*Cycleptus elongatus*	BUSK
Bluebreast darter	*Etheostoma camurum*	BBDR
Bluegill	*Lepomis macrochirus*	BLGL

Table H-1. Continued

Common name	Scientific name	Code
Bluegill x longear sunfish	*L. macrochirus* x *megalotis*	BGLE
Bluegill x orangespotted sunfish	*L. macrochirus* x *humilis*	BGOS
Bluegill x redear sunfish	*L. macrochirus* x *microlophus*	BGRS
Bluegill x warmouth	*L. macrochirus* x *gulosus*	BGWM
Bluehead shiner	*Notropis hubbsi*	BHSN
Bluntnose darter	*Etheostoma chlorosomum*	BNDR
Bluntnose minnow	*Pimephales notatus*	BNMW
Bowfin	*Amia calva*	BWFN
Brassy minnow	*Hybognathus hankinsoni*	BSMW
Brindled madtom	*Noturus miurus*	BDMT
Brook silverside	*Labidesthes sicculus*	BKSS
Brook stickleback	*Culaea inconstans*	BKSB
Brook trout	*Salvelinus fontinalis*	BKTT
Brown bullhead	*Ameiurus nebulosus*	BNBH
Brown trout	*Salmo trutta*	BNTT
Bull shark	*Carcharhinus leucas*	BLSK
Bullhead minnow	*Pimephales vigilax*	BHMW
Burbot	*Lota lota*	BRBT
Carp x goldfish hybrid	*Cyprinus carpio* x *auratus*	C*GF
Central mudminnow	*Umbra limi*	CMMW
Central stoneroller	*Campostoma anomalum*	CLSR
Chain pickerel	*Esox niger*	CNPK
Channel catfish	*Ictalurus punctatus*	CNCF
Channel shiner	*Notropis wickliffi*	CNSN
Chestnut lamprey	*Ichthyomyzon castaneus*	CNLP
Cisco	*Coregonus artedi*	CSCO
Coho salmon	*Oncorhynchus kisutch*	CHSM
Common carp	*Cyprinus carpio*	CARP
Common shiner	*Luxilus cornutus*	CMSN
Creek chub	*Semotilus atromaculatus*	CKCB
Creek chubsucker	*Erimyzon oblongus*	CKCS
Crystal darter	*Ammocrypta asprella*	CLDR
Cypress darter	*Etheostoma proelaire*	CPDR
Deepwater sculpin	*Myoxocephalus thompsoni*	DWSP
Dusky darter	*Percina sciera*	DYDR
Eastern sand darter	*Ammocrypta pellucida*	ESDR
Emerald shiner	*Notropis atherinoides*	ERSN
Fantail darter	*Etheostoma flabellare*	FTDR

Table H-1. Continued

Common name	Scientific name	Code
Fathead minnow	*Pimephales promelas*	FHMW
Flathead catfish	*Pylodictis olivaris*	FHCF
Flathead chub	*Platygobio gracilis*	FHCB
Flier	*Centrarchus macropterus*	FLER
Freckled madtom	*Noturus nocturnus*	FKMT
Freshwater drum	*Aplodinotus grunniens*	FWDM
Ghost shiner	*Notropis buchanani*	GTSN
Gizzard shad	*Dorosoma cepedianum*	GZSD
Golden redhorse	*Moxostoma erythrurum*	GDRH
Golden shiner	*Notemigonus crysoleucas*	GDSN
Goldeye	*Hiodon alosoides*	GDEY
Goldfish	*Carassius auratus*	GDFH
Grass carp	*Ctenopharyngodon idella*	GSCP
Grass pickerel	*Esox americanus vermiculatus*	GSPK
Gravel chub	*Erimystax x-punctatus*	GVCB
Greater redhorse	*Moxostoma valenciennesi*	GTRH
Green sunfish	*Lepomis cyanellus*	GNSF
Green sunfish x bluegill	*L. cyanellus* x *macrochirus*	GSBG
Green sunfish x pumpkinseed	*L. cyanellus* x *gibbosus*	GSPS
Green sunfish x unknown	*L. cyanellus* x sp.	GN*?
Green sunfish x warmouth	*L. cyanellus* x *gulosus*	GSWM
Green x orangespotted sunfish	*L. cyanellus* x *humilis*	GSOS
Green x redear sunfish	*L. cyanellus* x *microlophus*	GSRS
Greenside darter	*Etheostoma blennioides*	GSDR
Harlequin darter	*E. histrio*	HQDR
Highfin carpsucker	*Carpiodes velifer*	HFCS
Hornyhead chub	*Nocomis biguttatus*	HHCB
Inland silverside	*Menidia beryllina*	IDSS
Iowa darter	*Etheostoma exile*	IODR
Ironcolor shiner	*Notropis chalybaeus*	ICSN
Johnny darter	*Etheostoma nigrum*	JYDR
Lake chub	*Couesius plumbeus*	LKCB
Lake chubsucker	*Erimyzon sucetta*	LKCS
Lake sturgeon	*Acipenser fulvescens*	LKSG
Largemouth bass	*Micropterus salmoides*	LMBS
Largescale stoneroller	*Campostoma oligolepis*	LSSR
Larval fish	Unidentified	LRVL

