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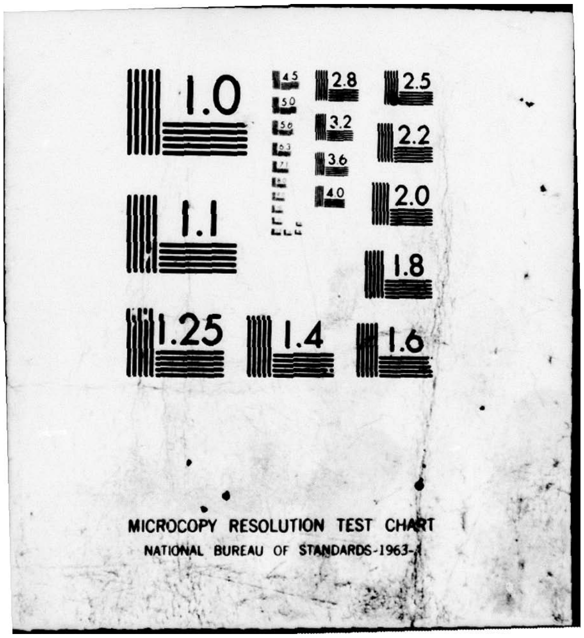

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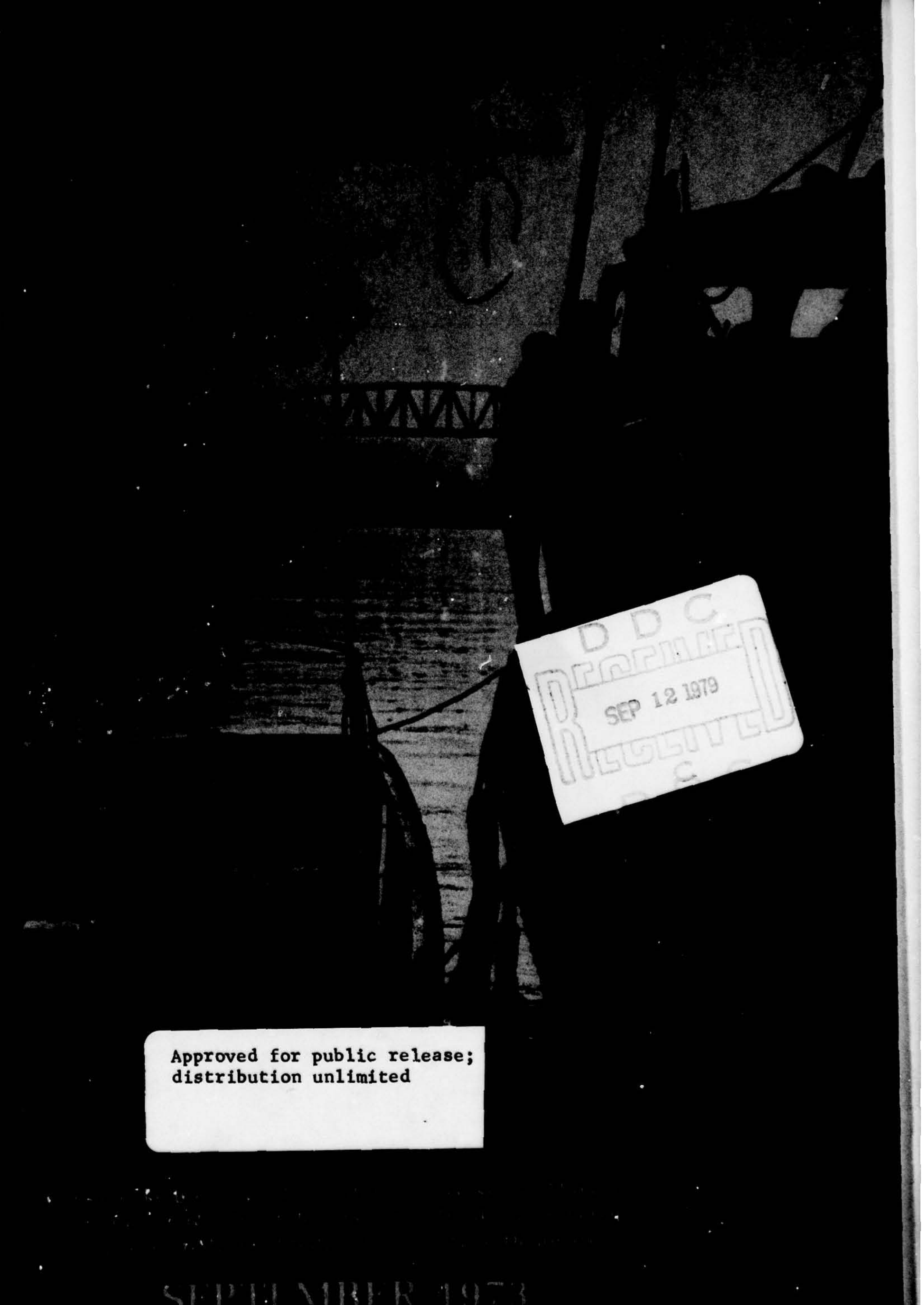

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→ This study was undertaken to determine the species of benthic invertebrates inhabiting the C & D Canal and Elk River and to determine the biomass of benthic invertebrates and seasonal changes at sampling areas, and give estimates on the effects of enlargement of C & D Canal.

