Habitat Conditions in Three Streams in the Idaho Batholith as Related to Aquatic Organisms

Data collected and report prepared by members of stream sedimentation study group.
T. C. Bjornn, R. L. Wallace, F. Watts, M. Brusven, M. Molnau, L. Stuehrenberg, D. Neilson, M. Sandine and H. Gibson

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INTRODUCTION

Most of the streams of the Salmon and Clearwater River drainages lie within the central Idaho batholith, a mountainous region of granitic-type base rock. Sediment, mainly coarse sand from decomposed granite, has become a serious problem by reducing water quality and the ability of the streams of the batholith. Aquatic biologists have not been able to adequately quantify or predict in advance the ability of streams to transport and clean themselves of excess sediment. The extent and duration of deleterious impacts of given amounts of sediments on aquatic organisms also are not well understood.

The following is a report of a study of sediment transport in stream channels and its effects on the aquatic biota. There are two major phases of this study, the laboratory stream channels and field studies of natural stream channels. This report summarizes our findings of the field studies for summer, 1972.

STUDY AREA

The study streams were located in the Idaho batholith, near Stanley, Idaho (Figure 1). Each stream was selected on the following criteria: 1) expected present level of sedimentation; 2) suitability to receive an experimental sediment injection during the 1973 field season; and 3) suitable populations of juvenile chinook salmon, *Oncorhynchus tshawytscha* and/or steelhead trout, *Salmo gairdneri*. Marsh Creek and Cape Horn Creek were picked to have low to moderate levels of sedimentation, and Elk Creek was selected to have a moderate to high level of sedimentation. A series of at least 3 pool-riffle combinations on each stream served as study areas in August to determine their present physical condition and to assess fish and insect populations and habitats, and the ability of each stream to move sediments.

METHODS AND MATERIALS

Measurements of the physical characteristics of each stream included detailed mapping of the stream configuration, bottom composition, and streambed profile (including degree of imbeddedness of the cobble), water depth, velocity, estimates of bedload sediment, water temperature and quality.

A transit and rod were used for mapping the streams. By zeroing the lower motion to magnetic north, the azimuth and distance by stadia were used to determine points along the stream boundaries. The boundaries were drawn in using the guide points and by a walking inspection of the stream boundary between the points.

The core sampler described by McNeil and Ahnell (1960) was used to determine the composition of the bed material to a depth of about 6 inches. The grain size distribution was determined by sieve analysis both in the field using a volumetric analyser described by McNeil and Ahnell (op. cit.) and in the laboratory where we ran a more detailed analysis of some samples. Those samples returned to the laboratory were analysed to check the accuracy of the field determinations. This comparison showed that the field analyses were within 3 percent of those made in the laboratory, and therefore, we accepted the field determinations as adequate and combined all the data from the analyses of core samples. Three core samples were taken from a pool on each stream and at least 17 were taken from a riffle on each stream. We divided the riffle into squares of one foot and selected the samples randomly.

Streambed profiles consisted of analysing the surface layer of bed material at one-foot intervals along two or three transect lines that were established across each riffle within the study sections. Three criteria were used: size of cobble, imbeddedness of this cobble, and size of the material around the cobble. The surface layer was visually analysed, ranked from 1 to 5 by each of the three criteria and the water depth recorded at one-foot intervals along the transect lines using methods described by Luedtke (1973). The observations were based only on the surface materials and did not include deeper sediments. In additions to these profiles, the bottom materials were classified for the entire study section using the same ranking for cobble size. By walking observation the various bottom materials were sketched in on the stream map using the guide points established in the initial boundary survey as reference points. This classification was done only on Cape Horn and Elk Creeks.

The depth and velocity at various cross sections were determined with the Gurley pygmy current meter. The distance from the stream bank to the sampling point was measured by a tape measure attached to the belt of the person with the current meter and read by a recording assistant on the stream bank.

The bedload discharge was estimated with a small portable pressure-differential sampler (Figure 2). By measuring a portion of the bedload with the sampler, the total bedload was estimated by simple expansion to cover the entire width of the stream and developing cross-section area-discharge relations.

Maximum and minimum temperatures were recorded for each stream during the period of study. Water quality measurements included pH, total hardness, and total dissolved solids. Total hardness and pH were estimated with Hach kits and total dissolved solids was determined with a Hach meter. Standing crop of periphyton was measured by the chlorophyll method (Strickland and Parsons, 1960).

Benthos samples were taken with a modified square-foot Hess bottom sampler. Each riffle was divided into quadrants and each quadrant was further divided into subquadrants. Samples were taken randomly in each quadrant. Two samples, one square foot each, were taken per quadrant. The material was preserved and stored in 75% ethyl alcohol until sorted and identified.

Drift invertebrates were collected from one riffle per stream. Three drift nets, 1' x 2' openings with 1 mm mesh cloth, were equally spaced across the stream. Water depth and current velocity were recorded in front of each net. Samples were collected for two hours, four times during one 24-hour period. Samples were preserved in 75% ethyl alcohol, sorted and identified.

The study of fish habitat was restricted to macro-habitat analysis of velocity, water depth, and size of streambed material. Fish populations were located and mapped by age and species using the wet suit method (Ellis, 1961). Overlays were then made for velocities at 1/2 water depth, water depth, and size of streambed material. From these overlays, fish per velocity, depth and size of streambed material were obtained. After the fish population had been mapped, fish were collected from the study area by electroshocker. Stomach samples were taken from the fish for analysis. Insects in the stomachs were compared to those in the drift samples. Scales were taken from some of the fish for age determination.

RESULTS

The average depth of the study sections of all streams was approximately 1 foot and velocities were generally less than 2 feet per second (Figures 3, 4 and 5). The size of the streambed material was mainly 2 to 6 inches in diameter in Cape Horn Creek, but in Elk Creek about 1/2 of the study section had streambed materials less than 1 inch in diameter (Figures 4 and 5).

Elk Creek had the largest proportion of bed materials finer than 1/4 inch in both pools and riffles, based on the analysis of the core samples (Table 1).

However, because of such small quantities of sediment collected in the sampler and the few samples collected (from 1 to 4 per stream) we feel that the estimates of sediment discharge are of little comparative value, except to indicate the small amount of bedload sediment transported in these streams during the summer period of low flow.

Grain size gradation charts were prepared from the results of average values of the composition of all core samples from the pools and riffles (Figures 6, 7 and 8). The riffles on Elk Creek contained more sediment than either Cape Horn or Marsh Creeks. The data presented above indicates that Elk Creek, selected as a study stream because it appeared to have a moderate to high level of sedimentation, did contain more sediment than either of the other two study streams.

We used the data gathered from streambed profiles along the transect lines to make qualitative and quantitative comparisons of the conditions of the surface materials on each riffle. The rankings for cobble size, imbeddedness, and size of surrounding materials were averaged and the means compared with T-tests. The results of the comparisons indicate that although riffles were selected for uniformity, differences did appear between transects on the same riffle (Table 2), suggesting that randomization should be used in streambed sampling over the entire riffle. Elk Creek, when compared to Cape Horn and Marsh Creeks, had a smaller cobble size and greater cobble imbeddedness; the surrounding material, however, was similar for all three streams. Marsh Creek transects were similar to those on Cape Horn Creek, based on the three characteristics ranked.

Water temperature ranged from 65 F to 47 F during the three-day study period on Marsh Creek. The maximum daily fluctuation was 18 F. Total hardness for Marsh Creek was 26 mg/ℓ and total dissolved solids was 33 ppm. On Cape

Horn Creek, the temperature ranged from 61 F to 46 F for the three days of study. The maximum daily fluctuation was 15 F. Total hardness was 27 mg/ℓ and total dissolved solids was 44 ppm. On Elk Creek, the temperature ranged from 61 F to 50 F during the four days of study and the maximum daily fluctuation was 11 F. Total hardness was 21 mg/ℓ and total dissolved solids was 34 ppm. The pH of all three streams was 7.1.

Insects of the order Ephemeroptera were the most abundant in the drift samples of all three streams, but basically the same groups of insects were found in the drift of all three streams (Table 3). Most of the drift occurred during the darkest hours of sampling. More insects were collected in the drift of Marsh and Cape Horn Creeks than from Elk Creek. Comparisons of number of drifting insects per cubic foot of flow in the three streams reveal that Elk Creek had the smallest number with Cape Horn Creek slightly below Marsh Creek (Table 4). Drift may be a useful index of the production of certain orders of insects, but variations in drift can occur between days and streams because of a wide variety of factors, as temperature, moonlight, weather, turbidity, etc. Therefore, one must make comparisons of drift samples on different days from different streams with caution.

The benthic samples were analyzed with the Shannon-Weaver species diversity index (Table 5). With this analysis, it is generally accepted that an index of 2.0 is poor, 3.0 is fair, and 4.0 is representative of a benthic fauna that is in good condition. Elk Creek had an average species diversity of 3.07 and 3.60 composite diversity for all samples. Cape Horn Creek had an average species diversity of 3.13 and 3.62 composite diversity. Marsh Creek had a 3.36 average species diversity and 3.77 composite diversity.

On the basis of three areas of investigation (streambed profiles of the riffles, insect drift, and benthos), Marsh Creek had the highest values in all three criteria. Cape Horn Creek rated below Marsh Creek, and Elk Creek had the lowest values of the three streams studied. These data indicate a positive correlation between substrate conditions (i.e., cobble size and imbeddedness) and the drifting insects or benthic invertebrates. To further test this relationship, each benthic sample was identified with its specific streambed profile value and water depth. Although sampling intensity was insufficient to produce conclusive results, the following are indicated: 1) there was no correlation between species diversity and water depth between 0.5 and 1.8 feet; 2) there was a positive correlation between cobble size and species diversity; 3) there was a positive correlation between imbeddedness and species diversity; and 4) there was a slight positive correlation between species diversity and size of the surrounding material. Further investigation of species diversity under varying streambed conditions would be needed to better define these relationships and to determine the interactions involved.

