Long Term Resource Monitoring Program

An element of the U.S. Army Corps of Engineers'
Upper Mississippi River Restoration-Environmental Management Program

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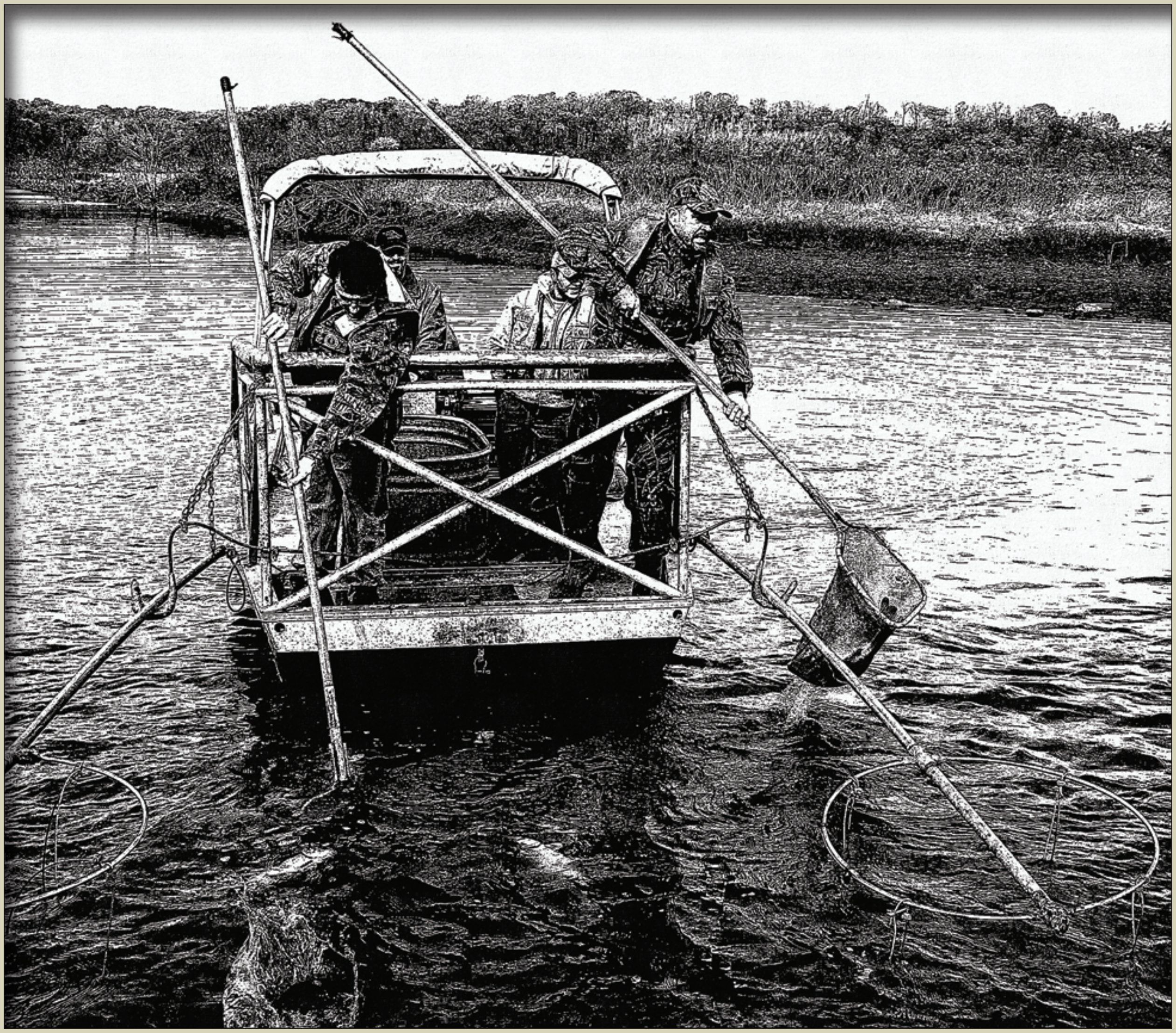
Long Term Resource Monitoring Program Procedures:

Fish Monitoring



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Long Term Resource Monitoring Program Procedures:

Fish Monitoring

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Preface

The U.S. Army Corps of Engineers' (USACE) Upper Mississippi River Restoration-Environmental Management Program (UMRR-EMP), including its Long Term Resource Monitoring Program element (LTRMP), was authorized under the Water Resources Development Act of 1986 (Public Law 99–662). The UMRR-EMP is a multi-federal and state agency partnership among the USACE, the U.S. Geological Survey's (USGS) Upper Midwest Environmental Sciences Center (UMESC), the U.S. Fish and Wildlife Service (USFWS), and the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The USACE provides guidance and has overall Program responsibility. UMESC provides science coordination and leadership for the LTRMP element.

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 element is to support decision makers with the information and understanding needed to manage the UMRS as a sustainable, large river ecosystem, given its multiple use character. The long-term goals of the LTRMP are to better understand the UMRS ecosystem and its resource problems, monitor and determine resource status and trends, develop management alternatives, and proper management and delivery of information.

This report supports Outcome 1: Enhanced knowledge about system status and trends in the Strategic and Operational Plan for the Long Term Resource Monitoring Program on the Upper Mississippi River System, Fiscal Years 2010-2014 (2009) and fulfills milestone #2013B5 from the FY13 LTRMP scope of work. This report was developed with funding provided by the USACE through the UMRR-EMP.

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1. Purpose of Revision

This manual constitutes the second revision of the U.S. Army Corps of Engineers' Upper Mississippi River Restoration-Environmental Management Program (UMRR-EMP) Long Term Resource Monitoring Program (LTRMP) element Fish Procedures Manual (Burkhardt et al. 1988; Gutreuter et al. 1995). The original (1988) manual merged and expanded on ideas and recommendations related to Upper Mississippi River fish sampling presented in several early documents (Burkhardt et al. 1988; Gutreuter 1997). The first revision to the manual was made in 1995 reflecting important protocol changes, such as the adoption of a stratified random sampling design. The 1995 procedures manual has been an important document through the years and has been cited in many reports and scientific manuscripts. The resulting data collected by the LTRMP fish component represent the largest dataset on fish within the Upper Mississippi River System (UMRS) with more than 44,000 collections of approximately 5.7 million fish.

The goal of this revision of the procedures manual is to document changes in LTRMP fish sampling procedures since 1995. Refinements to sampling methods become necessary as monitoring programs mature (Ickes and Burkhardt 2002). Possible refinements are identified through field experiences (e.g., sampling techniques and safety protocols), data analysis (e.g., planned and studied gear efficiencies and reallocations of effort), and technological advances (e.g., electronic data entry). Other changes may be required because of financial necessity (i.e., unplanned effort reductions). This version of the LTRMP fish monitoring manual describes the most current (2014) procedures of the LTRMP fish component. To document the full scope of history and changes, this manual (with future addenda), and the previous (1995) manual are provided online at *http://www.umesc.usgs.gov/data_library/fisheries/fish_page.html* (accessed December 11, 2013).

2. Acknowledgments

This document is the result of contributions of ideas from many individuals. It incorporates material from the first LTRMP procedures manual (Burkhardt et al. 1988) as well as substantial material from the 1995 procedures manual authored by Steve Gutreuter, Randy Burkhardt, and Kenneth Lubinski (Gutreuter et al. 1995). The LTRMP planned for self-evaluation and change early in the program (Gutreuter et al. 1995), and several refinements to enhance the ability of the program to provide useful, timely, relevant, and defensible information have been made (Ickes and Burkhardt 2002; Bartels et al. 2008). Other changes have been made to achieve budget compliance. Changes and refinements to the LTRMP fish monitoring program were based on past experience, study, and analysis. Adoption of these changes was the result of group efforts within the UMRR-EMP LTRMP.

We specifically thank Burke O'Neal of ETS Electrofishing (electrofishing expertise and diagrams) and Andy Bartels (gear schematics and equipment list) for their significant contributions to this manual. We thank the many LTRMP field station staff who worked for the success of the fish component. We particularly thank these past and present LTRMP staff: U.S. Geological Survey (USGS), Upper Midwest Environmental Sciences Center (UMESC)—Ben Schlifer, Jennifer Sauer, Barry Johnson, Jim Rogala, Dave Hanson, and Todd Koel; Minnesota Department of Natural Resources, Lake City Field Station—Steve DeLain, Mark Stopyro, and Walter Popp; Wisconsin Department of Natural Resources, La Crosse Field Station—Andy Bartels, Kraig Hoff, Eric Kramer, Kevin Mauel, Terry Dukerschein, and Jim Fischer; Iowa Department of Natural Resources, Bellevue Field Station—Mel Bowler, Mike Steuck, Dan Kirby, and Dave Bierman; Illinois Natural History Survey, Illinois River Biological Station—Paul Raibley, Kevin Irons, Blake Ruebush, Levi Solomon, Nerissa Michaels, Mark Pegg, and Greg Sass; Illinois Natural History Survey, National Great Rivers Research and Education Center—Rob Maher, Fred Cronin, Dirk Soergel, Kris

Maxson, and John Chick; and Missouri Department of Conservation, Open Rivers and Wetlands Field Station—Joe Ridings, David Herzog, Mike Petersen, and Bob Hrabik. Finally, we 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 Natural Resources, Illinois Natural History Survey, Missouri Department of Conservation, U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.

3. Monitoring Rationale, Approach, and Implementation

3.1 A General Case for Monitoring in the UMRS

Long-term monitoring is perhaps the most effective, and in some cases the only, means by which large, complex ecosystems such as the UMRS can be studied and managed. This is because large, complex systems such as the UMRS do not have comparable ecological analogues and thus do not easily lend themselves to reductive scientific methods (e.g., test and control subjects). Moreover, most large ecosystems have been modified to such an extent by human activity that no effective control systems exist. Consequently, changes in the state of the ecosystem, due to human activities or otherwise, can only be identified and investigated in the context of past observations on the same system, as opposed to differences in an experimental control.

To be optimally effective and efficient, a monitoring program should employ strict protocols that use standardized sampling methods, and that target informative characteristics of the ecosystem. To ensure comparability of the data and appropriate inference, the sampling design should be statistically rigorous, data collection should be continuous through time, and sampling should be scaled spatially and temporally to the system being studied. When designed properly, a monitoring program can be a powerful method for quantifying the status and trends of key ecosystem resources, understanding system dynamics in response to new stresses (e.g., invasive species introductions, commercial uses, changes in regional land use patterns, etc.), and for investigating the effects and efficacy of alternative management actions designed to rehabilitate the ecosystem.

3.2 A Case for Monitoring Fishes in the UMRS

The UMRS is probably the most biologically productive and economically important large floodplain river system in the United States (Patrick 1998; U.S. Geological Survey 1999), and fish are one of the most important goods and services the UMRS provides to humans (Carlander 1954). Fishes within the UMRS are the subject of commercial and recreational fisheries, both of which contribute substantially to local economies (Fremling et al. 1989). For example, recreation on the Upper Mississippi River was estimated to provide 18,000 jobs and $1.2 billion annually to the economy; and fishing is a key component of recreation on the river (Carlson et al. 1995; Sparks et al. 1998).

The UMRS is also a nexus of freshwater fish diversity in North America. Approximately one-fourth of the North American freshwater fish fauna is native to the UMRS Basin. Numerous species are recognized as endangered, threatened, or of particular conservation concern (see Ickes et al. 2005, Chapter 5 therein). Notable examples include the paddlefish (Polyodontidae—*Polyodon spathula*), one of only two extant species of paddlefishes in the world, and three species of sturgeons (Acipenseridae), perhaps the most threatened family of freshwater fishes in the world. Additionally, the Mississippi River is a crucial link in the spread of invasive species across much of the conterminous Unites States. The UMRS and its principal tributaries provide a highway for nonnative species to travel from areas as geographically disparate as the Atlantic Gulf Coast and the Laurentian Great Lakes, deep into the interior of the North American continent.

Scientists and fishery managers also recognize fish communities as an integrative index for a complex set of physical and biological conditions on the UMRS. Thus, fish communities, because of their diversity and response to environmental variation at multiple scales, frequently are used as indicators of ecological integrity for large river ecosystems (Gammon and Simon 2000; Schiemer 2000; Schmutz et al. 2000; Dukerschein et al. 2011). Moreover, the general public often perceives environmental impacts in the UMRS in terms of changes in the fish community or its habitat.

Because of their economic importance, conservation potential, and utility for assessing the ecological integrity of the UMRS aquatic ecosystem, fishes were chosen as a key ecological component to be monitored by the LTRMP (Jackson et al. 1981; U.S. Fish and Wildlife Service 1992). Fisheries data, thus collected, are used to quantify the status and trends of fish populations and communities (U.S. Geological Survey 1999; Johnson and Hagerty 2008), identify relations with various other ecological attributes (Barko and Herzog 2003; Barko et al. 2004; Koel 2004; Barko et al. 2005; Chick et al. 2005; Ickes et al. 2005; Barko et al. 2006; Kirby and Ickes 2006; Irons et al. 2007; Knights et al. 2008; Irons et al. 2009; Garvey et al. 2010; Dukerschein et al. 2011; McCain et al. 2011), and address fisheries management concerns in a multiuse, large river resource (U.S. Geological Survey 1999).

3.3 General Sampling Approach

The LTRMP monitors only selected aspects of fishes in the UMRS. Fisheries monitoring in the LTRMP emphasizes basic fish population and community characteristics that pertain to the indexed abundance, size structure, and community characterization of fishes (see Section 4 for additional details). Because of logistic limitations, monitoring in the LTRMP includes only a small subset of important fisheries variables. For example, although the LTRMP indexes abundance and gains information on size structure, it does not have the capacity to gain direct data on important dynamic rate functions such as mortality, age-structure, recruitment, fecundity, and age-at-maturity, though some of these can be inferred indirectly from index data collected by LTRMP, with limitations. Because the LTRMP is attempting to detect resource differences and similarities among the study reaches, as well as changes through time, sampling must be consistent and adhere closely to protocols. Without this consistency, apparent differences in physical and chemical characteristics can result from differences in methodology rather than actual temporal or spatial variation. Standard methods described in this manual are used in all LTRMP data collection efforts.

The LTRMP fish component takes an ecological community-based approach to monitoring. Fish community monitoring is performed by the state-employed staffs of five field stations that collect samples and information from the Mississippi River and one field station from the Illinois River. Each field station monitors reaches within an 80 km (50 mile) radius of their base station. The reaches covered by each field station are as follows from north to south: Lake City Field Station, Lake City, Minnesota (field station 1)—Navigation Pool 4, excluding Lake Pepin; La Crosse Field Station, La Crosse, Wisconsin (field station 2)—Navigation Pool 8; Bellevue Field Station, Bellevue, Iowa (field station 3)—Navigation Pool 13; Illinois River Biological Station, Havana, Illinois (field station 6)—La Grange Pool of the Illinois River; National Great Rivers Research and Education Center, East Alton, Illinois (field station 4)—Navigation Pool 26; Open Rivers and Wetlands Field Station, Jackson, Missouri (field station 5)—Open River reach (sometimes called the Middle Mississippi River), from the Ohio River confluence to about 100 miles upstream (Figure 1).

Figure 1. Locations of the six Upper Mississippi River System reaches monitored by Long Term Resource Monitoring Program field stations. Monitored river reaches are exaggerated to show detail and major cities are indicated for reference.

The timing and location of LTRMP fish community monitoring is guided by the information desired. Data are collected annually during a 20 week growing season, partitioned among three equal, discrete, yet contiguous time periods. The limited resources of the LTRMP and the large spatial expanse of the study area prohibit routine measurements at frequent intervals (i.e., daily or hourly) or close spatial intervals (i.e., less than 50 meters [m] between sampling points). However, measurements are achieved at intervals of time and space that allow the detection of large-scale changes in biotic responses among adjacent years and throughout long periods (i.e., multiple years). Consequently, the routine fish monitoring of LTRMP is designed to detect patterns and trends at spatial scales on the order of kilometers (km) and temporal scales of seasons, years, and decades.

Before 1993, all fisheries monitoring was performed at a set of fixed sampling locations selected nonrandomly (i.e., judgment sampling; termed "fixed" sampling from here on). In this pre-1993 design, statistical inferences were possible only for the specific locations selected for sampling. Replication of site types was inadequate, there was no statistical capability to extrapolate to larger areas or to site types, and points of special significance (i.e., tributary mouths, tailwaters, and wing dams) were not adequately represented. Consequently, the LTRMP scientific staff revised the design in 1992–1993. This new mixed sampling design combines the following: fixed site sampling for special site types (i.e., tributary mouths and tailwaters); simple random sampling from populations of engineered structures within study reaches (i.e., wing dams); and spatially stratified random sampling (SRS), to allow valid statistical inferences on sampled strata and across entire study reaches through time.

Currently, routine annual fish community monitoring in the LTRMP is performed in three concurrent phases: (1) fixed site sampling of important river features within study reaches, (2) simple random sampling of a discrete population of engineered structures (wing dams) within study reaches, and (3) spatially stratified random sampling of entire study reaches. Stratified random sampling represents the preponderance of effort in the LTRMP, and the former two phases represent minor elements in the annual effort. Further details of these designs are contained in Sections 3.4, 3.5, and 3.6.

3.4 Fixed Site Sampling

3.4.1 Historical Basis

Before 1993, all LTRMP fish component sampling locations were selected nonrandomly within designated study reaches. Correspondingly, all pre-1993 LTRMP fish data derive from a fixed site design and thus represent judgment samples. Details on pre-1993 fixed site sampling can be found in Gutreuter (1993) and Burkhardt et al. (1988). Because of issues associated with fixed site sampling conveyed in Section 3.3 (bias, inability to extend inferences beyond the sampling site, etc.), pre-1993 data typically are not used concomitantly with contemporary SRS data for trend analysis purposes. However, pre-1993 data remain useful for characterizing size structure within populations and developing length x weight relationships, for example, and continue to be served on LTRMP fish component raw data portals. Pre-1993 data are easily separable from SRS era data in that each pre-1993 barcode, which uniquely identifies a sample, is served as a negative numeric value, whereas SRS era barcodes are positive values.

3.4.2 General Aspects

Relative to this 2014 procedures manual update, fixed sites remain a minor part of annual LTRMP fish component sampling. Fixed site sampling continues uninterrupted in two unique river environments that cannot otherwise be effectively sampled using random sampling procedures. These include tailwater zones in Pools 4, 8, 13, and 26 in the Upper Mississippi River, and the La Grange pool of the Illinois River, as well as tributary mouths in the Open River reach of the Mississippi River (Figure 1). For the purpose of LTRMP fish sampling, a tailwater area is defined as the area immediately downstream from a lock and dam and includes the plunge-pool (scour hole) created by the dam, and a tailwater zone (TWZ) is defined as the first 500 m of shoreline below a lock and dam. A tributary mouth (TRI) is the portion of a tributary stream that is within the floodplain of a large river.

Additionally, a limited number of fixed sites are also sampled in areas of exceptional interest to the program and its partnering agencies (e.g., sites with historical records of endangered species; sites associated with habitat rehabilitation projects). These collections require repeated visits to specific sites, fulfilling a site-specific need to document trends that otherwise would not be gained in a randomized sampling effort.

3.5 Simple Random Sampling of Engineered Structures

3.5.1 Wing Dams

For the purpose of LTRMP fish sampling, a main (navigation) channel border-wing dam area (MCB-W) is a localized portion of main navigation channel border area in which a wing dam is the predominant physical feature. Wing dams are artificial (engineered) structures that act to divert flow to the navigation channel and are usually constructed of rock (see also Wilcox 1993). Wing dams protrude from the shoreline, typically perpendicular to flow, and may be totally submerged or emergent, depending on water elevation and construction height.

Wing dam sites are uniquely handled in the LTRMP fish component sampling protocol. Data deriving from wing dam sampling represent a simple random sample of these important structures within each study reach. Wing dams are distinct and discrete features within the UMRS and have no area-based weight on which to characterize them in the larger SRS sampling design (described in Section 3.6). Correspondingly, annual estimates of MCB-W metrics (e.g., catch per unit effort [CPUE]) are the simple mean, variance, and standard error, with derived estimates only applying to the population of wing dams comprising the sampling list, rather than all wing dams in the study reach.

Fish sampling by the LTRMP is restricted procedurally to those wing dams that (a) are at least 50 m-long (from shore to tip), and (b) have an exploitable hydraulic effect. There are no wing dam specific depth criteria for hoop nets or mini fyke nets as long as the nets can be set safely and will fish properly (i.e., they are fished according to the general methods and criteria described in Sections 5.4 and 5.6); however, wing dams submerged under more than 2 m of water (measured at the mid-point of the potential electrofishing run) are not electrofished. These procedural constraints were derived from pre-1993 experiences in deploying various LTRMP sampling gear in proximity to wing dams. In 1993, wing dams that fit these criteria were surveyed within each LTRMP study reach and a list of compliant wing dams was generated for each LTRMP study reach. This list represents a population (census) of all wing dams in each study reach that could be sampled using LTRMP fish component methods (Section 5). Annually, the LTRMP Database Administrator selects a sampling allocation (varies by study reach) for wing dam sites from these study-reach specific lists. Selection is achieved using randomization protocols (simple random sample with replacement) from the population list for each study reach, until a full annual allocation is achieved.

The number and physical characteristics of MCB-W sites vary widely among pools and can change annually as new wing dams are created or old ones become unable to be sampled. Consequently, it is the responsibility of each field station to annually verify and update their list of qualifying wing dams (and corresponding Universal Transverse Mercator [UTM] coordinates) by adding new wing dams that can be sampled during normal river conditions and removing old ones that consistently fail to meet procedural criteria. Updated wing dam lists must be provided to the LTRMP Database Administrator before each new field season so that annual sampling allocations can be generated.

3.5.2 Other Engineered Structures

Since 1993, several new engineering structures have become increasingly common in parts of the UMRS. Most are associated with U.S. Army Corps of Engineers (USACE) channel management activities to ensure commercial navigation. Two particular examples include (a) chevron dikes, and (b) bendway weirs. At the time of this writing, and as far as we are aware, these structures have only been placed in river miles within the management authority of the St. Louis District of the USACE. Because these structures are regional, the LTRMP fish component, as a more systemic assessment program, does not have procedures or protocols for sampling these new structures, though some localized assessments are made as part of the project emplacement process outside of the LTRMP. If these structures become more prominent throughout the UMRS, the UMRR-EMP LTRMP should consider whether or not they should be monitored through time in standardized ways and using common protocols. If the decision is made to do so, it is recommended that these structures be treated similarly to wing dams within the LTRMP fish component sampling protocols (simple random sample of these unique structures). An alternative would be a nonrandom and repeated measures assessment of a select few, similar to that described in Section 3.4.

3.6 Stratified Random Sampling within LTRMP Study Reaches

3.6.1 General Aspects and Strategies

An SRS design has been used in the LTRMP for monitoring fish, water quality, and invertebrates since 1993, and for vegetation since 1998. This approach is designed to give unbiased estimates that can be extrapolated to entire strata and study reaches and for making comparisons among strata, among study reaches, and through time. Random selection of sites eliminates most potential sources of sampling bias and produces results that can be extrapolated with known confidence. The use of defined statistical strata allows the sampling effort to be adjusted to variability within, or to the perceived ecological importance of, targeted areas. The SRS design tracks conditions at spatial scales corresponding to the statistical sampling strata or larger (i.e., whole study reach), and seasonal-annual time scales or longer. Seasonal SRS episodes are intended to encompass major seasonal events (i.e., spawning, recruitment, growth), but their scheduling is not changed from year to year, or in accordance with river conditions (e.g., hydrology, water temperature). The allocation of sampling locations among the statistical strata is not proportional to stratum surface area, so a weighting method (e.g., area based) must be used to extrapolate stratum-specific SRS estimators to an entire study reach. Additional details on weighting design-based estimates can be gained from online resources available through the LTRMP fish component home page: *http://www.umesc.usgs.gov/data_library/fisheries/fish_page.html* (accessed December 11, 2013).

The sample collection methods used in SRS (e.g., gear types and configurations, site quantification and characterization) are identical to those used for fixed sampling (Section 3.4) and engineered structures sampling (Section 3.5; also see Section 5 for gear descriptions and specifications). However, there are important differences among these sampling designs. For SRS: (a) the sampling locations are selected with statistical randomization to represent specific strata (aquatic area types; Wilcox 1993); (b) the suitability of the site and its precise location must be determined in the field at the time of sampling; and (c) a specific sampling site is unlikely to be sampled repeatedly through time except in reaches where certain strata are rare. An important concept of the SRS design in LTRMP fish monitoring is that the measurement at an individual sampling location is considered a random observation from a population (of possible sampling points). When pooled together, this set of random measurements provides an accurate indexed estimate of conditions within the entire stratum, even though any individual site measurement may not be a good representation of typical (i.e., average) conditions at the specific point of sampling or across the whole stratum during a seasonal or annual sampling episode.

3.6.2 Mathematical Estimators

For LTRMP stratified random sampling, mean CPUE is obtained from the conventional design-based estimator for stratified random samples (Cochran 1977). The mean CPUE of stratified samples, $\bar{y}_{st}$, is given by

$$\bar{y}_{st} = \frac{1}{N} \sum_{h=1}^{L} N_h \bar{y}_h \tag{1}$$

where N_h is the number of sampling units within stratum h, L is the total number of strata, $N = \Sigma_{h=1}^{L} N_h$, and $\bar{y}_h$ denotes the estimator of the simple mean of y for stratum h. The estimator of the variance of $\bar{y}_{st}$ is

$$s^2(\bar{y}_{st}) = \frac{1}{N^2} \sum_{h=1}^{L} N_h (N_h - n_h) \left(\frac{s_h^2}{n_h} \right) \tag{2}$$

where

$$s_h^2 = \frac{\sum_{i=1}^{n_h} (y_{hi} - \bar{y}_h)^2}{n_{h-1}}$$

is the usual estimator of the variance of $\bar{y}_h$, and n_h is the number of samples taken in stratum h (Cochran 1977). The standard error of $\bar{y}_{st}$ is therefore $s(\bar{y}_{st})$. For LTRMP SRS fish monitoring, all sampling units within the sampling frame are 50 m^2 square grid cells.

3.6.3 SRS Strata Definitions

The LTRMP originally described 11 SRS statistical strata (Gutreuter et al. 1995). From 1993 to 2002, sampling was achieved in six of these strata, but two were dropped from the design after considered study, deliberation, and decision by the UMRR-EMP partnership (Ickes and Burkhardt 2002). Since 2003, stratified random sampling for fish is achieved in four strata, although not all of these are present in each study area.

The four strata classes described below are based on enduring geomorphic and physical features, called aquatic areas (Wilcox 1993). The terminology used here generally is consistent with that used in Wilcox (1993). The strata are intended to represent reasonably permanent and enduring aquatic geomorphic features within the UMRS, rather than habitats or more transient components of possible habitat. For example, transient features such as vegetation create important habitats for many species but have proven to be too ephemeral to serve as sampling habitat types. Important transient features are recorded at the time of sampling. The current LTRMP fish sampling SRS strata are defined as follows:

a. ***Main channel border-unstructured area*** **(MCB-U).** An unstructured main (navigation) channel border area is the aquatic area between the margins of the main navigation channel and the nearest shoreline (island or mainland), excluding dams, lock walls, and wing dams. Revetted shoreline is included in the MCB-U strata class.

b. ***Side channel border*** **(SCB).** A side channel border is the border of all secondary and tertiary channels 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 in impounded areas above some dams) are not distinguished as side channels.

c. ***Backwater, contiguous-shoreline*** **(BWC-S).** Contiguous backwaters are aquatic areas that have some contiguous aquatic link to the main navigation channel but are mostly 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. Contiguous backwater-shoreline areas are those areas of backwaters that are within 50 m of the nearest shoreline.

d. ***Impounded-shoreline*** **(IMP-S).** 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. Impounded shoreline areas are those portions of impounded areas within 50 m of the nearest contemporary shoreline.

3.7 Sampling Implementation Details

3.7.1 Selection Process for Collection Sites

Before the sampling season, lists of primary and alternate sample collection sites are generated by the LTRMP Database Administrator. These lists are posted in the LTRMP fish section of the UMESC web site for sampling map creation by each field station. The database administrator also updates the fish data entry application with the primary, alternate, wing dam, and fixed sites and provides the application to the individual field crews to be loaded onto their field laptops.

