Yokley
Gooch
1976

THE EFFECT OF GRAVEL DREDGING ON RESERVOIR PRIMARY PRODUCTION, INVERTEBRATE PRODUCTION AND MUSSEL PRODUCTION

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TABLE OF CONTENTS

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Bill Campbell has represented well the Tennessee Wildlife Resources Agency and kept information moving so deadlines could be met.

As always, my wife Betty not only types and organizes, but understands and helps in every way.

A sincere thanks to all of these from the authors.

LIST OF FIGURES

LIST OF TABLES

Table *Page*

INTRODUCTION

The Tennessee Wildlife Resources Agency has been and now is concerned about the adverse effects of gravel dredging on the biota in the Tennessee River, which continues to be an on-going business in Tennessee. This study was initiated and supported through the cooperative participation of the Tennessee Wildlife Resources Agency and NOAA, National Oceanic and Atmospheric Administration under PL88-309, Project No. 2-245-R.

The objectives of this study have been to find those methods and organisms that reveal best the effects of gravel dredging on the biotic communities. Many macrobenthic organisms were observed and collected. These organisms were collected above and below the gravel dredging to compare their densities. Plankton was collected above and below the dredging to compare densities. Mussels were tagged and placed in areas above and below dredging to compare growth rates. The best methods for measuring effects of gravel dredging obtained from this study were use of tagged mussels as biological monitors and use of a variety of artificial substrates which become colonized with aquatic invertebrates. Growth differences of the mussels and different densities of the aquatic invertebrates above and below the dredging sites have been recorded. A longer study period would validate the effects even better particularly since the gravel dredging is occurring along much of the length of the Tennessee River and each dredged area is different especially in water volume, rate of flow, and depth. The combined effects of all of these dredging operations could be comparable to adding one more feather to the load until a single feather becomes the one which breaks the camel's back. Combining or adding together all of the dredged and disturbed areas in a given period plus the suspended materials moved and those areas affected multiplied by the effect in one area could show a significant effect on the biota. Individual gravel dredging sites may reveal minimal effects in a short study but the total combined effect could be much more noticeable.

LOCATION OF STUDY

The primary study area was located at Tennessee River Mile 174 to 175 above Saltillo, Tennessee at Petticoat Riffle. This stretch of the Tennessee River averages 400 meters in width and 5 to 11 meters in depth except at Petticoat Riffle where the depth is 4 to 5 meters. Petticoat Riffle is approximately 200 meters in length and 150 meters in width (Fig. 1).

The suction gravel dredge picks up all the bottom material which is carried upward and is then sorted to sizes and washed. The undesirable material is returned immediately to the river often leaving the bottom irregular and from one to several meters deeper. The wash water is also returned directly to the river leaving suspended solids in the water for some distance below the dredge depending upon particle size, rate of flow, and depth.

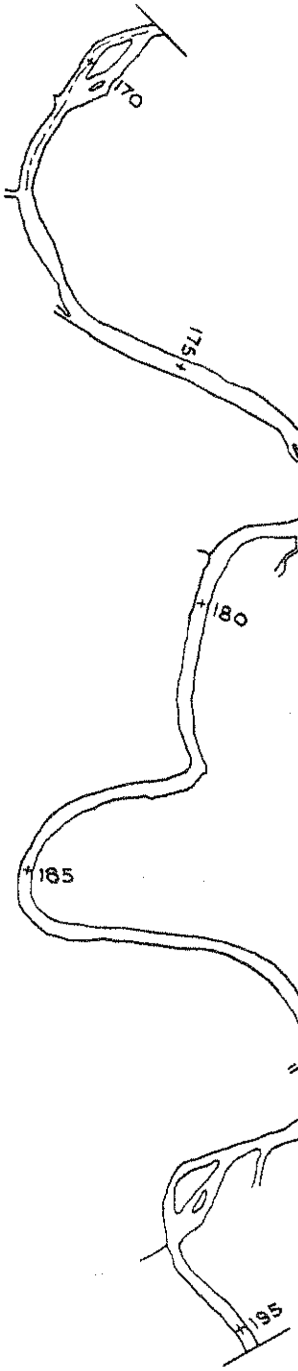

Fig. 1.--Tennessee River Study Area

PROCEDURES

Job number one was a study of the effect of gravel dredging on reservoir benthic organisms. The collecting of benthic organisms was to be done with a Petersen dredge above and below the gravel dredging operation. The samples were to be sufficient random grab samples to determine the normal inhabitants and their densities. After collecting numerous samples it was apparent that the grab samples were very inconsistent containing differing volumes and without the typical organisms known to occur in that particular niche. First hand observations using diving equipment revealed many organisms which dropped from the grab sample while it was being retrieved. Some samples contained tree branches, rocks, or objects which when caught in the sampler prevented it from closing and the entire sample was lost.

Equipment was thus designed for collecting benthos samples that was much more effective and consisted of artificial substrates. These substrates were composed of known surface areas including bricks, pieces of cut marble, and round concrete surfaces designed to fit into glass jars and could be retained along with the organisms colonizing the surfaces. The substrates were held in small hardware cloth baskets and placed above and below the active dredging. After periods of two to three weeks, the substrates were collected by placing the baskets in large plastic bags while they were still on the bottom. These were then carefully brought to the surface and preserved in containers of 5% formalin. Counts of organisms were made occupying the surfaces and these data are noted in Table I.

To relocate the substrates they were attached to floating surface markers. These were clearly labeled but several of the substrates were lost or removed. Either vandalism or curiosity was responsible for some of those lost. The effectiveness of a future study depends upon a secure location for the biological monitors which require time and expense to construct and use.

The organisms which colonized the artificial substrates were counted using a microscope and the numbers of organisms inhabiting the total areas of substrate surface recorded. Separate baskets of substrate surfaces were counted from each station. A sequential comparison index was determined by combining all organisms from a given collection. The organisms were arranged randomly in a straight line. Then, beginning at one end of the row the organisms were counted and if the one being counted differed from the preceding one the record indicated a new "run" had occurred. Therefore, a new run occurs when any organism is different from the preceding one. At the end of the row the number of runs and the total number of organisms are recorded. From these data the diversity index can be calculated. Undisturbed natural communities are assumed to have a high diversity; that is, a relatively large number of species and with no species having disproportionately large numbers of individuals. Usually, low diversity indicates water of low quality (Fig. 2).

The macrobenthos most commonly encountered on the substrates were caddis fly larvae, mayfly nymphs, free-living flatworms, dragon fly nymphs, and occasional hydra. Rarely dipteran larvae and roundworms were noted.