In assessing the fish populations by age, it is difficult to tell some age-group 0 chinooks from the smaller individuals of age-group 1 so they are all reported as age-group 0 chinook. Steelhead trout over age-group 1 are hard to distinguish and they are all reported as age-group 1 steelhead. In general, age-group 0 chinook salmon were found in water less than 2 feet in depth and water velocities less than 2 feet per second (Figures 9 through 16). The distribution of these juvenile chinook apparently were not correlated with the size of the streambed material. Age-group 1 chinook salmon were found in areas where the velocity was about 2 feet per second and the depth was less than 2 feet. There also was no apparent correlation between the distribution of these older chinook salmon and the size of the streambed material. Age-group 0 steelhead were found in water less than 1 foot in depth, in velocities less than 2 feet per second and over bed material less than 1 inch in diameter.

The older age groups of steelhead preferred areas where the water velocity was less than 1 foot per second and the depth was over 0.5 foot. The distribution of these juveniles was not correlated with size of the bed material, mainly because of the variability of sizes of this material in the pools where they were mainly found.

Insects of the order Diptera were more abundant in fish stomachs we examined than in the drift samples collected (Table 6). Insects of the order Ephemeroptera were the most abundant group of insects drifting in all three streams and were abundant in the diet of all groups of fish, but not to the same degree as they were found in the drift.

The data presented above is preliminary and a more complete analysis will be made on all aspects of this study.

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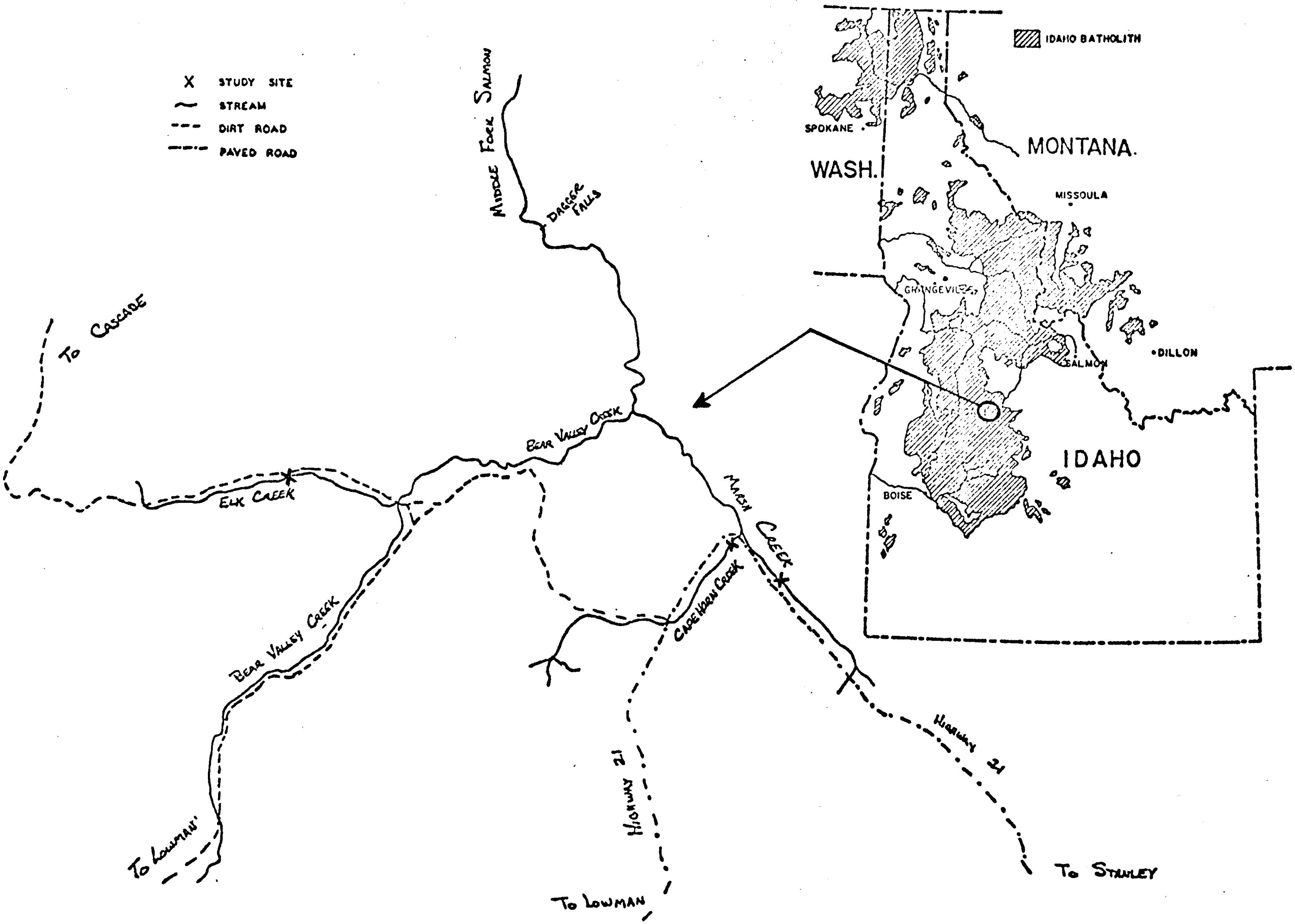

Figure 1. Map of the Idaho batholith, the study area, streams and study sites on each stream, 1972.

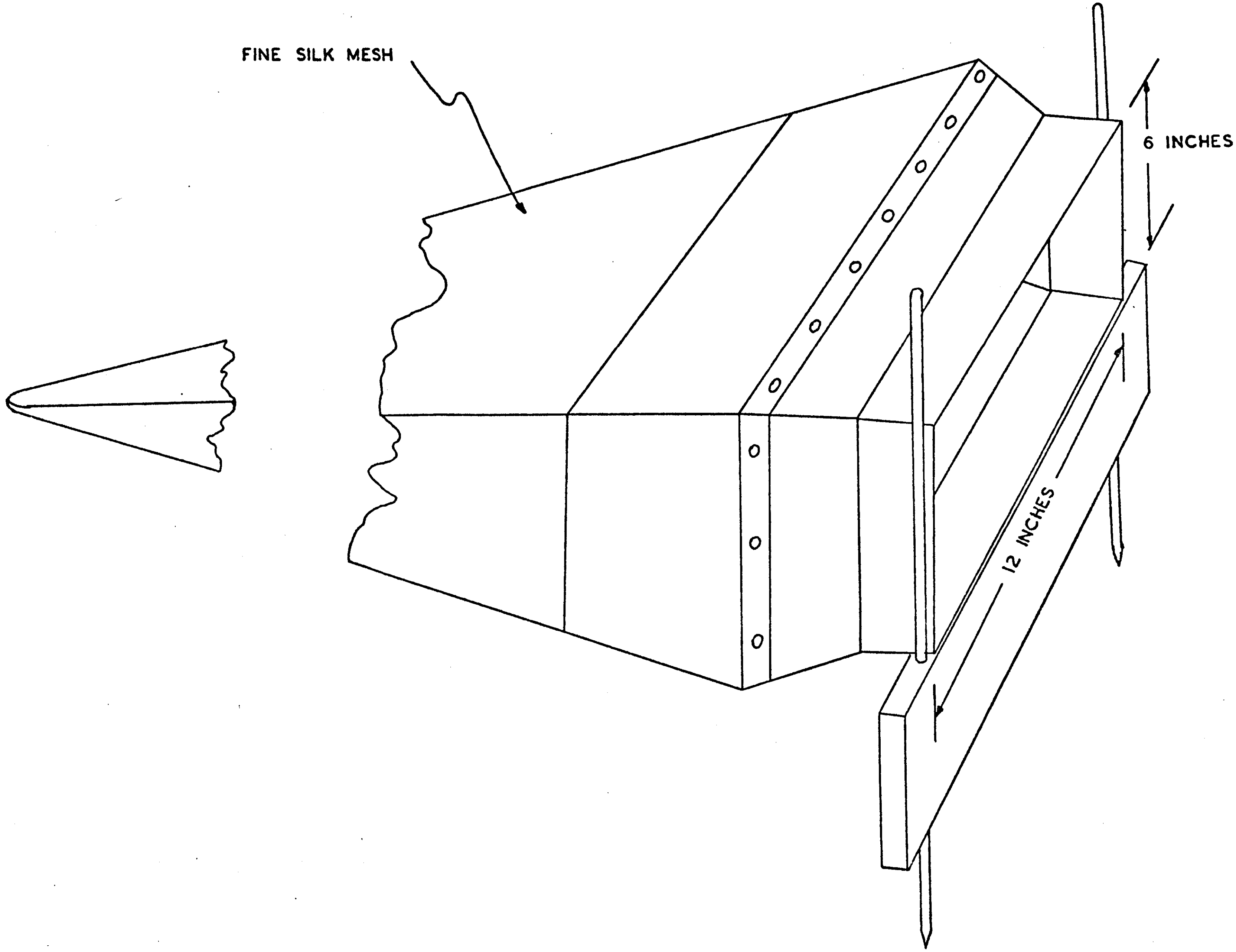

Figure 2. Portable pressure-differential bedload sampler used to estimate stream bedload, summer, 1972.