Stratified random sampling collection sites are represented by a 50 m × 50 m grid in a geographic information system (GIS) database. Grids are indexed and referenced by UTM coordinates in Zone 15, and the North American Datum 1983 (NAD 83). The GIS database includes delineations of the known extent of sampling strata. Areas known to be inaccessible, either for lack of legal access or because of physical conditions that preclude boat travel, are aliased from the sampling frame. Within each stratum and per sampling episode (time period), grids are selected at random (without replacement), 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 are 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.

3.7.2 Annual Allocation of Sampling Effort

Within the SRS sampling design, gear types are deployed independently within strata. That is, separate lists of randomly selected sampling sites are generated for each gear type and stratum. Because some gear cannot be deployed in certain conditions, not all gear types are deployed in each stratum; however, there are at least three gear types for each stratum (Table 1). Because the proportions of SRS strata vary among reaches, gear effort is allocated on a reach-specific basis.

Table 1. General list of sampling gear types used to collect fish data in Long Term Resource Monitoring Program sampling areas (stratified random sampling [SRS] strata, fixed site areas, and engineered structures). Because the proportions and availability of these sampling areas vary dramatically among study reaches, actual effort allocations may vary.

[MCB-U, main channel border-unstructured area; SCB, side channel border; BWC-S, backwater, contiguous-shoreline; IMP-S, impounded-shoreline; TWZ, tailwater zone; TRI, tributary mouth; MCB-W, main channel border-wing dam. X indicates that the particular gear is used in the sampling area and — indicates it is not used]

Sampling gear	Sampling areas						
	SRS strata				Fixed site areas		Engineered structures
	MCB-U	SCB	BWC-S	IMP-S	TWZ	TRI	MCB-W
Day electrofishing	X	X	X	X	—	X	X
Fyke netting	—	—	X	X	—	X	—
Mini fyke netting	X	X	X	X	—	X	X
Large hoop netting	X	X	—	—	—	X	X
Small hoop netting	X	X	—	—	—	X	X
Trawling	—	—	—	—	X	—	—
Number of study reaches	6	6	5	3	5	1	5

Effort allocation among SRS strata does not compromise unbiased estimation in stratified random sampling; however, effort allocation does affect the precision of estimates (Gutreuter et al. 1995). The approximate sampling allocation (Table 1) 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 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. Sampling effort 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.

Within the fixed sampling design, the most appropriate gear types are used to sample areas not otherwise sampled by the SRS design (e.g., trawling is used in the TWZ sampling area; see Section 3.4.2). Within the engineered structures sampling design, wing dam sites are selected by study reach from a study-reach specific list of wing dams that can be successfully sampled (see Section 3.5.1). For both fixed site sampling and engineered structures sampling, gear effort is allocated on a study-reach specific basis.

3.7.3 Seasonal Distribution of Fish Collections

The LTRMP seasonal allocation of samples was chosen to limit sampling during spring flooding and to exclude sampling during the winter when effective sampling is more difficult to achieve (Gutreuter 1997). The LTRMP fish sampling design incorporates full sets of collections made in all SRS strata, collections in fixed site areas, and at engineered structures, during each of three time periods: June 15 through July 31, August 1 through September 15, and September 16 through October 31. Sampling should start and end within those dates for each time period. In rare situations, a net may be set on one of the last 2 days of a time period and pulled after the time period. However, if a sample cannot be started within the allocated time period it should not be collected.

3.7.4 Locating Collection Sites During Field Operations

Comparing base maps to actual physical landscape features may be used to get within 25 m accuracy of a site location. For greater accuracy, fish crews routinely use Global Positioning System (GPS) receivers, particularly for sites located in open water or featureless areas. Sampling must be performed within 25 m upstream or downstream from the site location, but in some cases may be repositioned (within stratum) inshore or offshore, the distance needed to adjust to fluctuating water levels, water velocities, dense vegetation beds, and long, shallow slopes (detailed further for each gear in Section 5).

When sampling, the primary site is located in the field and a simple assessment is made as to whether or not the particular gear can be physically deployed, based upon standardized field protocols detailed in Section 5. The primary consideration is whether water depth is sufficient to permit access to the area. In addition, water depth and velocity must be within the ranges specified for the particular gear (Section 5). Other considerations are crew safety, the likelihood that gear will be recovered, public usage (i.e., whether sampling will interfere with public use, or vice versa), and physical site characteristics preventing gear deployment. If a site can be sampled, the gear is deployed according to procedures for that gear.

If an alternate SRS or wing dam site must be chosen because the primary site cannot be sampled, the data recorder should (1) enter the start date, time, accuracy, method, and a *2* in the Summary Code field of the primary site record, (2) enter a comment explaining the condition that prevents sampling, (3) locate the nearest alternate site that can be sampled and note its location code in the Site Comment field of the primary site record, and (4) open a record for the alternate site and enter all site information in the same manner as for the primary site (the application will automatically enter the primary site location code and its unique barcode number in the Site Comment field of the alternate site). If a fixed site cannot be sampled, no alternate is selected and the data recorder completes steps 1 and 2 above. Data entry procedures are detailed further in Section 7.2.

Note: Within the SRS sampling design, each alternate site can be sampled only once per time period, regardless of whether a different gear is used (Exception: Since large and small hoop nets are paired, they are always fished at the same primary or alternate site). However, alternate sites for engineered structures may be used again for a different gear type.

Field station staff scheduling their sampling effort must randomly intersperse various gear types and site locations in different segments of the study reach (e.g., upper, middle, and lower). For example, sampling must not proceed systematically from one end of the study reach to the other. Staff should avoid front-loading the time period with heavy sampling only to have little or no sampling to do late in the time period. Sampling crews must also randomly intersperse various gear types and study reach segments throughout each time period (e.g., all of the electrofishing must not be done within a single week in the lower segment).

4. Attributes

4.1 Catch Per Unit Effort

Ascertaining the true abundance of living animals (absolute population size, density, or biomass) is incredibly difficult and rarely, if ever, achieved. Doing so requires perfect sampling, with perfect methods, performed in specific ways (area or volumetric based enumeration). Correspondingly, it is almost always necessary to create a population index which is assumed to be related to true abundance or density (Arreguin-Sanchez 1996). Creating an index of abundance requires controlling important sources of error in the survey design, and the intersection of that design with field sampling methods and routines, which this wider procedures manual details. Therefore, index estimators are a reflection of both the actual numbers of biological organisms truly present and the ability of the index-based monitoring program to detect them.

The LTRMP fish component is an index-based monitoring program, which standardizes its methods and procedures in a design-based context (described herein) to achieve statistically unbiased and accurate index data. The principal index provided by the LTRMP is CPUE. The estimators (mean and variance) generated by the observations are assumed to be an index of the attributes LTRMP samples (e.g., species abundance). Two important points follow from this:

1. Annual indices of abundance (e.g., CPUE) in LTRMP are not a direct measure of actual annual abundance or density and should never be understood or represented as such from LTRMP fish component data sources. They are indices of abundance, observed in highly standardized ways through space and time.
2. The point of indexing annual abundance within LTRMP is not to provide annual point estimates of true abundance, but to monitor the indexed quantity in highly standardized ways to understand and infer dynamics through time, and differences and similarities in comparably measured indices across space.

The LTRMP seeks to monitor as large a part of the UMRS fish community as possible and practicable (to date, 144 species of fish plus several additional hybrids). As of 2014, six different gear types are used within the study design (see Ickes and Burkhardt [2002] for a historical treatment of LTRMP sampling methods). Catch per unit effort of species can be assessed for all specimens regardless of size or it can be assessed separately by using appropriate length categories (e.g., stock size) defined for each fish species (Anderson and Neumann 1996), but is always calculated and assessed on a gear-specific basis. Units of effort are specific to the gear and method used (Table 2), and CPUE can be calculated for an individual species or for species groups such as feeding guilds, reproductive guilds, habitat dependent groups, or functional groups (e.g., sport fishes, forage fishes, etc.) at design-based scales (see Section 3.6.2 for the mathematical estimators).

Table 2. Units of measure for recording Long Term Resource Monitoring Program (LTRMP) sampling effort for each gear; target effort for standard LTRMP gear deployments; and LTRMP standardized effort units for reporting catch per unit effort for each gear.

LTRMP gear	Units of measure	Target field effort*	Standardized effort units
Electrofishing	Minutes	15 minutes	15 minutes
Fyke net	Hours	24 hours	Net day
Mini fyke net	Hours	24 hours	Net day
Large hoop net	Hours	48 hours	Net day
Small hoop net	Hours	48 hours	Net day
Trawling	Meters	350 meters	Net haul

*Actual effort is recorded during sampling and can vary from the target. These minor deviations are adjusted for in standardized calculations.

4.2 Community Attributes

An ecological community refers to all the species found in a defined area and period of time (Ricklefs 1990). Therefore, what is known as a "fish community" would include all the species of fish that use a defined area during a defined period of time. The most common attributes measured and analyzed for an ecological community include the following: species richness—the number of species in a community; species diversity—various indices based on combining information on species richness and the evenness of abundances among species; community composition—the specific species found in a community; and community structure—the abundances (usually indexed) of each species found in a community (Field et al. 1982; Ricklefs 1990; Clarke 1993). Fish community attributes that are commonly measured and analyzed include all of the attributes above, as well as assorted indices of biological integrity that attempt to measure the biotic or ecological integrity of a community or ecosystem (Kwak and Freeman 2010; see also Dukerschein et al. 2011). Catch per unit effort data (or transformations thereof) are used to generate community-based metrics.

4.3 Other Attributes

Additional metrics and attributes can be generated from LTRMP fish component CPUE index data. These include measures of population ubiquity (e.g., frequency occurrence), size structure indices (e.g., proportional stock density, relative stock density), relativized abundance across a stated assemblage or community (relative abundance), and any of a number of indices of biological integrity (IBIs), among others. Each of these is a derivation of standardized CPUE data (or a transformation thereof) that the design supports, and correspondingly may require additional simplifying assumptions to gain the desired metric depending on use and intention.

5. Sampling Gear and Methods

5.1 Overview

Standardizing sampling effort, techniques, and gear is critical to allow for comparisons of data among field stations (for a basic list of equipment for LTRMP fish sampling, see Appendix A). It is fundamentally important that LTRMP Crew Leaders make sure the gear used meets the specifications described in this section. New gear should be measured and compared to LTRMP specifications. Moreover, maintaining and repairing the gear is equally critical to help ensure gear effectiveness does not diminish. Specifications for all LTRMP sampling gear can be found in Appendixes B and C.

5.2 Environmental Measurements at Each Sampling Site

A suite of environmental measurements are recorded at every site immediately before sampling for fishes (Table 3). Measurements are taken at the anticipated midpoint of a run (electrofishing, trawling) or at the net location for stationary gear. Water temperature, conductivity, dissolved oxygen, and current velocity are all taken 20 centimeters (cm) below surface. In addition, depth, Secchi transparency, vegetation, and qualitative appraisals of

Table 3. List of environmental variables measured at each Long Term Resource Monitoring Program fish sampling site, including variable type, measurement units, and measurement accuracy (in parentheses).

[cm, centimeters; µS/cm, microsiemens per centimeter; m/s, meters per second; ºC, degrees Celsius; mg/L, milligrams per liter; m, meters; and %, percent]

Variable name	Variable type	Units (and accuracy)
Secchi disk	Continuous	cm (nearest 1)
Specific conductivity	Continuous	µS/cm (nearest 1)
Water velocity	Continuous	m/s (nearest 0.01)
Water temperature	Continuous	°C (nearest 0.1)
Dissolved oxygen	Continuous	mg/L (nearest 0.1)
Water depth	Continuous	m (nearest 0.1)
Percent vegetation coverage	Categorical (4 categories)	%
Vegetation density	Categorical (2 categories)	Scaleless
Substrate	Categorical (4 categories)	Descriptive
Structures		
Woody debris/snags	Binomial	Presence or absence
Tributary mouth	Binomial	Presence or absence
Inlet/outlet channel	Binomial	Presence or absence
Flooded terrestrial	Binomial	Presence or absence
Wing dam/dyke	Binomial	Presence or absence
Revetment (rip-rap)	Binomial	Presence or absence
Low-head dam, closing structure, weir	Binomial	Presence or absence
Other	Binomial	Presence or absence

substrate composition and other proximate structures (e.g., woody debris, revetment) are recorded. Sampling time is recorded as Central Standard Time (CST) without observing daylight savings time. Water quality data are collected using a calibrated handheld oxygen/conductivity/temperature meter such as the YSI® (Yellow Springs Instruments, Inc.) Model 85 (or equivalent) unit, and current velocity is taken using a calibrated Marsh-McBirney Flo-Mate™ (or equivalent) flow meter.

5.3 Electrofishing

5.3.1 Electrofishing Equipment Specifications

To maximize standardization among electrofishing collections, the boats and electrofishing equipment used by each field crew have been assembled according to the specifications given below and in Appendix B. The electrofishing boats may have various hull designs; however, all electromechanical components must follow the specifications outlined in this manual. Electrofishing boats are typically 5.5–6.1 m (18–20 feet [ft])-long, flat-bottomed aluminum boats, powered by 100-horse power or greater outboard motors (Figure 2 and Appendix B-2).

The power supply for electrofishing is a 5,000 watts (W) or higher capacity alternating current (AC) generator equipped with a kill switch for safety. The generator supplies power to a control box which in turn produces pulsed direct current (DC) output. **For safe operation the generator frame and the control box must be grounded to the boat hull using hard-wiring methods such as grounding straps. In addition, to prevent damage to the control**

Figure 2. Photograph of a typical Long Term Resource Monitoring Program electrofishing boat. Boat pictured has optional driver safety cage to deflect jumping fish.

box the generator windings must be isolated from the frame of the generator (i.e., the generator must have a "floating neutral," sometimes referred to as an "ungrounded neutral" or "isolated neutral"). If a generator is replaced, verify that the new generator has a floating neutral by referring to the circuit diagrams presented in the generator operator's manual, contacting the manufacturer, or using the procedure outlined in Appendix B-9.

> **Note:** When using inverter style generators such as the Honda EU6500is, surging of the generator engine may be experienced and the output voltage from the control box may vary somewhat. This phenomenon is especially pronounced using the HIGH voltage range of the control box.

The boat hull serves as the cathode and two forward mounted fiberglass boom poles hold anodes extending 2.44 m (8 ft) from the front of the boat and spaced 3.05 m (10 ft) apart (measured center to center at the ends of the poles). The fiberglass boom poles are hollow, have an outer-diameter of 3.8 cm (1 1/2 inches), and a 0.64 cm (1/4 inch) wall thickness. Each anode consists of a stainless steel circular ring 0.91 m (3 ft) in diameter with four tubular 30 cm (12 inches)-long, 2.5 cm (1 inch) outer-diameter stainless steel droppers attached (Appendix B-2). The circular ring is constructed from 1.3 cm (1/2 inch) outer-diameter stainless steel rod, bent and welded to form a ring. Four evenly spaced holes are drilled in the ring for dropper cable attachment. The droppers are attached to the ring with lengths of 3.1 millimeter (1/8 inch) diameter uncoated stainless steel cable and U-bolt cable clamps. The clamps and stainless steel cables should be adjusted so that the cables measure 35.6 cm (14 inches) from the ring to the droppers, and the cable-dropper arrangements should have a total length of 66 cm (26 inches).

Two independent "deadman" safety switches are located at the front deck dip-netting stations. The switches consist of mats the dip-netters stand on to complete the safety circuit, or cut-off switches and lanyards (Cole Hersee M-597BP or similar) to be attached to each dip-netter (Appendix B-5). If a dip-netter steps off of a safety mat or moves far enough to tighten the lanyard and pull the safety clip from the switch, the switch will open causing power to shut down. Note: Cut-off switches with lanyards are preferred instead of mats because of a history of unreliability experienced with mat style switches in LTRMP electrofishing boats. Supplemental hand operated safety switches may be located at the rear of each dip-netting station. An emergency shutdown switch, or "panic button," is located on the control box console, and a final safety switch is attached to the driver. Optional safety cages may be constructed on boats to protect the driver, electronics, and throttle from jumping fish (e.g., silver carp [*Hypophthalmichthys molitrix*], and grass carp [*Ctenopharyngodon idella*]). Forward-mounted floodlights for special project night sampling are optional.

The LTRMP utilizes an MBS-1D "Wisconsin" type control box (shock box) designed for nominal 240 volt AC, single-phase operation from a portable generator. The MBS-1D (Figure 3) is manufactured by ETS Electrofishing, LLC of Verona, Wisconsin (formerly University of Wisconsin Engineering Technical Services Department). It is capable of delivering 4,800 W to the electrode system (limited by a 20 amp breaker input). The MBS-1D has several important features including electronic self-protection against overload (an overload lamp lights to indicate electronic shutdown). Pulse rates can be adjusted from 10 to 1,000 Hertz (Hz), and duty cycles from 1% to 100%. The standard LTRMP pulse rate is set at 60 Hz and duty cycle is set at 25%. Output voltage is adjustable from approximately 100 to 600 volts peak DC, depending on generator watt capacity and water conductivity. Two backlit liquid crystal displays (LCDs) continuously show peak pulsed voltage and amperage. The operator's manual for the MBS-1D control box can be viewed at the following link: *http://www.umesc.usgs.gov/data_library/fisheries/historical_documents.html* (accessed December 11, 2013).

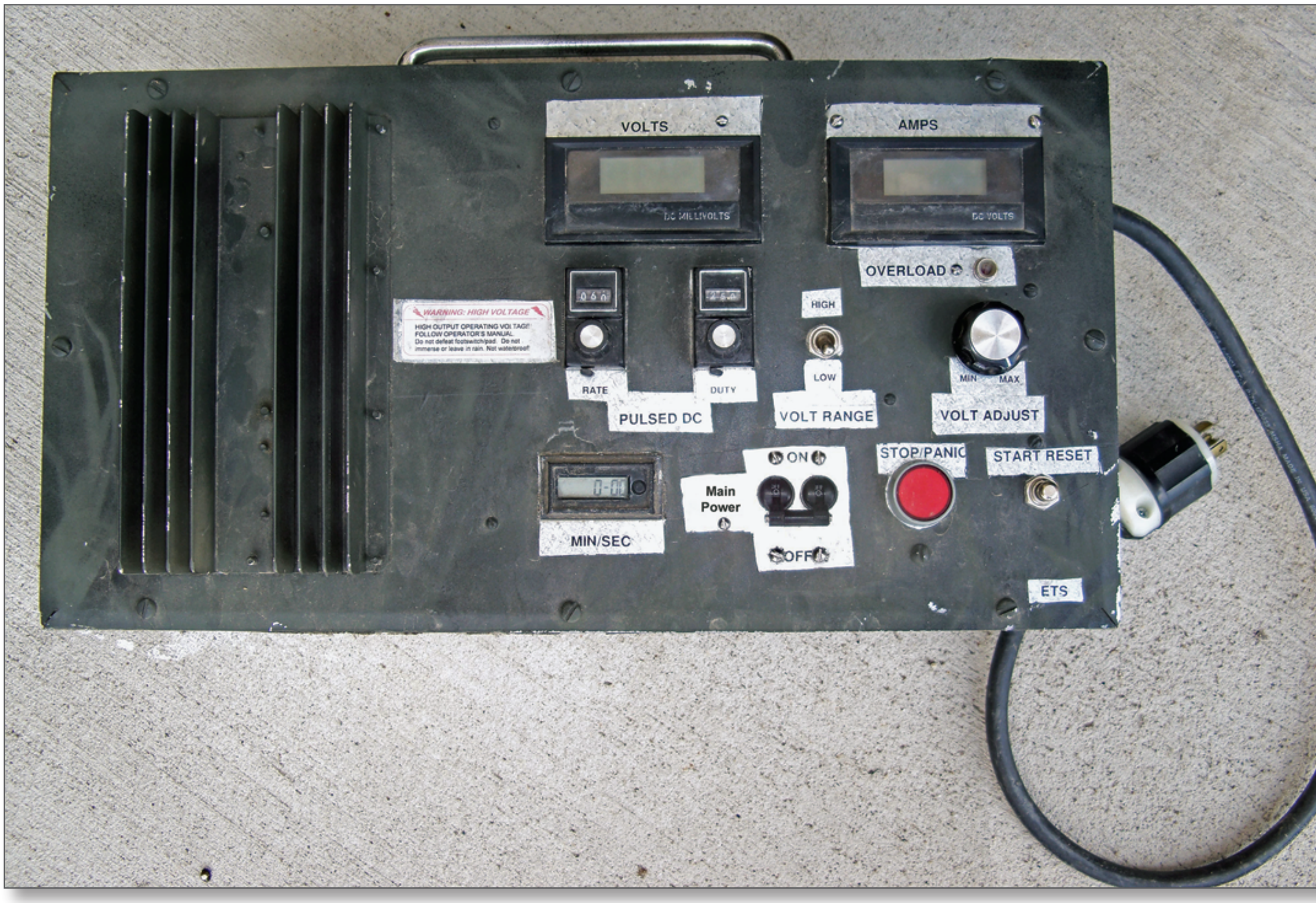

Figure 3. Close-up view of a model MBS-1D Wisconsin style control box used in all Long Term Resource Monitoring Program electrofishing boats (front panel was spray painted with flat black paint to reduce glare).

Routine maintenance and inspection of all electrical components, excluding circuits internal to the control box and generator, are necessary to ensure this gear is working properly. The contact points between the stainless steel rings and droppers of the anodes must be checked for corrosion and breakage regularly. Dropper cables should also be checked to ensure tight connections to the ring and to the droppers. All wires and plugs should be checked for corrosion, damage, fraying, or loose connections. **A continuity test of each anode and a generator output test should be done before each sampling time period, and when the system is modified or a problem is suspected (see procedures in Appendixes B-7 and B-8).** A multimeter capable of measuring AC voltage and resistance is used for these tests. In addition, the safety system should be tested regularly by stepping off of each safety mat or flipping each safety switch to be sure it turns off power output from the control box. If a new electrofishing boat is assembled, any electromechanical component of the system is modified or replaced, or if a problem is suspected but cannot be otherwise confirmed, the electrofishing field must be mapped using the procedures outlined in Appendix B-11.

Note: The control box should never be operated from the commercial power distribution system found in buildings. This will almost certainly damage the triac control section of the control box since commercial power systems do not have the surge current-limiting inductance found in generators.

5.3.2 Electrofishing Methods

A pulsed-DC field is used for indexing abundance because many fish caught in the electrical field are entrained to the anodes by galvanotaxis (Reynolds 1983). In theory, this electrotactic response should reduce sampling variability caused by differences in visibility of fish due to varying turbidity. The primary objective is to create an electromagnetic field that induces a constant power drop across a fixed length of fish tissue in 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. Power goals (in watts) have been calculated for various combinations of specific conductivity (in microsiemens per centimeter) and temperature (in degrees Celsius) to ensure potential transfer of 3,000 W from water to fish (Burkhardt and Gutreuter 1995; Appendix B-1).

With a click of the PG (power goal) button on the *Site Information Screen*, the fish data entry application automatically calculates and displays the power goal after water conductivity and temperature are entered (see Sections 7.2.1 and 7.2.2 for further description). Periodic adjustment of the voltage/amperage knob on the control box may be necessary during electrofishing to maintain the desired power goal. After completion of the electrofishing run, estimations of voltage and amperage actually used are entered into the fish data entry application. The application uses these values to automatically populate the Power Used field when the PG button is pressed again. **Because power output affects catch rates of fishes differently, it is critical that the power used in all LTRMP electrofishing runs is as close as possible to the power goal and does not deviate by more than 20%.** The LTRMP standardized pulse rate (60 Hz) and duty cycle (25%) are effective settings for many fish species across a broad range of water quality conditions. Occasionally these settings may drift and should be checked on the control box before each electrofishing run.

> **Note:** Maintaining proper dropper height is critical to ensure standardization of the electrofishing field and to reduce potential injuries to fish. Before each run, crews may need to adjust the height of the boom pole holders or re-distribute weight in the boat to ensure the droppers are positioned correctly. Approximately 70–80% of each dropper tube should be in the water and the attached steel cables should not enter the water. If the booms are too high, the dropper tubes may come out of the water interrupting the electrical field. Conversely, if the booms are too low the steel cables holding the dropper tubes may enter the water causing a higher than expected voltage gradient.

An electrofishing crew consists of a pilot and two persons operating dip-nets. Dip-netters use 30 cm (12 inches)-deep by 45 cm (17 5/8 inches)-wide, approximately square, dip-nets made of 3 millimeter (1/8 inch) diameter mesh (Model ELECTRO REGULAR D RC, Duraframe Dipnet Company, Viola, Wisconsin, or equivalent) mounted on 2.4 m (8 ft) fiberglass handles. Every fish possible is collected as it appears, regardless of size or species. Polarized sunglasses are recommended to reduce glare and increase dipping efficiency.

Because electrofishing requires potentially hazardous equipment, LTRMP Fish Crew Leaders should have adequate training and experience in electrofishing techniques. States may provide basic electrofishing training, but if additional training is needed or a new Crew Leader is hired, training in LTRMP electrofishing procedures will be provided by existing LTRMP Fish Crew Leaders or the LTRMP Fish Component Leader. The Fish Crew Leader is responsible for training new crew members. All crew members must successfully complete a course in cardiopulmonary resuscitation (see Section 6.7 for additional recommended training courses).

Standardized electrofishing is performed between 1 hour (h) after sunrise and 1 h before sunset CST, in aquatic areas where depth typically ranges from 0.5 to 3.0 m. Before starting an electrofishing run, the crew determines the collection site boundaries and surveys the area for safety concerns and other factors that could prevent completion of a standardized electrofishing run. Based on this initial assessment, the Crew Leader decides whether the site will be sampled or an alternate site chosen. The standardized unit of electrofishing effort is time, reported per 15 minutes (min) of effort (Table 2). Individual electrofishing runs should have a 15-minute duration and are approximately 200 m (220 yards)-long and 30 m (33 yards)-wide. If a run is modified from the target of 15 min and 200 m, the actual effort in minutes and length in meters are recorded.

The pilot remains standing during the electrofishing run, and operates the boat at a speed and along a path such that 15 min of effort allows coverage of the approximate sampling area. The pilot should maneuver the boat to maximize dip-netter access to fish, but should only modify the forward and backward movement of the boat to the extent that it does not interfere with the objective of obtaining 100% area coverage with a single 15 min pass (see Figure 4).

A standard electrofishing run begins at the upstream site boundary and follows the direction of flow, ending at the downstream site boundary (Figure 4). Electrofishing boat direction of travel may be modified by the pilot as needed to effectively sample wing dams or to maintain boat control in windy situations. Other factors such as crew safety, underwater obstacles, and public use (e.g., recreational boaters, swimmers, fishers, etc.) may necessitate modification of direction of travel. Banks, submerged logs, and any other structure within the sampling area are shocked thoroughly until they no longer yield fish. Dip-netted fish and all fish that leap into the boat (e.g., silver carp) during the 15 min of electrofishing are placed in the holding tank for processing. Fish that are observed but not collected during the run should not be entered in the *Fish Measurement Screen*. However, observations of unusual species may be documented in the Site Comment field. Chase boats may be used in high water velocity conditions to recover incapacitated fish. A *6* is recorded in the Summary Cd field on the *Site Information Screen* if a chase boat is used.

