AMERICAN FISHERIES SOCIETY
SOUTHERN DIVISION,
TROUT COMMITTEE

Standardized Sampling Guidelines for Wadeable Trout Streams

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The following guidelines for standardized sampling methods in wadeable trout streams are based on the recommendations of the Standardized Trout Stream Sampling sub-committee of the American Fisheries Society, Southern Division Trout Committee. Wadeable trout streams, exclusive of tailwaters, are defined as those that can be waded and sampled with backpack electrofishing gear. Southeastern trout streams are the primary focus of these guidelines, although they may be used (with or without modification) in other geographical regions. The objectives of these guidelines are:

1. Establishment of standardized sampling procedures that will provide a mechanism by which data can be more readily compared among various streams

2. Provision of standardized trend data on population changes (e.g., density, standing crop, species composition, size and age structure, etc.) through time as they relate to various abiotic effects (e.g., droughts, floods, regulation differences or changes, etc.)

Recommended Sampling Protocol

Station Selection

1. Since complete electrofishing surveys of even the smallest streams are usually impractical, fish stock assessments must be based on a sample of stream reaches (Bohlin et al. 1982). The recommended procedure for selecting these sampling sections (also referred to as stations or sites) for monitoring purposes is to use "representative" stream reaches that contain the major habitat types or units present, such as pools, riffles, runs, etc. If possible, streams should be traversed prior to station selection to ensure that major habitat types are included in proportion to their occurrence. Representative reaches can be chosen randomly or sited using specific criteria as project needs dictate. Bovee (1982) and Hamilton and Bergersen (1984) provide additional information regarding habitat-based site selection. Non-contiguous habitat units may also be sampled if "representative" reaches are unavailable or lack the desired level of precision for specific studies. Representative reaches are, however, recommended for long-term monitoring stations.

2. Minimum recommended station length is 100 m in streams ≤10 m in mean width as this length typically provides for the inclusion of at least one cycle of the basic stream habitat units present. The recommended station length in streams with mean widths exceeding 10 m is 200 m since it is difficult to include all major habitat types in 100-m stations in these larger streams. In practice, these station length recommendations should be used as points of reference since actual station lengths will often require adjustment to avoid habitat unit fragmentation and to make use of any fish passage obstructions present.

Sampling Techniques

1. Backpack electrofishing is the most commonly used, non-lethal means for sampling trout population in relatively small streams (Armour et al. 1983) and is recommended here. Other sampling techniques, such as ichthyocides and explosives, may be necessary under specific circumstances and are described in Armour et al. (1983) and Platts et al. (1983). Removal-depletion and mark-recapture population estimation techniques are typically employed with backpack electrofishing gear. The removal-depletion method, however, is strongly recommended because of its overall efficiency (Armour et al. 1983) and because its associated assumptions (see Section 2 below) are more easily met. For example, behavioral responses of trout released after capture by electrofishing and marking may be such that the assumption of equal catchability (among marked and unmarked fish) is violated (Mesa and Schreck 1989). Little change in the behavior of trout remaining in stream sections following successive removal-depletion electrofishing passes has been noted (Mesa and Schreck 1989).

Two to four removal passes, made in the upstream direction only, may be used in removal-depletion sampling (Armour et al. 1983), although three passes are ideal in nearly all situations (Figure 1). Bohlin (1982) and Bohlin et al. (1982) recommend three removal passes where capture probabilities (catchabilities) are ≥0.50, although they note that two passes may be sufficient where large populations are present (Figure 1). Catchability refers to a fish's estimated probability of capture on a given pass of a removal-depletion sample and characterizes the sample's reliability (Armour et al. 1983). Electrofishing catchabilities ranging from 0.50 to 0.70 are considered typical for stream salmonids (Bohlin 1982). In samples from Southeastern streams, catchabilities have averaged near 0.60 for adult trout (Figures 2 and 3). Catchabilities ≥0.50 will provide reliable population estimates.

The small size of young-of-the-year (YOY) trout tends to lower the catchability of this group. Field observations indicate that part of this lowered catchability may be due, in part, to the tendency of netters to first capture the larger individuals (adults) in a group of stunned fish. When relatively large numbers of YOY are present, the overall catchability estimate for the sample may be lowered into the 0.40 to 0.50 range if YOY data are not treated separately.