TABLE I--Macrobenthos Densities and Turbidity Measurements

COLLECTING	DIVERSITY INDEX		TOTAL NUMBER OF ORGANISMS IN SAMPLE		SUBSTRATE	DENSITY PER SQUARE INCH		SECCHI READING IN INCHES		MILLIGRAMS PER GALLON SETTLEABLE SOLIDS		
DATES	Above Dredge	Below Dredge	Above Dredge	Below Dredge	TOT. AREA Sq. Inch	Above Dredge	Below Dredge	Above Dredge	Below Dredge	At Surface	3 Meters	Bottom
8-23-75	.467	.687	621	597				49				
7-19-75	.494	.525	882	440	50.52	17.45	8.71	57	46	20 yards below dredge: 200	250	450
6- 5-75								45	45			
6-21-75								60	56			
6-14-75								50				
8- 9-75	.615	.633	1140	196	Above:409 Below:369	2.78	.53	53				
7- 6-75								50	50			

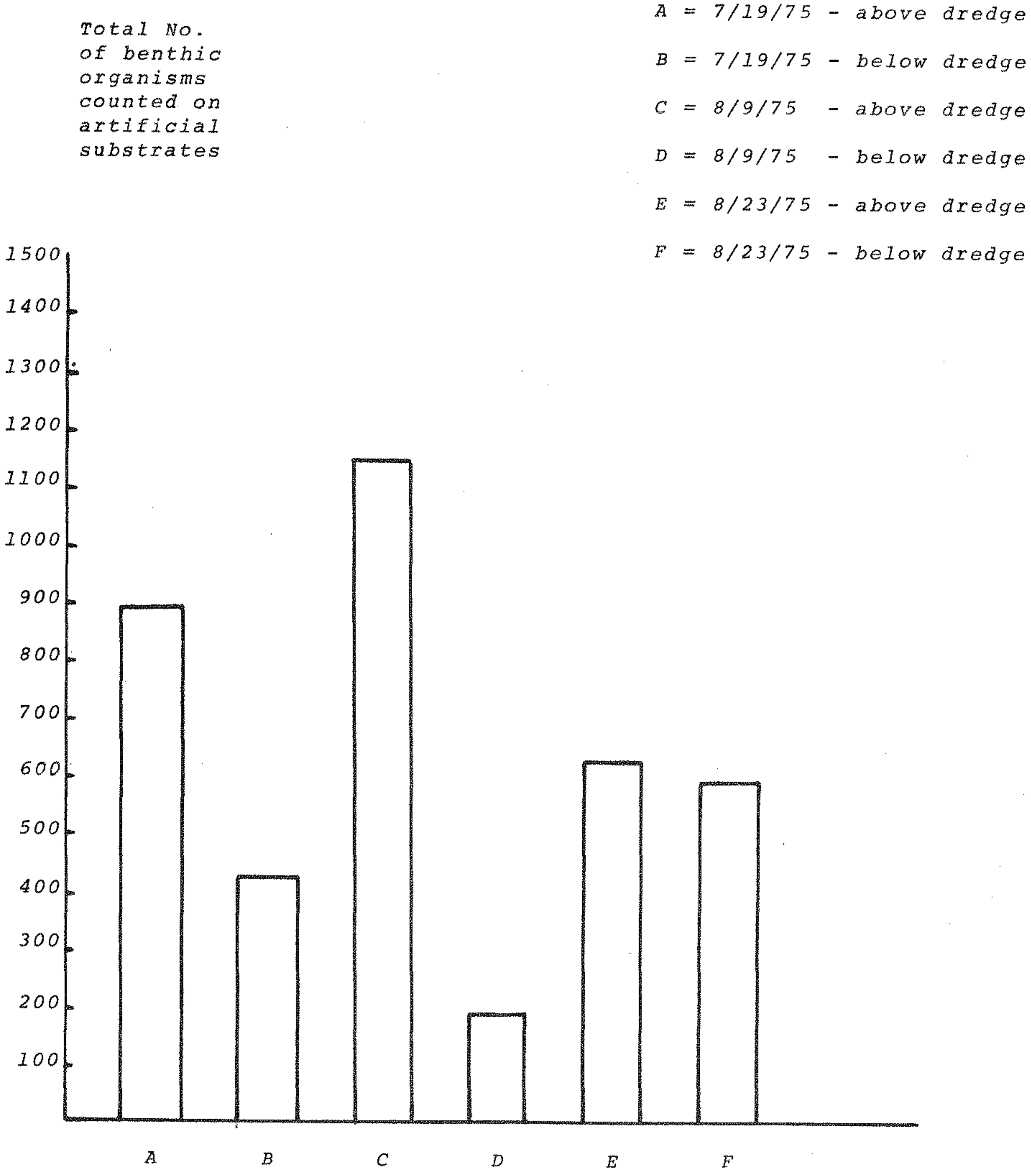
Total No. of benthic organisms counted on artificial substrates
A = 7/19/75 - above dredge
B = 7/19/75 - below dredge
C = 8/9/75 - above dredge
D = 8/9/75 - below dredge
E = 8/23/75 - above dredge
F = 8/23/75 - below dredge
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
A
B
C
D
E
F

Fig. 2.

The second job was to study the effect of gravel dredging on populations of freshwater mussels. Mussels were identified, aged, weighed, measured and marked before placement in study locations. Tagging of mussels was accomplished by using a metal template with 25 drill holes in it in rows of 5. The template was placed against the right or left valve and small drill holes made on the shell surface representing numbers. Using both right and left valves for marking surfaces almost 1500 mussels can be marked in one area. Each mussel was weighed in grams, and the length, height and width were measured in millimeters. The age was determined by counting the concentric growth rests. These mussels were returned directly to the river bottom and not placed in holding containers. The location of these tagged mussels was determined by extending a line from a fixed point on the shore to the point out in the river where the mussels were actually placed.

One of the weaknesses of this placement is difficulty in relocating the organisms. Much time is required to measure, weigh, mark and place these mussels in the selected sites and when lost much information is lost. Approximately 500 mussels were used in the analysis of effects of gravel dredging. These mussels were collected from a large population at T.R.M. 170.3 located above Swallow Bluff Island in a clean gravel environment and where the water is relatively shallow and free flowing. The species selected was Fusconaia ebena, which is the most dominant species now in the Tennessee River. It is commercially valuable in the cultured pearl industry. The species depends on the skipjack herring which is its host fish during the very young parasitic stages of its existence. A minimum of eight to twelve years is required for this mussel to grow large enough to be harvested and sold. These mussels may live and continue to grow for twenty or thirty more years in a good environment.

When water quality is good the species F. ebena may grow several times larger at a given age than others in a poor environment. Quality of habitat has a significant effect on growth rates of mussels, therefore the mussels selected were all members of a population in a specific area above Swallow Bluff Island. As Table II and III indicate, the original sizes and weights in age categories were nearly alike.

The mussels were placed in several locations to determine the effect of altered conditions on them. Some were placed in an area immediately behind the dredge where the bottom had been altered by removal of several sizes of gravel. These mussels were gone when a search for them occurred. Some were placed on the bottom at a previously dredged site along Wolfe Island and these had disappeared after one month. A second group of fifty to sixty mussels were placed in that same location and marked again. These were also gone after one month elapsed. Not a single mussel could be located of those marked. Some were placed below the gravel dredge where the bottom had not been altered but where the influence of suspended materials could be measured on the growth of the mussels. These were recovered after one year in this location and their weight and growth changes are recorded in Table III.

Some were placed above the dredge and their location marked by one of the red buoy cans in the river. These were lost however because the red buoy had been moved.

