Original: Fish Division
cc: Education-Game
Dr. Leonard
Dr. Shetter

INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

ALBERT S. HAZZARD, PH.D.
DIRECTOR

ADDRESS
UNIVERSITY MUSEUMS ANNEX
ANN ARBOR, MICHIGAN

June 3, 1942

REPORT NO. 788

BOTTOM FAUNA PRODUCTION IN SECTION B OF HUNT CREEK PRIOR TO INSTALLATION OF IMPROVEMENT DEVICES

by

Justin W. Leonard

Hunt Creek Experiment Station

Introduction

During the early fall of 1941, a series of 20 square-foot bottom samples were taken from Section B of Hunt Creek by staff members of the Hunt Creek Experiment Station. Each sample was collected from a situation expected to undergo alteration in physical character in response to the installation of stream improvement devices.

The sampling operations constitute one phase of the planned program for a detailed study of the immediate and long-term effects of so-called stream improvement on the physical and biological characteristics of the creek. Other aspects of the investigation include continuous intensive creel census of the section, estimates of the total trout population based on samples obtained by blocking off and seining 5 sample areas of Section B, and periodic observations on physical changes in the environment, made possible by the earlier preparation of a detailed, large-scale map of the area involved.

Creel census and population estimate information have been collected regularly since the opening of the 1939 trout season, and it is expected that such work will be continued for a period of years. It is believed that completion of the study will not only provide useful information on the effects, over a period of years, of known angling pressure and year-to-year variation in precipitation, temperature, and other climatic features, but will also make it possible to assess, much more reliably than has been feasible in the past, the effects of stream improvement devices on the size and condition of the trout population and the amount and composition of the natural food supply.

The most comprehensive work thus far made public dealing with the effects of stream improvement is that of Tarzwell (1936, 1938). The first of the citations covers work done in Michigan, and contains quite conclusive data supporting the view that, when stream improvement can be made to supplant a notoriously poor bottom type (sand) with one well known to be rich (gravel or rubble), bottom fauna production soars. It has not been shown, however, what changes in nature and quantity of bottom organisms may be expected when improvement devices are installed in an area where little alteration may be expected in the nature of the bottom type, as is the case with Section B.

The writer participated in some of the work reported by Tarzwell (1936) and may be permitted to observe that at that time methods of collecting and sorting bottom samples were not as well standardized as at present, nor was it always feasible to make comparative collections at the same time of year, a practice essential to accurate comparison for reasons pointed out by Needham (1934), Moffett (1936), and Leonard (1942). Greater accuracy may be expected in the project now under way in Section B, but Tarzwell's results may be considered sufficiently applicable to the question of the effect of stream improvement on bottom fauna production where alteration of bottom type is not the prime consideration to afford a valuable comparative check on future results here.

Acknowledgments

Samples were collected and sorted by Lawrence Bush, Paul Barrett and the writer. Determinations were made by Barrett and verified by the writer. Much assistance in calculations involved in the tabular presentation of the data was given by my wife, Fannie Leonard.

Methods and Materials

Collection of bottom samples from the sites of proposed structures was begun immediately prior to the start of construction, which was done under the direction of O. H. Clark. The sampling period extended from September 17 to October 15, 1941. As a rule, the sorting and measuring of each sample required at least one full working day.

Although every effort was made to obtain complete determinations of each species present, it was possible, in some instances, to carry identification only as far as family or genus. This was largely due to two reasons: (1) During the late summer and early fall many of the bottom organisms are in very early growth stages, and characters for specific identification have not yet developed; and (2) the life histories of many of the Hunt Creek organisms are not yet worked out. It has been the regular practice to separate species so far as possible, and, where names are not known, to assign arbitrary designations such as "species 1", "species 2", and so on, together with descriptive notes to permit application of correct nomenclature when further rearing work renders accurate determination feasible.

Samples were collected with the folding square-foot stream sampler of the type described by Surber (1936). Organisms were separated from bottom material in white enamel pans. They were sorted to species in watch glasses, counted, and their volume determined by displacement of water in a centrifuge tube graduated in tenths of a cubic centimeter, making it possible to estimate volumes to 0.025 cubic centimeter. Any items bulking less than the latter figure were recorded as "trace", then laid aside and all such measured together and entered as "traces combined" to provide the final total volume. During counting, organisms were identified under a binocular microscope. Sorting and measuring were carried out in water to avoid the necessity of allowing for shrinkage.

Section B of Hunt Creek flows almost entirely through cedar and spruce swamp. The banks are low and flat, with very numerous spongy seepage areas. Local openings in the swamp have permitted the establishment of occasional growths of alder and round-leaved aspen. Near the lower end of the section, tamarack becomes increasingly abundant. The stream itself is, in general, rather broad and shallow. The bottom is composed quite uniformly of sand and fine gravel, the latter ranging in size from that of a pea to that of a hen's egg. Sand and fine gravel almost always occur in a mixture; the bottom is not largely sandy in character. In some places, the dominant material has been overlaid with silt and detritus, and such deposits often sustain a growth of Veronica connata, the only higher aquatic plant occurring in significant amount throughout the section. Algal "cushions"[1] are of less frequent occurrence than in other sections of the creek, and Chara is seldom

[1] Throughout the Hunt Creek Experimental Area wherever sand occurs in uniform bars in the stream bed, extensive growths of algae are of very common occurrence. The algae (determined as Vaucheria sp. by Burton P. Hunt of the Institute staff) form felt-like mats covering the sand. The mats are roughly rounded peripherally, and may vary in area from less than one to 10 or more square feet. The density of growth is sufficient to check the normal tendency of the sand to shift continually with the current, so that after the mat has been in existence for some time, erosion lowers the sand level around it, resulting in a green-covered hummock or cushion of stabilized sand. The writer cannot recall having seen any other stream in the state where such growths are of the frequency and extent encountered in Hunt Creek, especially Sections A and C. The development of Vaucheria is very desirable, for it results in stabilization of considerable areas of shifting sand, and in additional harborage places for bottom organisms. The structure of the mat, composed of myriad interwoven filaments, has been found to shelter such food organisms as small mayfly nymphs (Baetis spp.), midge larvae (Palpomyia sp.) and various small caddis larvae.

seen. Very few depressions worthy of designation as "pools" existed prior to improvement. Extensive areas of fine gravel under 1 to 4 inches of water were common. About the only cover for trout was that afforded by limited undercutting of the low banks.

The results of the sampling operations are shown in tabular form (Tables 1 to 20), together with information on bottom type, water depth, current velocity, and position of sampling station in relation to the proposed improvement device.

