# Intra-season Variation in Largemouth Bass Electrofishing Catch-Per-Unit-Effort: Implications for Management Decisions

**Scott L. Van Horn,** *North Carolina Wildlife Resources Commission, 1517 E. Geer St., Durham, NC 27704*

**James W. Kornegay,** *North Carolina Wildlife Resources Commission, 306 Japonica Dr., Camden, NC 27921*

**Bennett Wynne,** *North Carolina Wildlife Resources Commission, 730 Colony Pl., Kinston, NC 28501*

**Wayne R. Chapman,** *North Carolina Wildlife Resources Commission, Rt. 5 Box 705, Albemarle, NC 28001*

*Abstract:* The objective of this study was to determine if largemouth bass (*Micropterus salmoides*) electrofishing catch-per-unit-effort (CPUE) varied within the traditional spring sampling season. Shoreline electrofishing for largemouth bass was conducted on Chowan River and Sutton Lake in 1990 and on Tuckertown Reservoir in 1989 and 1990. There were at least 6 sample stations per body of water. Each of the 3 study locations was sampled 3 times from March through June. The number of bass >200 mm captured and effort were recorded by sample station and date. Effort was measured in electroshock time at Chowan and Sutton and shoreline distance at Tuckertown. Friedman's nonparametric test was used to test for differences in CPUE among the 3 repeated samples (sample replicates) within each spring for each location. A significant difference was found only at Tuckertown in 1989. Failure to consider temporal changes in CPUE during spring electrofishing samples may cause errors in study conclusions and poor management decisions.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 45:254–260

Spring shoreline electrofishing is a common technique for sampling largemouth bass. Reynolds (1983) describes the technique and reviews 3 categories affecting electrofishing efficiency including fish characteristics, habitat characteristics, and operating conditions. Researchers and management agencies employ various strategies to reduce variation in electrofishing results including standardizing equipment and procedures (Gilliland 1985) and repeating samples over time at the same locations (Hubbard and Miranda 1986 and Johnson and Nielsen 1983).

Electrofishing catch rates expressed as the number of fish caught per unit shoreline sampling distance or elapsed electroshock time are routinely used as indices of largemouth bass abundance. Comparisons of CPUE through time are then used to evaluate changes in largemouth bass abundance associated with forage introductions (Anderson and Rabeni 1988), length limit changes (Summers 1988, Novinger 1987), changes in associated predator species (Boxrucker 1987), and other management or ecological manipulations. Largemouth bass management objectives may be stated in terms of meeting some minimum electrofishing CPUE. Occasionally changes in CPUE through time are combined with age information to estimate total mortality rates for largemouth bass.

Management decisions concerning largemouth bass are made within many fisheries management agencies on the basis of data supplied by repeated annual shoreline electrofishing samples from selected waters. A common sampling protocol is to electrofish a reservoir each spring at fixed sample sites until a predetermined shoreline distance, elapsed shocking time, or number of bass captured is met. Work at each reservoir may typically be completed within a week. Budget decisions often preclude sample replication in time and when effort and catches are large it is easy to be satisfied with such a sample. CPUE is readily calculated from such data and used to meet a variety of objectives. Unfortunately, the sampling protocol ignores many of the sources of variation in efficiency mentioned by Reynolds (1983) and in worst case will result in poor fisheries management decisions.

We conducted shoreline electrofishing samples on 3 water bodies in North Carolina but repeated the samples at varying time intervals between March and June. Our objective was to determine if largemouth bass electrofishing CPUE varied within the traditional spring sampling season.

## Methods

Daytime shoreline electrofishing was conducted during the spring of 1990 on the Chowan River and Sutton Lake and spring 1989 and 1990 on Tuckertown Reservoir. Chowan River is an 80-km blackwater tributary to Albemarle Sound in northeastern North Carolina. Sutton Lake is a 500-ha cooling pond for a coal fired electric generating facility located near Wilmington in the southeastern corner of the state. Tuckertown Reservoir (1,024 ha) is a mainstream impoundment of the Yadkin River located in the central region of North Carolina.

Largemouth bass were collected at Chowan River and Sutton Lake with a boat mounted electrofishing unit using pulsed DC current applied from a Smith-Root Mark VI electrofisher. Sampling at Tuckertown Reservoir was done similarly except a Coffelt electrofisher was used.

Sample stations were selected subjectively. We tried to distribute the stations over habitat types and the total area of each study location. The outside boundaries of each sample station were defined by markers on the shoreline. Sample station lengths were measured (m) at Tuckertown Reservoir.

Six stations were selected on the Chowan river and sampled over a 2-day period

at weekly intervals beginning 4 June 1990. Shoreline is poorly defined along the swampy borders of the Chowan so effort was recorded as elapsed electroshock time and varied by station.

Eight sample stations were electrofished at Sutton Lake once each in March, April, and May 1990. Again, effort was recorded as elapsed electroshock time and varied by station.