Another group was placed upstream in a habitat not influenced by silt or suspended materials and after one year these were collected, remeasured and reweighed. Their growth changes are recorded in Table II.

The differences in weight increase and growth is significant when compared to the specimens placed below the gravel dredge (Figure 3).

These differences are further magnified when considering the total area of the Tennessee River affected, the total number of mussels in these areas and the life span potential for mussels.

A dredged area loses the beds of mussels that inhabited it. The loose irregular bottom material will not support mussels for several months to years because it tends to shift and settle in position. Also, the assortment of particle sizes is not immediately favorable for mussels especially the first year stages. Since the bottom must first attract fish hosts carrying the larval mussels before the mussels return in large numbers, it may be many years before a lost population of mussels returns to a dredged area. About ten years would be the minimum time and possibly much more time would actually elapse before recovery could occur (Fig. 4).

Mussel beds are largely the result of their host fish concentrating in an area, and as the fish are feeding or spawning the metamorphosed mussels drop from their gills or fins and begin a free-living existence if the bottom is favorable. Then, for five or more years they go unnoticed while growing to about one inch in diameter. Another five years must elapse before they reach harvestable size for the cultured pearl industry. Whatever areas are dredged thus lose their mussel production for at least a decade. This is further amplified by the fact that these spawning areas are continuously being reduced and lost. Therefore, recovery time increases because the removed populations won't have neighboring populations from which the loss can be recruited.

The ability to recover, like the recoil of a stretched rubber band, decreases after each environmental change and extends the potential time for recovery.

TABLE II
Ages, Weights and Annual Growth Rates of Mussels Located Above Gravel Dredging

Species	Original Weight In Grams	Weight Gain in Grams	% Weight Increase After 1 Year	Shell Growth in mm			Age Group	Avg. % Weight Increase By Age Group
				Length	Height	Width		
Fusconaia ebena	83.0	10.5	13	3	3	2	9	19
	63.5	13.5	21	4	3	2	8	19
	69.0	17.5	25	4	3	2	8	19
	81.0	17.0	21	5	2	1	8	19
	65.5	8.5	13	2	2	1	8	19
	71.5	18.0	25	5	5	2	8	19
	90.5	9.0	10	2	2	2	8	19
	78.0	12.0	15	5	3	3	8	19
	80.5	13.5	17	4	4	3	8	19
	58.5	21.5	37	9	5	5	8	19
	70.0	11.5	16	4	3	3	8	19
	125	12.5	10	2	1	1	9	16
	75	13.5	18	3	2	2	9	16
	85.5	9.5	11	4	3	1	9	16
	89.0	16.5	19	3	3	1	9	16
	118	19.5	17	3	4	2	9	16
	89.5	16.5	18	4	4	3	9	16
	73.0	7.5	10	2	1	1	9	16
	96.0	14.5	15	2	2	1	9	16
	64.0	13.5	21	5	3	1	9	16
	85.0	15.0	18	3	2	1	9	16
	89.0	20.5	23	3	2	2	9	16
	78.0	9.5	12	3	2	2	9	16
	131	12.0	9	3	2	2	9	16
	79	27.5	35	6	6	3	9	16
	82	26.0	32	7	4	3	9	16
	113	13.5	12	5	3	1	9	16
	77	15.5	20	6	5	2	9	16
	70	22.0	31	7	5	3	9	16
	164.5	10.5	6	4	2	6	9	16
	88	16.5	19	5	4	2	9	16
	86.5	11.5	13	2	2	2	9	16
	81	11.5	14	3	3	3	9	16
	76	9.0	12	3	3	2	9	16
	89	8.0	9	3	2	1	9	16
	118	14.0	12	2	2	2	9	16
	115*	3.5	3	0	0	0	9	16
	64	12.5	20	3	3	2	9	16
	106	14.0	13	3	3	2	9	16

* Specimen injured when marked by a hole drilled through the shell when tagged.

(TABLE II cont.)

Ages, Weights and Annual Growth Rates of Mussels Located Above Gravel Dredging

Species	Original Weight In Grams	Weight Gain in Grams	% Weight Increase After 1 Year	Shell Growth in mm			Age Group	Avg. % Weight Increase By Age Group
				Length	Height	Width		
Fusconaia	107.5	20.5	19	2	3	2	10	21
ebena	101.5	17.0	17	2	2	2	10	21
	85	17.0	20	4	4	2	10	21
	119	9.5	8	3	2	1	10	21
	88	12.0	14	5	3	2	10	21
	72	12.5	17	4	2	2	10	21
	80	15.0	19	4	4	2	10	21
	96.5	12.5	13	3	2	2	10	21
	89	14.0	16	4	0	2	10	21
	110	10.5	10	3	2	2	10	21
	94.5	13.5	14	2	2	2	10	21
	91	13.5	15	3	3	2	10	21
	73	15.0	21	4	3	2	10	21
	115	16.0	14	2	2	2	10	21
	98	57.5	59	9	7	3	10	21
	79	21.0	27	7	5	3	10	21
	90	22.5	25	6	6	3	10	21
	101.5	15.5	15	6	3	2	10	21
	81	23.0	28	7	5	4	10	21
	74.5	16.5	22	5	4	3	10	21
	73.5	17.5	24	4	9	2	10	21
	67.5	17.5	26	5	5	3	10	21
	89	27.5	31	9	6	3	10	21
	73	12.0	16	5	3	1	10	21
	81	29.0	36	8	5	2	10	21
	79.5	24.0	30	6	4	3	10	21
	79.5	23.5	30	8	4	4	10	21
	74.5	21.5	29	7	6	2	10	21
	77	13.5	18	4	3	2	10	21
	80	10.5	13	3	2	1	10	21
	91	8.0	9	3	2	2	10	21
	84	14.0	17	4	3	2	11	19
	98	15.0	15	3	3	2	11	19
	151	18.5	12	4	3	2	11	19
	98.5	21.5	22	6	4	2	11	19
	86	13.0	15	5	3	2	11	19
	66	15.0	23	6	4	3	11	19
	95	25.0	26	8	5	3	11	19
	76.5	16.5	22	5	4	2	11	19

