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Comparison of Streamside Visual Counts to Electrofishing Estimates of Colorado River Cutthroat Trout Fry and Adults

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Abstract.—Streamside visual counts and depletion-removal electrofishing were compared for estimating fry and adult abundances of Colorado River cutthroat trout *Oncorhynchus clarki pleuriticus*. Visual counts of fry were significantly correlated ($R = 0.92$) with three-pass depletion-removal electrofishing estimates of abundance. Streamside visual counts were generally lower than electrofishing estimates, except in streams having turbulent water, where electrofishing was difficult. Disturbance of fry by observers reduced estimates obtained with the visual counts; however, visual counts can be a useful method for estimating the abundance of cutthroat trout fry in small streams with shallow water. For adults, correlations between streamside visual counts and electrofishing population estimates were low, and therefore visual counts were not considered a viable method for older fish.

Underwater visual counts by divers have been used as an index of fish abundance in streams (Northcote and Wilke 1963; Goldstein 1978; Gardiner 1984; Schill and Griffith 1984). Visual counts are appealing because they can be faster and less labor intensive than electrofishing or using toxicants, and because mortality of both target and nontarget species can be avoided.

Visual counts from streambanks can also be used to estimate fish abundance, but the accuracy of this method has seldom been evaluated. Problems in estimating fish abundance in this manner might be caused by water-surface glare, turbulence, low water clarity, depth, cryptic coloration of fish, use of cover by fish, and flight response by fish before they are seen. Yet, visual counts may be the preferred option when fish populations are assessed where shallow stream depth precludes diving or where sampling methods that generate mortality need to be avoided (e.g., in sampling rare or endangered species). Griffith (1981) found that visual counts by divers consistently underestimated age-0 brook trout *Salvelinus fontinalis*, presumably because these fish occupied shallower water than divers could easily survey. In such situations, streamside visual counts might be a more accurate method of estimating fry abundance.

The objectives of our study were to compare streamside visual counts with population estimates made by electrofishing for determining the abundances of fry and adult Colorado River cutthroat trout *Oncorhynchus clarki pleuriticus* and to determine how disturbance of cutthroat trout fry by observers might affect the accuracy of visual estimates.

Methods

Streamside visual counts of Colorado River cutthroat trout fry were conducted on high-elevation headwater streams (>2,500 m above mean sea level) in the North Fork Little Snake River (NFLSR) drainage in south-central Wyoming. Colorado River cutthroat trout were the only salmonid species in the drainage. These cutthroat trout populations constitute the purest remaining genetic strain of this subspecies among isolated headwater enclaves of the Colorado River drainage (Binns 1977). To protect this valuable native cutthroat trout stock, a fish-migration barrier was constructed downstream, and the drainage above this barrier was closed to angling before this study. The only other species of fish in the drainage above the barrier is the mottled sculpin *Cottus bairdi*.

Stream sites used in the surveys were first- and second-order mountain streams at elevations from 2,531 to 2,766 m with gradients (as percent channel slope) from 1.4 to 15.7% (Table 1). Wetted stream widths ranged from 1.1 to 3.7 m, and mean stream depths ranged from 7 to 25 cm. Each site was 100 m in length. Eighteen sites were selected to encompass the range and relative proportions of stream types (stream order and gradient) present within the drainage.

Visual counts of fry (age 0) and adults (≥ age 1) were made from streambanks along each of the 18 sites during August and September of 1987 or 1988. Fry were counted during the next 2 months after emergence from redds was complete. Each 100-m site was divided into pool and riffle stream reaches. Counts were conducted by two observers

TABLE 1.—Habitat characteristics of sites for streamside visual counts in the North Fork Little Snake River (NFLSR) drainage during 1987 and 1988.