Of the 20 samples collected, 17 were from the bottom type dominant throughout the section, fine gravel mixed with sand. The tables show that the actual species present remained remarkably constant throughout the series of samples. Variation in volume per sample was more due to variation in numbers of individuals than to difference in number of species represented. Table 21 presents a complete faunistic list based on the series of samples. It may be seen that of a total of 77 species of organisms, 21 were present in 10 or more of the samples, and largely determined the complexion of the situation. The habits of these species are such as to indicate that Section B is, in effect, one big riffle area, where the most successful bottom organisms are those adapted by form or habit to life on, under, or between gravel in fast current.

Running rapidly through the list of species given in Table 21 we find that the forms of most frequent occurrence throughout the section were: aquatic earthworms, which are among the few organisms apparently able to burrow in shifting sand with impunity; leeches, of a species which habitually clings, limpet-like, to the under sides of stones; small mayfly nymphs with streamlined body contours able to find harborage in small irregularities on the surfaces of stones, or to occupy the chinks between pieces of gravel; adult and larval marl beetles, which shun the current by burrowing shallowly in the surface layer of the stream bed, or by clinging to irregularities in submerged stones, and by tunneling in porous marl, if present; caddis larvae which cling to the under side of stones (Rhyacophila), crawling about freely, but first covering the slippery surfaces with a network of silken threads to provide a "toe-hold"; or caddis larvae which, like Mystrophora, the limnephilids and Brachycentrus, make cases of sand or plant material which may be rigidly affixed to any supporting surface; cranefly larvae with a tough outer pellicle capable of withstanding considerable abrasion, and having the faculty of expanding the terminal segments of their bodies to form "pushing rings", by means of which they burrow through sand and gravel; and midges and water mites adapted in a variety of ways to clinging or tunneling. The early growth stages of hairworms (in Hunt Creek Polygordius sp.) are parasitic within the bodies of various insects. Fully-grown specimens, non-parasitic in habit, are thought to occupy fresh-water habitats only for the purpose of reproduction.

In Table 22, material from the 20 samples is summarized to show the relative importance, both numerical and volumetric, of the bottom fauna, by major categories. It may be seen that, at the time of sampling, the creek through Section B was definitely a "caddisfly stream", these organisms bulking roughly twice and three times as large, respectively, as the two next most bulky groups, aquatic annelids and aquatic Diptera. Some noteworthy features of Section B revealed by the material in Table 22 are: the relatively low position occupied by mayflies, ranking fifth in volume, less than 8 per cent of the total; the even lower position of stoneflies, which made up only 2 per cent of the total volume; and the negligible occurrence of both "freshwater shrimp" and alder fly larvae, a reflection of the paucity of quiet water areas, aquatic plants and silt deposits in the section.

To provide a clearer conception of the food-producing caliber of Section B, figures based on previous work on other Lower Peninsula trout streams and on Section C of Hunt Creek are shown in Table 23. In compiling the figures from other streams, an attempt was made to select results of samples taken from situations approximating those encountered in Section B, and collected on comparable dates. Figures from the North Branch of the Au Sable, however, are supplied more for contrast than for comparison. This stream, where sampled, is four or five times as wide as Section B, has a considerably greater average depth, and flows over a bottom composed of medium gravel and rubble thickly coated with a porous marly deposit which offers harborage to burrowing forms as well as to species which cling to submerged surfaces. Physical conditions applying to sampling sites in the West Branch of the Sturgeon (between Vanderbilt and Wolverine), Kinne Creek (a private stream tributary to the Pere Marquette), and Section C of Hunt Creek are quite closely comparable to those of Section B, including swift current, low summer water temperatures, and but slight deposits of marl on the bottom material.

It may be seen that the bottom fauna of Section B prior to improvement agreed quite closely, both in numbers of species and individuals and in total volume, with that of Section C and of Kinne Creek, and that it is about twice that of the West Branch of the Sturgeon. The nearly three-fold greater volumetric production of the North Branch of the Au Sable is consistent with that stream's heavy production of trout. Of all the Michigan streams studied by the writer, the North Branch has yielded by far the largest bottom fauna samples, and the West Branch of the Sturgeon the smallest. The production of Section B, intermediate between these two extremes, is, in the opinion of the writer, very near the average for small, spring-fed streams of the northern Lower Peninsula.

This is not to be taken as indicating that such production is desirable in amount. It has been shown (Leonard, 1942) that in a nearby area of Hunt Creek having closely similar production, an average square foot of stream bottom contained only about three times the volume and four times the number of food organisms contained in the stomach of a 3-inch brook trout fingerling, based on averages of 22 stomachs. The writer has also shown (Leonard, 1941) that on the basis of stomach analyses of legal-length trout from the entire experimental area, it would require all of the bottom fauna from 2 square feet of bottom to make an average meal for 3 legal-length brook trout if only bottom foods were taken. Although the foregoing quoted figures were based on localized studies, they provide ample evidence that a very considerable increase in the food-producing capacity of Section B is greatly to be desired.

Relation of Bottom Fauna to Feeding Habits of Trout

During both 1940 and 1941, the stomachs of trout taken from Section B on dates approximating those of the bottom sample collections contained a preponderant amount of food of terrestrial origin. Bottom organisms were present in the following order of bulk: caddisfly larvae and pupae (*Mystrophora*, *Chimarrha*, *Hydropsyche*, limnephilids and *Brachycentrus*); dipterous larvae (chironomids, ceratopogonids and blackflies); adult hydrophilid beetles (almost certainly taken from the few quiet-water areas); and a negligible trace of mayfly nymph remains. In a few of the 1941 stomachs, considerable numbers of stonefly nymphs were found.

Although bottom organisms happened to be less important than terrestrial insects in these stomachs, there is a clear indication that practically all species of caddis larvae found in the bottom samples are available to trout. Stonefly nymphs, although very infrequent in the bottom samples, are known to be locally abundant in a few portions of Section B, and a trout happening on such an area might find them the dominant organism. The species taken, Nemoura sp., is found more often in trash-filled backwaters than on stones in fast water.

Conclusions

Data are presented to show that the bottom fauna production of Section B of Hunt Creek prior to the installation of improvement devices was probably near average for similar streams of the northern Lower Peninsula, but far from being of desirable amount. Limited evidence from trout stomach analyses indicates that the combination of species in the bottom fauna is probably satisfactory.