TABLE III

Ages, Weights and Annual Growth Rates of Mussels Located Below Gravel Dredging

Species	Original Weight in Grams	Weight Gain in Grams	% Weight Increase After 1 Year	Shell Growth in mm			Age Group	Avg. % Weight Increase By Age Group
				Length	Height	Width		
Fusconaia ebena	91.0	8.0	9	3	2	2	8	14
	91.0	11.0	12	2	2	1	8	14
	93.0	12.5	13	3	0	2	8	14
	72.0	9.5	13	2	1	3	8	14
	77.0	10.5	14	2	2	2	8	14
	80.0	12.0	15	3	2	2	8	14
	84.0	12.0	14	3	2	2	8	14
	87.0	16.0	18	3	2	2	8	14
	100.0	15.0	15	3	2	1	8	14
	87.0	13.0	15	2	1	2	8	14
	93.0	14.0	15	2	2	2	8	14
	90.0	12.0	13	3	2	2	8	14
	66.0	10.5	16	3	2	2	8	14
	82.0	11.0	13	2	2	0	9	12
	100.0	12.0	12	2	1	2	9	12
	100.0	13.0	13	2	2	1	9	12
	89.0	15.0	17	2	2	1	9	12
	107.0	9.5	9	3	2	1	9	12
	124.0	8.0	6	2	0	0	9	12
	139.0	8.5	6	1	1	1	9	12
	127.0	9.5	7	1	1	1	9	12
	91.0	9.0	10	2	1	1	9	12
	95.0	8.0	8	2	0	0	9	12
	127.0	6.0	5	2	1	1	9	12
	73.0	13.0	18	2	3	1	9	12
	95.0	25.0	26	6	4	4	9	12
	90.0	10.0	11	2	2	2	9	12
	77.0	11.5	15	3	1	2	9	12
	108.0	8.5	8	2	2	1	9	12
	136.0	8.0	6	3	2	1	9	12
	95.0	15.0	16	3	3	2	9	12
	97.0	13.5	14	2	2	1	9	12
	85.5	14.0	16	2	1	1	9	12
	77.0	12.5	16	1	5	2	9	12
	112.0	18.0	16	2	2	2	9	12
	77.0	12.5	16	3	2	1	9	12
	87.0	14.0	16	2	2	2	9	12
	112.0	16.0	14	3	2	2	9	12
	150.0	5.0	3	1	0	1	9	12
	132.0	13.0	10	3	2	1	9	12

TABLE III (cont.)

Ages, Weights and Annual Growth Rates of Mussels Located Below Gravel Dredging

Species	Original Weight in Grams	Weight Gain in Grams	% Weight Increase After 1 Year	Shell Growth in mm			Age Group	Avg. % Weight Increase By Age Group
				Length	Height	Width		
Fusconaia ebena	79.0	13.5	17	3	2	1	9	12
	97.0	10.0	10	2	1	2	9	12
	106.0	5.0	5	6	0	1	9	12
	74.0	13.0	18	3	2	2	9	12
	110.0	12.0	11	1	2	2	9	12
	89.0	13.5	15	3	3	2	9	12
	100.0	14.0	14	3	2	0	9	12
	99.0	11.0	11	2	1	1	10	14
	90.0	12.5	14	2	2	1	10	14
	77.0	9.0	12	2	1	1	10	14
	109.0	11.5	11	2	1	1	10	14
	138.0	16.0	12	1	1	2	10	14
	112.0	6.5	6	2	1	1	10	14
	115.0	14.0	12	3	1	2	10	14
	91.0	13.0	14	3	1	2	10	14
	112.0	16.0	14	3	2	2	10	14
	110.0	14.0	13	2	1	1	10	14
	90.0	14.5	16	3	2	2	10	14
	105.0	13.0	12	2	2	1	10	14
	105.0	6.5	6	2	2	2	10	14
	87.0	50.0	57	11	6	4	10	14
	111.0	12.5	11	2	2	1	10	14
	120.0	17.0	14	2	2	1	10	14
	94.0	11.0	12	2	1	2	10	14
	102.0	11.0	11	0	1	1	10	14
	157.0	8.0	5	1	1	1	10	14
	98.0	12.0	12	2	2	1	10	14
	97.0	13.0	13	3	2	2	10	14
	85.0	11.0	13	3	1	2	10	14
	94.0	10.0	11	1	0	1	10	14
	116.0	13.0	11	2	2	1	10	14
	109.0	12.0	11	2	1	2	10	14
	88.0	14.5	16	2	1	1	10	14
	97.0	17.0	18	3	2	2	10	14
	93.0	11.0	12	1	1	2	10	14
	110.0	15.5	14	3	1	2	10	14
	107.0	15.0	14	2	2	2	11	12
	115.0	13.0	11	3	2	2	11	12
	132.0	14.0	11	2	1	1	11	12
	102.0	12.5	12	3	2	2	11	12

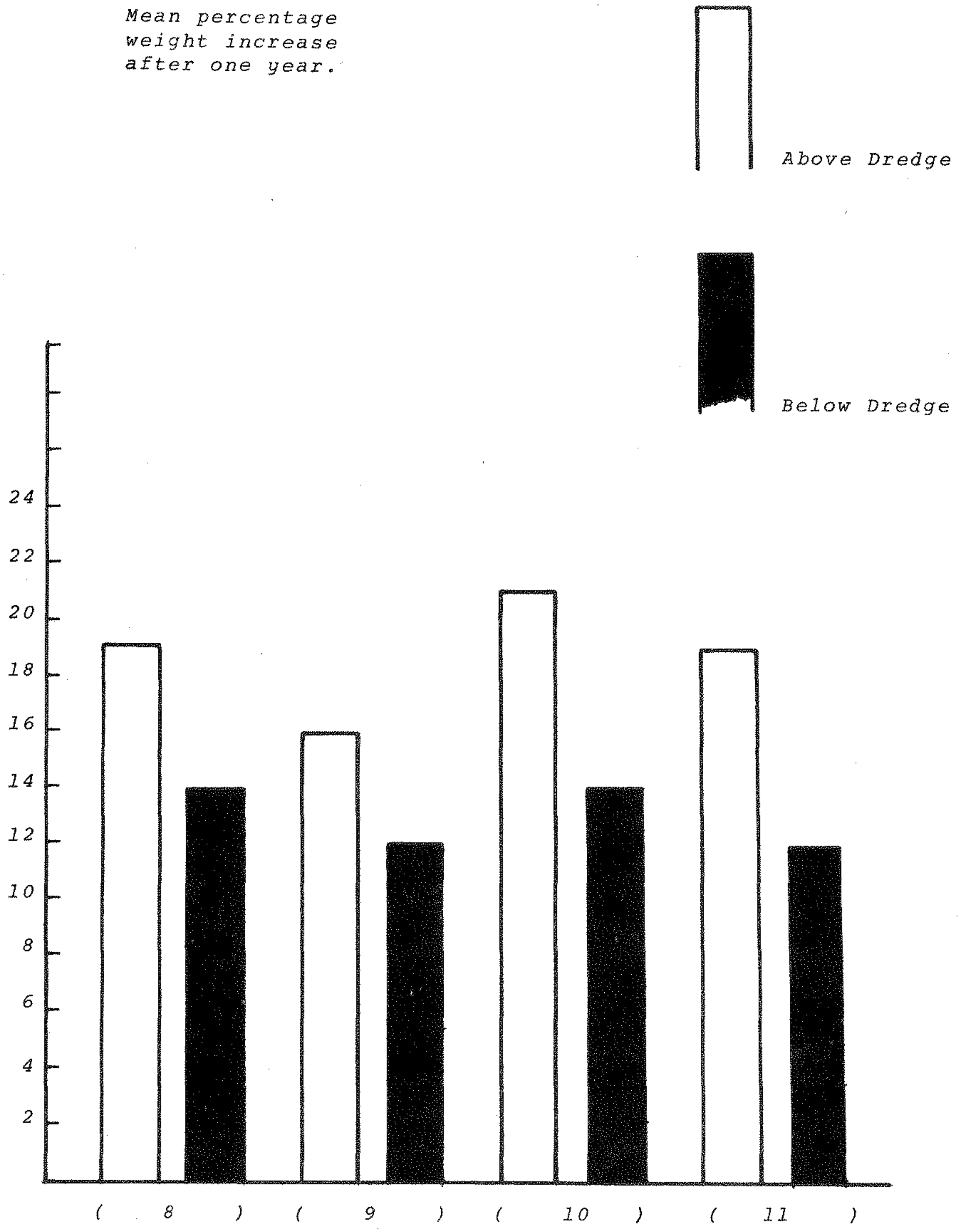
Mean percentage
weight increase
after one year.
Above Dredge
Below Dredge
24
22
20
18
16
14
12
10
8
6
4
2
(8)
(9)
(10)
(11)
Age Group in Years

Fig. 3.

