Protocol for conducting electrofishing surveys for juvenile Atlantic salmon in Gulf Nova Scotia rivers, Salmon Fishing Area (SFA) 18

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PROTOCOL FOR CONDUCTING ELECTROFISHING SURVEYS FOR JUVENILE ATLANTIC SALMON IN GULF NOVA SCOTIA RIVERS, SALMON FISHING AREA (SFA) 18

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Electrofishing is a method for capturing and sampling aquatic species. Its use by the Department of Fisheries and Oceans (DFO) began in the 1950s and continues to be used in the Gulf Region as the primary method for assessing juvenile salmon populations for science assessment programs. This report provides a detailed description of the field protocols that have been and continue to be employed by DFO in Gulf Nova Scotia (Gulf NS), Salmon Fishing Area (SFA) 18, and which are similar to those used in other SFAs by the Gulf Region Salmon and Diadromous Unit.

RÉSUMÉ

Daigle, A., Horsman, M., and Underhill, K. 2024. Protocol for conducting electrofishing surveys for juvenile Atlantic salmon in Gulf Nova Scotia rivers, Salmon Fishing Area (SFA) 18. Can. Manuscr. Rep. Fish. Aquat. Sci. 3287: v + 36 p.

La pêche électrique est une méthode de capture et d'échantillonnage des espèces aquatiques. Le ministère des Pêches et des Océans (MPO) a commencé à l'utiliser dans les années 1950 et continue de s'en servir dans la Région du Golfe comme principale méthode d'évaluation des populations de saumons juvéniles dans le cadre des programmes d'évaluation scientifique. Le présent rapport fournit une description détaillée des protocoles de terrain qui ont été et continuent d'être utilisés par le MPO dans le Golfe de la Nouvelle-Écosse (Golfe N.-É. ; partie de l'Unité du saumon et des poissons diadromes de la Direction des sciences de la Région du Golfe du MPO), étant entendu que ces méthodes sont semblables à celles utilisées par d'autres programmes au sein de l'Unité du saumon et des poissons diadromes.

INTRODUCTION

The Atlantic region of the Department of Fisheries and Oceans (DFO) began using electrofishing as a method to capture and sample aquatic species in the 1950s (Smith and Elson 1950). Sampling methods employed by Atlantic DFO for the purpose of assessing juvenile salmon populations has been relatively consistent since assessment programs were established (Chaput and Claytor 1989; LeBlanc and Chaput 2003; Chaput et al. 2005; Dauphin et al. 2021). Assessment programs continue to use electrofishing data to illustrate trends in the juvenile salmon population abundance over time (DFO 2023). The intent of this report is to outline the current detailed field protocols used for electrofishing surveys completed by DFO in Gulf Nova Scotia (Gulf NS; part of the Salmon and Diadromous Unit in the Science Branch of Gulf Region DFO), Salmon Fishing Area (SFA) 18. The field protocols outlined here are similar to those used in other SFAs by the Salmon and Diadromous Unit. This document does not purport to be a best practices guide, as best practices are implicit in the training and licensing of the activity.

SAFETY

This document discusses some safety measures but does not detail all aspects of electrofishing safety. Organizations may differ in their safe work procedures (SWPs) and/or safety guidelines. The Gulf Region's Salmon and Diadromous Group follows the SWP available in Appendix I.

TERMS

Sweep – The systematic sampling of a small area within a site using a backpack electrofishing unit. It is the path taken by the anode when submerged in water and applying power.

Pass – The systematic sampling of an entire site using a backpack electrofishing unit. Many sweeps make up a pass. When the full area being sampled has been completed through multiple sweeps, that is considered one full pass of the site.

Open site – Also known as catch per unit effort (CPUE) and single-pass sampling. No barriers are used. Site is sampled starting downriver, moving upriver.

Closed site – Also known as depletion, multi-pass removal, and successive removal sampling. Barrier nets are installed to prevent immigration or emigration from the site. Abundance can then be estimated by making multiple passes to deplete the fish community of interest. The first pass of a closed site is conducted like an open site; beginning downriver, moving upriver. Every successive pass is started upriver, moving downriver. Data from closed sites can be used to calibrate data from open sites in similar systems.

REQUIRED EQUIPMENT

BACKPACK ELECTROFISHING UNIT

- Smith-Root backpack electrofishing unit LR-24
- Cathode (10-feet of braided stainless steel cable with plug end covered in 6-feet of neoprene)
- Anode (11-inch stainless steel ring)
- Two 24V 11+AH lithium batteries

PERSONAL GEAR

- Waders
- Electrically insulated gloves with appropriate voltage rating
- Polarized sunglasses

SAMPLING GEAR AND RECORDING MATERIALS

- Dipnet
- One-person seine (approximately 1m x 1m)
- 5-Litre buckets with lids (3-6 depending on open vs closed site)
- Recovery tote (with small holes; good for closed and/or high density sites)
- Barrier nets (for closed sites)
- Crutch poles (for closed sites)
- Clipboard
- Waterproof data sheets
- Pencils
- Two small aquarium type dip nets (for scooping fish from buckets)
- Fish tote (to use as a table)
- Fish anesthetic and measuring syringe
- Digital scale with container to hold and weigh fish
- Holding box for scale (transparent cover is helpful on windy days)
- Battery powered aerators
- Measuring board
- Knife or tweezers for scale sampling
- Scale envelopes
- Microscope slides to directly mount scale samples in the field
- Spare batteries for aerators and scale
- Two large multiday packs that can be used to carry gear from the vehicle to the site
- Sweep markers (e.g. Clothes pins with flagging tape tied on)
- Sampling license

SITE MEASUREMENTS AND WATER QUALITY

- Weighted rope for delineating a false bank (required when unsafe to sample full width of river)
- 100-meter measuring tape
- Water conductivity and temperature meter
- Meter stick
- GPS

SELECTING A SITE

Electrofishing sites for the Gulf NS program were selected as far back as 1957. They were selected based on the quality of juvenile (fry and parr) Atlantic salmon habitat and for practical factors such as accessibility, proximity to other sites, and in watersheds of interest. Historical sites continue to be sampled, however, adding, altering and eliminating sites does occur, so understanding how to select an appropriate site remains important.

Quality habitat for juvenile Atlantic salmon is often comprised of a majority of riffles, with potentially some component of runs, pools, or flats (Appendix II). Ideally a site will have a combined majority component of pebble, cobble, rocks, and the presence of boulders, with smaller proportion of other substrate types (Appendix II). This combination of habitat provides cover for fish under rocks, and habitat for invertebrates for fish to feed on within the riffle. There may be exceptions, but in general, riffles with cover (substrate) for juvenile salmon are targeted for electrofishing surveys.

Another consideration is the size of the site, as ideally it will be large enough to conduct a minimum of 500-seconds of electrofishing using the methods outlined later in this document. If planning to select a closed site, there are additional factors (rocks, velocity, depth, banks, vegetation) to consider to facilitate barricading. Care must also be taken to select a site with reasonable access, as extra equipment must be carried.

Site selection must also consider safety and accessibility for the crew. Any potential obstacles or nearby hazards should be considered and avoided. These could include unsafe terrain when accessing the site, overhanging trees at risk of falling, nearby falls or rapids, or anything else that may arise during site inspections.

ASSESSING AND ACCESSING A SITE

This is the appropriate time to determine if the site is safe to sample. Is the flow and water level safe to be wading in? Are environmental conditions appropriate (is it raining? Is a storm forming? Etc.)? Choose the safest route to access a site. When approaching the river, avoid stepping in areas that may be included in the survey area. The area to be surveyed should not be disturbed prior to sampling, as disturbance introduces bias in the data.

COLLECTING INITIAL SITE INFORMATION

On the sampling sheet (Appendix II) record:

- Water temperature (22°C is the maximum threshold for electrofishing juvenile salmon in the Gulf Region and above which surveys are not completed for reasons of fish health)
- Conductivity (actual and specific)
- Date
- Site coordinates
- Major watershed

DETERMINING BACKPACK ELECTROFISHING UNIT SETTINGS

1. After recording basic site information and confirming that water temperature is appropriate for electrofishing, the crew should don their electrofishing gear.
2. Next, decide who will be completing which task. At a minimum, the crew lead (certified backpack electrofishing unit operator) is required to use the LR-24 and a second is required to use the seine. Ideally, electrofishing is conducted with a third person equipped with the dipnet.
3. The crew can now walk downstream of their site (approximately 30-feet or more) and enter the water.
4. Once in the water, determine the voltage required to produce the desired behaviour from fish located in the area. The Salmon and Diadromous Unit in DFO Gulf Region keep duty cycle (36%) and frequency (60Hz) consistent for all sites (Appendix III). Only voltage is adjusted by site. In general, sites with higher conductivities require less voltage than sites with lower conductivities. Regardless, it is always fish behaviour that determines the voltage. The voltage selected should effectively stun fish so that they can be captured without causing injury or death. If settings are well adjusted, fish swim toward the anode while electricity is being applied (galvanotaxis). If there is uncertainty around what voltage to use, choose a low voltage (e.g., 200V) to begin testing.
5. Once in position (Appendix IV, B), the person using the LR-24 will indicate that they are going to begin shocking. Standard shocking technique should be followed (Appendix IV, C to N).
6. Continue sweeping until fish behaviour can be observed. Are fish getting stunned or swimming away? If stunned, are they recovering well in the collection bucket (return to upright position and swimming in under 20-seconds)? If desired behaviour is not achieved, adjust voltage (50V increments are often used) and test again. Repeat until the desired behaviour is observed.

