ESTIMATING RELATIVE ABUNDANCE OF STREAM MACROINVERTEBRATES WITH AN ELECTROFISHING SAMPLER

JERRY W. NAGEL

Department of Biological Sciences, East Tennessee State University, Johnson City, TN 37614

ABSTRACT--A backpack electrofishing unit with a food strainer attached to one electrode was used to sample stream macroinvertebrates. This technique yielded estimates in seasonal patterns of relative abundance which were similar to those reported by others for streams in this region. Additionally, this method exhibited relatively low variability between samples. Fifteen samples can be collected, sorted to order, and counted in <2 h using this technique. Catch rate was less than directly proportional to variations in voltage or power and suggests the method is robust to moderate variations in stream conductivity.

The conventional sampling methods currently used for estimating the relative or absolute abundance of stream macroinvertebrates are time-consuming and generally yield highly variable estimates (Resh, 1979; Allen and Russek, 1985). This may discourage investigators from gathering information on macroinvertebrate abundance in studies where such information could be useful but is not the major objective. An example might be fisheries investigations of growth and survival of stream-dwelling salmonids. I have developed a sampling method based on an electrofishing technique which yields a relative estimate of macroinvertebrate density that requires a relatively short time to complete and has low variability. It is biased toward unattached riffle species and, therefore, should not be considered as a replacement for conventional quantitative methods used in rigorous studies of macroinvertebrate densities and diversity. However, in addition to its potential value for obtaining crude relative abundance estimates in fisheries studies, it could also prove useful in macroinvertebrate life-history studies of species vulnerable to this method.

MATERIALS AND METHODS

For routine collecting throughout the year, the sampling device consisted of a 200-mm diameter metal food strainer of the type available in the kitchen supply section of most discount stores; this strainer had approximately five meshes /cm. The metal strainer was detached from its handle and attached to a 1.5-m commercially available electrode handle. The other electrode handle contained the bare metal loop ordinarily used to support netting. The primary power source for these electrodes was a home-made backpack electrofishing unit consisting of a 12-v motorcycle battery and a 200-w DC to AC power inverter which supplied a 115-v current. Total weight of this unit was 9 kg which permitted a single operator to kneel easily at streamside for transfer of the benthos sample from the strainer to collecting vials.

During the sampling process, I carried a bucket containing a 250-mm diameter pan, collecting vials, a funnel, and a rinse bottle containing preservative. I would position the strainer against the substrate in an area with sufficient current flow to wash macroinvertebrates dislodged by the electricity into the strainer. I would then turn on the current and slowly sweep the other electrode toward the strainer from a point determined by how far I could reach with the electrode (approximately 2 m) for a count-of-10 period using the "one thousand one, etc." technique. During this sampling period, I was careful not to mechanically disturb the substrate with the moving electrode. After collecting the sample, I quickly inverted the strainer over the pan positioned on the nearby bank and dislodged the specimens into the pan by tapping the strainer. I then rinsed them into a collecting vial through a funnel. This procedure, repeated at 20-m intervals until I had collected 15 samples, took <1 h. In the laboratory, I could identify to order and count the number of specimens in <1 h because each sample was essentially free of debris. Samples were collected at bimonthly intervals from a single 300-m stretch of Briar Creek, a small, mountain trout stream in Washington County, Tennessee.

To determine the influence of different voltages on sampling efficiency, a 14.4-kg commercially available backpack electrofishing unit, with the capacity to provide AC voltages ranging from 0 to 700, was used as a power source. On 10 May 1986, I conducted a sampling session to determine the effects of different voltages on the collecting efficiency of this technique using the 14.4-kg electrofishing unit. I followed the procedures described previously but alternated between 125 v and 500 v on successive samples until I had obtained 15 samples at each voltage. This sampling session was conducted on a 600-m stretch of Briar Creek not used for the bimonthly samples.

RESULTS AND DISCUSSION

Bimonthly Samples--Table 1 summarizes the results of 2.5 years of bimonthly samples of macroinvertebrates from Briar Creek. Seasonal trends in the mean total count per sample indicated peak abundance during the winter and minimum abundance during the summer. This is similar to patterns observed by Cada et al. (1987) using Hess stream-bottom samplers and drift nets in other streams in this area. Peak values in 1987 and 1988 were considerably lower than those obtained in 1986 and may reflect the severe droughts experienced by this region during the summers of 1986 and 1987.

Table 1 also presents 95% confidence intervals and 95% confidence intervals expressed as a percentage of the mean. For this study, 95% confidence intervals expressed as a percentage of the mean ranged from 21.6 to 45.7%. This is roughly comparable to the precision obtained for 15 drift-net samples (Allan, 1984; Allan and Russek, 1985).

TABLE 1. Mean total count of macroinvertebrates from Briar Creek, Washington County, Tennessee, at bimonthly intervals from March 1986 to July 1988. Values for each date are based on 15 samples.

Date	Mean	95% CI	CI as % of mean
Mar 1986	87.6	21.9	25.0
May 1986	47.3	11.2	23.6
Jul 1986	12.7	4.5	35.9
Sep 1986	4.5	1.3	28.8
Nov 1986	31.2	6.9	22.1
Jan 1987	46.1	11.9	25.8
Mar 1987	26.3	10.0	38.2
May 1987	15.7	5.8	37.0
Jul 1987	4.1	1.4	34.1
Sep 1987	7.1	2.4	34.4
Nov 1987	11.1	2.5	22.3
Jan 1988	11.1	2.5	22.7
Mar 1988	27.8	6.0	21.6
May 1988	20.1	9.2	45.7
Jul 1988	4.9	2.1	43.9

Equal precision using quantitative methods such as Hess or Surber samplers would require approximately 80 samples for 21.6% to 20 samples for 45.7% precision (Resch, 1979).

Like any sampling method, this method shows selectivity with regard to the taxa which are vulnerable to it. The method is biased toward unattached riffle species. The percent composition of the 5,249 aquatic macroinvertebrates collected during the course of this study was 81.4% Ephemeroptera, 15.0% Plecoptera, 2.7% Diptera, and 0.9% Trichoptera. By contrast, the average percent composition for the same taxa in 10 southern Appalachian streams sampled by kick-sampling was 41.9, 16.2, 14.1, and 18.8%, respectively (Penrose et al., 1982).

Voltage Effect--Mean total counts were 51.2 and 144.2 for 125 v and 500v, respectively. A Kruskal-Wallis test yielded a test value of 13.627 ($d.f. = 1$, $P < 0.001$), indicating that there was a difference in sampling efficiency for the two voltages. The increase in total catch (2.8-fold) was not directly proportional to the four-fold increase in voltage. Neither is it directly proportional to the increase in power which is proportional to the square of the voltage (a 16-fold increase in this case). These relationships suggest that this technique might be relatively unaffected by modest variations in conductivity and could also be used for comparisons between streams with two-fold or even three-fold differences in conductivity. However, the demonstrated increase in sampling efficiency with higher voltages suggests caution in using this method to compare streams with different conductivities.

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