Protocol for Monitoring Fish Communities in Small Streams in the Heartland Inventory and Monitoring Network

SOP 4: Fish Community Sampling, Version 1.1

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.0	4/12/2017 & 3/30/2020	Dodd	Moved equipment list from SOP 1 to this SOP; moved weather field sheet to SOP 5; minor modifications to fish field sheets to reflect changes in database; added QA/QC and Certification procedures	To make SOPs stand-alone documents for field use and publication. Reduce data entry errors by revising field forms to more closely match database data entry forms. Increase accuracy of data collection	1.1

The fish sampling protocols described in this SOP present methods for collecting a representative sample of the fish community from a stream. Such a sample should contain most, if not all, species in the stream at the time of sampling, in numbers proportional to their actual abundance.

For parks previously monitored using seining techniques (HOME, PIPE, TAPR), the methodology presented below follows closely with Peitz and Rowell (2004). Parks where electrofishing methods will be used (EFMO, HEHO, HOSP, GWCA, PERI, WICR) follow guidance in Petersen *et al.* (2008). The methods have been modified from these two protocols, where appropriate, to meet the specific objectives of monitoring fish communities in small streams. Modifications to the prairie fish protocol (Peitz and Rowell 2004) have been made to enhance data collection without compromising comparisons to historical data collected under that protocol. Further, only those portions of the Petersen *et al.* (2008) protocol applicable to electrofishing in small wadeable streams are included here. This SOP presents techniques for fish sampling and procedures for processing fish samples.

Seining Methods for Wadeable Streams (PIPE, TAPR, and HOME)

Wadeable streams can be sampled using a common sense seine (1.2 m tall with a 6.44 mm mesh size) or a bag seine, depending on the size of the stream. Use and effectiveness of a particular seine depends on the channel units (e.g., riffles, runs, pools), channel size, and instream habitat/structure present in the sampling reach. Seines are most commonly used in

wadeable streams with smaller substrates such as gravel or sand with little or no woody debris. The presence of submerged objects such as woody snags or boulders in a sampling area can make it difficult to collect a representative sample. Therefore, the potential for collecting a representative and repeatable sample should be evaluated before seining an area. For sampling riffles, which typically have larger gravel and cobble substrate, a method known as kick seining is used. Seining methods, which are less invasive than other techniques, were selected for PIPE and TAPR due to the presence of the federally endangered Topeka shiner (*Notropis topeka*). At HOME, the soft bottom and turbid conditions at Cub Creek makes seining methods ideal for sampling fish.

Selecting Seining Sites within a Reach

An attempt should be made to sample fish from five sites (or locations; see Figure 1 below) within each reach (see Table 3 and Appendices 1-3 in Protocol Narrative for reach locations). Previous monitoring under the prairie fish protocol (Peitz and Rowell 2004) suggests that not all stream reaches contain enough water to sample five sites. Therefore, three to five sample sites will represent the stream reaches sampled. If water levels are too low to obtain samples from at least three sites, that reach will not be sampled.

Sample sites should be chosen based on availability of channel units (riffles, runs, pools) within the reach. Pools are the predominant channel unit in prairie streams, and accordingly, most samples will be taken from this habitat. Within the reach, sampling always starts with the most downstream site and moves upstream to avoid fouling water at upstream sites prior to sampling (Figure 1). The channel unit type for each site should be recorded on the habitat data sheets (see SOP 5, Figure 3) and all fish collected at each site are kept separate for recording purposes (see Sample Processing section below).

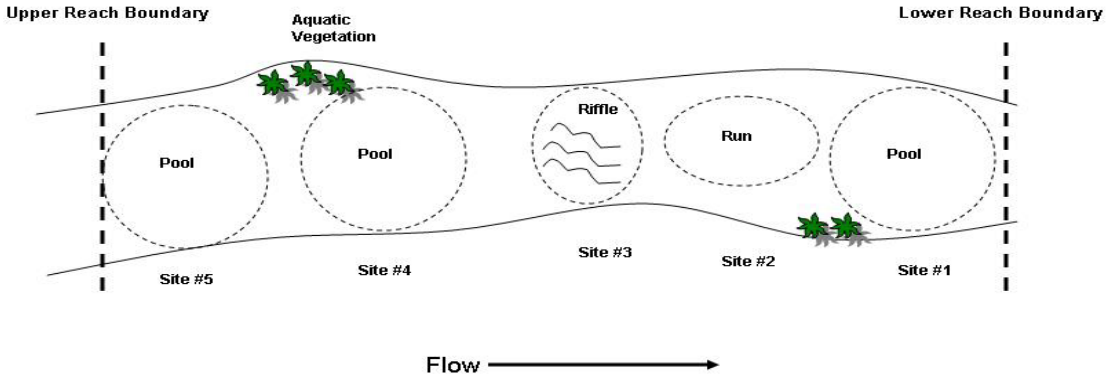

Figure 1. Hypothetical reach and site placement for streams sampled with seining methods.

Seining Techniques

Fish are captured using a two man common sense seine with an approximate height of 1.2 m and a mesh size of 6.44 mm. Width of seine used will vary depending on width of stream. Within a site, sampling is conducted with the direction of flow. Equipment necessary for collecting fish communities with seining techniques is listed in Table 1.

Table 1. Equipment list for fish community sampling at seined parks (PIPE, TAPR, HOME).