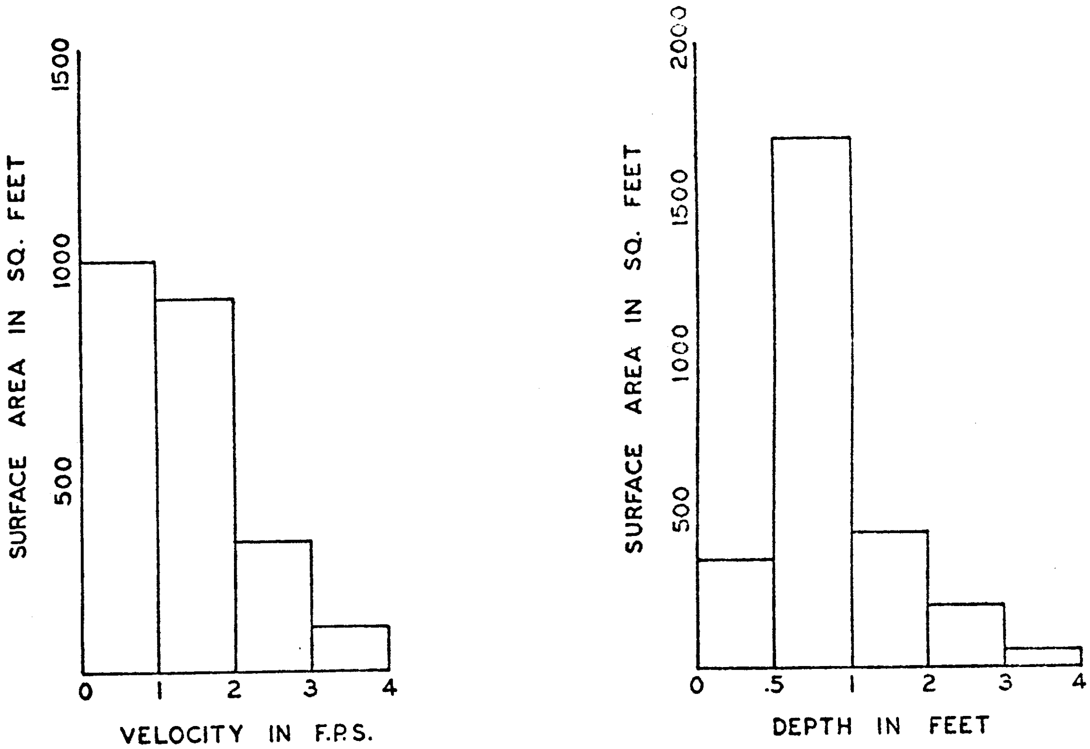

Figure 3. Amount of surface area for various velocities and depths, Marsh Creek, August, 1972.

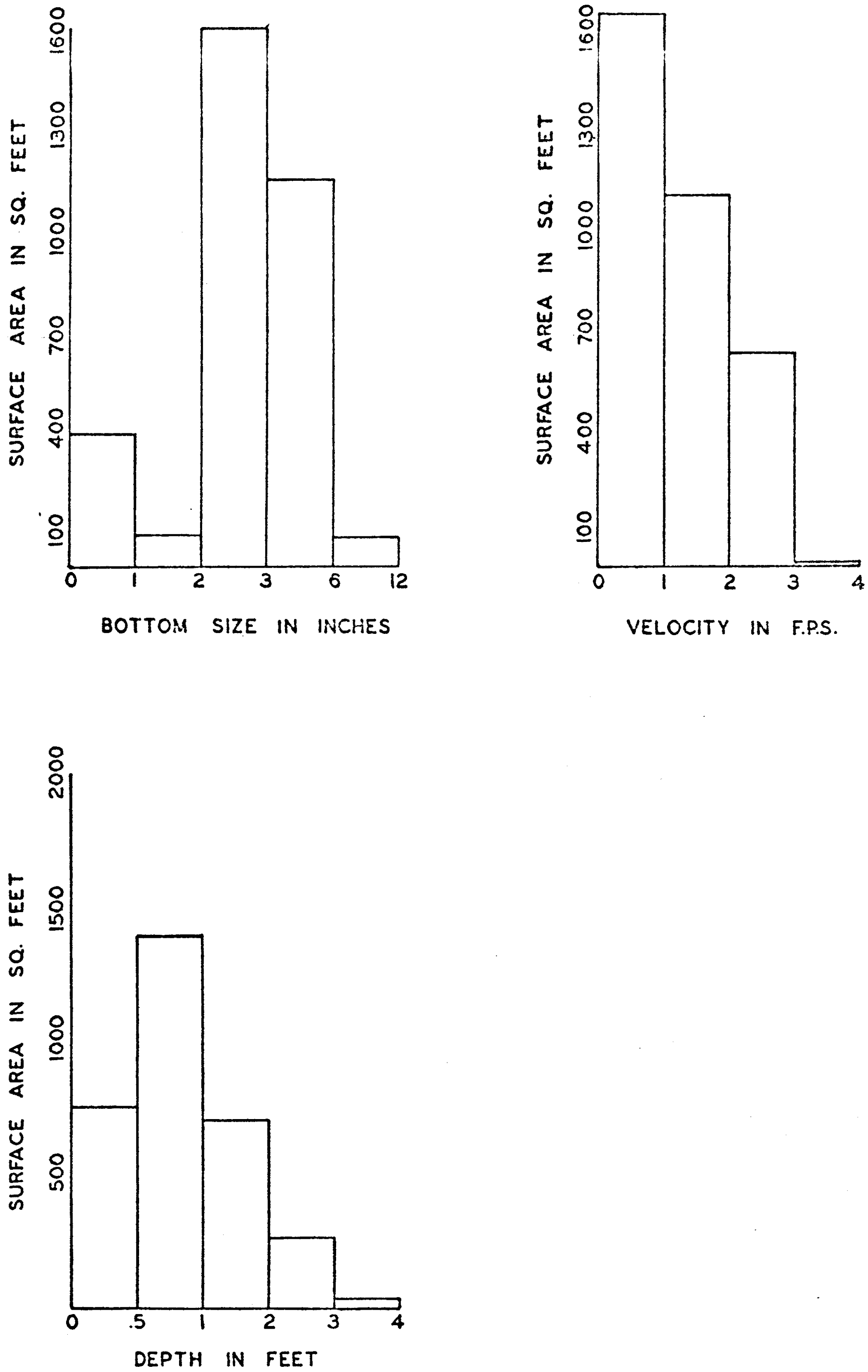

Figure 4. Amount of surface area for various velocities, depths and size of bottom materials, Cape Horn Creek, August, 1972.

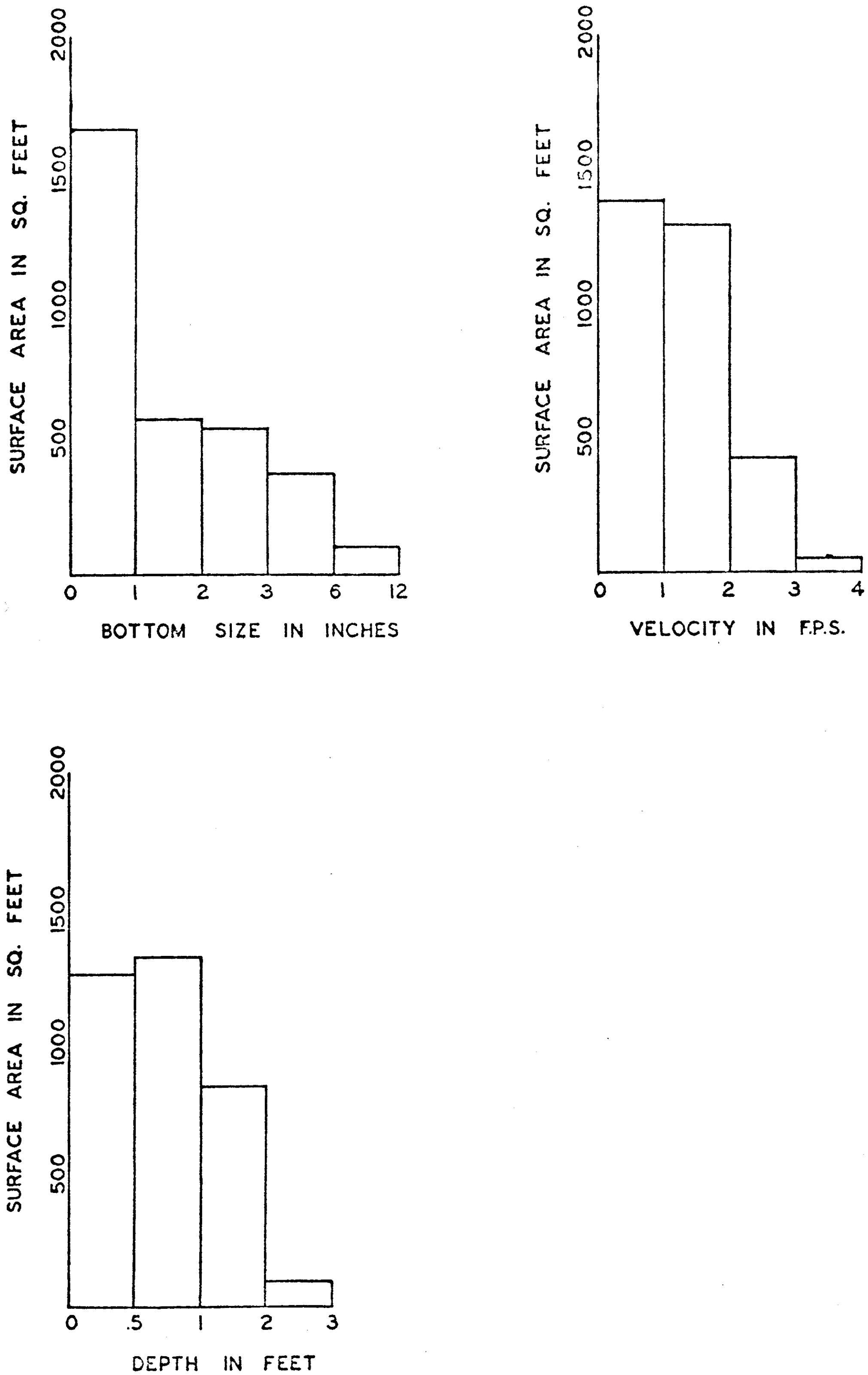

Figure 5. Amount of surface area for various velocities, depths and size of bottom materials, Elk Creek, August, 1972.

