Impacts of Electrofishing Injury on Idaho Stream Salmonids at the Population Scale

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ABSTRACT—This study assesses the mortality impacts of electrofishing at the population scale based on levels of sampling by Idaho Department Fish and Game (IDFG) and non-IDFG projects during the 1995 and 1996 field seasons. We estimated electrofishing induced population mortality by considering the proportion of stream reach shocked during sampling, the probability of fish exposure to an electric field based on sampling method used, and a hypothesized worst-case (25%) mortality rate for all electroshocked fish. For IDFG mark-recapture estimates the mean mortality from shocking was 1.05% with a range of 0.13-4.02%. For Idaho Department of Fish and Game (IDFG) removal sampling, we estimate a mean population mortality of 0.38% with a range of 0.02-2.91%. For non-IDFG sampling mean population mortality averaged 1.11% with a range of 0.05-7.71%. Fifty-one percent of all mortality estimates were less than 0.50%. These low estimates are likely worst-case electrofishing effects because the high assumed mortality value used is not supported by any literature values. We conclude the impacts due to sampling using electrofishing methods does not constitute a meaningful impact to Idaho stream trout at the population level, especially when compared to annual natural mortality levels for most stream salmonids which typically equal 30-60%.

Introduction

Electrofishing is a widely used and highly effective sampling tool in the management of stream salmonids and other species (Schill and Beland 1995; Reynolds 1996). The use of electrofishing as a sampling tool began in the 1940’s and became commonplace in the 1950’s and 1960’s. Despite the completion of several early injury studies, the technique was considered relatively benign for many years (Reynolds 1996). Recent concern regarding injury of fish collected with electrofishing methods was first raised by Sharber and Carothers (1988), who reported high injury rates for a sample of rainbow trout from the Colorado River. Since this initial effort to quantify injuries, additional studies have documented injury levels of up to 70% for trout sampled using traditional electrofishing methods (Sharber et al. 1994: Fredenberg 1992; Holmes et al. 1990; McMichael 1993; Thompson et at. 1997; Habera et al. 1996). Although short term injury rates from samples of electrofished salmonids often appear to be high, short-term mortality is often low (McMichael 1993; Hudy 1985; Pratt 1955; McCrimmon and Bidgood 1965).

Methods

We estimated the probability of electrofishing mortality at the population scale for each sampling effort using the proportion of the stream reach shocked, probability of trout electrical exposure for a given electrofishing application, and an assumed worst case estimate of mortality for fish collected.

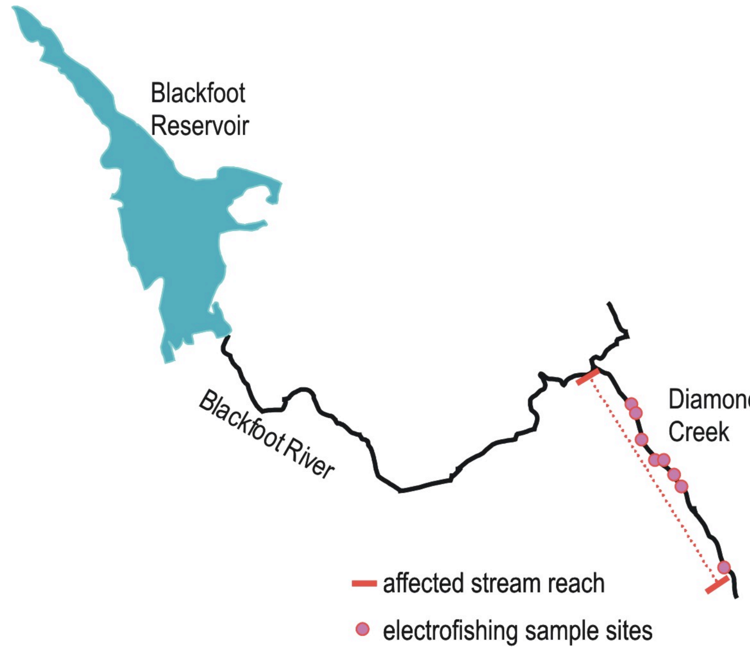

Figure 1. Example of stream reach used for extrapolation from sample to population scale. Expansion of sections was restricted to equal stream order from which samples where collected as determined by 1:100,000 scale maps.

We used 67%, 89%, 96% as the probability of capture or electrical exposure (E) for 1 pass, 2 pass and 3 pass removal sampling. These values represent general capture efficiencies for Idaho streams (Meyers 1999) and are virtually the same as that reported by McMichael et al. (1998). For mark-recapture estimates we used the proportion of fish recaptured as the probability of exposure. This mark-recapture probability was doubled to account for electrical exposure during both the mark and recapture runs (McMichael et al. 1998). Although declines in long-term survival of electrofished salmonids has not been documented relative to control samples, we chose 25% as an estimate of mortality due to electrofishing injury to represent a worst case long-term mortality rate for this study.

The following equation was used to calculate the probability of mortality at the population scale for each sample site or combined sites on a stream reach:

$$M = PE\ (0.25)$$

where M = the estimated mortality resulting for a stream reach;

P = the proportion of the stream reach length shocked during sampling;

E = the probability of trout electrical exposure per site based on the sampling method applied.

