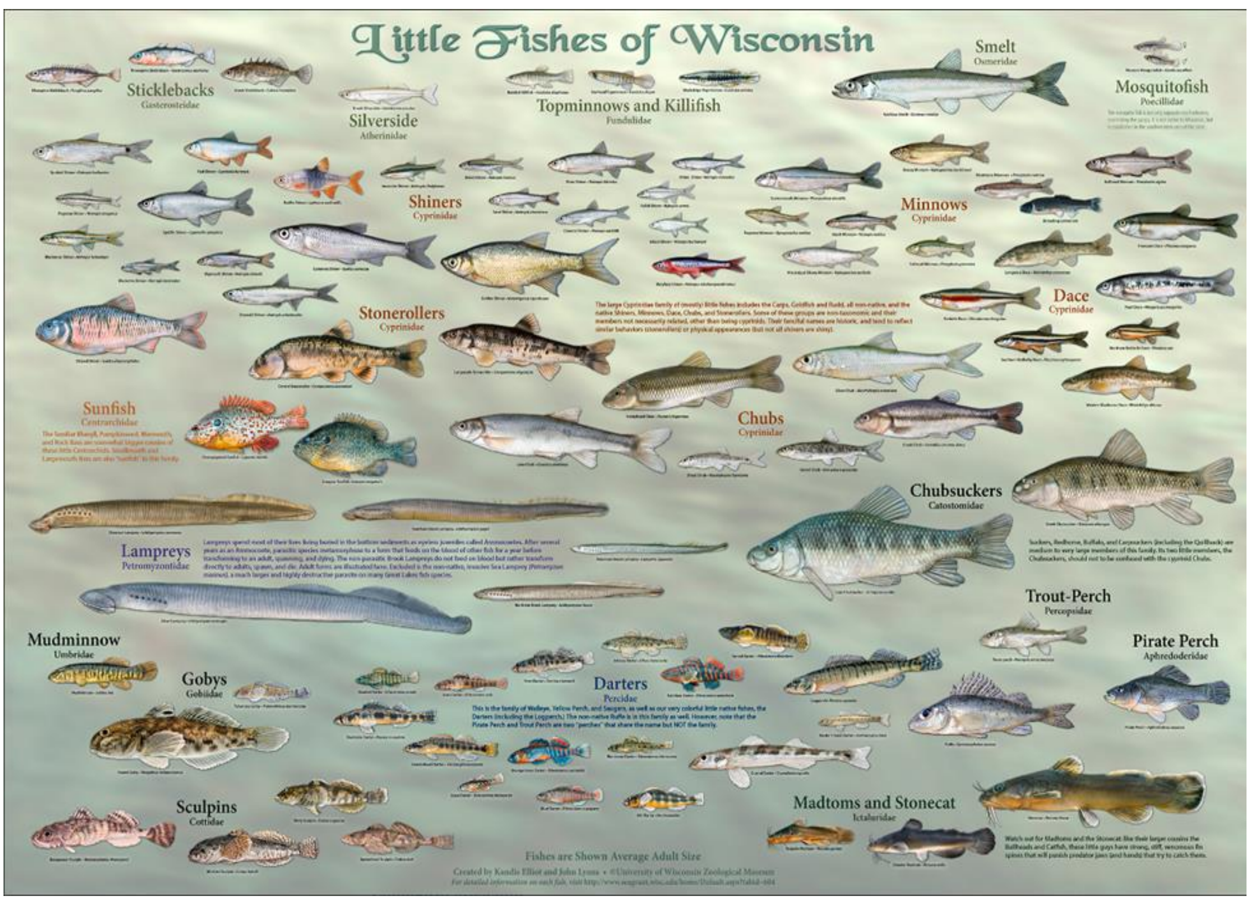
Guidelines for Assessing Fish Communities of Wadeable Streams in Wisconsin v2.0

Contents



A. Introduction and Scope

There are numerous environmental stressors that have potential effects on the biologic communities, and the overall health of stream ecosystems. Many of these stressors vary considerably in space and time, and it may be difficult to unravel the interacting effect of many stressors present ephemerally, or only present at low levels. By directly assessing the composition of fish in a waterbody we can directly observe the overall effects of many stressors on aquatic life, by directly examining changes in the structure or composition. Fish are good indicators of environmental quality as they are long lived, so the composition of the assemblage reflects the cumulative environmental quality over a longer time period. Additionally, fish community composition is largely influenced by stream size and temperature combinations so that accurate expectations for a healthy fish community can be used to develop benchmarks.