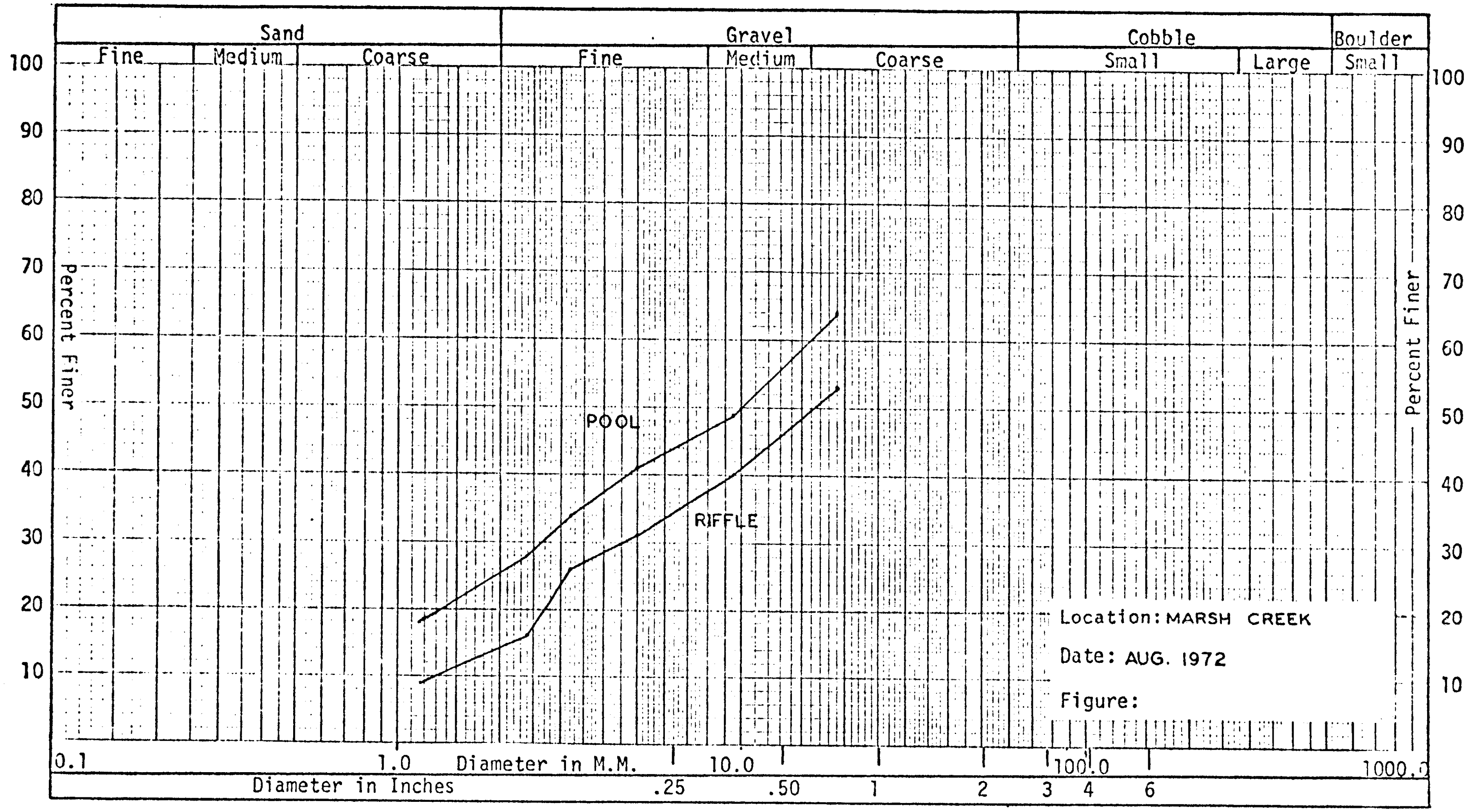

Figure 6. Percentage grain size of bottom materials in pools and riffles sampled with the core sampler, Marsh Creek, August, 1972. (pool, n=3; riffle, n=23)

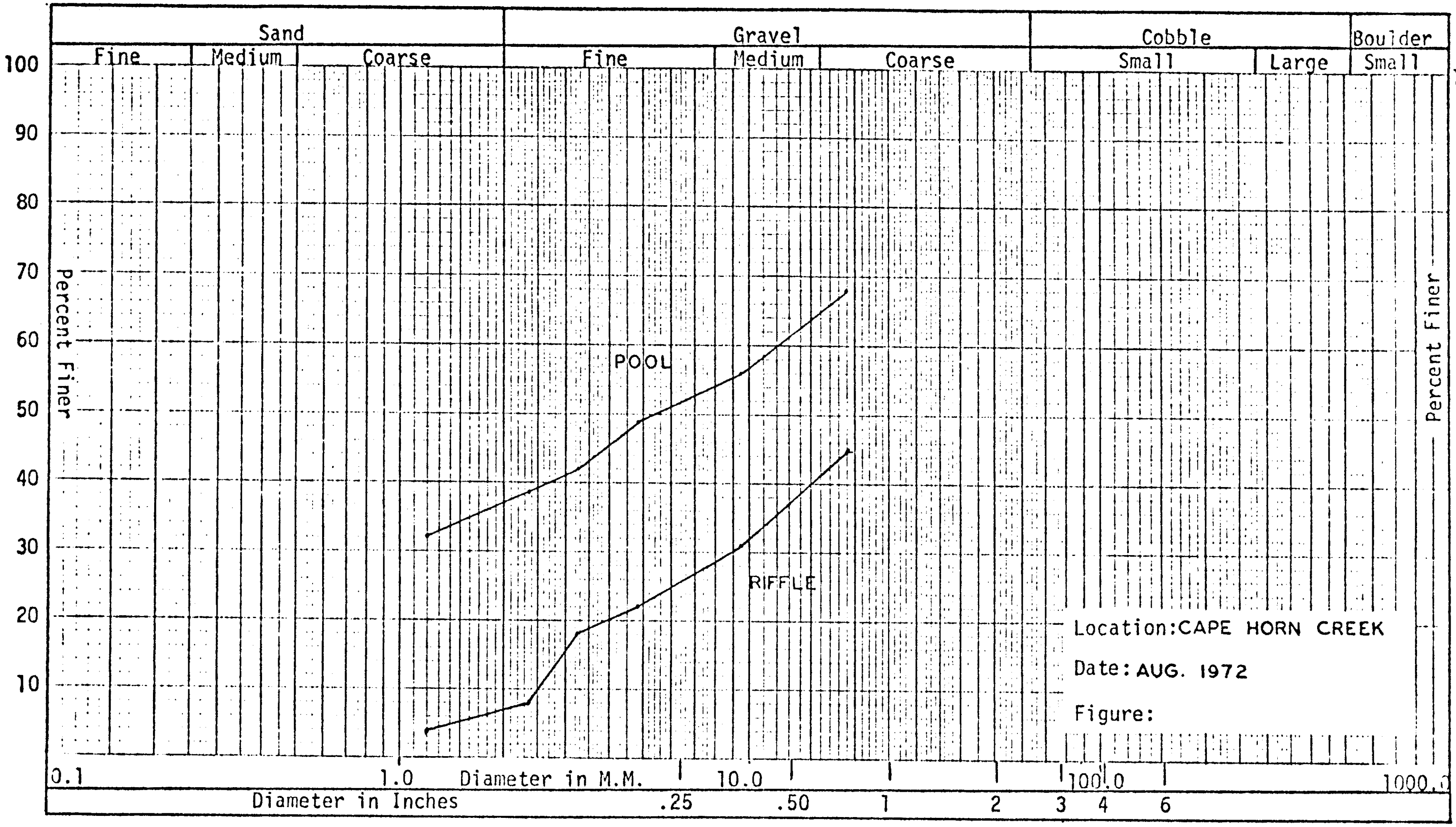

Figure 7. Percentage grain size of bottom materials in pools and riffles sampled with the core sampler, Cape Horn Creek, August, 1972. (pool, n=3; riffle, n=17)