7. With voltage determined, examine output amperage from the LR-24. To do so, the person operating the LR-24 needs to place the anode at the furthest position from the cathode and slowly sweep toward it, while another crew member records the low and high amperage readings.
8. When shocking has ceased and settings have been recorded, reset the LR-24 timer and turn the unit off.
9. Once recovered and while remaining 30-feet or more downstream of the area to be sampled, release fish throughout the habitat to avoid crowding.

ELECTROFISHING AN OPEN SITE

1. Using the shoreline, so as not to disturb the sampling area, walk to where the lower end of the site will commence. Mark this point with a sweep marker for taking site measurements later.
2. Facing upriver, the person using the seine will be the first to enter the site. All participants must avoid areas that will be sampled. The seine should be placed so that the bottom is tight to the streambed, perpendicular to the streamflow and in line with the sweep marker. The person using the seine (the seiner) should be standing downstream and outside of the site. Communication between the seiner and the person operating the LR-24 (the electrofisher) is essential to keep the area covered by sweeps similar in size (systematic) and to keep a straight line while moving across the stream. The seiner should have a target picked out, perpendicular to flow, on the opposite bank that they are moving toward after each sweep.
3. The electrofisher also uses a sweep marker on the bank to identify where the electrofishing will begin, generally 1- to 2-meters upstream of the seine, but no further than the person using the dipnet (the dipnetter) can reach. On this first sweep, the electrofisher typically remains on the bank (Appendix IV, B). The electrofisher needs to make sure the cathode is in the water, and behind the seine. The electrofisher (or dipnetter; team preference) should have a bucket containing fresh, clean (avoid sediment) water to place the captured fish.
4. The dipnetter will normally work between the seiner and the electrofisher. However, this position can be difficult when next to shore. If room is limited, it is best for the dipnetter to go on the other side of the seiner while being careful not to disturb the site.
5. With everyone in position, the LR-24 can be turned on. Confirm that the timer was reset. The electrofisher should check that the seiner and dipnetter are ready, and then apply power to initiate the sweep. The anode starts upriver from the seine, but not further than the dipnetter's reach. The anode must be submerged, but near the water's surface. It should move in an S-shape toward the seine

(Appendix IV, C to N) without extending past the width of the seine. The electrofisher should try to keep power continuously applied until the end of the sweep. Once the sweep is complete, the power trigger is released and the anode removed to give the seiner room to pull up the seine.

6. While power is being applied by the electrofisher, the dipnetter should be on high alert to catch fish with the dipnet. Fish should be captured while stunned and floating. If the dipnet hits the anode, the electrofisher will try to work around to continue the sweep. Although there are times that the electrofisher will have to cease applying power prior to completion of a sweep, it should be avoided as pauses will allow fish to escape. Sometimes the seiner will use a smaller, single-hand dipnet for use when power is being applied. However, only proficient seiners employ this technique and use of the dipnet should not inhibit proper seine operation.
7. When the sweep is complete (power stops and anode is removed), the seiner lifts the seine, using an upstream scooping motion. This will prevent fish from falling off the seine. The best practice is for the seiner to lift the net as soon as the sweep is complete because fish recover quickly and will swim out of the seine given the opportunity. Always lift and check the seine (Figure 1), even if the seiner thinks no fish were caught.
8. If fish are in the seine, the dipnetter then transfers fish from the seine to the sample bucket using their dipnet (Figure 1).
9. The seiner moves one seine width across the site. Once the seiner is positioned, the electrofisher will take a step closer to properly position for the next sweep. The dipnetter should be positioned where they have the best chance to dipnet fish (Appendix IV, B to N; Figure 2).
10. Once the crew is in position and ready, the electrofisher will begin applying power and steps 5-9 will be repeated until the opposite bank is reached.
11. The seiner should place a sweep marker to indicate the spot that represents the lower end of the site. The electrofisher should also place a sweep marker where the top of the last sweep was located.
12. The seiner can now move upstream and place the seine in line with the sweep marker the electrofisher just placed at the top of the last sweep. That is, the top of the last sweep has now become the lower line for the next section back across the stream. The seiner will aim for the sweep marker on the opposite bank that the electrofisher placed before the initial sweep.
13. This process of systematic sweeps, from bank to bank, and then upriver, continues until the site is complete. As a rule of thumb, the DFO Gulf NS program aims for 500-seconds of electrofishing time (recorded by the LR-24 timer) per site.

14. When the upper end of the site is reached (determined by end of suitable habitat, or based on time, or a combination of the two) be sure to use sweep markers to indicate where the site ends and turn off power to the LR-24.

Note that sites can sometimes be so wide, or the current so strong, that it is not practical to sample from bank to bank. In those cases, a false bank can be created prior to sampling by using anchored rope running the length of the site. Avoid disturbing the sample area when creating the false bank. Be sure to leave the anchored rope in place until all sampling and site measurements are complete.

PROCESSING THE SAMPLE

1. Find a suitable area to set up an anesthetic bath (Appendix VI), a measuring board, a scale, and a recovery bucket (Figure 3).
2. Check on the fish in the sample bucket. If crowded, get a second bucket with fresh water and divide the catch. Attach a battery-operated aerator to each bucket.
3. If an electrofishing team consists of three members:
    i. One person handles fish for species identification, length, and weight.
    ii. The second person records the biological details (Appendix V). This person should position themselves close to the sample bucket so they can also monitor fish welfare. Periodic addition of water can be required to keep temperature suitable.
    iii. The third person takes salmon parr scales. They should aim to collect scales from two parr in each 10-mm size class (e.g., 80- to 89-mm, 90- to 99-mm, etc.).
4. **The Fish Handler**: responsible for dipping fish from the sample bucket into the anesthetic bath. This should be done in small batches to minimize fish exposure to the anesthetic. When fish are dormant, they are identified to species, measured for fork length (mm), and weighed (g; Figure 4). Salmon parr are checked for presence or absence of an adipose fin to determine hatchery or wild origin. They are also checked for precociousness by applying gentle pressure in a sweeping motion on the ventral side from the pelvic fin to the vent. If milt is produced, the parr is considered a precocious male. If a scale sample needs to be taken, the Fish Handler will pass the specimen to the Scale Sampler. If no scales are needed, the fish will be placed in the recovery bucket.
5. **The Note Taker**: responsible for documenting (Appendix V) the information provided by the Fish Handler. The Note Taker is also responsible for:
    i. The welfare of the fish in the sample bucket
    ii. Keeping a running tally of samples taken with the aim of:

i. 50 fry, length and weight – enumerate remaining fry
ii. 50 parr, length and weight – enumerate remaining parr
iii. Two scale samples from every 10-mm size bin for parr
iv. 50 total length and weight measurements from other species – enumerate remaining species
v. Note any mortalities

iii. For the scale samples, the Note Taker needs to communicate with the Scale Sampler so that they both record the same unique fish sample identifier. This step allows the biological details to be linked with the scales collected and is imperative.

6. **The Scale Sampler** : responsible for collecting scales from parr (Figure 5). Scales should be collected with either tweezers or a small knife (e.g. multitool knife), then spread onto a prepared slide (sample identifier indicated, plastic film pulled back; Appendix VII). A drop of water can be used to separate scales from a clump. Clumps of scales should be avoided because overlapping scales are difficult to age. When all scales are distributed, pull the plastic film overtop and smooth out wrinkles (Figure 6). The fish sample identifier should be written on the slide, corresponding scale envelope, and data sheet. If time permits, biological details should be filled in on the scale envelope, if time is short this step can be completed later. The Scale Sampler should be positioned near the recovery bucket and are responsible for monitoring recovery.
7. Processing continues until all captured species have been identified and counted. Sampled species should remain in the recovery bucket(s) until site measurements are taken. It is recommended to put a lid on the recovery bucket and set it in a shallow section of water outside of the site to regulate temperature. A rock can be used to weigh the bucket down to prevent tipping.