This standard operating procedures (SOP) document pertains to the collection of fish in wadeable streams for the calculation of one of the WDNR's fish Index of Biotic Integrity (fIBI). Individual fish IBIs are developed for warmwater streams (Lyons 1992a), coldwater streams (Lyons et al. 1996), headwater streams (Lyons 2006), and cold transitional and warm transitional streams (Lyons 2012). For purposes of the fIBI, a wadeable stream is a stream that is wadeable (generally <1.5 meters deep) in greater than 50% of the study reach during base flow. A separate SOP outlines procedures for collecting fish in nonwadeable rivers to calculate the large river fish IBI (Lyons et al. 2001).

The Wisconsin Department of Natural Resources uses the fIBI as an indicator of aquatic ecosystem health and to assess against appropriate aquatic life benchmarks. The fIBI was built to reflect structural changes in fish assemblages in response to local and watershed-level disturbance, riparian condition and local habitat quality. As such, the fIBI reflects the response of the fish assemblage to multiple types, and multiple scales, of environmental disturbance.

This SOP also pertains to the collection of fish samples to calculate additional metrics useful for describing fish composition besides the fIBI. Additional metrics are calculated by the WDNR Fisheries Management database based on the observed assemblage. For example, metrics such as the percent tolerant or percent intolerant individuals, catch per unit effort, species length-frequency distributions, among others, have been used to evaluate the status or trends of waterbodies by researchers and resource managers for decades. These metrics can be useful for analyzing fish assemblage composition depending on the specific study objectives.

To calculate the fIBI for biologic assessments samples must be collected in a consistent, standardized process from standard habitat types. Sections B-F describe the standardized fish data collection methods from wadeable streams. Additional recommended methods for non-standard fish collections are discussed in Section G.

B. Summary of Method

Fish sampling from wadeable streams for the calculation of the fish IBI (fIBI) must occur during the appropriate index period which is generally May 15th - September 15th, with adjustments made for a rough north-south statewide split. General index period for the southern 2/3 of the state is May 15th – September 30th, while the index period for the northern 1/3 of the state is May 30th-September 15th. These dates may be adjusted earlier or later depending on specific seasonal weather patterns. Sampling should be conducted well after spring runoff and before fall high water and at least one week after summer high water events. Additionally, temperature changes can trigger fish movement causing additional catch, or resident fish leaving the reach. Sampling should be conducted after spring rapid temperature rise (>~55 °F) and before the rapid drop of temperature in fall (<~60 °F). Electrofishing should be conducted during periods of sufficient water clarity. As a general rule, at least 30cm is required for effective netting. However, some streams rarely have visibility this high (e.g. disturbed streams in clay soil watersheds) and low visibility conditions should always be noted in the database (ideally as measured with turbidity tube). Lastly, water levels should be near baseflow. Usually there will not be a long-term flow record for that site and staff will have to gauge bankfull height from riparian clues and determine if stream is at or below that level.

It is advised to enter the stream at the downstream end of the sampling reach (working upstream). The sampling station should begin outside of the influence of dams, bridges or other manmade structures at the access point that change the hydrology of the steam channel. Start the station at least one complete pool-riffle segment or 10 times the mean stream width away from any structure. Look for a riffle or other fish movement impediment to begin the station. At this location, measure at least five representative stream widths and calculate the mean stream width (MSW). Total reach length will be equal to 35 times MSW, with a minimum of 100m and maximum of 400m. WDNR research determined that at 35x MSW, stream shocking will capture 95% of the fish species present at that site (Lyons 1992b). The sample reach should end at another fish movement barrier, the total reach length can be slightly shortened or extended to end at a fish movement impediment (e.g. riffle). Take care not to overly disturb the stream reach when measuring stream widths or laying out the reach. If there are soft sediments and/or slow stream velocity, disturbing the stream bed will lower visibility and decrease collection efficiency. It is more important to stop and start the stream reach at fish movement barriers, than have a stream reach of exactly 35x MSW. Some stream reaches will consist solely of slow-moving run habitat with no riffles, staff should do their best to find some other fish movement deterrent, if possible. If conducting a quantitative fish physical habitat survey, this will be conducted in the same reach as the fish survey (WDNR 2002).

