

Standard Operating Procedure 9: Fish Sampling, version 1.0

Fish sampling in Shenandoah National Park involves multiple-pass electrofishing. To prevent fish from entering or leaving the sample site during sampling, field crews will ensure that appropriate barriers to fish movement are present at the downstream and upstream end of the sample reach. A list of fish species encountered in SHEN is in Table 1. Tables of site information on the number of personnel and electrofishers recommended for each site are included in Appendix A.

1. Constructing a habitat break.

- a. Upon arrival at individual monitoring sites, the upper and lower tag trees need to be located and the associated start and end points of the reach need to be identified. These points then need to be assessed for adequacy as barriers to fish movements into or out of the site. This is important as fish movements into or out of the site should be minimized during sampling. Habitat breaks at some of the sites require additional measures such as the construction of temporary impediments to fish movement using adjacent cobble or small boulders. Before making any modifications to habitat breaks, particularly at the upstream end, make sure that all activities associated with the use of the Hydrolab® have been completed. Otherwise, modify each habitat break as necessary to impede fish movement. In many cases, the existing breaks are adequate and consist of relatively permanent geomorphic features (e.g. bedrock or boulder step). During assessment or construction of the upper break, it is helpful if the upstream break is temporarily visually marked for the electrofishing crew. Small rock cairns can function as a useful reference aid to electrofishing crews working upstream. This action can be accomplished expediently by one person in between the Hydrolab® sample and the first electrofishing pass.
- b. Block nets are typically needed at the largest sites (lower Rapidan and lower Moorman's River) to adequately block the downstream end of these sections to impede fish movements into or out of the site. Associated gear includes a 100' x 3/8" length of steel cable, 3/8" cable clamps, 45 double-ended snap connectors and a 3/8" socket set with spare 9/16" sockets. These items are typically stored together in a single five-gallon bucket. A cable is first stretched between two trees. Then the top of each net is suspended from the steel cable and the bottom of the net is anchored to the streambed with large rocks. The net should be visually inspected for stuck fish during or after each run.

1) Setting up the electrofisher.

- a. The remainder of the crew should be busy assembling the electrofishing gear and/or setting up a fish processing site. At this point, all personnel assigned to participate in the first electrofishing pass should have the appropriate waders or hip boots on, and should have located a suitable pair of gloves and polarized glasses. The person running the backpack unit should ensure that the probes are properly attached and the battery is plugged in before putting the battery cover back on the unit. A uniform setting of 70 Hertz and a pulse width of 1 millisecond is used across all park waters – this is an established and effective setting for

electrofishing brook trout in Virginia. For the battery units, this is the 7% setting for the duty cycle and for the Generator units it is “J” on the alphabetical knob and “2” on the numerical knob. For adjustment or use of LR-24 electrofishers, see Smith-Root manual (Smith-Root 2009).

- b. When using the generator units: Prior to the first pass of the day, it is a good idea to start the generators and allow them to warm up for several minutes before entering the stream. Let them run at the high RPM setting otherwise they foul the sparkplugs extremely fast. Make sure that the fuel cap lever is set to the ON position. Locate the engine switch on the generator and set it to the choke position. After taking up the slack, pull the starter cord rapidly to start the engine. One or two pulls are usually sufficient. Then, move the engine switch from choke position to ON. The person designated to operate the unit needs to make sure that the probes are securely attached to the transformer box and that the box is plugged into the generator.
- c. Voltage outputs on all units will be set to the same range as determined by stream conductivity (see table 1). All unit voltage settings will be determined by either the fisheries program manager or the lead biological technician. Volume of flow and the reaction of fish to the electrical field will dictate the final setting. All settings should remain the same through all electrofishing passes for that stream reach.

Table 1. The voltages listed in this table are approximate starting points for adjusting the voltage for a particular conductivity.