COLLECTING SITE MEASUREMENTS AND EQUIPMENT DETAILS

1. Obtain “site measurements and equipment details” form (Appendix II). Some information should already be filled from the initial site information collection.
2. Indicate the “Type of site” sampled. This is done as an overall percentage. Follow the definitions provided on the form. Must total 100%.
3. Using the measuring tape, measure the length of the left and right banks (as determined by looking downstream; Appendix VIII). Then measure the upper, middle, and lower widths of the site (Appendix VIII).
4. Measure depth at 25%, 50%, and 75% of the stream widths at the lower, middle, and upper boundaries of the surveyed site; a total of nine depths (Appendix VIII).

5. While moving around the site, locate and record maximum depth.
6. Identify, in percent, the types of substrate located within the site. Use the definitions provided on the form. Substrate type percentages must also total 100%.
7. Look at the electrofishing unit (power on), record the timer data in the CPUE row. This should be the finished time. The start time should have been 0 if the timer was reset prior to sampling. For an open site, additional rows under CPUE are not informative. For a closed site, those additional rows represent the time taken to complete each pass.
8. Enter additional electrofishing unit information:
    a. Electrofisher make and model
    b. Frequency used
    c. Duty cycle
    d. Voltage
9. Record the names of the crew and what position they held while sampling.
10. Finally, indicate any additional information that may be important in the “notes field” (i.e. false bank, higher than average water levels, any potential change of typical site location due to obstructions, etc.).
11. Once all site and equipment measurements have been collected, recovered fish are released in small batches throughout the site.

ELECTROFISHING A CLOSED SITE

1. Upon arriving at a site, select a wetted area that is approximately 200- to 250-meters^2. The width of the site will determine the type of barrier to install. That is, if the width of the site is relatively narrow, two barriers can be used, one each for the lower and upper end. In this scenario, barriers are installed from bank to bank (Figure 7). However, if the site width is relatively large, a 3-sided barrier will need to be installed (Figure 8).
2. Gulf NS barrier nets are made of 3/16-inch knotless nylon netting with a minimum two foot skirt of durable material sewn on the bottom. When setting up the barriers, the skirt always faces upriver. Starting at the lower end, run the barrier from bank to bank. Rocks and boulders may be required to prevent the barrier from being carried downstream by the current (Figure 9). Make sure to place rocks and boulders on the skirt, as the mesh is fragile and holes can form allowing for fish passage. Be sure to overcompensate the amount of barrier on each bank to account for the slight increase in site water level while the barrier nets are up.

3. With the barrier anchored across the stream, it now needs to be rocked in. This is done by selecting rocks, boulders, and other substrate to anchor the skirt to the streambed. Avoid grabbing substrate from inside the site. Avoid holes or gaps, as fish will find them. Closed sites are labour intensive. Do not begin sampling until you are certain the site is properly closed. If a site is not properly closed and only discovered after sampling has begun, data are discarded and the site needs to be redone at a later date. A helpful technique for rocking the skirt is to lift boulders, slide the skirt into the boulder indentation, and then let the boulder fall back in place. Rocks, cobbles, and pebbles are used to cover small sections of skirt between boulders. If your fingers can fit between rocks, so can fish!
4. When the skirt is rocked in, the netting can be pulled out of the water and anchored in an upright position with the use of crutch sticks (see Figure 7 and Figure 8).
5. With the second barrier, repeat the installation process at the upper end of the site.
6. With barriers properly constructed, follow the steps previously outlined in “Determining backpack electrofisher settings”.
7. Begin sampling the site following the method outlined in “Electrofishing an open site”. Closed sites calibrate data from open sites, making the first pass critical and needs to reflect how an open site is sampled (starting downriver, moving upriver). Starting at the lower end is a bit challenging because the crew needs to sample close to the barrier without disturbing it. On this lower line, the seiner and dipnetter need to set up the same way as if it was an open site. If fish are missed by the seiner and dipnetter, but can be seen on the barrier net, do not collect them. In a true open site, those fish would have been missed.
8. Once the first pass of the site is completed, record the time displayed on the unit and shut it down.
9. Check on the individuals in the sample bucket. Add more water and/or divide the catch if necessary. Attach an aerator. Place the bucket securely in the water, outside of the site. Identify the bucket as containing CPUE fish.
10. When the crew is ready, they will prepare to start depletion pass 1. Depletion passes are similar to the CPUE pass, with the main difference being the direction of the pass. With CPUE, the crew starts at the low end and moves upstream. For depletion passes, the crew starts upstream and moves down. The crew still needs to sample facing upstream, but the direction of sampling goes downstream.
11. When the lower end is reached, it is now critical to collect fish trapped on the lower barrier net.

12. When the first depletion pass is complete, record the time displayed on the unit and shut it down.
13. Tend to the sample bucket as in step 9.
14. Repeat steps 10-13 until the site is depleted. This can take 3-5 depletion passes. Every pass should catch less fish than the previous and the final pass should not catch any (or near zero). If catch numbers per pass are not declining, or alter between increasing and decreasing, it could be an indication that the site is not properly closed off. Investigate and cease sampling if that is the case.
15. When the site is depleted, begin processing fish from each pass. Processing is the same as outlined in “Processing the sample”, but clearly indicate which fish came from which pass (CPUE, depletion pass 1, 2, 3, etc.).
16. Once processing is complete, site measurements can be taken as described in “Collecting site measurements”. Remove barrier nets once site measurements are complete. Release all fish throughout (redistribute) the site after recovery and the site is clear.

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FIGURES

Figure 1: Checking the seine for fish and transferring fish to the sample bucket. In this image, the person on seine has lifted the seine and opened it to check for the presence of captured fish. The dipnetter is also checking the seine, and uses the dipnet to transfer any fish from the seine to the bucket (which here is being held by the person with the backpack electrofishing unit). Photo credit Suncica Avlijas.

Figure 2: Positioning of team members based off the gear they are using. In this photo there is a team of three; the person with the backpack electrofishing unit, the person using the dipnet, and the person using the seine. Photo credit Suncica Avlijas.

Figure 3: Examples (a-c) of how to set up the processing station for sampling fish. Find a suitable area to set up an anesthetic bath, a measuring board, a scale, and a recovery bucket. Team members should be positioned in close proximity to make communication easy and to provide assistance when needed. Photo credit (a-c) Ian Copps.

Figure 4: Fish being weighed on an electronic scale. The scale is in a wooden box to help stabilize and block the wind. Having a small container or tray to place the fish on aids in taking the weight.

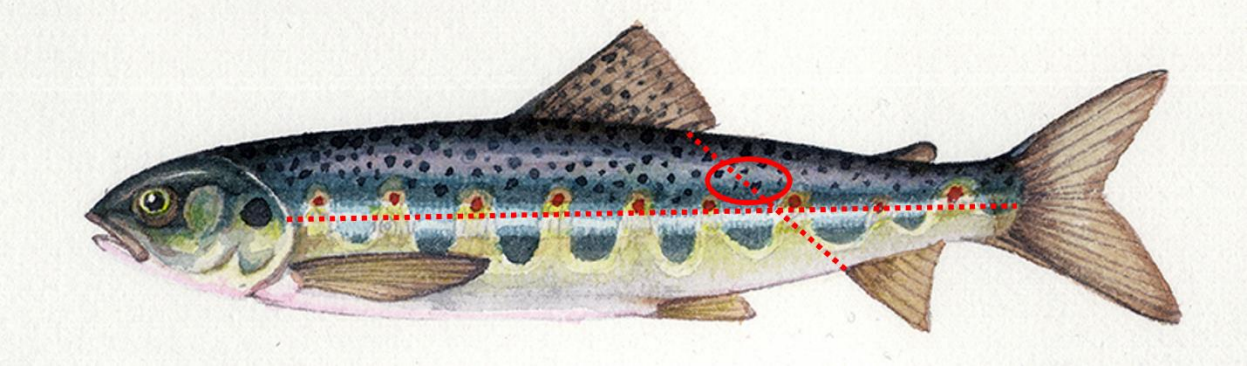


Figure 5: Preferred scale sampling area on Atlantic salmon parr (red circled area). Scales need to be sampled 2-3 scale rows above the lateral line (horizontal red dashed line), on the diagonal running from posterior base of the dorsal fin to the anterior base of the anal fin (diagonal red dashed line). Illustration edited from Harper 2015.