Ten sample stations were electrofished on Tuckertown Reservoir at approximately 2-week intervals beginning in early April and ending in May in 1989 and 1990. Effort was recorded by distance instead of time. Sample stations varied in length.

Catch-per-unit-effort for each sampling station and replicate was calculated as number of fish captured per minute of electroshock time for Chowan and Sutton and number of fish captured per 100 m shoreline electrofished at Tuckertown. Only fish >200 mm were included in the CPUE calculations. Catch-per-unit-effort was compared among replicates within each year by study location using Friedman's nonparametric test.

## Results

A total of 310 largemouth bass >200 mm were collected from the Chowan in 11.54 hours of actual electroshocking time (Table 1). Pooled CPUE for each replicate sample was 0.36, 0.59, and 0.37 fish/minute from first to last week (Table 2). Friedman's test (Systat 1985) indicated there were no differences among sample weeks ($P = 0.130$).

A total of 140 largemouth bass >200 mm were captured at Sutton Lake in 10.41 hours of electrofishing. Pooled CPUE's for March, April, and May were 0.25, 0.17, and 0.27 fish/minute (Table 3). Friedman's test failed to discern a difference in CPUE among samples ($P = 0.882$).

A total of 1,309 bass >200 mm were captured at Tuckertown Reservoir in 50.3 km of shoreline electrofishing in 1989. Pooled CPUE's increased steadily through

**Table 1.** Electroshocking effort from largemouth bass samples collected Chowan River, Sutton Lake, and Tuckertown Reservoir, North Carolina.

| Location | Sampling effort | | |
|---|---|---|---|
| | Sample 1 | Sample 2 | Sample 3 |
| Chowan River | | | |
| 1990 (hours) | 4.25 | 3.70 | 3.59 |
| Sutton Lake | | | |
| 1990 (hours) | 3.27 | 4.12 | 3.02 |
| Tuckertown Reservoir | | | |
| 1989 (m) | 17216 | 16516 | 16606 |
| 1990 (m) | 20847 | 20361 | 20900 |

**Table 2.** Electrofishing catch-per-unit-effort of largemouth bass (fish >200 mm) from Chowan River, North Carolina, in June 1990.

| Station | CPUE (fish/min) | | |
|---|---|---|---|
| | 6/4,5 | 6/11,12 | 6/18,19 |
| 1 | 0.17 | 0.34 | 0.17 |
| 2 | 0.40 | 0.78 | 0.36 |
| 3 | 0.25 | 0.74 | 0.82 |
| 4 | 0.36 | 0.41 | 0.26 |
| 5 | 0.78 | 0.49 | 0.27 |
| 6 | 0.34 | 0.64 | 0.36 |
| Pooled CPUE | 0.36 | 0.59 | 0.37 |

**Table 3.** Electrofishing catch-per-unit-effort of largemouth bass (fish >200 mm) from Sutton Lake, North Carolina, in March–May 1990.

| Station | CPUE (fish/min) | | |
|---|---|---|---|
| | 3/19,20 | 4/9,10 | 5/15 |
| 1 | 0.13 | 0.03 | 0.13 |
| 2 | 0.04 | 0.19 | 0.20 |
| 3 | 0.09 | 0.27 | 0.43 |
| 4 | 1.37 | 0.08 | 0.41 |
| 5 | 0.49 | 0.30 | 0.28 |
| 6 | 0.09 | 0.24 | 0.22 |
| 7 | 0.09 | 0.20 | 0.17 |
| 8 | 0.35 | 0.11 | 0.24 |
| Pooled CPUE | 0.25 | 0.17 | 0.27 |

the sampling period from 1.85 fish/100 m to 3.43 fish/100 m or about an 86% increase in CPUE (Table 4). Friedman's test indicated a highly significant difference in CPUE among sampling periods ($P = 0.002$). The following year (1990), a total of 1,304 fish >200 mm were captured in 62.1 km of shoreline electrofishing. Pooled CPUE's changed from 2.09 to 2.39 and then dropped to 1.83 fish/100 m during the April–May samples (Table 5). Friedman's test failed to find differences among sample replicates ($P = 0.928$).

## Discussion

High variation among our sample stations made detecting small differences in CPUE between replicates very difficult. However, the significant differences among sample replicates that we observed at Tuckertown Reservoir in 1990 indicate that electrofishing efficiency can vary intra-seasonally. The resulting temporal variation

**Table 4.** Electrofishing catch-per-unit-effort of largemouth bass (fish >200 mm) from Tuckertown Reservoir, North Carolina, during April–May 1989.

| Station | CPUE (fish/100m) | | |
|---|---|---|---|
| | 4/3–13 | 4/24–5/5 | 5/12–22 |
| 1 | 1.98 | 2.79 | 4.56 |
| 2 | 2.88 | 3.04 | 6.65 |
| 3 | 1.76 | 3.23 | 3.80 |
| 4 | 1.88 | 2.16 | 2.87 |
| 5 | 1.84 | 2.77 | 3.20 |
| 6 | 2.16 | 4.46 | 2.93 |
| 7 | 2.51 | 1.94 | 2.35 |
| 8 | 1.53 | 2.25 | 2.30 |
| 9 | 1.01 | 3.45 | 4.57 |
| 10 | 0.84 | 1.07 | 1.16 |
| Pooled CPUE | 1.85 | 2.56 | 3.43 |