Equipment	Quantity/Size
Common Sense seine	2-3 (1.2 m height, 6.44 mm mesh, varying lengths for stream sizes)
5 gallon buckets	5-6
1 gallon buckets	5-6
Aerators	5-6 (one for each 5 gallon bucket)
Waders	1 per person on crew
Aquarium dip nets	3-4
Measuring board	1 (in millimeters)
Electronic scales	1 (in grams)
Fish holding container for scale	1
Specimen jars	5 per reach (pint to gallon jars)
Buffered 10% formalin	1 half gallon container
Fish identification book	1
Camera	1
GPS	1
Stop watch	1
Fish Data sheet	at least 1 sheet per site (3-5 per reach)

When sampling pool and run channel units, two crew members conducting the sampling enter the site at the upstream end. The seine is extended the full width of channel, if possible. One or two (depending on site width) crew members hold a second seine at the bottom of the site to block fish from moving downstream and out of the site. The seine is hauled in a downstream direction with the lead line held on the stream bottom (Figure 2). Seining speed is slightly faster than the current allowing for fish to be trapped against the net. Faster speeds will push water in front of the seine and force fish away from the net. When crew members reach the block net, they should swoop one end of the seine in front of the block net and onto the bank. At the same time, those holding the block net should raise their net out of the water, collecting fish that avoided the seine.

When sampling riffle channel units, kick seining is used. The seine is placed at the downstream end of the riffle by one or two crewmembers, and the substrate is kicked to dislodge benthic fish species that are carried by the current into the seine (Figure 2).

All captured fish are immediately placed in aerated buckets, containing water taken from the site. All fish from a site are processed separately.

Figure 2. Example of seining pools/runs (left) and kick seining riffles (right).

Electrofishing Methods for Wadeable Streams (EFMO, GWCA, HEHO, HOSP, PERI, and WICR)

Electrofishing methods will follow those outlined in Petersen *et al*. 2008 for wadeable streams. Electrofishing is viewed as the single most effective method for sampling stream fish communities (Bagenal 1978; Barbour *et al*. 1999) and involves the use of electricity to capture fish. A high-voltage potential is applied between two or more electrodes that are placed in the water. The voltage potential is created with either direct current or alternating current; only direct current will be used in this protocol due to lower incidence of injury to fish. Direct current produces a unidirectional, constant electrical current. Pulsed direct current, a modified direct current, produces a unidirectional electrical current composed of a sequence of cyclic impulses (Meador *et al.*, 1993). The frequency of the pulses produced when using pulsed direct current can be adjusted by the operator.

General Electrofishing Procedures

Channel width, depth, and access should be considered before choosing between backpack and tow barge electrofishing gears (Figure 3). Backpack electrofishing (with a single anode) should be used in shallow (<1 m) and narrow (<5 m wide) reaches. A crew of three is needed: one operator, one netter, and one crewmember to also net and carry the holding bucket. Tow barge electrofishing gear (multiple anodes) is more effective in wide (>5 m) wadeable reaches with pools deeper than 1 m. A crew of five to six is needed: two or three operators, one manning the tow barge, and two netters. All crewmembers must wear low voltage rubber gloves and waders (nylon or neoprene) to protect them from the electrical current and wear polarized glasses to enhance their ability to see fish. A list of equipment is in Table 2. Techniques for set up and collecting samples using either backpack or towed electrofishing gear are generally similar.

Figure 3. Backpack (left) and tow barge (right) electrofishing gear used in wadeable streams.

Table 2. Equipment list for fish community sampling at electrofished parks (EFMO, GWCA, HEHO, HOSP, PERI, WICR).

Equipment	Quantity/Size
Backpack electrofishing unit	1 (pulsed direct current with adjustments for frequency and duty cycle)
Anode pole	1
Cathode	1
Battery & charger	2-3 (12 volt)
Tow barge unit	1
Pulse box	1 (direct current or pulsed DC)
Anode pole	2
Barge with Cathode	1 (1.5 m length, 0.7 m width);
Tub/Live Well	1 (10 -15 gallon)
Generator	1 (3500 watts minimum)
Gas can	2-3 gallons
Dip nets	2-4 (depending on use of backpack or tow barge at a site)
Waders	1 per person on crew (nylon or neoprene – No breathable)
Low voltage gloves	1 per person on the crew
Polarized sunglasses	1 per person on the crew
5 gallon buckets	5-6
Aerators	5-6 (1 per 5 gallon bucket)
1 gallon buckets	5-6
Aquarium dip nets	3-4
Measuring board	1 (in millimeters)
Electronic scales	1 (in grams)
Fish holding container for scale	1
Specimen jars	1 per reach (pint to gallon jars)
Buffered 10% formalin	1 half gallon container
Fish identification book	1
Camera	1
GPS	1
Fish Data sheet	at least 1 sheet per reach

Settings for Electrofishing Gear

Prior to sampling, conductivity of the water should be measured to aid in selecting voltage, frequency, and duty cycle for the electrofishing gear being used. The effectiveness of electrofishing gear is primarily affected by water conductivity. Low conductivity water (<100 uS/cm) is resistant to flow, reducing the amount of electrical current traveling through the water. High conductivity water (> 600 uS/cm) concentrates a narrow electrical field between

the electrodes (Meador *et al.,* 1993). A general rule for voltage is to set the gear's volts such that output is approximately 3,000 watts (voltage X amperage). If the gear is without ammeters, some pre-sampling experimentation is necessary. In low conductivity water, high voltage and low amperage are needed. In high conductivity water, low voltage and high amperage are needed.

For pulsed DC electrofishing gear, frequency and duty cycle can be adjusted. Pulse rate should be set to produce an effective collection of all fish species and sizes while minimizing injury. A general rule for frequency is to set the pulse rate range from 30 to 60 pulses per second (pps). Frequencies greater than 60 pps are effective in collecting fish but can cause injuries, especially to larger fish (Coffelt Manufacturing, Inc., cited in Meador *et al.* (1993); McMichael *et al.,* 1998). Pulse rates less than 30 pps have caused low incidence of injury, but are generally ineffective in collecting fish. A general rule for duty cycle is to set the electrofisher between 25% and 100%. Duty cycle is calculated as pulse frequency X pulse duration X 100. Electrofishing with intermediate to high duty cycles reduces injury and mortality to fish (Dolan and Miranda 2004).