Year and stream	Elevation (m)	Gradient (%)	Flow (m^3/s)	Width (m)	Mean depth (cm)
1987					
NFLSR	2,766	2.5	0.004	1.1	9
NFLSR	2,731	7.5	0.021	2.6	18
Third Creek	2,743	14.0	0.001	1.5	13
Third Creek	2,725	5.3	0.001	1.7	7
Green Timber Creek	2,566	1.4	0.005	1.6	10
Green Timber Creek	2,533	3.2	0.006	2.4	13
1988					
NFLSR	2,766	2.5	0.007	1.2	10
NFLSR	2,761	2.0	0.010	2.0	25
NFLSR	2,734	7.0	0.032	3.1	15
NFLSR	2,731	7.5	0.036	3.0	18
Third Creek	2,743	14.0	0.011	2.1	7
Third Creek	2,725	5.3	0.012	2.4	16
Deadman Creek	2,719	15.7	0.008	3.1	14
Deadman Creek	2,713	14.7	0.008	2.6	12
Deadman Creek	2,609	11.8	0.017	3.7	19
Green Timber Creek	2,566	1.4	0.007	1.8	12
Green Timber Creek	2,533	3.2	0.012	2.6	15
Harrison Creek	2,531	10.7	0.007	2.7	7

simultaneously crawling along the stream on opposite banks. Both observers stopped at each stream reach (i.e., pool or riffle) and remained stationary while counting both fry and adults. Observers, communicating with each other, identified positions of all observed fish so that none were counted twice. After 5 min, a single count was recorded for all fish seen at that reach. The observers then moved away from the streambank and crawled upstream to the next stream reach and repeated these observations until the entire 100-m site was covered. This approach allowed the entire site to be visually sampled without overlapping or missing reaches. Observers moved away from the stream margins before proceeding to the next observation point to prevent causing upstream movement of fish.

When glare or turbulence prevented observation to the stream bottom, a clear plastic (Plexiglas) sled (Figure 1) was drifted downstream to the turbulent area and then pulled across the stream surface to allow a clear view of the bottom. Two sleds were used during the surveys, one measuring 52 × 36 × 10 cm and the other measuring 32 × 22 × 6 cm. The front of the sled was curved upward (with heat) to facilitate skimming across the water surface. The sides and rear were sealed with silicone. Fish showed little reaction to the sled.

Abundance estimates were determined by electrofishing within 48 h of visual counts at each of the 18 sites. Barriers were placed at the upstream and downstream boundaries of each survey reach to ensure closure (White et al. 1982). Three consecutive passes were made with a Coffelt BP-6 backpack shocker unit. An additional pass was made at the NFLSR site at 2,731 m elevation in 1987 because of high fish abundance. Pulsating 170- or 240-V DC was used. Small aquarium nets (145 × 125 mm and 100 × 75 mm) were used to capture fry. Fry and adults were placed in separate flow-through holding nets between passes and later released back into capture areas.

Response of fry to disturbance by observers was examined to determine how fright reactions might influence the accuracy of streamside counts. Fry at two study sites (Harrison and Green Timber creeks) were visually located and then deliberately disturbed by approaching the stream margin. Fish

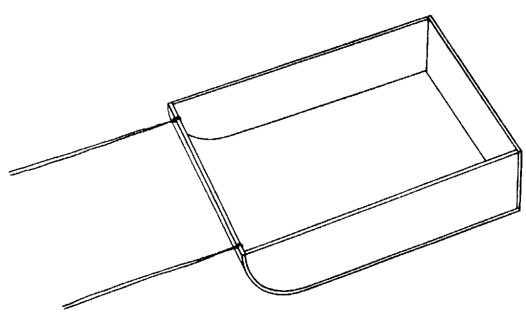

FIGURE 1.—Clear plastic sled used during streamside visual counts of fish to reduce surface glare and turbulence (sizes used: 52 × 36 × 10 cm and 32 × 22 × 6 cm).

not exhibiting a fright response were further disturbed by a single arm wave over their position in the stream. Fry response was recorded in five categories: (1) no movement to cover, (2) movement to cover followed by reemergence, (3) movement to cover and no reemergence, (4) movement to turbulent water followed by reemergence, and (5) movement to turbulent water and no reemergence. Reemergence time for fry was measured over a 5-min period by an observer on his hands and knees. No response to disturbance was tested on adults.

Population estimates were calculated according to a removal-depletion maximum-likelihood formula (Platts et al. 1983). All data were analyzed with SAS statistical software (SAS 1989). Simple linear regression was used to compare streamside visual counts with depletion-removal population estimates. The level of significance was selected at $P \leq 0.05$.

Results

Total lengths of cutthroat trout fry present during the study ranged from 20 to 52 mm. Age-1 and older fish (considered adults) ranged from 67 to 215 mm.