Figures quoted from other workers show that the installation of stream improvement may result in great increases in bottom fauna production if the nature of the area improved is such that action of the devices results in a more productive bottom type. The study of Section B now in progress should be of great value in revealing whether or not improvement devices will result in increased bottom fauna production when installed in an area already average in quality. If future work shows that little change has been made in the bottom fauna, the planned studies of possible changes in size and quality of the resident trout population may be expected to provide valuable facts on the relative value, to trout populations, of the important limiting environmental factors of food, shelter, and cover.

Literature Cited

Leonard, J. W.

1941. The feeding habits of legal brook trout in Hunt Creek during the 1940 fishing season. Inst. for Fish. Res., Rept. No. 659, pp. 1-20, tables 1-10.

1942. Some observations on the winter feeding habits of brook trout fingerlings in relation to natural food organisms present. Trans. Am. Fish. Soc., 71: 160-168, in press.

Moffett, James W.

1936. A quantitative study of the bottom fauna in some Utah streams variously affected by erosion. Bull. Univ. Utah, 26 (9): 1-32.

Needham, P. R.

1934. Quantitative studies of stream bottom foods. Trans. Am. Fish. Soc., 64: 238-247.

Surber, Eugene W.

1936. Rainbow trout and bottom fauna production in one mile of stream. Trans. Am. Fish. Soc., 66: 193-202.

Tarzwell, Clarence M.

1936. Experimental evidence on the value of trout stream improvement in Michigan. Trans. Am. Fish. Soc., 66: 177-187.

1938. An evaluation of the methods and results of stream improvement in the southwest. Trans. 3d. N. Am. Wildlife Conf., 1938: 339-364.

INSTITUTE FOR FISHERIES RESEARCH

By Justin W. Leonard

Report approved by: A. S. Hazzard

Report typed by: R. Bauch

Table 1. Square-foot bottom sample in lee of Structure No. 1. Bottom, fine sand and gravel; water depth, 10 inches; current, medium. October 15, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Worms and leeches)			
Oligochaeta	1	2	0.025
Hirudinea	1	2	0.025
Ephemeroptera (Mayflies)			
Ephemerella invaria - N	1	7	0.025
Paraleptophlebia mollis - N	1	3	trace
Plecoptera (Stoneflies)			
Isoperla sp. - N	1	1	trace
Capnia manitoba - N	1	1	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	30	0.075
Stenelmis sp. - A	1	1	trace
Trichoptera (Caddisflies)			
Mystrophora sp. - L	1	46	0.050
Mystrophora sp. - P	1	7	0.050
Hydropsyche sp. - L	1	5	trace
Limnephilidae - L	3	41	0.350
Brachycentrus americanus - L	1	1	trace
Diptera (True flies)			
Tipula sp. - L	1	1	0.100
Rhaphidolabis sp. - L	1	13	0.075
Tipulidae - L	1	3	trace
Chironomidae sp. 1 - L	1	1	trace
sp. 2 - L	1	1	trace
sp. 3 - L	1	2	trace
sp. 4 - L	1	1	trace
sp. 5 - L	1	2	trace
sp. 6 - L	1	14	trace
Arachnida (Water mites)			
Hydracarina	1	2	trace
Traces Combined			0.125
Totals	25	187	0.900 cc.

Table 2. Square-foot bottom sample off end and 6 feet above Structure No. 2. Bottom, fine gravel; water depth, 10 inches; current, swift. October 14, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Mollusca (Snails and clams)			
Pisidium sp.	1	2	trace
Annelida (Worms and leeches)			
Oligochaeta	1	6	0.100
Ephemeroptera (Mayflies)			
Ephemerella invaria - N	1	4	0.025
Plecoptera (Stoneflies)			
Isogenus frontalis - N	1	2	0.100
Coleoptera (Beetles)			
Stenelmis sp. - L	1	28	0.075
Trichoptera (Caddisflies)			
Hydropsyche sp. - L	1	14	0.200
Mystrophora sp. - L	1	43	0.075
Mystrophora sp. - P	1	1	trace
Limnephilidae - L	1	26	0.250
Brachycentrus americanus - L	1	1	trace
Diptera (True flies)			
Tipulidae - L	1	8	0.025
Antocha saxicola - L	1	1	trace
Eriocera sp. - L	1	3	trace
Rhaphidolabis sp. - L	1	80	0.400
Chironomidae sp. 1 - L	1	1	trace
sp. 3 - L	1	2	trace
sp. 4 - L	1	34	trace
sp. 6 - L	1	146	trace
Arachnida (Water mites)			
Hydracarina	1	3	trace
Traces Combined			0.025
Totals	19	405	1.275 cc.

Table 3. Square-foot bottom sample in lee of Structure No. 3. Bottom, fine gravel and sand; water depth, 8 inches; current, swift. October 13, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Worms)			
Oligochaeta	1	3	0.050
Ephemeroptera (Mayflies)			
Rhithrogena sp. - N	1	1	trace
Ephemerella invaria - N	1	16	0.025
Paraleptophlebia mollis - N	1	2	trace
Baetis sp. - N	2	7	trace
Plecoptera (Stoneflies)			
Capnia manitoba - N	1	27	trace
Isoperla sp. - N	1	2	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	13	0.025
Trichoptera (Caddisflies)			
Hydropsyche sp. - L	1	7	0.075
Mystrophora sp. - L	1	144	0.100
Mystrophora sp. - P	1	5	trace
Limnephilidae - L	1	46	0.450
Brachycentrus americanus - L	1	2	trace
Diptera (True flies)			
Tipulidae - L	1	15	0.050
Rhaphidolabis sp.	1	29	0.125
Chironomidae sp. 2 - L	1	5	trace
sp. 3 - L	1	2	trace
sp. 4 - L	1	27	trace
sp. 7 - L	1	2	trace
sp. 6 - L	1	198	trace
Ceratopogonidae - L	1	5	trace
Traces Combined			0.025
Totals	22	558	0.925 cc.