Downstream of the beginning of the reach, test the electrofishing equipment and safety gear before conducting your sampling run. For small streams (less than ~2 meters MSW), a single backpack shocker is usually adequate for collecting fish. Anything larger will require the use of 2 backpack shockers, or ideally a tow barge electrofishing unit. Conduct a single pass of the sampling reach moving upstream covering the entire stream using a zig-zag pattern to sample all habitat types (run, riffle, pool). Spend extra time shocking area that likely hold more fish using your probe to reach into undercut banks, large woody debris, deep holes, etc. Collect all possible fish and transfer to a holding tank (plastic tub, bucket, etc.) for later identification and enumeration. For longer reaches, or sites with high abundance or biomass of fish, staff may need to frequently stop, identify and release captured fish to ensure survival. If stopping mid-station is necessary, try to stop as some sort of natural barrier such as a riffle to prevent released fish from moving upstream back into the sampling reach. Finish the station at a natural fish barrier, then count and identify to species and all individuals captured.

C. Safety

WDNR staff must follow specific safety SOPs that are related to electrofishing. Fisheries Management and Water Quality Bureaus have collectively developed written and in-person trainings that staff must attend on a regular basis (e.g. 5-year electrofishing certification). WDNR staff from other programs and volunteers must complete electrofishing trainings before they are allowed to participate. Additionally, Water Resources stream biologists are required to attend electrofishing and non-gamefish identification trainings as they are offered. All other Department, Division and Bureau field sampling and safety SOPs pertain while electrofishing.

D. Equipment

Be aware of your equipment's capabilities and limitations. Read the appropriate user manual and be familiar with the operation of your particular unit. You will increase the efficiency and life of your equipment by following those guidelines.

Pulsed DC Backpack Shocker

A backpack shocker is a self-contained, highly portable electrofishing device that, as the name suggests, is worn on the operator's back. They are typically used in streams less than 2 meters wide, although multiple units/operators can be used on larger systems. An external 12-volt battery powers the unit and is generally capable of outputting 0.5-5 amps and a 100-600 volts. An anode and cathode are attached to the shocker. The operator carries the anode in one hand and a net for collecting stunned fish in the other, while the cathode trails behind in the water. The operator moves upstream, sweeping the anode from side-to-side, collecting the fish and transferring them to another person carrying a bucket.

Some pulsed DC backpack shockers allow the settings to be varied, whereas others have a single fixed value for pulse rate and duty cycle. If values can be varied, they should be set to the appropriate level at the beginning of sampling and not changed during sampling. This may require preliminary sampling just outside the reach to determine the values where shocking is most effective. The same values should be used for all sampling within a station, between stations within a stream, and among samples of the same station over time. Sampling for many species is most effective and least harmful at pulse rates of 40-80 per second and at duty cycles of 10-20%. This information must be recorded on the data sheet and entered into the database.

"Straight" DC Stream Shocker

A typical stream, or tow barge, shocker consists of a floatable craft ("boat"), generally made from plastic, Kevlar, or other material rugged enough to withstand being pulled over rocks or other hard substrate. The boat may be small enough to fit in streams as narrow as 2 meters, but can be used for much larger, wadable streams. The boat must be large enough to contain the basic components of an electrofishing system including a generator, container for holding fish, and a control box with a rheostat to control power output (generally 2.5-8 amps) and provide connection for 1 to 3 anodes. A 12-volt battery powers the control box safety circuits. The bottom of the boat contains stainless steel strips to act as a cathode. The stream shocker is pulled upstream by 1 person who is responsible for pulling the boat, controlling electrical output (amps/volts), tending to reels and cords, placing fish in the holding tank, and most importantly, shutting off power should an emergency arise. One to three other people then each tend to their respective anode, carrying a net and capturing the stunned fish. The size of the generator required is based on the number of anodes required for sampling, conductivity of the stream, and output necessary to effectively collect fish (see “A Guideline for Portable Direct Current Electrofishing Systems (WDNR, 1971)).