When crews encounter a dense vegetation bed (aquatic or flooded terrestrial), a long, shallow slope, or other structure (e.g., sunken barge) that prevents reaching the shore, they may electrofish the outer edge of that area and designate it as a “pseudo-shoreline” by recording a summary code of *7*. These sampling efforts may be repositioned offshore in a perpendicular direction as needed to sample the edge of the area, but cannot be moved upstream or downstream more than 25 m, nor moved into a new sampling stratum. Electrofishing is performed in sparsely

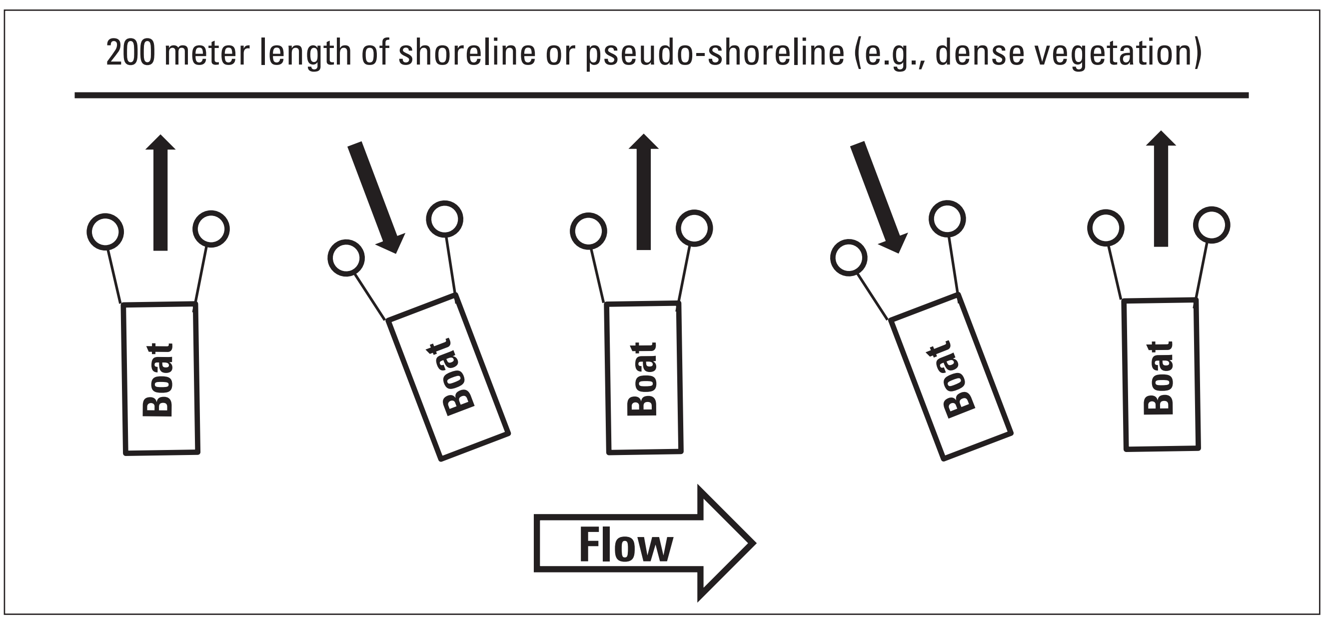

Figure 4. Generalized pattern of Long Term Resource Monitoring Program electrofishing boat maneuvers along a shoreline or pseudo-shoreline (e.g., dense vegetation bed or long, shallow slope). Arrows indicate direction of boat travel. Boat should approach shore as perpendicularly as possible, beginning at the upstream site boundary and moving downstream.

vegetated areas in the same manner as unvegetated areas so long as the boat motor can properly propel the boat and not become clogged with vegetation, causing overheating.

Electrofishing of wing dams is restricted to those wing dams that have an exploitable hydraulic effect (see Section 3.5.1). Therefore, wing dams submerged under more than 2 m of water are not electrofished, and the Crew Leader must carefully evaluate whether or not wing dams submerged under 1–2 m of water or with current velocity greater than 0.5 meters per second (m/s) can be electrofished safely and effectively. In addition, wing dams shorter than 50 m are not sampled. Water quality and physical characteristics of the site are measured at the anticipated midpoint of the run. These measurements and the above criteria are used by the Crew Leader to determine whether the wing dam will be sampled, or an alternate wing dam chosen. Crews may begin the sampling run on either the upstream or downstream side of the wing dam and may shock parts of one or both sides of the wing dam as needed to reach the target effort of 15 minutes and 200 m. Boat maneuvers for electrofishing along wing dams are the same as for electrofishing a shoreline (boat approaches wing dam face in a perpendicular fashion).

Flow velocity, wing dam elevation, and other habitat conditions can vary along the length of a wing dam, resulting in different assemblages or size distributions of fish at various points along the wing dam. Consequently, crews may extend an electrofishing run longer than 15 min and may choose to shock the whole wing dam to thoroughly sample this habitat. Conversely, crews may shock less than 15 min if there is insufficient wing dam area meeting the criteria mentioned above (and in Section 3.5.1) to make a 15 min run. In all cases, the actual number of minutes of electrofishing and the approximate number of meters of shoreline that were shocked are recorded.

5.4 Hoop Netting

A LTRMP hoop net set consists of paired deployment of a large, baited hoop net and a small, baited hoop net (Appendixes C-1 and C-2) placed in the same sampling area. Both nets are baited with 3 kilograms (kg) of soybean cake. One kg is placed in a bag constructed of 1.9 cm (3/4 inch) bar mesh, tied to the last hoop inside the cod end of the net, and 2 kg are placed loosely in the cod end of the net. In situations where the bait would otherwise be rapidly lost from the net and bait bag (e.g., high current velocity, small pieces of bait), a bag constructed of smaller mesh may be used and all bait may be placed in the bag.

Hoop nets are fished with the mouth of the net facing downstream. The two hoop nets are deployed in parallel sets, with the smaller net nearer shore (Figure 5). The nets do not have to be placed adjacent to each other and may be displaced longitudinally when doing so will help satisfy depth requirements. Hoop nets must be deployed in sites where depth is sufficient to submerge the throats of the nets. When a net cannot be set safely, or may not fish effectively because of high current velocity or other adverse river conditions, the closest alternate site that can be sampled should be chosen.

Each hoop net is anchored using a 15–61 m (50–200 ft)-long rope tied to either a stake or a net anchor, depending on which will work best given the substrate composition, depth, and velocity conditions at the sample location (see Appendix C-3 for suggested anchor design specifications). Where current speed is insufficient to hold a hoop net open, an approximately 15 m (50 ft)-long line is tied to a bridle at the mouth of the net and the other end of the line is tied to an anchor or stake to hold the net open. The bridle is made by tying the ends of a short rope to opposite sides of the first hoop, and a loop (attachment point for anchor line) is made in the center of the bridle rope using an overhand knot. Wherever current velocity is sufficient to hold the net open, the downstream end (mouth) is not bridled.

Landmarks, GPS, or a visible float and rope attached at the mouth or anchor line of the net are aids in net retrieval. If using a float, the line must be sufficiently long that the net is not lifted upward from the bottom of the river. Hoop nets are retrieved by towing a grappling hook to snare the anchor line, or by lifting the optional float. Each hoop net of the pair is treated as an individual sample during data collection (i.e., separate data entry records are completed for each net).

At wing dam sites, hoop nets are set within 100 m downstream of the wing dam and within the scour hole (if present). Hoop nets are deployed only at those wing dams meeting the general criteria established in Section 3.5.1. If the net cannot be set safely or if it will not fish effectively because of high current velocity or other adverse river conditions, the closest wing dam site that can be sampled must be chosen as an alternate. Ideally, 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; however, river conditions (e.g., high current velocity) may require a modified deployment such as moving the nets closer to the shoreline.

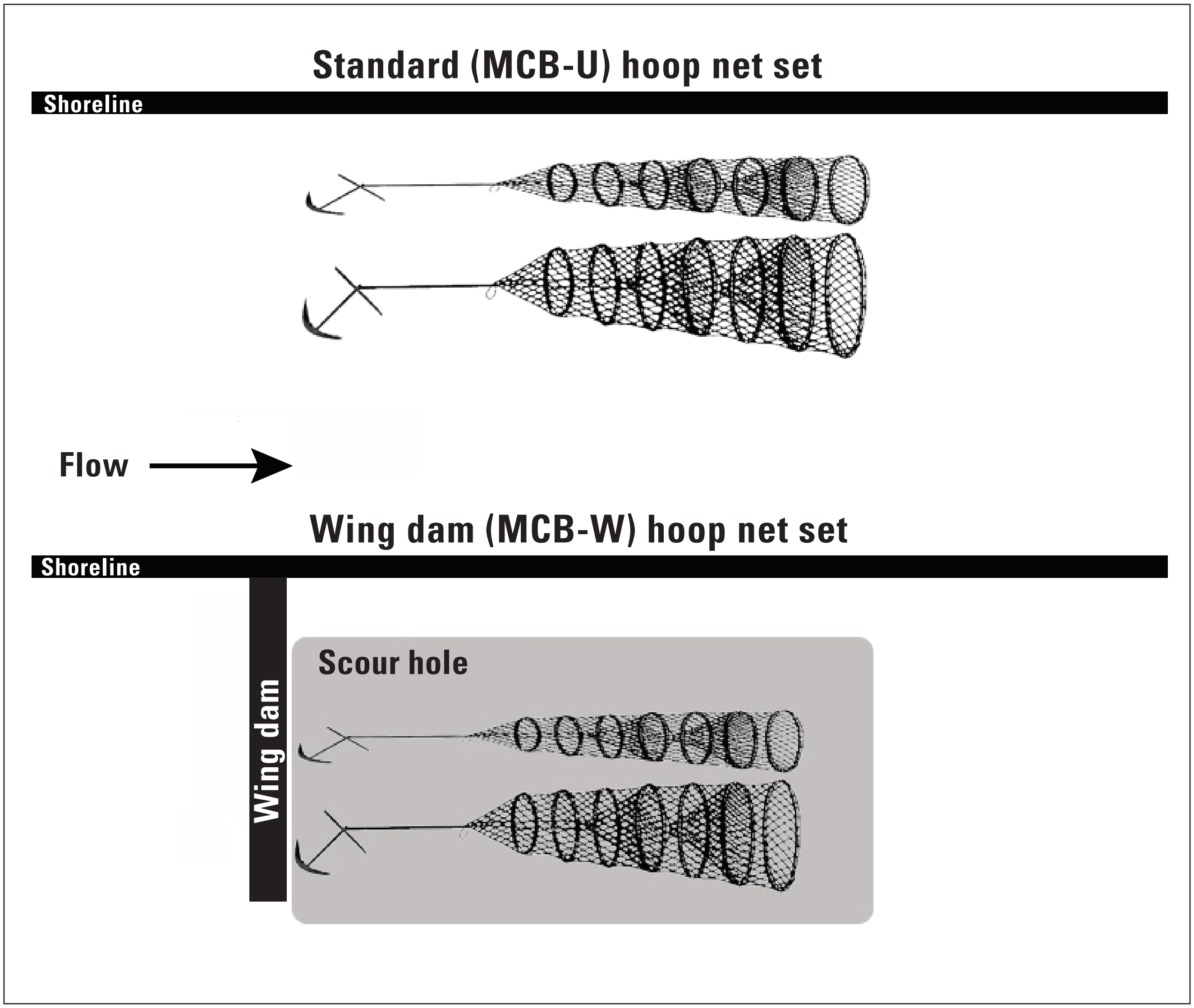

Figure 5. Typical Long Term Resource Monitoring Program hoop net sets in main channel border-unstructured (MCB-U) and main channel border-wing dam (MCB-W) sampling areas. Nets are parallel, mouth facing downstream, small hoop net closer to shoreline. Nets are set in the scour hole for wing dam sets.

If one sample from a hoop net pair is lost, the record for the failed net gets a *1* in the Summary Cd field indicating that the site may be resampled within the time period, and an explanation for the loss is entered into the Site Comment field (e.g., net lost, stolen, ripped, etc.). Data are recorded normally for the successfully fished net. If the site is resampled again or if an alternate site must be chosen (within the time period), data from the original successfully fished net and the failed net should be overwritten by data from the new pair of hoop nets.

Hoop nets are deployed for approximately 48 h, and the standardized unit of hoop netting effort is the net day, where days are 24.0 h (Table 2). Therefore, a 48 h hoop net deployment produces an effort of 2.0 net days for each net of the pair. Actual deployment times may vary from the 48 h target but are accounted for by recording the actual number of hours the nets were fished.

5.5 Fyke Netting

Fyke nets (Appendix C-4) are deployed in areas where depth is at least sufficient to submerge the throats of the nets. Leads are fully extended, with two exceptions. The first exception is where bed slope is steeper than approximately 30 degrees (i.e., the cab would lie at a depth greater than approximately 7.6 m [25 ft]). The second exception is where full extension of the lead would put the cab in strong current that could roll the net. In either exception, leads may be shortened to no less than 6.1 m (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 of *6* is recorded for otherwise normally completed samples.

In unvegetated or sparsely vegetated areas with accessible shorelines, fyke nets are deployed perpendicular to shore (Figure 6) with the lead anchored to shore or other structure (e.g., logjam or sunken barge). When vegetation is present, the crew determines whether it is sparse enough for the lead and net to reach the substrate and whether the shore can be reached without clogging the boat motor with vegetation, causing overheating. Where vegetation (aquatic or flooded terrestrial) is too dense for staking a net to shore, sampling efforts may be repositioned perpendicularly offshore to the vegetation bed edge, providing the net is not moved into a different stratum. The net is set perpendicular to the vegetation bed with the lead staked 1 m (3.2 ft) inside the outer edge of the vegetation bed. A summary code of *7* (indicating a pseudo-shoreline was used) is recorded for otherwise normally completed samples. In unvegetated or sparsely vegetated areas where a long, shallow slope is too shallow to submerge the throats of the net, the net may be moved up to 25 m upstream or downstream along the bank to a deeper location; however, the net may not be moved offshore to the open water edge of the shallow slope. There is no situation where the lead of a fyke net may be staked in open water: it is always staked either at shore, the edge of a dense vegetation bed, or on structure that provides a barrier to fish. If the net cannot be set within these limits, the nearest suitable alternate site must be chosen.

The cod end may be anchored using a variety of techniques (e.g., rebar, concrete anchors, stakes) dependent on the habitat features of the site. Fyke nets are deployed for approximately 24 h and the standardized unit of fyke netting effort is the net day, where days are 24.0 h (Table 2). Actual deployment times may vary from the 24 h target but are accounted for by recording the actual number of hours the nets were fished. Thus, a fyke net deployed for 27 h is an effort of 1.125 net days.

Figure 6. Standard Long Term Resource Monitoring Program fyke net set. Throats are completely submerged, lead is staked to shoreline, net is stretched perpendicular to the shoreline, and rear of net is staked/anchored in deeper water. Mini fyke nets are set in identical fashion.

5.6 Mini Fyke Netting

Mini fyke nets (Appendix C-5) are deployed following the same criteria and exceptions used for fyke nets (see Section 5.5). Where shortening of leads on mini fyke nets is permitted, leads may be shortened to no less than 1.8 m (6 ft). The cod end may be anchored using a variety of techniques (e.g., rebar, concrete anchors, stakes) dependent on the habitat features of the site. Mini fyke nets are deployed for approximately 24 h and the standard unit of mini fyke netting effort is the 24.0 h net day. Thus, a mini fyke net deployed for 27 h is an effort of 1.125 net days.

A unique design feature of the LTRMP mini fyke nets is a 51 millimeter (2 inch) inner diameter, 6.4 millimeter (1/4 inch)-thick, stainless steel or nickel plated ring sewn into the throat of the net (Appendix C-5). This ring prevents turtles and larger predatory fish from getting through the throat of the net and has the added benefit of keeping the throat from collapsing.

Mini fyke nets are deployed only at those wing dams meeting the general criteria established in Section 3.5.1. If the Crew Leader determines that the net cannot be set safely or that it will not fish effectively because of high current velocity or other adverse river conditions, the closest wing dam site that can be sampled must be chosen as an alternate. Mini fyke nets should be set on the upstream side of the wing dam where depth and current allow the net to be fished without risk of rolling over. If the net cannot be properly set on the upstream side of the wing dam, it may be set on the downstream side.

5.7 Trawling

Trawling is done at permanently fixed sampling sites in the TWZ sampling area using a two-seam slingshot balloon trawl (Figure 7; Appendix C-6). The standardized unit of trawling effort is the net haul (Table 2). The target distance for each haul is 350 m, and up to four hauls are made per site. Each haul is recorded separately in the fish data entry application; i.e., for each trawling site, the data entry application is preloaded with a series of replicate sites, all labeled with the same site name plus a unique extension of -1T, -2T, -3T, or -4T corresponding to the haul number. The haul number (1–4) is also recorded in User Defined field 12 as each row of fish data is entered (see Section 7.2 for recording instructions). Note: Before 2012, each trawl haul was recorded in the same record (no unique site name extensions corresponding to haul number) and each haul was distinguished only by recording the haul number in User Defined field 12.

SAFETY: Both tailwaters and trawling are inherently dangerous, making trawling the most dangerous type of LTRMP sampling. The Crew Leader must carefully judge whether sampling can be done safely based on site conditions (current velocity, waves, wind, debris, etc.). All crew members must wear life jackets, and a very sharp knife capable of cutting trawl ropes should be easily accessible in case of an emergency. Trawling should be done only from the bow of the boat: it is too dangerous to trawl from the stern of boats of the size typically used by the LTRMP.

Tailwater zones are highly variable day-to-day and among river reaches. Nonetheless, the objective is to get as close as safely possible to the dam to start the trawling haul. The goal is to sample 350 m of the immediate area below the dam, staying in the downstream flow as opposed to slack water or large eddies. The initial 350 m haul should be measured using either a GPS (e.g., the "man overboard" feature) or a range finder. Once the range is established it is acceptable to use relatively permanent and unique fixed landmarks. Where possible, trawl hauls are made parallel to each other and should be spaced so that a new area of water is trawled by each haul.

The trawl is attached to the otter boards (Figure 7; Appendix C-6), which are secured with 100 ft (30 m) towropes. The towropes are tied to sturdy contact points on or around the bow of a preferably large boat. A long rope (30–46 m [100–150 ft]) and float may be tied to the back (cod end) of the trawl to help monitor the net's trawling path and for net recovery in case of snags. The trawl is deployed from the bow with the boat going backwards downstream at a speed that keeps the footrope and chain of the net in close contact with the river bottom without the net rolling on itself; in other words, the boat needs to be going slightly faster than the current. Watching speed relative to debris, bubbles, etc., is perhaps the easiest way to gage speed. At the end of the 350 m haul, the boat should be kept in reverse at idle speed to keep the net from rolling or twisting upon retrieval. The net should come up open and untwisted if the sample was collected properly. Start Time should begin when the net effectively starts fishing (i.e., when the ropes are tight and net begins moving downstream), and the Finish Time should be recorded when the net is pulled to the water surface.

If a haul must be cut short (pulled less than 350 m) because of obstructions or for safety and the gear fished properly, record the actual time and distance fished. If the trawl becomes snagged for more than a few moments, likely resulting in the loss of fish, the run should be started over.

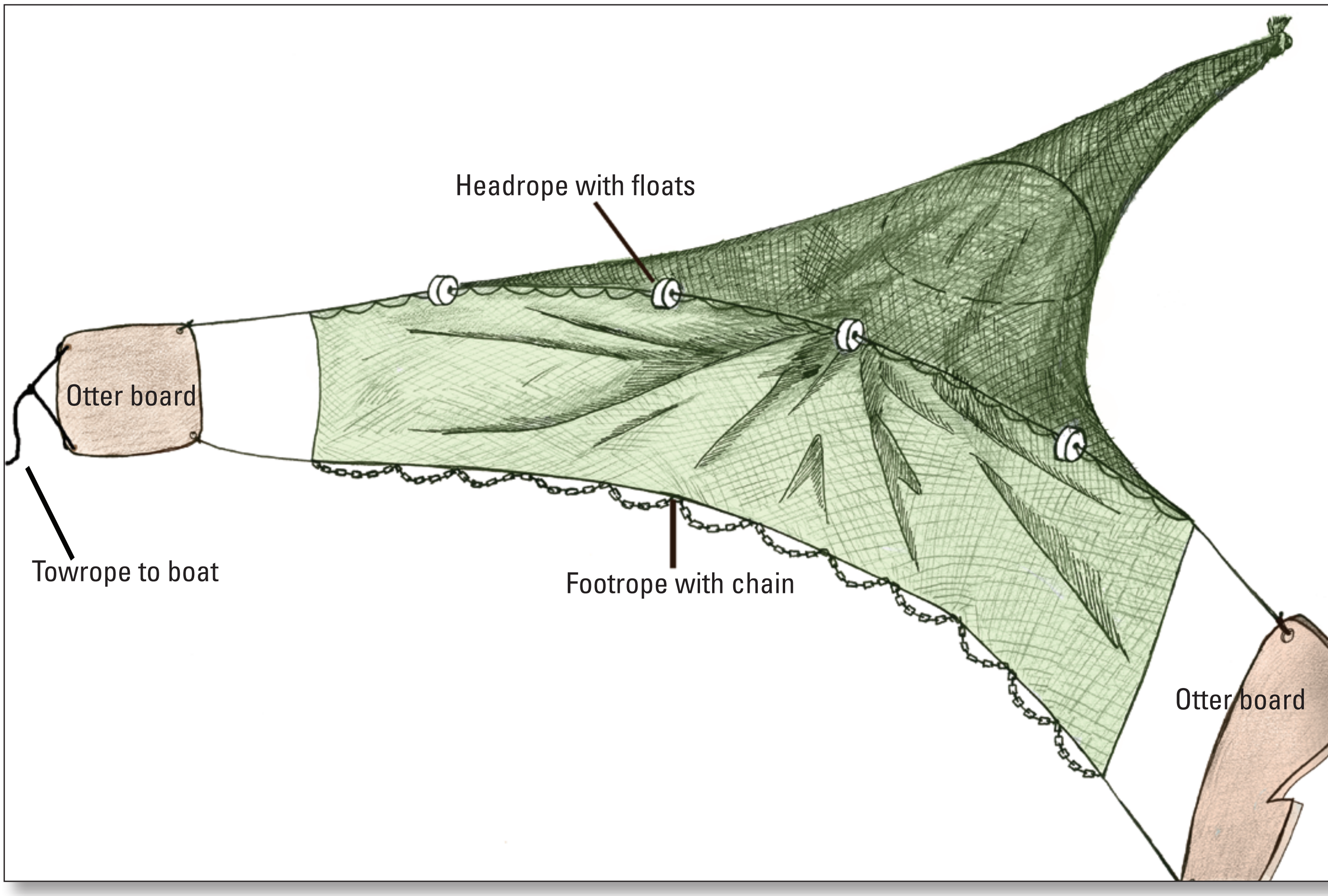

Figure 7. Depiction of a standard Long Term Resource Monitoring Program trawl and attached otter boards during deployment (graphic based on drawing by A. J. Hendershott, Missouri Department of Conservation).

5.8 Gear Maintenance

Crew Leaders must ensure that each piece of sampling gear is well maintained in order to sustain a constant sampling efficiency. All nets, including dip-nets, should be free of rips and holes. Nets should be periodically stretched and inspected to make sure the leads are fully stretched to maintain maximum height, throats are properly tied and open, mesh is properly secured to the frames and hoops, and to look for broken mesh. A repair kit or spare nets (including dip-nets) should be taken in the field in case of damage. Instructions on net repair can be found in Gebhards (1996). If bare threads of the mesh can be seen, the nets must be tarred (fyke and hoop nets) or green dipped (mini fyke nets and trawls) before field season begins. It is important to keep up on net tarring and green dipping because untreated nets are less durable and may fish differently than treated nets. If nets are overly muddy or full of debris, they must be cleaned before setting. Routine inspection and testing of the components of the electrofishing gear are critical to ensure standardized electrical output, and are required before each time period. Methods for maintaining and testing these components are detailed in Section 5.3.1 and Appendix B.

6. Fish Identification and Measurement

6.1 General Information

Sections 6.1 through 6.9 contain guidelines for collecting and recording fish and related data. The data collected during fish sampling consist of (a) an unambiguous description of the sample in space and time, (b) site-specific observations and measurements of habitat characteristics, (c) quality control information, and (d) enumerations and measurements of fish catches. Instructions for electronic data entry are given in Section 7.2. Appendix D contains suggested references to be used in the identification of fish.

A summary code should be assigned to the sample before fish are processed. A summary code is a numeric code from 1–8, documenting the overall quality of the sample and modifications to protocols that may affect proper interpretation of the data (Table 4). Crew Leaders are responsible for the critical task of selecting the most accurate summary code. Summary codes 1–2 describe unsuccessful sampling attempts, and summary codes 3–8 describe various degrees of sampling success. Summary code 5 is reserved for normally completed samples. In general, data from collections having summary codes greater than or equal to 3 are used in analyses and reports. Exceptions to this rule apply to specific data. For example, weight data from collections having summary code 4 (weighing equipment probably in error) should not be used to construct weight-length equations.

Table 4. Long Term Resource Monitoring Program fish sampling summary codes. A numeric code from 1–8 is assigned to each collection effort to document success or failure of a sampling attempt. Codes 1–2 describe unsuccessful sampling attempts, whereas codes 3–8 describe successful attempts.

Summary code	Evaluation of the sampling attempt
1	Gear failure; site may be resampled within the time period. Explain gear failure in Site Comment field.
2	Site cannot be sampled (e.g., site is dry or inaccessible). Describe conditions in Site Comment field.
3	Sample collected under unusual environmental conditions that may have influenced gear efficiency. Describe these conditions in Site Comment field.
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). Describe the gear modification in Site Comment field.
7	A gear normally deployed along a shoreline was deployed along a pseudo-shoreline. The edge of a shallow slope, dense vegetation bed, or other structure may qualify for sampling as a pseudo-shoreline, depending on gear type (see gear descriptions, sections 5.3, 5.5, and 5.6).
8	Minor gear damage or noncritical gear alteration noticed at completion of sample. Gear efficiency not appreciably affected. Explain in Site Comment field.

6.2 Identifying, Measuring, and Enumerating Fish

Fish must be identified to species to the extent reasonably possible. Specimens that cannot be identified to species 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. Pencil and Rite in the Rain® (or similar) waterproof paper should be used if the label will come in contact with chemicals (e.g., alcohol) that could dissolve ink or degrade regular paper. All preserved specimens, with the exception of those sent to an identification expert, are identified, measured, and enumerated at the laboratory as time permits. Scientific and common names are those most recently established by the American Fisheries Society (Nelson et al. 2004). Four-character fish species codes (Appendix E) established by the LTRMP are used for reporting species during data entry.

Counts by species and length are required for LTRMP routine monitoring collections. During routine measurement, LTRMP fish specimens of all sizes are categorized into 10 millimeter (mm) length groups labeled by their lower length boundary. For instance, the 90 mm length group includes all fish 90 through 99 mm. As each individual fish is measured, the appropriate length group is recorded. The data entry program enters a *1* in the GRP field by default, indicating that fish lengths were entered in 10 mm length groups. An exception arises during time period 3 for select species that are also weighed (detailed in Section 6.4). Fish that are weighed must be measured to the nearest mm instead of being categorized into 10 mm length groups. If a weight is entered, the data entry program automatically removes the *1* from the GRP field because exact lengths are required when fish are weighed. To record a fish to the nearest mm without entering a weight, the recorder must manually remove the *1* from the GRP field. Note: Field stations are free to measure fish to the nearest mm at any time to meet individual field station needs or the objectives of special projects.

Maximum total length (abbreviated as “T” in the data entry application) is used for all fish unless unique physiology necessitates the use of another measurement method. Maximum total length is the greatest possible length of the fish, measured from the anterior-most extreme of the head (jaw closed) to the most distant lobe of the caudal fin (lobes compressed to achieve maximum length; Anderson and Gutreuter 1983).

Fork length (F) is the distance from the anterior-most extreme of the head (jaw closed) to the fork of the caudal fin (tip of median fin rays; Anderson and Gutreuter 1983). Fork length should be used for sturgeons (e.g., *Acipenser fulvescens, Scaphirhynchus platorynchus*, and *Scaphirhynchus albus*) and other fishes that have rigid upper caudal lobes or variable caudal filaments. Paddlefish are unique in that fork length is measured from the front of the eye to the fork of the caudal fin.

Standard length (S) is the distance from the anterior-most extreme of the head (jaw closed) to the posterior margin of the hypural bone as manifested by the “notch” created by flexing the caudal peduncle (Anderson and Gutreuter 1983). Standard length is recorded for specimens that have damaged or deformed caudal fins, but these individuals are not included in population structure analyses. The TFS field automatically defaults to *T* because maximum total length is the assumed measurement method. If fork length or standard length is used, the *T* must be manually replaced with an *F* or an *S*.