Conductivity (uS/L)	Approximate Voltage Setting (v)
10	1,000-1,200
20	900-1,000
30	600-800
40	400-500
50	300
60	300
70	200
80+	100

2) **Electrofishing.**

- a. Each unit will be tested briefly at a point downstream from the lower habitat break to evaluate fish responses to the selected outputs. Following any last minute adjustments, the timer of the electrofisher is reset to zero and the first pass begins immediately above the lower habitat break. On sites where two or more units are being operated together, the operators must work together as a team and remain abreast of each other in the streambed along with associated netters to the extent possible. The line abreast crew formation should methodically shock all habitats while electrofishing in a manner as appropriate to minimize fish escapes downstream. The electrofisher operators set the pace of the entire stream crew and should maintain a constant forward momentum, but not move so fast that habitat

is missed. The objective is three thorough and efficient passes of equal effort through the site. Following the conclusion of each pass, record the number of seconds of electrofishing effort in association with the identification number of the electrofisher(s) utilized in the sampling effort (all SHEN electrofishers have an identification number clearly marked on the machine). If more trout are caught on the 3rd pass than on the 2nd pass, a 4th pass will be conducted to establish a depletion curve.

- b. Although some fish smaller than 40mm may be captured, in general, little effort will be spent by the electrofishing crew in the pursuit and capture of fish smaller than 40mm. This is due the difficult identification of small cyprinids, high mortality of small fish during electrofishing events, and inadequate mesh sizes on sampling gear for capture of fish less than 40mm in total length.

3) Netting, Bucketing, and Transporting Fish.

- a. All fish encountered within the site should be netted and bucketed as quickly and efficiently as possible. Stunned fish should be netted with a rapid scooping action from below, not from above the fish. Anticipate receiving a large number of fish from the net attached to the anode as the operator will be routinely passing stunned fish to the nearest available netter. The benthic fishes including suckers, sculpin, darters, and some dace routinely become lodged in streambed substrates. These fish often have to be extracted by hand and it is imperative to make sure that the operators have cut power to the probes and raised them clear of the water before reaching for a lodged fish. Netters should never stick their hands in the water without verbal conformation with **ALL** personnel who are operating electrofishers (see SOP 2).
- b. Those persons carrying and transporting buckets are responsible for the welfare of the captured fish. Moderate volumes of live fish in the buckets should be routinely transported to the processing site. **Always work to prevent overcrowding in the buckets and overheating of the bucket water.** During the first pass, on sites of high fish volume, or at sites with water temperatures in excess of 16 °C, transports from the stream crew to the processing site may be as frequent as every five minutes. In most cases, there will be additional personnel on site that can serve in this role. Water management and the prevention of overcrowding in the buckets is the key to fish survival. On sites where fish abundance is not as great, the water in individual buckets should be changed and replaced with fresh water from the stream about every eight minutes prior to transport to the processing site. In these cases, do the water changes at a convenient habitat break so that the operators can momentarily stop electrofishing. Water changes should not be done over the stream to prevent accidental escapes. Rather, move to a convenient location on the adjacent stream bank, pour the fish into one of the large dip nets and then dump the fish into a bucket of fresh water. If any fish manage to flip out of the net or bucket during the transfer over land, they can quickly be recovered. On sites with a large number of small fish (e.g. juvenile blacknose dace) place one net inside the other and then pour the fish from the bucket. This will trap most of the smaller fish that slip through the holes in the first net.

4) Processing Fish.

