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UNDERESTIMATION OF STANDING CROP BY THE SURBER SAMPLER[1]

ABSTRACT

Before the flow of water from Jackson Lake into the Snake River was stopped by closure of a dam, invertebrates were collected in five Surber samples from a downstream riffle. After the water had receded from the riffle, five 0.093-m^2 areas of the exposed streambed substrate were hand-collected and the invertebrates removed.

Predrawdown samples contained 4,286 invertebrates weighing 6.3 g while postdrawn samples contained 15,490 weighing 13.6 g. Large differences between submerged and exposed samples resulted from passage of smaller insects through the fine mesh of the Surber sampler and from backwash created by the sampler.

Although biologists have sampled stream invertebrates with Surber samplers (Surber 1936) for many years, no one has ever determined the total number of invertebrates that escape through the mesh and around the sides of the sampler. The variability of standing crop estimates obtained with the sampler, however, has been reported (Leonard 1939; Kennedy 1967) and extensively studied (Needham and Usinger 1956; Chutter and Noble 1966; Chutter 1972).

Jackson Lake Dam on the Snake River was closed on 30 October 1966 so that the degree of undercutting beneath it could be determined. The shutdown provided an opportunity to compare the number and weight of invertebrates collected from a riffle with a Surber sampler before the drawdown with the number and weight of invertebrates contained in areas of the same size on the exposed streambed after the drawdown.

By standard methods (Needham and Needham 1962), I collected five Surber samples (the area sampled is 1 ft^2 or 0.093 m^2) of invertebrates from a riffle 1.6 km downstream from the dam. The canvas sleeve of the sampler was tapered and the mesh of the net had 0.5-mm space between parallel threads. Where the samples were collected the riffle was composed mostly of boulders, 0.05–0.15 m in diameter, embedded to various degrees in the compact rubble-gravel substrate which was several meters thick. The sampler was firmly placed on the streambed in 0.2–0.3 m of water where current speed was about 0.91 m/sec. Stones, 0.05–0.15 m in diameter, were rubbed clean inside the net. Small stones and gravel within the 0.093-m^2 area and to a depth of about 0.15 m were stirred and rubbed together at the opening of the net until only clean gravel remained. Invertebrates and the small amount of debris and gravel in the sampler were preserved in museum fluid. Later, all the invertebrates were separated from the inert matter using the sugar flo-

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TABLE 1. *Organisms collected in five 0.093-m² (1 ft²) samples taken from a riffle before and during exposure. A = Total number collected; B = total weight; C = mean weight (in mg)*

	Surber samples			Hand collections		
	A	B	C	A	B	C
Alloperla sp.	—	—	—	1	1.0	1.0
Isoperla sp.	463	486.0	1.0	1,348	993.0	0.7
Ephemerella inermis Eaton	777	837.0	1.1	1,681	973.0	0.6
Baetis tricaudatus Dodds	—	—	—	2	2.0	1.0
Baetis sp. probably *bicaudatus* Dodds	—	—	—	1	1.0	1.0
Paraleptophlebia sp.	—	—	—	1	1.0	1.0
Rithrogena hageni McDunnough	6	6.0	1.0	32	24.0	0.8
Hydropsyche sp.	1,491	4,159.0	2.8	3,119	8,542.0	2.7
Hydroptila sp.	5	2.8	0.6	1	1.0	1.0
Glossosoma montana Ross	605	477.0	0.8	1,552	1,057.0	0.7
Oecetis sp.	38	64.0	1.7	2	1.0	0.5
Chironomidae	746	210.0	0.3	6,054	1,669.0	0.3
Simulium sp.	115	34.0	0.3	1,689	257.0	0.2
Atherix variegata Walker	—	—	—	1	30.0	30.0
Metachela sp.	1	0.8	0.8	3	2.2	0.7
Elmidae	6	4.8	0.8	2	1.0	0.5
Acarina	1	0.4	0.4	1	0.3	0.3
Stagnicola bulimoides Lea	8	25.0	3.1	—	—	—
Pisidium sp.	24	5.2	0.2	—	—	—
Totals	4,286	6,312.0		15,490	13,555.5	
Mean			1.5			0.9

tation method (Anderson 1959) and by searching through the debris. They were identified with the aid of a reference collection from the Snake River (Kroger 1970) and their wet weights determined.

Within 20 min of the recession of water from the riffle, five exposed samples, 0.093 m² by about 0.1 m deep, were collected in the same type substrate and as close to the Surber sample areas as possible. Each 0.01 m³ sample of rubble-gravel substrate, which contained all invertebrates in the 0.093-m² exposed areas, was placed into a bucket of concentrated sugar solution. Floating invertebrates and debris were removed and preserved in museum fluid; the gravel was stirred and rubbed together many times until no organisms floated to the surface. I later separated invertebrates from the debris by using sugar solution with lower specific gravity and by searching through the inert matter. Weights were determined at the same time as those for the Surber sample collections. All macroscopic invertebrates present in the exposed areas were collected by the sugar flotation method except those whose specific gravity prevented them from floating to the surface.