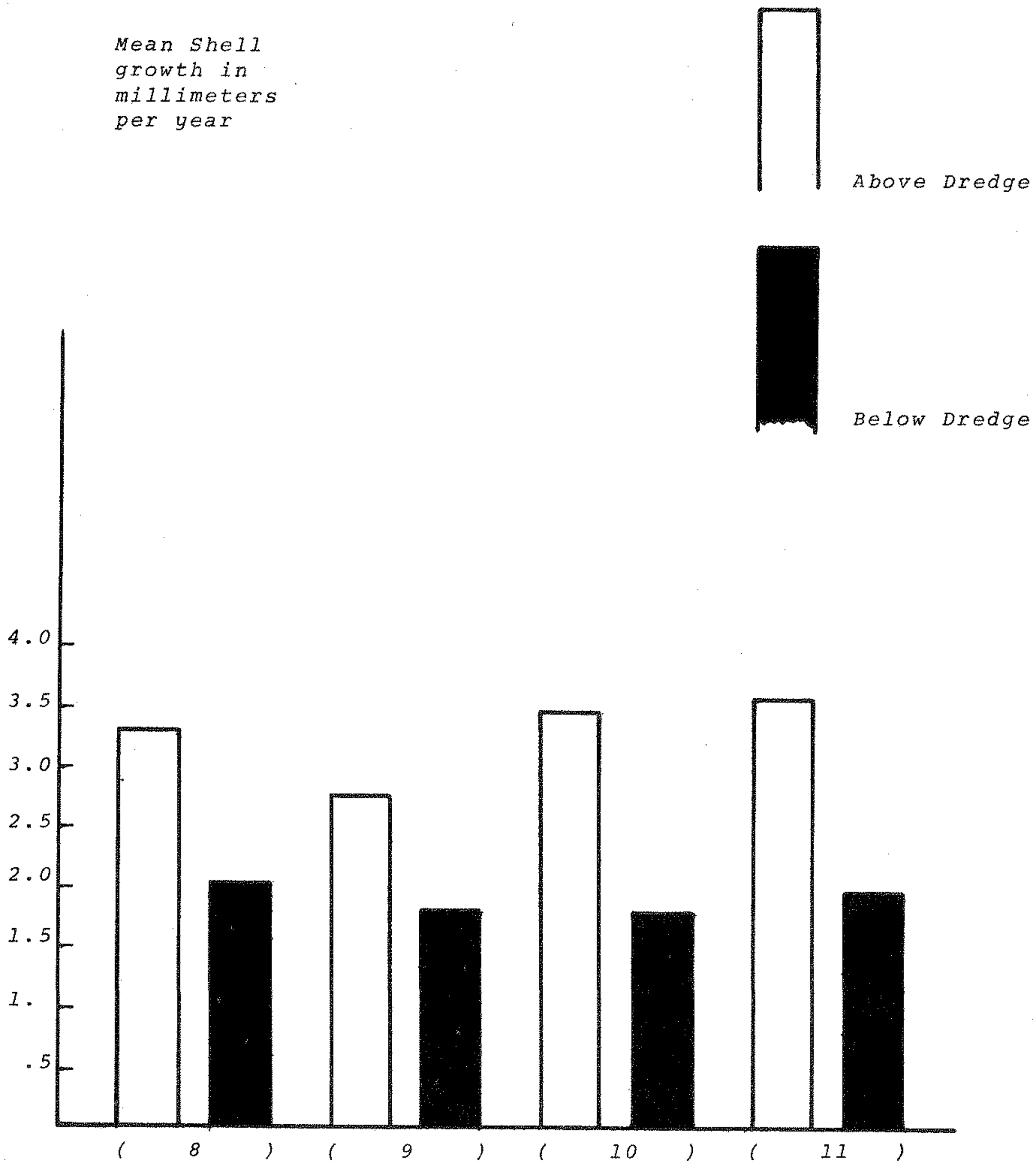
Mean Shell growth in millimeters per year
Above Dredge
Below Dredge
4.0
3.5
3.0
2.5
2.0
1.5
1.
.5
(8)
(9)
(10)
(11)
Age Group in Years

Fig. 4.

The third job was a study of the effects of gravel dredging on reservoir seasonal plankton production. The samples were vertically collected with a Wisconsin plankton net throughout the depth of the sampled area. The sampled sites were located above and below the gravel dredge. In the laboratory the preserved sample was mixed well before an aliquot was withdrawn with a Henson-Stempel pipette. A sample of exactly one milliliter was introduced into a Sedgwick-Rafter counting cell. The count was made using a 10X objective and 10X ocular. Three or more aliquots of each sample were counted to arrive at a mean for that sample.

The volume of water filtered through the sampler was determined by the formula $V= r^2d$ when V equals the water volume, r equals the radius of net mouth, π equals 3.1416 and d equals the depth of sampler at start of vertical haul (total length of course through water).

Table IV represents the results of these data.

Plankton samples and counts have not shown a clear indication of effect of gravel dredging, possibly because plankton is not exposed to buildup of silt and settleable solids (Fig. 5).

The number of organisms per liter was determined by counting the average number of organisms per one milliliter of concentrated sample then multiplying this count by 1000 and dividing this by the concentration factor.

The concentration factor is determined by dividing the volume of lake water filtered by the volume of concentrate.

The three major types of zooplankters counted and used as possible monitors of the effects of gravel dredging are Rotifers, Cladocera and Copepoda. Occasionally other organisms were observed in the counts and the green alga, <u>Pediastrum</u> was counted. Rotifers are probably the single major toxonomic category that is most characteristic of freshwater. Hundreds of species of Rotifers have been described and the attempt here is not to identify the species of Rotifers but to determine their densities in each sample. Cladocera or water fleas are quite large usually between .2 and 3.0 millimeters long. Copepoda like the Cladocera are almost universally distributed in the plankton and large in size ranging from 0.3 to 3.2 millimeters in length.