The pathology code (PC) field is used to record physical abnormalities discovered on fish during processing. Each fish is briefly examined for visible signs of abnormalities (e.g., injury, disease, parasite burden, etc.) and an appropriate pathology code (Table 5) is recorded in the PC field. To record abnormalities not listed, enter a *6* in the PC field and describe the abnormality in the Site Comment field. If the PC field is blank a “0” is assumed, indicating no abnormalities.

Table 5. Long Term Resource Monitoring Program fish pathology codes. A numeric code from 1–6 is assigned to fish with visible external injury, disease, parasite burden, or other anomaly. Fish with no noticeable abnormalities are assigned a code of 0 or the pathology code field is intentionally left blank.

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

6.3 Subsampling

If too many specimens are collected for timely identification and measurement in the field, specimens may either be preserved in a fixative for enumeration later, or a subsample may be selected for measurement followed by enumeration or estimation of the remaining sample. Subsampling is defined as taking a representative manageable sample from a larger (unmanageable) sample. Subsampling is necessary to keep fish alive and to keep sampling time manageable. Large fish and species that do not dominate the collection are processed normally. The Crew Leader then determines if subsampling will be necessary based on whether the remaining sample is too large to efficiently work up.

If subsampling is necessary, the first step is routine processing of a subsample of at least 200 randomly selected individuals of a species. To accomplish this, the field crew mixes the holding tank, scoops out fish with a scoop net, processes the fish and records the data normally (as per Section 6.2). This process is repeated until at least 200 fish of a species have been recorded. When feasible, the remaining fish of that species should be counted. However, for very large catches, the count may be estimated by first weighing the total remaining sample (w_t), then counting (n_s) and taking a combined weight (w_s) of approximately 100 random fish from the sample, and finally calculating the total count ($\hat{n}_t$) as:

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

Because the density of fish flesh is nearly constant (to achieve neutral buoyancy), volume is proportional to weight (Anderson and Neumann 1996). Therefore, volumetric measures may be used rather than weight measures in the equation above. The enumerated or estimated total count of fish not measured individually is recorded by entering the species code, leaving length blank, removing the *1* from the GRP field (default is *1*), and recording the count (recording bulk weight is optional).

6.4 Weight Measurements from Key Species During Time Period 3

Individual weight data are collected from key species including black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), sauger (*Sander canadensis*), smallmouth buffalo (*Ictiobus bubalus*), and walleye (*Sander vitreus*) during time period 3. These species were selected because they are species of particular interest (e.g., game or commercial fishes), representatives of various guilds of fishes (feeding guilds, reproductive guilds, habitat dependent groups, or functional groups), and are relatively common among all 6 reaches sampled.

During time period 3, individual length and weight measurements should be taken from a subsample of these species from each sampling site where they are captured. These subsamples consist of random selection of at least three individuals per 10 mm length group. These fish are measured to the nearest 1 mm and are weighed in grams using a quality digital scale. Properly calibrated spring scales may be used in emergencies (e.g., gear failure, extreme weather conditions). After three individuals per 10 mm length group have been weighed and measured to the nearest mm, all remaining fish need only be measured to the nearest 10 mm length group. Note: Field stations are free to weigh additional fish at any time during the sampling season to meet individual field station needs or the objectives of special projects.

6.5 Collecting Special Project Data

The LTRMP sampling methodology was developed for collecting routine LTRMP fish monitoring data, but can also be adapted for use with other special projects as the need arises. The objectives of the project must be coordinated with the LTRMP Fish Component Leader, who will assign a unique special project code and determine the process of data management for the project. The principal investigator (PI) for the special project should provide the LTRMP Fish Component Leader with a project study plan detailing all pertinent information about the project including the funding source, purpose of the project, sampling location, the time frame for the project, and how it is being implemented (including details such as unique faunal codes, alternative gear specifications, user defined field assignments in the electronic data entry application, etc.). After the LTRMP Fish Component Leader assigns the project a special project code, the LTRMP Database Administrator will add the new code to the list of special project codes available for field station use in the electronic data entry application.

The LTRMP data entry application may be used for recording data from special projects. The *Special Projects Screen* is accessed from the *Site Information Screen* of the data entry application (see Section 7.2.1 for details). If a special project includes collection of specialized data not normally collected during routine LTRMP monitoring, it may be recorded in the User Defined fields which are described in more detail in Sections 7.2.3 and 7.2.4. The Special Project PI can be creative in determining the best use of the User Defined fields for recording specialized data, but it is the Special Project PI's responsibility to maintain documentation of all deviations from standard LTRMP protocols, including specific data field assignments unique to the project (e.g., User Defined field assignments). This documentation should be included in the project study plan provided to the LTRMP Fish Component Leader.

6.6 Incidental Catches of Turtles

Throughout the life of the program, turtles have been a constant by-catch of LTRMP sampling. Their presence in the catch affords an opportunity to collect additional data about an important component of the ecosystem with minimal expenditure of additional sampling time or effort. A specialized turtle data entry screen is built into the data entry application and is accessed from the fish *Site Information Screen*. When the *Turtle Measurement Screen* is opened it is linked to the *Site Information Screen* it was opened from, linking all of the site data to the *Turtle Measurement Screen*. Species, gender, and carapace length are recorded for each turtle. If a gender determination cannot be made, gender is recorded as "sub-adult" (if turtle is too young for gender determination) or "unidentifiable" (if gender of adult cannot be determined). A very approximate guideline for most turtle species encountered in the UMRS is that gender is difficult to determine when carapace length is less than 100 mm (John Tucker, Herpetologist, INHS, oral communication, March 2012). Species identification and gender determination methods are described in Johnson and Briggler 2012, located online at *http://www.umesc.usgs.gov/data_library/fisheries/historical_documents.html* (accessed December 11, 2013). Long Term Resource Monitoring Program turtle species codes are listed in Appendix F.

6.7 Training and Safety Considerations

The first level of quality assurance associated with data collection for the LTRMP happens when a data entry record is completed in the field. The Crew Leader ensures 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 sessions. Therefore, at least one person in the fish sampling crew is a designated LTRMP Crew Leader. Training of new staff is done by the Crew Leader and may be supplemented with additional training sessions given by the LTRMP Fish Component Leader or Database Administrator. **Cardiopulmonary resuscitation certification is required for staff working on electrofishing boats and is recommended for all field staff.** Other recommended courses are First Aid, the U.S. Coastguard's Boating Safety and Seamanship (or similar) course, and related continuing education courses.

In addition to training courses, some practical considerations can help ensure crew safety and welfare. Loose fitting, light colored clothing, wide-brimmed hats, sunscreen, polarized sunglasses, and plenty of drinking water can help prevent heat exhaustion. Likewise, dressing in layers, consuming adequate calories, staying hydrated, and wearing warm hats, gloves, boots, etc., can help prevent hypothermia. Closed footwear is strongly recommended (instead of sandals) to avoid foot injuries. Boots that lace using rings or eyelets are preferred instead of boots with hooks, which can catch on netting and pose a tripping hazard. Life jackets should be in good condition and the correct size for the user. Crews should closely monitor weather and river conditions, and always err on the side of safety when deciding to sample.

6.8 Fish Identification and Reference Collections

Up-to-date identification keys are carried in the field to facilitate field identification (see Appendix D for a list of recommended keys). When a specimen cannot be identified to the Crew Leader's satisfaction, it is placed in a container labeled with the location code, pool/reach code, project code, start date and time, gear code, and stratum code and preserved in fixative. The fish is later identified at the field station, or if necessary, sent to a fish identification expert. It is a good practice to record length and weight data before sending the specimen to an outside expert for identification in case the specimen is identified but not returned.

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(s) making the identification.

6.9 Investigating Fish Kills

Field personnel should investigate 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, Meyer and Barclay (1990).

7. Data Management

7.1 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. All LTRMP field staff that collect fish data are expected to understand and comply with data recording and tracking procedures.

In 2003, the LTRMP fish component went digital with the creation of an electronic fish data entry application. Direct data entry has improved the speed and accuracy of collecting and entering data while decreasing the number of potential errors identified in the raw, unreconciled data by an order of magnitude. Currently (as of 2014), data for more than 5.7 million UMRS fish are housed in a centralized database, which is available to researchers, river managers, and the public in both the raw data form as well as multiple types of Web-based graphical database browsers (see Section 7.4).

7.2 Electronic Data Entry

In 2003, paper datasheets were replaced with direct data entry into an electronic fish data entry application (Figures 8 and 9) loaded onto ruggedized field laptops. The change to digital data capture has produced significant time and cost savings to the LTRMP fish crews and data managers. Operation of the application's interface is straight-forward with a similar layout to the original paper datasheets, as well as clickable fields, buttons, drop down menus, tabs, and calculators. Most of the errors in data recording are caught at the source (i.e., in the field) by use of syntax, contextual, and range checks made by software running real-time in the background of the program.

A ruggedized laptop with the data entry application should be used, whenever possible, to record site and fish data in the field. On occasions when this is not possible (e.g., extreme conditions, rain, malfunctioning equipment), standard LTRMP data sheets (Appendix G) printed on waterproof paper may be used for entering data into the application at a later date.

The data entry application is continually evolving to improve efficiency and to meet field station and database needs. A new version of the data entry application is provided by the LTRMP Database Administrator annually. The application comes preloaded with each field station's primary, alternate, wing dam, and fixed sites for the sampling season. It may also include special project sites if requested.

Fish sampling data are recorded in the electronic fish data entry application on two data screens: the *Site Information Screen* and the *Fish Measurement Screen*. A collection is defined as a sampling venture consisting of a unique combination of location, time, and sampling gear. The *Site Information Screen* (Sections 7.2.1 and 7.2.2) is completed for each collection. This screen 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. The *Fish Measurement Screen* (Sections 7.2.3. and 7.2.4) is used to record fish catch data from each collection. These data screens serve as the primary means of data capture for routine LTRMP monitoring efforts. Both data screens were designed to optimize the mix of flexibility, simplicity, visual clarity, capture of essential data, and quality assurance objectives.

When initially opening the application, the user will have to select their appropriate field station number, crew leader code, time period, and recording site information from drop down menus on the first screen. This information determines which collection sites (by field station and time period) can be accessed in the application, and pre-populates some fields saving data entry time and reducing data entry errors.

On the second screen, users will have several options to navigate to data sheets, menus, data access, and user preferences. Only the top button "LTRMP Fish Data Sheet" will be discussed in detail here. Once the button is selected, a new screen called the *Site Information Screen* (Figure 8) will open and will be pre-populated with the crew leader code, and field station and time period specific site data (e.g., site lists). Crew Leaders are responsible for ensuring that data are entered in the fish data entry application accurately and completely. Completion of all fields is mandatory, except where noted below.

7.2.1 Site Information Screen Instructions

An example of the *Site Information Screen* is given below (Figure 8). Newer versions of the software application might appear slightly different; however, Figure 8 should still provide a basic guideline to the *Site Information Screen*. This screen was designed to mimic the paper version of the LTRMP fish site data sheet (Appendix G-1).

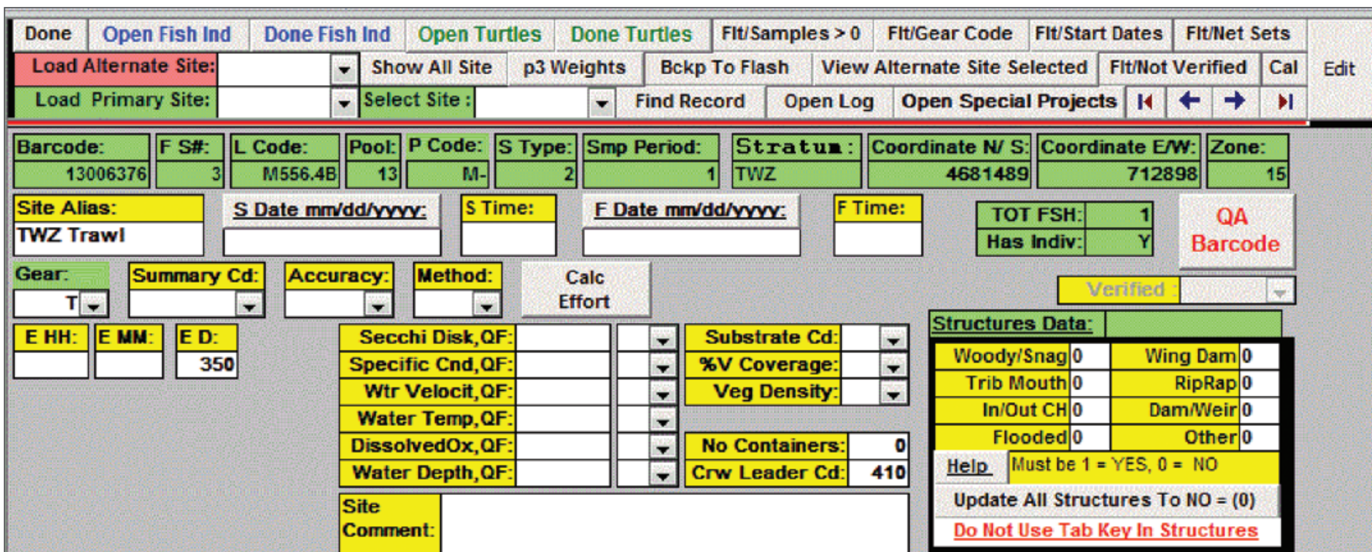

Figure 8. Image capture of the Site Information Screen from the Long Term Resource Monitoring Program fish data entry application.

At the very top of the main data entry form, there are three rows of gray buttons. These allow the user to perform various tasks outside of an individual record. The first button "Done" will exit back to the main menu. "Open Fish Ind" will open the *Fish Measurement Screen* and hide the *Site Information Screen*. "Done Fish Ind" closes the *Fish Measurement Screen* and reveals the *Site Information Screen.* Similarly, "Open Turtles" opens the *Turtle Measurement Screen* and "Done Turtles" closes it. The turtle data are automatically linked to the fish site record currently open and thus all of the site and measurement information is linked to that site and barcode. The Open Special Projects button opens up a new *Site Information Screen* and corresponding *Fish Measurement Screen* for sites that are classified outside of LTRMP standard data collection.

Many of the gray buttons allow you to run filters (“Flt/...”) for searching and sorting records. These buttons launch filtering macros based on the descriptive text suffix unique to each button (e.g., Flt/Not Verified). These filters are designed to aid maintenance/navigation of the records that have been entered previously and to assist in quality assurance (QA) checks before submitting the data to UMESC. The button labeled “Cal” opens a calculator, and the button labeled “Open Log” opens an electronic log book for record keeping comments. The button termed “Show All Site” refreshes all records following an earlier filter. The button labeled “Bckp to Flash” performs an instantaneous backup of the database to the flash card. This should be done several times each day during data collection. Finally, the button labeled “Edit” is for the rare occasion that a green (preloaded data) field requires editing.

All of the green fields are automatically assigned, preloaded, and filled out for each site. These fields include the Barcode, Field Station Number, Location Code, Pool, Project Code, Site Type, Sampling Period, Stratum, Gear Code, UTM Zone, and Coordinates; generally you should not edit these fields. White fields with yellow labels are editable fields for entering data using drop down menus or keyed-entry. To enter a start date/time, finish date/time, or calculate total effort, you may click on the gray buttons adjacent to those fields for automatic capture of the data, or you may enter/edit them yourself.

Electronic data entry of a collection begins with information particular to a sampling site. In the upper left-hand corner of the *Site Information Screen,* the user will select a site under the Load Primary Site field from the drop-down list. Sites for the active time period (chosen when the application was loaded) are sorted by location code. Alternate sites may be selected the same way under the Load Alternate Site field. However, the alternate site will be linked to the primary site that is currently active, automatically entering the primary site location code and its unique barcode number in the Site Comment field of the alternate site. It is a good practice to also type the alternate site code into the Site Comment field of the primary site that is being replaced (e.g., ALTERNATE SITE SAMPLED IS F40A).

Other than the Site Alias, Site Comment, and Veg Density fields, all data fields should be filled out for any sample with a summary code greater than 2. **Do not bypass the Structures fields**, even if you have no structures to record. Either click in one of the boxes to record a structure or click on the gray button labeled “Update All Structures to NO = (0)” at the bottom of the structure box to update all the fields to “0”.

For electrofishing sites, additional fields will become active under the Effort fields. Enter the conductivity and temperature in the appropriate fields, and then click the gray button labeled “PG” (power goal) to calculate the power goal to be used during electrofishing. After electrofishing, enter the volts and amps actually used and click the PG button to calculate power used. For detailed descriptions of all *Site Information Screen* data fields, see Section 7.2.2.

7.2.2 Site Information Screen Field Descriptions

Most fields of the *Site Information Screen* should be filled out at the beginning of a sampling collection. The layout of the *Site Information Screen* and data recording instructions are described in Section 7.2.1. Detailed descriptions of each field in the *Site Information Screen* follow:

Field name	Description and coding instructions
Barcode	A barcode is automatically assigned when a site is selected and loaded into the *Site Information Screen*.
FS#	One-digit numeric field station number: **1 = Lake City, MN** **4 = East Alton, IL** **2 = La Crosse, WI** **5 = Jackson, MO** **3 = Bellevue, IA** **6 = Havana, IL**
L. Code	Alphanumeric code for LTRMP location code having the format *nnnnn.nnnnn*. The format for SRS sites is *nnnn.RS*, where *nnnn* is the site number from the sampling map or site list. The general format for fixed sites and engineered structures is *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. The format is the same for fixed trawling sites, but with an additional extension corresponding to the haul number. The format is *rmmm.ma-hT*, where *h* designates the haul number (1–4).
Pool	Two-digit alphanumeric code for the LTRMP study reach or pool number: **04 = Pool 4, UMR** **26 = Pool 26, UMR** **08 = Pool 8, UMR** **LG = La Grange Pool, Illinois River** **13 = Pool 13, UMR** **OR = Open Mississippi River**
P Code	Four-digit alphanumeric LTRMP project code. The format is generally *A-nnn*, where *A* is a letter describing project type and, when used, *nnn* is a special project number. Project types are as follows: **M = Base monitoring of SRS sites, fixed sites, and engineered structures** **B = HREP biological response monitoring** **E = Ad hoc exploratory sampling** **R = Special research project** **A = Additional Program Element project** **EMER = Emergency sampling (e.g., flood or spill response)** **TURT = Turtles collected as by-catch during routine LTRMP fish sampling** **Note:** A three digit project number *nnn* is not recorded for base monitoring (M-); however, the LTRMP Fish Component Leader will assign project numbers for all other project types. To ensure the integrity of the data, all project numbers must be obtained from the LTRMP Fish Component Leader using procedures detailed in Section 6.5 above.
S 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**

Field name	Description and coding instructions
Smp Period	One-digit numeric LTRMP sampling time period code. Example: During the first sampling time period, a *1* is entered in the Smp Period field. Note: This field is labeled "Smp Period" in the *Site Information Screen,* but is referred to as "Time Period" in the opening screen of the data entry application, within the LTRMP database, and throughout the rest of this manual.
Stratum (Sampling Area)	Alphabetic field with LTRMP sampling area type description: **BWC-S = Backwater, contiguous-shoreline (SRS)** **MCB-U = Main channel border-unstructured (SRS)** **MCB-W = Main channel border-wing dam (Engineered Structures)** **IMP-S = Impounded-shoreline (SRS)** **SCB = Side channel border (SRS)** **TWZ = Tailwater zone (Fixed Site Areas)** **TRI = Tributary mouth (Fixed Site Areas)**
Coordinates N/S	Seven-digit field to record latitudinal (north/south) GPS coordinates of the collection location. Units are UTM Northing (Datum NAD 83). For fixed sampling sites and wing dam sites, this value should be measured using a GPS device when each site is first established and reported to the LTRMP Database Administrator (details in Section 3.5.1). On subsequent visits, most fixed sites can be relocated from a base map with acceptable accuracy (25 m) or from landmarks. Stratified random sampling sites should be located using a GPS device, or base maps where acceptable accuracy (25 m) can be achieved.
Coordinates E/W	Six-digit field to record the longitudinal (east/west) coordinates of the collection location. Units are UTM Easting (Datum NAD 83). For fixed sampling sites and wing dam sites, this value should be measured using a GPS device when the site is first established and reported to the LTRMP Database Administrator (details in Section 3.5.1). On subsequent visits, most fixed sites can be relocated from a base map with acceptable accuracy (25 m) or from landmarks. Stratified random sampling sites should be located using a GPS device, or base maps where acceptable accuracy (25 m) can be achieved.
Zone	Two-digit numeric field to record UTM GPS zone. LTRMP data reside in either Zone 15 or 16.
Site Alias	Space is provided to record an optional site alias for field station use.
S Date mm/dd/yyyy	Date on which a gear collection was initiated (e.g., the date on which a net was set). Eight-digit numeric *mmddyyyy* format wherein April 1, 2012, is recorded as 04012012.

Field name	Description and coding instructions
S Time	Four-digit 2400 h (military) Central Standard Time at which a gear sample begins (e.g., the time a net was set or an electrofishing run was begun). Sample Time is unaffected by changes in the clock due to daylight savings time. When a gear sample is begun, immediately obtain the time value by clicking the "S Date mm/dd/yyyy" button or entering it from a reliable time source. 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.
F Date mm/dd/yyyy	Date on which a gear sample was completed (e.g., the date on which a net was lifted). Format is the same as "S Date mm/dd/yyyy"
F Time	Four-digit 2400 h Central Standard Time at which a gear sample is completed (e.g., the time that a net is lifted or an electrofishing run [actual electrofishing time] is completed). Finish Time is unaffected by changes in the clock due to daylight savings time. Format and accuracy requirements are the same as for "S Time."
TOT FSH	A pre-populated numeric field to record the total number of fish (of all species, whether enumerated in the field or lab) recorded on the *Fish Measurement Screen*.
Has Indiv	A pre-populated field that displays Y (yes) or N (no) if data has been entered in the *Fish Measurement Screen.*
Gear	Alphabetic gear codes, summarized below: **D = Day electrofishing (1 h after sunrise to 1 h before sunset)** **F = Fyke netting** **HS = Hoop netting, small** **HL = Hoop netting, large** **M = Mini fyke netting** **T = Trawling**
Summary Cd	A numeric code documenting the overall quality of a sample collection as described in Section 6.1: **1 = Gear failure; site may be resampled within time period** **2 = Site cannot be sampled (e.g., site is dry or inaccessible)** **3 = Sample collected during unusual environmental conditions** **4 = Weighing equipment may be in error because of 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 alteration**

Field name	Description and coding instructions
Accuracy	A numeric code to record a measure of positioning accuracy. **1 = Almost certain accuracy within 25 m using uniquely identifiable features (undisturbed marker, wing dam, day mark, etc.)** **2 = High confidence of accuracy within 25 m using identifiable features on a base map** **3 = Other than above** **4 = Site inaccessible**
Method	A numeric code specifying the method used to locate the collection site, as follows: **1 = Base map and site features (UTM coordinates)** **2 = GPS or similar device (UTM coordinates)** **3 = GPS or similar device (latitude/longitude coordinates)** **4 = Base map and site features (latitude/longitude coordinates)** **5 = Site inaccessible**
E HH / E MM	Two fields displaying the duration of gear deployment or electrofishing effort. Format is in 2400 h (military) time, *hh:mm* (e.g., a net fished for 25 h and 15 min is recorded as 25:15). Selecting the Calc Effort button fills this automatically using the difference between finish date and time and start date and time.
E D	A numeric field for recording the length (in meters) of an electrofishing run or trawl haul.
The electrofishing fields below are only visible when an electrofishing site is selected	
Power Goal	A field to record the predetermined electrofishing power goal (in watts). This can be calculated using the PG button after specific conductivity and water temperature values have been recorded.
Power Used	A field to record the actual average electrofishing power (in watts) consumption. This can be calculated by clicking the PG button after average volts and amps used during the electrofishing run have been recorded. Alternatively, it can be calculated manually using the equation volts used x amps used = watts (power used).
*Quality Field (QF) codes for volts and amps fields below are:	**Blank = Normal operation/acceptable measurement** **0 = Equipment inoperative** **1 = Unstable reading**
Volts, QF*	A numeric field to record average DC volts used during an electrofishing run. QF codes are located in adjacent drop down menu.
Amps, QF*	A numeric field to record average DC current (in amperes) used during an electrofishing run. QF codes are located in adjacent drop down menu.

Field name	Description and coding instructions
Pulse Rate	A numeric field to record electrofishing pulse frequency in Hertz (cycles/second). Default is 60.
Duty Cycle	A numeric field to record electrofishing duty cycle (percentage of time current is flowing). Default is 25.
*QF codes for all water quality fields below are:	**Blank = Normal measurement/no problems** **0 = Equipment inoperative** **1 = Equipment in question** **2 = Reading off scale (High)** **3 = Reading off scale (Low)** **5 = Sample unusable or unobtainable** **9 = Non-standard method used**
Secchi Disk, QF*	A numeric field for recording measurement of water transparency to the nearest 1 cm using a Secchi disk. QF codes are located in adjacent drop down menu.
Specific Cnd, QF*	Four-digit numeric field to record specific conductivity to the nearest 1 µS/cm. QF codes are located in adjacent drop down menu.
Wtr Velocit, QF*	Three-digit numeric field to record water velocity to the nearest 0.01 m/s. QF codes are located in adjacent drop down menu.
Water Temp, QF*	Three-digit numeric field to record water temperature measurement to the nearest 0.1 °C. QF codes are located in adjacent drop down menu.
DissolvedOx, QF*	Three-digit numeric field to record dissolved oxygen concentration to the nearest 0.1 mg/L. QF codes are located in adjacent drop down menu.
Water Depth, QF*	Three-digit numeric field to record water depth to the nearest 0.1 m. QF codes are located in adjacent drop down menu.
Substrate Cd	A numeric field to record qualitative observations of sediments based on visual and tactile observation. Codes 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)**

Field name	Description and coding instructions
%V Coverage	Numeric field to record a qualitative estimate of percent of area within a 100 meter radius in which there is emergent or submersed aquatic vegetation, or both, 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% and more coverage**
Veg Density	One-digit numeric field to record a qualitative estimate of density of both emergent and submersed aquatic vegetation within a 100 meter 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 less than 10 stems/m^2) and does not create an "edge" at its perimeter.** **2 = Prevailing vegetation is dense (probably greater than 10 stems/m^2) and creates a distinct "edge" at its perimeter.**
No. containers	A field to record the number of individual containers (whirl-paks®, vials, jars, etc.) containing specimens that were returned to the field station or laboratory for identification and measurement. Default value is *0* (zero) for no fish returned to the field station or laboratory.
Crw Leader Cd	A field to record the LTRMP crew leader identification code. These codes are permanently assigned to LTRMP field station staff. The code of the crew member who is responsible for the particular sample collection is automatically filled out based on the crew leader code selected before opening the *Site Information Screen*.
Verified	When completely done with a fish collection, review all required fields of the *Site Information Screen* and associated *Fish Measurement Screen* to ensure they are completed and correct. Then select the QA Barcode button to run a quality assurance check on the data record. If errors are reported, correct them and run the QA Barcode check again. Once no errors are reported, select *V* from the drop down menu of the Verified field. **V = Record Verified** **Blank = Record Not Verified**
Structures Data	Eight check-off boxes (fields) to record presence of habitat structure within a 100 m radius. To record presence of one or more of the features listed, record a *1* in the appropriate box. To record presence of features not listed, record a *1* in the "Other" box and describe the feature(s) in the Site Comment field. **Important:** If no structures are present, select the Update All Structures to NO = (0) button.
Site Comment	Use this field to record miscellaneous comments and observations. This field accepts a maximum of 80 characters. Abbreviate as needed to capture key ideas.

7.2.3 Fish Measurement Screen Instructions

An example of the *Fish Measurement Screen* (Figure 9) is given below. Revised versions of the software application might appear slightly different; however, Figure 9 should still provide a basic guideline to the *Fish Measurement Screen*. This screen was designed to mimic the original paper version of the LTRMP fish measurement data sheet (Appendix G-2).