Electrofishing Techniques

Regardless of the gear used, a single electrofishing pass is made in the reach (Figure 4). Sampling begins at the downstream boundary of the sampling reach and proceeds upstream. Sampling in an upstream direction in wadeable streams is preferred because disturbance of the streambed by crewmembers increases turbidity and reduces visibility of the stunned fish (Hendricks *et al.*, 1980). Sampling requires alternating between banks in a "zigzag" pattern to cover habitat features as one proceeds upstream (Figure 4). Using the zigzag pattern, every effort is made to sample all geomorphic channel units (riffles, runs, pools) and instream habitat features, such as woody snags, undercut banks, macrophyte beds, or large boulders.

The technique used to effectively collect fish community data depends on the habitats sampled within the reach. Continuous application of electrical current and herding of fish by the operator is used in open run habitats. Fish generally respond to continuous electrical current by avoiding exposure to the electrical field, resulting in fish moving just ahead and away from the operator. The operator uses the current to herd the fish into natural barriers such as banks, bars, or shallow riffles to facilitate capture. Intermittent application of electrical current and herding fish to the operator can be used in runs or long pools in *narrow* reaches. This technique requires a crewmember (or two) to enter the reach upstream of the operator. The crewmember(s) moves downstream toward the operator, creating a disturbance and driving fish downstream. The electricity is turned on once the fish are visible and close to the anode. To sample shallow riffles, the operator sweeps the anode across the riffle from upstream to downstream while walking across the riffle. Crewmembers with nets are positioned downstream of the operator to collect stunned fish. The ambush technique should be used when a reach has complex instream habitat such as woody debris, boulder fields, etc. Using this technique, the operator approaches the habitat feature with the electrical current off. In quick succession, the anode is thrust close to the habitat feature, the current is turned on, and the anode is withdrawn from the feature. This produces galvanotaxis, where the

current forces the fish to swim out from the habitat feature and towards the anode (Meador *et al*., 1993).

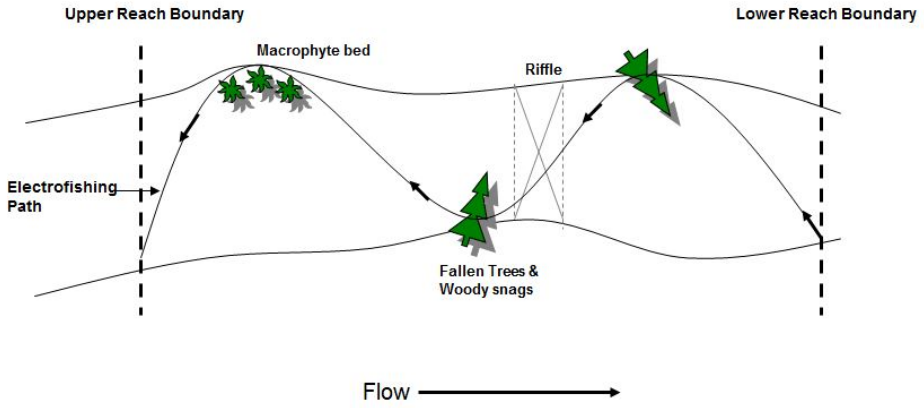

Figure 4. Single pass zigzag sampling technique used in backpack or towed electrofishing for wadeable streams.

Sample Processing of Fish Community Data

The goal of processing fish in the field is to collect information on taxonomic identification, length, weight, abundance, and the presence of external anomalies, with minimal harm to specimens that will be released alive back into the stream. Many species are too small or difficult to identify in the field. These specimens must be brought back to the HTLN laboratory at Missouri State University for processing. All threatened and endangered species or candidate species for listing will be released where they were collected.

Captured fish are placed in a live cage or aerated holding tanks/buckets during processing to reduce stress and mortality. Regardless of the effort made to minimize handling and stress to fish, some mortality will occur. For reaches in which fish are seined (PIPE, TAPR, and HOME), all fish collected from each site within the reach will be kept separate during processing and recording. For those parks where electrofishing gear is used, fish collected using different gears (backpack versus tow barge units) within the same reach are processed separately.

Fish are sorted into identifiable and unidentifiable groups. Identifications are made to species level by the project leader or certified crew leader (see section below for certification process) who are familiar with the fish species commonly found in the study area. Table 3 at the end of this SOP lists species known to occur or within range of the nine parks sampled in this protocol. Taxonomic nomenclature follows that established by the American Fisheries Society's Committee on Names of Fishes (Page *et al.* 2013). Threatened and endangered or sensitive fish species should be identified and measured before other species.

A subsample of 30 individuals per species from a reach will be measured. A “blind grab” technique is used where a dip net is passed through the entire bucket or holding tank to ensure fish of various sizes of a species are captured with each “grab”. **For parks where seining is used at three to five sites within a reach, fish of a particular species will continue to be measured at all sites until 30 individuals have been measured for the entire reach. However, fish from different sites within a reach are recorded on separate data sheets (Figure 5)**. For example, 20 bluntnose minnows are collected at site #1, 13 collected from site #2, and 6 collected from site #3. The 20 fish from site #1 would be measured and recorded on the site #1 data sheet and 10 fish from site #2 would be measured and recorded on site #2 data sheet. Now that 30 have been measured for the reach, the remaining bluntnose minnows from sites #2 and #3 would be counted and recorded under “Additional Species Count” on their respective data sheets. The fish field sheet for seined parks is in Figure 5. The fish field sheet for electrofished parks is in Figure 6.