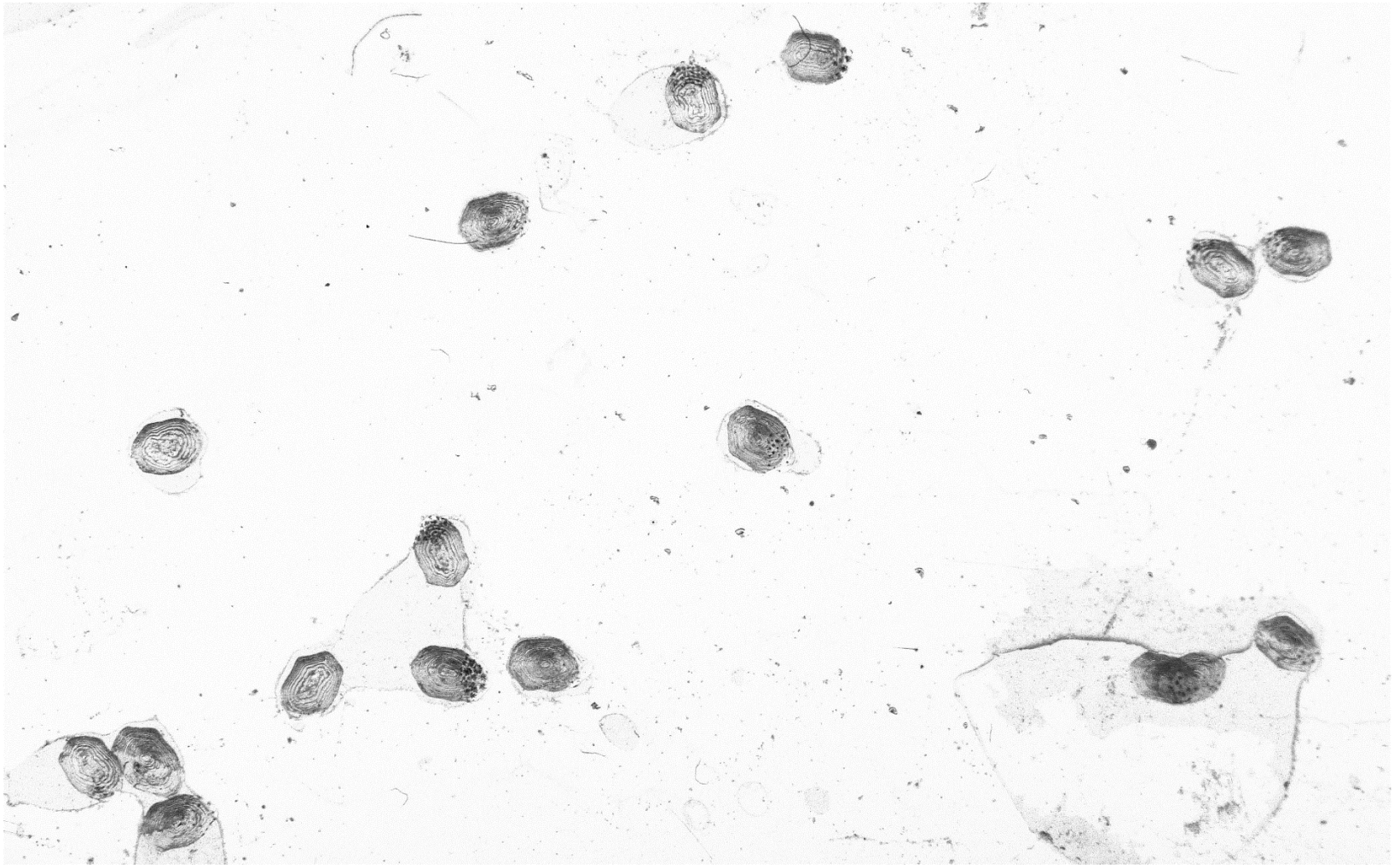


Figure 6: Image of Atlantic salmon parr scales taken with a Leica S9i stereomicroscope at 0.6 magnification. Scales were collected in the field during an electrofishing survey. Majority of scales have been well distributed on the slide, providing clarity for age interpretation. Note the presence of two overlapping scales in the bottom right corner of the image. Overlapping scales should be avoided as age interpretation will be difficult to impossible. It is difficult to redistribute scales after the field sampling event.

Figure 7: Closed site using two barrier nets installed bank to bank. Barrier nets have been rocked in to prevent fish from entering or exiting the site. Crutch poles are used to hold the nets up after rocking. Photo credit Suncica Avlijas.

Figure 8: Three-sided closed site using a single barrier net. Barrier nets have been rocked in to prevent fish from entering or exiting the site. Crutch poles are used to hold the nets up after rocking them in.

Figure 9: Rocking the barrier net skirt to secure in place. One member of the team holds a portion of the barrier net so that it does not wash downstream into the site. Meanwhile, two other team members are rocking in the skirt of the barrier net. Normally, it is advised not to reach into the site to collect rocks and boulders, but sometimes this cannot be avoided. Photo credit Suncica Avlijas.

APPENDICES

APPENDIX I: SAFE WORK PROCEDURE CREATED BY GULF REGION SALMON AND DIADROMOUS UNIT

Fisheries and Oceans Canada | Pêches et Océans Canada

SAFE WORK PROCEDURE

SWP010 – Electrofishing Operations with Backpack

(en français)

OBJECTIVE

To define safe operating procedures when *Electrofishing with a Backpack*.

POTENTIAL HAZARDS

Biological / Ergonomic / Physical Psychosocial Hazards:

- Inadequate training may result in numerous types of physical injury (e.g., electric shock, drowning, etc.)
- Persons with underlying medical conditions may be putting themselves at risk when participating in electrofishing activities.
- A lack of personal protective equipment may result in numerous types of physical injury (e.g., electrick schok, drowning, cuts, slips, trips, and falls, etc.)
- Not respecting the safety rules may cause personal injruies, injuries to others and damage to equipment.
- Inadequate inspections may lead to personal injuries or injuries to others.
- Potential for delayed response when the necessary safety equipment is unavailable or when injury or dangerous situations occur in remote locations where limited or no communication method is available or when the roads to access sites are in bad conditions. This type of situation has the potential to impact relationship among crew members during times of increased stress levels.
- Prolonged exposure to biological materials (e.g., ticks, plants, animals and their byproducts) or extreme heat or cold may cause health affects which may not be immediately noticeable by the affected person.
- Not understanding your role and responsibilities can lead to frustration among members and could put yourself and others at risk for injury.
- If travelling through private property there is potential for confrontation with landowners.
- Other potential hazards when participating in electrofishing operations:
    - Animal attacks
    - Punctures or lacerations from teeth, spines, hooks of live animals, or needles or other equipment
    - Insect bites and potential transmission of Lyme disease, allergies
    - Blisters, abraisons, contusions
    - Slips, trips, and falls (slippery embanqments, substrate and current)
    - Fatigue, UV exposure, heat exhaustion and heat stroke
    - Entering and working in an unknown environment with a risk of encountering moving objects (e.g. logs and other floating debris)
    - Cold water and hypothermia
    - Sudden changes in weather conditions (i.e. rain, high winds, lightning, sudden changes in water levels, poor visibility)
    - Personal injury caused by carrying or lifting items awkwardly, strains, sprains
    - Personal injury caused by equipment failure
    - Transfer of infectious agents through potentially contaminated sharps objects

ROLES AND RESPONSIBILITIES

Supervisor's Responsibilities

- Ensure only commercially available certified electrofishing equipment is used (Homemade equipment or in-house expertise equipment is not allowed).
- Provide necessary supervision and ensure workers are properly certified.
- Provide appropriate safety equipment.
- Ensure workers are aware of their rights and responsibilities.
- Designate qualified persons and ensure completion of the Annual Checklist for Backpack Electrofishing Units (Annex A).

Crew Lead's Responsibilities

- Supervise daily operations and ensure safety of the team.
- Identify and assess site hazards and ensure adequate control measures are in place before initiating electrofishing work procedures.
- Conduct bank-side crew talks regarding equipment and safe work procedures.
- Inspect equipment and ensure maintenance and repair.
- Prevent hazardous work procedures.

Crew Members' Responsibilities

- Be knowledgeable of and follow provided instruction, training, and written safe work procedures.
- Ensure the manual for the Electrofisher unit being used is available and that they are thoroughly familiar with it.
- Report identified and/or observed hazardous conditions to the supervisor or employer.

DEFINITIONS

Qualified Person – Means, in respect of a specified duty, a person who, because of his or her knowledge, training and experience, is qualified to perform that duty safely and properly (from the Canada Labour Code). For electrofishing, a qualified person will be an individual who has obtained an electrofishing certificate from an accredited institution, and thus can be the crew lead of a DFO electrofishing team. It is the responsibility of the supervisor to designate this person.

Crew Lead – Is the person responsible for the safety of the crew, the enforcement of all safety regulations and the instruction of other untrained crew members in the safe use of Electrofishers and emergency response procedures.

Crew Member - Is a person involved in electrofishing operations and who has received instruction in the safe use of Electrofishers.

HEALTH, SAFETY AND TRAINING CONSIDERATIONS

Training

- A minimum of 2 crew members for each electrofishing team (crew lead and one other member) require Standard First Aid/CPR level C.
- Crew leads need to have completed an electrofishing course and received certification. (There is no requirement to recertify your electrofishing certificate; however, if there is a significant pause in your electrofishing fieldwork (e.g., four years or more) we recommend that you recertify.)
- On the job training for crew members to be completed by Crew Lead.
- Read the electrofishing backpack operator's manual for the respective unit;

- Read **THA029/SWP029 Working in the Field and Isolated Areas.**

Medical Exam

All persons engaged in electrofishing operations must have a preplacement medical and periodic medicals thereafter as per recommendations of the Treasury Board of Canada (TBS) – Appendix A Occupational Health Evaluation Standard Schedule. If you have any medical condition that puts you at risk, they must be reported at preplacement or regular medical exams as per Health Canada's Occupational Health Assessment Guide. Proof of valid medical certificate is required for all crew members who plan on actively participating in electrofishing activities.