2. Three important assumptions apply if reliable electrofishing data are to be obtained using the removal-depletion method: (1) no fish may enter or leave the study site during sampling; (2) each fish has and equal chance of being captured; and (3) catchability remains constant with each removal (Armour et al. 1983; Van Deventer and Platts 1983). The use of block nets is necessary to meet the first assumption, particularly at the downstream end of sampling sites. The upstream boundary of sampling sites can often be located where fish passage is obstructed (e.g., by small waterfalls or cascades), thus making a block net unnecessary. The other two assumptions can be reasonably met by maintaining uniform sampling effort and equipment settings (e.g., current and voltage) among the removal passes. One netter per electrofishing unit (in addition to the operator) per pass is recommended and the availability of a back-up electrofishing unit will permit equal effort among passes should a unit fail during the sample.

3. Alternating current (AC) is recommended for sampling the softwater streams typically encountered in the Southeast since it has proven to be more effective than direct current (DC). The most suitable voltages appear to be 300-700 VAC in streams with conductivities of ≤50 µS (µmhos). Battery-powered (DC) electrofishing units can be used if desired where conductivity is higher (>50 µS) and may be necessary in wilderness areas where internal-combustion engines are prohibited. Information regarding the current and voltage used should always be recorded on the appropriate field data sheets.

4. Unpublished data from Great Smoky Mountains National Park and Cherokee National Forest (Tennessee) indicate that one electrofishing unit will provide reliable quantitative data from streams up to 4 m in mean width (Figure 3). Additionally, Habera et al. (1992) and Russell (1992) found that many streams with a mean width of 4.5-6 m can also be adequately sampled with one electrofishing unit. The results of Habera et al. (1992) and Russell (1992) also indicate, however, that site-specific decisions should be made where mean stream width are in the 4.5- to 6-m range. Higher-gradient streams with distinct habitat units can often be sampled more easily with one unit than lower-gradient streams without distinct habitat units.

Electrofishing effort (in terms of electrofishing units) must be increased in wider streams if assumptions associated with the removal-depletion method are to be met. As a general rule, one electrofishing unit per 3 m of mean stream width has provided reliable data in streams over 4 m wide (Figure 3) and is, therefore, recommended. Other stream features such as channel morphology and habitat types present may also affect the number of electrofishing units required. Therefore, decisions regarding the use of an additional electrofishing unit in situations where mean width suggests this may be necessary (i.e., >4 m) should be based on these factors as well.

Sample Timing

1. The recommended stream sampling period is summer and early fall (June - October), primarily because this time frame coincides with the period of lowest stream flows in the Southeast. Stream flow rates have a marked effect on electrofishing efficiency; therefore, avoid sampling during high flow conditions (e.g., those typically occurring in the winter and early spring or after storm events). Sampling during summer and early fall also permits collection of YOY trout and subsequent assessment of year-class strength. Disadvantages associated with winter and early spring sampling, notwithstanding high stream flows, may include safety hazards (e.g., anchor ice) and lowered fish catchability related to extremely cold water and the tendency for trout to enter the substrate and not float well when stunned (Armour 1983). Sampling during the period of peak leaf fall may present problems with keeping block nets in place and with seeing and retrieving stunned fish.

2. Temporal differences in trout life-history parameters at higher elevations (e.g., spawning dates) may necessitate delaying sampling to late summer if YOY assessments are to be made.

3. Individual streams should be sampled at approximately the same time each year, particularly if the stream is part of a long-term monitoring program.

Data Collection and Analysis

1. Mean stream width based on multiple measurements (a minimum of 10 per sample site) should be determined as this is necessary for calculating the surface area of the site. Other physicochemical features such as gradient, elevation, substrate composition, discharge, basic water quality parameters, etc. can be measured or characterized as needed. These data may greatly enhance comparisons between streams by helping to explain part of the observed variability.

2. Minimum data to be collected from individual adult and YOY trout (and other game fish) include total length (mm) and weight (g). Total number and total weight by species may be recorded for non-game species if desired. Electronic scales expedite the handling of large numbers of specimens. Hand-held spring scales are highly accurate if maintained and are easily carried to remote sampling locations (Jennings 1989).