- a. At the processing site, there will be at least one and possibly three or four large plastic tubs each containing 15 to 18 gallons of fresh stream water. When high numbers of fish are present, it is most convenient to sort fish from one or two of the large tubs. To keep the water in the tubs fresh and relatively free of debris, any transported fish should first be poured into a large dip net and then dumped into the tub(s). On sites having relatively low fish volumes, it is often more convenient to sort from the five gallon buckets, exchanging buckets with fish for empty buckets as needed for transport. Trout should be sorted into and recovered in the plastic tubs since they tend to be the larger fish, both in terms of body size and total volume in the sample. They should be processed in small lots in a 5 gallon bucket. The same principle should be applied to other species as well when large volumes of individual species are captured. The large tubs in these cases are the best line of defense against additional stress and/or mortality. Otherwise, the typically smaller volumes of other fish species can be easily accommodated, by species, in five-gallon buckets.
- b. Only staff that are familiar with the species found in a study reach should be responsible for fish identification and sorting.
- c. In situations where there are enough personnel for a separate processing crew, trout processing can begin once the first of the transported buckets has been sorted. If fish are to be anesthetized, refer to anesthesia directions (included with anesthetic) or consult with the lead biological technician.
- d. All gamefish (salmonids and centrarchids) are individually measured to the nearest 1.0 mm and weighed to the nearest 0.1 g. For measuring total lengths, place fish on the measuring board nose first such that their nose is in contact with the wooden stop at the “0” end of the ruler. Record the total length out to the absolute tip of the compressed caudal fin. If the gamefish has a physical deformity, discoloration, unusual feature, or is collected for other research questions, please note this on the data sheet (see Notes Codes on datasheet). Next, make sure that the electronic balance has been tared to “0” (while the container being used as a pan is present on the balance), place the fish into the container on the balance and record the total weight. Due to water accumulations in the container, or wind, or other variables, the balance will likely need to be tared after each fish. Immediately following both measurements, the fish should be returned to a tub containing fresh water (designated as the “recovery bucket”). Water can be quickly poured out of the container following each fish to reduce re-taring.
- e. Following each pass, make the line between the rows on the gamefish data form (SOP 19) darker and extend it to the margin. This will greatly expedite distinguishing the pass number during data entry while ensuring an accurate count for the number of fish to be added for data entry.
- f. The nongame fish (i.e. not trout, centrarchids, or ictalurids) should not be subjected anesthetized (**with the exception noted below**) since they are not processed individually. Once the entire pass has been completed, and all of the nongame species sorted, the entire catch, by species needs to be counted. After the total count has been recorded on the nongame data form (SOP 18), determine the smallest and largest fish of each species and record or call out the length of each.

Also, record or call out the total number of mortalities or dead fish by species. **Make sure that the data recorder acknowledges the receipt of each record since there may be several people processing nongame fish simultaneously.**

The data recorder needs to make sure that each entry for a particular species corresponds to the current electrofishing pass being processed. Once all of the count and length data have been recorded for an individual species, a mass weight needs to be determined on the balance. Use a larger container for this since fish will be flipping about as soon as they are poured into the container for weighing.

In situations involving large numbers of individual nongame species, particularly blacknose dace, it may be helpful to very briefly anesthetize the fish prior to the taking the cumulative weight. This reduces the tendency of fish to flip themselves out of the container while the lot is being weighed. Record total mass weights for each species to the nearest 0.1 g. Due to balance precision, fish weighed on the 6,000 g scale can only be measured in 0.5 g increments.

- g. As the fish processing for each species including the trout are completed, have them immediately transported to holding cages located in the stream, outside of the transect. To reduce additional mortality during fish recovery, holding cages should be set up in areas where current velocities are extremely low and depth is maximized. All fish from all passes will be held in the holding cages until the site is completed.

5) **Multiple Passes.**

- a. Passes two and three and the associated transport and fish data processing will be done in a similar manner as the first pass. The primary difference is that fish volumes should dramatically decrease with each successive pass. In the event that more trout are captured during the third pass than during the second, a fourth pass will be conducted to reestablish the depletion curve. At the conclusion of all passes, all live fish are released back into the stream in the approximate proportions and habitats from which they were captured. All mortalities are separated out during processing and disposed of well away from the stream bank, preferably under a log or large rock.