**Table 5.** Electrofishing catch-per-unit-effort of largemouth bass (fish >200 mm) from Tuckertown Reservoir, North Carolina, during April–May 1990.

| Station | CPUE (fish/100m) | | |
|---|---|---|---|
| | 4/2–11 | 4/16–25 | 5/1–14 |
| 1 | 2.59 | 1.88 | 2.69 |
| 2 | 4.01 | 3.95 | 1.36 |
| 3 | 2.66 | 1.36 | 1.98 |
| 4 | 1.83 | 1.84 | 2.04 |
| 5 | 1.72 | 3.26 | 1.90 |
| 6 | 3.39 | 3.03 | 3.53 |
| 7 | 4.02 | 3.00 | 1.71 |
| 8 | 2.21 | 2.21 | 1.70 |
| 9 | 1.45 | 4.19 | 3.04 |
| 10 | 0.49 | 0.57 | 0.26 |
| Pooled CPUE | 2.09 | 2.39 | 1.83 |

in CPUE has important consequences for designing and interpreting studies using electrofishing CPUE as an index of largemouth bass abundance.

If our sampling protocol had required a single electrofishing trip through each sample station we would have had no sense of the temporal variation at Tuckertown. Fishery managers may be interested in measuring changes in adult largemouth bass abundance as low as 15% or 20%. When significant differences in CPUE due to temporal variation in electrofishing efficiency (and not population differences) exceed 15% or 20%, annual single pass electrofishing samples may fail to detect real

changes of this order of magnitude or indicate changes where none have occurred based solely on chosen sample days.

The Tuckertown Reservoir data were collected with the intention of examining changes in largemouth bass abundance associated with a change in size and creel regulations (Chapman et al. 1991). Suppose an objective of the regulations change was to increase CPUE of bass >300 mm by at least 25% over a 3-year study period. Assume the significant difference among samples in 1989 were not related to fish length and select any 1 of the 3 sample replicates to fulfill a 1-pass sample protocol. The possible CPUE's could thus differ from one another by increases of 34% to 85% (or correspondingly, by decreases of 25% to 46%). If this scenario was repeated as pre- and post-regulations change sampling, we would be unable to discern how largemouth bass abundance changed during the study.

Good precision and strong statistical tests indicating significance offer no protection against reaching false conclusions from sample comparisons based on annual single pass electrofishing if intra-seasonal variation in CPUE is present. The results may simply be 2 good estimates of CPUE dependant upon the prevailing electrofishing conditions.

When fisheries managers are interested in measuring small changes in CPUE which may have important fisheries management consequences it is important that the power of any statistical test is adequate (Peterman 1990) and that temporal variation in electrofishing efficiency is addressed. Traditional single pass electrofishing samples commonly used to monitor fish populations may be inadequate.

## Literature Cited

Anderson, W.M. and C.F. Rabeni. 1988. Effects of gizzard shad introduction on a small-impoundment fishery. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:175–184.

Boxrucker, J. 1987. Largemouth bass influence on size structure of crappie populations. North Am. J. Fish. Manage. 7:273–278.

Chapman, W.R., Jones, T.W., and S.L. Van Horn. 1991. Evaluation of a 300–400 mm protected slot regulation for largemouth bass. N.C. Wildl. Resour. Comm., Raleigh, Fed. Aid Proj. F-23-S. 21pp.

Gilliland, E. 1985. Evaluation of Oklahoma's standardized electrofishing in calculating population structure indices. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 39:277–287.

Hubbard, W.D. and L.E. Miranda, 1986. Competence of non-random electrofishing sampling in assessment of structural indices. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 40:79–84.

Johnson, D.L. and L.A. Nielsen. 1983. Sampling considerations. Pages 1–21 *in* L.A. Nielsen and D.L. Johnson, eds. Fisheries techniques. Am. Fish. Soc., Bethesda, Md.

Novinger, G.D. 1987. Evaluation of a 15.0-inch minimum length limit on largemouth bass and spotted bass catches at Table Rock Lake, Missouri. North.Am. J. Fish. Manage. 7:260–272.

Peterman, R.M. 1990. Statistical power analysis can improve fisheries research and management. Can. J. Fish. and Aquat. Sci. 47:2–15.

Reynolds, J.B. 1983. Electrofishing. Pages 147–163 *in* L.A. Nielsen and D.L. Johnson, eds. Fisheries techniques. Am. Fish. Soc., Bethesda, Md.

Summers, G.L. 1988. Largemouth bass population changes following implementation of a slot length limit. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:209–217.

Systat Inc., 1985. Systat, the system for statistics. Systat Inc., Evanston, Ill. 417pp.