Personal Protective Equipment (PPE)

All crew members are to be provided with the necessary personal safety equipment indicated below:

- Chest or hip waders*
- Electrofishing gloves* (non-conductive, waterproof, at least 14 inches in length)
- Wading boots*
- Personal Flotation Device (PFD) (where applicable)
- Additional PPE as specified in relevant THA/SWP

*Suitable waders are generally constructed of neoprene, PVC, or other non-breathable materials. Breathable, lightweight waders may not have adequate electrical insulating properties, however, logistical or climate constraints may necessitate the use of this type of wader. In the event that breathable waders are used for electrofishing activities, the following precautions will be followed:

- Operators must wear dry clothing that covers bare skin within the wader, if clothing worn under the waders becomes wet (e.g., from sweat or humidity), the crew member must leave the operations immediately to change into dry clothes and ensure the inside of their waders is not covered by moisture.

*Waders, boots and gloves must be tested for potential leaks and inspected for any other flaws prior to conducting any electrofishing. All crew members shall immediately leave the operation if any leak is detected and before returning, obtain dry equipment. If wearing non-breathable waders, mild dampness from perspiration or humidity is considered normal.

Safety Equipment

- Compass and/or a GPS
- Communication device (i.e., cell phone, satellite phone, VHF radio)
- First Aid Kit equipped with CPR pocket mask with 1-way valve and appropriately stocked as per TB standards.

Safety Rules

- All hazardous occurrences as defined under the Canadian Occupational Safety and Health Regulations must be reported on the Hazardous Occurrence Investigation Report form (HOIR) and sent to the Gulf Region Occupational Health and Safety Advisor.
- At no time will an electrofishing operation commence without a **minimum of two or more participants**. One participant shall be the ***crew leader*** and the remaining participants are the ***crew members***.
- A **crew leader** shall be appointed to each electrofishing team.
- Weather conditions should be checked before travelling to the sampling site to avoid being caught in adverse weather conditions. If the forecast does not permit safe working conditions, postpone the outing. Electrofishing operations should cease during inclement weather such as moderate to heavy rain, lightning or thunderstorms; seek shelter.

- Take extra precautions in areas where incidents of Lyme disease are higher.
- Night electrofishing shall be avoided unless required by the study design; a separate risk assessment is to be conducted prior to night electrofishing that will include any additional hazards.

Inspection of Equipment

- An annual in-house inspection of each Electrofisher needs to be completed by a qualified person. See Annex A for the checklist.
- In addition, each electrofishing unit must be inspected and determined to be operating within specification by a recognized manufacturer of backpack electrofishing equipment at least once every 3 years (or 5 years if used less than 10 days per year).

PROCEDURE

- Each member is to provide an up-to-date emergency contact to the Crew Lead prior to departure.
- Have a spare change of clothes available.
- If applicable, landowners should be contacted well in advance of the sampling event to discuss acquiring permission to sample on their land. Read **THA006/SWP006 Dealing with Difficult Clients.**
- The Crew Lead is responsible for performing a visual check of the equipment on each day of operation.
- Ensure staff don the appropriate PPE prior to starting the activity.
- If any leak is detected in gloves, waders, boots, etc., employees must leave the operation immediately and change into dry equipment before re-commencing activities.
- Personal floatation devices (PFDs) must be worn when the crew leader considers the water is of sufficient depth or velocity for a PFD to be effective as protection from drowning. Crew members also have the option to wear a PFD at all times if they choose to.
- Use the minimum voltage possible to obtain the desired results as required for the survey purpose.
- The unit operator shall make sure that personnel are ready and clear of any danger before turning on the power. Confirmation of readiness from all members of the crew (e.g. thumbs-up) and calling out loud that the power is on or off are best practices.
- The Electrofisher must have an audible signal (preferred) or visible signal that operates when there is output voltage present. An audible signal is required on any new equipment purchased
- Operate slowly and carefully. Footing in most streams is poor and most falls occur when personnel are hurrying.
- No employees shall reach into the water in the vicinity of an active electrode. If an employee needs to reach their hand into the water, this should be clearly communicated by the crew member and confirmed by the crew leader. The electrode must be lifted out of the water before the employees reaches in.
- Take frequent breaks to avoid fatigue. Operations should cease when fatigue sets in.
- Backpack Electrofisher shall be shut off prior to entering or leaving a stream, and the battery terminals disconnected when not in use or when transporting the unit.
- Captured fish must be maintained in an appropriate environment at water temperatures that will not cause thermal stress if being retained for site measurement and counting. If fish are being sampled for other purposes, they must be appropriately housed or euthanized.
- If sampling fish on site; handle fish carefully, be aware of which species of fish have spines that could puncture your skin, handle with extra caution. Read **THA007/SWP007 Use and Disposal of Sharps**.

REFERENCES

Annex A – Annual Electrofisher Unit Checklist
THA010 Electrofishing Operations with Backpack
THA006/SWP006 Dealing with Difficult Clients
THA007/SWP007 Use and Disposal of Sharps
THA016/SWP016 Safe Lifting, Handling and Transportation (under/over 45kg)
THA029/SWP029 Working in the Field and Isolated Areas

Directives and Regulations

- Canada Labour Code Part II
- DFO Occupational Health and Safety Manual
- Canada Occupational Health & Safety Regulations (SOR/86-304)
  - Part XVI - First Aid
  - Schedule I - Requirements for First Aid Kits
  - Schedule II - Content of First Aid Kits
  - Schedule III – Additional First Aid Supplies and Equipment for Remote Workspaces
- National Joint Council Directive - Part XVII - First Aid (njc-cnm.gc.ca)
- TBS - Directive on Occupational Health Evaluations- Canada.ca
- TBS - Occupational Health Evaluation Standard (publications.gc.ca) (Appendix A – Occupational Health Evaluation Standard Schedule)

Equipment

- Electrofishers - Smith-Root
- Choosing lifejackets and personal flotation devices (PFDs) (canada.ca)
- CCOHS: Protection Against Drowning

Lyme Disease

- Lyme Disease: Pamphlet: Enjoy the outdoors, without a tick - Canada.ca
- Mobile Application for Ticks (eTick)

Safety Video

- Wader Safety: https://www.youtube.com/watch?v=K2HkpfQzMAI

Forms

Gulf Region Occupational Health and Safety – Fillable Hazardous Occurrence Report of Injury or Illness (HOIR)

Fisheries and Oceans Canada | Pêches et Océans Canada

Annex A – Annual Checklist for Backpack Electrofishing Units

Electrofishing Unit

Unit Make	Model	Serial Number

☐ unit has been serviced within the last 3 years or 5 years if used less than 10 days per year
☐ electrical connections and wiring in good condition
☐ no visible damage/cracks to unit casing
☐ adequate protection on wiring (no visible cracks, tears or chafing)
☐ voltage gauge (if fitted) indicates high voltage output working
☐ controls and gauges operational
☐ audible signal working
☐ visual signal working (if fitted)
☐ main power switch working, clearly marked and accessible
☐ mercury tilt switch working when tipped in each direction
☐ anode pressure switch working and resets to the "off" position when released
☐ anode ring clean, in good condition, fastened securely and checked for continuity
☐ anode handle in good condition and is of non-conductive material
☐ cathode cable and insulation in good condition
☐ cathode clean, securely fastened and checked for continuity
☐ backpack frame made from non-conductive material, straps not cracked, broken or frayed, buckles operating
☐ backpack quick release mechanisms working properly

Power Source

☐ non spillable gel cell battery
☐ battery terminals clean
☐ no visible cracks/holes in casing or wires
☐ capable of holding full charge

Ancillary Equipment

☐ dip net handle(s) in good condition and made of non-conductive material
☐ First Aid kit(s) present and fully stocked
☐ operators manuals present
☐ review log book for completeness, problems, required maintenance etc.

Comments

_____

_____

_____

☐ Unit meets Annual Inspection requirements ☐ Unit does not meet Annual Inspection requirements

Inspected by	day / month / year

APPENDIX II: SITE MEASUREMENTS AND EQUIPMENT DETAILS FORM

Year		Month		Day	
Major Watershed					

Arrival Time	
Departure Time	
Site ID	
Site Nickname	
Latitude	
Longitude	

Type of site (percent of each type based on surface area)

%	**Riffle**	Fast current	Shallow depth < 23cm or 9"	Turbulent usually broken flow
%	**Run**	Fast current	Depth > 23cm or 9"	Turbulent and sometimes broken flow
%	**Flats**	Slow current	Depth < 46cm or 18"	Smooth surface
%	**Pool**	Slow current	Depth > 46cm or 18"	Smooth surface

Note: Left and Right Banks are determined by looking DOWNSTREAM

Length	Left	m	**Width**	Lower	m
	Right	m		Middle	m
				Upper	m

Depths measured where stream widths taken

	25%	50%	75%
Lower	cm	cm	cm
Middle	cm	cm	cm
Upper	cm	cm	cm
		Maximum Depth	cm

Substrate Type (approximate percentage as visible area)

%	Fine silt or clay
%	Sand (<2mm or 1/8")
%	Gravel (2 to 16mm or 1/8 to 1/2")
%	Pebble (16 to 60mm or 1/2 to 2-1/2")
%	Cobble (60 to 250mm or 2-1/2" to 10")
%	Rocks (250 to 500mm or 10 to 20")
%	Boulder (>500mm or 20")
%	Bedrock

Electrofisher timer data; Reading on Smith Root Counter

Pass	Start	Finish	Elapsed
CPUE			
1			
2			
3			
4			
5			

Overhanging vegetation

Left bank with overhang	%	Max. meters of canopy overhang left bank	m
Right bank with overhang	%	Max. meters of canopy overhang right bank	m

Site temperature and conductivity

Water Temp (°C)	
Actual Conductivity (µs)	
Specific Conductivity (µs)	

Note: SC should be the higher conductance reading as long as water temp is below 25°C

Crew information

Probe	
Seine	
Dipnet	
Other	

Electrofisher settings information

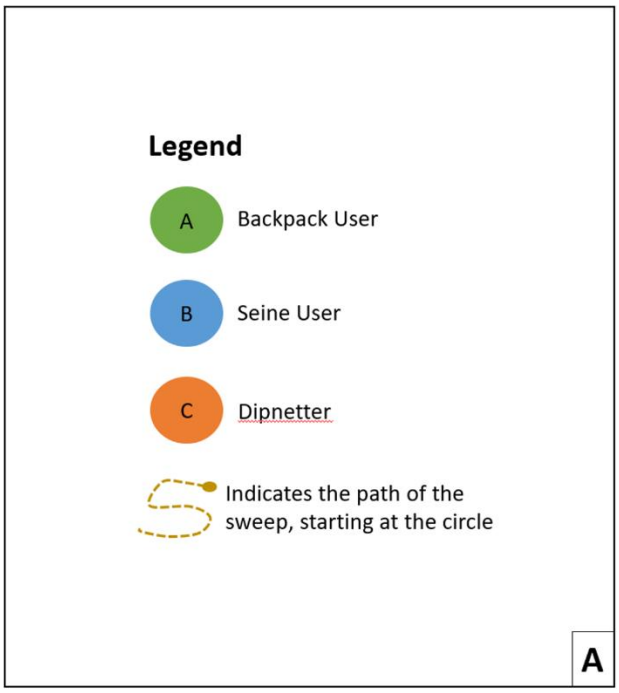
Electrofisher Model	
Serial #	
Pulse Type	
Frequency (Hz)	
Duty Cycle (%)	
Voltage (V)	
Amperage (low)	
Amperage (high)	

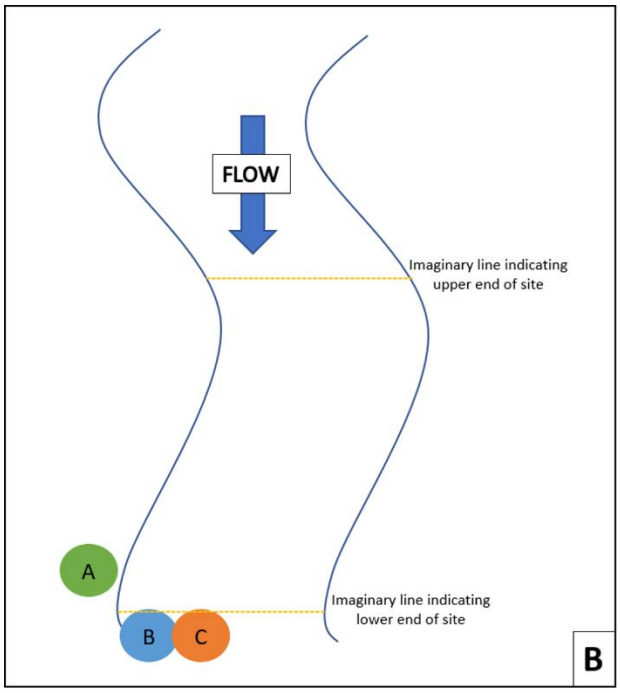
Notes:

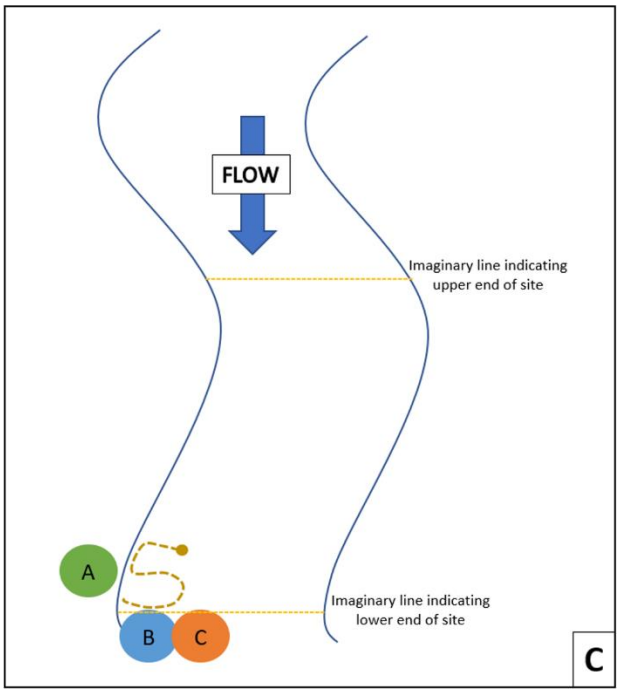
APPENDIX III: COMMON ELECTROFISHING BACKPACK SETTINGS

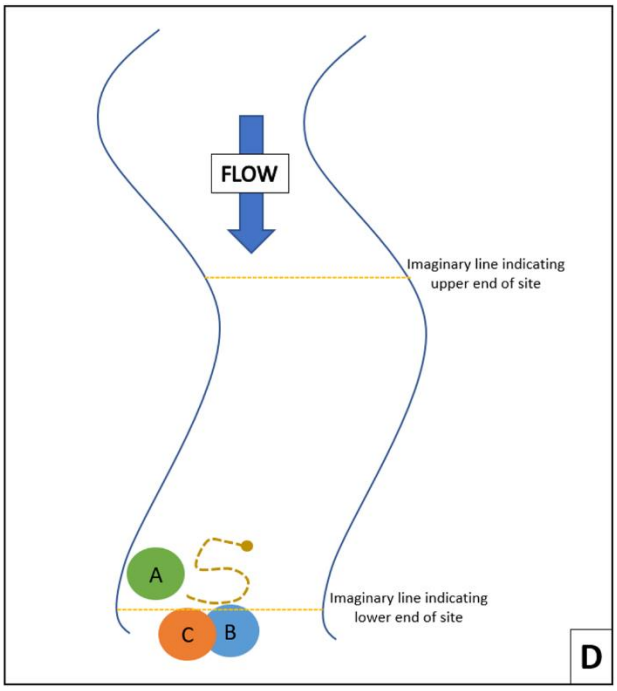
Electrofishing Unit:	Smith-Root LR24
Frequency (Hz):	60
Duty cycle (%):	36
Voltage:	Site dependent

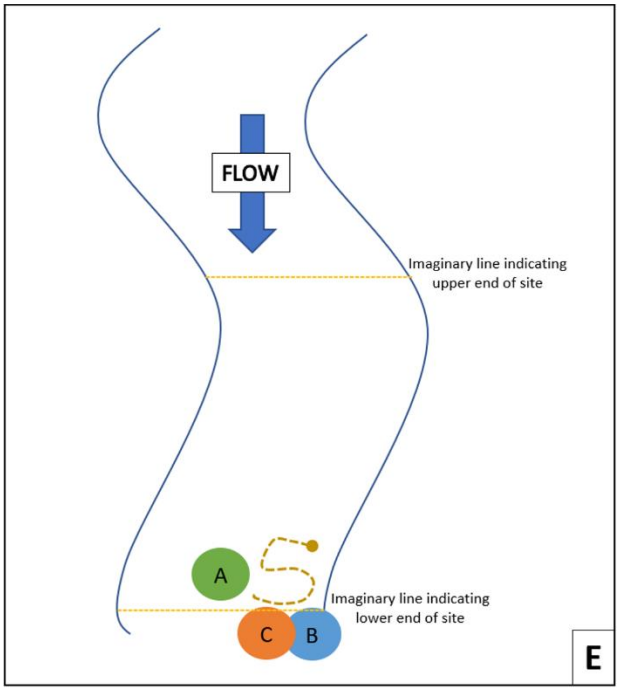
APPENDIX IV: CREW POSITIONING AND SYSTEMATIC SITE SAMPLING







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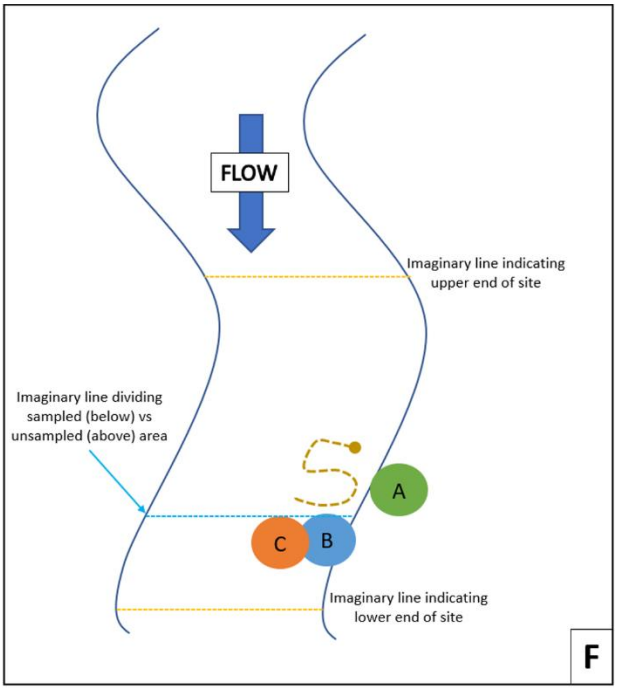
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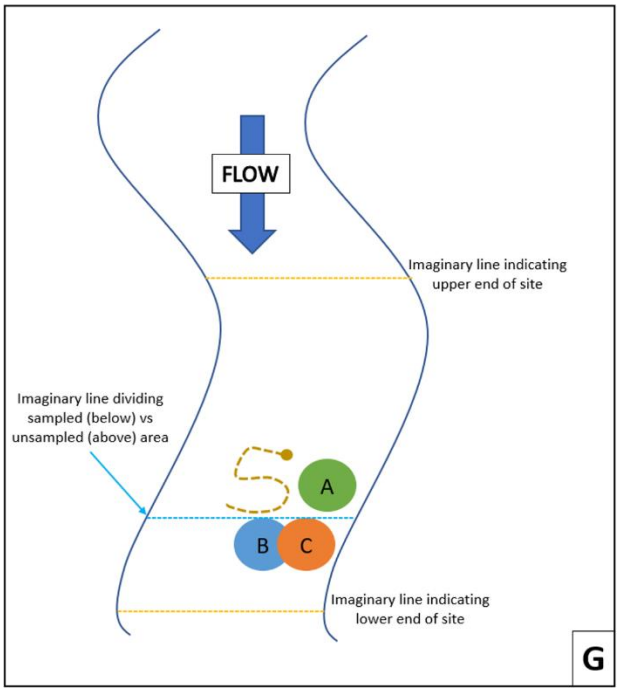
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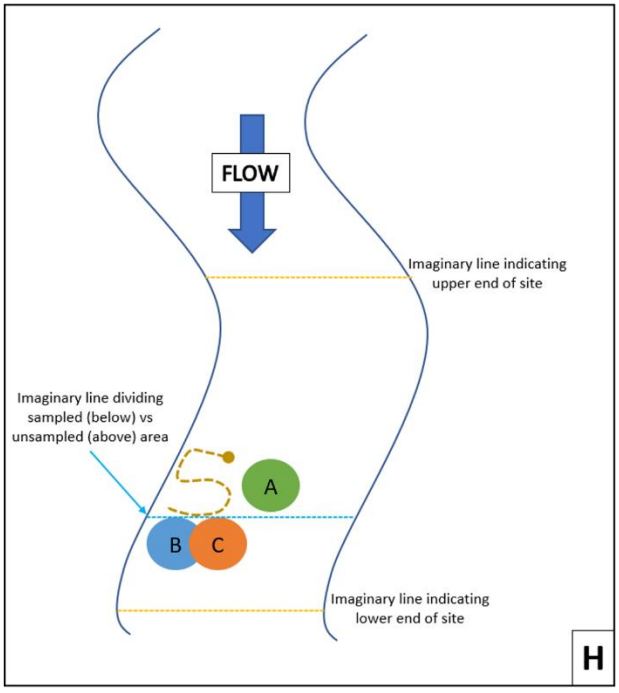
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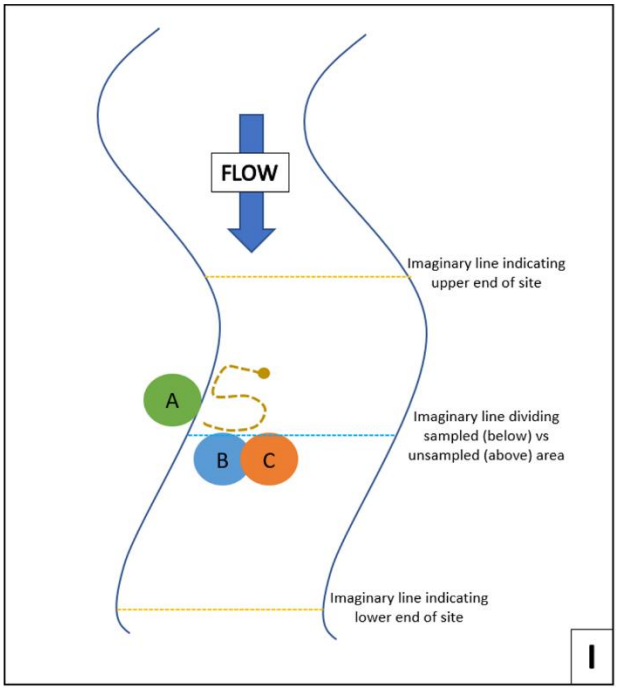
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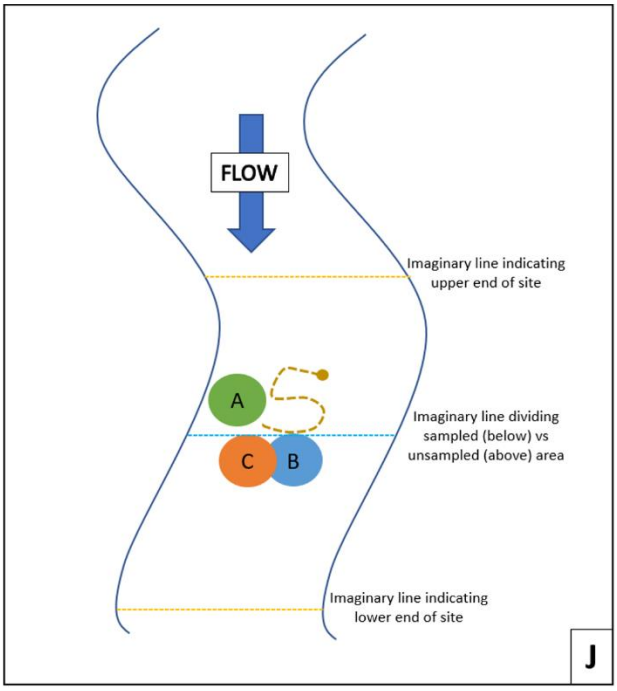
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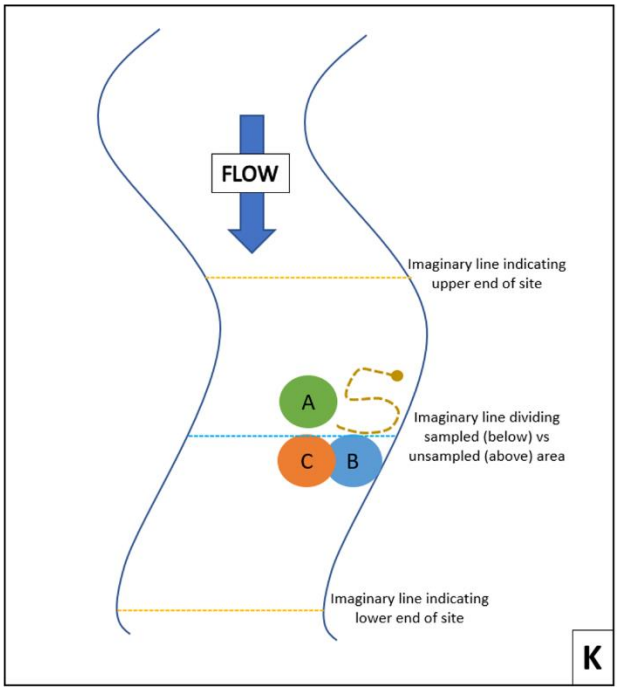
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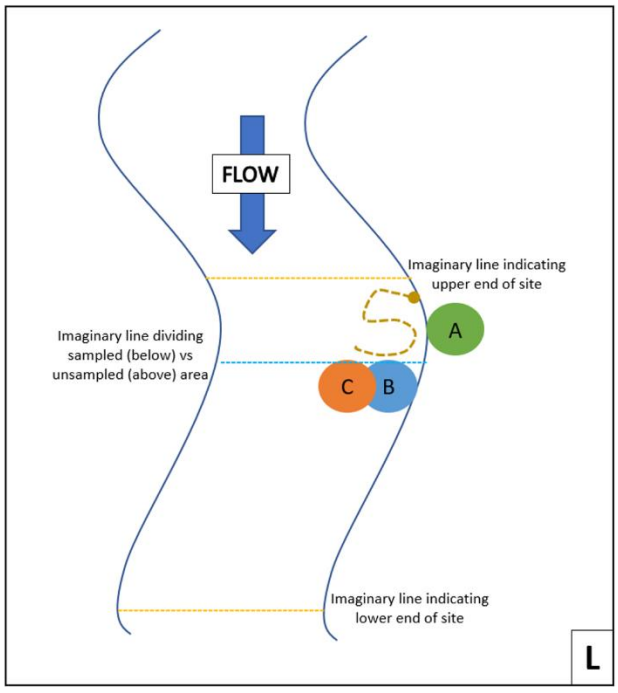
Imaginary line indicating lower end of site
K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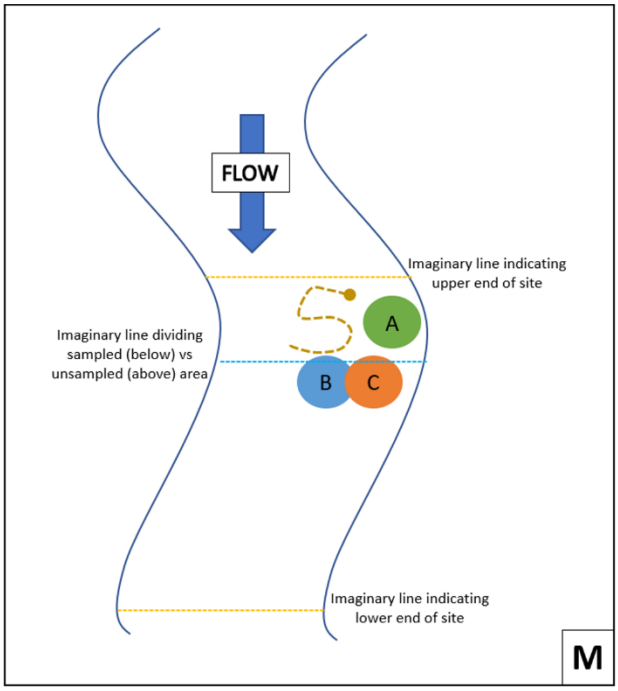
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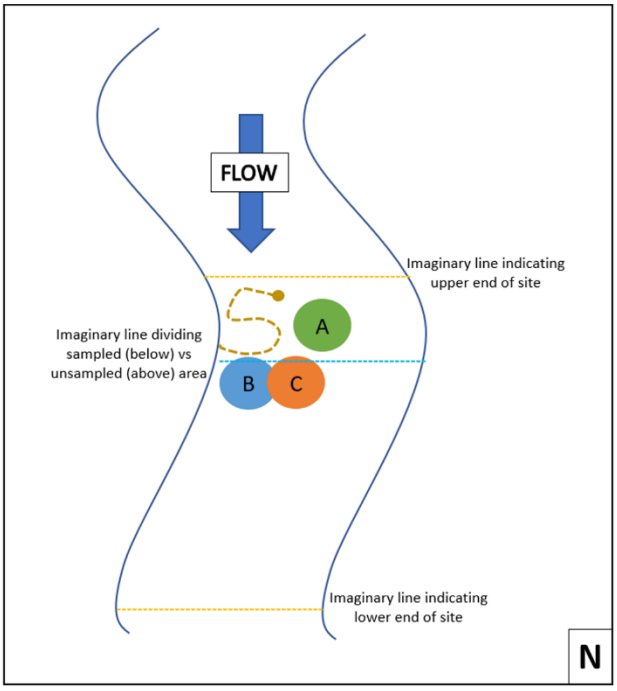
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APPENDIX V: BIOLOGICAL DETAILS FORM

Site code

BN	Brown Trout
BKT	Brook Trout

	Pass	Fry	Length (mm)	Weight (0.1 g)		Pass	Parr	Length (mm)	Weight (0.1 g)		Pass	Other Species	Length (mm)	Weight (0.1 g)
1					51					101				
2					52					102				
3					53					103				
4					54					104				
5					55					105				
6					56					106				
7					57					107				
8					58					108				
9					59					109				
10					60					110				
11					61					111				
12					62					112				
13					63					113				
14					64					114				
15					65					115				
16					66					116				
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28					78					128				
29					79					129				
30					80					130				
31					81					131				
32					82					132				
33					83					133				
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46					96					146				
47					97					147				
48					98					148				
49					99					149				
50					100					150				

APPENDIX VI: CLOVE OIL SOLUTION AS A FISH ANESTHETIC

Clove oil when mixed with ethanol can be used as a fish anesthetic. It is relatively inexpensive and is generally regarded safe for the user and for the fish. However it is light sensitive and recovery period after the anesthesia may be long, especially in cold (<5°C) water.

How to prepare a clove oil solution for field use

1. To help the 100% clove oil mix with water it must be diluted with 95% ethanol. Prepare a solution of clove oil, using a 9:1 ratio of ethanol to clove oil (nine parts ethanol, one part clove oil).
2. Keep this solution in a dark bottle and store in a dark area when not in use.
3. Prepare an anesthetic bath using a ratio of 2ml of clove oil solution to 5L of water. If fish are not going to sleep, the concentration may be too weak and more clove oil solution may be required. Increase the concentration of the bath in small increments until the desired response is achieved. If fish are not recovering well from the bath, the concentration may be too strong. Add more water to the bath to dilute the concentration.

APPENDIX VII: HOW TO MAKE SCALE SLIDES

Supplies

- Acetate sheet 20”x50” (thickness 0.020 inch)
- 3/4 inch double sided tape
- Utility Knife
- Meter stick
- Marker
- Stretch’n Seal plastic wrap

Procedure

1. Using marker, place a small tick mark on both the top and bottom of the acetate sheet (20-inch by 50-inch) every 7-cm along the length (50-inch). You should end up with 18 divisions (17 tick marks).

2. Starting at the first tick mark (7-cm), run a strip of tape down the width (20-inch) of the acetate sheet so that half the tape is on either side of the top and bottom tick mark. This step is important as you will eventually cut the sheet down the middle of the tape.

3. Repeat the taping for every second set of ticks (14-cm) for a total of nine strips of tape.

4. Peel off the protective layer from the double sided tape.

5. The Stretch’n Seal is approximately 12-inch wide. Two widths of Stetch’n Seal will be required to fully cover the acetate sheet.

6. Starting at the top of the acetate sheet , unroll just enough Stretch’n Seal to run past the first tape. Ensure the Stretch’n Seal is straight and has no wrinkles in it before continuing.

7. Unroll enough Stretch’n Seal to run past the next tape, stretching it slightly as you go. Stretching will help keep wrinkles to a minimum. Continue across the acetate sheet.

8. Repeat steps 6 and 7 for bottom half.

9. Once all Stretch’n Seal is in place, run your forearm across the entire sheet to remove any visible wrinkles.

10. Trim off all excess Stretch’n Seal hanging over the edges of the sheet.

11. Place your meter stick at the midpoint of each tape (tick marks) and run your utility knife down the acetate sheet, etching the sheet as you go. Light pressure is recommended, as it is not necessary to cut right through the sheet.

12. Once you have etched all the tape, slide the sheet over the edge of a table so that half is hanging over. Shape sheet in half. There should now be two sheets of 20-inch by 25-inch.

13. Now finish etching all remaining 7-cm marks on both sheets.

14. Using a marker, place a tick mark on the top and bottom of the sheet every 1-inch on the 20-inch side of the sheet. These ticks should be perpendicular to the tape.

15. Using the utility knife and meter stick, etch the sheet at the 1-inch tick marks.

16. The slides are now created but remain stuck together on the sheet. Sheets can be further broken down until a manageable size is obtained (for example, 30 slides per sheet).

17. Store sheets of slides with paper between each sheet to prevent sticking.

It is recommended to only break sheets into individual slides (1-inch by 7-cm) as needed, in order to prevent damage to slides.

APPENDIX VIII: SITE MEASUREMENT DIAGRAM