Table 4. Square-foot bottom sample off end of Structure No. 4. Bottom, fine gravel and sand; water depth, 5 inches; current, swift. October 9, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Earthworms)			
Oligochaeta	1	26	1.425
Ephemeroptera (Mayflies)			
Rhithrogena sp. - N	1	1	trace
Stenonema rivulicolum - N	1	1	trace
Baetis brunneicolor - N	1	1	trace
Baetis sp. - N (minute)	1	10	trace
Paraleptophlebia mollis - N	1	6	trace
Ephemerella invaria - N	1	54	0.075
Plecoptera (Stoneflies)			
Taeniopteryx nivalis - N	1	1	trace
Capnia manitoba - N	1	48	0.050
Isoperla sp. - N	2	9	0.025
Coleoptera (Beetles)			
Stenelmis sp. - L	1	63	0.075
Stenelmis sp. - A	1	20	0.050
Trichoptera (Caddisflies)			
Mystrophora sp. - L	1	203	0.050
Mystrophora sp. - P	1	10	0.050
Hydropsyche sp. 1 - L	1	215	1.100
Hydropsyche sp. 2 - L	1	1	trace
Limnephilidae - L	1	17	0.050
Brachycentrus americanus - L	1	8	0.025
Diptera (True flies)			
Tipulidae - L	1	2	trace
Antocha saxicola - L	1	3	trace
Dicranota sp. - L	1	3	trace
Rhaphidolabis sp. - L	1	28	0.200
Simulium venustum - P	1	1	trace
Chironomidae sp. 1 - L	1	8	trace
sp. 3 - L	1	1	trace
sp. 4 - L	1	3	trace
sp. 5 - L	1	1	trace
sp. 6 - L	1	23	trace
sp. 7 - P	1	1	trace
sp. 8 - L	1	1	trace
Ceratopogonidae - L	1	17	trace
Anthomyiidae - L	1	1	trace
Hydracarina (Water mites)	1	17	trace
Traces Combined			0.125
Totals	34	804	3.300 cc.

Table 5. Square-foot bottom sample off end of Structure No. 5. Bottom, sand supporting beds of *Veronica connata* and *Vallisneria*; water depth, 14 inches; current, swift. October 7, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Platyhelminthes (Flatworms)			
Planaria sp.	1	1	trace
Mollusca (Clams)			
Pisidium sp.	1	22	0.075
Annelida (Worms and leeches)			
Oligochaeta	1	6	0.025
Hirudinea	1	1	trace
Crustacea (Scuds, etc.)			
Gammarus sp.	1	1	0.025
Ephemeroptera (Mayflies)			
Hexagenia occulta - N	1	3	0.125
Baetis brunneicolor - N	1	4	trace
Baetis vagans - N	1	1	trace
Baetis pygmaeus - N	1	3	trace
Paraleptophlebia mollis - N	1	11	trace
Ephemerella invaria - N	1	75	0.125
Odonata (Dragonflies)			
Boyeria vinosa - N	1	2	trace
Cordulegaster maculatus - N	1	2	0.200
Plecoptera (Stoneflies)			
Taeniopteryx nivalis - N	1	4	trace
Capnia manitoba - N	1	1	trace
Isoperla sp. - N	1	18	0.075
Gen. et sp. ? (N, minute)	1	27	trace
Isogenus frontalis - N	1	1	trace
Neuroptera (Alder flies, etc.)			
Sialis sp. - L	1	1	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	21	0.025
Stenelmis sp. - A	1	2	trace
Trichoptera (Caddisflies)			
Hydropsyche sp. 1 - L (*sparna*?)	1	200	1.450
Hydropsyche sp. 2 - L	1	7	0.150
Rhyacophila sp. 1 - L	1	1	trace
Mystrophora sp. - L	1	2	trace
Limnephilidae - L	3	5	0.275
Brachycentrus americanus - L	1	77	0.225

(Continued)

Table 5, continued.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Diptera (True flies)			
Pedicia sp. - L	1	1	trace
Eriocera sp. - L	1	3	trace
Rhaphidolabis sp. - L	1	31	0.075
Simulium venustum - L	1	1	trace
Chironomidae sp. 1 - L	1	1	trace
sp. 2 - L	1	8	trace
sp. 3 - L	1	11	trace
sp. 4 - L	1	7	trace
sp. 5 - L	1	1	trace
sp. 6 - L	1	7	trace
sp. 7 - L	1	4	trace
sp. 8 - L	1	1	trace
sp. ? - P	1	1	trace
Ceratopogonidae - L	1	27	0.025
Chrysops sp. - L	1	3	trace
Arachnida			
Hydracarina (Water mites)	1	38	trace
All Traces Combined			0.525
Totals	45	644	3.400 cc.

Table 6. Square-foot bottom sample in lee of Structure No. 6. Bottom, fine to medium gravel and sand; water depth, 6 inches; current, swift. October 6, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Nemathelminthes			
(Free-living round worms)	1	3	trace
Annelida (Worms and leeches)			
Oligochaeta	1	1	0.025
Hirudinea	1	1	trace
Ephemeroptera (Mayflies)			
Baetis brunneicolor - N	1	1	trace
Baetis sp. - N (very minute)	1	4	trace
Ephemerella invaria - N	1	12	trace
Plecoptera (Stoneflies)			
Capnia manitoba - N	1	8	trace
Isoperla sp. - N	1	4	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	25	0.025
Stenelmis sp. - A	1	1	trace
Trichoptera (Caddisflies)			
Hydropsyche sp. 1 - L	1	33	0.300
Mystrophora sp. - L	1	64	0.150
Mystrophora sp. - P	1	7	0.050
Limnephilidae - L	1	25	0.350
Brachycentrus americanus	1	7	trace
Diptera (True flies)			
Antocha saxicola - L	1	1	trace
Rhaphidolabis sp. - L	1	21	0.100
Tipulidae - L	1	2	trace
Chironomidae sp. 1 - L	1	3	trace
sp. 2 - L	1	3	trace
sp. 3 - L	1	4	trace
sp. 4 - L	1	4	trace
sp. 5 - L	1	2	trace
sp. 8 - L	1	244	trace
Palpomyia sp. - L	1	28	trace
Anthomyiidae - L	1	1	trace
Traces Combined			0.025
Totals	26	509	1.025 cc.

Table 7. Square-foot bottom sample in lee of Structure No. 7. Bottom, medium gravel and sand; water depth, 8 inches; current, swift. October 3, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Nemathelminthes			
(Free-living roundworms)	2	2	trace
Mollusca (Snails and clams)			
Gastropoda	1	1	0.025
Pisidium sp.	1	1	trace
Annelida (Worms and leeches)			
Oligochaeta	1	21	0.300
Hirudinea	1	1	trace
Ephemeroptera (Mayflies)			
Baetis brunneicolor - N	1	3	trace
Baetis sp. - N (very minute)	1	3	trace
Ephemerella invaria - N	1	17	0.025
Plecoptera (Stoneflies)			
Capnia manitoba - N	1	5	trace
Isogenus frontalis - N	1	2	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	54	0.100
Stenelmis sp. - A	1	3	0.025
Trichoptera (Caddisflies)			
Hydropsyche sp. 1 - L	1	75	0.600
Hydropsyche sp. 2 - L	1	4	0.025
Rhyacophila sp. 1 - L	1	1	0.025
Mystrophora sp. - L	1	85	0.050
Mystrophora sp. - P	1	4	trace
Limnephilidae - L	2	13	0.050
Brachycentrus americanus - L	1	12	trace
Diptera (True flies)			
Antocha saxicola - L	1	3	trace
Rhaphidolabis sp. - L	1	11	0.025
Tipula sp. - L	1	1	0.150
Tipulidae - L	1	1	trace
Chironomidae sp. 1 - L	1	1	trace
sp. 2 - L	1	3	trace
sp. 3 - L	1	14	trace
sp. 4 - L	1	5	trace
sp. 5 - L	1	2	trace
sp. 6 - L	1	653	0.025
sp. 7 - L	1	9	trace
sp. 8 - L	1	1	trace
sp. 9 - L	1	3	trace
sp.10 - L	1	1	trace