3. The recommended computer software for processing electrofishing data acquired using the removal-depletion method is MicroFish 3.0 (Van Deventer and Platts 1989). This software uses the maximum-likelihood method (Carle and Strub 1978; Van Deventer and Platts 1983) to calculate population estimates and provides various other population statistics such as mean length, weight, and condition factors. MicroFish 3.0 output can be used, along with surface area measurements for each sampling station, to calculate fish densities and standing crops. Densities and standing crops serve as basic means for comparing trout populations among sites, streams, or years. It is recommended that adult and YOY trout population estimates (and other statistics) be calculated separately since YOY catchabilities tend to be lower than those for adults.

Summary

These guidelines constitute an attempt to standardize trout stream sampling procedures and promote data exchange among the various natural resource management agencies represented by members of the American Fisheries Society, Southern Division Trout Committee. Compliance with these guidelines is strictly voluntary, although it is anticipated that widespread acceptance of the concept of standardized trout stream sampling procedures will provide the basis for a sound regional coldwater fisheries database. Such a database would enable more accurate assessments of trout population responses to various environmental and management changes within and across the Southeast region and might eventually decrease the amount of sampling necessary in the future.

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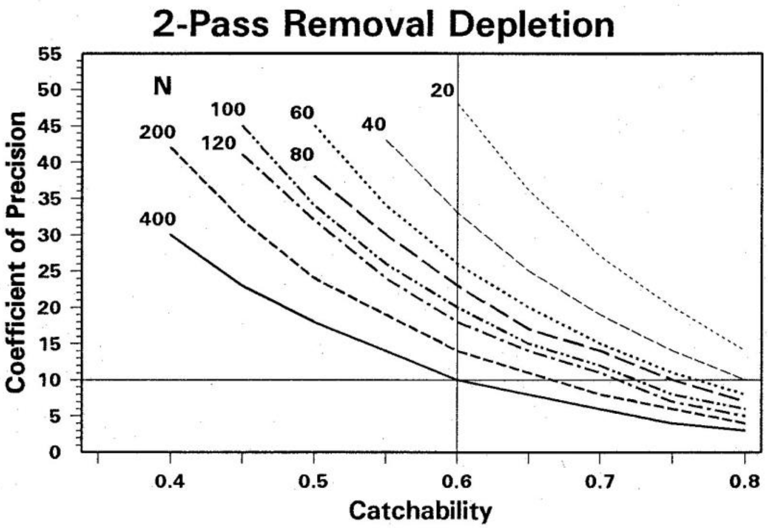