TABLE IV

OLLECTION		SAMPLE SITE				CLADOCERA		COPEPODA		ROTIFERS		GREEN ALGA (PEDIASTRUM)		
		Above Dredge		Below Dredge										
ATE	TIME	Depth	Ml.conc.	Depth	Ml. conc.	Average Number per Ml. conc.	Average Number per liter lake water	Average Number per Ml. conc.	Average Number per liter lake water	Average Number per Ml. conc.	Average Number per liter lake water	Average Number per Ml. conc.	Average Number per liter lake water	Total Number Organisms per liter lake water
/5/75	2:00	17	180			1.67	1.09	.67	.44	0	0	9	5.9	7.43
/5/75	2:00	25	175			1.67	.722	0	0	0	0	9.3	4.0	4.72
/5/75	2:15	25	175			3.67	1.59	1	.43	.67	.29	9.67	4.18	6.49
/5/75	3:00			25	200	3.0	1.48	.67	.33	1.33	.66	11.0	5.44	7.91
/5/75	3:00			25	175	3.0	1.3	.5	.22	4.75	2.05	14.75	6.38	9.95
/5/75	3:45			25	225	4.0	2.22	.67	.37	3.33	1.85	10.3	5.73	10.17
/2/75	2:00	16	225			2.33	2.02	.33	.286	3.0	2.6	4.33	3.76	8.67
/2/75	2:00	20	275			.67	.57	.67	.57	2.33	1.98	3.67	3.12	6.24
/2/75	2:00			30	200	2.67	1.1	.33	.14	2.33	.96	11.67	4.8	7.0
/6/75	10:15	17	180			3.33	2.18	1.0	.65	10.3	6.74	5.3	3.47	13.04
/6/75	10:20	25	250			3.0	1.85	.33	.20	10.0	6.2	13.0	8.03	16.28
/6/75	10:30			25	250	5.0	3.09	1	.62	11.3	6.98	14.3	8.84	19.53
/19/75	12:00	15	300			4	4.94	1	1.24	4.67	5.77	5	6.18	18.13
/19/75	12:00	15	250			2.33	2.4	.67	.69	5.33	5.49	2.67	2.75	11.33
/19/75	1:00			25	300	2.67	1.98	.33	.24	4.67	3.46	13.67	10.14	15.82
/19/75	1:10			25	260	5	3.2	1	.64	3.67	2.36	12.0	7.71	13.91

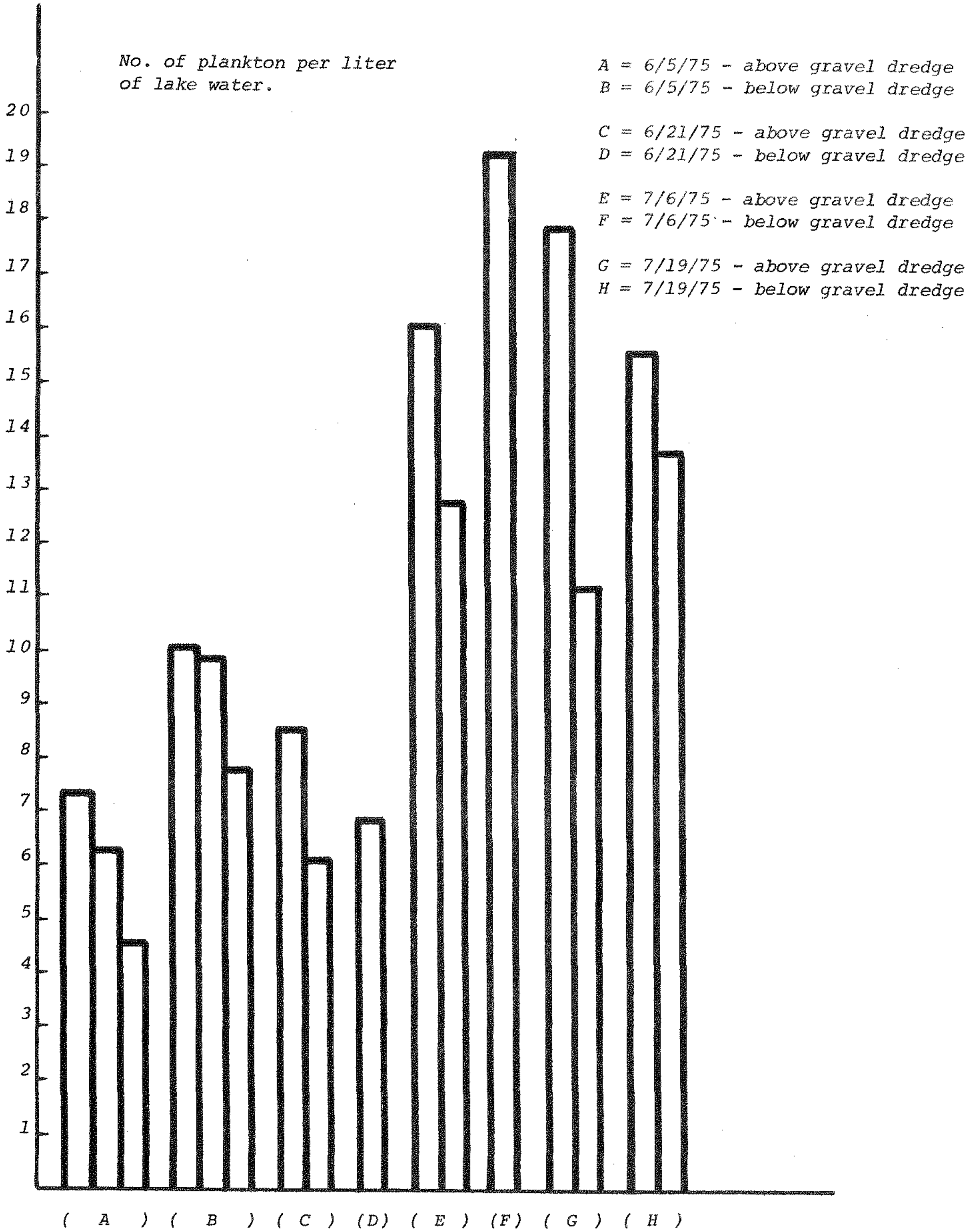
No. of plankton per liter of lake water.
A = 6/5/75 - above gravel dredge
B = 6/5/75 - below gravel dredge
C = 6/21/75 - above gravel dredge
D = 6/21/75 - below gravel dredge
E = 7/6/75 - above gravel dredge
F = 7/6/75 - below gravel dredge
G = 7/19/75 - above gravel dredge
H = 7/19/75 - below gravel dredge
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
(A)
(B)
(C)
(D)
(E)
(F)
(G)
(H)

Fig. 5

CONCLUSION

The resilience of the Tennessee River is not the same along its length nor are the organisms equally capable of bouncing back to their original densities.

Plankton appears to be least affected by the gravel dredging when comparing those organisms studied. The rate of flow of water at T.R.M. 174 is so fast that the suspended material disperses or settles very rapidly and has little effect on plankton densities. Also the fast moving water continually restores the lost plankton almost immediately after it is lost. Recruitment of any lost plankton occurs very quickly.

The macrobenthos, including arthropods, annelids, flatworms, and coelenterates are also quickly replaced from surrounding populations as colonization of artificial substrates indicates, but silt does reduce the densities of these organisms below dredging.