Other equipment

Standard chest waders (breathable waders are not allowed when electrofishing)
wading belts
Polarized sunglasses
Hearing protection
Clipboard, data sheets
GPS
Surveyors tape
Nets - 1/8-inch mesh size
Measuring device (e.g. “bump-board)
Camera (for vouchering)

Conductivity and Electrofishing Efficiency

The conductivity, a measure of the concentration of dissolved ions in the water, is one of the major factors that affects electrofishing efficiency. Observed conductivity ranges in Wisconsin are anywhere between 50-1500 µS/s, while the optimal range for electrofishing is ~200-300 µS/s. This means that it is relatively common to encounter conductivity that is outside the optimal range while conducting a fish survey.

In waterbodies with extremely low conductivity, below 100 µS/s, such as bog drainage or stained northern streams, it may be difficult to produce enough power to sufficiently stun fish. To compensate for these situations, use more power or increase anode surface area to increase amperage. If increasing the voltage, use caution as this is more dangerous to the operator(s) and may harm fish.

High conductivity waterbodies, greater than ~600 µS/s, cause electrofishing problems as the amperage is too high. Operators can decrease the surface area of the anode or decrease the pulse rate of the duty cycle on backpack units. In extremely high conductivity waterbodies, those greater than ~1000 µS/s, it may be very difficult to efficiently net fish. The current may bypass the fish tissue altogether as the conductivity of the waterbody approaches that of fish tissue. Additionally, using standard backpack shockers in systems with conductivity greater than ~1000 µS/s may cause catastrophic failure of the unit. Specially modified units that work in high conductivity waters, or mini-tow barge shockers are the recommended equipment in these systems. Extremely high conductivities can be found in highly urbanized systems or in certain effluent dominated streams.

E. Collection Procedures

The following procedures outline the step-by-step approach for fish collections from wadeable streams. These procedures assume fish data collection is for calculating the WDNR fish IBI and conducted during the appropriate index period. Read Section B for a summary of these procedures before following the step by step procedures below. There are numerous situations that can be encountered when working on the variety of streams across Wisconsin, and all those site-specific conditions cannot be covered here. All WDNR staff must accompany experienced Water Resources staff to gain first hand, peer-to-peer training before leading their own electrofishing crew. There are many other fish collection procedures that can be used to calculate numerous other fish metrics that do not have step-by-step details outlined in this SOP; some are discussed in Section G.

Sample Collection

1. Ideally, approach the target reach downstream or, if approaching from upstream avoid disturbing the site as much as possible and wait for water clarity to return to normal before electrofishing.
2. Starting at least 10 stream widths, or one riffle-pool complex, away from man-made objects affecting hydrology to begin looking for a place to begin the sampling reach. The reach should begin at a fish movement impediment (e.g. riffle). If none are found, select any representative location.
    a. Record all pertinent information on the field data sheets that describe the beginning location (e.g. GPS location), site location and time.
    b. Near the start location, measure stream width at 5 representative locations and calculate the mean stream width (MSW). The total length of the sampling reach is calculated as 35 times the MSW.
3. Establish the end location of the reach, either before the sampling run or during the electrofishing run.
    a. Staff may desire to “lay-out” the station before sampling begins by using a tape measure (100-meter minimum recommended), GPS or range finder.
    b. Conversely, staff can measure the distance “as they go” using a tape measure or GPS attached to the electrofishing staff/equipment. Measuring as-you-go is only advised if the reach is very narrow/small (i.e. 100m) and easily measured, or if it is a slow velocity stream with the stream bed is full of fine sediment and will take a long time to clear following a disturbance.
        i. If using a GPS unit in a wooded environment or other conditions which may impede satellite coverage GPS readings may be unreliable.
        ii. In wide streams, which requires lots of horizontal movement from the electrofishing operators to cover bank-to-bank, GPS readings may severely underestimate reach length.
4. After locating the end of the reach (35 x MSW) look for another fish movement barrier to mark the end of the reach. The reach can be slightly shortened or extended to find a good barrier. Record the end GPS location of the sampling reach on the data sheet.