Total length of 30 individuals for each species is measured and recorded (Figure 7). Anomalies and presence of black spot (*Neascus* spp.), a fish parasite, are recorded for each fish measured. Anomalies are externally visible skin or subcutaneous disorders or parasites (Ohio EPA 1987). They include deformities, eroded fins, lesions, and tumors, collectively referred to as "DELT anomalies" (Sanders *et al.* 1999). Other external anomalies, such as anchor worm (*Lernaea* spp.) and popeye disease, should be noted in the comments section next to the measurement for an individual fish. Weight measurements are obtained by using portable electronic scales (Figure 7). A batch weight will be recorded for smaller species (*e.g.*, minnows, darters, sculpins, and madtoms). Individual weights will be recorded for species that have a large size range (*e.g.*, bass, sunfish, catfish, suckers). Once 30 fish of a species have been measured from a reach, the remaining specimens of that species are counted and recorded under “Additional Species Count” on the field sheet.

FISH COMMUNITY DATA FORM – SEINED PARKS

Page ___ of ___

Park: ________ Stream #: ________ Stream Reach: ______________ Site #: ______

Date: _________ Time*: _________ Gear: ___________ Sample Effort (sec.)*: __________

*Transfer data from Physical Habitat Data sheet

Seine Hauls*: __________

Seine Reach Length (m)*: __________

Anom = Anomalies Code: D = deformities, E = eroded fins, L = Lesions, T = tumors, B = blackspot
Vchrd = specimen preserved (check if Yes) Cmts = Comments (for Topeka shiners, give age as Juvenile or Mature)

Species:					
TL (mm)	Wt (g)	Anom	Vchrd	BatchID	Cmts
				Additional Species Count:	

Species:					
TL (mm)	Wt (g)	Anom	Vchrd	BatchID	Cmts
				Additional Species Count:	

Species:					
TL (mm)	Wt (g)	Anom	Vchrd	BatchID	Cmts
				Additional Species Count:	

Species:					
TL (mm)	Wt (g)	Anom	Vchrd	BatchID	Cmts
				Additional Species Count:	

Species:					
TL (mm)	Wt (g)	Anom	Vchrd	BatchID	Cmts
				Additional Species Count:	

Species:					
TL (mm)	Wt (g)	Anom	Vchrd	BatchID	Cmts
				Additional Species Count:	

Figure 5. Fish community field form for parks where seining methods are employed.

FISH COMMUNITY DATA FORM – ELECTROFISHED PARKS page ____ of ____

Park: _______________ Stream Name_____________ Stream#:__________ Date:___________

IDed by:__________ Recorder:___________ Gear:_____________ Effort(sec):__________

Crew: *Operator(s):*__________________ *Barge (if applicable):*_____________ *Netter(s):* ___________________

Anomalies: D = Deformities, E = Eroded fins, L = Lesions, T = tumors, B = Blackspot
Vchrd. = specimen preserved (check if Yes). **Cmts** = comments

Species						Species						Species					
TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts	TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts	TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts
Additional Species Count:						Additional Species Count:						Additional Species Count:					

Species						Species						Species					
TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts	TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts	TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts
Additional Species Count:						Additional Species Count:						Additional Species Count:					

Species						Species						Species					
TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts	TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts	TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts
Additional Species Count:						Additional Species Count:						Additional Species Count:					

Species						Species						Species					
TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts	TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts	TL (mm)	Wt (g)	Anom	Vchrd	Batch ID	Cmts
Additional Species Count:						Additional Species Count:						Additional Species Count:					

Figure 6. Fish community field form for parks where electrofishing methods are employed.

Figure 7. Total length measurement for an individual (left) and batch weight for a subsample of smaller fish (right).

Some specimens may be too small or difficult to identify in the field. These specimens will be preserve in 10 percent buffered formalin for later identification in the laboratory or for a reference collection.

All unidentified specimens collected within a reach using electrofishing gear can be preserved in a single jar with a label that contains the park, stream name and/or number, reach, date, gear type, and sampling effort (Figure 8). For seined reaches, unknown specimens from each site within the reach should be preserved in separate jars and the site number should also be recorded on the label.

All preserved specimens will be identified at the HTLN Aquatic Program laboratory at Missouri State University using a microscope and relevant identification keys and field guides (Smith 1979; Robinson and Buchanan 1988; Pflieger 1997; Bosanko 2007; Kansas Fishes Committee 2014). Some specimens will be kept as a reference collection for teaching fish identification to new crewmembers and HTLN staff. Reference specimens will be kept in individual jars/vials with a label and preserved in 10% buffered formalin. Specimens not used for a reference collection will be disposed of after one year.

QA/QC

Quality Assurance (QA) Procedures:

QA include all activities and skills of staff members that ensure data collection is high quality and prevents inconsistencies. For collection of fish data, all crew members will review collecting methods described in this SOP.

Two critical elements to collect quality data and maintain consistency across years is: an adequate number of **experienced** crew members and the consistency in the team conducting the fish sampling. To maintain data quality consistency and efficiency while keeping the crew safe, a crew of three to six people are needed for fish sampling, depending on the gear used and size of the stream. At least half of the crew must be experienced (i.e. one field season of experience) with electrofishing and seining procedures and gears. The project lead and field crew lead are to have extensive experience (at least 2-3 field seasons) in

electrofishing procedures and must have completed the U.S. Fish and Wildlife Service (USFWS) electrofishing course (Principles and Techniques of Electrofishing). For backpack electrofishing, a crew of three is needed and at least one must have completed the USFWS electrofishing course. For tow barge electrofishing, five to six crewmembers are needed with at least two crewmembers having completed the USFWS electrofishing course. For seining, two to three crewmembers are required. Crew members who are inexperienced with fish sampling gear will undergo training by the project lead or field crew lead prior to the field season to learn safety features and proper sampling techniques of the equipment. At least two people on the crew must have competent data recording abilities. This will ensure that the numerous fish measurements and counts will be recorded accurately. Prior to recording data, the project or crew lead will explain and demonstrate to new crewmembers how to record data on the field forms and will check the data recording during fish processing.