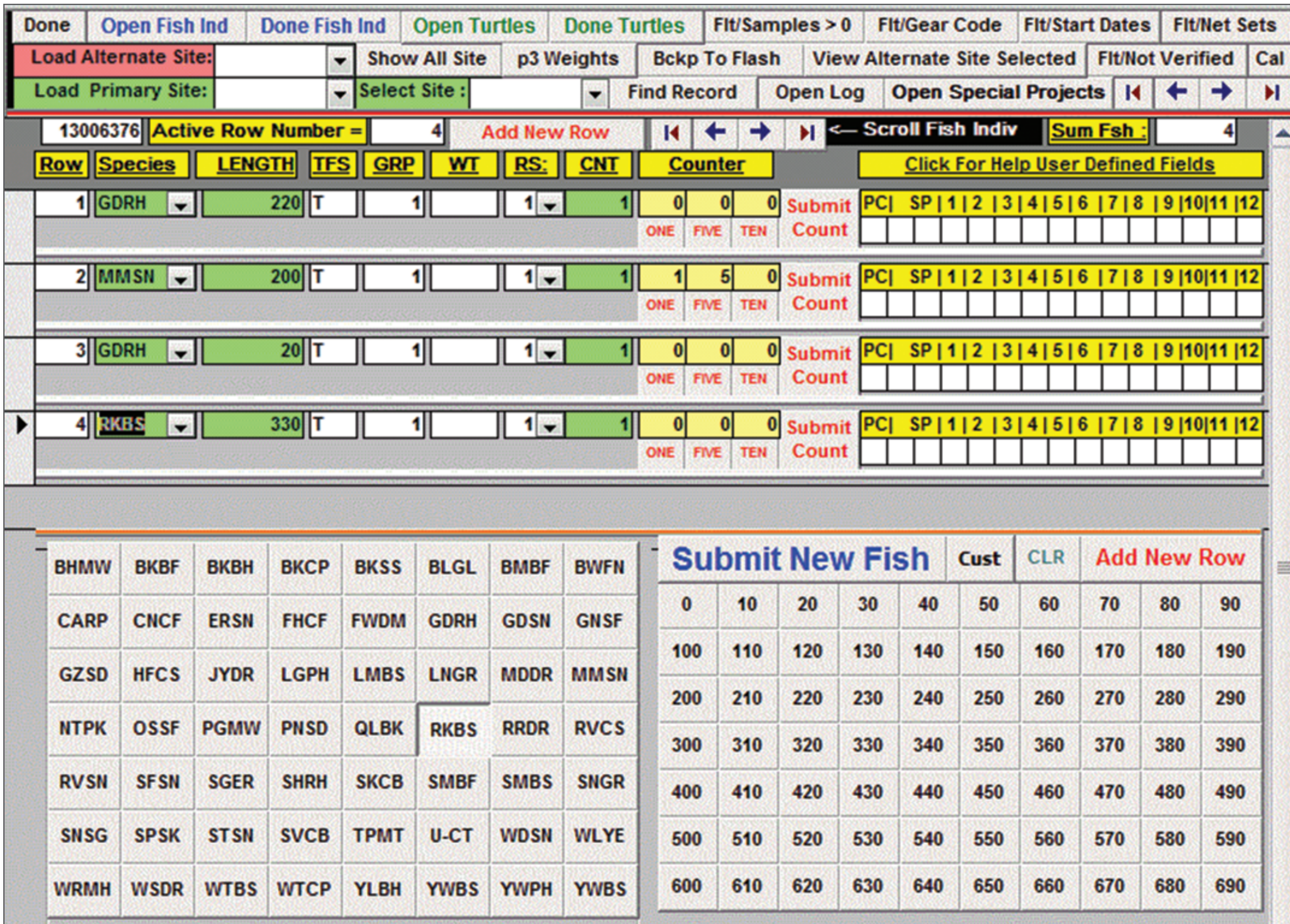

Figure 9. Image capture of the Fish Measurement Screen from the Long Term Resource Monitoring Program fish data entry application.

The top of the *Fish Measurement Screen* (Figure 9) has the same three rows of gray buttons as the *Site Information Screen* (Figure 8). Below the three rows of gray buttons, the screen has columns and rows much like a spreadsheet. The yellow fields in the top row of the spreadsheet are fixed column titles and are not able to be edited. The rows are added as needed to the screen as data are entered. The green fields under column titles “Species,” “Length,” and “CNT” are the primary fields for data entry.

There are several ways to enter data into the *Fish Measurement Screen*; we will discuss the two primary techniques. At the bottom of the screen there are two blocks of gray buttons: the left block of buttons contains fish species codes and the right block contains 10 mm length groups. The default fish species code buttons contain the most common fish species collected throughout the LTRMP; however, the Cust button on top of the right block of buttons can be used to modify the fish species code buttons to the most common codes used by each individual field station.

Note: When encountering a new species not found in the LTRMP drop down menu list, a fish species code of "NWSP" (New Species) has been provided in the data entry application. Select the NWSP code; if the species identity is known, enter the name in the Site Comment field of the *Site Information Screen*; otherwise enter the name of the collector and the location where the specimen will be stored for later identification. When the data are submitted at the end of the field season, the LTRMP Database Administrator and Fish Component Leader will assign a new fish species code to the observation, and update the LTRMP database and fish data entry application with the new fish species code.

The most common and efficient way to enter fish data is to follow the steps listed below:

1. Click a fish species code button from the left block of gray buttons (it will remain selected).
2. Click a length group button from the right block of gray buttons.
3. Click the Submit New Fish button.

A row of data will be filled out above the buttons with the information selected. If an exact length is taken, do steps 1 and 3, click inside the Length field, and type in the exact length. If a weight (WT) is taken, it must be typed in. The species code remains selected after a fish is submitted, allowing additional individual fish of the same species to be entered using only steps 2 and 3.

An alternative way to enter fish data is to follow the steps listed below:

1. Click the Add New Row button either on top of the column headers or on top of the right block of gray buttons.
2. Click inside the Species field for that row and type in or select a species code from the drop down menu.
3. Click inside the Length field and type in the length or length group value.

The fish count (CNT) defaults to *1* indicating one fish when a row is created. To the right of the fish count column is the "Counter" column containing fish tally buttons with counts of 1, 5, and 10. When multiple fish of a length group are counted, recorders can tally large amounts of fish quickly using this feature. The Submit Count button must be clicked to move the tallied fish into the fish count column. A program error warning will be displayed if you fail to submit these fish. Note: If no fish are caught in a particular collection (electrofishing run, hoop net set, trawl haul, etc.), record a species code of *NFSH* and a Fish Count of *0*.

Other columns include the following:

"TFS" = type of fish length measurement taken. Default is *T* for maximum total length. An *F* indicates fork length, and *S* stands for standard length (full description in Sections 6.2 and 7.2.4).

"GRP" = group width. Default is *1* cm (indicating that 10 mm length groups were used during measurement), but it will default to blank if a weight, and therefore exact length, is added. To record an exact length without entering a weight, the recorder must manually remove the *1* from the GRP field.

"RS" = recording site. Defaults to the value entered when the application was first opened.

"User Defined Fields" and all other *Fish Measurement Screen* data fields are described in detail in Section 7.2.4.

7.2.4 Fish Measurement Screen Field Descriptions

The *Fish Measurement Screen* is used to document fish samples in the field and the laboratory. The layout of the *Fish Measurement Screen* and data recording instructions are described in Section 7.2.3. Detailed descriptions of each field in the *Fish Measurement Screen* follow:

Field name	Description and coding instructions
Barcode	The assigned barcode is displayed in the white field in the upper left corner.
Active Row Number	Displays the number of the row you are currently working in.
Sum Fish	Displays a total count of the fish entered in the record.
Row	Displays the row number.
Species	Four-digit alphabetic field to record LTRMP fish species code identifiers. These fish species codes are cross-referenced to American Fisheries Society accepted common and scientific names in Appendix E.
LENGTH	Four-digit numeric field to record individual length measurements or lower bounds (minima) of length groups. This field is left blank only to designate unmeasured fish; otherwise, it must be completed.
TFS	One-digit alphabetic field to record the system used for length measurement: **T = Default value. 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). For paddlefish, measure from front of the eye to fork.** **S = Standard length; distance from anterior-most extreme of head (jaw closed) to caudal peduncle (posterior margin of hypural bone).** **Note:** Use standard length for fish with damaged caudal fins. Use fork length for fishes such as paddlefish or sturgeons that have rigid caudal fins or variable length caudal filaments.
GRP	A numeric field to record the width of a length group from within which fish were enumerated or bulk weighed. For example, to record counts from fish in the 10 mm length interval from 290 to 299 mm, the lower bound (minima) of the length group is 290 (recorded in the LENGTH field) and the GRP is recorded as a *1* indicating a 1 cm (10 mm) length group. Make this field blank for fish that are unmeasured or individually measured to the nearest 1 mm.
WT	A numeric field to record individual or aggregate weights (in grams).

Field name	Description and coding instructions
RS	A numeric field to record the site at which fish were identified, enumerated, and measured. The recording site field will default to the value entered when opening the program. **1 = Field** **2 = Lab**
CNT	A numeric field to record a total count of fish represented by each row of data. For example, if a particular fish is measured to the nearest 1 mm, then CNT is *1;* if just one fish of a particular length group is encountered during length group enumeration, then CNT is also *1*. However, if 10 fish of a particular length group are encountered during length group enumeration, then CNT is *10*.
Counter	The counter fields are used to quickly tally multiple or large amounts of fish. There are buttons for values of 1, 5, and 10 fish, which will simply tally fish until the Submit Count button is selected, summing the fish and adding the tallied number of fish to the total count recorded in the CNT field.
PC (Pathology Code)	One-digit field to record LTRMP fish health/pathology codes (Table 5) as follows: **0 or blank = No visible abnormality** **1 = Parasite** **2 = Skeletal abnormality** **3 = Tumors** **4 = Injury** **5 = Skin/fin/eye** **6 = Other**
SP (Subproject)	Two-digit field that may be utilized during special projects sampling to record specialized information not routinely collected during standardized monitoring activities. The Special Project principal investigator (PI) can be creative in determining the best use of this field for recording specialized data, but it is the PI's responsibility to generate documentation of specific data field assignments and share them with the LTRMP Fish Component Leader and the LTRMP Database Administrator, to accompany data archival files. **Note:** This field was formerly used for recording information needed to interpret the User Defined fields (Section 6.2.3 in Gutreuter et al. 1995). This field is not currently used for routine LTRMP fish monitoring. It is used only for special projects data recording.
UDFs 1–12	Fields 1–11 may be used during special projects sampling to record specialized information not routinely collected during standardized monitoring activities. The Special Project PI can be creative in determining the best use of the User Defined fields for recording specialized data, but it is the PI's responsibility to generate documentation of these specific data field assignments and share them with the LTRMP Fish Component Leader and the LTRMP Database Administrator, to accompany data archival files. User Defined Field 12 is used to record the trawl haul number (1–4) for LTRMP trawling.

7.3 Data Review (Quality Assurance) and Submission to UMESC

After the completion of time period 3 sampling, all specimens preserved during field season for later identification should be identified, measured, weighed (only required for key species in time period 3), and enumerated in the laboratory. Unidentifiable specimens are sent to an identification expert. When entering preserved fish data into the data entry application, a *2* is entered in the Recording Site (RS) field indicating that fish were recorded in the laboratory.

When all field and laboratory collections from the field season have been entered into the data entry application, a comparison between the completed records in the data entry application and the site allocations should be made to ensure that a record exists for every site that was allocated. If there is no record for a site, a record should be created. A description of the situation that resulted in the site being missed should be entered in the Site Comment field, and the appropriate code should be entered in the Summary Cd field.

Each record should be reviewed to ensure that all required fields of the *Site Information Screen* and associated *Fish Measurement Screen* are completed and correct. In addition to this general review, specific checks of a few particular fields will help reduce errors. For instance, when reviewing the Structures Data fields, ensure that at least one field contains a *1* or that they have all been updated to *0*; if not, select the Update All Structures to NO = (0) button to update them to zero. For alternate site records, confirm that the Site Comment fields of the alternate and primary sites contain references to each other (e.g., TOO SHALLOW TO SAMPLE. ALTERNATE SITE IS F40A; or PRIMARY LOCATION CODE=M8.RS). When reviewing fish records, ensure that the GRP (group width) field is blank if fish were measured to the nearest mm or if a total fish count was entered as part of subsampling.

When all records are reviewed and corrected to the Crew Leader's satisfaction, select the QA Barcode button to run a quality assurance check on each data record. Each time errors are reported, correct them and run the QA Barcode check again. When no errors are reported, select *V* from the drop down menu of the Verified field to show that the record has been completed, reviewed, and verified for export to the LTRMP Database Administrator. When all records have been verified, the Crew Leader selects "Export Data to UMESC" from the main menu, which generates two data export files: one containing site information and the other containing fish information.

Note: When selecting "Export Data to UMESC" you will be asked if you would also like to export special projects data or turtle data, or both. Exporting special projects data generates an additional two files and turtle data generates one file. These data do not undergo the same computer based QA checks as the standard LTRMP data, are housed in separate databases at UMESC, and are not served on the Website but are available upon request.

The Crew Leader emails the data export files to the LTRMP Database Administrator who runs a quality assurance/quality control (QA/QC) computer script on the data and returns an error flag report to the Crew Leader. The Crew Leader finds and corrects the flagged errors in the data entry application and notifies the database administrator of the specific corrections needed. The LTRMP Database Administrator makes the indicated corrections and re-runs the QA/QC computer script on the data. If no error flags are returned, the database administrator promotes the data to the Level 1 Database, making it publicly available from the LTRMP Fisheries page of the UMESC website (see link in Section 7.4).

After the data are verified, corrected, and promoted, two paper copies of the data and two copies of the data sheet log are printed for archiving; one copy of each is archived at the field station, and one copy of each is shipped to the LTRMP Database Administrator. To print paper data records, select "Fish Report Menu" from the main menu of the data entry application. From the list of reports that appear, first select "UMESC LTRMP Fish All Data Sheets," which will produce a report in data sheet format ready for printing. Next, select "Fish Datasheet Log" to produce a printable report (log) listing key tracking information by barcode.

7.4 LTRMP Fish Data Products Provided by the UMESC

Data for more than 5.7 million UMRS fish are housed in the UMESC databases, which are available on the web to researchers, river managers, and the public. These data are available in many different forms, from downloadable raw data to multiple web-based analytical and graphical database browsers that provide immediate access to a suite of population and community fish metrics. The analysis tools available are constantly evolving and advancing with developments in technology and to meet partnership demands. The available products can be found at *http://www.umesc.usgs.gov/data_library/fisheries/fish_page.html* (accessed December 11, 2013). When LTRMP fish random and fixed sampling data are downloaded, the corresponding metadata are delivered as a standalone link. To request special projects data or for specifics regarding database management protocols, database browsers, or data visualization tools, please contact the LTRMP Database Administrator or LTRMP Fish Component Leader (contact information links can be found at the website listed above).

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Appendix A

Basic Equipment for LTRMP Monitoring

This table lists major equipment needed for one field station to sample fish using LTRMP protocols. The list is not comprehensive but should provide a good starting point for outfitting a LTRMP style fish monitoring program.

A few things to note:

1. Vehicles capable of towing boats are not included in the table.
2. Field station capital and labor costs are not included in the table.
3. Vendors listed in this table are merely examples and vendors may change with time. Listing of a vendor in this table does not constitute an endorsement.
4. It is **crucial** to keep some equipment standardized; these items are noted by an *.
5. It is crucial to keep the electrofishing control box standardized. Currently, it is only manufactured by ETS Electrofishing, LLC, of Verona, Wisconsin.
6. The number of electrofishing control boxes and field rugged laptops recommended below includes one for everyday use and one for backup.

Appendix A. Basic Equipment List for Long Term Resource Monitoring Program (LTRMP) Fish Monitoring.

[ft, feet; m, meters; HP, horse power; —, information unavailable]

Description (recommended # of units)	Vendor	Vendor URL
Boats and motors		
Electrofishing boat (aluminum, 18+ ft [5.5 m])	Kann	*www.kannmfg.com/products/marine/*
Electrofishing boat trailer	Kann	*www.kannmfg.com/products/marine/*
Net boat (aluminum, 18+ ft [5.5 m])	Oquawka	*www.oquawkaboats.com/*
or, Net boat (fiberglass, 21 ft [6.4 m])	Carolina Skiff	*www.carolinaskiff.com/*
Net boat trailer	Oquawka	*www.oquawkaboats.com/*
or, Net boat trailer	EZ Loader	*www.ezloader.com/*
70+ HP outboard motors (2)	Evinrude/Bombardier	*www.evinrude.com/*
9.9 HP kicker outboard motors (optional)	Evinrude/Bombardier	*www.evinrude.com/*
Miscellaneous: rope, anchor, lights, batteries, fuel tanks, safety equipment, bilge pump		
Electrofishing components		
* MBS-1D Electrofishing control box (2)	ETS Electrofishing	*www.etselectrofishing.com/*
* Periodic service of control box	ETS Electrofishing	*www.etselectrofishing.com/*
Generator (5,000 watts or more)	Honda	*www.hondapowerequipment.com/*
* Electrofishing boat booms (2)	WS Hampshire	*www.wshampshire.com/index.html*
* Electrofishing dip nets (2)	Duraframe	*www.duraframedipnet.com/*
Tank fill pump	Rule	*www.rule-industries.com/*
Holding tank (approx. 100 gallon [379 liter])	Various suppliers	—
Miscellaneous: safety equipment, gloves, boots, raingear, tank dip net, tank aeration		
Net gear		
* Mini fyke net (8)	Miller Net Company	*www.millernets.com/*
* Large fyke net (8)	Miller Net Company	*www.millernets.com/*
* Small hoop net (8)	Miller Net Company	*www.millernets.com/*
* Large hoop net (8)	Miller Net Company	*www.millernets.com/*
* Trawl nets (2), otter boards and ropes (4)	Netco, LLC	*www.netcollc.com/*
Miscellaneous: rebar/stakes, anchors, rope, floats, bean bait, hoop net drag, twine, shuttle, net preservative		
Data capture and environmental sampling equipment		
Field rugged laptop	Getac	*www.us.getac.com/*
Velocity meter	Marsh McBirney	*www.marsh-mcbirney.com/*
Conductivity/DO/Temperature meter	YSI	*www.ysi.com/*
Secchi disk	Ward	*www.wardsci.com/*
Electronic scale	A&D Weighing	*www.andonline.com/* (SK-WP Series)
GPS/depth sounder (2)	Garmin	*www.garmin.com/us/*
Measuring boards	Various suppliers	—
Miscellaneous and lab		
Stereo microscope	Leica Microsytems	*www.leica-microsystems.com/*
Marine radio/cell phone	Various suppliers	—
Personal floatation devices	Various suppliers	—
Survival suits	Mustang	*www.mustangsurvival.com/*
Lab supplies (bottles, forceps, trays)	Various suppliers	—
Digital camera (for vouchering)	Various suppliers	—

* Crucial component to keep standardized.

Appendix B

Long Term Resource Monitoring Program Electrofishing Information

Appendix B-1. Long Term Resource Monitoring Program (LTRMP) electrofishing power goal chart. Standardized power settings (in watts) for various water temperatures and specific conductivities. Electrofishing at these power settings ensures potential transfer of 3,000 watts from water to fish (Burkhardt and Gutreuter 1995).

[µS/cm, microsiemens per centimeter; and °C, degrees Celsius]

Specific Conductivity (µS/cm)	Temperature (°C)								
	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

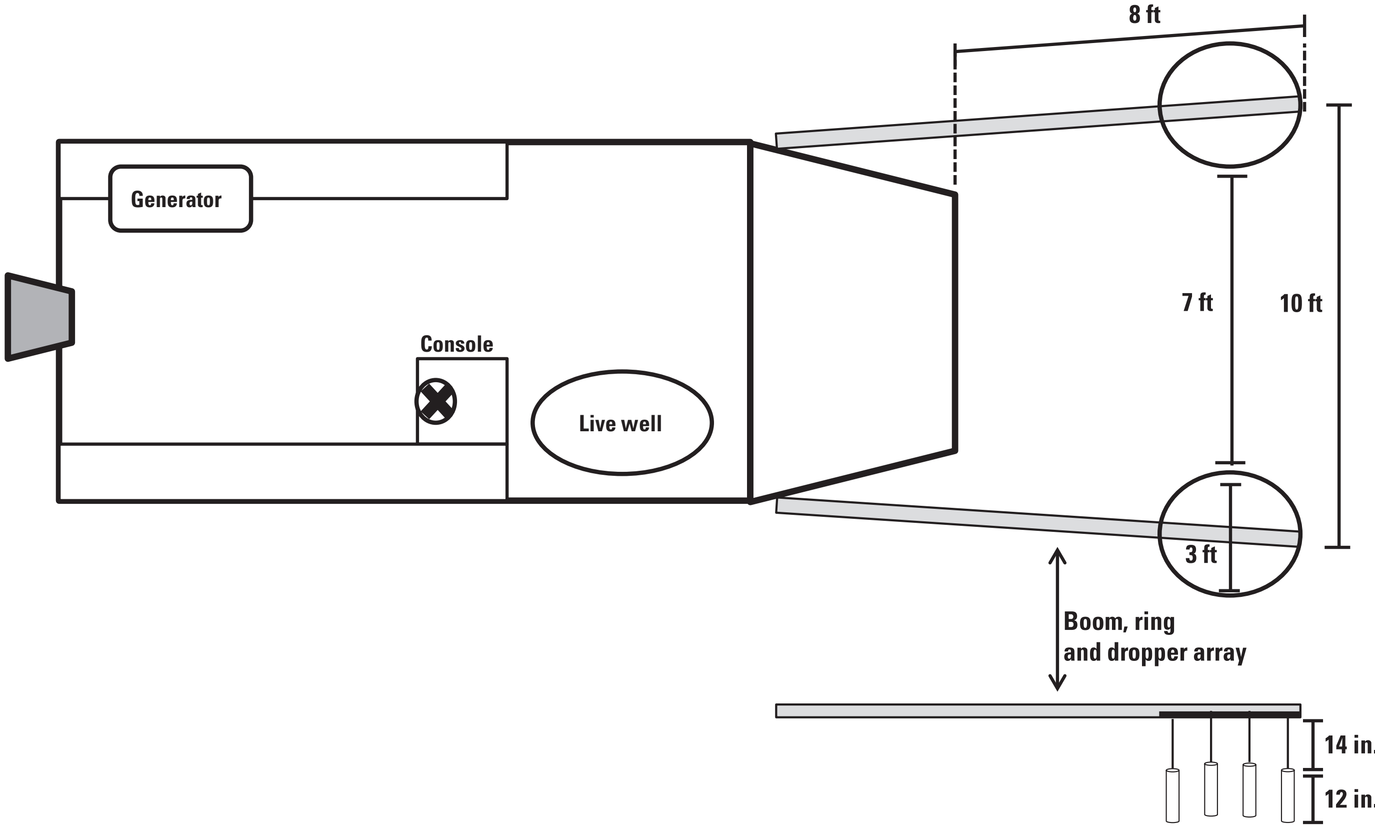
Specific Conductivity (µS/cm)	Temperature (°C)								
	5	10	15	20	25	30	35	40	45
315	3051	3124	3216	3319	3432	3551	3676	3804	3935
325	3064	3145	3243	3353	3471	3596	3726	3860	3996
335	3079	3166	3270	3386	3511	3642	3777	3916	4058
345	3094	3188	3299	3421	3551	3687	3828	3973	4120
355	3110	3211	3328	3456	3592	3734	3880	4030	4182
365	3127	3234	3357	3491	3633	3781	3932	4087	4245
375	3144	3258	3388	3528	3675	3828	3985	4145	4308
385	3162	3283	3419	3564	3717	3876	4038	4204	4372
395	3181	3308	3450	3601	3760	3924	4091	4262	4436
405	3201	3334	3482	3639	3803	3972	4145	4321	4500
415	3221	3360	3514	3677	3846	4021	4199	4380	4564
425	3242	3387	3546	3715	3890	4070	4253	4440	4628
435	3263	3414	3579	3753	3934	4119	4308	4499	4693
445	3284	3442	3613	3792	3978	4168	4362	4559	4758
455	3306	3470	3646	3831	4022	4218	4417	4619	4823
465	3328	3498	3680	3870	4067	4268	4472	4679	4888
475	3351	3527	3714	3910	4112	4318	4527	4740	4954
485	3374	3555	3749	3950	4157	4368	4583	4800	5019
495	3397	3584	3783	3990	4202	4419	4639	4861	5085
505	3421	3614	3818	4030	4248	4469	4694	4922	5151
515	3445	3643	3853	4071	4293	4520	4750	4983	5217
525	3469	3673	3889	4111	4339	4571	4806	5044	5283
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

Appendix B-1. Long Term Resource Monitoring Program (LTRMP) electrofishing power goal chart. Standardized power settings (in watts) for various water temperatures and specific conductivities. Electrofishing at these power settings ensures potential transfer of 3,000 watts from water to fish (Burkhardt and Gutreuter 1995).—Continued

[µS/cm, microsiemens per centimeter; and °C, degrees Celsius]

Specific Conductivity (µS/cm)	Temperature (°C)								
	5	10	15	20	25	30	35	40	45
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
645	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

Specific Conductivity (µS/cm)	Temperature (°C)								
	5	10	15	20	25	30	35	40	45
825	4270	4634	5006	5382	5761	6143	6527	6913	7299
835	4298	4668	5044	5425	5810	6197	6586	6976	7367
845	4326	4701	5083	5469	5858	6250	6644	7039	7435
855	4355	4735	5121	5512	5907	6303	6702	7102	7503
865	4383	4768	5160	5556	5955	6357	6760	7165	7571
875	4412	4802	5198	5599	6004	6410	6819	7228	7639
885	4440	4835	5237	5643	6052	6464	6877	7292	7707
895	4469	4869	5276	5687	6101	6517	6935	7355	7775
905	4498	4903	5314	5730	6149	6571	6994	7418	7843
915	4526	4937	5353	5774	6198	6624	7052	7481	7912
925	4555	4970	5392	5818	6247	6678	7110	7545	7980
935	4584	5004	5431	5862	6295	6731	7169	7608	8048
945	4613	5038	5470	5905	6344	6785	7227	7671	8116
955	4642	5072	5509	5949	6393	6839	7286	7735	8184
965	4670	5106	5548	5993	6442	6892	7344	7798	8253
975	4699	5140	5587	6037	6490	6946	7403	7861	8321
985	4728	5174	5626	6081	6539	7000	7462	7925	8389
995	4758	5208	5665	6125	6588	7053	7520	7988	8457
1005	4787	5242	5704	6169	6637	7107	7579	8052	8526
1015	4816	5276	5743	6213	6686	7161	7637	8115	8594
1025	4845	5311	5782	6257	6735	7215	7696	8179	8662
1035	4874	5345	5821	6301	6784	7268	7755	8242	8731

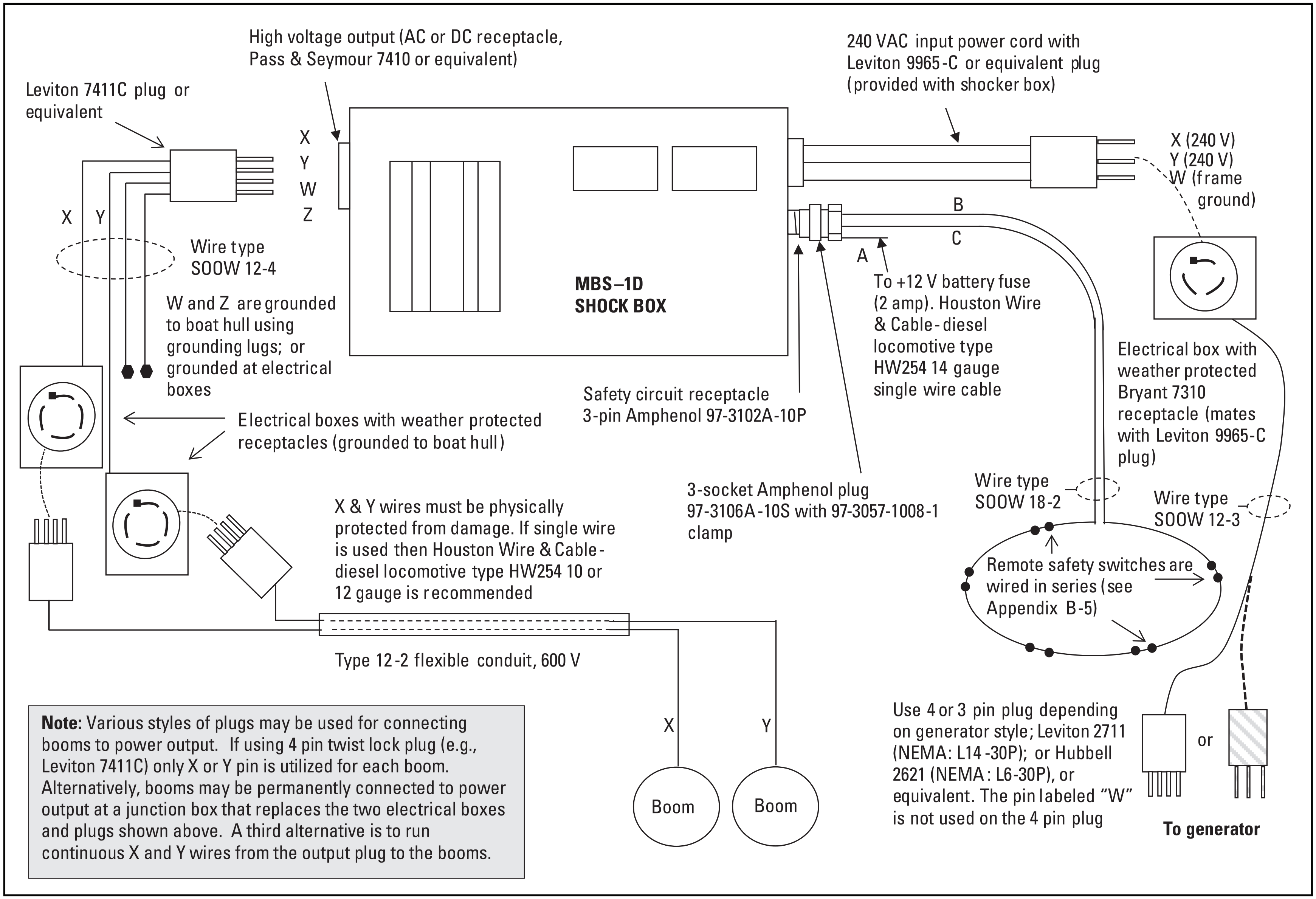


Appendix B-2. Top view of the basic layout of a Long Term Resource Monitoring Program electrofishing boat showing the configuration of the electrofishing booms and anode arrays. Measurements are in feet (ft) and inches (in.). Side view of one boom, ring and dropper array is also shown.