   a. It is more critical to find a fish barrier at the end of the reach than the beginning. As you work upstream electrofishing, highly mobile fish may be "pushed" upstream as they try to avoid the electricity. A barrier will trap fish in the reach from escaping outside of the reach and allow collection.
5. At the beginning of the sampling reach turn on electrofishing equipment to ensure proper operation (test safety switches, check meter readings). Ensure that all staff have safety gear (hearing protection, wading belts, polarized sunglasses).
6. Begin sampling run by moving upstream in a zig-zag pattern covering all habitat types. Staff should attempt to capture as many fish as possible, taking special care to check for small fish that are easily missed.
7. Working upstream, net stunned fish and transfer to the holding tank (generally a 5-gallon bucket for back-pack sampling or a tub placed inside the tow barge). For all fish, but especially larger fish, always try to net individuals head-first. For best results assume fish are deeper, larger and more active than they appear. Netting aggressively will lead to a higher capture rate.
   a. Try to transfer fish into the holding tank as soon as possible. Making multiple net-dips will expose previously collected fish to electricity more often than needed, possibly leading to mortality.
8. Cover all habitat types, remembering different sampling strategies are required to efficiently collect fish on different habitats, such as:
   a. Riffles: Small bottom dwelling fish often inhabit riffles, these can be difficult to see and net. Try placing the net firmly against the bottom of the riffle and use the probe to sweep in an upstream to downstream motion (towards yourself and the net) using the water velocity to sweep fish into your net.
   b. Runs: Typically, this is an easy habitat to collect fish, however fewer fish are usually located in open runs due to the lack of habitat cover. Attempt to zig-zag through runs covering as much area as possible, including shorelines with overhanging vegetation. Often, large fish will be visible in runs but will swim upstream to avoid the electricity. Keep forcing the fish upstream and they will usually find some cover to hide under, or be trapped by the next riffle where they are easier to collect.
   c. Pools: Pools are slow, deep pockets of water that often hold some of the larger fish in a stream. If large enough, pools may be too deep to wade and effectively shock. Position staff downstream to deter fish from escaping, and reach into the pool with your probe slowly raising the probe to the surface. Fish will be attracted to the probe and may raise to the surface where they are visible. Be patient, it may take many attempts to "raise" fish from deep pools.
   d. "Fishy" habitat: Pay particular attention to likely fish hiding places, such as undercut banks, log jams, pools at the bottom of riffles, or any other obstruction that provides cover. If the habitat is particularly large, two crew members may be needed to shock the same area. Pay attention to positioning, so any fish that escape must do so upstream. Then thoroughly work the area with your probe, reach under

obstructions and pulling the probe towards you as fish are attracted to the end of the probe.

e. While sampling larger streams with a tow barge with multiple probes, large woody habitat may be difficult to access and effectively stun and net fish. A technique such as a fish drive may prove fruitful. Position two probes on the downstream end of the large woody debris, have the outside probe swing upstream along the opposite bank and then begin working the woody debris downstream towards the other two probes taking care to not overly disturb sediment and limit visibility of the downstream operators.

In small streams fish identification and enumeration can be conducted at the end of the sampling run. If the stream is large, or progress is slow (high biomass of fish, slow wading around/over obstacles, etc.), then you may need to stop one or more times during sampling run to count and identify fish to ensure survival. Check on the condition of fish during the sample run, if some fish are "belly-up" or the holding tank looks full, then you will need to stop the run. Again, if stopping mid-station is necessary, try to stop as some sort of natural barrier such as a riffle or treefall to prevent released fish from potentially moving upstream.