Freshwater mussels are sedentary and have low resilience requiring much longer time to bounce back. Anything which causes the host fish of a mussel species to avoid or leave an area also eliminates the mussels. Many of the fish species that serve as hosts to freshwater mussels are not tolerent to silt. Without the host fish as the vehicle that moves the mussel to a new area it has no resilience.

Mussels have had a prominent historical and economic significance in the Tennessee River. The ecological role of mussels has not been completely evaluated but it is known that the quality of water they inhabit is usually good. Mussels do filter suspended organic matter from the water and improve its quality for fish and other swimming forms. Mussels are natural food for muskrats, some aquatic birds and some fish.

The number of mussel species living in the Tennessee River today is less than half the number recorded fifty years ago. The remaining species are decreasing now even faster based on surveys made in the past few years. When a mussel species disappears the host fish species has probably disappeared and many other organisms now known to be interrelated.

RECOMMENDATIONS

1. Surveys and impact studies should precede any new gravel dredging sites in the Tennessee River and its tributaries. These impact statements should be presented to the state game and fish agencies that the proposals would affect to act as they see fit.

2. Biological monitors ought to be placed above and below gravel dredges in all areas of the Tennessee River to assess the intensity of effect on the biota. Monitoring should occur on a continuing basis to compile data and differences in effect at each dredging site.

Fig. 6.--Abandoned dredge spoils along Wolf Island at T.R.M. 192.

Fig. 7.--Site along Wolf Island where some tagged mussels were placed.

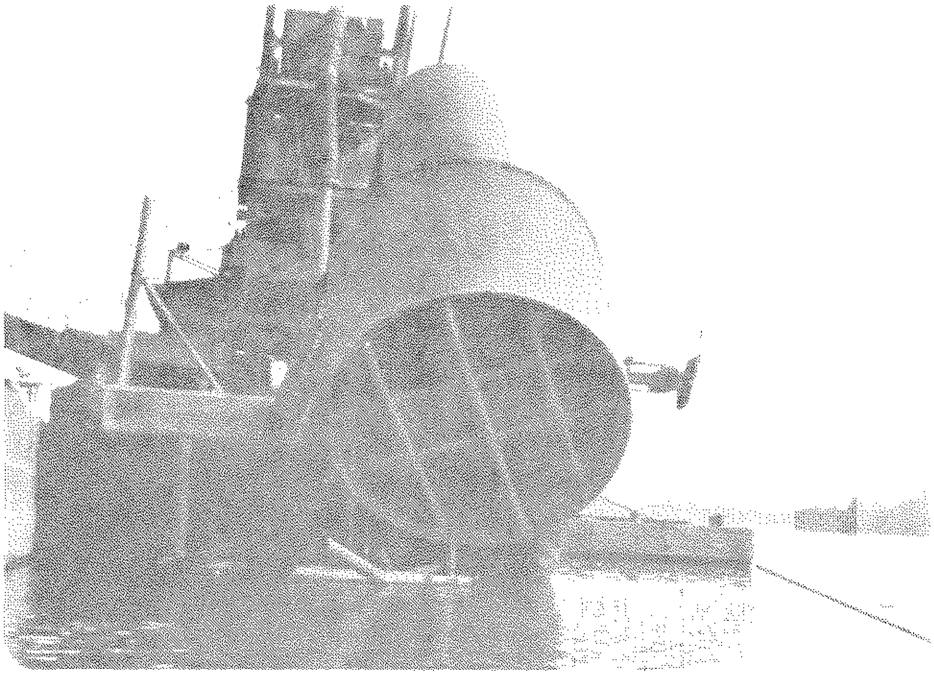

Fig. 8.--Entrance or mouth end of suction dredge.

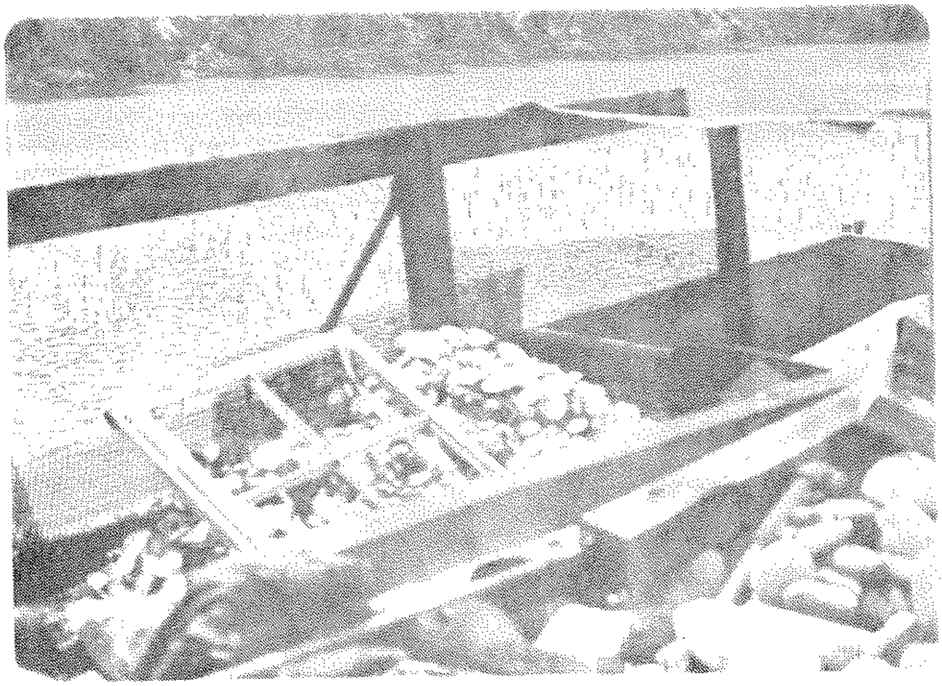

Fig. 9.--An assortment of items collected by the gravel dredge.

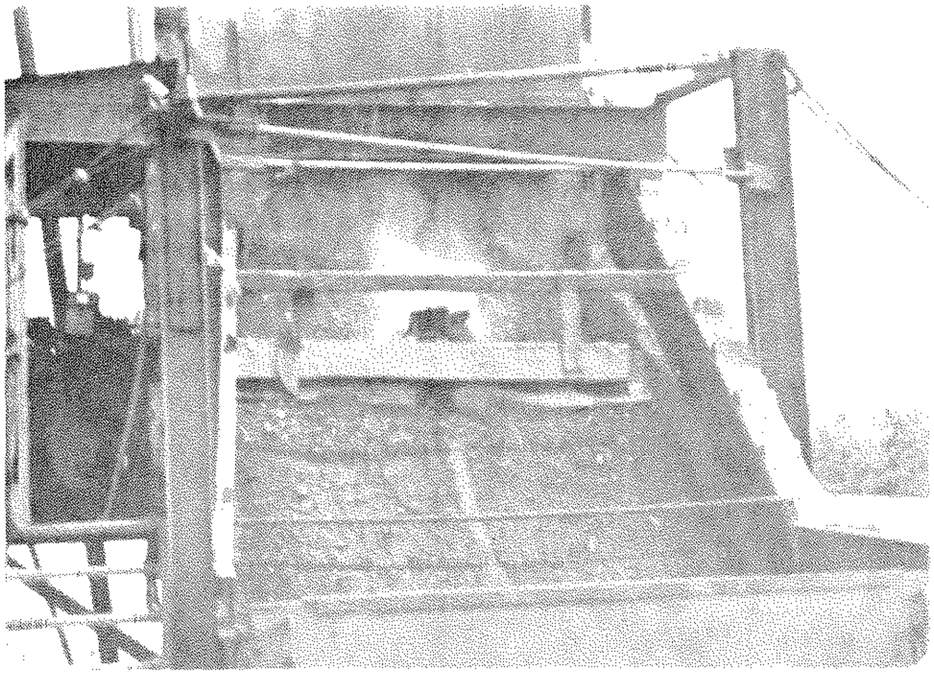

Fig. 10.--As bottom material is sorted it is also washed.