(Continued)

Table 7, continued.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Diptera (Continued)			
Palpomyia sp. - L	1	24	trace
Anthomyiidae - L	1	2	trace
Chrysops sp. - L	1	1	trace
Hydracarina (Water mites)	1	16	trace
Traces Combined			0.100
Totals	39	1,058	1.525 cc.

Table 8. Square-foot bottom sample in lee of Structure No. 9. Bottom, medium gravel and sand; water depth, 14 inches; current, swift. October 1, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Nemathelminthes			
(Free-living roundworms)	1	2	trace
Annelida (Worms)			
Oligochaeta	1	1	0.025
Crustacea (Scuds, etc.)			
Gammarus sp.	1	1	0.025
Ephemeroptera (Mayflies)			
Baetis brunneicolor - N	1	2	0.025
Ephemerella invaria - N	1	2	trace
Plecoptera (Stoneflies)			
Isoperla sp. - N	1	2	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	9	trace
Trichoptera (Caddisflies)			
Hydroptilidae - L	1	1	trace
Hydropsyche sp. 1 - L	1	1	trace
Rhyacophila sp. 1 - L	1	1	trace
Mystrophora sp. - L	1	3	trace
Limnephilidae - L	2	4	0.025
Brachycentrus americanus - L	1	3	trace
Diptera (True flies)			
Eriocera sp. - L	1	2	0.025
Rhaphidolabis sp. - L	1	24	0.125
Tipulidae - L	1	6	trace
Chironomidae sp. 3 - L	1	2	trace
sp. 5 - L	1	2	trace
sp. 6 - L	1	216	trace
sp. 7 - L	1	18	trace
sp. 9 - L	1	1	trace
sp.11 - L	1	1	trace
Palpomyia sp. - L	1	22	trace
Hydracarina (Water mites)	1	5	trace
Traces Combined			0.050
Totals	25	331	0.300 cc.

Table 9. Square-foot bottom sample in lee of Structure No. 10. Bottom, silt with a trace of sand; water depth, 11 inches; current, slow. September 30, 1941.

ORGANISMS	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Worms and leeches)			
Oligochaeta (Tubificidae)	1	175	0.500
Hirudinea	1	1	0.075
Mollusca (Snails and clams)			
Gastropoda	1	2	trace
Pisidium sp.	1	64	0.900
Ephemeroptera (Mayflies)			
Hexagenia occulta - N	1	14	1.200
Baetis cingulatus - N	1	3	trace
Trichoptera (Caddisflies)			
Molanna sp. - L	1	1	trace
Diptera (True flies)			
Eriocera sp. - L	1	2	trace
Limnophila sp. - L	1	1	trace
Chironomidae sp. 1 - L	1	10	trace
sp. 4 - L	1	29	trace
sp. 5 - L	1	6	trace
sp. 8 - L	1	34	0.050
sp.12 - L	1	2	trace
sp.13 - L	1	1	trace
sp. ? - P	1	4	trace
Palpomyia sp. - L	1	26	trace
Hydracarina (Water mites)	1	1	trace
Traces Combined			0.150
Totals	18	376	2.875 cc.

Table 10. Square-foot bottom sample in lee of Structure No. 11. Bottom, fine gravel and sand; water depth, 4 inches; current, swift. September 29, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Platyhelminthes (Flatworms)			
Planaria sp.	1	1	trace
Annelida (Worms)			
Tubificidae	1	1	trace
Lumbriculidae	1	10	0.450
Ephemeroptera (Mayflies)			
Ephemerella bicolor - N	1	1	trace
Ephemerella invaria - N	1	1	trace
Plecoptera (Stoneflies)			
Capnia manitoba - N	1	3	trace
Isogenus frontalis - N	1	2	0.025
Coleoptera (Beetles)			
Stenelmis sp. - L	1	16	0.025
Trichoptera (Caddisflies)			
Hydropsyche sp. 1 - L	1	3	trace
Mystrophora sp. - L	1	61	0.100
Mystrophora sp. - P	1	4	0.025
Limnephilidae - L	1	6	0.025
Diptera (True flies)			
Antocha saxicola - L	1	1	trace
Eriocera sp. - L	1	2	trace
Rhaphidolabis sp. - L	1	17	0.050
Tipulidae - L	1	8	trace
Chironomidae - sp. 1 - L	1	1	trace
sp. 3 - L	1	7	trace
sp. 5 - L	1	2	trace
sp. 7 - L	1	4	trace
sp. 8 - L	1	194	trace
sp.10 - L	1	3	trace
sp.14 - L	1	1	trace
Palpomyia sp. - L	1	9	trace
Traces Combined			0.025
Totals	24	358	0.725 cc.

Table 11. Square-foot bottom sample off end of Structure No. 12. Bottom, silt over sand with some organic debris, supporting a growth of round-leaf Potamogeton; water depth, 7 inches; current, moderate. September 26, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Worms and leeches)			
Tubificidae	1	107	0.275
Lumbriculidae	1	3	trace
Hirudinea	1	1	0.050
Mollusca (Clams)			
Pisidium sp.	1	60	0.450
Crustacea (Scuds, etc.)			
Gammarus sp.	1	9	0.100
Hyalella sp.	1	1	trace
Ephemeroptera (Mayflies)			
Paraleptophlebia mollis - N	1	1	trace
Baetis brunneicolor - N	1	1	trace
Plecoptera (Stoneflies)			
Capnia manitoba - N	1	1	trace
Isoperla sp. - N	1	1	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	1	trace
Trichoptera (Caddisflies)			
Hydropsyche sp. 1 - L	1	1	trace
Rhyacophila sp. 1 - L	1	1	0.025
Molannidae - L	1	5	trace
Limnephilidae - L	1	5	trace
Diptera (True flies)			
Limnophila sp. - L	1	1	trace
Rhaphidolabis sp. - L	1	4	0.025
Chironomidae sp. 2 - L	1	126	trace
sp. 8 - L	1	2	trace
sp. 9 - L	1	1	trace
sp.10 - L	1	2	trace
sp.15 - L	1	1	trace
sp.16 - L	1	1	trace
Palpomyia sp. - L	1	14	trace
Anthomyiidae - L	1	1	trace
Traces Combined			0.025
Totals	25	351	0.950 cc.