Table H-1. Continued

Common name	Scientific name	Code
Least brook lamprey	*Lampetra aepyptera*	LBLP
Least darter	*Etheostoma microperca*	LTDR
Logperch	*Percina caprodes*	LGPH
Longear sunfish	*Lepomis megalotis*	LESF
Longnose dace	*Rhinichthys cataractae*	LNDC
Longnose gar	*Lepisosteus osseus*	LNGR
Longnose sucker	*Catostomus catostomus*	LNSK
Mimic shiner	*Notropis volucellus*	MMSN
Mississippi silverside	*Menidia audens*	MSSS
Mississippi silvery minnow	*Hybognathus nuchalis*	SVMW
Mooneye	*Hiodon tergisus*	MNEY
Mottled sculpin	*Cottus bairdi*	MDSP
Mountain madtom	*Noturus eleutherus*	MTMT
Mud darter	*Etheostoma asprigene*	MDDR
Muskellunge	*Esox masquinongy*	MSKG
Ninespine stickleback	*Pungitius pungitius*	NSSB
No fish caught	*Nocatchus pisces*	NFSH
Northern brook lamprey	*Ichthyomyzon fossor*	NBLP
Northern hog sucker	*Hypentelium nigricans*	NHSK
Northern madtom	*Noturus stigmosus*	NTMT
Northern pike	*Esox lucius*	NTPK
Northern redbelly dace	*Phoxinus eos*	NRBD
Northern studfish	*Fundulus catenatus*	NTSF
Orangespotted sunfish	*Lepomis humilis*	OSSF
Orangespotted x longear sunfish	*L. humilis* x *megalotis*	OSLE
Orangethroat darter	*Etheostoma spectabile*	OTDR
Ozark minnow	*Notropis nubilus*	OZMW
Paddlefish	*Polyodon spathula*	PDFH
Pallid shiner	*Notropis amnis*	PDSN
Pallid sturgeon	*Scaphirhynchus albus*	PDSG
Pearl dace	*Margariscus margarita*	PLDC
Pirate perch	*Aphredoderus sayanus*	PRPH
Plains minnow	*Hybognathus placitus*	PNMW
Pugnose minnow	*Opsopoeodus emiliae*	PGMW
Pugnose shiner	*Notropis anogenus*	PNSN
Pumpkinseed	*Lepomis gibbosus*	PNSD
Pumpkinseed x bluegill	*L. gibbosus* x *macrochirus*	PSBG
Pumpkinseed x orangespotted sunfish	*L. gibbosus* x *humilis*	PSOS

Table H-1. Continued

Common name	Scientific name	Code
Pumpkinseed x warmouth	*L. gibbosus* x *gulosus*	PSWM
Quillback	*Carpiodes cyprinus*	QLBK
Rainbow darter	*Etheostoma caeruleum*	RBDR
Rainbow smelt	*Osmerus mordax*	RBST
Rainbow trout	*Oncorhynchus mykiss*	RBTT
Red shiner	*Cyprinella lutrensis*	RDSN
Redear sunfish	*Lepomis microlophus*	RESF
Redear sunfish x warmouth	*L. microlophus* x *gulosus*	RSWM
Redfin shiner	*Lythrurus umbratilis*	RFSN
Ribbon shiner	*Notropis fumeus*	RBSN
River carpsucker	*Carpiodes carpio*	RVCS
River chub	*Nocomis micropogon*	RVCB
River darter	*Percina shumardi*	RRDR
River redhorse	*Moxostoma carinatum*	RVRH
River shiner	*Notropis blennius*	RVSN
Rock bass	*Ambloplites rupestris*	RKBS
Rosefin shiner	*Lythrurus ardens*	RSSN
Rosyface shiner	*Notropis rubellus*	RYSN
Sand shiner	*N. stramineus*	SNSN
Sauger	*Stizostedion canadense*	SGER
Sauger x walleye hybrid	*S. canadense* x *vitreum*	SGWE
Sea lamprey	*Petromyzon marinus*	SELP
Shadow bass	*Ambloplites ariommus*	SWBS
Shorthead redhorse	*Moxostoma macrolepidotum*	SHRH
Shortnose gar	*Lepisosteus platostomus*	SNGR
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	SNSG
Sicklefin chub	*Macrhybopsis meeki*	SFCB
Silver carp	*Hypopthalmichthys molitrix*	SVCP
Silver chub	*Macrhybopsis storeriana*	SVCB
Silver lamprey	*Ichthyomyzon unicuspis*	SVLP
Silver redhorse	*Moxostoma anisurum*	SVRH
Silverband shiner	*Notropis shumardi*	SBSN
Silverjaw minnow	*N. buccatus*	SJMW
Skipjack herring	*Alosa chrysochloris*	SJHR
Slender madtom	*Noturus exilis*	SDMT
Slenderhead darter	*Percina phoxocephala*	SHDR
Slimy sculpin	*Cottus cognatus*	SYSP
Slough darter	*Etheostoma gracile*	SLDR
Smallmouth bass	*Micropterus dolomieu*	SMBS