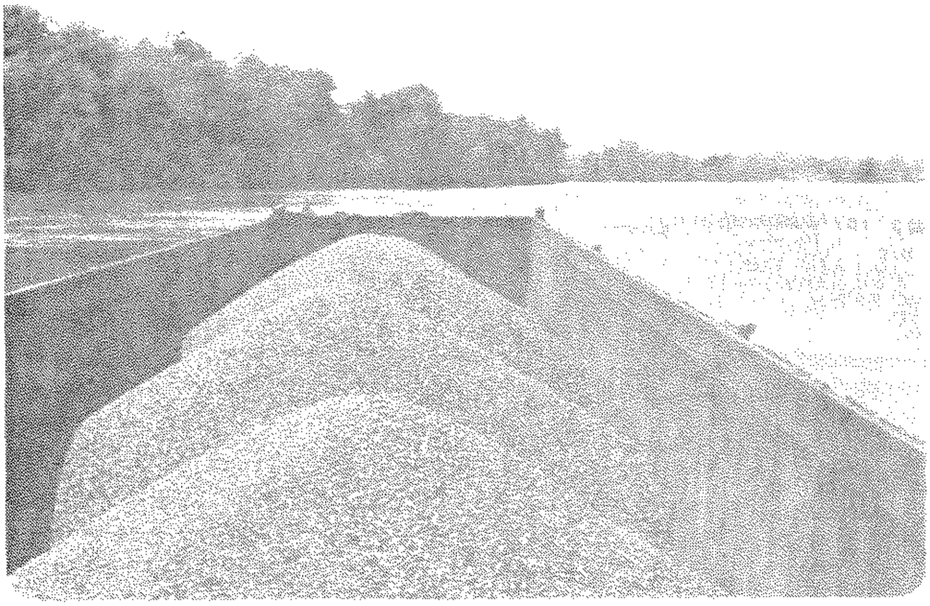

Fig. 11.--Clean gravel from which wash water went directly back into river.

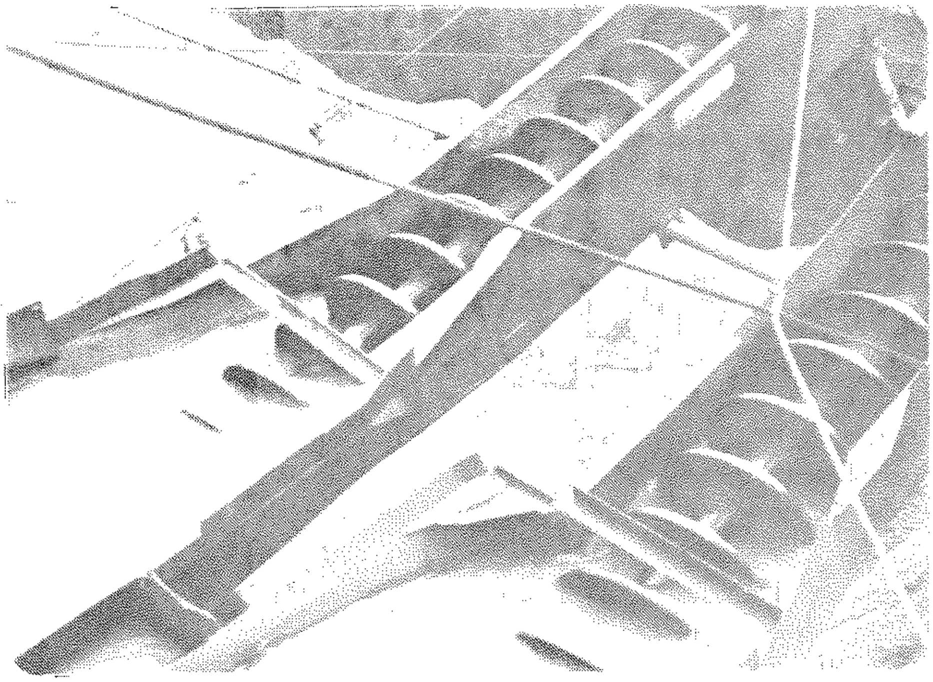

Fig. 12.--Washing, sorting, and loading of sand.

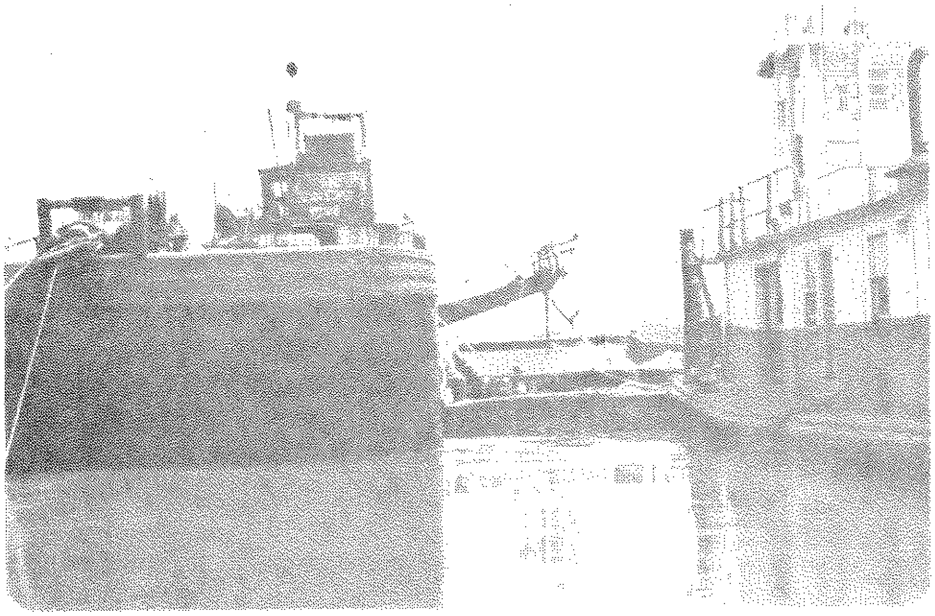

Fig. 13.--Sand entering barge. Water behind dredge filled with suspended matter and near location of some tagged mussels.

Fig. 14.--Tagged mussels used in monitoring effects of gravel dredging.