Quality Control (QC) and Certification Procedures:

Prior to the field season, the project and field crew leads need to refamiliarize themselves with the fish fauna by examining preserved specimens located in the reference collection and reviewing fish species lists collected within the parks.

The project lead for fish monitoring will have taxonomic expertise, having completed an Ichthyology course and having 3 or more years of fish identification experience. The project lead will be the QA officer for both experienced staff (i.e. have 1-2 years of fish identification experience or have taken an Ichthyology class) and inexperienced staff who will assist with fish identifications.

Field crew leads responsible for fish identifications down to the species level will have completed an Ichthyology course and be certified by the QA officer (i.e., project lead). To obtain certification, crew leads will independently identify a subset of 50% of the fish collected in at least 2 parks from each of the following regions: prairies/deciduous forests (EFMO, HEHO, HOME, PIPE.TAPR) and Ozarks/Ouachita forests (GWCA, HOSP, PERI, WICR). A 90% agreement between crew leads and QA officer is required for certification. If crew leads have been certified based on procedures described in the fish sampling SOP of the HTLN River Fish Monitoring Protocol for BUFF and OZAR (Dodd et al. 2018), this will substitute for the 2 parks in the Ozarks/Ouachita forest region.

Only the project lead or certified crew leads will be allowed to make final determinations of identifications to the species level. If a species is identified that is not within the range of region in which the park is located, the specimen will be preserved and sent to a taxonomic expert. If a species is identified as not being collected previously at a park but is within it's native range, the specimen will be identified by at least two different certified crew members for verification.

In the field, the project lead or crew leads will train other crewmembers in coarse identification of specimens, separating them into families or sub-family groups (such as sunfish, sculpins, minnows, and darters) to aid in initial sorting and processing of fish.

Jar Labels for Seined Parks	Jar Labels for Electrofished Parks
Park: Stream Name or #: Reach: Date: Site #: Channel Unit: Gear: Effort (sec.):	Park: Stream Name: Stream #: Date: Gear: Effort (sec.):
Park: Stream Name or #: Reach: Date: Site #: Channel Unit: Gear: Effort (sec.):	Park: Stream Name: Stream #: Date: Gear: Effort (sec.):
Park: Stream Name or #: Reach: Date: Site #: Channel Unit: Gear: Effort (sec.):	Park: Stream Name: Stream #: Date: Gear: Effort (sec.):
Park: Stream Name or #: Reach: Date: Site #: Channel Unit: Gear: Effort (sec.):	Park: Stream Name: Stream #: Date: Gear: Effort (sec.):

Figure 8. Labels for specimen jars for parks sampled using seining methods (left labels) and using electrofishing methods (right labels).

Table 3. Fish species known or within range of the nine parks sampled in this protocol. Species are classified by tolerance, trophic status, spawning preference, and federal status.

Family	Scientific Name	Common Name	Lithophilic Spawner	Top Carnivore	Diet	Tolerance	Status
Amblyopsidae	Typhlichthys subterraneus	Southern cavefish	No	No	Invertivorous	Intolerant	
Amiidae	Amia calva	Bowfin	No	Yes	Piscivorous	Moderate	
Anguillidae	Anguilla rostrata	American eel	No	Yes	Piscivorous	Moderate	
Aphredoderidae	Aphredoderus sayanus	Pirate perch	No	No	Insectivorous	Moderate	
Atherinopsidae	Labidesthes sicculus	Brook silverside	No	No	Insectivorous	Moderate	
Atherinopsidae	Menidia audens	Mississippi silverside	No	No	Insectivorous	Moderate	
Atherinopsidae	Menidia beryllina	Inland silverside	No	No	Insectivorous	Moderate	
Catostomidae	Carpiodes carpio	River carpsucker	No	No	Omnivore	Moderate	
Catostomidae	Carpiodes cyprinus	Quillback	No	No	Omnivore	Moderate	
Catostomidae	Carpiodes velifer	Highfin carpsucker	No	No	Omnivore	Intolerant	
Catostomidae	Catostomus commersonii	White sucker	Yes	No	Omnivore	Tolerant	
Catostomidae	Cycleptus elongatus	Blue sucker	Yes	No	Insectivorous	Intolerant	
Catostomidae	Erimyzon claviformis	Western creek chubsucker	Yes	No	Insectivorous	Moderate	
Catostomidae	Erimyzon oblongus	Eastern creek chubsucker	Yes	No	Insectivorous	Moderate	
Catostomidae	Erimyzon sucetta	Lake chubsucker	Yes	No	Insectivorous	Moderate	
Catostomidae	Hypentelium nigricans	Northern hog sucker	Yes	No	Insectivorous	Intolerant	
Catostomidae	Ictiobus bubalus	Smallmouth buffalo	No	No	Insectivorous	Moderate	
Catostomidae	Ictiobus cyprinellus	Bigmouth buffalo	No	No	Insectivorous	Moderate	
Catostomidae	Ictiobus niger	Black buffalo	No	No	Insectivorous	Moderate	
Catostomidae	Minytrema melanops	Spotted sucker	Yes	No	Insectivorous	Moderate	
Catostomidae	Moxostoma anisurum	Silver redhorse	Yes	No	Insectivorous	Moderate	
Catostomidae	Moxostoma carinatum	River redhorse	Yes	No	Insectivorous	Intolerant	
Catostomidae	Moxostoma duquesnei	Black redhorse	Yes	No	Insectivorous	Intolerant	