Fish Identification and Handling

When the fish survey has been completed, all fish captured must be identified to species and recorded on the datasheet. In general, one person will record the information on the datasheet while one or more are identifying and returning fish to the stream. There are multiple resources for field identification of Wisconsin fish species. A few good resources are "UW Sea Grant Institute's Wisconsin Fish Identification Tool" (available at www.wiscfish.org and as mobile app) and "Field Guide to Wisconsin Streams" (Miller et al. 2014). Accurate identification to species of all individuals is important as the species diversity and composition affects the fIBI calculation. Any uncertain fish in the field should be vouchered and later verified (see Specimen Vouchering section). A good preparation step prior to conducting a fish survey is to review any previous fish surveys in the waterbody; however, that does not substitute for accurate field identification training. Very few species (e.g. lamprey ammocoete, rosyface/carmine shiner (*Notropis rubellus/N. percobromus*)) are not able to be field identified to species during the recommended summer time survey period.

Measuring Gamefish

Many staff choose to measure lengths of individual gamefish species for additional informational purposes, or for data sharing with Fisheries Management. If desired, staff can measure the length of certain species to track changes in gamefish numbers and size structure at a particular site. If many young-of-the-year (YOY) are present it is recommended that staff measure the first 25 individuals, then count the remaining. Staff may measure all YOY if desired.

Suggested Species to Measure Individual Lengths	
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salmo trutta*
Rainbow trout	*Onchorhynchus mykiss*
Northern pike	*Esox lucius*
Smallmouth bass	*Micropterus dolomieu*
Largemouth bass	*Micropterus salmoides*
Sauger	*Stizostedion canadense*
Walleye	*Stizostedion vitreum*
Catfish Species	
"Panfish" Species	

Specimen Vouchering

Photo Verification

Following the completion of the fish survey, there may be fish collected that cannot be confidently field identified to species. A decent camera can capture images sufficient to properly identify most species and is the recommended method of specimen vouchering. Photo verification allows for the specimen to be returned to the stream while allowing accurate identification. A good side profile of the fish needing verification is usually sufficient. If the specimen in question is close in description to another fish species, then a picture of the distinguishing characteristics (i.e. mouth, fins) is recommended. The resources for field identification of Wisconsin fish species can help identify the distinguishing characteristics between related species.

Preservation

If pictures cannot be taken or a decent camera is not available, specimens can be preserved for vouchering. It is recommended to bring freezer bags along on fish surveys to store fish until return to the office. The date and location of the survey should be written on the bag. The number of fish vouchered should be documented on the datasheet. If immediate identification of the fish cannot be attained, fish can be chemically preserved with formalin or alcohol (ethanol is usually available at WDNR offices as it is the preferred preservative for macroinvertebrates).

Fish may lose colors and tissue integrity which makes identification difficult if preserved in formalin or alcohol. Transportation, exposure and storage safety concerns may limit the availability of formalin. Ethanol is not ideal for long-term storage, or storage of large bodied fish for any length of time. For these reasons photo vouchering or immediate freezing is advised to avoid the use of chemical preservatives. Once verified, the correct species name and count should be written on the datasheet and the specimen can be discarded. Biologists should remember to record the data for the previously unidentified species on the appropriate field sheets and in the FM database.

F. Data Management

In SWIMS

a. Determine if you are using an existing station or creating a new station for your sampling event. This information can be easily checked by turning on monitoring locations in the Surface Water Data View (search this term on WDNR website to access the Viewer).

b. Contact a SWIMS database coordinator if you need help or user permission to create a SWIMS Station.

   i. If you need to create a new station this can be done before the fish collection, but is not required.

   ii. Do not create multiple SWIMS stations that are very close to each other. If needed, exact location (GPS) can be included later in the site information on the field form. Also, include approximate distance upstream or downstream of the road crossing (or SWIMS Station ID) if the sample isn't exactly at the SWIMS station location, which is usually located at a road crossing.

In FMDB

a. Prior to entering fish collection data in the FMDB, the SWIMS station should be linked. The connection can be easily checked by turning the FMDB layer on in the SWDV and ensure the fish icon is present at the SWIMS station. If not then proceed to link the SWIMS station to the FMDB.

   i. The FMDB is managed cooperatively between WDNR and USGS. To ensure proper and consistent data entry please refer to data entry guidance and instructions specific for this database.