Table H-1. Continued

Common name	Scientific name	Code
Smallmouth buffalo	*Ictiobus bubalus*	SMBF
Southern redbelly dace	*Phoxinus erythrogaster*	SRBD
Speckled chub	*Macrhybopsis aestivalis*	SKCB
Spotfin shiner	*Cyprinella spiloptera*	SFSN
Spottail darter	*Etheostoma squamiceps*	SPDR
Spottail shiner	*Notropis hudsonius*	STSN
Spotted bass	*Micropterus punctulatus*	STBS
Spotted gar	*Lepisosteus oculatus*	STGR
Spotted sucker	*Minytrema melanops*	SPSK
Spotted sunfish	*Lepomis punctatus*	STSF
Spring cavefish	*Chologaster agassizi*	SGCF
Starhead topminnow	*Fundulus dispar*	SHTM
Steelcolor shiner	*Cyprinella whipplei*	SCSN
Stonecat	*Noturus flavus*	STCT
Striped bass	*Morone saxatilis*	SDBS
Striped mullet	*Mugil cephalus*	SPMT
Striped shiner	*Luxilus chrysocephalus*	SPSN
Striped x white bass	*Morone saxatilis* x *chrysops*	SBWB
Stripetail darter	*Etheostoma kennicotti*	STDR
Sturgeon chub	*Macrhybopsis gelida*	SGCB
Suckermouth minnow	*Phenacobius mirabilis*	SMMW
Tadpole madtom	*Noturus gyrinus*	TPMT
Threadfin shad	*Dorosoma petenense*	TFSD
Tiger muskellunge	*Esox masquinongy* x *lucius*	MGNP
Trout perch	*Percopsis omiscomaycus*	TTPH
Unidentified	Unidentified	UNID
Unidentified *Etheostoma*	*Etheostoma* sp.	U-ET
Unidentified *Lepomis*	*Lepomis* sp.	U-LP
Unidentified Percidae	Unidentified Percidae	U-PC
Unidentified Percina	*Percina* sp.	U-PN
Unidentified *Stizostedion*	*Stizostedion* sp.	U-ST
Unidentified buffalo	*Ictiobus* sp.	U-BF
Unidentified carpsucker	*Carpiodes* sp.	U-CS
Unidentified chub	*Macrhybopsis* sp.	U-HY
Unidentified darter	*Percina* or *Etheostoma* sp.	U-DR
Unidentified lamprey	*Petromyzontidae*	U-LY
Unidentified minnow	Unidentified Cyprinidae	U-CY
Unidentified redhorse	*Moxostoma* sp.	U-RH
Unidentified shiner	*Notropis* sp.	U-NO
Unidentified sucker	Unidentified Catostomidae	U-CT

Table H-1. Continued

Common name	Scientific name	Code
Unidentified sunfish	Unidentified Centrarchidae	U-CN
Walleye	*Stizostedion vitreum*	WLYE
Warmouth	*Lepomis gulosus*	WRMH
Weed shiner	*Notropis texanus*	WDSN
Western mosquitofish	*Gambusia affinis*	MQTF
Western sand darter	*Ammocrypta clara*	WSDR
Western silvery minnow	*Hybognathus argyritis*	WSMW
White bass	*Morone chrysops*	WTBS
White catfish	*Ameiurus catus*	WTCF
White crappie	*Pomoxis annularis*	WTCP
White perch	*Morone americana*	WTPH
White sucker	*Catostomus commersoni*	WTSK
Yellow bass	*Morone mississippiensis*	YWBS
Yellow bullhead	*Ameiurus natalis*	YLBH
Yellow perch	*Perca flavescens*	YWPH

Table H-2. Long Term Resource Monitoring Program (LTRMP) list of fish codes and fishes arranged alphabetically by LTRMP code. Nomenclature follows Robins et al. (1990).

Code	Common name	Scientific name
ABLP	American brook lamprey	*Lampetra appendix*
ALGR	Alligator gar	*Lepisosteus spatula*
ALSD	Alabama shad	*Alosa alabamae*
ALWF	Alewife	*A. pseudoharengus*
AMEL	American eel	*Anguilla rostrata*
BBDR	Bluebreast darter	*Etheostoma camurum*
BCSN	Blackchin shiner	*Notropis heterodon*
BCWC	Black x white crappie	*Pomoxis nigromaculatus* x *annularis*
BDDR	Banded darter	*Etheostoma zonale*
BDKF	Banded killifish	*Fundulus diaphanus*
BDMT	Brindled madtom	*Noturus miurus*
BDSP	Banded sculpin	*Cottus carolinae*
BECB	Bigeye chub	*Notropis amblops*
BESN	Bigeye shiner	*N. boops*
BGLE	Bluegill x longear sunfish	*Lepomis macrochirus* x *megalotis*
BGOS	Bluegill x orangespotted sunfish	*L. macrochirus* x *humilis*
BGRS	Bluegill x redear sunfish	*L. macrochirus* x *microlophus*
BGWM	Bluegill x warmouth	*L. macrochirus* x *gulosus*
BHCP	Bighead carp	*Hypopthalmichthys nobilis*
BHMW	Bullhead minnow	*Pimephales vigilax*
BHSN	Bluehead shiner	*Notropis hubbsi*
BKBF	Black buffalo	*Ictiobus niger*
BKBH	Black bullhead	*Ameiurus melas*
BKCP	Black crappie	*Pomoxis nigromaculatus*
BKRH	Black redhorse	*Moxostoma duquesnei*
BKSB	Brook stickleback	*Culaea inconstans*
BKSS	Brook silverside	*Labidesthes sicculus*
BKTT	Brook trout	*Salvelinus fontinalis*
BLCF	Blue catfish	*Ictalurus furcatus*
BLGL	Bluegill	*Lepomis macrochirus*
BLSK	Bull shark	*Carcharhinus leucas*
BLTR	Bloater	*Coregonus hoyi*
BMBF	Bigmouth buffalo	*Ictiobus cyprinellus*
BMSN	Bigmouth shiner	*Notropis dorsalis*
BNBH	Brown bullhead	*Ameiurus nebulosus*
BNDC	Blacknose dace	*Rhinichthys atratulus*
BNDR	Bluntnose darter	*Etheostoma chlorosomum*
BNMW	Bluntnose minnow	*Pimephales notatus*
BNSN	Blacknose shiner	*Notropis heterolepis*
BNTT	Brown trout	*Salmo trutta*