The results indicated clearly that the Surber sampler was collecting only about one-fourth of the invertebrates present in the 0.093-m² areas (Table 1). The hand-collected samples actually contained more than the numbers listed because snails, fingernail clams, and some stonecased caddisflies were not removed from the large amounts of gravel collected.

Even though variability of Surber sample counts is notoriously great (*see* Chutter 1972), a t test showed the means for number and weight of organisms in the samples (Table 2) are significantly different ($P < 0.005$). The nonparametric Mann-Whitney U test was also calculated because Surber sample counts might not be normally distributed. The observed U of 25 is significant ($P < 0.01$). No information has been reported on variability of exposed samples. Variance of the number of invertebrates in the five exposed samples was about half that of the Surber samples; variance of the weight of invertebrates in the exposed samples was slightly larger than that of the Surber samples.

A drift net and migration trap were placed in the riffle before drawdown to determine whether any invertebrates actively drifted in or migrated with the rapidly receding water, as they have been reported to do in naturally receding waters (Larimore et al. 1959) and when flow is artificially reduced (Elliott 1967; Minshall and Winger 1968). A Surber sampler attached to a metal stabilizing frame was used as a drift net. The migration trap ($0.15 \times 0.15 \times 1.2$ m) was covered with window screen except for a tapered, slot-type opening (0.03×1.2 m) on one side. The opening faced shoreward and was level with the substrate so that any animals crawling toward deeper water would have gone into the trap. Since nothing was caught in the net or trap, both of which had been used successfully on other occasions, I concluded that no invertebrates moved into deeper water.

Organisms may have been concentrated in exposed samples because invertebrates moved to the surface of the streambed when flow within the substrate ceased. Coleman and Hynes (1970) showed that invertebrates inhabit deep layers in loose gravel substrates, but I do not believe they occupy deep substrate levels in this riffle; it is too firm for them to penetrate. Gravel dust and silt are so compacted into all spaces between boulders, stones, and even pebbles that small boulders partially embedded in the compacted gravel were difficult to dislodge. I saw large invertebrates only at the substrate surface when I collected the exposed samples; I saw none as deep as even 2.5 cm. Sculpins (*Cottus* sp.) are noted for their burrowing ability in loose gravel substrate (Phillips and Claire 1966); they were found only under overhanging edges of boulders in Surber samples and all sculpins I collected from the exposed substrate were at the surface. Evidently both large invertebrates and sculpins occupy only the top layer of this streambed.

TABLE 2. *Total number and weight of invertebrates collected in Surber and exposed samples, both 0.093 m^2 (1 ft^2)*

	Surber samples		Exposed samples	
	No.	wt	No.	wt
	1,122	1,882.4	2,977	2,662.0
	681	1,337.8	3,116	3,735.8
	1,422	1,798.8	3,594	2,059.7
	762	988.0	3,010	2,143.0
	299	305.0	2,793	2,955.0
Total	4,286	6,312.0	15,490	13,555.5
Mean	857.2	1,262.4	3,098	2,711.1

Standing crop was underestimated because many of the smallest invertebrates crawled directly through the sampler's fine mesh and others were carried out of the 0.093-m^2 areas in backwash created by the tapered sleeve of the net and by the resistance of the fine mesh. Even though the data do not permit assignment of loss values to escapement through the mesh and to backwash, I believe that both losses were significant. The mean weights of most invertebrates were greater in the Surber samples than in the hand-collected samples (Table 1), indicating loss of the smallest individuals through the mesh, as other workers (Gaufin et al. 1956; Macan 1958; Waters 1966) have reported. Since I observed silt and debris in the 0.093-m^2 areas to go upstream and flow around the sides of the sampler, I assume that some invertebrates also were carried with these back currents. Many *Hydropsyche* larvae, most too large to pass through the mesh, were evidently lost because of backwash (Badcock 1949); Minckley (1963) tried to prevent backwash because it produced a significant sampling error. In addition to underestimating standing crop, Surber sample collections misrepresent the abundance of groups of invertebrates relative to one another; certain organisms such as chironomids and simuliids obviously escape the sampler more readily than others (Table 1).

The loss of organisms reported by others is substantiated by my quantitative data. Because standard Surber samplers capture only a small percentage of the invertebrates in the areas they sample, they should not be used to estimate standing crops unless the number of each species escaping through the mesh and around the sides of the sampler can be determined.

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