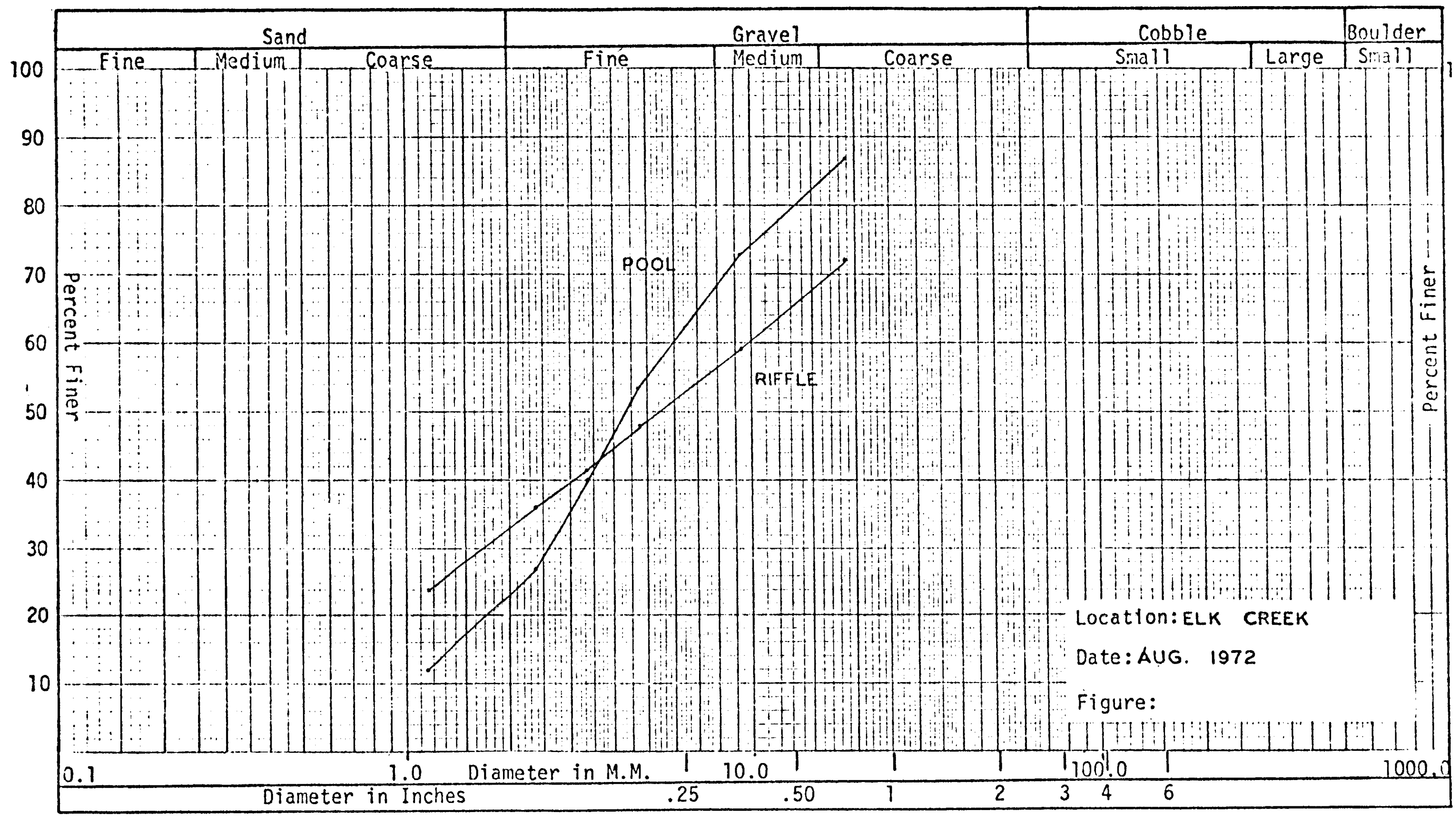

Figure 8. Percentage grain size of bottom materials in pools and riffles sampled with the core sampler, Elk Creek, August, 1972. (pool, n=3; riffle, n=29)

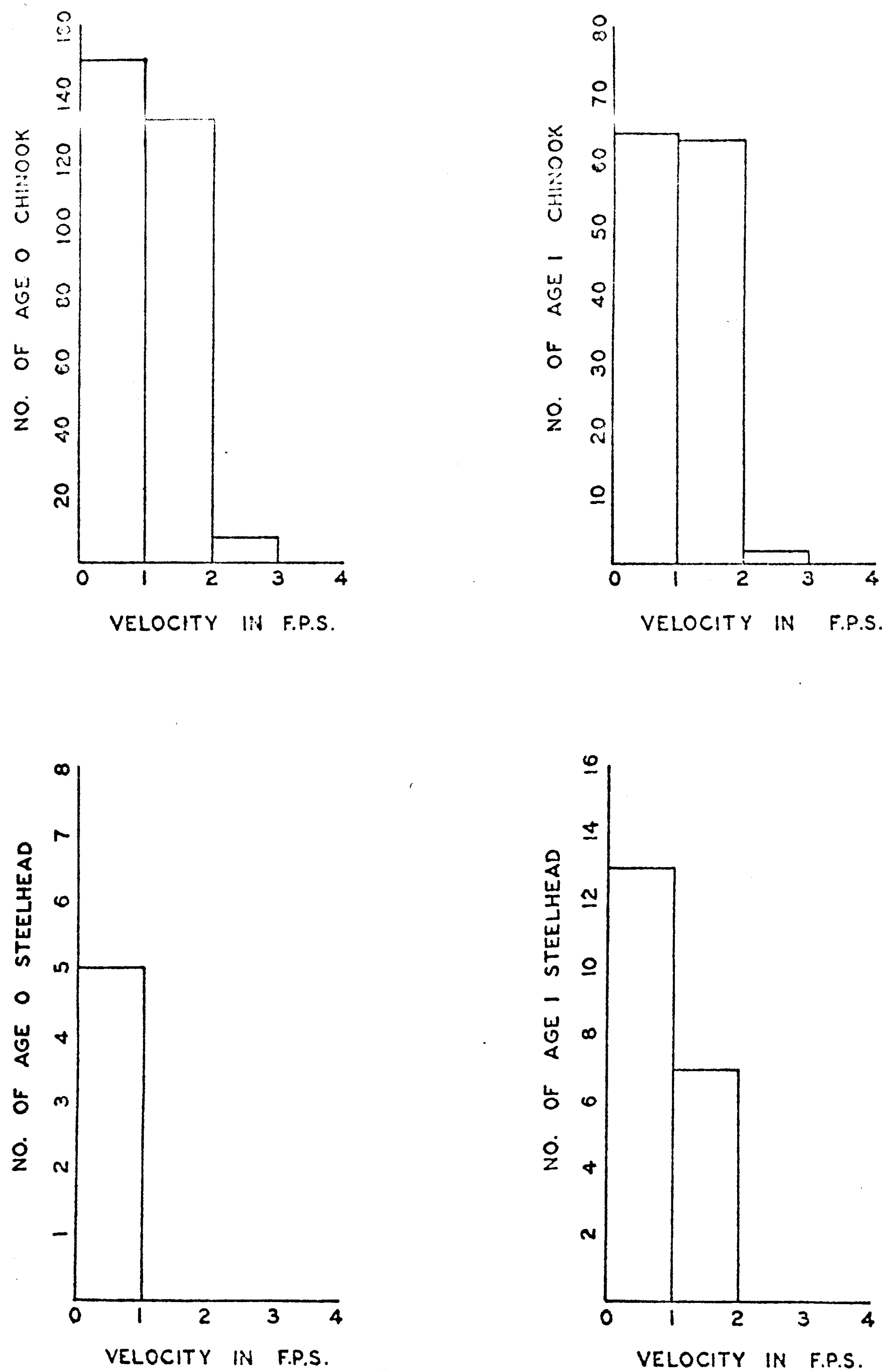

Figure 9. Number of juvenile chinook salmon and steelhead trout found in various velocities, Marsh Creek, August, 1972.

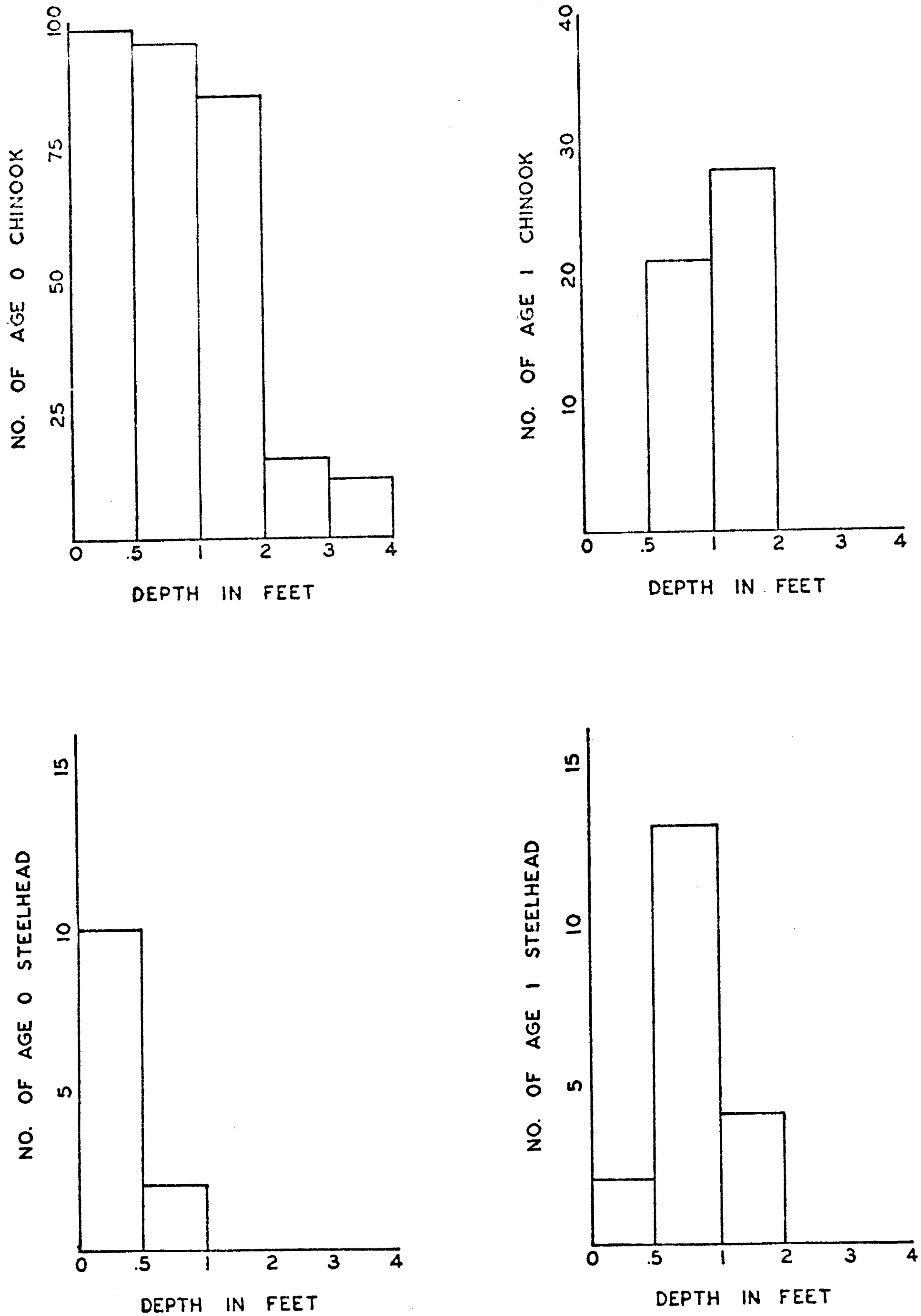

Figure 10. Number of juvenile chinook salmon and steelhead trout found in various velocities, Marsh Creek, August, 1972.