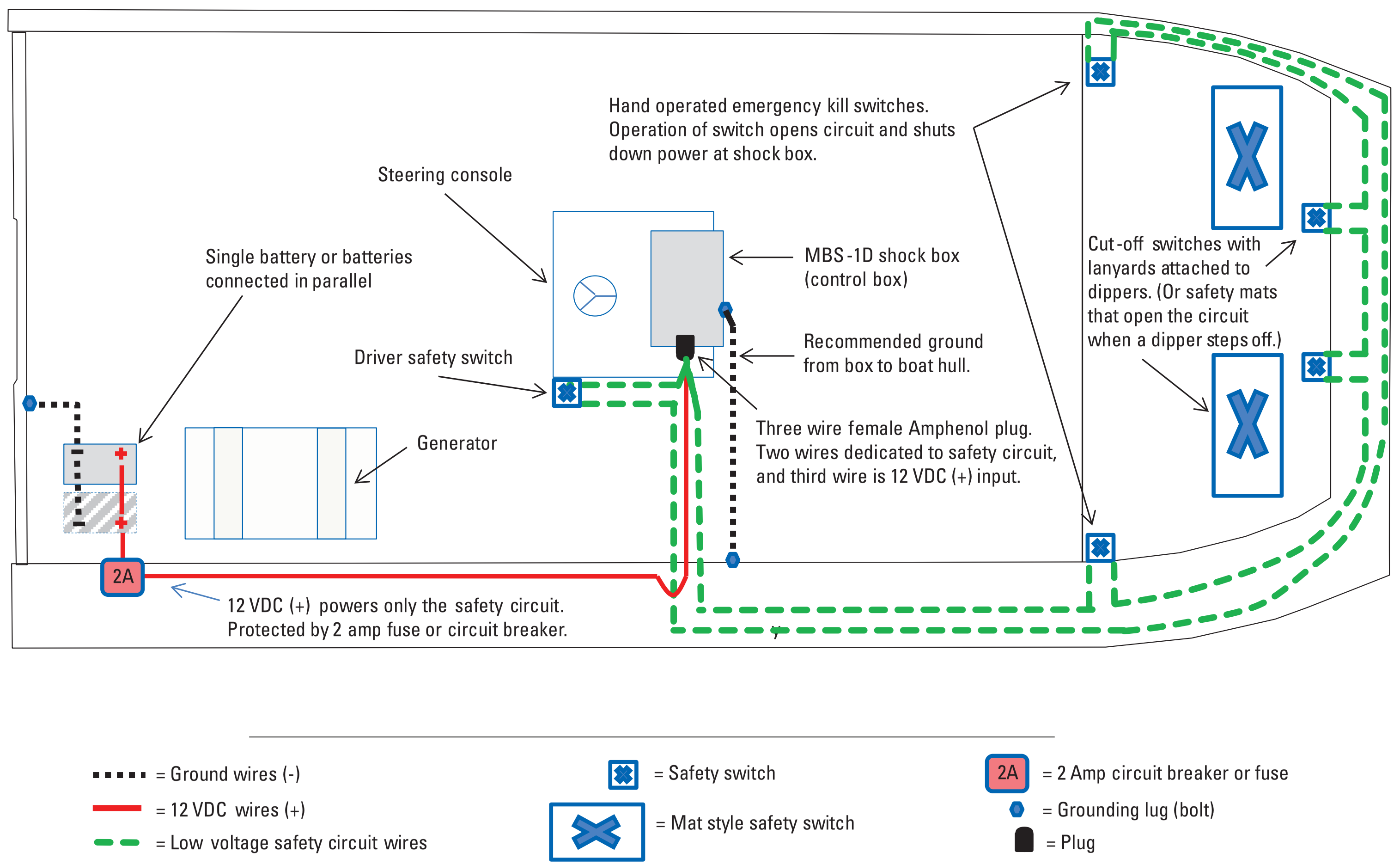
Appendix B-3. List of basic items for wiring a Long Term Resource Monitoring Program electrofishing boat. Because wiring methods may vary from boat to boat, this list may not be sufficient for some boats or may contain unneeded items. SOOW and SEOOW are ratings indicating that cable is 600 volt rated, oil and solvent resistant, and weather resistant.

[ft, feet; in., inches; V, volts; A, amps; —, information unavailable]

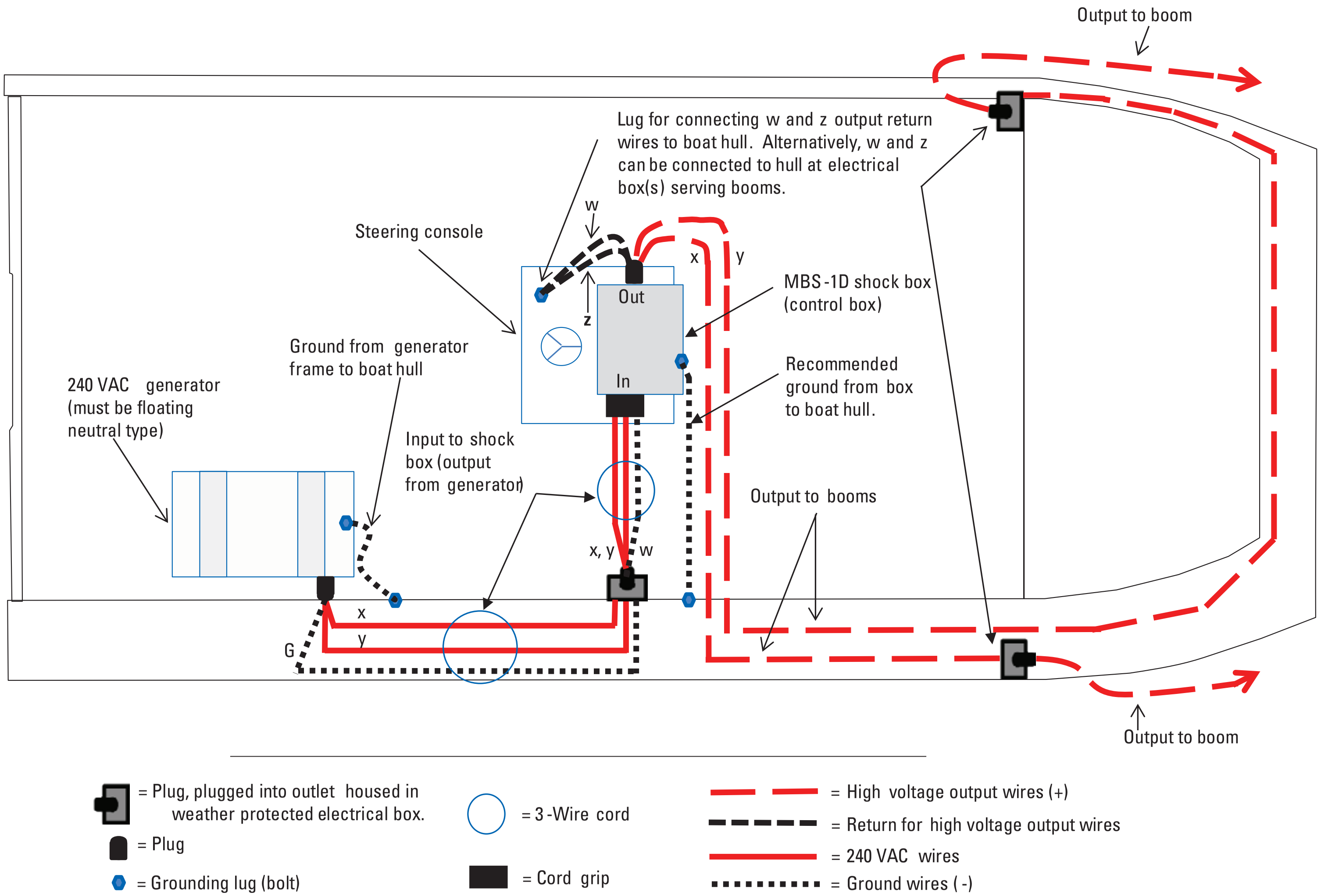
Part description	Vendor	Part number	Quantity	Web site
Rail-mounted emergency stop switch	McMaster	6156K42	2	*mcmaster.com*
TH Marine tethered dip-netter switch (or, Cole Hersee M-597BP)	Wholesale Marine	T-H-KS-1	3	*wholesalemarine.com*
Aluminum single-gang electrical box, 3 inches deep	McMaster	7219K81	2	*mcmaster.com*
Steel electrical box cover plate	McMaster	7219K5	2	*mcmaster.com*
Strain-relief fittings for 1/2 inch multi-conductor cables	McMaster	7529K26	4	*mcmaster.com*
Strain-relief fittings for 3/4 inch multi-conductor cables	McMaster	7529K713	1	*mcmaster.com*
3-prong twist lock generator plug, 250V, 30A	McMaster	7162K53	1	*mcmaster.com*
3-prong twist lock covered receptacle for control box supply, 250V, 20A	Viking Electric	AHD 7310B	1	*vikingelectric.com*
90-degree plug adapter for control box supply plug	Viking Electric	HBL3WAA	1	*vikingelectric.com*
4-prong twist lock plug for control box output, 600V, 30A	Viking Electric	HBL7411C	1	*vikingelectric.com*
3-prong Amphenol plug, 1 inch female	Allied Electronics	97-3106A-16-10S	1	*alliedelec.com*
Strain relief sleeve for Amphenol plug	Allied Electronics	97-3057-1008-1	1	*alliedelec.com*
3-lug, 300V, 20A terminal block for 12V accessories	McMaster	7527K43	2	*mcmaster.com*
2-lug, 600V, 30A terminal block for boom wires	McMaster	5566T31	4	*mcmaster.com*
4-lug, 300V, 20A terminal block for safety circuit	McMaster	7527K44	1	*mcmaster.com*
12 gauge, 3 conductor stranded cable (generator to control box)	McMaster	7080K44	50 ft	*mcmaster.com*
12 gauge, 4 conductor stranded cable (control box output to booms)	McMaster	7080K53	30 ft	*mcmaster.com*
14 gauge, 3 conductor stranded cable (safety circuit)	McMaster	7080K43	50 ft	*mcmaster.com*
14 gauge, single conductor stranded cable (safety circuit)	Houston Wire	HW254-01401	50 ft	*houwire.com*
18 gauge, 2 conductor stranded SOOW/SEOOW cable (safety circuit)	McMaster	—	50 ft	*mcmaster.com*
Multiconductor cable connector, 1/2 inch, to clamp cable at gang box entry	McMaster	7798K41	2	*mcmaster.com*
Insulated raintight compression conduit connector, 1/2 inch	McMaster	1841T21	4	*mcmaster.com*
12 gauge tinned, stranded wire, black (for wiring accessories)	McMaster	7587K212	100 ft	*mcmaster.com*
12 gauge tinned, stranded wire, red (for wiring accessories)	McMaster	7587K226	100 ft	*mcmaster.com*
14 gauge tinned, stranded wire, black (for wiring accessories)	McMaster	7587K971	100 ft	*mcmaster.com*
14 gauge tinned, stranded wire, red (for wiring accessories)	McMaster	7587K972	100 ft	*mcmaster.com*
14 gauge tinned, stranded wire, blue (for wiring accessories)	McMaster	7587K98	100 ft	*mcmaster.com*
3/8 inch blue wire loom	McMaster	7700K181	100 ft	*mcmaster.com*
3/8 inch black wire loom	McMaster	7840K22	100 ft	*mcmaster.com*
Outlet box for boom wire terminal block	McMaster	71695K12	1	*mcmaster.com*
Box cover for boom wire terminal block	McMaster	71695K43	1	*mcmaster.com*
90 degree twist lock plug for control box output	McMaster	2351K29	1	*mcmaster.com*



Appendix B-4. Model MBS-1D shock box (control box) and associated wiring configuration used in Long Term Resource Monitoring Program electrofishing boats. SOOW is a rating indicating that cable is 600 volt (V) rated, oil and solvent resistant, and weather resistant; AC = alternating current; and DC = direct current.



Appendix B-5. Generalized Long Term Resource Monitoring Program electrofishing boat low voltage safety circuit. Safety switches are wired in series, completing a single circuit connected to the control box through an Amphenol military style plug. All switches remain in the closed position until a crew member activates a switch manually, steps off of a safety mat, or puts enough tension on a lanyard to activate and open the safety switch. Any open switch shuts down power at the control box. VDC = volts direct current. For clarity, the electrofishing 240 volts alternating current input and high voltage output circuits are detailed separately in Appendix B-6.



Appendix B-6. Generalized diagram of the Long Term Resource Monitoring Program electrofishing control box 240 volts alternating current (VAC) input and high voltage output circuits. Wiring labels x, y, w, z , and G correspond to terminal identification labels used by plug and outlet manufacturers. For clarity, the electrofishing low voltage safety circuit is detailed separately in Appendix B-5.

Appendix B-7. Continuity Test of Anodes

This procedure should be used for testing continuity of Long Term Resource Monitoring Program electrofishing boat anodes. Testing must be performed before each sampling time period, and when a problem is suspected or system modifications have been made. A digital multimeter capable of measuring resistance within a tenth (0.1) of an ohm (Ω) is used for this test.

1. This test is performed with the generator and control box turned off, and is easiest to perform with the boat out of the water.
2. This test may be performed with the booms extended or folded back, but the anode arrays (rings and droppers) must not be touching the boat. If the multimeter probe wires are too short for this test with booms extended, it may help to fold the booms back.
3. Unplug the high voltage anode input plug from the control box high voltage output receptacle.
4. Identify the X and Y pins of this plug using the Leviton 7411C plug diagram in Appendix B-10.
5. Set multimeter to the lowest resistance range, or use automatic range (ohms or Ω).
6. Touch multimeter probe tips together to get a baseline reading (typically 0 to a few tenths of an ohm). Or if the meter allows, “zero” the meter with probe tips touching.
7. Touch/connect one multimeter probe to the X or Y pin of the anode input plug, and the other probe to one of the droppers of the corresponding (X or Y) anode. Be sure to “dig in” the probe tips to get past any surface corrosion that could inflate the readings. Also, make sure that the rings and droppers are not touching the boat. Repeat this test for each dropper and for both the X and Y pins.
8. Subtract the baseline reading (obtained in step 6) from each measurement to determine the total resistance of the anode circuit. To receive a “full pass” on this continuity test, circuit resistance must be less than 2 ohms. Resistance readings less than 2 ohms have no measurable effect on the emanating aqueous electrical field, but should still be rectified when possible because sources of resistance (e.g., corroded or loose connections) tend to get worse with time. Resistance readings above 2 ohms require immediate attention as this may impair and affect the effective fishing field and fishing power.
9. Resistance can often be traced to corrosion in the dropper wires or weak connections with the stainless steel ring. If it was not performed immediately before the continuity test, routine maintenance (e.g., wire brushing or replacing components; tightening connections) should certainly be performed before further testing to find the sources of resistance.
10. To locate sources of resistance in the circuitry, repeat the steps for testing continuity of the anode circuit (steps 5–8), but instead of testing the total anode circuit as outlined, methodically test each component and connection within the anode circuit. For example, one probe is touched (dug in to make good contact) to a dropper and the other to its attached cable to test the resistance of the connection between the two components. Remember that resistance is additive, so several slightly elevated readings below 2 ohms may add up to a reading greater than 2 ohms for the anode circuit. As sources of unacceptable resistance are identified, components should be cleaned, tightened, or replaced

Appendix B-8. Generator Output Test

This procedure should be used for testing Long Term Resource Monitoring Program electrofishing boat generator output. A multimeter capable of measuring 250 volts alternating current (VAC) or higher is used for this test.

This test must be performed:

a. before each sampling time period.

b. before putting a replacement generator into service.

c. after any generator repairs or system modifications.

d. whenever a problem is suspected.

1. Unplug the 240 VAC plug from the 240 VAC output receptacle of the generator.
2. Identify the X and Y sockets of the generator output receptacle. Receptacle styles vary by manufacturer, but two commonly used receptacles are the Leviton 2620 and 2710 diagrammed in Appendix B-10. Terminal diagrams are often given on receptacle manufacturer websites.
3. **Use extreme caution: you are about to measure high voltage. Do not perform this test with wet hands or while standing in water.** Start the generator. This test is performed with the generator running.
4. Set the multimeter to the 250 VAC or higher range, or use the automatic range setting.
5. While being extremely careful to only handle the insulated part of the multimeter probes, insert the metal tip of one probe into the X socket and the other into the Y socket of the generator output receptacle. It may be necessary to move the probe tips within the sockets to ensure good contact with the internal metal contacts of the receptacle.
6. The multimeter should read between 220 VAC and 250 VAC. A larger variation should be investigated.

Appendix B-9. Generator Floating Neutral Test

This procedure can be used to test Long Term Resource Monitoring Program (LTRMP) electrofishing boat generators for floating (isolated) neutral. When installing a new generator in an LTRMP electrofishing boat, crews must verify that the generator windings are isolated from the generator frame.

> **Note:** There are two types of generators: those with isolated windings, usually called "isolated neutral" or "floating neutral" generators; and those with frame grounded windings, usually called "grounded neutral" generators. **Generators that have frame-grounded windings will damage the MBS-1D control box.**

1. The best way to verify that the generator windings are isolated from the generator frame is to contact the manufacturer. If this is not possible, a multimeter capable of measuring resistance can be used for this test providing the generator's 240 volts alternating current (VAC) receptacle has a neutral socket.*
2. This test is performed with generator turned **OFF**.
3. Unplug all plugs from the generator's output receptacle(s).
4. Identify the neutral and ground sockets of the 240 VAC generator output receptacle (for example see Leviton 2710 receptacle diagram in Appendix B-10, or refer to the receptacle manufacturer's website). Note that recep-

tacle styles vary by manufacturer, but typically the “L” shaped socket is the “ground” socket which is purposely attached to the frame of the generator. Note also that typically the “hot” sockets are opposite each other and look identical to each other. The neutral socket typically will be opposite the ground socket.*

5. Set multimeter to measure resistance in ohms (Ω). The highest resistance range such as mega-ohms (M Ω) or at least kilo-ohms (K Ω) should be selected (or use “automatic range”). Touch the probe tips together to get a baseline reading. Baseline resistance readings are typically 0 to a few ohms. The reading must indicate infinite ohms (open circuit) when probes are separated.

6. Before proceeding, it is a good idea to follow this step to make sure it is possible for your multimeter probes to make good electrical contact with both the receptacle contacts and the generator frame. Insert one probe tip into the ground socket of the generator output receptacle. Touch the other probe tip to bare metal on the generator frame (the heads of screws are often good contact points). If the probes are making good contact, the resistance reading will be 0 to a few ohms, and you are ready to proceed to the next step. If the readings are higher than a few ohms continue to move the probe around within the socket and scratch through any surface film on the metal of the generator frame with the other probe until they make sufficient contact to achieve a resistance reading of 0 to a few ohms.

7. **Do NOT use the ground socket in this step.** Insert one probe tip into the neutral socket of the generator output receptacle. Touch the other probe tip to bare metal on the generator frame. The meter must read infinite ohms if the generator windings are isolated from the generator frame (floating-neutral). **NOTE: It is important to move the probe around within the socket and scratch through any surface film on the bare metal with the other probe to ensure that the probe tips are making good contact; otherwise, an infinite ohm reading could be due to poor contact rather than due to an isolated-neutral generator!**

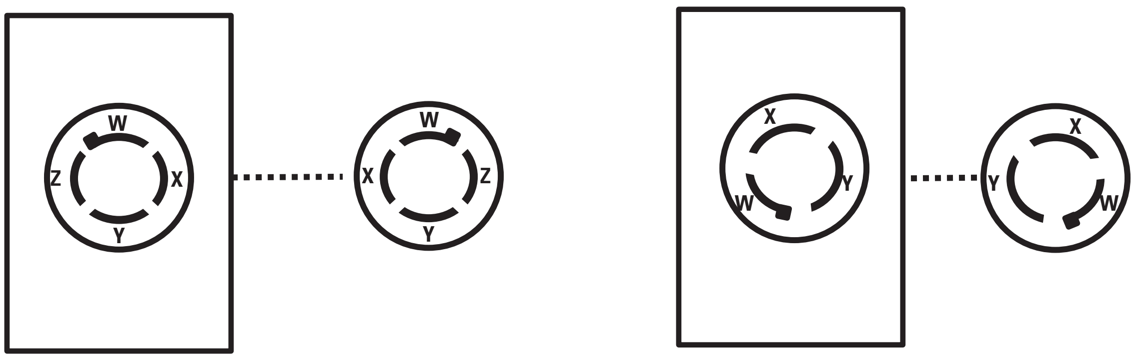
8. Any meter reading less than infinite ohms indicates that the generator windings are not isolated from the generator frame (not a floating neutral). If the neutral is not floating, consult with the manufacturer or a qualified electrician to see if it is possible to remove the connection between the neutral generator windings and the generator frame.

9. **BE SURE TO RETEST FOR ISOLATION AFTER ANY MODIFICATION HAS BEEN MADE TO THE GENERATOR.**

WARNING: Shock Hazard! If a generator has been modified for electrofishing purposes by isolating the neutral, it should be returned to its original configuration before being repurposed for anything other than electrofishing.

*** If your generator does not have a neutral socket in the 240 VAC output receptacle, you will have to either contact the manufacturer to verify winding isolation, or have a technician familiar with generator isolation testing techniques perform a “live test” of the generator’s output by measuring alternating current (AC) voltage across a load between each of the generator’s “hot” sockets, in turn, and the frame of the generator. If more than a few volts are measured, the windings of the generator are NOT isolated from the frame.**

Appendix B-10. Terminal configurations and labels for connectors used in Long Term Resource Monitoring Program electrofishing boats.

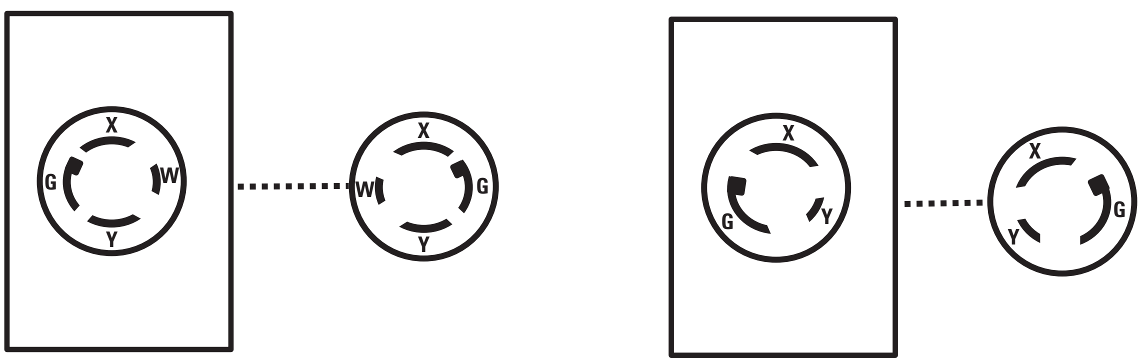


Pass & Seymour 7410 receptacle

Leviton 7411C plug

Bryant 7310 receptacle

Leviton 9965 plug

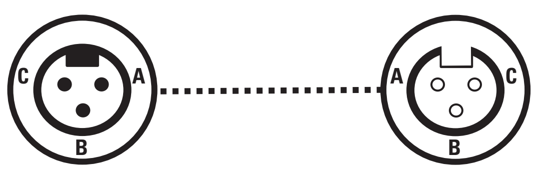


Leviton 2710 receptacle (NEMA L14-30R)

Leviton 2711 plug (NEMA L14-30P)

Leviton 2620 receptacle (NEMA L6-30R)

Hubbell 2621 plug (NEMA L6-30P)



3-pin Amphenol receptacle 97-3102A-10P

3-socket Amphenol plug 97-3106A-10S

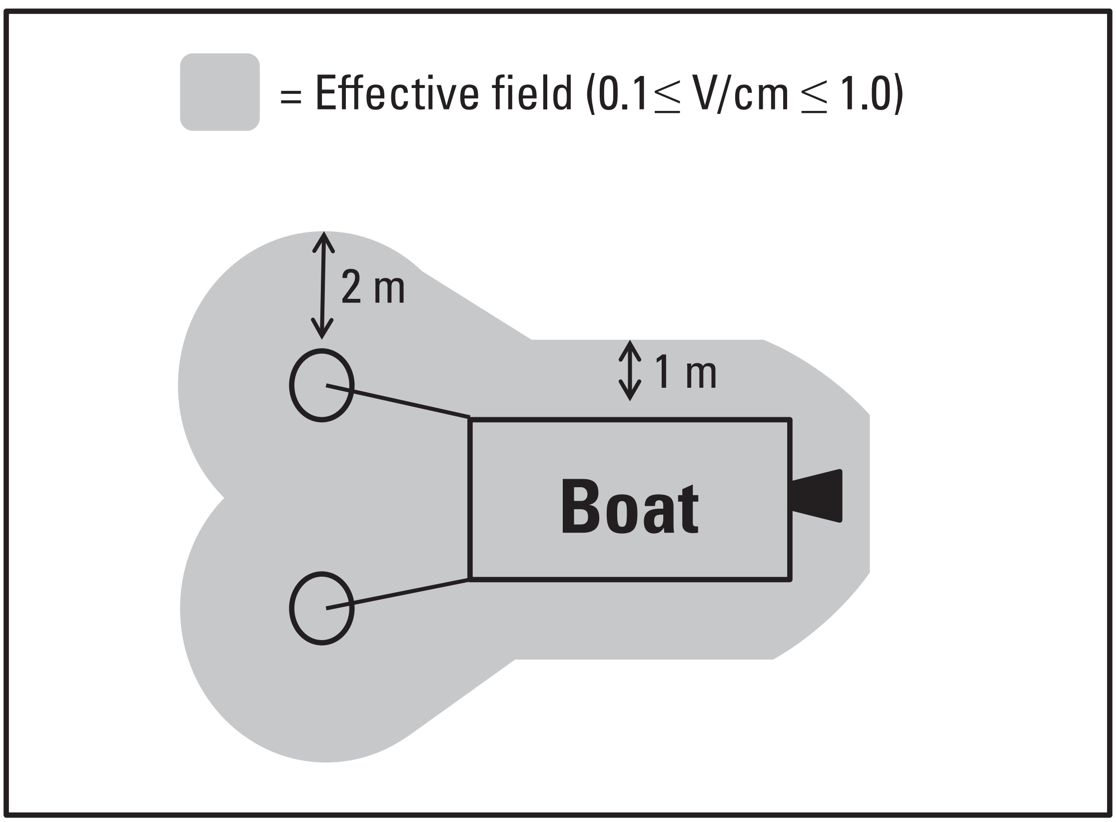
Appendix B-11. Mapping Electrical Fields Surrounding Long Term Resource Monitoring Program (LTRMP) Electrofishing Boats

To ensure standardization, the electrical field emanating from an LTRMP electrofishing boat should be mapped if a new electrofishing boat is assembled, any major electromechanical component of the system is modified or replaced, or if a problem is suspected but cannot be otherwise confirmed.