Table H-2. Continued

Code	Common name	Scientific name
BPSF	Banded pygmy sunfish	*Elassoma zonatum*
BPTM	Blackspotted topminnow	*Fundulus olivaceus*
BRBT	Burbot	*Lota lota*
BSDR	Blackside darter	*Percina maculata*
BSMW	Brassy minnow	*Hybognathus hankinsoni*
BTSF	Bantam sunfish	*Lepomis symmetricus*
BTSN	Blacktail shiner	*Cyprinella venusta*
BTTM	Blackstripe topminnow	*Fundulus notatus*
BUSK	Blue sucker	*Cycleptus elongatus*
BWFN	Bowfin	*Amia calva*
C*GF	Carp x goldfish hybrid	*Cyprinus carpio* x *auratus*
CARP	Common carp	*C. carpio*
CHSM	Coho salmon	*Oncorhynchus kisutch*
CKCB	Creek chub	*Semotilus atromaculatus*
CKCS	Creek chubsucker	*Erimyzon oblongus*
CLDR	Crystal darter	*Ammocrypta asprella*
CLSR	Central stoneroller	*Campostoma anomalum*
CMMW	Central mudminnow	*Umbra limi*
CMSN	Common shiner	*Luxilus cornutus*
CNCF	Channel catfish	*Ictalurus punctatus*
CNLP	Chestnut lamprey	*Ichthyomyzon castaneus*
CNPK	Chain pickerel	*Esox niger*
CNSN	Channel shiner	*Notropis wickliffi*
CPDR	Cypress darter	*Etheostoma proelaire*
CSCO	Cisco	*Coregonus artedi*
DWSP	Deepwater sculpin	*Myoxocephalus thompsoni*
DYDR	Dusky darter	*Percina sciera*
ERSN	Emerald shiner	*Notropis atherinoides*
ESDR	Eastern sand darter	*Ammocrypta pellucida*
FHCB	Flathead chub	*Platygobio gracilis*
FHCF	Flathead catfish	*Pylodictis olivaris*
FHMW	Fathead minnow	*Pimephales promelas*
FKMT	Freckled madtom	*Noturus nocturnus*
FLER	Flier	*Centrarchus macropterus*
FTDR	Fantail darter	*Etheostoma flabellare*
FWDM	Freshwater drum	*Aplodinotus grunniens*
GDEY	Goldeye	*Hiodon alosoides*

Table H-2. Continued

Code	Common name	Scientific name
GDFH	Goldfish	*Carassius auratus*
GDRH	Golden redhorse	*Moxostoma erythrurum*
GDSN	Golden shiner	*Notemigonus crysoleucas*
GN*?	Green sunfish x unknown	*Lepomis cyanellus* x sp.
GNSF	Green sunfish	*L cyanellus*
GSBG	Green sunfish x bluegill	*L. cyanellus* x *macrochirus*
GSCP	Grass carp	*Ctenopharyngodon idella*
GSDR	Greenside darter	*Etheostoma blennioides*
GSOS	Green x orangespotted sunfish	*Lepomis cyanellus* x *humilis*
GSPK	Grass pickerel	*Esox americanus vermiculatus*
GSPS	Green sunfish x pumpkinseed	*Lepomis cyanellus* x *gibbosus*
GSRS	Green x redear sunfish	*L. cyanellus* x *microlophus*
GSWM	Green sunfish x warmouth	*L. cyanellus* x *gulosus*
GTRH	Greater redhorse	*Moxostoma valenciennesi*
GTSN	Ghost shiner	*Notropis buchanani*
GVCB	Gravel chub	*Erimystax x-punctatus*
GZSD	Gizzard shad	*Dorosoma cepedianum*
HFCS	Highfin carpsucker	*Carpiodes velifer*
HHCB	Hornyhead chub	*Nocomis biguttatus*
HQDR	Harlequin darter	*Etheostoma histrio*
ICSN	Ironcolor shiner	*Notropis chalybaeus*
IDSS	Inland silverside	*Menidia beryllina*
IODR	Iowa darter	*Etheostoma exile*
JYDR	Johnny darter	*E. nigrum*
LBLP	Least brook lamprey	*Lampetra aepyptera*
LESF	Longear sunfish	*Lepomis megalotis*
LGPH	Logperch	*Percina caprodes*
LKCB	Lake chub	*Couesius plumbeus*
LKCS	Lake chubsucker	*Erimyzon sucetta*
LKSG	Lake sturgeon	*Acipenser fulvescens*
LMBS	Largemouth bass	*Micropterus salmoides*
LNDC	Longnose dace	*Rhinichthys cataractae*
LNGR	Longnose gar	*Lepisosteus osseus*
LNSK	Longnose sucker	*Catostomus catostomus*
LRVL	Larval fish	Unidentified
LSSR	Largescale stoneroller	*Campostoma oligolepis*
LTDR	Least darter	*Etheostoma microperca*