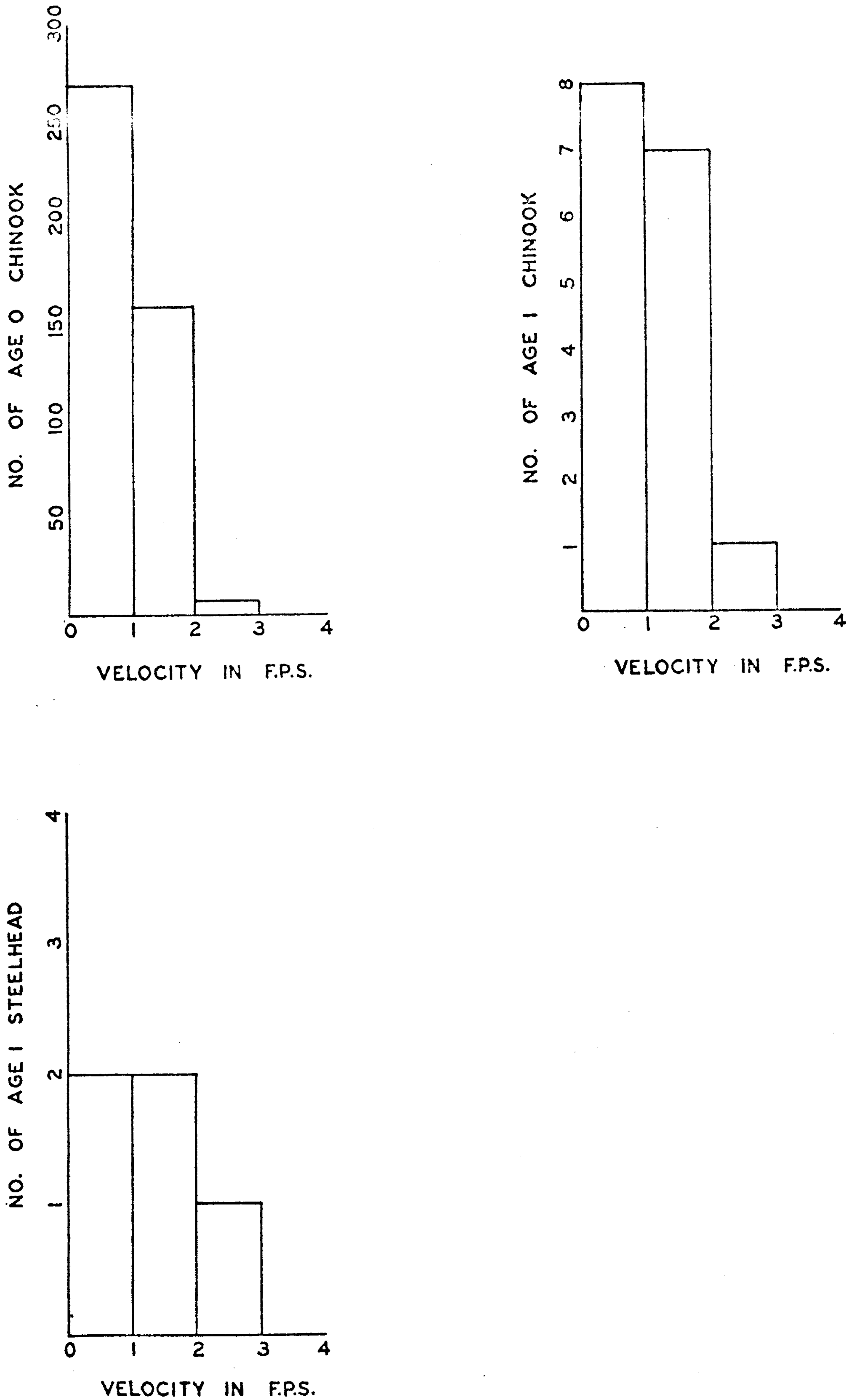

Figure 11. Number of juvenile chinook salmon and steelhead trout found in various velocities, Cape Horn Creek, August, 1972.

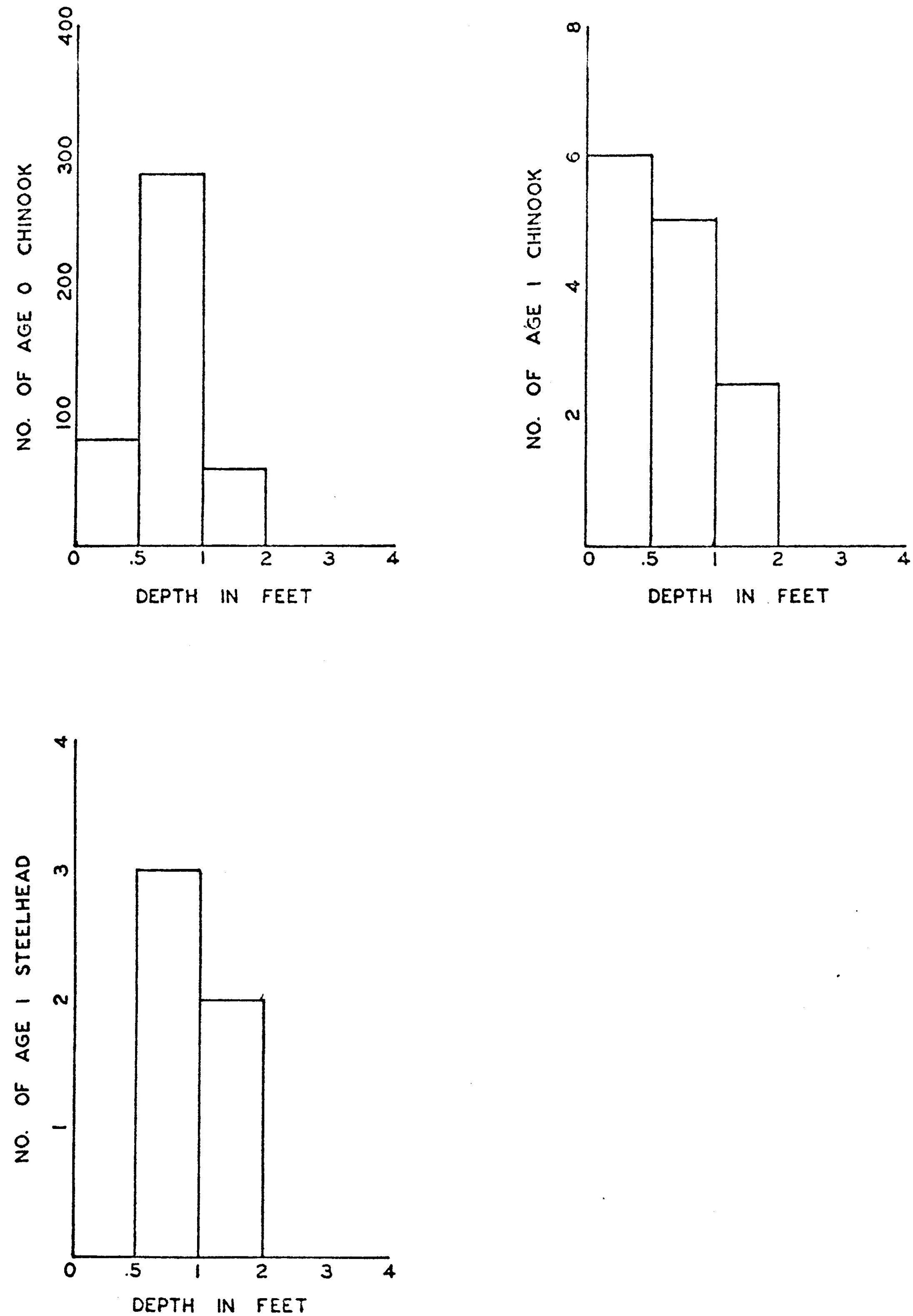

Figure 12. Number of juvenile chinook salmon and steelhead trout found in various water depths, Cape Horn Creek, August, 1972.