Table 12. Square-foot bottom sample in lee of Structure No. 13. Bottom, sand and fine gravel; water depth, 2 inches; current, moderate. September 24, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Gordiacea			
Polygordius sp.	1	1	0.050
Nemethelminthes			
(Free-living roundworms)	1	1	trace
Annelida (Worms and leeches)			
Oligochaeta	2	11	0.200
Hirudinea	1	1	trace
Ephemeroptera (Mayflies)			
Paraleptophlebia mollis - N	1	1	trace
Ephemerella invaria - N	1	17	trace
Baetis brunneicolor - N	1	32	0.050
Baetis cingulatus - N	1	1	trace
Baetis pygmaeus - N	1	1	trace
Baetis vagans - N	1	10	trace
Baetis sp. - N (very minute)	1	21	trace
Plecoptera (Stoneflies)			
Capnia manitoba - N	1	10	trace
Isogenus frontalis - N	1	6	0.050
Acroneuria sp. - N	1	1	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	70	0.150
Stenelmis sp. - A	1	8	0.025
Trichoptera (Caddisflies)			
Hydroptilidae - L	1	1	trace
Hydropsyche sp. 1 - L	1	9	0.125
Hydropsyche sp. 2 - L	1	50	0.325
Chimarrha aterrima - L	1	1	trace
Rhyacophila sp. 1 - L	1	6	0.050
Mystrophora sp. - L	1	110	0.125
Mystrophora sp. - P	1	5	0.050
Brachycentrus americanus - L	1	10	0.025
Diptera (True flies)			
Antocha saxicola - L	1	4	trace
Eriocera sp. - L	1	1	trace
Dicranota sp. - L	1	4	trace
Rhaphidolabis sp. - L	1	15	0.075
Tipulidae - L	1	7	trace
Chironomidae sp. 1 - L	1	12	trace
sp. 3 - L	1	35	trace
sp. 4 - L	1	9	trace
sp. 5 - L	1	4	trace
sp. 7 - L	1	1	trace
sp. 8 - L	1	33	trace
sp.10 - L	1	1	trace

(Continued)

Table 12, continued.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Diptera (Continued)			
Palpomyia sp. - L	1	26	0.025
Simulium venustum - L	1	3	trace
Hydracarina (Water mites)	1	16	trace
Traces Combined			0.275
Totals	40	555	1.600 cc.

Table 13. Square-foot bottom sample in lee of Structure No. 14. Bottom, fine gravel and sand; water depth, 8 inches; current, medium. September 23, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Nemathelminthes (Roundworms)	1	3	trace
Ephemeroptera (Mayflies)			
Paraleptophlebia mollis - N	1	3	trace
Ephemerella invaria - N	1	2	trace
Baetis brunneicolor - N	1	1	trace
Plecoptera (Stoneflies)			
Nemoura sp. - N	1	4	trace
Isogenus frontalis - N	1	2	0.050
Coleoptera (Beetles)			
Stenelmis sp. - L	1	9	trace
Stenelmis sp. - A	1	2	trace
Trichoptera (Caddisflies)			
Rhyacophila sp. - L	1	1	trace
Mystrophora sp. - L	1	9	trace
Chimarrha aterrima - L	1	1	trace
Hydropsyche sp. - L	1	5	0.050
Brachycentrus americanus - L	1	2	trace
Diptera (True flies)			
Tipulidae - L	1	3	trace
Eriocera sp. - L	1	1	trace
Dicranota sp. - L	1	1	trace
Rhaphidolabis sp. - L	1	9	0.025
Chironomidae sp. 1 - L	1	10	trace
sp. 2 - L	1	3	trace
Ceratopogonidae - L	1	17	trace
Traces Combined			0.100
Totals	20	88	0.225 cc.

Table 14. Square-foot bottom sample in lee of Structure No. 16. Bottom, fine gravel; water depth, 2 inches; current, slow. September 23, 1942.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Worms and leeches)			
Oligochaeta	1	1	0.025
Hirudinea	1	4	0.025
Mollusca (Snails and clams)			
Gastropoda	1	3	0.025
Pisidium sp.	1	5	0.050
Crustacea (Scuds)			
Hyalella sp.	1	16	0.025
Ephemeroptera (Mayflies)			
Ephemerella invaria - N	1	1	trace
Odonata (Dragonflies)			
Cordulegaster maculatus - N	1	2	0.125
Plecoptera (Stoneflies)			
Capnia manitoba - N	1	43	0.025
Nemoura sp. - N	1	1	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	13	0.025
Stenelmis sp. - A	1	2	0.050
Trichoptera (Caddisflies)			
Mystrophora sp. - L	1	32	0.050
Mystrophora sp. - P	1	2	trace
Limnephilidae - L	3	4	0.050
Limnephilidae - P	1	1	trace
Diptera (True flies)			
Rhaphidolabis sp. - L	1	1	trace
Chironomidae sp. 5 - L	1	1	trace
sp. 6 - L	1	12	trace
sp. 8 - L	1	9	trace
Ceratopogonidae - L	1	4	trace
Chrysops sp. - L	1	1	trace
Traces Combined			0.025
Totals	23	158	0.500 cc.