Catostomidae	Moxostoma erythrurum	Golden redhorse	Yes	No	Insectivorous	Moderate	
Catostomidae	Moxostoma macrolepidotum	Shorthead redhorse	Yes	No	Insectivorous	Moderate	
Catostomidae	Moxostoma pisolabrum	Pealip Redhorse	Yes	No	Insectivorous	Moderate	
Catostomidae	Moxostoma valenciennesi	Greater redhorse	Yes	No	Insectivorous	Intolerant	
Centrarchidae	Ambloplites constellatus	Ozark bass	Yes	Yes	Piscivorous	Intolerant	
Centrarchidae	Ambloplites rupestris	Rock bass	Yes	Yes	Piscivorous	Intolerant	
Centrarchidae	Centrarchus macropterus	Flier	Yes	No	Insectivorous	Moderate	
Centrarchidae	Lepomis cyanellus	Green sunfish	No	No	Invertivorous	Tolerant	
Centrarchidae	Lepomis gibbosus	Pumpkinseed	No	No	Insectivorous	Moderate	
Centrarchidae	Lepomis gulosus	Warmouth	No	No	Piscivorous	Moderate	
Centrarchidae	Lepomis humilis	Orangespotted sunfish	No	No	Insectivorous	Moderate	
Centrarchidae	Lepomis macrochirus	Bluegill	No	No	Insectivorous	Tolerant	
Centrarchidae	Lepomis megalotis	Longear sunfish	Yes	No	Insectivorous	Moderate	
Centrarchidae	Lepomis microlophus	Redear sunfish	No	No	Insectivorous	Moderate	
Centrarchidae	Lepomis miniatus	Redspotted sunfish	No	No	Insectivorous	Moderate	
Centrarchidae	Lepomis punctatus	Spotted sunfish	No	No	Insectivorous	Moderate	
Centrarchidae	Lepomis symmetricus	Bantam sunfish	Yes	No	Insectivorous	Moderate	
Centrarchidae	Micropterus dolomieu	Smallmouth bass	Yes	Yes	Piscivorous	Intolerant	
Centrarchidae	Micropterus punctulatus	Spotted bass	No	Yes	Piscivorous	Moderate	
Centrarchidae	Micropterus salmoides	Largemouth bass	No	Yes	Piscivorous	Tolerant	
Centrarchidae	Pomoxis annularis	White crappie	No	Yes	Piscivorous	Moderate	
Centrarchidae	Pomoxis nigromaculatus	Black crappie	No	Yes	Piscivorous	Moderate	
Clupeidae	Dorosoma cepedianum	Gizzard shad	No	No	Omnivore	Tolerant	
Clupeidae	Dorosoma petenense	Treadfin shad	No	No	Omnivore	Moderate	
Cottidae	Cottus bairdii	Mottled sculpin	Yes	No	Insectivorous	Intolerant	
Cottidae	Cottus carolinae	Banded sculpin	Yes	No	Insectivorous	Intolerant	
Cottidae	Cottus hypselurus	Ozark sculpin	Yes	No	Insectivorous	Intolerant	

Cottidae	Cottus immaculatus	Knobfin Sculpin	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Campostoma anomalum	Central stoneroller	Yes	No	Algivorous	Moderate	
Cyprinidae	Campostoma oligolepis	Largescale stoneroller	Yes	No	Algivorous	Moderate	
Cyprinidae	Carassius auratus	Goldfish	No	No	Omnivore	Tolerant	
Cyprinidae	Chrosomus eos	Northern redbelly dace	No	No	Herbivorous	Moderate	
Cyprinidae	Chrosomus erythrogaster	Southern redbelly dace	Yes	No	Herbivorous	Intolerant	
Cyprinidae	Chrosomus neogaeus	Finescale dace	No	No	Insectivorous	Moderate	
Cyprinidae	Clinostomus elongatus	Redside dace	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Ctenopharyngodon idella	Grass carp	No	No	Herbivorous	Moderate	
Cyprinidae	Cyprinella camura	Bluntface shiner	No	No	Insectivorous	Intolerant	
Cyprinidae	Cyprinella galactura	Whitetail shiner	No	No	Insectivorous	Intolerant	
Cyprinidae	Cyprinella lutrensis	Red shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Cyprinella spiloptera	Spotfin shiner	No	No	Insectivorous	Moderate	
Cyprinidae	Cyprinella venusta	Blacktail shiner	No	No	Insectivorous	Moderate	
Cyprinidae	Cyprinella whipplei	Steelcolor shiner	No	No	Insectivorous	Intolerant	
Cyprinidae	Cyprinus carpio	Common carp	No	No	Omnivore	Tolerant	
Cyprinidae	Erimystax dissimilis	Streamline chub	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Erimystax harryi	Ozark chub	Yes	No	Insectivorous	Moderate	
Cyprinidae	Erimystax x-punctatus	Gravel chub	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Hybognathus hankinsoni	Brassy minnow	No	No	Omnivore	Moderate	
Cyprinidae	Hybognathus hayi	Cypress minnow	No	No	Herbivorous	Moderate	
Cyprinidae	Hybognathus nuchalis	Mississippi silvery minnow	No	No	Herbivorous	Moderate	
Cyprinidae	Hybopsis amblops	Bigeye chub	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Hybopsis amnis	Pallid shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Hypophthalmichthys molitrix	Silver carp	No	No	Omnivore	Tolerant	
Cyprinidae	Luxilus cardinalis	Cardinal shiner	Yes	No	Generalist	Intolerant	
Cyprinidae	Luxilus chrysocephalus	Striped shiner	Yes	No	Insectivorous	Moderate	