Table H-2. Continued

Code	Common name	Scientific name
MDDR	Mud darter	*E. asprigene*
MDSP	Mottled sculpin	*Cottus bairdi*
MGNP	Tiger muskellunge	*Esox masquinongy* x *lucius*
MMSN	Mimic shiner	*Notropis volucellus*
MNEY	Mooneye	*Hiodon tergisus*
MQTF	Western mosquitofish	*Gambusia affinis*
MSKG	Muskellunge	*Esox masquinongy*
MSSS	Mississippi silverside	*Menidia audens*
MTMT	Mountain madtom	*Noturus eleutherus*
NBLP	Northern brook lamprey	*Ichthyomyzon fossor*
NFSH	No fish caught	*Nocatchus pisces*
NHSK	Northern hog sucker	*Hypentelium nigricans*
NRBD	Northern redbelly dace	*Phoxinus eos*
NSSB	Ninespine stickleback	*Pungitius pungitius*
NTMT	Northern madtom	*Noturus stigmosus*
NTPK	Northern pike	*Esox lucius*
NTSF	Northern studfish	*Fundulus catenatus*
OSLE	Orangespotted x longear sunfish	*Lepomis humilis* x *megalotis*
OSSF	Orangespotted sunfish	*L. humilis*
OTDR	Orangethroat darter	*Etheostoma spectabile*
OZMW	Ozark minnow	*Notropis nubilus*
PDFH	Paddlefish	*Polyodon spathula*
PDSG	Pallid sturgeon	*Scaphirhynchus albus*
PDSN	Pallid shiner	*Notropis amnis*
PGMW	Pugnose minnow	*Opsopoeodus emiliae*
PLDC	Pearl dace	*Margariscus margarita*
PNMW	Plains minnow	*Hybognathus placitus*
PNSD	Pumpkinseed	*Lepomis gibbosus*
PNSN	Pugnose shiner	*Notropis anogenus*
PRPH	Pirate perch	*Aphredoderus sayanus*
PSBG	Pumpkinseed x bluegill	*Lepomis gibbosus x macrochirus*
PSOS	Pumpkinseed x orangespotted sunfish	*L. gibbosus* x *humilis*
PSWM	Pumpkinseed x warmouth	*L. gibbosus* x *gulosus*
QLBK	Quillback	*Carpiodes cyprinus*
RBDR	Rainbow darter	*Etheostoma caeruleum*
RBSN	Ribbon shiner	*Notropis fumeus*
RBST	Rainbow smelt	*Osmerus mordax*

Table H-2. Continued

Code	Common name	Scientific name
RBTT	Rainbow trout	*Oncorhynchus mykiss*
RDSN	Red shiner	*Cyprinella lutrensis*
RESF	Redear sunfish	*Lepomis microlophus*
RFSN	Redfin shiner	*Lythrurus umbratilis*
RKBS	Rock bass	*Ambloplites rupestris*
RRDR	River darter	*Percina shumardi*
RSSN	Rosefin shiner	*Lythrurus ardens*
RSWM	Redear sunfish x warmouth	*L. microlophus* x *gulosus*
RVCB	River chub	*Nocomis micropogon*
RVCS	River carpsucker	*Carpiodes carpio*
RVRH	River redhorse	*Moxostoma carinatum*
RVSN	River shiner	*Notropis blennius*
RYSN	Rosyface shiner	*N. rubellus*
SBSN	Silverband shiner	*N. shumardi*
SBWB	Striped x white bass	*Morone saxatilis* x *chrysops*
SCSN	Steelcolor shiner	*Cyprinella whipplei*
SDBS	Striped bass	*Morone saxatilis*
SDMT	Slender madtom	*Noturus exilis*
SELP	Sea lamprey	*Petromyzon marinus*
SFCB	Sicklefin chub	*Macrhybopsis meeki*
SFSN	Spotfin shiner	*Cyprinella spiloptera*
SGCB	Sturgeon chub	*Macrhybopsis gelida*
SGCF	Spring cavefish	*Chologaster agassizi*
SGER	Sauger	*Stizostedion canadense*
SGWE	Sauger x walleye hybrid	*S. canadense* x *vitreum*
SHDR	Slenderhead darter	*Percina phoxocephala*
SHRH	Shorthead redhorse	*Moxostoma macrolepidotum*
SHTM	Starhead topminnow	*Fundulus dispar*
SJHR	Skipjack herring	*Alosa chrysochloris*
SJMW	Silverjaw minnow	*Notropis buccatus*
SKCB	Speckled chub	*Macrhybopsis aestivalis*
SLDR	Slough darter	*Etheostoma gracile*
SMBF	Smallmouth buffalo	*Ictiobus bubalus*
SMBS	Smallmouth bass	*Micropterus dolomieu*
SMMW	Suckermouth minnow	*Phenacobius mirabilis*
SNGR	Shortnose gar	*Lepisosteus platostomus*
SNSG	Shovelnose sturgeon	*Scaphirhynchus platorynchus*
SNSN	Sand shiner	*Notropis stramineus*
SPDR	Spottail darter	*Etheostoma squamiceps*
SPMT	Striped mullet	*Mugil cephalus*
SPSK	Spotted sucker	*Minytrema melanops*