Table 15. Square-foot bottom sample in lee of Structure No. 17. Bottom, sand and detritus with some algal growth; water depth, 10 inches; current, medium. September 22, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Worms and leeches)			
Oligochaeta	1	7	0.100
Hirudinea	1	1	0.025
Mollusca (Clams)			
Pisidium sp.	1	3	0.200
Crustacea (Scuds)			
Gammarus sp.	1	1	0.025
Ephemeroptera (Mayflies)			
Paraleptophlebia mollis - N	1	4	trace
Ephemerella invaria - N	1	2	trace
Baetis brunneicolor - N	1	15	0.050
Baetis vagans - N	1	3	trace
Odonata (Dragonflies)			
Boyeria vinosa - N	1	1	0.050
Plecoptera (Stoneflies)			
Nemoura sp. - N	1	1	trace
Isogenus frontalis - N	1	4	0.050
Coleoptera (Beetles)			
Stenelmis sp. - L	1	15	trace
Trichoptera (Caddisflies)			
Rhyacophila sp. - L	1	1	trace
Mystrophora sp. - L	1	1	trace
Chimarrha aterrima - L	1	2	0.025
Hydropsyche sp. - L	1	18	0.200
Limnephilidae - L	1	1	trace
Brachycentrus americanus - L	1	5	trace
Diptera (True flies)			
Tipula abdominalis - L	1	1	0.400
Tipula sp. - L	1	1	0.125
Tipulidae - L	1	9	trace
Rhaphidolabis sp. - L	1	16	0.100
Eriocera sp. - L	1	7	0.025
Dicranota sp. - L	1	1	trace
Simulium venustum - L	1	2	trace

(Continued)

Table 15, continued.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Diptera (Continued)			
Chironomidae sp. 1 - L	1	3	trace
sp. 2 - L	1	1	trace
sp. 3 - L	1	1	trace
sp. 4 - L	1	7	trace
sp. 5 - L	1	1	trace
sp. 6 - L	1	1	trace
sp. 7 - L	1	2	trace
sp. 8 - L	1	1	trace
sp. 9 - L	1	47	trace
sp.10 - L	1	41	trace
sp.11 - L	1	2	trace
Ceratopogonidae - L	1	35	trace
Anthomyiidae - L	1	1	trace
Hydracarina (Water mites)	1	8	trace
Traces Combined			0.125
Totals	39	273	1.500 cc.

Table 16. Square-foot bottom sample in lee of Structure No. 18. Bottom, sand and fine gravel; water depth, 8 to 10 inches; current, medium. September 20, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Worms)			
Oligochaeta	1	4	0.100
Mollusca (Clams)			
Pisidium sp.	1	3	0.050
Crustacea (Scuds)			
Gammarus sp.	1	1	0.025
Ephemeroptera (Mayflies)			
Ephemerella invaria - N	1	1	trace
Baetis brunneicolor - N	1	9	0.050
Baetis vagans - N	1	5	0.025
Plecoptera (Stoneflies)			
Isogenus frontalis - N	1	3	0.075
Coleoptera (Beetles)			
Stenelmis sp. - L	1	7	trace
Trichoptera (Caddisflies)			
Rhyacophila sp. - L	1	1	trace
Mystrophora sp. - L	1	40	0.050
Mystrophora sp. - P	1	4	0.025
Hydropsyche sp. - L	1	10	0.075
Brachycentrus americanus	1	1	trace
Diptera (True flies)			
Rhaphidolabis sp. - L	1	17	0.050
Tipula sp. - L	1	1	0.300
Tipulidae - L	1	12	trace
Simulium venustum - L	1	1	trace
Chironomidae - L	3	6	trace
Ceratopogonidae - L	1	22	trace
Tabanus sp. - L	1	1	0.025
Hydracarina (Water mites)	1	2	trace
Totals	23	151	0.850 cc.

Table 17. Square-foot bottom sample in lee of Structure No. 19. Bottom, sand with detritus; water depth, 5 inches; current, sluggish. September 19, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Nemathelminthes (Roundworms)	1	1	trace
Annelida (Earthworms)			
Oligochaeta	1	3	0.025
Crustacea (Scuds)			
Gammarus sp.	1	3	0.050
Hyalella sp.	1	2	0.025
Ephemeroptera (Mayflies)			
Paraleptophlebia mollis - N	1	10	0.025
Ephemerella invaria - N	1	11	trace
Baetis brunneicolor - N	1	23	0.025
Baetis vagans - N	1	9	trace
Baetis sp. (minute) - N	1	4	trace
Plecoptera (Stoneflies)			
Allocapnia torontoensis - N	1	1	trace
Leuctra sp. - N	1	1	trace
Isoperla ventralis - N	1	1	trace
Isogenus frontalis - N	1	7	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	6	trace
Trichoptera (Caddisflies)			
Rhyacophila sp. 1 - L	1	6	0.050
Mystrophora sp. - L	1	10	trace
Hydropsyche sp. - L	1	40	0.200
Limnephilidae - L	1	2	0.075
Brachycentrus americanus	1	11	0.025
Diptera (True flies)			
Antocha saxicola - L	1	2	trace
Rhaphidolabis sp. - L	1	10	0.050
Tipulidae - L	1	14	trace
Simulium venustum - L	1	17	0.025
Simulium venustum - P	1	1	trace
Chironomidae - L	2	49	0.025
Ceratopogonidae - L	1	11	trace
Hydracarina (Water mites)	1	5	trace
Traces Combined			0.025
Totals	28	260	0.650 cc.

Table 18. Square-foot bottom sample off end of Structure No. 20. Bottom, fine and medium gravel; water depth, 10 inches; current, swift. September 19, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Earthworms)			
Oligochaeta	1	1	0.025
Ephemeroptera (Mayflies)			
Paraleptophlebia mollis - N	1	1	trace
Ephemerella invaria - N	1	1	trace
Baetis brunneicolor - N	1	2	trace
Baetis vagans - N	1	2	trace
Baetis sp. (minute) - N	1	3	trace
Plecoptera (Stoneflies)			
Capnia manitoba - N	1	1	trace
Isogenus frontalis - N	1	1	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	3	trace
Trichoptera (Caddisflies)			
Rhyacophila sp. 1 - L	1	1	trace
Mystrophora sp. - L	1	162	0.150
Mystrophora sp. - P	1	2	0.050
Diptera (True flies)			
Rhaphidolabis sp. - L	1	6	0.050
Tipulidae - L	1	2	trace
Chironomidae - L	3	18	trace
Ceratopogonidae - L	1	7	trace
Hydracarina (Water mites)	1	6	trace
Traces Combined			0.025
Totals	19	219	0.300 cc.

Table 19. Square-foot bottom sample in lee of Structure No. 21. Bottom, fine shifting sand and detritus; water depth, 10 to 12 inches; current, medium. September 18, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Earthworms)			
Oligochaeta	1	4	0.200
Ephemeroptera (Mayflies)			
Paraleptophlebia mollis - N	1	4	trace
Ephemerella invaria - N	1	2	trace
Baetis brunneicolor - N	1	2	trace
Baetis vagans - N	1	3	trace
Odonata (Dragonflies)			
Cordulegaster maculatus - N	1	1	0.600
Coleoptera (Beetles)			
Stenelmis sp. - L	1	2	trace
Stenelmis sp. - A	1	1	trace
Trichoptera (Caddisflies)			
Rhyacophila sp. 1 - L	1	1	trace
Mystrophora sp. - L	1	10	0.025
Mystrophora sp. - P	1	2	0.050
Hydropsyche sp. - L	1	3	0.050
Brachycentrus americanus - L	1	7	trace
Diptera (True flies)			
Antocha saxicola - L	1	2	trace
Rhaphidolabis sp. - L	1	21	0.050
Tipulidae - L	1	16	0.050
Chironomidae - L	3	46	0.025
Ceratopogonidae - L	1	21	trace
Hydracarina (Water mites)	1	4	trace
Traces Combined			0.100
Totals	21	152	1.150 cc.