Field Sheets

a. Over the years, many staff have developed and use various forms for field data collection. It is not necessary to use a specific field form for data collection only that specific and correct information is collected to ensure applicable metrics and indexes can be calculated. The recent development of the Fish and Habitat field form tool for use with a Microsoft tablet has allowed for an alternative data collection and entry mechanism. As with a paper form, certain critical information is required to be collected and entered with the use of a field tablet. See below for specific fields and parameters to collect while conducting a fish survey visit.

Fields required to be recorded and entered into Fisheries Management Database

1. **Site Data**
   a. Collectors – Names of all collectors
   b. Sample Date – DD/MM/YYYY
   c. Waterbody Type – Wadeable Stream
   d. WBIC – Water Body Identification Code
   e. Site ID (SWIMS ID) – Should be SWIMS ID for all Water Quality projects
   f. County - Location of sample reach
2. **Survey Data**
   a. Primary Survey Purpose – One of many options depending on project type
   b. Primary Survey Type – Electrofishing
   c. Primary Target – All Species for any IBI run
   d. Distance Shocked (and units) – measured with a measuring tape, GPS or GIS
   e. Mean Stream Width – meters, important, this is required for the calculation of Cool-Warm Fish IBI
   f. Type of Pass – Single upstream
   g. Start Time and End Time – Record times or total minutes
   h. Water Temperature (°F) – spot measurement at time of survey
   i. Notes – enter any notes about survey or site directly into FMDB
3. **Electrofishing Equipment**
   a. Gear Type - Stream Shocker or Backpack Shocker
   b. Number of Gear Units – Number of shocking units
   c. Number of Probes – Usually 1-3, may be more if multiple Gear Units
   d. Current Type – Straight DC or Pulsed DC
   e. Volts – Readout from shocking unit
   f. Amps – Readout from shocking unit
   g. Dipnet Mesh Size – Should be 1/8-inch

G. Non-Standard Collection Procedures

Alternative sampling methods can be used to assess the current biologic status of fish depending on the data needs. Other metrics that describe fish structure may be a better estimation of the current condition of a site, depending on the specific project objectives. The following briefly describes situations where staff may want to consider alternative fish collection methods; this list is not exhaustive of all possible scenarios and procedures.

Occasionally staff may be involved in projects where the fish survey is not intended for computation of a fish IBI. Depending on specific project objectives staff may be involved in sampling to detect rare or transient species, document presence of early life stages or conduct thorough abundance/biomass surveys. For these situations, or other similar data needs, modification to the above procedure can be made by adjusting the following techniques. If standard WDNR protocols (outlined above) are not followed, the data cannot be used to calculate one of WDNR's fish IBI's.

1) Mesh size – WDNR standard protocols require 1/8-inch mesh size for dip nets. This size opening is adequate for all but the smallest fish (young of the year (YOY) or lamprey may escape). If a specific project is documenting abundance of YOY or other extremely small-bodied individuals, a smaller mesh size is beneficial.

2) Seasonal presence – If a project objective requires the detection of fish that may only be present in the stream seasonally, monitoring will be required outside of the traditional IBI index period. Some fish species may only use a particular stream reach for spawning or overwintering, and not be detected during traditional surveys. Use caution when designing a monitoring plan as some spawning fish will only occupy a stream for a few days when conditions are right, and may be very difficult to find through electrofishing methods. Other approaches may include visual surveys for eggs, redds, eDNA sampling or searching historical records.

3) Block nets – if precise abundance or biomass estimates are required for a survey, then block nets may be necessary to prevent upstream fish movement out of the sampling reach. This may be especially important in run dominated streams with little fish cover or natural riffles to prevent escape. Additionally, if two block nets (upstream and downstream) are deployed multiple passes can be made to ensure a high capture rate.

H. SOP Tracking and Updates

Version Number	Date	Sections	Name	Approval
1.0	03/2001	All		
2.0	04/17/2018	All	Stream Tech Team	Mike Shupryt

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