Table 1. Shenandoah National Park Fish Species List (2017)

COMMON NAME	ACRONYM	SPECIES	FAMILY
American Eel	AME	<i>Anguilla rostrata</i>	Anguillidae
Mountain Redbelly Dace	MRD	<i>Phoxinus oreas</i>	Cyprinidae
Rosyside Dace	RYD	<i>Clinostomus funduloides</i>	Cyprinidae
Longnose Dace	LGD	<i>Rhinichthys cataractae</i>	Cyprinidae
Blacknose Dace	BKD	<i>Rhinichthys atratulus</i>	Cyprinidae
Central Stoneroller	CES	<i>Campostoma anomalum</i>	Cyprinidae
Fallfish	FAF	<i>Semotilus corporalis</i>	Cyprinidae
Creek Chub	CRC	<i>Semotilus atromaculatus</i>	Cyprinidae
Cutlips Minnow	CUM	<i>Exoglossum maxillingua</i>	Cyprinidae
River Chub	RRC	<i>Nocomis micropogon</i>	Cyprinidae
Bluehead Chub	BHC	<i>Nocomis leptcephalus</i>	Cyprinidae
Common Shiner	COS	<i>Luxilus cornutus</i>	Cyprinidae
Satinfin Shiner ¹	SNS	<i>Cyprinella analostana</i>	Cyprinidae
Spotfin Shiner	SFS	<i>Cyprinella spiloptera</i>	Cyprinidae
Bluntnose Minnow	BLM	<i>Pimephales notatus</i>	Cyprinidae
Common Carp	CAP	<i>Cyprinus carpio</i>	Cyprinidae
Northern Hogsucker	NHS	<i>Hypentelium nigricans</i>	Catostomidae
Torrent Sucker	TOS	<i>Thoburnia rhotocoea</i>	Catostomidae
White Sucker	WHS	<i>Catostomus commersoni</i>	Catostomidae
Margined Madtom	MAM	<i>Noturus insignis</i>	Ictaluridae
Brown Bullhead	BRB	<i>Ameiurus nebulosus</i>	Ictaluridae
Yellow Bullhead	YEB	<i>Ameiurus natalis</i>	Ictaluridae
Brook Trout	BKT	<i>Salvelinus fontinalis</i>	Salmonidae
Brown Trout	BRT	<i>Salmo trutta</i>	Salmonidae
Tiger Trout ²	TGT	<i>Salmo X Salvelinus</i>	Salmonidae
Rainbow Trout	RBT	<i>Oncorhynchus mykiss</i>	Salmonidae
Mottled Sculpin	MTS	<i>Cottus bairdi</i>	Cottidae
Potomac Sculpin	POS	<i>Cottus girardi</i>	Cottidae
Rock Bass	ROB	<i>Ambloplites rupestris</i>	Centrarchidae
Smallmouth Bass	SMB	<i>Micropterus dolomieu</i>	Centrarchidae
Largemouth Bass	LMB	<i>Micropterus salmoides</i>	Centrarchidae
Redbreast Sunfish	RDB	<i>Lepomis auritus</i>	Centrarchidae
Bluegill	BLG	<i>Lepomis macrochirus</i>	Centrarchidae
Pumpkinseed	PKS	<i>Lepomis gibbosus</i>	Centrarchidae
Green Sunfish	GSF	<i>Lepomis cyanellus</i>	Centrarchidae
Longear Sunfish	LOS	<i>Lepomis megalotis</i>	Centrarchidae
Johnny Darter ¹	JOD	<i>Etheostoma nigrum</i>	Percidae
Tessellated Darter	TED	<i>Etheostoma olmstedii</i>	Percidae
Fantail Darter	FAD	<i>Etheostoma flabellare</i>	Percidae
Greenside Darter ¹	GRD	<i>Etheostoma belniioides</i>	Percidae
American Brook Lamprey	ABL	<i>Lethenteron appendix</i>	Petromyzontidae

¹ extremely rare: Three satinfins found in the lower Rapidan in 1999. Three greenside darters found in Pass Run in 1998. Two Johnny darters found in lower Moorman's, North Fork in 1995 prior to the 1995 flood.

² hybrid (progeny of female brown and male brook trout)

SOP Revision History

All protocols, regardless of how sound they are originally, require modification as new and different information becomes available. SOP version numbers increase incrementally by tenths (e.g. version 1.1, version 1.2...etc.) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 ...). Small changes or additions to existing methods will be reviewed in-house by Shenandoah or Mid-Atlantic Network staff. However, if a complete change in methods is sought, an outside review is required.

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #