# Susitna-Watana Hydroelectric Project Document
# ARLIS Uniform Cover Page

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November 14, 2014

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

**Re: Susitna-Watana Hydroelectric Project, Project No. 14241-000**

***Filing of Initial Study Plan Meetings Transcripts and Additional Information in Response to October 2014 Initial Study Plan Meetings***

Dear Secretary Bose:

By letter dated January 28, 2014, the Federal Energy Regulatory Commission (Commission or FERC) modified the procedural schedule for the preparation and review of the Initial Study Report (ISR) for the proposed Susitna-Watana Hydroelectric Project, FERC Project No. 14241 (Project).[1] As required by the Commission's January 28 letter, the Alaska Energy Authority (AEA) filed the ISR with the Commission on June 3, 2014 and conducted ISR meetings on October 15, 16, 17, 21, 22, and 23, 2014. Attached as Attachments A-1 through F-2 are the written transcripts (along with the agenda and PowerPoint presentations) for these ISR meetings.

During the October ISR meetings, AEA and licensing participants identified certain technical memoranda and other information that AEA would file with the Commission by November 15, 2014. In accordance, AEA is filing and distributing the following technical memoranda and other information:

- Attachment G: *Glacier and Runoff Changes (Study 7.7) and Fluvial Geomorphology (Study 6.5) - Assessment of the Potential for Changes in Sediment Delivery to Watana Reservoir Due to Glacial Surges Technical Memorandum*. This technical memorandum documents AEA's analysis of the potential changes to sediment delivery from the upper Susitna watershed into the Project's reservoir from glacial surges.

- Attachment H: *Riparian Instream Flow (Study 8.6) and Fluvial Geomorphology (Study 6.6) - Dam Effects on Downstream Channel and Floodplain Geomorphology and Riparian Plant Communities and Ecosystems − Literature Review Technical Memorandum*. This literature review technical

[1] Letter from Jeff Wright, FERC Office of Energy Projects, to Wayne Dyok, Alaska Energy Authority, Project No. 14241-000 (issued Jan. 28, 2014).


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memorandum synthesizes historic physical and biologic data for the Susitna River floodplain vegetation (including 1980s studies), studies of hydro project impacts on downstream floodplain plant communities, and studies of un-impacted floodplain plant community successional processes.

- Attachment I: *Susitna River Fish Distribution and Abundance Implementation Plan, Appendix 3. Protocol for Site-Specific Gear Type Selection, Version 5*. In accordance with the fish distribution and abundance studies, as described in Revised Study Plan (RSP) Sections 9.5 and 9.6 and in the Fish Distribution and Abundance Implementation Plan, this appendix establishes the protocol for site-specific gear type selection for fish surveys. Throughout study plan implementation, AEA has updated this appendix as needed to provide consistent direction to all field teams. Version 1 of Appendix 3 was originally filed with the Fish Distribution and Abundance Implementation Plan in March 2013. That version was updated twice (Versions 2 and 3) during the 2013 field season to accommodate protocol changes that related to FERC's April 1, 2013 Study Plan Determination, field permits, and lessons learned during study implementation. Version 4 was the protocol used for the 2014 field season and was updated with respect to the prioritization of gear use and based on 2013 data collected. This version herein, Version 5, will be followed during the 2015 field season.

- Attachment J: *Fish Distribution and Abundance in the Upper and Middle/Lower Susitna River (Studies 9.5 and 9.6): Draft Chinook and Coho Salmon Identification Protocol.* This document established a Chinook and coho salmon identification protocol to support accurate and consistent field identification across field teams. It will allow for additional quality control and assurance of field identification calls and for estimation and reporting of any field identification error that may occur in future sampling efforts.

- Attachment K: *Characterization and Mapping of Aquatic Habitats (9.9), Errata to Initial Study Report Part A - Appendix A, Remote Line Mapping, 2012.* This errata provides a corrected version of map book for Remote Line Mapping, 2012. The version filed with the ISR (June 3, 2014) used a data query to build the maps in geomorphic reaches MR-1 to UR-5 that mistakenly did not include side slough habitat, so that no side sloughs were depicted on the Appendix A maps 1 through 21. This version was corrected by including side slough habitat in the data query for geomorphic reaches MR-1 to UR-5. This version now includes side sloughs.

- Attachment L: *Characterization and Mapping of Aquatic Habitats Study 9.9, Revised Map Book for 2012 Remote Line Mapping*. This map book represents an update to the version published on June 3, 2014 with the Study 9.9 Initial Study Report and the errata provided concurrently with this filing (*see* Attachment K). The maps presented include all macrohabitat and mesohabitat line identifications available in the 2012 Remote Line Mapping ArcGIS shapefile. This map book should be considered a full replacement for previous versions and represents the final product for the 2012 remote line habitat mapping effort.

- Attachment M: *Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries (Study 9.12), Fish Passage Criteria Technical Memorandum*. This technical memorandum presents a proposed final list of fish species that will be included in the fish barrier analysis as well as depth, leaping and velocity passage criteria for selected fish species. AEA previously consulted with the federal agencies and other licensing participants regarding the information within the technical memorandum during a March 19, 2014 Fisheries Technical Meeting.

In addition to the technical memoranda and other information identified above, AEA is filing a short errata (Attachment N) to the *Mercury Assessment and Potential for Bioaccumulation Study (Study 5.7), Evaluation of Continued Mercury Monitoring Beyond 2014 Technical Memorandum*. This technical memorandum, which was originally filed on September 30, 2014, evaluates the need for continued monitoring of mercury data beyond 2014 and whether the existing data collection efforts are sufficient to satisfy objectives for characterizing baseline mercury conditions in the Susitna River and tributaries (RSP Section 5.7.1). Since the filing of this TM and based upon the ongoing QA/QC of the data reported in that TM, AEA discovered errors in the TM. The attached TM corrects those errors. Additionally, the errata corrects corresponding errors in the Mercury Assessment and Potential for Bioaccumulation presentation presented during the October 16, 2014 ISR meeting.

Finally, AEA notes that data collected during the Study Plan implementation, to the extent they have been verified through AEA's quality assurance and quality control (QAQC) procedures and are publicly available, can be accessed at http://gis.suhydro.org/isr_mtg. On November 14, 2014, AEA posted the following data to this website:

- *Baseline Water Quality Data (Study 5.5)*, 2013 QAQC water quality data and DVRs per the Quality Assurance Project Plan.
- *Breeding Survey Study of Landbirds and Shorebirds (Study 10.16)*, cumulative 2013-2014 data.
- *Characterization and Mapping of Aquatic Habitats (Study 9.9)*, ArcGIS shapefile "ISR_9_9_AQHAB_RemoteLineMapping_2012.shp" used to generate the maps in Attachment L.

AEA appreciates the opportunity to provide this additional information to the Commission and licensing participants, which it believes will be helpful in determining the appropriate development of the 2015 study plan as set forth in the ISR. If you have questions concerning this submission please contact me at wdyok@aidea.org or (907) 771-3955.

Sincerely,

Wayne Dyok
Project Manager
Alaska Energy Authority

Attachments

cc: Distribution List (w/o Attachments)

# Susitna-Watana Hydroelectric Project

# (FERC No. 14241)

# Susitna River Fish Distribution and Abundance Implementation Plan:

# Appendix 3. Protocol for Site-Specific Gear Type Selection; Version 5

Prepared for

Alaska Energy Authority

Prepared by

R2 Resource Consultants, Inc.

November 2014

# APPENDIX 3. PROTOCOL FOR SITE-SPECIFIC GEAR TYPE SELECTION - VERSION 5

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# 1. INTRODUCTION

During the Susitna-Watana Hydro fish distribution and abundance studies, as described in RSP Sections 9.5 and 9.6 (AEA 2012) and in the Fish Distribution and Abundance Implementation Plan (R2 Resource Consultants, Inc. 2013), fish surveys will be conducted by multiple field crews. Each field crew will be equipped with a variety of gear types for sampling (see Section 8 of the Implementation Plan) and will need to select appropriate gear types to deploy based on varying habitat conditions. To properly address study objectives that require fish collection across diverse habitat types and multiple seasons, targeting a wide variety of life stages and species that inhabit different areas of the water column, a standardized approach for gear type selection is imperative.

The effectiveness of fish sampling gear is variable both in time and space and is influenced by physiochemical site parameters (turbidity, velocity, depth, substrate size and conductivity), cover types (aquatic vegetation, snags and debris), as well as target fish behavior (diet for baited techniques, activity periods, microhabitat preferences, and migration patterns).

This protocol will be used by field crews when selecting appropriate gear types in order to facilitate the use of standardized and repeatable sampling methods among different crews, in varying habitats, and across seasons. In subsequent revisions, gear selection priority and sampling approach has been updated based on FERC study plan determinations, review of data, feedback from field crews on logistical constraints, and according to annual ADF&G permit restrictions. All fish sampling crews will use this document during annual orientation and training prior to the field season and are expected to carry a copy of this appendix with them in the field. Decision trees are included for crews to quickly determine the appropriate gear types to use based on site conditions (Figures 1-4).

This appendix is a living document and updated versions will be produced as needed to provide consistent direction to all field teams. Version 1 of Appendix 3 was originally filed with the Fish Distribution and Abundance Implementation Plan in March 2013. That version was updated twice (Versions 2 and 3) during the 2013 field season to accommodate protocol changes that related to FERC's Study Plan Determination, field permits, and lessons learned during implementation in our first field season. Version 4 was the protocol used for the 2014 field season and was updated with respect to the prioritization of gear use and based on 2013 data collected. This version herein, Version 5 will be followed during the 2015 field season.

# 2. GEAR TYPE SELECTION APPROACH

The sampling techniques presented in Section 8 of the Implementation Plan have been organized into two tiers for both wadeable and non-wadeable stream conditions (Table 1). Under each scenario (i.e., wadeable and non-wadeable conditions), the first tier represents a set of methods that should be employed at each sampling site whenever feasible. Consistent application of the Tier 1 methods should be used wherever feasible such that fish distribution and abundance surveys are standardized and repeatable across space and time. However, it is expected that some Tier 1 methods will not be suitable under a given set of habitat or microhabitat conditions. Thus, alternative or supplemental gear types may need to be employed. These alternative and supplemental sampling techniques have been categorized as Tier 2 methods and should be used when the complexity of the habitat or presence of adult salmon limits the application or Tier 1 methods. Specific habitat and microhabitat conditions conducive for sampling with each of the Tier 1 and Tier 2 methods are provided in Tables 2 and 3. For each sampling technique, constraints with respect to depth, velocity, conductivity, visibility, water temperature, substrate and instream cover characteristics, and adult salmon presence are identified where applicable. Table 4 provides recommended target voltages for backpack electrofishing. Table 5 also provides other bulleted notes on requirements and/or limitations (e.g., selectivity for small or large fish, potential lethality) associated with each gear type.

Whenever feasible (water clarity, depth, and velocity) snorkeling, should be employed consistently as the first technique because it does not involve fish handling (moved from Tier 2 to Tier 1 in 2014 for emphasis). Techniques that require overnight or 24-hour soak times should be set last before leaving the site. For example, if snorkeling, electrofishing and minnow trapping are the techniques selected for a site, they should be done in that order. Snorkeling as the first method is also advantageous because it will alert field crews to the presence of adult salmon and trout in the sampling unit (electrofishing is prohibited in the presence of this life stage) and aid in subsequent gear selection and placement. In instances when two active sampling techniques are selected, most commonly electrofishing and seining, they should be employed on separate days whenever possible and electrofishing should follow seining (Poesch 2014).

For relative abundance sampling, block nets should be used whenever site conditions allow (moderate depths of 1-5 feet and little to no velocity) and should be set with minimal disturbance of the site prior to any sampling activities. Block netting is only suitable for low gradient habitats; this generally includes upland sloughs, side sloughs, beaver complexes, and some low gradient tributaries (e.g., Whiskers Creek and Chase Creek). If block nets are selected for a sampling unit during event one, efforts should be made to consistently use block nets during subsequent sampling.

# 3. LEVEL OF SAMPLING EFFORT

Although catch per unit effort (CPUE) estimates offer a way to standardize capture data across sampling units and events, field crews are expected to follow additional guidelines that are aimed at ensuring an appropriate level of effort is being applied for each sampling event. These guidelines are presented in Table 5. Regardless of the sampling method applied, representative length and width measurements will be taken to describe the area surveyed for each method employed at a given site. Drawings that indicate number and locations of nets and/or traps deployed throughout the unit will also be prepared for each sample and will aide in gear retrieval. Additional parameters that will be recorded to gauge the effectiveness of each selected method and to estimate catch per unit effort (CPUE) are shown on the method-specific field forms provided in Appendix 10 of the Fish Distribution and Abundance Implementation Plan (R2 Resource Consultants, Inc. 2013).

For distribution and relative abundance sampling, a minimum of three techniques should be used at a sampling unit. For example, when a main channel unit contains both wadeable and non-wadeable areas the non-wadeable area may be sampled with (1) boat electrofishing and the wadeable area along the channel margins may be sampled with (2) backpack electrofishing, and (3) minnow traps (Figure 5). The sampling unit length is 500 meters for the non-wadeable main channel and side channel areas and a subsample of the wadeable nearshore sampling area (e.g., 200 m). Off-channel and tributary sampling unit lengths are 20 x the channel width or 200 m, whichever is less. When an off-channel or tributary unit contains a diversity of mesohabitat types (pool, riffle, glide) ensure that at least two techniques are employed in each available habitat (i.e., no mesohabitats go un-sampled or sampled with only one technique, Figures 6-8). Depending on site conditions and limitations or restrictions associated with Tier 1 techniques, it is also recommended that minnow traps and hoop traps are paired together as they differ in size and species selectivity. The appropriate level of effort should be determined for each gear type prior to sampling based on the length and area of mesohabitat available. For example, if a 200 m site only contains 80 meters of habitat appropriate for minnow trapping, 8-16 traps (1-2 traps per 10 meters) should be fished depending on the channel width and habitat complexity.

# 4. MICROHABITAT DIVERSITY

Although fish distribution and abundance sampling will be conducted within macrohabitats (e.g., side channel, side slough, tributary plume) and mesohabitats (e.g., riffle, run/glide, pool), it is anticipated that sampling sites will range in their degree of habitat complexity and microhabitat diversity. For example, some habitats may be relatively uniform throughout the length and width of the sampling unit, whereas others may be characterized by multiple microhabitat conditions. Various microhabitat conditions within a sample unit may result from differences in depth, flow, and the abundance and spatial distribution of instream cover types (e.g., undercut banks, aquatic vegetation, woody debris, and large boulders). For this reason, it is expected that different gear types will be needed to survey different microhabitats within a given site.

For example, we will consider a mainstem habitat sampling unit that is composed of largely non-wadeable and moderately turbid run/glide habitat with an average velocity of 4 feet per second (fps), has an average thalweg depth of 0.8 meters (m), but also is characterized by wadeable and sparsely vegetated channel margins, or “edge habitat”, with uniform gravel substrates in some areas and large cobbles in other areas. Sampling in this unit would require the use of Tier 1 methods for non-wadeable habitats that meet the microhabitat conditions specified in Table 2 and may include boat electrofishing and drift gillnetting. Additionally, one Tier 2 gear type that is suited to sampling the mainstem channel would be employed including: minnow traps, beach seines, or backpack electrofishing along wadeable edge habitat or angling or trotlines in non-wadeable areas.

# 5. REFERENCES

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# 6. TABLES

Table 1. Tier 1 and Tier 2 Fish Distribution and Abundance Sampling Methods for Use in Wadeable and Non-Wadeable Survey Areas

| Wading Condition[a] | Tier 1 Methods[b] | Tier 2 Methods[b] |
|---|---|---|
| wadeable | ▪ fyke nets (FYK)<br>▪ snorkeling (SNK)[d]<br>▪ beach seines (SEN)<br>▪ backpack electrofishing (PEF) | ▪ hoop traps (HOT)<br>▪ baited minnow traps (MINB)<br>▪ set gill nets (GNS) &/or drift gill nets (GNF)<br>▪ angling (ANG)<br>▪ baited trotlines (TRLB) &/or set lines (STLB) |
| non-wadeable | ▪ boat electrofishing (BEF)<br>▪ fyke nets (FYK), &/or hoop traps (HOT)<br>▪ set gill nets (GNS) &/or drift gill nets (GNF) | ▪ snorkeling (SNK)[d]<br>▪ angling (ANG)<br>▪ baited trotlines (TRLB) &/or set lines (STLB)<br>▪ baited minnow traps (MINB)[c,d]<br>▪ beach seines (SEN) in wadeable edge microhabitats[d]<br>▪ backpack electrofishing (PEF) in wadeable edge microhabitats[d] |

[a] Habitats and microhabitats can be generally characterized as wadeable or non-wadeable using the "rule of 10". If the product of the water depth, expressed in feet, and the average velocity, expressed in feet per second, at a given habitat or microhabitat is less than 10, then the habitat is likely to be wadeable for most field crew members. Conversely, if the product is 10 or greater, then the habitat is not likely to be wadeable. Other factors (e.g., mossy and/or boulder substrates) are also likely to affect whether or not a habitat can be safely waded. Ultimately, safety is the priority concern, and each crew must determine for themselves whether or not a habitat can be safely waded without posing significant risk to its team members.

[b] Tier 1 represents the set of methods that should be employed at each sampling site whenever feasible; Tier 2 represents alternative and supplemental sampling techniques that may be used when habitat conditions preclude the use of and/or limit the efficacy of the Tier 1 methods.

[c] The use of minnow traps was stressed in 2013 study efforts, however they are very selective and the same fish species and sizes can be sampled through more versatile fyke netting and seining. In 2014, the use of minnow traps has been dropped to Tier 2 and they should generally be used when they are the best option available for example in deep, non-wadeable upland sloughs.

[d] In habitats that are largely non-wadeable, gear types suited for use in wadeable habitats may be employed to sample wadeable edge habitats. Generally, gear types appropriate for sampling edge habitats include seining, backpack electrofishing, minnow trapping, and snorkeling; note that these latter two methods may be used to sample non-wadeable habitats as well.

Table 2. Recommended Habitat Conditions and Other Sampling Guidelines and/or Limitations for Individual Gear Types

| Method | Suitable Habitat/Microhabitat Conditions | Other Sampling Notes, Requirements, and/or Limitations |
|---|---|---|
| beach seines (SEN) | ▪ wadeable habitats<br>▪ depth ≤1.2 m<br>▪ velocity ≤3 fps (low to moderate)<br>▪ homogenous gravel & sand/silt substrates<br>▪ no woody debris or large substrate snags<br>▪ minimal aquatic vegetation<br>▪ minimal undercut banks | ▪ employ at all sites where feasible, even if only along channel margin<br>▪ can be size selective, depending on mesh size<br>▪ suitable for use with block nets for relative abundance sampling when feasible |
| backpack electrofishing (PEF) | ▪ wadeable habitats<br>▪ depths ≤1 m<br>▪ velocity ≤5 fps (low to high)<br>▪ conductivity 40-350 µS/cm<br>▪ visibility ≥0.5 m<br>▪ water temperatures ≥4 ºC<br>▪ adult salmon not present | ▪ employ at all sites with no adult salmonids (salmon, trout, and char >12 inches)<br>▪ if adult salmon or trout are observed, sampling activity must cease<br>suitable for use with block nets for relative abundance sampling when feasible |
| snorkeling (SNK) | ▪ wadeable & non-wadeable habitats<br>▪ depth ≥0.2 m<br>▪ velocity ≤5 fps (low to *high*)<br>▪ visibility ≥2 m<br>▪ water temperature ≥5 ºC (preferred), if daytime | ▪ whenever conditions permit employ as first technique prior to sampling techniques that require fish capture and handling<br>▪ number of divers varies with channel width<br>▪ suitable for use with block nets for relative abundance sampling when feasible |
| fyke nets (FYK) | ▪ wadeable<br>▪ depth ≥0.5 m<br>▪ velocity ≤3 fps (low to moderate) | ▪ not suitable for use with block nets |
| minnow traps, baited (MINB) | ▪ wadeable & non-wadeable habitats<br>▪ depth ≥0.4 m<br>▪ velocity ≤3 fps (low to moderate) | ▪ should be employed only when best method available<br>▪ selective for smaller fish<br>▪ suitable for use with block nets for relative abundance sampling when feasible<br>▪ Can be paired with hoop traps as they differ in species and size selectivity |
| hoop traps (HOT) | ▪ wadeable & non-wadeable habitats<br>▪ depth ≥0.5 m<br>▪ velocity ≤3 fps (low to moderate) | ▪ selective for medium-large fish attracted to bait<br>▪ suitable for use with block nets for relative abundance sampling when feasible<br>▪ Can be paired with minnow traps as they differ in species and size selectivity |

| Method | Suitable Habitat/Microhabitat Conditions | Other Sampling Notes, Requirements, and/or Limitations |
|---|---|---|
| angling (ANG) | ▪ wadeable & non-wadeable habitats | ▪ selective for medium to large fish<br>▪ non-preferred method for relative abundance sampling due to highly variable efficiency among anglers<br>▪ not suitable for use with block nets |
| trotlines, baited (TRLB) & set lines, baited (STLB) | ▪ wadeable & non-wadeable habitats<br>▪ velocity ≤4 fps (low to moderately high) | ▪ selective for medium to large fish<br>▪ not suitable for use with block nets<br>▪ non-preferred method for relative abundance sampling<br>▪ potentially lethal sampling method<br>▪ in higher velocities, bait may be detached from hooks; if this occurs, alternative methods should be used |
| set gill nets (GNS) | ▪ wadeable & non-wadeable habitats<br>▪ depth ≤2 m<br>▪ velocity ≤1 fps (low)<br>▪ no woody debris or large substrate snags<br>▪ minimal aquatic vegetation | ▪ size selective<br>▪ no instream wood or boulders<br>▪ low levels of aquatic vegetation<br>▪ not suitable for use with block nets<br>▪ non-preferred method for relative abundance sampling<br>▪ potentially lethal sampling method |
| drift gill nets (GNF) | ▪ wadeable & non-wadeable habitats<br>▪ depth ≤2 m<br>▪ velocity ≤5 fps (low to high)<br>▪ no woody debris or large substrate snags | ▪ size selective<br>▪ no instream wood or boulders<br>▪ low levels aquatic vegetation<br>▪ not suitable for use with block nets<br>▪ non-preferred method for relative abundance sampling<br>▪ potentially lethal sampling method |
| boat electrofishing (BEF) | ▪ non-wadeable habitats<br>▪ depth ≥1 m and ≤3 m<br>▪ velocity ≤5 fps (low to high)<br>▪ conductivity 40-350 µS/cm<br>▪ visibility ≥0.5 m<br>▪ water temperatures ≥3 ºC<br>▪ adult salmon not present | ▪ employ at all sites with no adult salmonids (salmon, trout, and char)<br>▪ if adult salmon or trout are observed, sampling activity must cease<br>▪ not suitable for use with block nets |

References: Smith Root, Temple and Pearsons 2007, O'Neal 2007, WSDOT 2012, Dunham et al. 2009.

Table 3. A guide to fish distribution and abundance sampling technique selection by habitat type and ranking.

| Technique | Main channel | Side channel | Upland slough | Side slough | Beaver complex | Backwater | Tributary | Trib or slough mouth | Clear water plume | Pool | Glide | Riffle | Boulder Riffle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit Length | 500m or 20 x wcw[1] | 500m or 20 x wcw | 200m or 20 x wcw | 200m or 20 x wcw | 200m or 20 x wcw | 200m or 20 x wcw | 200m or 20 x wcw | 200m or 20 x wcw | 200m or 20 x wcw | na | na | na | na |
| Backpack Electrofishing | Margin-1 | Margin-1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | Margin-1 |
| Boat Electrofishing | 1 | 1 | | | | | 1 | 1 | 1 | 1 | 1 | 1 | |
| Seining | Margin-2 | Margin-2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | Margin-2 |
| Snorkeling | Margin-3* | 3* | 3* | 3* | 3* | 3* | 3* | 3* | 3* | 3* | 3* | 3* | 1* |
| Fyke net | Margin-4 | Margin-4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | 4 | | |
| Minnow trapping | Margin-5 | Margin-5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | Pocket water-1 |
| Hoop trap | 2 | 3 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5 | 5 | | Pocket water-2 |
| Angling | 3 | 4 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 6 | 4 | 2 |
| Trotline | 4 | 5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 7 | | |
| Set gill net | 5 | 6 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 8 | | | |
| Drift gillnet | 5 | 6 | 9 | 9 | | 9 | 9 | 9 | 9 | 8 | 8 | | 3 |

*whenever feasible (as site conditions allow) snorkeling should be employed as the first technique before techniques that require fish capture and handling.

[1]wcw= wetted channel width

Table 4. Recommended target voltage for standardized backpack electrofishing (constant power transfer) for juvenile salmonids in cold water at various ambient water conductivities (from Buckwalter 2012 et al.).

| Ambient conductivity (µS/cm) | Target voltage | | Ambient conductivity (µS/cm) | Target voltage | |
|---|---|---|---|---|---|
| | pulsed DC[a] | Smooth DC | | pulsed DC | Smooth DC |
| 20 | 1155 | 490 | 170 | 306 | 130 |
| 30 | 834 | 354 | 180 | 299 | 127 |
| 40 | 674 | 286 | 190 | 294 | 125 |
| 50 | 577 | 245 | 200 | 289 | 123 |
| 60 | 513 | 218 | 210 | 284 | 121 |
| 70 | 467 | 199 | 220 | 280 | 119 |
| 80 | 433 | 184 | 230 | 276 | 117 |
| 90 | 406 | 173 | 240 | 273 | 116 |
| 100 | 385 | 163 | 250 | 269 | 115 |
| 110 | 367 | 156 | 260 | 266 | 113 |
| 120 | 353 | 150 | 270 | 264 | 112 |
| 130 | 340 | 145 | 280 | 261 | 111 |
| 140 | 330 | 140 | 290 | 259 | 110 |
| 150 | 321 | 136 | 300 | 257 | 109 |
| 160 | 313 | 133 | | | |

*Note*: Target voltage values were calculated for a Smith-Root LR-24 backpack electrofisher fitted with a standard Smith-Root rat-tail cathode (a 10-ft length of braided, 3/16-in stainless-steel cable with the connected end insulated with a 6-ft length of neoprene) and a single anode pole having a standard Smith-Root 11-inch-diameter 3/8-in stainless-steel anode ring, and are optimized for capturing juvenile salmonids in cold, wadeable flowing waters with predominantly rocky substrates. These target voltages may not be optimal for electrofishing systems having a different internal resistance (i.e., different electrofishing system, electrode type, or if electrodes are heavily corroded), if targeting different fish species/life stages, or when electrofishing in nonwadeable waters or over predominantly fine substrates.

We prepared this power-standardization table based on the power-transfer theory for electrofishing (Kolz 1989), using water ambient conductivity measurements and metered electrofisher output values (peak voltage and current) selected while electrofishing to maximize capture-prone responses (taxis and forced swimming) and minimize responses associated with elevated trauma (immobilization, branding, spinal deformities, or recovery period exceeding 15 seconds) in target fish. We assumed fish conductivity = 100 µS/cm.

*This table provides a starting voltage setting for standardized backpack electrofishing. While electrofishing, always monitor the response of target and non-target organisms, and fine-tune electrofisher operations and settings as recommended in the user's manual to achieve the desired response.*

[a] 30 pulses per second, 12% duty cycle (4 mS pulse width)

Table 5. Method-Specific Levels of Effort for Distribution and Relative Abundance Sampling

| Method | Level of Effort for Distribution Sampling | Level of Effort for Relative Abundance Sampling |
|---|---|---|
| beach seines (SEN) | ▪ as many seine pulls as needed to cover the seineable area.<br>▪ 1 pass | ▪ as many seine pulls as needed to cover the seineable area.<br>▪ 1 pass<br>▪ use block nets when feasible |
| backpack electrofishing (PEF) | ▪ as much time as needed to cover the entire area that can be electrofished<br>▪ recommended pulse duration of >240s for 200m x 1m (200 $m^2$) site, >480s for 200 x 2.5m (500$m^2$) site, >1,020s for 200m x 10m (2000$m^2$) site<br>▪ 1 electrofisher per 5-10 m width of channel<br>▪ 1-pass | ▪ as much time as needed to cover the entire area that can be electrofished<br>▪ recommended pulse duration of >240s for 200m x 1m (200 $m^2$) site, >480s for 200 x 2.5m (500$m^2$) site, >1,020s for 200m x 10m (2000$m^2$) site<br>▪ 1 electrofisher per 5-10 m width of channel<br>▪ 1-pass<br>▪ Use block nets when feasible |
| snorkeling (SNK) | ▪ as much time as needed to cover the entire area that can be snorkeled<br>▪ 1 snorkeler per 5-m width of channel<br>▪ 1-pass | ▪ as much time as needed to cover the entire area that can be snorkeled<br>▪ 1 snorkeler per 5-m width of channel<br>▪ 1 pass<br>▪ Use block nets where feasible |
| fyke nets (FYK) | ▪ 1 net per sample unit<br>▪ 18-24-hour overnight soak | ▪ 1 net per sample unit<br>▪ 18-24-hour overnight soak |
| minnow traps, baited (MINB) | ▪ 1-2 traps per 10-m of sample unit, 20 traps per 200 meters<br>▪ divide unit into quadrants and distribute traps in throughout<br>▪ 24-hour overnight soak<br>▪ 1-pass | ▪ 1-2 traps per 10-m of sampling unit, 20 traps per 200 meters<br>▪ divide unit into quadrants and distribute traps throughout<br>▪ 24-hour overnight soak<br>▪ 1-pass<br>▪ Use block nets where feasible |
| hoop traps (HOT) | ▪ 1 trap per 50-m of appropriate habitat in sampling unit<br>▪ distribute traps evenly throughout trappable microhabitats<br>▪ soak overnight but for ≤12 hours<br>▪ 1-pass | ▪ 1 trap per 50-m of appropriate habitat in sampling unit<br>▪ distribute traps evenly throughout trappable microhabitats<br>▪ soak overnight but for ≤12 hours<br>▪ 1-pass<br>▪ Use block nets where feasible |
| angling (ANG) | ▪ up to 60 minutes of total angling time<br>▪ 1 pass | ▪ up to 60 minutes of total angling time<br>▪ 1 pass |
| trotlines, baited (TRLB) & set lines, baited (STLB) | ▪ 1 line per 50-m of appropriate habitat in sampling unit<br>▪ distribute lines evenly throughout fishable microhabitats<br>▪ 1 overnight soak<br>▪ may need to check lines more often at beginning of set, can rebait hooks after check<br>▪ Hook gap ≥3/4” | ▪ 1 line per 50-m of appropriate habitat in sampling unit<br>▪ distribute lines evenly throughout fishable microhabitats<br>▪ 1 overnight soak<br>▪<br>▪ may need to check lines more often at beginning of set, do not rebait hooks until daily check |
| set gill nets (GNS)[1] | ▪ 1 net per sample unit<br>▪ soak overnight but for ≤10 hours<br>▪ constantly/closely monitor net at beginning of set (hourly for first 2-3 hours) and check in early morning<br>▪ 1 pass | ▪ 1 net per sample unit<br>▪ soak overnight but for ≤10 hours<br>▪ Constantly/closely monitor net at beginning of set (hourly for first 2-3 hours) and check in early morning<br>▪ 1 pass |

| Method | Level of Effort for Distribution Sampling | Level of Effort for Relative Abundance Sampling |
|---|---|---|
| drift gill nets (GNF) | ▪ 1 net per sample unit<br>▪ 30-minute soak time, or less if net saturated with fish or sampling area is limited or completed<br>▪ 1 pass<br>▪ Monitor net constantly | ▪ 1 net per sample unit<br>▪ 30-minute soak time, or less if net saturated with fish<br>▪ 1 pass<br>▪ Monitor net constantly |
| boat electrofishing (BEF) | ▪ as much time as needed to cover the entire area that can be electrofished<br>▪ 1 pass, zigzag to cover variable depths | ▪ as much time as needed to cover the entire area that can be electrofished<br>▪ 1 pass, zigzag to cover variable depths |

Notes:

1 Since gillnets are potentially lethal nets, they should be monitored for the first hour of an extended set to prevent excessive catch and mortality.

# 7. FIGURES

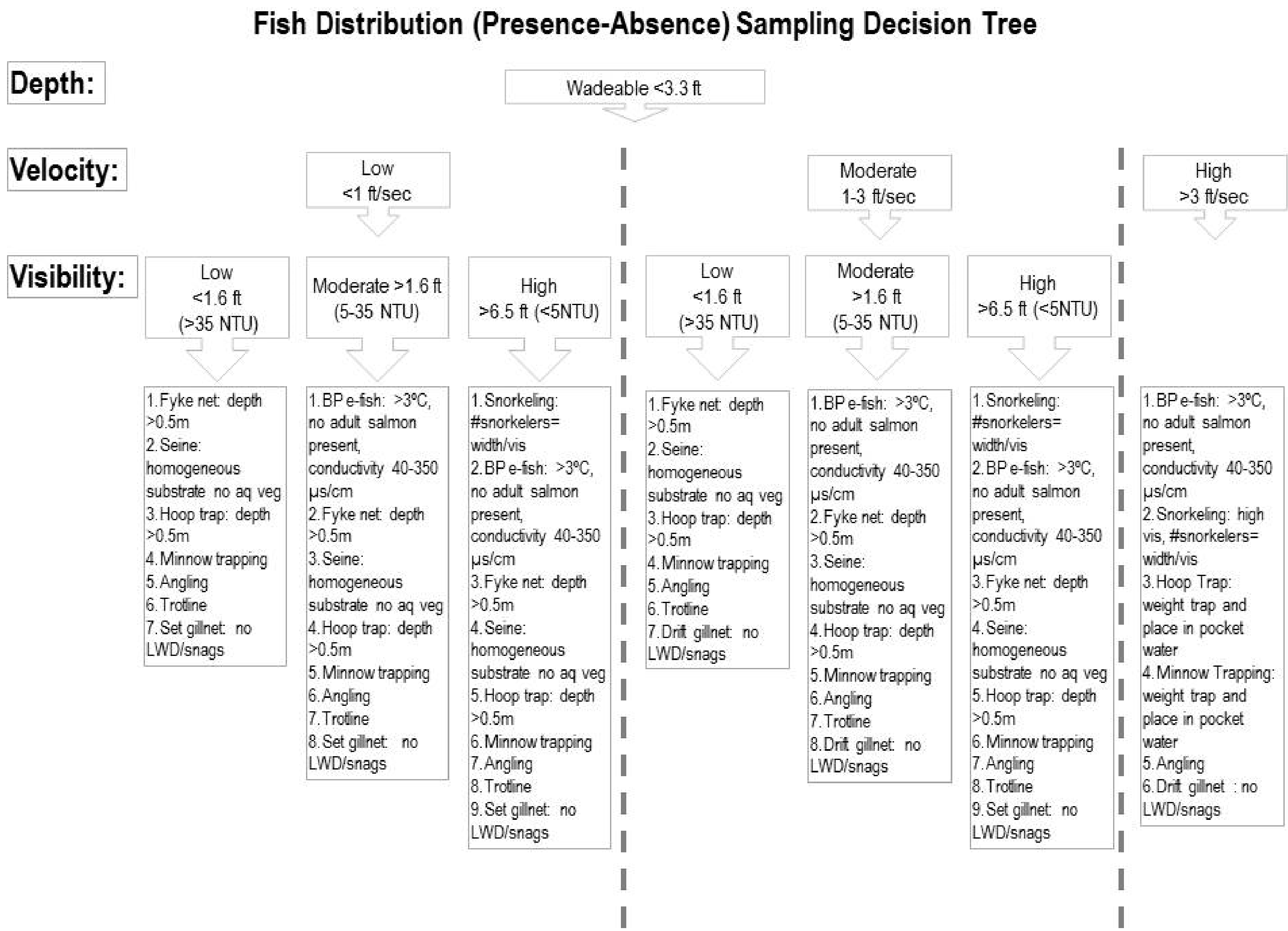


Figure 1. Decision tree guide for fish distribution sampling in wadeable habitats.

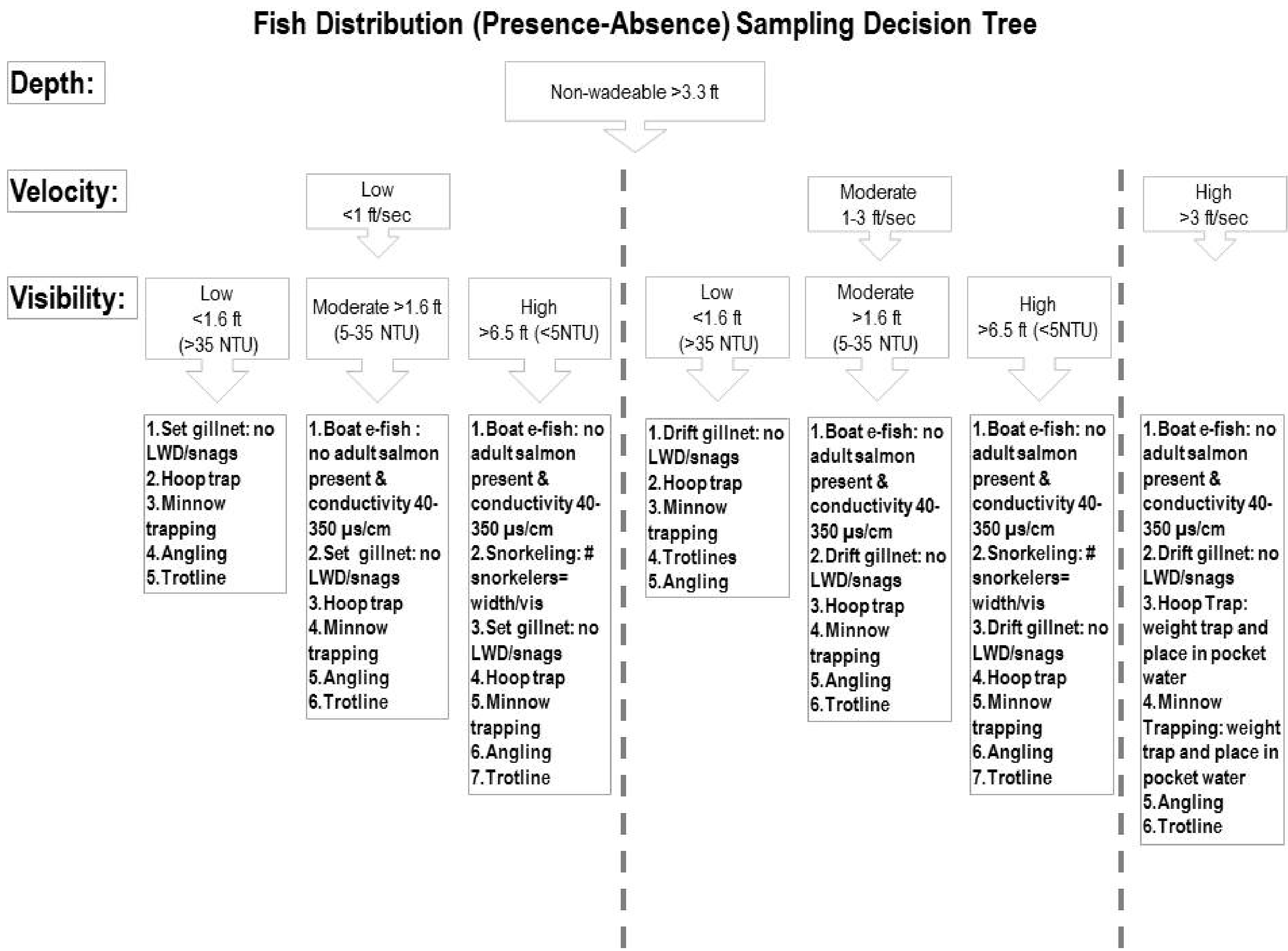


Figure 2. Decision tree guide for fish distribution sampling in non-wadeable habitats.

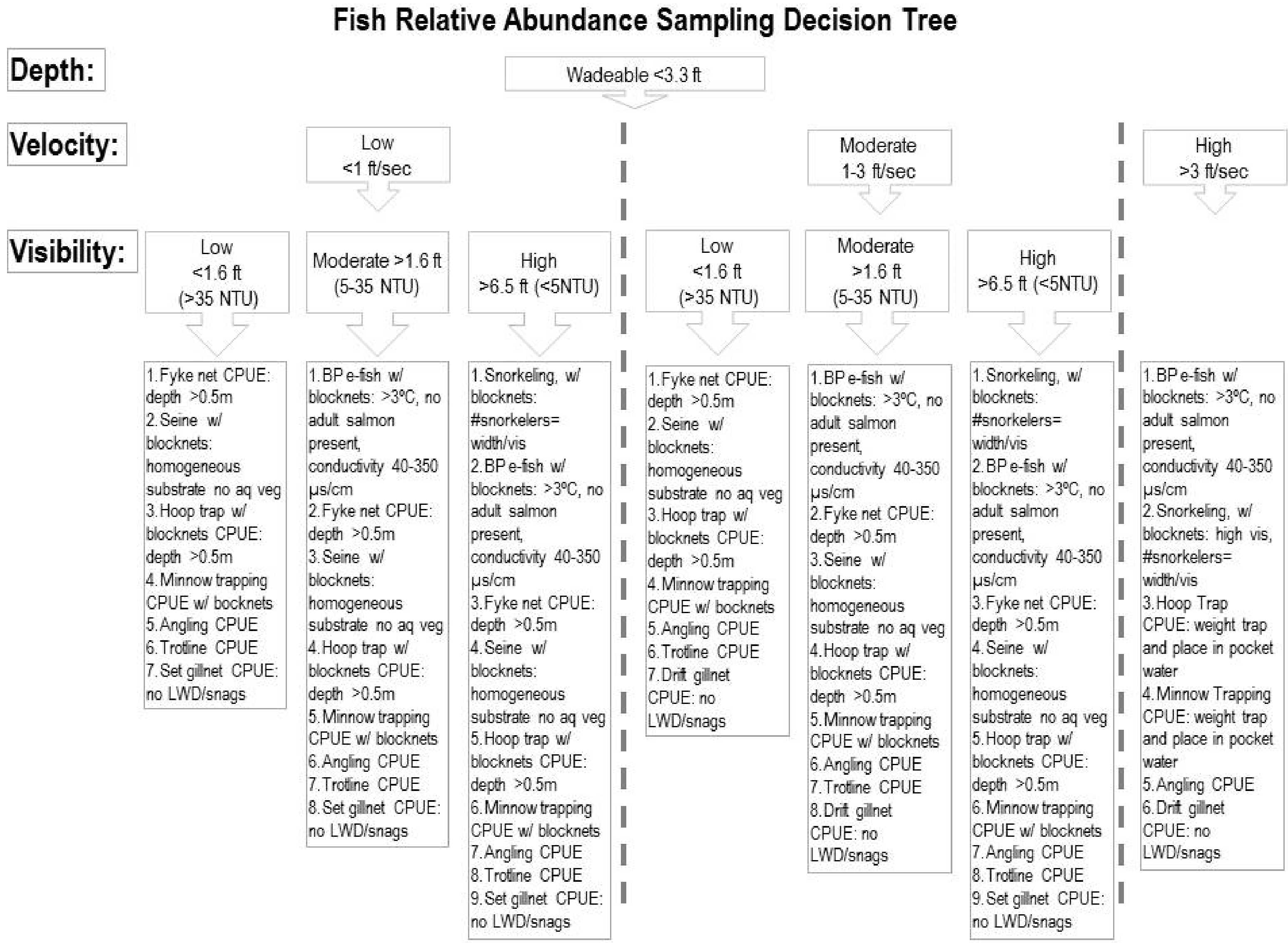


Figure 3. Decision tree guide for relative abundance sampling in wadeable habitats

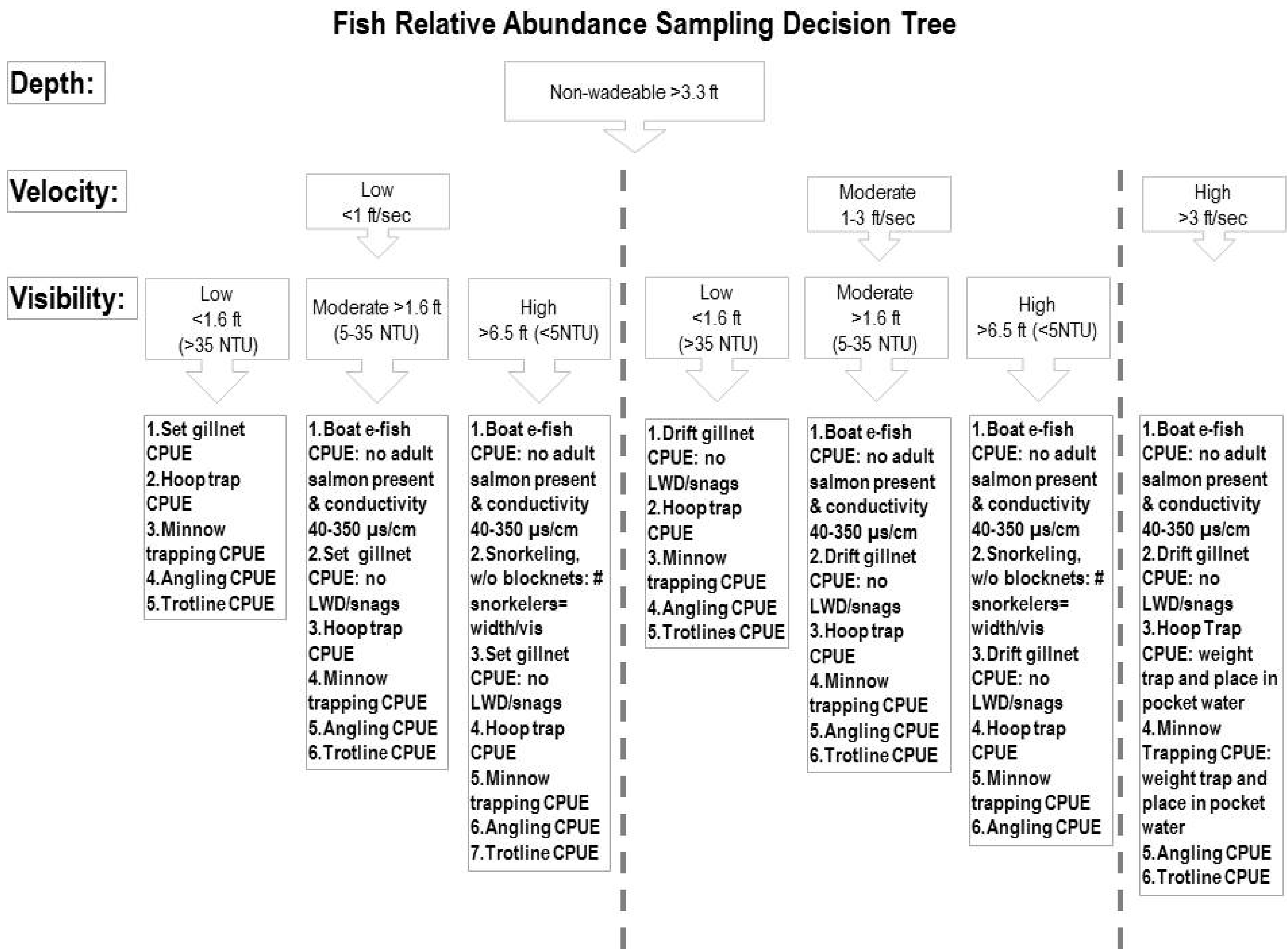


Figure 4. Decision tree guide for relative abundance sampling in non-wadeable habitats.

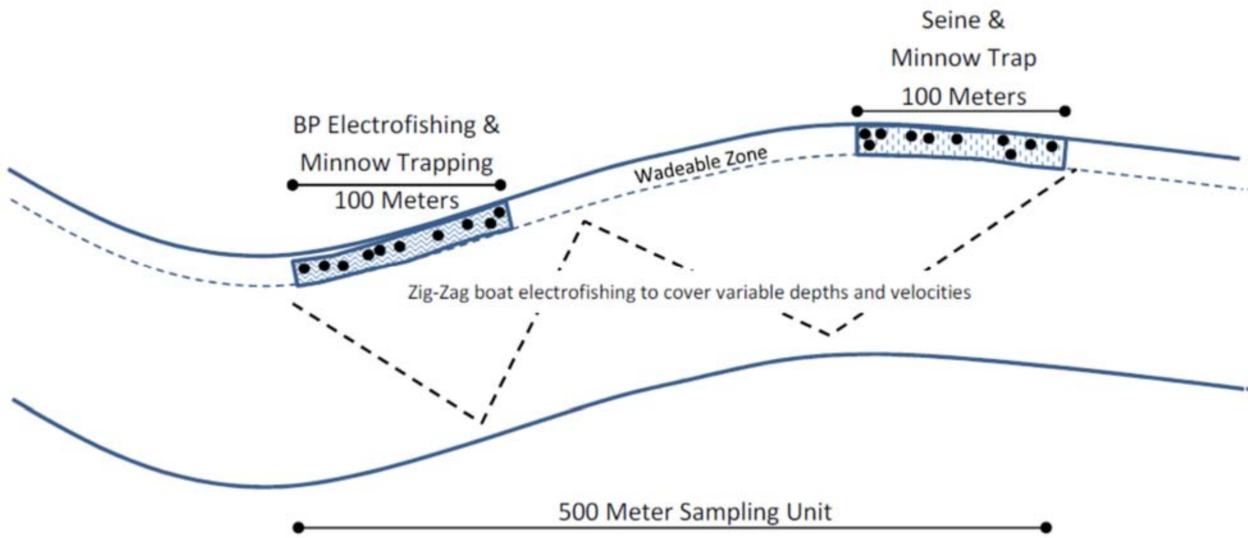


Figure 5. Schematic example of main channel sampling unit.

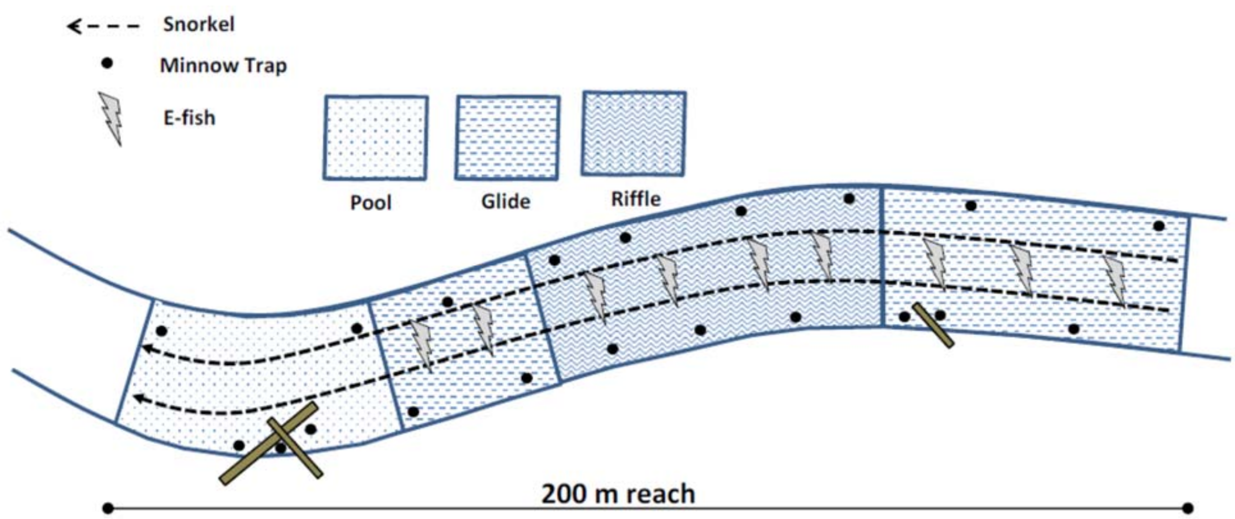


Figure 6. Schematic example of off-channel sampling unit. Snorkeling, electrofishing and minnow trapping were the techniques selected.

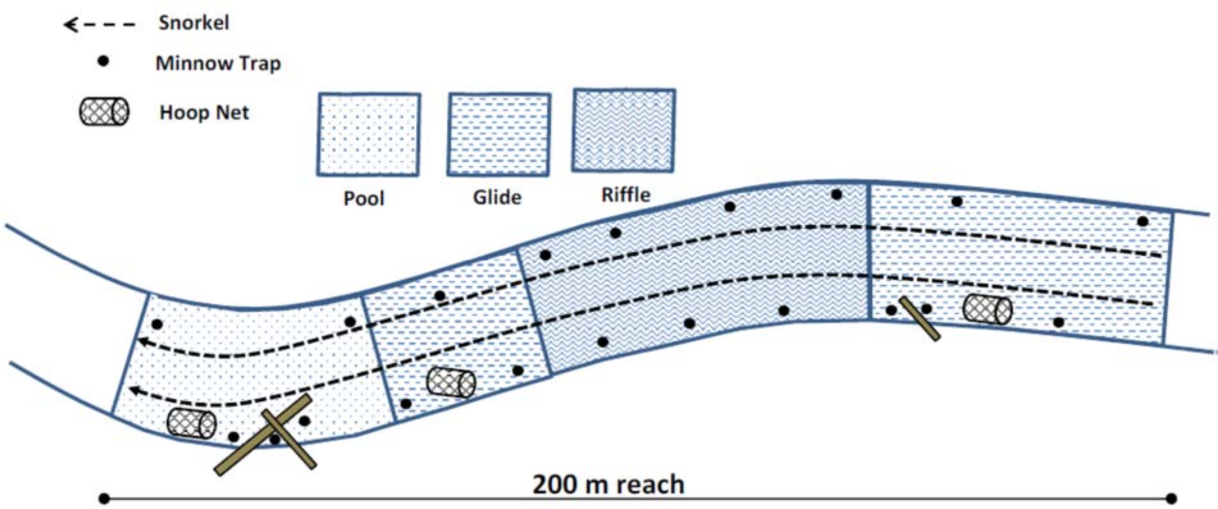


Figure 7. Schematic example of off-channel sampling unit. Because of adult salmon present in the sampling unit, snorkeling, minnow trapping, and hoop netting were the techniques selected.

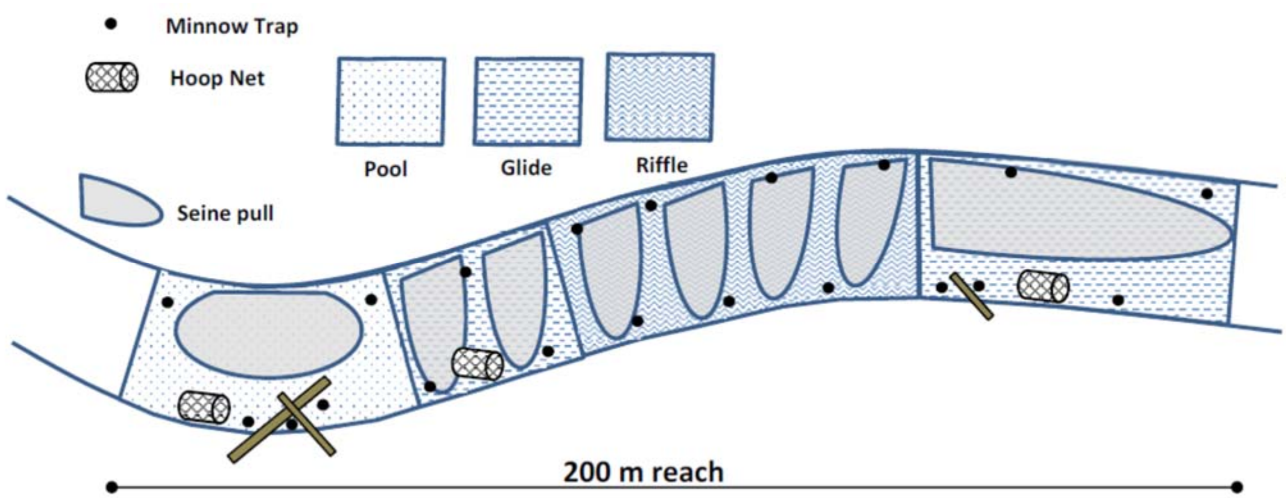


Figure 8. Schematic example of off channel sampling unit. Because of adult salmon presence and limited visibility, minnow trapping, seining and hoop trapping were the techniques selected.