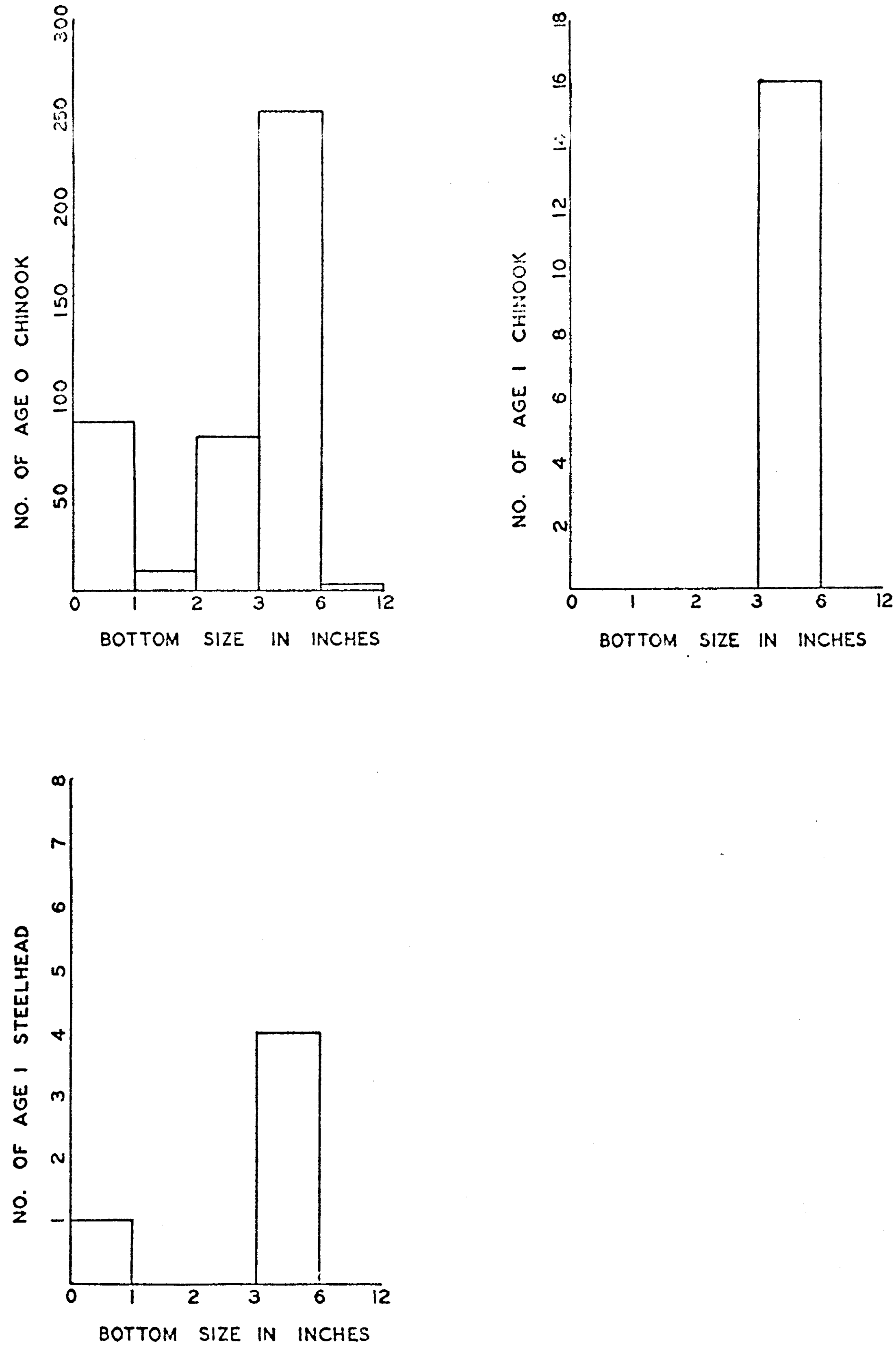

Figure 13. Number of juvenile chinook salmon and steelhead trout found over various sizes of streambed material, Cape Horn Creek, August, 1972.

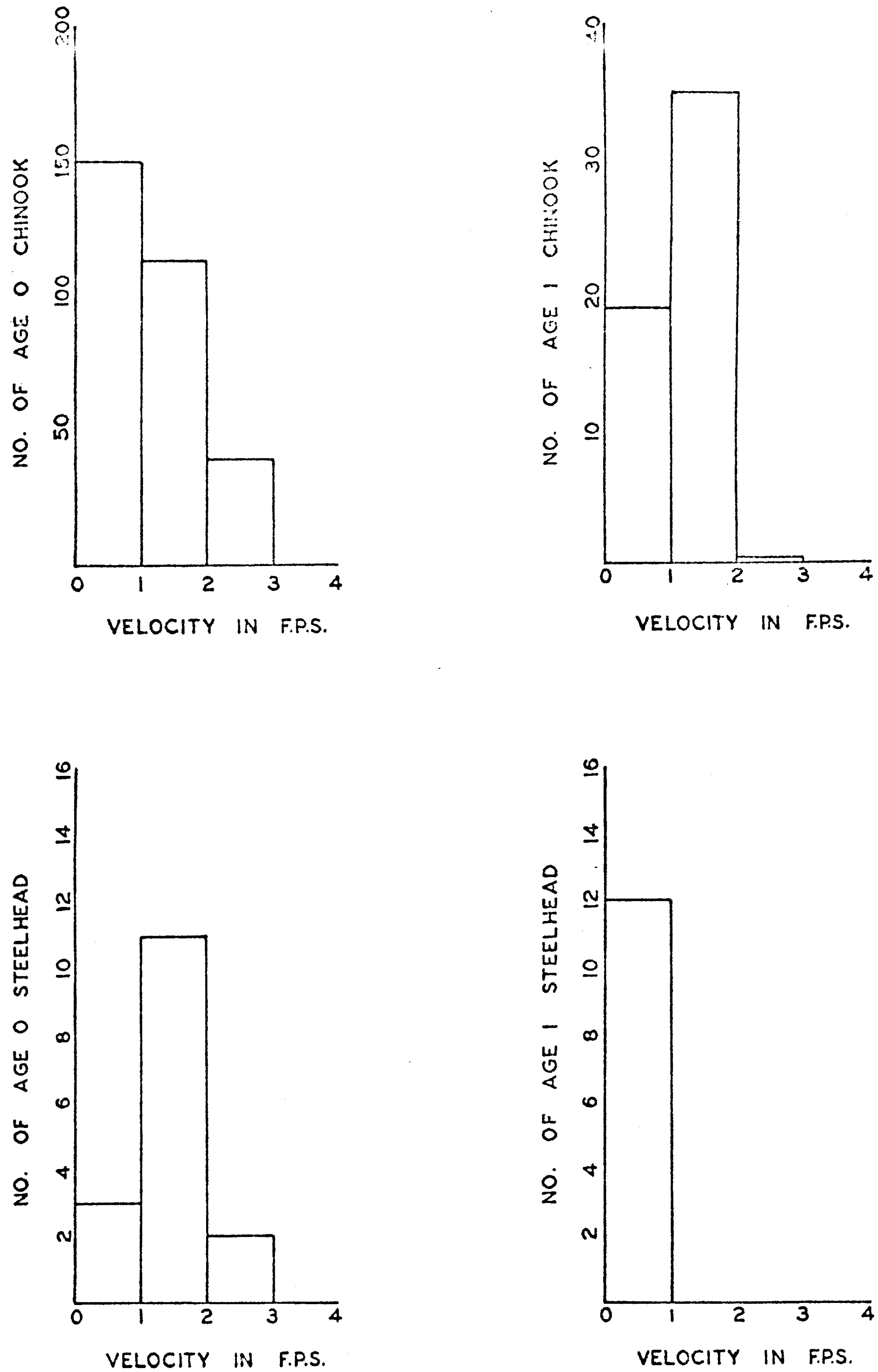

Figure 14. Number of juvenile chinook salmon and steelhead trout found in various velocities, Elk Creek, August, 1972.

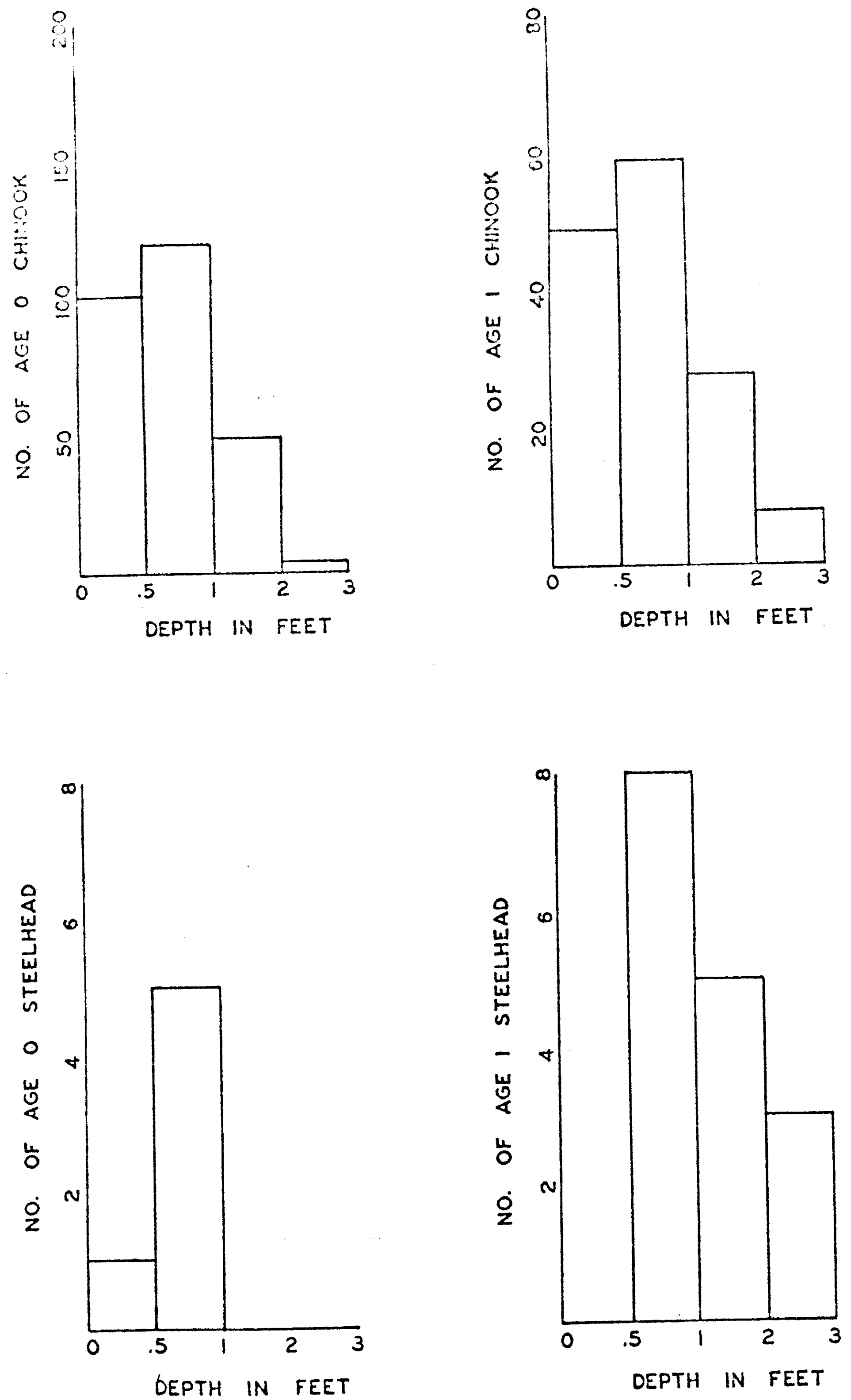

Figure 15. Number of juvenile chinook salmon and steelhead trout found in various water depths, Elk Creek, August, 1972.

