COMPARATIVE EFFECTIVENESS OF THE STANDARD SURBER SAMPLER AND A HYDRAULIC MODIFICATION FOR ESTIMATING BOTTOM FAUNA POPULATIONS

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For more than 30 years, aquatic biologists have been using the Surber [10] square-foot bottom sampler to obtain qualitative and quantitative measurements of stream bottom fauna. This sampler consists of two brass frames, each 1 foot square, hinged together so that they form a right angle when extended. One frame then fits over the square foot of streambed to be sampled, and the other is provided with a net into which organisms drift as they are dislodged from the streambed. The net generally is constructed from 23-mesh silk or nylon bolting cloth. In practice, the biologist hand stirs the bottom material within the square-foot area to a depth of a few inches. The dislodged organisms then drift into the collecting net.

A major disadvantage of this procedure is the time required to obtain a thorough scrubbing of the substrate. A lesser disadvantage, that of the numbing effect on hands and arms after long periods of exposure to cold water, can be partially overcome by full-arm-length rubber gauntlets.

Fishery biologists have used hydraulic units for the past several years to sample salmon eggs and preemergent fry in streambed gravels [7]. These samplers consist of a portable centrifugal pump (usually mounted on a packboard or a small raft), a water intake hose, and an outlet or exhaust hose, terminating in a 3-foot length of pipe. A jet of mixed air and water, regulated in force by the pump throttle, is controlled by aiming the pipe into the sample area. This water force loosens and stirs up gravel and the associated fish and invertebrate life, which wash down into a collecting net immediately below the sample area. At times, numerous aquatic insects and other bottom organisms have been observed in these egg and fry samples.

Several studies have demonstrated great variability in kinds and numbers of bottom organisms found within a generally uniform section of streambed. Because of this variation, the number of samples required to determine the kinds and numbers of animals actually present within acceptable limits of error is very large. Leonard [6] felt that one well-handled Surber sample could give a reliable index of the total volume of bottom organisms present in a uniform bottom type, but that meaningful estimates of total numbers and composition required much more sampling effort.

Needham and Usinger [9] used the Surber sampler on a uniform section of streambed 100 feet long by 30 feet wide. To obtain 95-percent confidence that their samples were representative of this section, they determined that 194 samples would be required if total wet weight of organisms was the desired product. If total number of organisms was the figure needed,
73 samples would be required. They did not, however, define their allowable error. An interesting sidelight of their study was that several people doing the sampling could be trained to be consistent in technique, so that one person need not do all the sampling in a given program.

Chutter [2] reappraised Needham and Usinger's [9] data and pointed out that some of their conclusions were erroneous. He predicted that 448 samples rather than 73 would be needed to establish a 5-percent confidence interval around the sample mean at the 95-percent probability level.

Morgan and Egglishaw [8], in selecting a sampling method for a bottom fauna survey, discarded the Surber method because they felt that it was too time-consuming. They finally settled on a kick-sampling technique.

K. Radway Allen [1] felt that the degree of variation among selected similar samples was too great to be due entirely to random variation, and that possibly unidentified microhabitats or behavior of the animals was the contributive factor.

Hales [5] found that variation in stream bottom fauna is so great that reasonably precise estimates are impossible without excessively numerous samples.

Chutter and Noble [9] analyzed 10 samples collected from a stony section of a South African streambed and concluded that for "normal" purposes three samples of 1 square foot each would adequately describe the numbers and composition of the fauna in uniform habitat of this type.

Gaufin et al. [4] noted in a qualitative study that as many as 10 to 15 percent of the species present in a given habitat type were not discovered, on the average, until at least eight samples had been taken. These species, however, were usually represented by only a few individuals. These investigators also noted that wherever a species was widespread, indicating that it was well adapted to its environment, individuals tended to cluster in particularly favorable microhabitats. As a result, even when seemingly similar bottom types were sampled, some samples would yield only two or three individuals of a given species and in others a hundred or more individuals might be present.

We decided to compare the effectiveness of the Surber sampler and the standard hydraulic sampler. If we found the hydraulic method to be significantly more effective, then we would further develop the hydraulic unit to facilitate portability and ease of handling.

STUDY LOCATIONS AND METHODS

Comparisons of the Surber and hydraulic samplers were made at two field locations in southeast Alaska. One stream was located near the head of the South Arm of Hood Bay, on the southwestern side of Admiralty Island. The other stream was Fish Creek, located on the northern end of Douglas Island, near Juneau.