Table H-2. Continued

Code	Common name	Scientific name
SPSN	Striped shiner	*Luxilus chrysocephalus*
SRBD	Southern redbelly dace	*Phoxinus erythrogaster*
STBS	Spotted bass	*Micropterus punctulatus*
STCT	Stonecat	*Noturus flavus*
STDR	Stripetail darter	*Etheostoma kennicotti*
STGR	Spotted gar	*Lepisosteus oculatus*
STSF	Spotted sunfish	*Lepomis punctatus*
STSN	Spottail shiner	*Notropis hudsonius*
SVCB	Silver chub	*Macrhybopsis storeriana*
SVCP	Silver carp	*Hypopthalmichthys molitrix*
SVLP	Silver lamprey	*Ichthyomyzon unicuspis*
SVMW	Mississippi silvery minnow	*Hybognathus nuchalis*
SVRH	Silver redhorse	*Moxostoma anisurum*
SWBS	Shadow bass	*Ambloplites ariommus*
SYSP	Slimy sculpin	*Cottus cognatus*
TFSD	Threadfin shad	*Dorosoma petenense*
TPMT	Tadpole madtom	*Noturus gyrinus*
TTPH	Trout perch	*Percopsis omiscomaycus*
U-BF	Unidentified buffalo	*Ictiobus* sp.
U-CN	Unidentified sunfish	Unidentified Centrarchidae
U-CS	Unidentified carpsucker	*Carpiodes* sp.
U-CT	Unidentified sucker	Unidentified Catostomidae
U-CY	Unidentified minnow	Unidentified Cyprinidae
U-DR	Unidentified darter	*Percina or Etheostoma* sp.
U-ET	Unidentified *Etheostoma*	*Etheostoma* sp.
U-HY	Unidentified chub	*Macrhybopsis* sp.
U-LP	Unidentified *Lepomis*	*Lepomis* sp.
U-LY	Unidentified lamprey	*Petromyzontidae*
U-NO	Unidentified shiner	*Notropis* sp.
U-PC	Unidentified Percidae	Unidentified Percidae
U-PN	Unidentified Percina	*Percina* sp.
U-RH	Unidentified redhorse	*Moxostoma* sp.
U-ST	Unidentified *Stizostedion*	*Stizostedion* sp.
UNID	Unidentified	Unidentified
WDSN	Weed shiner	*Notropis texanus*
WLYE	Walleye	*Stizostedion vitreum*
WRMH	Warmouth	*Lepomis gulosus*
WSDR	Western sand darter	*Ammocrypta clara*
WSMW	Western silvery minnow	*Hybognathus argyritis*

Table H-2. Continued

Code	Common name	Scientific name
WTBS	White bass	*Morone chrysops*
WTCF	White catfish	*Ameiurus catus*
WTCP	White crappie	*Pomoxis annularis*
WTPH	White perch	*Morone americana*
WTSK	White sucker	*Catostomus commersoni*
YLBH	Yellow bullhead	*Ameiurus natalis*
YOYF	Age-0 fish (young-of-the-year)	Unidentified
YWBS	Yellow bass	*Morone mississippiensis*
YWPH	Yellow perch	*Perca flavescens*

Table H-3. List of obsolete Long Term Resource Monitoring Program fish codes. These codes have been replaced or deleted because of nomenclature changes.

Code	Common name	Scientific name
CMSR	Central stoneroller (OBS)	*Campostoma anomalum*
WTSG	Pallid sturgeon (OBS)	*Scaphirhynchus albus*

Table H-4. Long Term Resource Monitoring Program list of fishes, arranged phylogenetically by family, then alphabetically by genus and species. Hybrids are listed after respective genera. Nomenclature follows Robins et al. (1990).

Common name	Scientific name
Family Petromyzontidae	
Chestnut lamprey	*Ichthyomyzon castaneus*
Northern brook lamprey	*I. fossor*
Silver lamprey	*I. unicuspis*
Least brook lamprey	*Lampetra aepyptera*
American brook lamprey	*L. appendix*
Sea lamprey	*Petromyzon marinus*
Family Carcharhinidae	
Bull shark	*Carcharhinus leucas*
Family Acipenseridae	
Lake sturgeon	*Acipenser fulvescens*
Pallid sturgeon	*Scaphirhynchus albus*
Shovelnose sturgeon	*S. platorynchus*
Family Polyodontidae	
Paddlefish	*Polyodon spathula*
Family Lepisosteidae	
Spotted gar	*Lepisosteus oculatus*
Longnose gar	*L. osseus*
Shortnose gar	*L. platostomus*
Alligator gar	*L. spatula*
Family Amiidae	
Bowfin	*Amia calva*
Family Hiodontidae	
Goldeye	*Hiodon alosoides*
Mooneye	*H. tergisus*
Family Anguillidae	
American eel	*Anguilla rostrata*
Family Clupeidae	
Alabama shad	*Alosa alabamae*
Skipjack herring	*A. chrysochloris*
Alewife	*A. pseudoharengus*