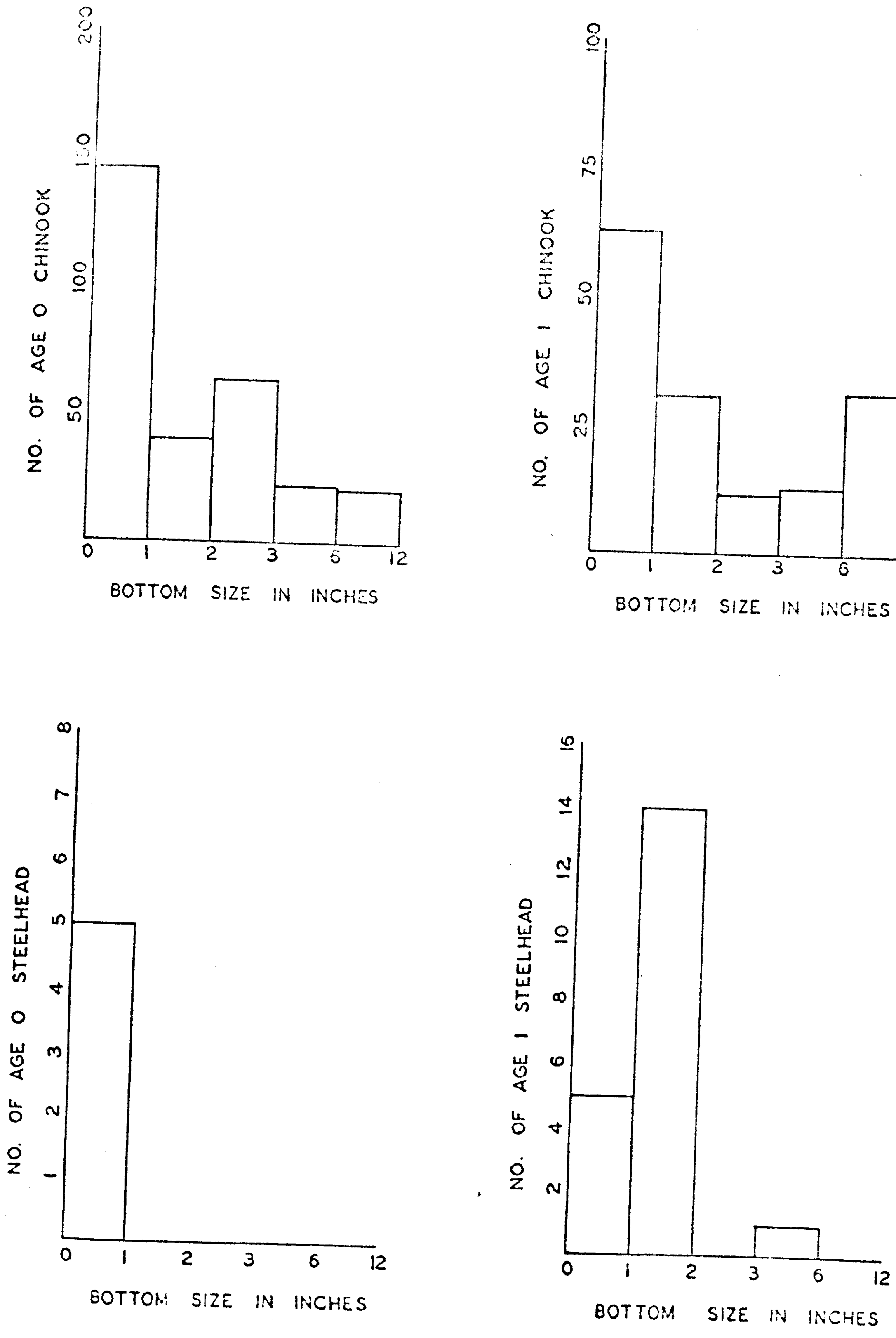

Figure 16. Number of juvenile chinook salmon and steelhead trout found over various sizes of streambed material, Elk Creek, August, 1972.

Table 1. Volume of flow, sediment discharge and composition of bed materials in pools and riffles of the three study streams, August, 1972.

Study Stream	Date	Composition of Bed Material (percent finer than 1/4 inch)		Water Discharge	Sediment Discharge
		pool	riffle	c.f.s.	pounds per day
Marsh Creek	August 8	44	34	42.1	7.1
Cape Horn Creek	August 12	52	26	40.8	7.9
Elk Creek	August 15	63	52	71.9	3.7

Table 2. Comparison of water depth, cobble size, imbeddedness of cobble, and the size of the material surrounding the cobble of each transect. The transects with the same 'identical set' letters are statistically similar.

Stream Transect	Identical Sets	Average Transect Factors: Water Depth (inches)	Cobble Size	Imbedded Depth	Surrounding Material
Marsh Creek No. 1	A	10.51	3.62	3.77	1.90
Marsh Creek No. 2		4.74	3.38	3.98	2.15
Cape Horn No. 1	C	8.96	3.33	3.85	1.48
Cape Horn No. 2	ACD	9.79	3.55	3.28	1.34
Cape Horn No. 3	D	9.91	3.87	3.74	1.43
Elk Creek No. 1	E	9.08	2.65	3.33	1.80
Elk Creek No. 2		11.17	3.11	3.97	2.11
Elk Creek No. 3	H	14.72	2.97	2.64	1.58
Elk Creek No. 4	HI	18.10	2.66	2.55	1.76
Elk Creek No. 5	EIJ	8.80	2.88	3.12	1.88
Elk Creek No. 6	EIJ	7.92	2.67	2.85	1.90

Table 3. Number of drifting insects, by order, collected by drift nets on the three study streams from August 8 to 15, 1972.

	0500 - 0700 hours Section				1200 - 1400 hours Section				2000 - 2200 hours Section				2400 - 0200 hours Section				Grand Totals
	A	B	C	Total	A	B	C	Total	A	B	C	Total	A	B	C	Total	
Marsh Creek																	
Ephemeroptera	88	56	65	209	27	10	26	63	92	306	122	510	573	188	290	1051	
Plecoptera	5	0	3	8	1	0	0	1	0	3	8	11	18	10	12	40	
Trichoptera	5	3	1	9	15	3	2	20	8	4	4	16	21	6	6	33	
Coleoptera	16	7	3	26	25	3	4	32	22	15	10	47	78	24	30	132	
Diptera	8	8	5	21	6	4	10	20	26	108	28	162	102	64	14	180	
Totals				273				136				746				1436	2591
Cape Horn Creek																	
Ephemeroptera	5	0	111	116	10	22	10	42	18	39	26	83	167	360	520	1047	
Plecoptera	6	10	9	25	1	1	3	5	6	7	2	15	54	73	122	249	
Trichoptera	2	13	2	17	2	25	2	29	4	8	6	18	10	12	6	28	
Coleoptera	8	16	6	30	2	6	3	11	4	5	4	13	2	23	84	109	
Diptera	7	9	6	22	1	11	3	15	6	8	8	22	6	36	34	76	
Totals				210				102				151				1509	1972
Elk Creek																	
Ephemeroptera	29	15	7	51	26	8	5	49	18	16	6	40	160	81	53	294	
Plecoptera	1	1	0	2	0	1	0	1	0	1	0	1	4	11	2	17	
Trichoptera	2	0	0	2	3	0	0	3	1	1	4	6	6	2	2	10	
Coleoptera	4	0	2	6	1	2	1	4	3	3	1	7	142	3	1	145	
Diptera	10	3	4	17	4	3	1	8	10	11	9	30	14	18	11	43	
Totals				78				65				84				509	736

Table 4. Numbers of drifting insects per cubic foot of water flowing over riffles in Marsh, Cape Horn, and Elk Creek from August 8 to 15, 1972.

Location	Time Periods			
	0500-0700	1200-1400	2000-2200	2400-0200
Marsh Creek				
Ephemeroptera	159	51	354	814
Plecoptera	7	1	9	31
Trichoptera	7	16	12	25
Coleoptera	19	25	34	102
Diptera	15	16	106	127
Cape Horn Creek				
Ephemeroptera	42	35	65	690
Plecoptera	20	4	16	176
Trichoptera	13	22	14	27
Coleoptera	26	8	11	47
Diptera	19	11	19	47
Elk Creek				
Ephemeroptera	23	16	16	149
Plecoptera	2	1	1	8
Trichoptera	1	1	9	5
Coleoptera	4	4	4	31
Diptera	10	4	21	28

Table 5. Species diversity of each benthic sampling unit based upon the Shannon-Weaver Diversity Index.

Sample (2 sq. ft.)	Individual Diversity	Redundancy	Average Diversity	Composite Riffle Diversity	Composite Riffle Redundancy
MARSH CREEK			3.36	3.77	.26
1	3.48	.22			
2	3.22	.22			
3	3.05	.25			
4	3.46	.24			
5	3.62	.12			
6	3.31	.23			
CAPE HORN			3.13	3.62	.30
1	2.72	.34			
2	2.78	.32			
3	3.02	.28			
4	3.44	.26			
5	3.28	.27			
6	3.48	.19			
7	3.22	.14			
8	3.25	.25			
9	3.19	.22			
ELK CREEK			3.07	3.60	.27
1	3.07	.15			
2	2.67	.33			
3	3.19	.21			
4	3.09	.26			
5	3.24	.22			
6	2.80	.32			
7	3.32	.27			
8	3.10	.17			
9	3.15	.21			