At each of the two study streams, samples were taken from several different types of stream bottoms, ranging from sand and fine gravel to large rocks. Most were taken from typical salmon spawning gravels. At each point, a sample was taken with the hydraulic unit immediately adjacent to one taken with the Surber sampler. The Surber sampler was used with the hydraulic unit to delineate the square foot of bottom to be sampled and to collect the dislodged organisms. Each sample was later sorted, organisms were identified to the rank of order, counted, and then each sample was blotted and weighed to the nearest milligram.

RESULTS AND DISCUSSION

Both chi-square and analysis of variance tests failed to show any significant differences between the Surber samples and the hydraulic samples. This was true for comparisons of total number of organisms, wet weight of samples, and species composition of the fauna. There was considerable variation among samples (see table), and variation among differences of paired observations was great enough to mask any real differences that existed between the two methods. However, the two methods showed some obvious similarities (see table). For example, at Hood Bay Creek the bulk of the samples collected by both hydraulic and Surber methods consisted of trichopterans and oligochaetes. Both sampling methods at Fish Creek showed oligochaetes to be the dominant invertebrates present.
Mean number and range of invertebrates per square foot as sampled by Surber and hydraulic methods, Hood Bay Creek and Fish Creek

<table>
<thead>
<tr>
<th>Invertebrates</th>
<th>Hood Bay Creek</th>
<th></th>
<th>Fish Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surber (n=5)</td>
<td>Hydraulic (n=5)</td>
<td>Surber (n=10)</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>Trichoptera</td>
<td>10.2</td>
<td>0-32</td>
<td>31.4</td>
</tr>
<tr>
<td>Plecoptera</td>
<td>3.6</td>
<td>0-12</td>
<td>1.2</td>
</tr>
<tr>
<td>Ephemeroptera</td>
<td>1.0</td>
<td>0-3</td>
<td>1.2</td>
</tr>
<tr>
<td>Diptera</td>
<td>4.0</td>
<td>0-9</td>
<td>6.6</td>
</tr>
<tr>
<td>Oligochaeta</td>
<td>10.8</td>
<td>0-53</td>
<td>16.0</td>
</tr>
<tr>
<td>Other</td>
<td>2.4</td>
<td>0-8</td>
<td>3.6</td>
</tr>
<tr>
<td>Total number</td>
<td>32.0</td>
<td>0-65</td>
<td>60.0</td>
</tr>
<tr>
<td>Wet weight (grams)</td>
<td>0.565</td>
<td>0.023-1.914</td>
<td>0.521</td>
</tr>
</tbody>
</table>

The range in numbers of some of the groups among samples (see table) is evidence of the clustering effect observed by Gaufin et al. [4]. Although the hydraulic method generally yielded more organisms than did the Surber method, the hydraulic method was not as productive in sections with slow current. Even when the pump is set at its slowest speed, the velocity of water expelled from the pump tends to scatter specimen-bearing sediments and organic material rather than wash them into the net. When the Surber sampler alone was used, the substrate could be agitated more gently and the material directed into the net by simply fanning water into the net by hand. The hydraulic unit may better collect larger, heavier organisms such as some of the Trichoptera larvae, since the upwelling action of the unit seems to keep these heavier animals suspended long enough for them to be washed into the net. The hydraulic method also resulted in greater accumulations of silt and sand in the collecting net. The abrasive action of these accumulations, both in the net and in sorting and storage containers, destroyed many of the more fragile organisms such as chironomid and other dipterous larvae.

Both techniques are best suited for sampling streambeds composed of fine to coarse gravels and small stones, with water velocities sufficient to pass organisms downstream into the collecting net. Each of the two methods has advantages and disadvantages. The Surber technique is more portable for sampling in areas not readily accessible. It is a better method in areas where water currents are slow, and where streambeds contain considerable silt, sand, or fine organic materials. The hydraulic unit does a more thorough job of stirring up the substrate and is faster and handier for obtaining many samples from a small area. It is more effective for sampling organisms in deeper lying sediments.

The great variation among samples using either method would allow the two systems to be used jointly. The observer must realize, however, that estimates of abundance will be negatively biased, since neither method is capable of collecting all insects within each of the square foot areas that are sampled. At best, therefore, these methods can only provide usable indices of abundance of bottom fauna and show the investigator what organisms are present in the sample area. When the sampling effort is minimal, a great deal of precision cannot be expected through the use of either technique alone or in combination.

New techniques for quickly making quantitative analyses of benthic fauna should be explored and developed; a reliable method would be a great contribution to the study of aquatic environments.

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