Table H-4. Continued

Common name	Scientific name
Gizzard shad	*Dorosoma cepedianum*
Threadfin shad	*D. petenense*
Family Cyprinidae	
Central stoneroller	*Campostoma anomalum*
Largescale stoneroller	*C. oligolepis*
Goldfish	*Carassius auratus*
Lake chub	*Couesius plumbeus*
Grass carp	*Ctenopharyngodon idella*
Red shiner	*Cyprinella lutrensis*
Spotfin shiner	*C. spiloptera*
Blacktail shiner	*C. venusta*
Steelcolor shiner	*C. whipplei*
Common carp	*Cyprinus carpio*
Carp x goldfish hybrid	*C. carpio* x *auratus*
Gravel chub	*Erimystax x-punctatus*
Western silvery minnow	*Hybognathus argyritis*
Brassy minnow	*H. hankinsoni*
Mississippi silvery minnow	*H. nuchalis*
Plains minnow	*H. placitus*
Silver carp	*Hypopthalmichthys molitrix*
Bighead carp	*H. nobilis*
Striped shiner	*Luxilus chrysocephalus*
Common shiner	*L. cornutus*
Rosefin shiner	*Lythrurus ardens*
Redfin shiner	*L. umbratilis*
Speckled chub	*Macrhybopsis aestivalis*
Sturgeon chub	*M. gelida*
Sicklefin chub	*M. meeki*
Silver chub	*M. storeriana*
Pearl dace	*Margariscus margarita*
Hornyhead chub	*Nocomis biguttatus*
River chub	*N. micropogon*
Golden shiner	*Notemigonus crysoleucas*
Pallid shiner	*Notropis amnis*
Bigeye chub	*N. amblops*
Pugnose shiner	*N. anogenus*
Emerald shiner	*N. atherinoides*
River shiner	*N. blennius*
Bigeye shiner	*N. boops*
Silverjaw minnow	*N. buccatus*
Ghost shiner	*N. buchanani*

Table H-4. Continued

Common name	Scientific name
Ironcolor shiner	*N. chalybaeus*
Bigmouth shiner	*N. dorsalis*
Ribbon shiner	*N. fumeus*
Blackchin shiner	*N. heterodon*
Blacknose shiner	*N. heterolepis*
Bluehead shiner	*N. hubbsi*
Spottail shiner	*N. hudsonius*
Ozark minnow	*N. nubilus*
Rosyface shiner	*N. rubellus*
Silverband shiner	*N. shumardi*
Sand shiner	*N. stramineus*
Weed shiner	*N. texanus*
Mimic shiner	*N. volucellus*
Channel shiner	*N. wickliffi*
Pugnose minnow	*Opsopoeodus emiliae*
Suckermouth minnow	*Phenacobius mirabilis*
Northern redbelly dace	*Phoxinus eos*
Southern redbelly dace	*P. erythrogaster*
Bluntnose minnow	*Pimephales notatus*
Fathead minnow	*P. promelas*
Bullhead minnow	*P. vigilax*
Flathead chub	*Platygobio gracilis*
Blacknose dace	*Rhinichthys atratulus*
Longnose dace	*R. cataractae*
Creek chub	*Semotilus atromaculatus*
Family Catostomidae	
River carpsucker	*Carpiodes carpio*
Quillback	*C. cyprinus*
Highfin carpsucker	*C. velifer*
Longnose sucker	*Catostomus catostomus*
White sucker	*C. commersoni*
Blue sucker	*Cycleptus elongatus*
Creek chubsucker	*Erimyzon oblongus*
Lake chubsucker	*E. sucetta*
Northern hog sucker	*Hypentelium nigricans*
Smallmouth buffalo	*Ictiobus bubalus*
Bigmouth buffalo	*I. cyprinellus*
Black buffalo	*I. niger*
Spotted sucker	*Minytrema melanops*
Silver redhorse	*Moxostoma anisurum*
River redhorse	*M. carinatum*

Table H-4. Continued

Common name	Scientific name
Black redhorse	*M. duquesnei*
Golden redhorse	*M. erythrurum*
Shorthead redhorse	*M. macrolepidotum*
Greater redhorse	*M. valenciennesi*
Family Ictaluridae	
White catfish	*Ameiurus catus*
Black bullhead	*A. melas*
Yellow bullhead	*A. natalis*
Brown bullhead	*A. nebulosus*
Blue catfish	*Ictalurus furcatus*
Channel catfish	*I. punctatus*
Mountain madtom	*Noturus eleutherus*
Slender madtom	*N. exilis*
Stonecat	*N. flavus*
Tadpole madtom	*N. gyrinus*
Brindled madtom	*N. miurus*
Freckled madtom	*N. nocturnus*
Northern madtom	*N. stigmosus*
Flathead catfish	*Pylodictis olivaris*
Family Esocidae	
Grass pickerel	*Esox americanus*
vermiculatus	
Northern pike	*E. lucius*
Muskellunge	*E. masquinongy*
Tiger muskellunge	*E. masquinongy* x *lucius*
Chain pickerel	*E. niger*
Family Umbridae	
Central mudminnow	*Umbra limi*
Family Osmeridae	
Rainbow smelt	*Osmerus mordax*
Family Salmonidae	
Cisco	*Coregonus artedi*
Bloater	*C. hoyi*
Coho salmon	*Oncorhynchus kisutch*
Rainbow trout	*O. mykiss*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus fontinalis*

Table H-4. Continued

Common name	Scientific name
Family Percopsidae	
Trout perch	*Percopsis omiscomaycus*
Family Aphredoderidae	
Pirate perch	*Aphredoderus sayanus*
Family Amblyopsidae	
Spring cavefish	*Chologaster agassizi*
Family Gadidae	
Burbot	*Lota lota*
Family Cyprinodontidae	
Northern studfish	*Fundulus catenatus*
Banded killifish	*F. diaphanus*
Starhead topminnow	*F. dispar*
Blackstripe topminnow	*F. notatus*
Blackspotted topminnow	*F. olivaceus*
Family Poeciliidae	
Western mosquitofish	*Gambusia affinis*
Family Atherinidae	
Brook silverside	*Labidesthes sicculus*
Mississippi silverside	*Menidia audens*
Inland silverside	*M. beryllina*
Family Gasterosteidae	
Brook stickleback	*Culaea inconstans*
Ninespine stickleback	*Pungitius pungitius*
Family Cottidae	
Mottled sculpin	*Cottus bairdi*
Banded sculpin	*C. carolinae*
Slimy sculpin	*C. cognatus*
Deepwater sculpin	*Myoxocephalus thompsoni*
Family Percichthyidae	
White perch	*Morone americana*
White bass	*M. chrysops*
Yellow bass	*M. mississippiensis*
Striped bass	*M. saxatilis*