The effective voltage gradient for capture of fish ranges from 0.1 to 1.0 V/cm (volts/centimeter [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 along 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 the figure below.

This figure shows the approximate shape of the effective ($0.1 \leq$ V/cm ≤ 1.0) electrical field around a Long Term Resource Monitoring Program electrofishing boat operating at the 3,000 watt power goal. Shaded area is the effective field, measured in meters (m).



Appendix C

Long Term Resource Monitoring Program (LTRMP) Net Specifications

Standardization of sampling effort, methods, and gear is critical to allow for comparisons of data through time and among field stations. It is important that LTRMP Fish Crew Leaders ensure that each net meets the specifications described in this section. New nets should be measured and compared to LTRMP net specifications. Net maintenance and repair are critical to ensure that net dimensions and effectiveness do not change. Specifications for LTRMP sampling gear can be found in Appendixes B and C. Refer to Section 5 for additional details about LTRMP gear and sampling protocols.

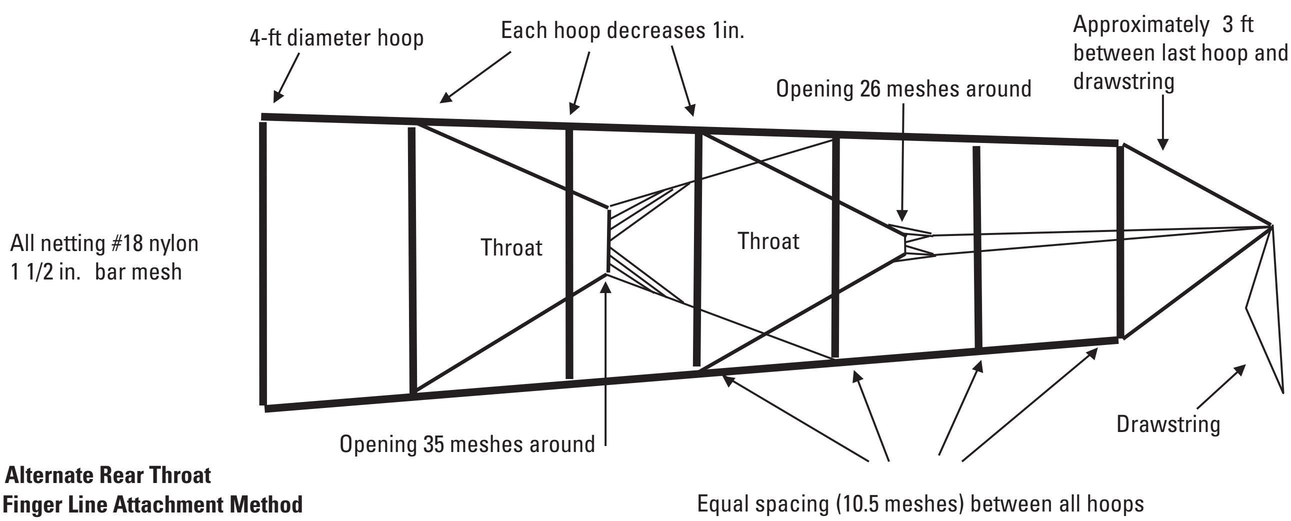
Appendix C-1. Long Term Resource Monitoring Program (LTRMP) large hoop net specifications.

Measurement unit abbreviations are: m = meters; cm = centimeters; ft = feet, and in. = inches.

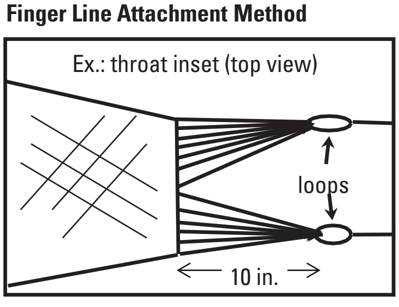
- 16 ft long (4.8 m).
- 7 fiberglass hoops.
- First hoop is 4 ft diameter (1.2 m).
- All remaining six hoops decrease 1 inch (2.5 cm) in diameter successively to rear; hoops are equally spaced, with 10.5 meshes between each hoop.
- #18 nylon netting, 1 1/2 in. bar mesh (3.7 cm), protected with a black asphalt type coating.
- Two finger-style throats are attached to second and fourth hoops. Throat dimensions are 35 meshes around (at rear) x 15.5 meshes long for the front throat, and 26 meshes around (at rear) x 13.5 meshes long for the rear throat. Throats are hand tapered, with crowfoot-style finger lines, attached to each mesh and to two tension strings per throat; tension strings from the front throat are attached to the fifth hoop, and from the rear throat to the cod-end drawstring. An alternate throat finger line attachment method is to run paired finger lines from corresponding top and bottom meshes through loops at the ends of two tension strings to the regular attachment points. All finger lines are made of #18 black nylon twine, and tension strings are made of #72 black nylon twine (see inset below).
- 8 ft long (2.4 m), 1/4 in. (0.6 cm) braided nylon drawstring at rear coated with asphalt type coating.

Schematic of LTRMP large hoop net

Top View



Alternate Rear Throat Finger Line Attachment Method



Example: There are 13 finger lines on the rear throat. Each line picks up a mesh on the top and on the bottom of the throat. Six lines on the right side of the throat pick up 12 meshes, and 7 lines on the left side pick up 14 meshes. Each line runs from a mesh on the bottom of the throat, through one of the tension string loops, and then back to a mesh on top.

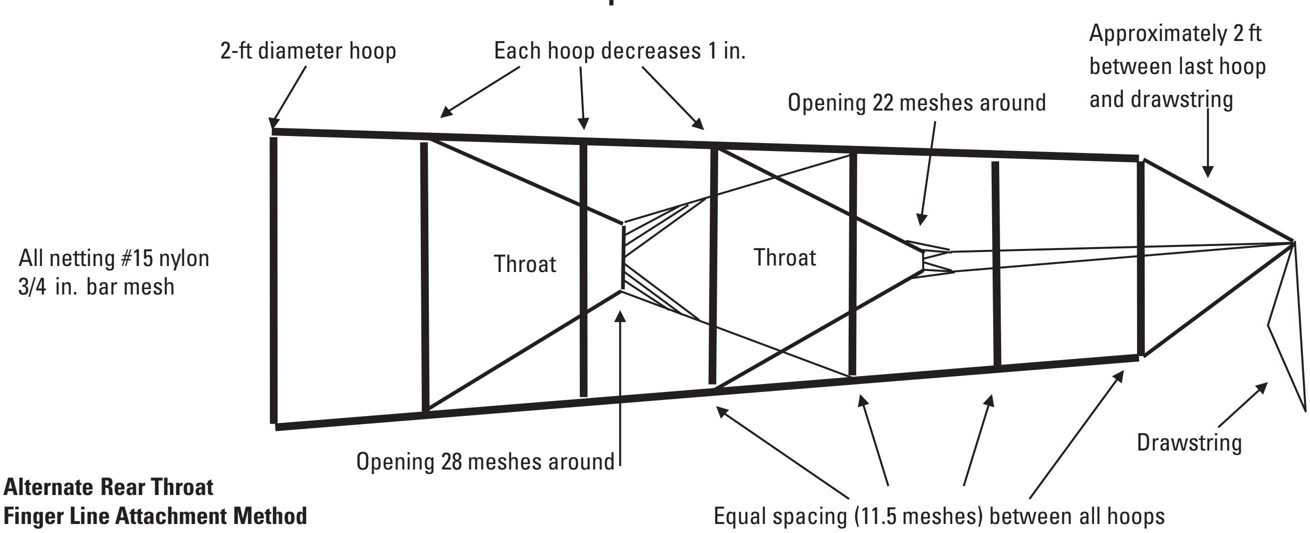
Appendix C-2. Long Term Resource Monitoring Program (LTRMP) small hoop net specifications.

Measurement unit abbreviations are: m = meters; cm = centimeters; ft = feet, and in. = inches.

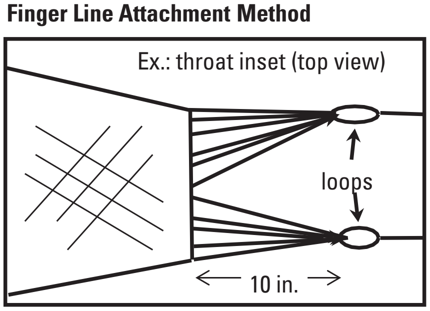
- 10 ft long (3 m).
- 7 fiberglass hoops.
- First hoop is 2 ft diameter (0.6 m).
- All remaining six hoops decrease 1 inch (2.5 cm) in diameter successively to rear; hoops are equally spaced, with 11.5 meshes between each hoop.
- #15 nylon netting, 3/4 in. bar mesh (1.8 cm), protected with a black asphalt type coating.
- Two finger-style throats are attached to second and fourth hoops. Throat dimensions are 28 meshes around (at rear) x 14 meshes long for the front throat, and 22 meshes around (at rear) x 12.5 meshes long for the rear throat. Throats are hand tapered, with crowfoot-style finger lines, attached to each mesh and to two tension strings per throat; tension strings from the front throat are attached to the fifth hoop, and from the rear throat to the cod-end drawstring. An alternate throat finger line attachment method is to run paired finger lines from corresponding top and bottom meshes through loops at the end of two tension strings to the regular attachment points (see inset below). All finger lines are made of #15 black nylon twine, and tension strings are made of #72 black nylon twine.
- 6 ft long (1.8 m), 1/4 in. (0.6 cm) braided nylon drawstring at rear, coated with asphalt type coating.

Schematic of LTRMP small hoop net

Top View



Alternate Rear Throat Finger Line Attachment Method

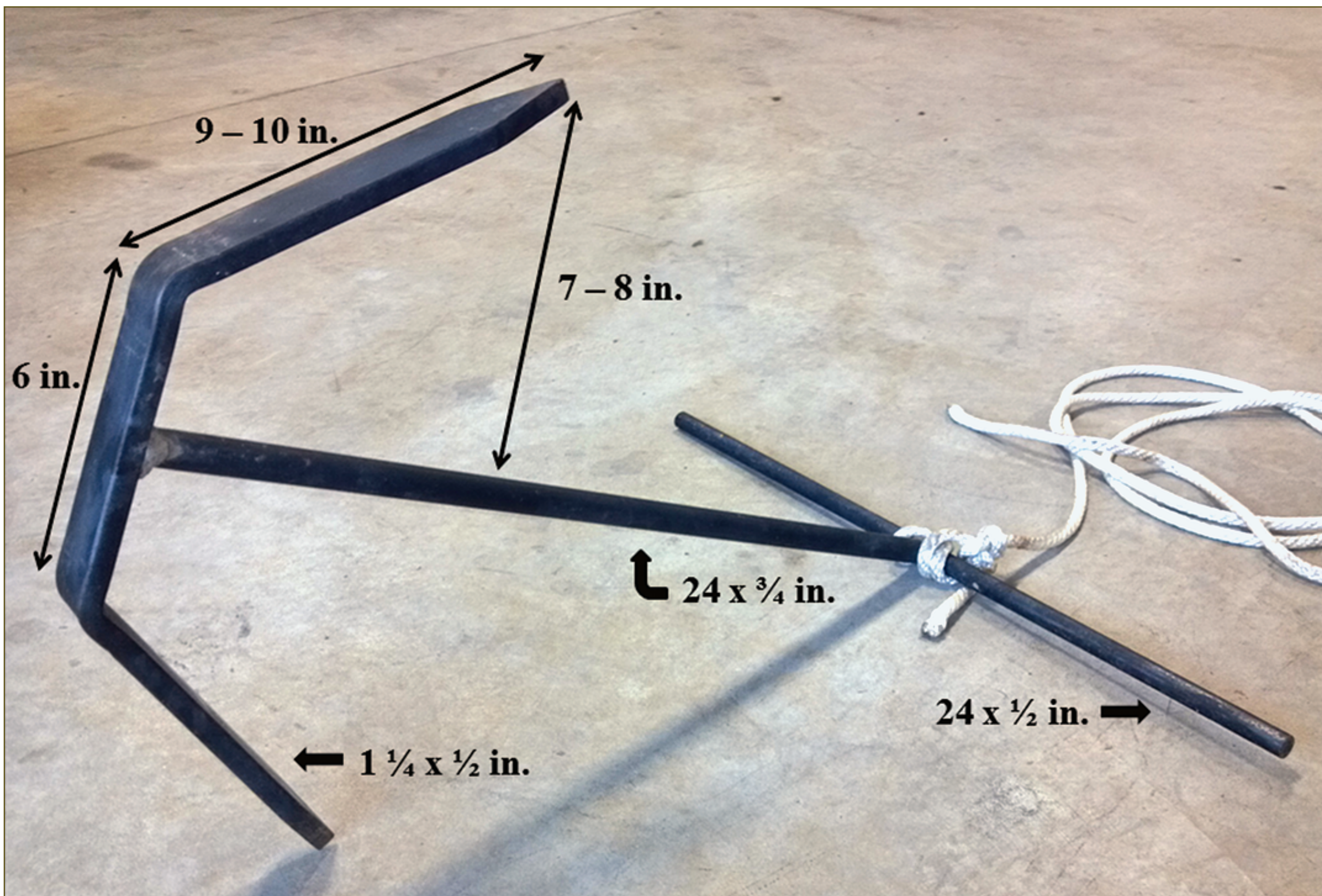


Example: There are 11 finger lines on the rear throat. Each line picks up a mesh on the top and on the bottom of the throat. Five lines on the right side of the throat pick up 10 meshes, and 6 lines on the left side pick up 12 meshes. Each line runs from a mesh on the bottom of the throat, through one of the tension string loops, and then back to a mesh on top.

Appendix C-3. Recommended Long Term Resource Monitoring Program (LTRMP) hoop net anchor specifications.

Measurement unit abbreviations are: cm = centimeters; mm = millimeters; and in. = inches.

- The main shaft is a 24 in. (61 cm) long x 3/4 in. (19 mm) diameter steel rod.
- The cross bar is a 24 in. (61 cm) long x 1/2 in. (13 mm) diameter steel rod.
- The anchor blade is a steel bar approximately 24 in. (61 cm) long x 1 1/4 in. (32 mm) wide x 1/2 in. (13 mm) thick.
- The anchor blade should be bent leaving approximately 6 in. (15 cm) flat at the base of the anchor, resulting in 9 in. (23 cm) long tines, bent to within approximately 7 in. (18 cm) of the main shaft.
- Anchor tine tips should be cut to an angle, leaving the tips sharp enough to dig into a hard clay bottom.



Photograph showing dimensions of recommended LTRMP hoop net anchor

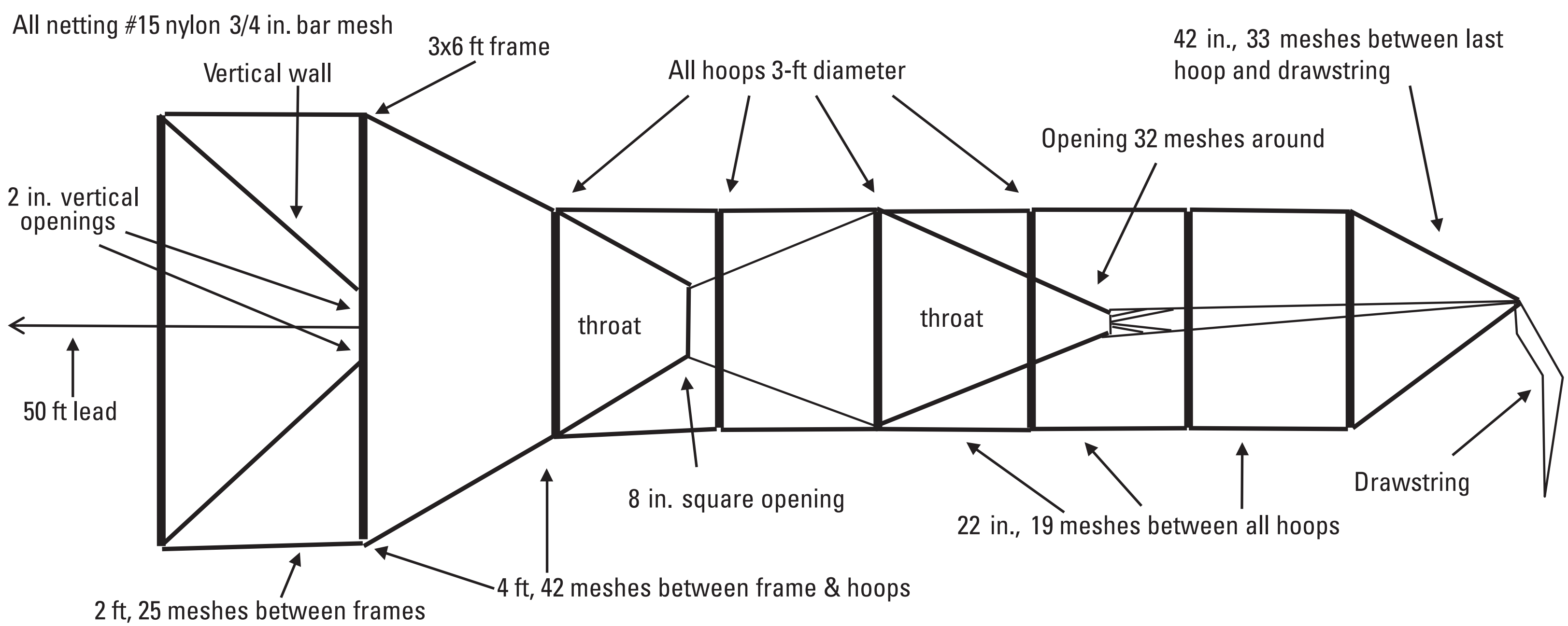
Appendix C-4. Long Term Resource Monitoring Program (LTRMP) fyke net specifications.

Measurement unit abbreviations are: m = meters; cm = centimeters; ft = feet; in. = inches; oz = ounces; and g = grams.

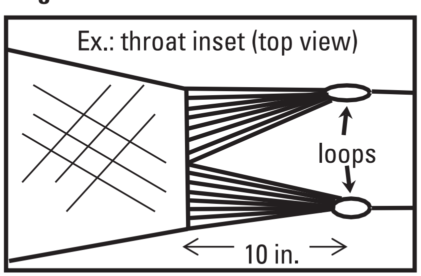
- Lead is 50 ft long x 4 1/2 ft high (15.2 m x 1.4 m), with floats every 36 in. (91.4 cm) along the float line, and lead weights every 12 in. (30.5 cm) along the lead line.
- Weights are 1 1/2 in. (3.8 cm) long, and weigh approximately 1 oz (28.3 g).
- Floats are 1 5/8 in. x 4 3/8 in. (4.1 cm x 11.1 cm) black hard foam (3 oz [85 g] buoyancy).
- Frame is constructed of 2 rectangles 3 ft x 6 ft (0.9 m x 1.8 m) made of 5/16 in. (0.8 cm) black oil temper spring steel, with center vertical crossbar in each frame.
- Cab is made of six 5/16 in. spring steel hoops, 3 ft (0.9 m) diameter.
- Cab and frame together are approximately 20 ft (6 m) long. There are 25 meshes between frame rectangles; 42 meshes between the rear rectangle and the first hoop; 19 meshes between all hoops; and 33 meshes between last hoop and draw string.
- All netting is 3/4 in. (1.8 cm) bar mesh, #15 nylon, coated with black asphalt type coating.
- Lead continues into net to rear of frame. Inner wings (wall throats) of frame extend from outer corners of front rectangle to middle of rear rectangle, with a 2 in. (5.1 cm) vertical gap between wings and lead at middle of rear rectangle on either side of lead.
- Front throat begins at the first hoop and is square style, 20 meshes long, and knitted to 40 meshes around (10 per side) at rear; attached to the third hoop with 4 tension strings.
- Rear throat begins at the third hoop and is crowfoot style, 28 meshes long, and knitted to 32 meshes around at rear with 2 tension strings attached to cod end drawstring. An alternate rear throat finger line design is to run paired finger lines from corresponding top and bottom meshes through loops at end of two tension strings to cod end drawstring (see inset below). All finger lines are made of #15 black nylon twine, and tension strings are made of #72 black nylon twine.
- 8 ft long (2.4 m), 1/4 in. (0.6 cm) braided nylon drawstring at rear, coated with asphalt type coating.
- Optional: Lower corners of both rectangular frames covered with 1/2 in. (1.2 cm) diameter plastic tubing, slit lengthwise and lashed to frame to protect corners from abrasion, extending 12 in. (30.5 cm) across the bottom, and 12 in. up the side from each corner.

Schematic of LTRMP fyke net

Top View



Alternate Rear Throat
Finger Line Attachment Method



Example: There are 16 finger lines on the rear throat. Each line picks up a mesh on the top and on the bottom of the throat. Eight lines on the right side of the throat pick up 16 meshes, and 8 lines on the left side pick up 16 meshes. Each line runs from a mesh on the bottom of the throat, through one of the tension string loops, and then back to a mesh on top.

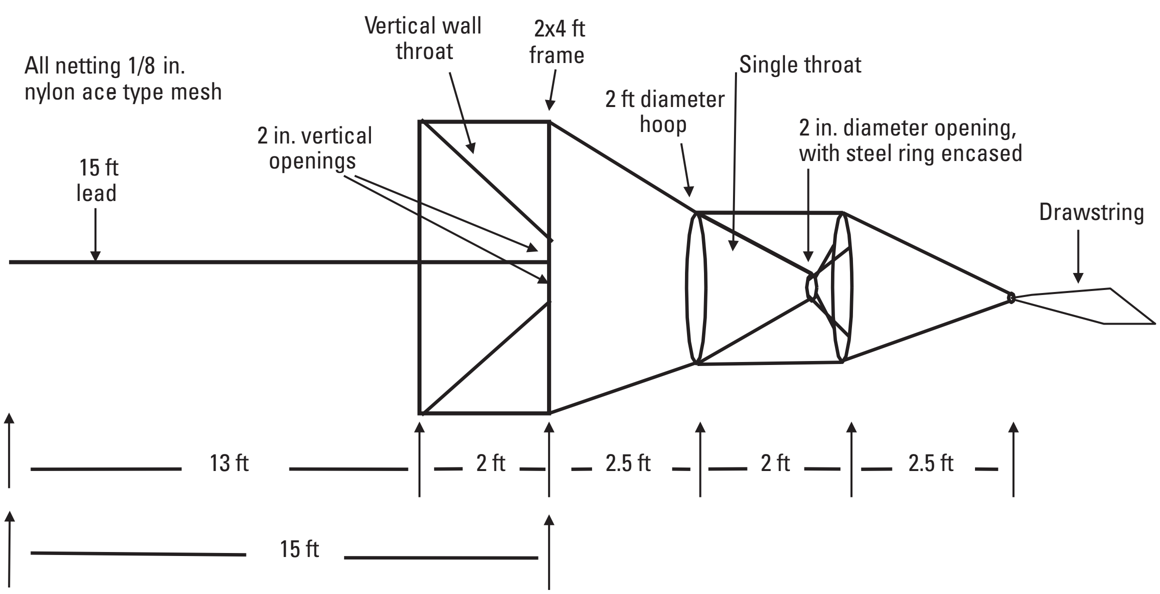
Appendix C-5. Long Term Resource Monitoring Program (LTRMP) mini fyke net specifications.

Measurement unit abbreviations are: m = meters; cm = centimeters; mm = millimeters; ft = feet; in. = inches; oz = ounces; and g = grams.

- Lead is 15 ft long x 2 ft high (4.6 m x 0.6 m), with floats every 36 in. (91.4 cm) along the float line, and lead weights every 18 in. (45.7 cm) along the lead line.
- Weights are 1 1/2 in. (3.8 cm) long, and weigh approximately 1 oz (28.3 g).
- Floats are 2 in. diameter x 1 1/2 in. (5.1 cm x 3.8 cm) thick hard foam (2 oz [56.7 g] buoyancy).
- Frame is constructed of 2 rectangles 2 ft x 4 ft (0.6 m x 1.2 m) made of 5/16 in. (0.8 cm) black oil temper spring steel, with center vertical crossbar in each frame.
- Cab is made of two 5/16 in. (0.8 cm) spring steel hoops, 2 ft (0.6 m) diameter.
- Cab and frame together are 9 ft (2.7 m) long.
- All netting is 1/8 in. (3 mm) ace type nylon netting, coated with green latex type dip.
- Lead continues into net to rear of frame and is sewn to vertical crossbar. Inner wings (vertical wall throats) of frame extend from outer corners of front rectangle to middle of rear rectangle, with a 2 in. (5.1 cm) vertical gap between wings and lead at middle of rear rectangle on either side of lead.
- Single throat from the first hoop back, tapered to a 2 in. (5 cm) diameter hole at rear, with a 2 in. inner diameter x 1/4 in. thick (51 x 6.4 mm) stainless steel or nickel plated ring sewn in, and 4 tension strings tied to rear hoop.
- 6 ft long (1.8 m), 3/16 in. (0.5 cm) braided nylon drawstring at rear enclosed in a sewn casing, coated with green latex type dip.
- Optional: Lower corners of both rectangular frames covered with 1/2 in. diameter plastic tubing, slit lengthwise and lashed to frame to protect corners from abrasion, extending 12 in. across the bottom, and 12 in. up the side from each corner.

Schematic of LTRMP mini fyke net

Top View

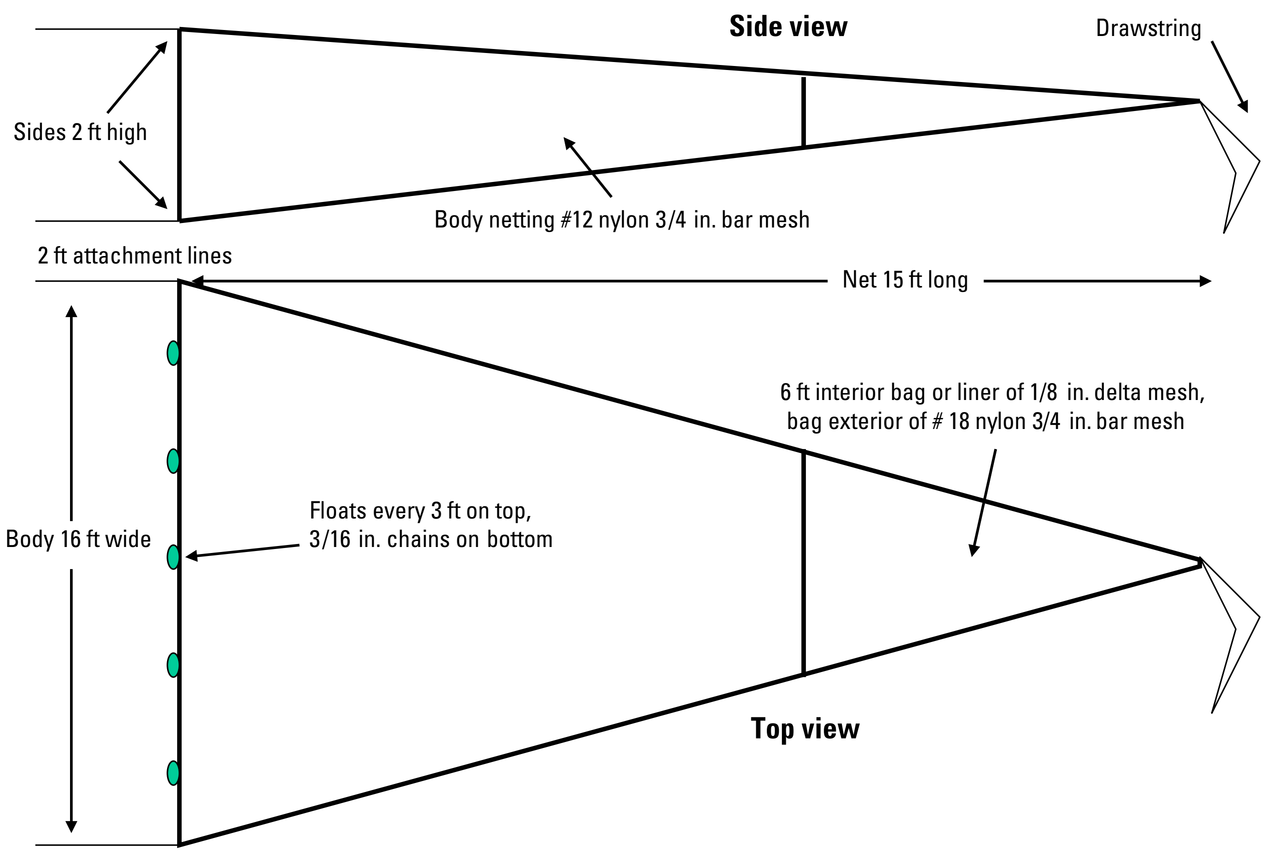


Appendix C-6. Long Term Resource Monitoring Program (LTRMP) slingshot balloon trawl specifications.