Table 20. Square-foot bottom sample off end of Structure No. 23. Bottom, sand and medium gravel; water depth, 12 inches; current, very swift. September 17, 1941.

ORGANISM	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
Annelida (Earthworms)			
Oligochaeta	1	2	trace
Ephemeroptera (Mayflies)			
Baetis brunneicolor - N	1	8	trace
Plecoptera (Stoneflies)			
Isogenus frontalis - N	1	1	trace
Coleoptera (Beetles)			
Stenelmis sp. - L	1	4	trace
Trichoptera (Caddisflies)			
Rhyacophila sp. - L	1	4	trace
Mystrophora sp. - L	1	137	0.200
Mystrophora sp. - P	1	5	trace
Hydropsyche sp. - L	1	11	0.100
Brachycentrus americanus - L	1	5	trace
Diptera (True flies)			
Rhaphidolabis sp. - L	1	5	trace
Chironomidae - L	2	9	trace
Ceratopogonidae - L	1	3	trace
Traces Combined			0.100
Totals	13	194	0.400 cc.

Table 21. Species list of organisms encountered in Section B bottom samples taken September 17 to October 15, 1941, showing frequency of occurrence of each species in the series of 20 samples. Group totals in parentheses.

ORGANISM	NUMBER OF SAMPLES WITH ORGANISM
Platyhelminthes (Flatworms)	(2)
Nemathelminthes (Roundworms)	(6)
Annelida (Aq. Earthworms)	(19)
Tubificidae	3
Lumbriculidae	17
Hirudinea (Leeches)	10
Mollusca (Snails and clams)	(8)
Gastropoda	3
Pisidium sp.	8
Crustacea (Scuds)	(7)
Gammarus sp.	6
Hyalella sp.	3
Ephemeroptera (Mayflies)	(20)
Hexagenia occulta	2
Stenonema rivulicolum	1
Rhithrogena sp.	2
Paraleptophlebia mollis	11
Ephemerella bicolor	1
Ephemerella invaria	17
Baetis brunneicolor	14
Baetis cingulatus	2
Baetis pygmaeus	2
Baetis vagans	7
Baetis sp.	6
Odonata (Dragonflies)	(4)
Boyeria vinosa	2
Cordulegaster maculatus	3
Plecoptera (Stoneflies)	(18)
Taeniopteryx nivalis	2
Capnia manitoba	11
Allocapnia torontoensis	1
Leuctra sp.	1
Nemoura sp.	3
Isoperla ventralis	1
Isoperla sp.	7
Acroneuria sp.	1
Isogenus frontalis	11
Neuroptera (Alder flies)	(1)
Sialis sp.	1
Coleoptera (Beetles)	(19)
Stenelmis sp.	19
Trichoptera (Caddisflies)	(20)
Hydroptilidae	2
Rhyacophila sp. 1	12
Rhyacophila sp. 2	2
Mystrophora americana	18
Chimarrha aterrima	3
Hydropsyche sp. 1	17
Hydropsyche sp. 2	4
Molanna sp.	2
Limnephilidae (3 spp.)	13
Brachycentrus americanus	17
Diptera (True flies)	(20)
Tipulidae sp. A	15
Tipula abdominalis	1
Tipula sp.	4
Antocha saxicola	8
Dicranota sp.	4
Eriocera sp.	8
Rhaphidolabis sp.	20
Pedicia sp.	1
Limnophila sp.	1
Simulium venustum	6
Chironomidae, sp. 1	16
sp. 2	13
sp. 3	14
sp. 4	10
sp. 5	11
sp. 6	9
sp. 7	7
sp. 8	10
sp. 9	4
sp.10	5
sp.11	2
sp.12	1
sp.13	1
sp.14	1
sp.15	1
sp.16	1
Ceratopogonidae	18
Anthomyiidae	5
Tabanus sp.	3
Chrysops sp.	1
Hydracarina (Water mites)	(13)
Gordiacea	(1)

Table 22. Numerical and volumetric ranking of major groups of organisms represented in 20 square-foot stream bottom samples taken from Hunt Creek Section B, September 17 to October 15, 1941. Listing is in order of volumetric importance.

ORGANISM	PERCENTAGE OF TOTAL NUMBER OF ORGANISMS	PERCENTAGE OF TOTAL VOLUME OF ORGANISMS
Trichoptera (Caddisflies)	30.53	36.82
Annelida (Aquatic earthworms and leeches)	5.40	16.71
Diptera (Midges, craneflies, etc.)	44.02	12.61
Traces combined [1]	...	8.10
Ephemeroptera (Mayflies)	6.45	7.70
Mollusca (Snails and clams)	2.20	7.30
Odonata (Dragonflies)	0.10	4.00
Coleoptera (Marl beetles)	5.63	3.07
Plecoptera (Stoneflies)	3.40	2.15
Crustacea (Scuds or freshwater shrimp)	0.46	1.24
Gordiacea (Hair worms)	0.01	0.20
Hydracarina (Water mites)	1.62	0.10
Nemathelminthes (Free living roundworms)	0.15	... [2]
Platyhelminthes (Free living flatworms)	0.02	... [2]
Neuroptera (Alder flies, etc.)	0.01	... [2]
Total	100.00	100.00

[1] Made up of various organisms too small for individual volumetric measurement.

[2] Volume less than 0.01 per cent.

Table 23. Comparative figures on bottom fauna production in various Lower Peninsula trout streams. All figures of number and volume are averages. Numbers of species and individuals are shown to the nearest whole number.

STREAM	DATE	NUMBER OF SAMPLES	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS	VOLUME IN CUBIC CENTIMETERS
North Branch of Au Sable	August 21	5	34	2,371	3.661
North Branch of Au Sable	October 31	5	22	2,813	4.860
West Branch of Sturgeon	September 17	16	14	129	0.628
Kinne Creek	November 7	4	20	316	1.694
Hunt Creek, Section C	September 15-21	5	22	388	1.155
HUNT CREEK, SECTION B	Sept. 17-Oct. 15	20	26	382	1.220