Table H-4. Continued

Common name	Scientific name
Striped x white bass	*M. saxatilis* x *chrysops*
Family Centrarchidae	
Shadow bass	*Ambloplites ariommus*
Rock bass	*A. rupestris*
Flier	*Centrarchus macropterus*
Banded pygmy sunfish	*Elassoma zonatum*
Green sunfish	*Lepomis cyanellus*
Pumpkinseed	*L. gibbosus*
Warmouth	*L. gulosus*
Orangespotted sunfish	*L. humilis*
Bluegill	*L. macrochirus*
Longear sunfish	*L. megalotis*
Redear sunfish	*L. microlophus*
Spotted sunfish	*L. punctatus*
Bantam sunfish	*L. symmetricus*
Green sunfish x pumpkinseed	*L. cyanellus* x *gibbosus*
Green sunfish x warmouth	*L. cyanellus* x *gulosus*
Green x orangespotted sunfish	*L. cyanellus* x *humilis*
Green sunfish x bluegill	*L. cyanellus* x *macrochirus*
Green x redear sunfish	*L. cyanellus* x *microlophus*
Green sunfish x unknown	*L. cyanellus* x sp.
Pumpkinseed x warmouth	*L. gibbosus* x *gulosus*
Pumpkinseed x orangespotted sunfish	*L. gibbosus* x *humilis*
Pumpkinseed x bluegill	*L. gibbosus* x *macrochirus*
Orangespotted x longear sunfish	*L. humilis* x *megalotis*
Bluegill x warmouth	*L. macrochirus* x *gulosus*
Bluegill x orangespotted sunfish	*L. macrochirus* x *humilis*
Bluegill x longear sunfish	*L. macrochirus* x *megalotis*
Bluegill x redear sunfish	*L. macrochirus* x *microlophus*
Redear sunfish x warmouth	*L. microlophus* x *gulosus*
Smallmouth bass	*Micropterus dolomieu*
Spotted bass	*M. punctulatus*
Largemouth bass	*M. salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*P. nigromaculatus*
Black x white crappie	*P. nigromaculatus* x *annularis*

Table H-4. Continued

Common name	Scientific name
Family Percidae	
Crystal darter	*Ammocrypta asprella*
Western sand darter	*A. clara*
Eastern sand darter	*A. pellucida*
Mud darter	*Etheostoma asprigene*
Greenside darter	*E. blennioides*
Rainbow darter	*E. caeruleum*
Bluebreast darter	*E. camurum*
Bluntnose darter	*E. chlorosomum*
Iowa darter	*E. exile*
Fantail darter	*E. flabellare*
Slough darter	*E. gracile*
Harlequin darter	*E. histrio*
Stripetail darter	*E. kennicotti*
Least darter	*E. microperca*
Johnny darter	*E. nigrum*
Cypress darter	*E. proelaire*
Orangethroat darter	*E. spectabile*
Spottail darter	*E. squamiceps*
Banded darter	*E. zonale*
Yellow perch	*Perca flavescens*
Logperch	*Percina caprodes*
Blackside darter	*P. maculata*
Slenderhead darter	*P. phoxocephala*
Dusky darter	*P. sciera*
River darter	*P. shumardi*
Sauger	*Stizostedion canadense*
Walleye	*S. vitreum*
Sauger x walleye hybrid	*S. canadense* x *vitreum*
Family Sciaenidae	
Freshwater drum	*Aplodinotus grunniens*
Family Mugilidae	
Striped mullet	*Mugil cephalus*

Appendix I

Fish Identification Expert

Robert Hrabik
Open River Field Station
Missouri Department of Conservation
3815 East Jackson Boulevard
Jackson, MO 63755

Appendix J

Fish Data Sheet Log

Fish Data Sheet Log

Long Term Resource Monitoring Program
Environmental Management Technical Center
575 Lester Avenue, Onalaska, WI 54650

Page ☐☐ of ☐☐

Field Station ☐

Collection Sheet Bar Code	Number of Sheets		Date Logged	Crew Code	Initials
	Collection	Measurement			
	☐ 0 or 1	☐☐	☐☐☐☐☐☐	☐☐☐	______
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	☐ 0 or 1	☐☐	☐☐☐☐☐☐	☐☐☐	______
	☐ 0 or 1	☐☐	☐☐☐☐☐☐	☐☐☐	______

Field Station: Complete QA/QC procedures for submission of data for entry when logging data sheets. Make two (2) copies of this sheet. Use this original as a cover for batch submitted for entry. Mail one copy directly to EMTC and file the remaining one.

Date Mailed to Data Entry	Date Received by Data Entry	Date Sent to EMTC	Date Received by EMTC
☐☐☐☐☐☐	☐☐☐☐☐☐	☐☐☐☐☐☐	☐☐☐☐☐☐
Signature:	Signature:	Signature:	Signature:

EMTC 01/20/95

The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information to maintain the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the National Biological Service, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.