Cyprinidae	Luxilus cornutus	Common shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Luxilus pilsbryi	Duskystripe shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Luxilus zonatus	Bleeding shiner	Yes	No	Invertivorous	Moderate	
Cyprinidae	Lythrurus ardens	Rosefin shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Lythrurus fumeus	Ribbon shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Lythrurus umbratilis	Redfin shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Macrhybopsis hyostoma	Speckled chub	No	No	Insectivorous	Intolerant	
Cyprinidae	Macrhybopsis storeriana	Silver chub	No	No	Insectivorous	Moderate	
Cyprinidae	Nocomis asper	Redspot chub	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Nocomis biguttatus	Hornyhead chub	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Nocomis micropogon	River chub	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Notemigonus crysoleucas	Golden shiner	No	No	Omnivore	Tolerant	
Cyprinidae	Notropis atherinoides	Emerald shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Notropis blennius	River shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Notropis boops	Bigeye shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Notropis buccatus	Silverjaw minnow	Yes	No	Insectivorous	Moderate	
Cyprinidae	Notropis buchanani	Ghost shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Notropis chalybaeus	Ironcolor shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Notropis dorsalis	Bigmouth shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Notropis greenei	Wedgespot shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Notropis heterolepis	Blacknose shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Notropis hudsonius	Spottail shiner	No	No	Insectivorous	Moderate	
Cyprinidae	Notropis maculatus	Taillight shiner	No	No	Insectivorous	Moderate	
Cyprinidae	Notropis nubilus	Ozark minnow	Yes	No	Herbivorous	Intolerant	
Cyprinidae	Notropis ozarcanus	Ozark shiner	Yes	No	Herbivorous	Moderate	
Cyprinidae	Notropis percobromus	Carmine shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Notropis photogenis	Silver shiner	Yes	No	Insectivorous	Intolerant	

Cyprinidae	Notropis rubellus	Rosyface shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Notropis sabinae	Sabine shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Notropis stramineus	Sand shiner	Yes	No	Insectivorous	Moderate	
Cyprinidae	Notropis telescopus	Telescope shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Notropis texanus	Weed shiner	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Notropis topeka	Topeka shiner	Yes	No	Insectivorous	Intolerant	Endangered
Cyprinidae	Notropis volucellus	Mimic shiner	No	No	Insectivorous	Intolerant	
Cyprinidae	Opsopoeodus emiliae	Pugnose minnow	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Phenacobius mirabilis	Suckermouth minnow	Yes	No	Insectivorous	Moderate	
Cyprinidae	Pimephales notatus	Bluntnose minnow	No	No	Omnivore	Tolerant	
Cyprinidae	Pimephales promelas	Fathead minnow	No	No	Omnivore	Tolerant	
Cyprinidae	Pimephales tenellus	Slim minnow	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Pimephales vigilax	Bullhead minnow	No	No	Omnivore	Moderate	
Cyprinidae	Rhinichthys atratulus	Blacknose dace	Yes	No	Generalist	Tolerant	
Cyprinidae	Rhinichthys cataractae	Longnose dace	Yes	No	Insectivorous	Intolerant	
Cyprinidae	Semotilus atromaculatus	Creek chub	Yes	No	Generalist	Tolerant	
Esocidae	Esox americanus vermiculatus	Grass pickerel	No	Yes	Piscivorous	Moderate	
Esocidae	Esox lucius	Northern pike	No	Yes	Piscivorous	Moderate	
Esocidae	Esox masquinongy	Muskellunge	No	Yes	Piscivorous	Moderate	
Esocidae	Esox niger	Chain pickerel	No	Yes	Piscivorous	Moderate	
Esocidae	Umbra limi	Central mudminnow	No	No	Insectivorous	Tolerant	
Fundulidae	Fundulus catenatus	Northern studfish	Yes	No	Insectivorous	Intolerant	
Fundulidae	Fundulus chrysotus	Golden topminnow	No	No	Insectivorous	Intolerant	
Fundulidae	Fundulus dispar	Starhead topminnow	No	No	Insectivorous	Intolerant	
Fundulidae	Fundulus notatus	Blackstripe topminnow	No	No	Insectivorous	Moderate	
Fundulidae	Fundulus olivaceus	Blackspotted topminnow	No	No	Insectivorous	Moderate	
Fundulidae	Fundulus sciadicus	Plains topminnow	No	No	Insectivorous	Intolerant	

Gadidae	Lota lota	Burbot	No	Yes	Piscivorous	Moderate	
Gasterosteidae	Culaea inconstans	Brook stickleback	No	No	Insectivorous	Moderate	
Ictaluridae	Ameiurus melas	Black bullhead	Yes	No	Insectivorous	Moderate	
Ictaluridae	Ameiurus natalis	Yellow bullhead	Yes	No	Insectivorous	Tolerant	
Ictaluridae	Ameiurus nebulosus	Brown bullhead	Yes	No	Insectivorous	Tolerant	
Ictaluridae	Ictalurus furcatus	Blue catfish	No	No	Piscivorous	Moderate	
Ictaluridae	Ictalurus punctatus	Channel catfish	No	No	Piscivorous	Moderate	
Ictaluridae	Noturus albater	Ozark madtom	Yes	No	Insectivorous	Intolerant	
Ictaluridae	Noturus exilis	Slender madtom	Yes	No	Insectivorous	Intolerant	
Ictaluridae	Noturus flavater	Checkered madtom	Yes	No	Insectivorous	Intolerant	
Ictaluridae	Noturus flavus	Stonecat	Yes	No	Insectivorous	Intolerant	
Ictaluridae	Noturus gyrinus	Tadpole madtom	Yes	No	Insectivorous	Moderate	
Ictaluridae	Noturus lachneri	Ouachita madtom	Yes	No	Invertivorous	Intolerant	
Ictaluridae	Noturus miurus	Brindled madtom	Yes	No	Insectivorous	Intolerant	
Ictaluridae	Noturus nocturnus	Freckled madtom	Yes	No	Insectivorous	Moderate	
Ictaluridae	Noturus placidus	Neosho madtom	Yes	No	Insectivorous	Intolerant	Threatened
Ictaluridae	Pylodictis olivaris	Flathead catfish	No	Yes	Piscivorous	Moderate	
Ictaluridae	Noturus maydeni	Black River madtom	Yes	No	Insectivorous	Intolerant	
Lepisosteidae	Lepisosteus oculatus	Spotted gar	No	Yes	Piscivorous	Moderate	
Lepisosteidae	Lepisosteus osseus	Longnose gar	No	Yes	Piscivorous	Moderate	
Lepisosteidae	Lepisosteus platostomus	Shortnose gar	No	Yes	Piscivorous	Moderate	
Moronidae	Morone americana	White perch	No	Yes	Piscivorous	Moderate	
Moronidae	Morone chrysops	White bass	No	Yes	Piscivorous	Moderate	
Moronidae	Morone mississippiensis	Yellow bass	No	Yes	Piscivorous	Moderate	
Moronidae	Morone saxatilis	Striped bass	No	Yes	Piscivorous	Moderate	
Mugilidae	Mugil cephalus	Striped mullet	No	No	Invertivorous	Moderate	
Percidae	Ammocrypta clara	Western sand darter	Yes	No	Insectivorous	Intolerant	