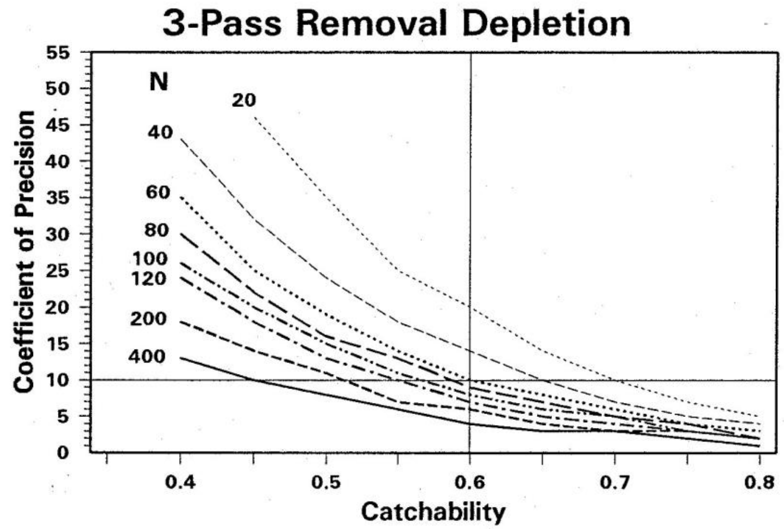

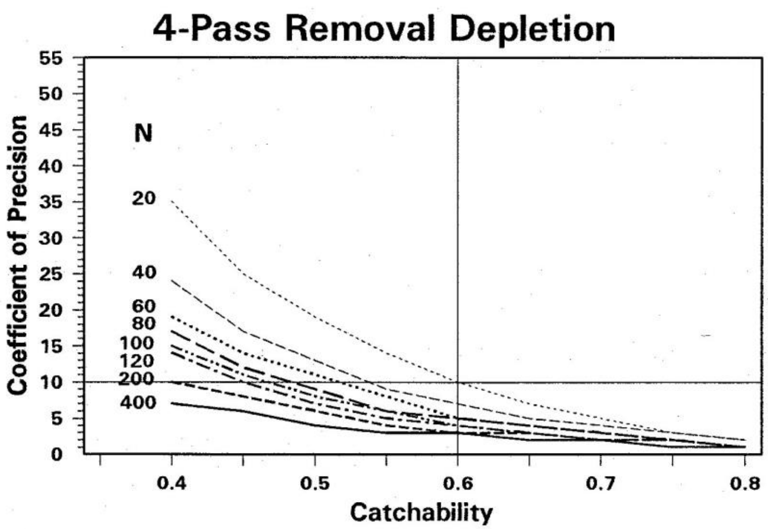

Figure 1. Coefficient of precision (Van Deventer and Platts 1989) vs. catchability curves for population sizes (N) ranging from 20-400 with 2-, 3-, and 4-pass removal depletions. The coefficient of precision, CP(N), is a measure of the difference between N (actual population size) and the corresponding population estimate (ˆN). For example, a CP(N) of 10% means that ˆN will be within 10% of N at the 95% confidence level. The graphs indicate that to maintain a given level of precision (e.g., 10%), catchability must increase as N decreases since the effect of capturing (or not capturing) a given fish on a given pass becomes increasingly important when N is relatively small and each fish represents a larger proportion of N. Using a reference catchability of 0.60, which the literature (Bohlin 1982) and data (unpublished) from GSMNP indicate is average, it is apparent that a 10% level of precision is possible only when sampling the largest populations (N≥400) with 2-pass removal depletions. Catchabilities of >0.75 must be achieved when sampling small populations (N<50) using 2-pass depletions if a 10% level of precision is to be obtained. Conversely, catchability need not exceed 0.60 for population sizes as low as 20 to achieve a 10% level of precision with 4-pass depletion samples. However, the additional effort required for four removal passes often would not justify any added precision. Three-pass depletions with catchabilities near 0.60 permit high levels of precision (≤10%) for populations where N≥60. Where N<60, somewhat higher carchabilities are necessary (0.65-0.70) but not unrealistic. Graphs are adaptations of those presented in Van Deventer and Platts (1989).