Measurement unit abbreviations are: m = meters; cm = centimeters; mm = millimeters; ft = feet, and in. = inches.

- Body of #12 nylon netting, 3/4 in. (1.8 cm) bar mesh, coated with green latex type dip.
- Bag of #18 nylon netting, 3/4 in. (1.8 cm) bar mesh, with 1/8 in. (3 mm) x 6 ft (1.8 m) delta type netting liner, lining the rearward 6 feet of the body, all coated with green latex type dip.
- Body dimensions are 16 ft (4.8 m) wide at the mouth x 15 ft (4.5 m) long. Sides of net are 2 ft (0.6 m) high and middle of net is about 6 ft (1.8 m) high when spread. It has a 6 ft long, 1/4 in. (6 mm) braided nylon drawstring at the rear.
- Floats on top side every 36 in. (91.4 cm) along headrope, and a 3/16 in. (0.5 cm) steel chain on bottom along footrope. The 3/8 in. (1 cm) braided polypropylene headrope and footrope continue 2 ft (0.6 m) past the edges of the net to form attachment lines.
- Dimensions of otter boards for spreading and sinking the net are 15 in. x 30 in. (38.1 cm x 76.2 cm; Memphis Net and Twine BD2 or equivalent).
- Towropes are 100 ft (30 m) long (Memphis Net and Twine DT5, DT2, or equivalent).

Schematic of LTRMP slingshot balloon trawl, side and top view



Appendix D

Fish Keys Commonly Used by Long Term Resource Monitoring Program (LTRMP) Fish Specialists

Becker, G. C. 1983. Fishes of Wisconsin. The University of Wisconsin Press, Madison.

Page, L. M., and B. M. Burr. 2011. Peterson field guide to freshwater fishes of North America north of Mexico, 2nd edition. Houghton Mifflin Harcourt, New York.

Pflieger, W. L. 1997. The fishes of Missouri, Revised edition. Missouri Department of Conservation, Jefferson City, Missouri.

Appendix E

Long Term Resource Monitoring Program (LTRMP) Lists of Fishes and Fish Species Codes

Appendix E-1. List of Long Term Resource Monitoring Program fish species codes arranged alphabetically by fish common name (including hybrids). Scientific names are included. Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004).

Common name	Scientific name	Code
Age-0 fish (young-of-the-year)	Age-0 fish	YOYF
American brook lamprey	*Lampetra appendix*	ABLP
American eel	*Anguilla rostrata*	AMEL
Banded darter	*Etheostoma zonale*	BDDR
Bigeye chub	*Hybopsis amblops*	BECB
Bigeye shiner	*Notropis boops*	BESN
Bighead carp	*Hypophthalmichthys 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 crappie x white crappie hybrid	*P. nigromaculatus x P. annularis*	BCWC
Blackside darter	*Percina maculata*	BSDR
Blackspotted topminnow	*Fundulus olivaceus*	BPTM
Blackstripe topminnow	*Fundulus notatus*	BTTM
Blacktail shiner	*Cyprinella venusta*	BTSN
Bleeding shiner	*Luxilus zonatus*	BDSN
Blue catfish	*Ictalurus furcatus*	BLCF
Blue sucker	*Cycleptus elongatus*	BUSK
Bluegill	*Lepomis macrochirus*	BLGL
Bluegill x longear sunfish hybrid	*L. macrochirus x L. megalotis*	BGLE
Bluegill x orangespotted sunfish hybrid	*L. macrochirus x L. humilis*	BGOS
Bluegill x redear sunfish hybrid	*L. macrochirus x L. microlophus*	BGRS
Bluegill x warmouth hybrid	*L. macrochirus x L. gulosus*	BGWM
Bluntnose darter	*Etheostoma chlorosoma*	BNDR
Bluntnose minnow	*Pimephales notatus*	BNMW
Bowfin	*Amia calva*	BWFN
Brassy minnow	*Hybognathus hankinsoni*	BSMW
Brook silverside	*Labidesthes sicculus*	BKSS
Brook stickleback	*Culaea inconstans*	BKSB
Brown bullhead	*Ameiurus nebulosus*	BNBH
Brown trout	*Salmo trutta*	BNTT
Bullhead minnow	*Pimephales vigilax*	BHMW
Burbot	*Lota lota*	BRBT
Central mudminnow	*Umbra limi*	CMMW
Central stoneroller	*Campostoma anomalum*	CLSR
Channel catfish	*Ictalurus punctatus*	CNCF

Appendix E-1. List of Long Term Resource Monitoring Program fish species codes arranged alphabetically by fish common name (including hybrids). Scientific names are included. Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004). —Continued

Common name	Scientific name	Code
Channel shiner	*Notropis wickliffi*	CNSN
Chestnut lamprey	*Ichthyomyzon castaneus*	CNLP
Common carp	*Cyprinus carpio*	CARP
Common carp x goldfish hybrid	*C. carpio x Carassius auratus*	CCGF
Common shiner	*Luxilus cornutus*	CMSN
Creek chub	*Semotilus atromaculatus*	CKCB
Creek chubsucker	*Erimyzon oblongus*	CKCS
Crystal darter	*Crystallaria asprella*	CLDR
Dusky darter	*Percina sciera*	DYDR
Emerald shiner	*Notropis atherinoides*	ERSN
Fantail darter	*Etheostoma flabellare*	FTDR
Fathead minnow	*Pimephales promelas*	FHMW
Flathead catfish	*Pylodictis olivaris*	FHCF
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
Green sunfish	*Lepomis cyanellus*	GNSF
Green sunfish x bluegill hybrid	*L. cyanellus x L. macrochirus*	GSBG
Green sunfish x orangespotted sunfish hybrid	*L. cyanellus x L. humilis*	GSOS
Green sunfish x pumpkinseed hybrid	*L. cyanellus x L. gibbosus*	GSPS
Green sunfish x redear hybrid	*L. cyanellus x L. microlophus*	GSRS
Green sunfish x warmouth hybrid	*L. cyanellus x L. gulosus*	GSWM
Greenside darter	*Etheostoma blennioides*	GSDR
Highfin carpsucker	*Carpiodes velifer*	HFCS
Hornyhead chub	*Nocomis biguttatus*	HHCB
Inland silverside	*Menidia beryllina*	IDSS
Iowa darter	*Etheostoma exile*	IODR
Johnny darter	*Etheostoma nigrum*	JYDR
Lake sturgeon	*Acipenser fulvescens*	LKSG
Largemouth bass	*Micropterus salmoides*	LMBS

Appendix E-1. List of Long Term Resource Monitoring Program fish species codes arranged alphabetically by fish common name (including hybrids). Scientific names are included. Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004). —Continued

Common name	Scientific name	Code
Largescale stoneroller	*Campostoma oligolepis*	LSSR
Larval fish	Larval fish	LRVL
Least brook lamprey	*Lampetra aepyptera*	LBLP
Logperch	*Percina caprodes*	LGPH
Longear sunfish	*Lepomis megalotis*	LESF
Longnose gar	*Lepisosteus osseus*	LNGR
Longnose gar x spotted gar hybrid	*L. osseus x L. oculatus*	LNST
Mimic shiner	*Notropis volucellus*	MMSN
Mississippi silvery minnow	*Hybognathus nuchalis*	SVMW
Mooneye	*Hiodon tergisus*	MNEY
Mud darter	*Etheostoma asprigene*	MDDR
Muskellunge	*Esox masquinongy*	MSKG
New species	New species	NWSP
No fish caught	No fish caught	NFSH
Northern hog sucker	*Hypentelium nigricans*	NHSK
Northern pike	*Esox lucius*	NTPK
Northern studfish	*Fundulus catenatus*	NTSF
Orangespotted sunfish	*Lepomis humilis*	OSSF
Orangespotted sunfish x longear sunfish hybrid	*L. humilis x L. megalotis*	OSLE
Orangethroat darter	*Etheostoma spectabile*	OTDR
Ozark minnow	*Notropis nubilus*	OZMW
Paddlefish	*Polyodon spathula*	PDFH
Pallid shiner	*Hybopsis amnis*	PDSN
Pirate perch	*Aphredoderus sayanus*	PRPH
Plains minnow	*Hybognathus placitus*	PNMW
Pugnose minnow	*Opsopoeodus emiliae*	PGMW
Pumpkinseed	*Lepomis gibbosus*	PNSD
Pumpkinseed x bluegill hybrid	*L. gibbosus x L. macrochirus*	PSBG
Pumpkinseed x orangespotted sunfish hybrid	*L. gibbosus x L. humilis*	PSOS
Pumpkinseed x warmouth hybrid	*L. gibbosus x L. gulosus*	PSWM
Quillback	*Carpiodes cyprinus*	QLBK
Rainbow smelt	*Osmerus mordax*	RBST
Red shiner	*Cyprinella lutrensis*	RDSN
Redear sunfish	*Lepomis microlophus*	RESF
Redfin shiner	*Lythrurus umbratilis*	RFSN
Redspotted sunfish	*Lepomis miniatus*	RSSF
River carpsucker	*Carpiodes carpio*	RVCS
River chub	*Nocomis micropogon*	RVCB

Appendix E-1. List of Long Term Resource Monitoring Program fish species codes arranged alphabetically by fish common name (including hybrids). Scientific names are included. Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004). —Continued

Common name	Scientific name	Code
River darter	*Percina shumardi*	RRDR
River redhorse	*Moxostoma carinatum*	RVRH
River shiner	*Notropis blennius*	RVSN
Rock bass	*Ambloplites rupestris*	RKBS
Round goby	*Neogobius melanostomus*	RDGY
Rudd	*Scardinius erythrophthalmus*	RUDD
Sand shiner	*Notropis stramineus*	SNSN
Sauger	*Sander canadensis*	SGER
Sauger x walleye hybrid	*S. canadensis x S. vitreus*	SGWE
Shorthead redhorse	*Moxostoma macrolepidotum*	SHRH
Shortnose gar	*Lepisosteus platostomus*	SNGR
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	SNSG
Shovelnose sturgeon x pallid sturgeon hybrid	*S. platorynchus x S. albus*	SNPD
Sicklefin chub	*Macrhybopsis meeki*	SFCB
Silver carp	*Hypophthalmichthys molitrix*	SVCP
Silver carp x bighead carp hybrid	*H. molitrix x H. nobilis*	SCBC
Silver chub	*Macrhybopsis storeriana*	SVCB
Silver lamprey	*Ichthyomyzon unicuspis*	SVLP
Silver redhorse	*Moxostoma anisurum*	SVRH
Silverband shiner	*Notropis shumardi*	SBSN
Skipjack herring	*Alosa chrysochloris*	SJHR
Slenderhead darter	*Percina phoxocephala*	SHDR
Slough darter	*Etheostoma gracile*	SLDR
Smallmouth bass	*Micropterus dolomieu*	SMBS
Smallmouth buffalo	*Ictiobus bubalus*	SMBF
Southern redbelly dace	*Phoxinus erythrogaster*	SRBD
Speckled chub	*Macrhybopsis aestivalis*	SKCB
Spotfin shiner	*Cyprinella spiloptera*	SFSN
Spottail shiner	*Notropis hudsonius*	STSN
Spotted bass	*Micropterus punctulatus*	STBS
Spotted gar	*Lepisosteus oculatus*	STGR
Spotted sucker	*Minytrema melanops*	SPSK
Starhead topminnow	*Fundulus dispar*	SHTM
Stonecat	*Noturus flavus*	STCT
Striped bass	*Morone saxatilis*	SDBS
Striped bass x white bass hybrid	*M. saxatilis x M. chrysops*	SBWB
Striped mullet	*Mugil cephalus*	SPMT
Striped shiner	*Luxilus chrysocephalus*	SPSN

Appendix E-1. List of Long Term Resource Monitoring Program fish species codes arranged alphabetically by fish common name (including hybrids). Scientific names are included. Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004). —Continued

Common name	Scientific name	Code
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 E. lucius*	MGNP
Trout-perch	*Percopsis omiscomaycus*	TTPH
Unidentified	Unidentified	UNID
Unidentified sturgeons	Acipenseridae	U-SG
Unidentified suckers	Catostomidae	U-CT
Unidentified sunfishes	Centrarchidae	U-CN
Unidentified shads	Clupeidae	U-CL
Unidentified minnows	Cyprinidae	U-CY
Unidentified mooneyes	Hiodontidae	U-HI
Unidentified catfishes	Ictaluridae	U-IL
Unidentified perches	Percidae	U-PC
Unidentified lampreys	Petromyzontidae	U-LY
Walleye	*Sander vitreus*	WLYE
Warmouth	*Lepomis gulosus*	WRMH
Wedgespot shiner	*Notropis greenei*	WSSN
Weed shiner	*Notropis texanus*	WDSN
Western blacknose dace	*Rhinichthys obtusus*	BNDC
Western mosquitofish	*Gambusia affinis*	MQTF
Western sand darter	*Ammocrypta clara*	WSDR
Western silvery minnow	*Hybognathus argyritis*	WSMW
White bass	*Morone chrysops*	WTBS
White crappie	*Pomoxis annularis*	WTCP
White perch	*Morone americana*	WTPH
White perch x yellow bass hybrid	*M. americana x M. mississippiensis*	WPYB
White sucker	*Catostomus commersonii*	WTSK
Yellow bass	*Morone mississippiensis*	YWBS
Yellow bullhead	*Ameiurus natalis*	YLBH
Yellow perch	*Perca flavescens*	YWPH

Appendix E-2. List of Long Term Resource Monitoring Program fish species codes arranged phylogenetically by family, then alphabetically by genus and species (excluding hybrids). Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004).

Code	Common name	Family	Scientific name
		Petromyzontidae	
CNLP	Chestnut lamprey		*Ichthyomyzon castaneus*
SVLP	Silver lamprey		*I. unicuspis*
LBLP	Least brook lamprey		*Lampetra aepyptera*
ABLP	American brook lamprey		*L. appendix*
		Acipenseridae	
LKSG	Lake sturgeon		*Acipenser fulvescens*
SNSG	Shovelnose sturgeon		*Scaphirhynchus platorynchus*
		Polyodontidae	
PDFH	Paddlefish		*Polyodon spathula*
		Lepisosteidae	
STGR	Spotted gar		*Lepisosteus oculatus*
LNGR	Longnose gar		*L. osseus*
SNGR	Shortnose gar		*L. platostomus*
		Amiidae	
BWFN	Bowfin		*Amia calva*
		Hiodontidae	
GDEY	Goldeye		*Hiodon alosoides*
MNEY	Mooneye		*H. tergisus*
		Anguillidae	
AMEL	American eel		*Anguilla rostrata*
		Clupeidae	
SJHR	Skipjack herring		*Alosa chrysochloris*
GZSD	Gizzard shad		*Dorosoma cepedianum*
TFSD	Threadfin shad		*D. petenense*
		Cyprinidae	
CLSR	Central stoneroller		*Campostoma anomalum*
LSSR	Largescale stoneroller		*C. oligolepis*
GDFH	Goldfish		*Carassius auratus*
GSCP	Grass carp		*Ctenopharyngodon idella*
RDSN	Red shiner		*Cyprinella lutrensis*
SFSN	Spotfin shiner		*C. spiloptera*
BTSN	Blacktail shiner		*C. venusta*
CARP	Common carp		*Cyprinus carpio*
WSMW	Western silvery minnow		*Hybognathus argyritis*
BSMW	Brassy minnow		*H. hankinsoni*
SVMW	Mississippi silvery minnow		*H. nuchalis*
PNMW	Plains minnow		*H. placitus*

Appendix E-2. List of Long Term Resource Monitoring Program fish species codes arranged phylogenetically by family, then alphabetically by genus and species (excluding hybrids). Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004).—Continued

Code	Common name	Family	Scientific name
		Cyprinidae (continued)	
BECB	Bigeye chub		*Hybopsis amblops*
PDSN	Pallid shiner		*H. amnis*
SVCP	Silver carp		*Hypophthalmichthys molitrix*
BHCP	Bighead carp		*H. nobilis*
SPSN	Striped shiner		*Luxilus chrysocephalus*
CMSN	Common shiner		*L. cornutus*
BDSN	Bleeding shiner		*L. zonatus*
RFSN	Redfin shiner		*Lythrurus umbratilis*
SKCB	Speckled chub		*Macrhybopsis aestivalis*
SGCB	Sturgeon chub		*M. gelida*
SFCB	Sicklefin chub		*M. meeki*
SVCB	Silver chub		*M. storeriana*
HHCB	Hornyhead chub		*Nocomis biguttatus*
RVCB	River chub		*N. micropogon*
GDSN	Golden shiner		*Notemigonus crysoleucas*
ERSN	Emerald shiner		*Notropis atherinoides*
RVSN	River shiner		*N. blennius*
BESN	Bigeye shiner		*N. boops*
GTSN	Ghost shiner		*N. buchanani*
BMSN	Bigmouth shiner		*N. dorsalis*
WSSN	Wedgespot shiner		*N. Greenei*
STSN	Spottail shiner		*N. hudsonius*
OZMW	Ozark minnow		*N. nubilus*
SBSN	Silverband shiner		*N. shumardi*
SNSN	Sand shiner		*N. stramineus*
WDSN	Weed shiner		*N. texanus*
MMSN	Mimic shiner		*N. volucellus*
CNSN	Channel shiner		*N. wickliffi*
PGMW	Pugnose minnow		*Opsopoeodus emiliae*
SMMW	Suckermouth minnow		*Phenacobius mirabilis*
SRBD	Southern redbelly dace		*Phoxinus erythrogaster*
BNMW	Bluntnose minnow		*Pimephales notatus*
FHMW	Fathead minnow		*P. promelas*
BHMW	Bullhead minnow		*P. vigilax*
BNDC	Western blacknose dace		*Rhinichthys obtusus*
RUDD	Rudd		*Scardinius erythrophthalmus*
CKCB	Creek chub		*Semotilus atromaculatus*

Appendix E-2. List of Long Term Resource Monitoring Program fish species codes arranged phylogenetically by family, then alphabetically by genus and species (excluding hybrids). Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004).—Continued

Code	Common name	Family	Scientific name
		Catostomidae	
RVCS	River carpsucker		*Carpiodes carpio*
QLBK	Quillback		*C. cyprinus*
HFCS	Highfin carpsucker		*C. velifer*
WTSK	White sucker		*Catostomus commersonii*
BUSK	Blue sucker		*Cycleptus elongatus*
CKCS	Creek chubsucker		*Erimyzon oblongus*
NHSK	Northern hog sucker		*Hypentelium nigricans*
SMBF	Smallmouth buffalo		*Ictiobus bubalus*
BMBF	Bigmouth buffalo		*I. cyprinellus*
BKBF	Black buffalo		*I. niger*
SPSK	Spotted sucker		*Minytrema melanops*
SVRH	Silver redhorse		*Moxostoma anisurum*
RVRH	River redhorse		*M. carinatum*
GDRH	Golden redhorse		*M. erythrurum*
SHRH	Shorthead redhorse		*M. macrolepidotum*
		Ictaluridae	
BKBH	Black bullhead		*Ameiurus melas*
YLBH	Yellow bullhead		*A. natalis*
BNBH	Brown bullhead		*A. nebulosus*
BLCF	Blue catfish		*Ictalurus furcatus*
CNCF	Channel catfish		*I. punctatus*
STCT	Stonecat		*Noturus flavus*
TPMT	Tadpole madtom		*N. gyrinus*
FKMT	Freckled madtom		*N. nocturnus*
FHCF	Flathead catfish		*Pylodictis olivaris*
		Esocidae	
GSPK	Grass pickerel		*Esox americanus vermiculatus*
NTPK	Northern pike		*E. lucius*
MSKG	Muskellunge		*E. masquinongy*
		Umbridae	
CMMW	Central mudminnow		*Umbra limi*
		Osmeridae	
RBST	Rainbow smelt		*Osmerus mordax*
		Salmonidae	
BNTT	Brown trout		*Salmo trutta*
		Percopsidae	
TTPH	Trout-perch		*Percopsis omiscomaycus*

Appendix E-2. List of Long Term Resource Monitoring Program fish species codes arranged phylogenetically by family, then alphabetically by genus and species (excluding hybrids). Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004).—Continued

Code	Common name	Family	Scientific name
		Aphredoderidae	
PRPH	Pirate perch		*Aphredoderus sayanus*
		Gadidae	
BRBT	Burbot		*Lota lota*
		Mugilidae	
SPMT	Striped mullet		*Mugil cephalus*
		Atherinopsidae	
BKSS	Brook silverside		*Labidesthes sicculus*
IDSS	Inland silverside		*Menidia beryllina*
		Fundulidae	
NTSF	Northern studfish		*Fundulus catenatus*
SHTM	Starhead topminnow		*F. dispar*
BTTM	Blackstripe topminnow		*F. notatus*
BPTM	Blackspotted topminnow		*F. olivaceus*
		Poeciliidae	
MQTF	Western mosquitofish		*Gambusia affinis*
		Gasterosteidae	
BKSB	Brook stickleback		*Culaea inconstans*
		Moronidae	
WTPH	White perch		*Morone americana*
WTBS	White bass		*M. chrysops*
YWBS	Yellow bass		*M. mississippiensis*
SDBS	Striped bass		*M. saxatilis*
		Centrarchidae	
RKBS	Rock bass		*Ambloplites rupestris*
FLER	Flier		*Centrarchus macropterus*
GNSF	Green sunfish		*Lepomis cyanellus*
PNSD	Pumpkinseed		*L. gibbosus*
WRMH	Warmouth		*L. gulosus*
OSSF	Orangespotted sunfish		*L. humilis*
BLGL	Bluegill		*L. macrochirus*
LESF	Longear sunfish		*L. megalotis*
RESF	Redear sunfish		*L. microlophus*
RSSF	Redspotted sunfish		*L. miniatus*
SMBS	Smallmouth bass		*Micropterus dolomieu*
STBS	Spotted bass		*M. punctulatus*
LMBS	Largemouth bass		*M. salmoides*
WTCP	White crappie		*Pomoxis annularis*
BKCP	Black crappie		*P. nigromaculatus*

Appendix E-2. List of Long Term Resource Monitoring Program fish species codes arranged phylogenetically by family, then alphabetically by genus and species (excluding hybrids). Nomenclature follows American Fisheries Society standard naming conventions (Nelson et al. 2004).—Continued

Code	Common name	Family	Scientific name
		Percidae	
WSDR	Western sand darter		*Ammocrypta clara*
CLDR	Crystal darter		*Crystallaria asprella*
MDDR	Mud darter		*Etheostoma asprigene*
GSDR	Greenside darter		*E. blennioides*
BNDR	Bluntnose darter		*E. chlorosoma*
IODR	Iowa darter		*E. exile*
FTDR	Fantail darter		*E. flabellare*
SLDR	Slough darter		*E. gracile*
JYDR	Johnny darter		*E. nigrum*
OTDR	Orangethroat darter		*E. spectabile*
BDDR	Banded darter		*E. zonale*
YWPH	Yellow perch		*Perca flavescens*
LGPH	Logperch		*Percina caprodes*
BSDR	Blackside darter		*P. maculata*
SHDR	Slenderhead darter		*P. phoxocephala*
DYDR	Dusky darter		*P. sciera*
RRDR	River darter		*P. shumardi*
SGER	Sauger		*Sander canadensis*
WLYE	Walleye		*S. vitreus*
		Sciaenidae	
FWDM	Freshwater drum		*Aplodinotus grunniens*
		Gobiidae	
RDGY	Round goby		*Neogobius melanostomus*

Appendix F

Long Term Resource Monitoring Program (LTRMP) Turtle Species Codes

Upper Mississippi River turtles, and turtle species codes used in the LTRMP turtle data entry application. Common and scientific names are included. A LTRMP turtle identification key can be found online at *http://www.umesc.usgs.gov/data_library/fisheries/historical_documents.html* (accessed December 11, 2013).

Common name	Scientific name	LTRMP code
Alligator snapping turtle	*Macrochelys temminckii*	ASNT
Eastern snapping turtle (formerly common snapping turtle)	*Chelydra serpentina*	CSNT
Eastern musk turtle (formerly common musk turtle)	*Sternotherus odoratus*	CMKT
False map turtle	*Graptemys pseudogeographica pseudogeographica*	FMPT
Mississippi map turtle	*Graptemys pseudogeographica kohnii*	MMPT
Ouachita map turtle	*Graptemys ouachitensis ouachitensis*	OMPT
Northern map turtle (formerly common map turtle)	*Graptemys geographica*	CMPT
Midland painted turtle	*Chrysemys picta marginata*	MPTT
Western painted turtle	*Chrysemys picta belli*	WPTT
River cooter	*Pseudemys concinna*	RCOT
Red-eared slider	*Trachemys scripta elegans*	RESL
Midland smooth softshell	*Apalone mutica mutica*	SMSS
Spiny softshell	*Apalone spinifera*	SPSS
Yellow mud turtle* (formerly Illinois mud turtle)	*Kinosternon flavescens*	IMDT
Blanding's turtle*	*Emydoidea blandingii*	BLDT
Wood turtle*	*Glyptemys insculpta*	WODT

*Rare species. Should be reported to respective state agencies if captured

Appendix G

Long Term Resource Monitoring Program (LTRMP) Data Sheets

Appendix G-1. Long Term Resource Monitoring Program Site Information data sheet.

This data sheet can be found online at *http://www.umesc.usgs.gov/data_library/fisheries/historical_documents.html* (accessed December 11, 2013).

Fish Collection Sheet

Long Term Resource Monitoring Program
USGS
2630 Fanta Reed Road
La Crosse, WI 54603

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

E/W Coordinates

1=UTM (Map)
2=UTM (GPS)
3=L/L (GPS)
4=L/L (Map)

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.

May 2013

Appendix G-2. Long Term Resource Monitoring Program Fish Measurement data sheet.

This data sheet can be found online at *http://www.umesc.usgs.gov/data_library/fisheries/historical_documents.html* (accessed December 11, 2013)..

Fish Measurement Sheet

Long Term Resource Monitoring Program
USGS
2630 Fanta Reed Road
La Crosse, WI 54603

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		Length (min) (mm)	TFS	GRP (WTH) (cm)	Weight (g)	Fish Count	Working Tally	P C	Sub-Proj.		User Defined Fields											
	Name	Code										1	2	3	4	5	6	7	8	9	10	11	12
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
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11																							
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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: ________

May 2013

The Upper Mississippi River Restoration-Environmental Management Program (UMRR-EMP), including its Long Term Resource Monitoring Program (LTRMP) element, was authorized by the Water Resources Development Act (WRDA) of 1986. The mission of the LTRMP element is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple use character. The LTRMP element is implemented by the U.S. Geological Survey, Upper Midwest Environment Sciences Center, in cooperation with the five Upper Mississippi River System states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin; overall management responsibility of the UMRR-EMP is vested with the U.S. Army Corps of Engineers.