Streamside visual counts of cutthroat trout fry were significantly correlated ($R = 0.92$) to electrofishing population estimates (Figure 2). The slope

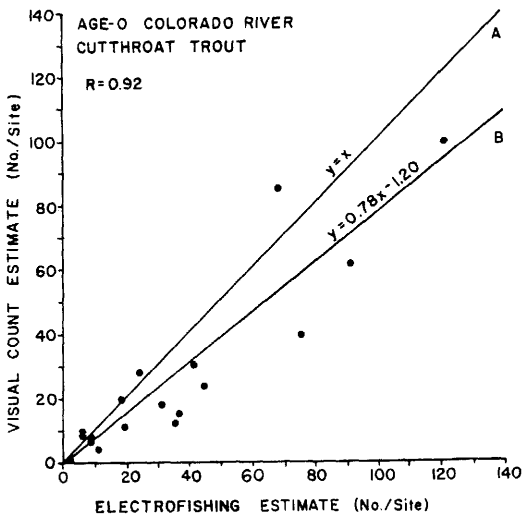

FIGURE 2.—Relation of abundance estimates (number per 100-m site) made by streamside visual counts and by electrofishing for age-0 Colorado River cutthroat trout in the North Fork Little Snake River, Wyoming. Line A indicates the ideal relationship, when both techniques detect the same number of fry. Line B is the observed relationship.

of the regression line was significantly less than one ($t = 2.59$, df = 17, $0.01 < P < 0.05$), indicating that visual counts generally underestimated fry abundance relative to electrofishing estimates. Fry counts averaged about 78% of the electrofishing estimates. At five sites where turbulent water made electrofishing and netting difficult, fry estimates made from visual counts were greater than the electrofishing estimates. When electrofished, however, fry were often drawn into turbulent water where visibility was low and netting was difficult. Immediate mortality to fry from electrofishing was generally low (average mortality, 3.3%).

In turbulent streams, some fry tended to occupy small pockets of calm water behind cover, and thus were easy to count. Other fry required use of the sled before they were observed. The number of fry seen at each site with the sled ranged from 0 to 14% of the total. The sled was most useful at sites having more turbulent water where the highest percentages of fry were observed.

Streamside visual counts of adult cutthroat trout were not significantly correlated to population estimates derived by electrofishing (slope, $t = 1.857$, df = 17, $P = 0.082$). Counts at individual sites ranged from 5 to 98% of the respective electrofishing estimates. No immediate mortality from electrofishing was evident in adults.

When intentionally disturbed by observers, 52.2% of the fry sought cover: 45.9% used nearby rocks or woody debris, whereas 6.3% sought refuge in faster water. The remaining 47.8% of the fry never sought cover and either displayed no response or only slightly shifted their position within the stream, and thus remained visible.

Disturbance of the fry by observers reduced the visual-count estimates. Streamside visual counts of undisturbed fry in Harrison and Green Timber creeks were 87% of the electrofishing estimates for these sites (Figure 3). After disturbance, visual-count estimates declined to 40% of the electrofishing estimates. Following a 5-min wait period, the visual-count estimates recovered to 71% of the electrofishing estimate. Most fry that returned to visible positions did so in less than 2 min. However, 18% of the fry that sought cover did not return to a visible position within 5 min, which reduced the visual-count estimates from 87 to 71% of the electrofishing estimate.

Discussion

Streamside visual counts of Colorado River cutthroat trout fry in small streams were related to abundance estimates obtained by electrofishing.

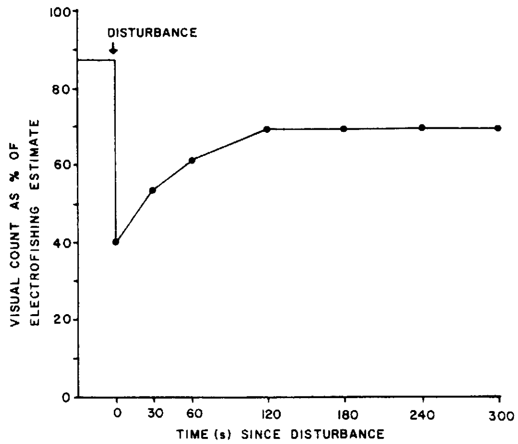

FIGURE 3.—Effect of observer disturbance on streamside visual counts of fry in Harrison and Green Timber creeks. Before disturbance, visual counts averaged 87% of the electrofishing estimate. Immediately following disturbance, the visual counts averaged only 40% of the electrofishing estimates, with recovery to 71% after 5 min. Total number of observations was 111.