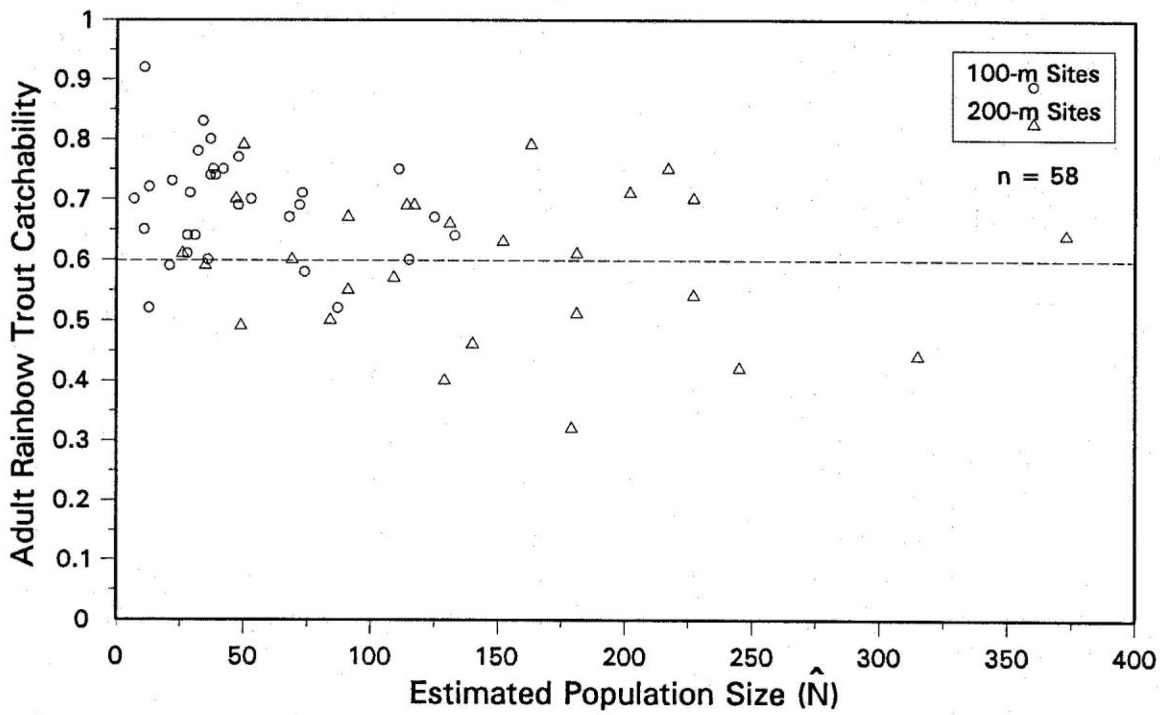

Figure 2. Adult rainbow trout catchabilities for 3-pass depletion samples from 58 Tennessee and North Carolina populations (100-200 m sites). Catchabilities averaging near 0.60 were achieved over a range of population sizes.

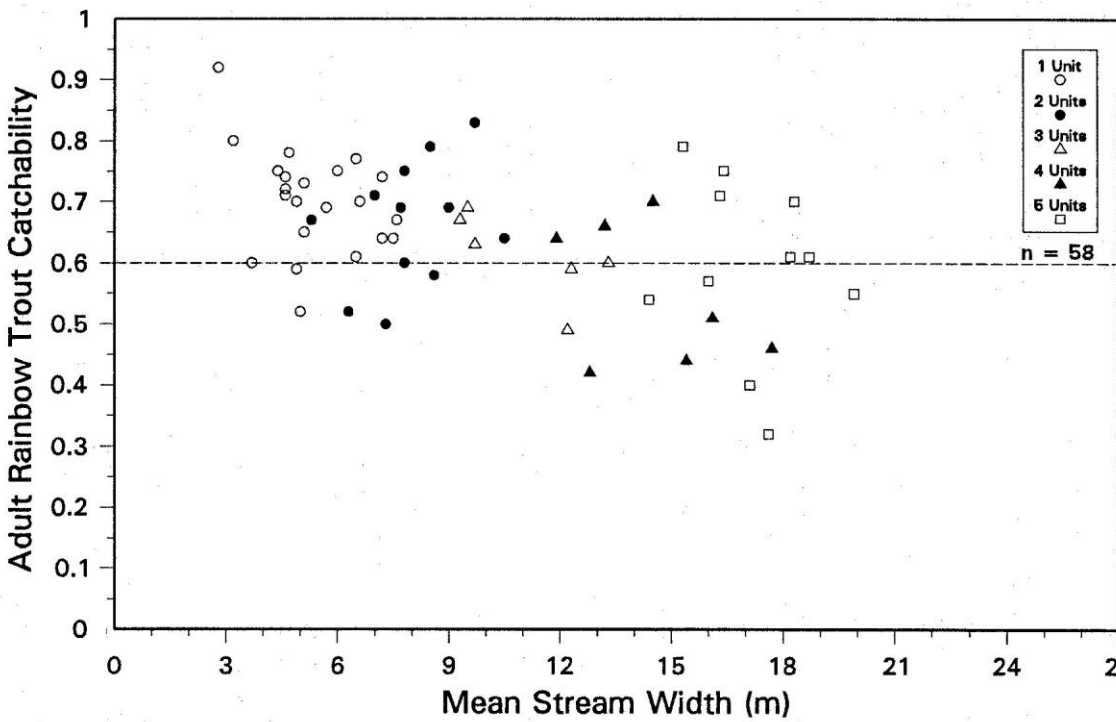

Figure 3. Adult rainbow trout catchabilities for 3-pass depletion samples of 58 Tennessee and North Carolina populations from a range of stream sizes. Catchabilities averaging near 0.60 were achieved in wider streams by employing additional electrofishing units, typically at the rate of one unit per 3 to 4 m of mean stream width.