Results

IDFG Sampling

IDFG sampled 162 stream reaches during 1995 and 1996 using electrofishing methods, the majority of which were done with two or three pass techniques for population estimation (Table 1). Using the two criteria established above to identify population boundaries, sampling at the reported intensities typically results in a small proportion of available habitat being electrofished. Estimated mean mortality resulting from electrofishing injury at the reach or population level equaled 0.46% for all samples combined. The range of estimated mortality was 0.02-4.02% for all sections (Table 1).

Table 1. Summary of electrofishing mortality estimates at the population scale for 162 stream reaches sampled by Idaho Department of Fish and Game (IDFG) and 305 stream reaches sampled by non-IDFG agencies during 1995 and 1996.

Sample Effort	No. of sample reaches[1]	Estimated Mortality_ (%) Mean	Std	Range
IDFG				
Mark-recapture	25	1.05	0.88	0.13-4.02
Removal				
One pass	10	0.45	0.52	0.02-1.73
Two pass	68	0.39	0.45	0.05-2.91
Three pass	59	0.30	0.34	0.04-1.65
Total	**162**	**0.46**	**0.57**	**0.02-4.02**
Non-IDFG Agencies				
One pass	204	0.95	1.01	0.05-7.71
Two pass	21	0.48	0.24	0.13-1.13
Three pass	80	1.69	1.02	0.15-4.00
Total	**305**	**1.11**	**1.04**	**0.05-7.71**

[1] Stream defined as the length of stream.
[2] Mortality due to electrofishing at the sample level reported as a percentage of the population with a stream reach.

Non IDFG Sampling

Non IDFG electrofishing accounted for sampling in 305 Idaho stream reaches during 1995 and 1996. Most non IDFG sampling consisted of one pass electrofishing efforts for species composition (Table 1). Estimated mean mortality at the population scale equaled 1.11% for all sites with a range of 0.05-7.71% (Table 1). Several projects completed intensive sampling associated with research and fish tagging projects which resulted in the higher mortality estimates. Thirty-seven percent of the stream reaches had estimated mortality impacts of 0.50% or less (Figure 3). Fifty-three percent of the population mortality estimates were < 1.0% with the maximum mortality impact of 7.71% in a consultant presence/absence sample which extended over the entire stream reach.

Discussion

Based on high injury levels at the sample scale, restrictions on the use of electrofishing collection methods and wave forms have been initiated and called for (Nielsen 1998). Alaska banned electrofishing methods on trophy trout management waters (Holmes et al. 1990) based primarily on fishing guide observations of injured fish (J. Reynolds, University of Alaska, pers communication). Montana has restricted the use of pulsed direct current over 30 Hz (Fredenberg 1992). Snyder (1995) suggested electrofishing methods should not be used when working with sensitive species. Bonar et al. (1997) suggested that electrofishing not be used to collect bull trout in Washington. These suggested or implemented policy shifts were based on injury rates observed in samples of salmonids collected with electrofishing techniques.

Several limitations in our study methods should be considered. We used standardized values for trout electrical exposure during multiple pass electrofishing sampling in 1995 and 1996. The values represent a general average for capture efficiencies derived from 2 and 3 pass removal estimates in Idaho (Meyers et al 1999). We did not attempt to adjust capture efficiencies or mortality rates for size or species of fish collected. A final limitation of this study is our assumption (as in McMichael et al. 1998) that sample sections are representative of abundance and densities of the larger population within adjacent reaches of the same stream order. Due to worst case mortality applied, we do not believe these generalizations significantly effect our conclusions.

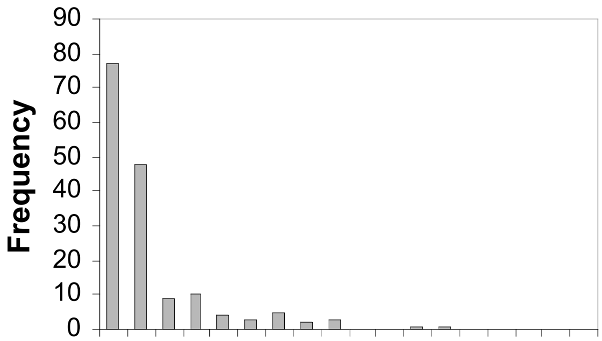

Figure 2. Distribution of estimated mortality at the population scale by Idaho Department of Fish and Game in 162 stream reaches during 1995 and 1996.

Although electrofishing impacts at the population scale effects appear unlikely (Schill and Beland 1995; McMichael et al. 1998; Habera et al. 1999; the present study results), injuries to individual fish are important. Public perception regarding injuries of individual fish may override the best studies that document limited impacts on the sample and population scales, thereby resulting in major restrictions in the use of electrofishing methods (Schill and Beland 1995). We strongly support efforts to reduce injury of salmonids due to electrofishing collection and suggest biologists use smooth DC or low frequency pulsed DC when capture efficiencies can still be maintained (Reynolds and Holliman, this symposium).

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