Percidae	Ammocrypta pellucida	Eastern sand darter	Yes	No	Insectivorous	Intolerant	
Percidae	Crystallaria asprella	Crystal darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma asprigene	Mud darter	No	No	Insectivorous	Moderate	
Percidae	Etheostoma autmnale	Autumn darter	Yes	No	Invertivorous	Intolerant	
Percidae	Etheostoma blennioides	Greenside darter	No	No	Insectivorous	Intolerant	
Percidae	Etheostoma caeruleum	Rainbow darter	Yes	No	Insectivorous	Moderate	
Percidae	Etheostoma camurum	Blue Breast darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma chlorosoma	Bluntnose darter	No	No	Insectivorous	Moderate	
Percidae	Etheostoma collettei	Creole darter	Yes	No	Invertivorous	Moderate	
Percidae	Etheostoma cragini	Arkansas darter	Yes	No	Invertivorous	Intolerant	
Percidae	Etheostoma erythrozonum	Meramac saddled darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma euzonum	Arkansas saddled darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma exile	Iowa darter	No	No	Insectivorous	Moderate	
Percidae	Etheostoma flabellare	Fantail darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma fusiforme	Swamp darter	No	No	Insectivorous	Moderate	
Percidae	Etheostoma gracile	Slough darter	No	No	Insectivorous	Moderate	
Percidae	Etheostoma histrio	Harlequin darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma juliae	Yoke darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma mihileze	Sunburst darter	Yes	No	Invertivorous	Intolerant	
Percidae	Etheostoma nigrum	Johnny darter	Yes	No	Insectivorous	Moderate	
Percidae	Etheostoma proeliare	Cypress darter	No	No	Invertivorous	Moderate	
Percidae	Etheostoma punctulatum	Stippled darter	Yes	No	Invertivorous	Intolerant	
Percidae	Etheostoma radiosum	Orangebelly darter	Yes	No	Invertivorous	Intolerant	
Percidae	Etheostoma spectabile	Orangethroat darter	Yes	No	Insectivorous	Moderate	
Percidae	Etheostoma stigmaeum	Speckled darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma teddyroosevelt	Highland darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma tetrazonum	Missouri saddled darter	Yes	No	Insectivorous	Intolerant	

Percidae	Etheostoma tippecanoe	Tippecanoe darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma uniporum	Current darter	Yes	No	Insectivorous	Moderate	
Percidae	Etheostoma variatum	Variegate darter	Yes	No	Insectivorous	Intolerant	
Percidae	Etheostoma zonale	Banded darter	No	No	Insectivorous	Intolerant	
Percidae	Perca flavescens	Yellow perch	No	Yes	Piscivorous	Moderate	
Percidae	Percina caprodes	Logperch	Yes	No	Insectivorous	Moderate	
Percidae	Percina copelandi	Channel darter	Yes	No	Insectivorous	Intolerant	
Percidae	Percina cymatotaenia	Bluestripe darter	Yes	No	Insectivorous	Moderate	
Percidae	Percina evides	Gilt darter	Yes	No	Insectivorous	Intolerant	
Percidae	Percina maculata	Blackside darter	Yes	No	Insectivorous	Moderate	
Percidae	Percina phoxocephala	Slenderhead darter	Yes	No	Insectivorous	Intolerant	
Percidae	Percina sciera	Dusky darter	Yes	No	Insectivorous	Moderate	
Percidae	Percina shumardi	River darter	Yes	No	Insectivorous	Moderate	
Percidae	Percina uranidea	Stargazing darter	Yes	No	Insectivorous	Intolerant	
Percidae	Sander canadensis	Sauger	Yes	Yes	Piscivorous	Moderate	
Percidae	Sander vitreus	Walleye	Yes	Yes	Piscivorous	Intolerant	
Petromyzontidae	Ichthyomyzon castaneus	Chestnut lamprey	Yes	No	Piscivorous	Moderate	
Petromyzontidae	Ichthyomyzon fossor	Northern brook lamprey	Yes	No	Filter feeder	Intolerant	
Petromyzontidae	Ichthyomyzon gagei	Southern Brook Lamprey	Yes	No	filter feeder	intolerant	
Petromyzontidae	Ichthyomyzon unicuspis	Silver lamprey	Yes	No	Piscivorous	Moderate	
Petromyzontidae	Lampetra aepyptera	Least Brook lamprey	Yes	No	Filter feeder	Moderate	
Petromyzontidae	Lethenteron appendix	American Brook lamprey	Yes	No	Filter feeder	Intolerant	
Poeciliidae	Gambusia affinis	Western Mosquitofish	No	No	Insectivorous	Tolerant	
Polyodontidae	Polyodon spathula	Paddlefish	Yes	No	Filter feeder	Intolerant	
Salmonidae	Oncorhynchus mykiss	Rainbow trout	Yes	No	Piscivorous	Intolerant	
Salmonidae	Salmo trutta	Brown trout	Yes	No	Piscivorous	Intolerant	
Salmonidae	Salvelinus fontinalis	Brook trout	Yes	No	Piscivorous	Moderate	

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