Visual counts averaged about 78% of the electrofishing estimates. At turbulent-water sites, visual counts resulted in fry estimates that were higher than electrofishing estimates. Disturbance by observers reduced the accuracy of the visual estimates. Visual counts, however, were poor estimators of abundances of adult Colorado River cutthroat trout in these same streams because adults appeared to use overhead cover more often than did fry.

Visual surveys conducted by divers have yielded mixed results. Northcote and Wilke (1963) found that under clear water conditions, diver counts were moderately accurate in estimating fish abundance in two streams in British Columbia. Comparisons of the mean numbers of fish counted by a two-diver team with numbers of fish subsequently recovered after poisoning were 59% for rainbow trout *Oncorhynchus mykiss,* 64% for mountain whitefish *Prosopium williamsoni,* and 50% for largescale suckers *Catostomus macrocheilus.* Griffith (1981) found that visual counts consistently underestimated age-0 brook trout, presumably because divers could not survey in shallow water where fry were concentrated. In such cases, streamside visual counts may be a superior alternative to underwater observations for estimating the abundance of age-0 trout in shallow water.

Biologists must be aware of nonsampling biases associated with visual counts. Disturbances to fry by observers during sampling are of concern because they reduce the accuracy of counts. To minimize disturbance, observers need to maintain a low profile, wear camouflaged clothes, and avoid movement during the visual count as much as possible. In our study after an observer moves into a counting position, a 2-min wait is recommended to allow disturbed fish to return to a visible position in the stream. However, even with care not to disturb fish, it is probable that some fry will move to cover before being observed.

Our sampling was conducted by the same people, so we did not examine the repeatability of counts made by different observers. Differences in vision, persistence, interest, and even time of day may affect counts. Hankin and Reeves (1988) suggested that repeatability of visual counts among observers may be low, but that counts by individual observers are repeatable. Training individuals before conducting surveys may be one way to reduce variability among observers.

We feel that, in small streams, streamside visual counts can provide a valid censusing tool for cutthroat trout fry and possibly fry of other salmonids if care is taken to standardize the sampling technique and reduce disturbance. Visual counts could be used to monitor year-class strength or changes in fry abundance related to changes in habitat quality. The Wyoming Game and Fish Department uses streamside visual counts to monitor abundance of Colorado River cutthroat trout fry in our study streams. Because this technique does not injure fish, it could be extremely valuable in reducing electrofishing injuries or in working with rare or endangered species of fish.

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References

Binns, N. A. 1977. Present status of indigenous populations of cutthroat trout (*Salmo clarki*) in southwest Wyoming. Wyoming Game and Fish Department, Fisheries Technical Bulletin 2, Cheyenne.

Gardiner, W. R. 1984. Estimating population densities of salmonids in deep water in streams. Journal of Fish Biology 24:41–49.

Goldstein, R. M. 1978. Quantitative comparison of seining and underwater observation for stream fishery surveys. Progressive Fish-Culturist 40:108–111.

Griffith, J. S. 1981. Estimation of the age-frequency distribution of stream-dwelling trout by underwater observation. Progressive Fish-Culturist 43:51–53.

Hankin, D. G., and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45:834–844.

Northcote, T. G., and D. W. Wilke. 1963. Underwater census of stream fish populations. Transactions of the American Fisheries Society 92:146–151.

Platts, W. S., W. F. Megahan, and G. W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. U.S. Forest Service, Intermountain Range and Experimental Station, INT-138.33-36, Ogden, Utah.

SAS. 1989. SAS statistical packages, version 6. SAS Institute, Cary, North Carolina.

Schill, D. J., and J. S. Griffith. 1984. Use of underwater observations to estimate cutthroat trout abundance in the Yellowstone River. North American Journal of Fisheries Management 4:479–487.

White, G. C., D. R. Anderson, K. P. Burnham, and D. L. Otis. 1982. Capture–recapture and removal methods for sampling closed populations. Los Alamos National Laboratory, LA-8787-NERP, Los Alamos, New Mexico.