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APPENDIX III

Benthos of Maryland Waters in and Near C and D Canal[1]

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INTRODUCTION

Since the early 1800's, water between the Chesapeake and Delaware Bays has been exchanged in increasing rates with each reconstruction of the Chesapeake and Delaware Canal. The latest enlargement, which began in 1958, deepened the Canal from 27 ft to 35 ft and widened it from 250 ft to 450 ft. At the presnet time this dredging project is virtually completed and upon completion an additional net eastward discharge of water from the Chesapeake has been estimated at 1,650 cubic ft per second (Pritchard, 1970). This flow of water, which is subject to tidal cycles, may be totally fresh during periods of high freshwater runoff from the Susquehanna watershed or slightly saline during drier periods of the year. As a consequence, the increased diversion of water through the enlarged C and D Canal will result in a longitudinal shift of the salinity pattern up the Chesapeake Bay.

The objectives of this study were: (1) to determine the species of benthic invertebrates inhabiting the C and D Canal and the Elk River, an approaching waterway to the Canal, (2) to determine the biomass of benthic invertebrates and seasonal changes at representative stations throughout the study area, and (3) to estimate the effects of the enlarged Canal on the present fauna.

Several persons contributed a substantial amount of personnel effort towards this study, while others freely gave assistance when called upon. The author wishes to recognize them for their parts in completion of this investigation.

Construction of much of the field gear and operation thereof was very ably performed by Richard Z. Younger, Jr. The crew of the R/V ORION and AQUARIUS were essential and provided excellent working conditions for the field operations. Mrs. Carla Lankford sorted the benthic samples in the laboratory.

Dr. Selwyn R. Roback of the Philadelphia Academy of Sciences identified or provided specimens for identification of the insect larvae. Dr. Donald R. Boesch of the Virginia Institute of Marine Science identified the species of oligochaetes. Also Dr. Donald Heinle provided identification of the copepods found in fish stomachs.

MATERIALS AND METHODS

Sampling stations were established in the Maryland section of the C and D Canal, the Elk River, Bohemia River, and in the Chesapeake Bay at the mouth of the Sassafras River (Fig. 1). Two stations (101, 102) located furthest from the Canal at the mouth of the Sassafras River were chosen because of a prior study in this particular area using similar sampling techniques. Water depth at the different stations ranged from 2 to 40 ft, with some stations chosen in the ship channel within and outside the Canal proper. Samples from water deeper than 4 ft were taken from aboard the R/V ORION. Samples from water less than this depth were taken and processed from a Boston Whaler outboard boat especially rigged for taking bottom samples.

Three replicate samples were taken quarterly at each station using a 0.1 m van Veen grab. The bottom material contained in the grabs was placed on a 0.7-mm mesh opening screen and washed on board the research vessel. The residual material with specimens was flushed into plastic jars and fixed with 10% formalin. Approximately 3 days later the formalin was replaced with 70% ethyl alcohol. This material was further washed in the laboratory and the entire sample was examined for benthic organisms. After sorting, the specimens were placed in vials and preserved again in alcohol for future identification and enumeration. A card index was kept for each station listing the number of all species found during each particular sampling period.

Samples of the sediment were taken at each station by means of the van Veen grab. An aliquot of the sediment sample was washed through a No. 230 (63 um) U. S. Standard Sieve to collect a sample of the silts and clays in the filtrate. The sand fraction which remained on the screen was then dried in an oven at approximately 100 C. After drying, the sand was then shaken through the U. S. Standard Sieve Series Nos. 10, 18, 35, 60, 120, and 230. The sample of the filtrate which contained the silts and clays was then filtered through a Millipore filter and dried to a constant weight. A second aliquot of the filtrate was used for clay analysis after it was allowed to sit undisturbed for 2 hr. This 50 ml sample was also filtered through a Millipore filter and then allowed to dry before weighing. A percentage of the weights for each of the following size categories was then determined based on the weight of the original sediment sample. The sizes were gravel, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt, and clay.

Biomass values from selected stations were expressed in terms of dry weight per unit area. This was obtained by drying all specimens from a sample to a constant weight at 70 C. Average weights for those species not found whole in the sample were obtained by selecting representative individuals from other samples. Mollusk shells were not included in the dry weights.

RESULTS

Quarterly sampling at the 19 stations shown in Figure 1 yielded a total of 16 benthic invertebrate species. A list of species and number of specimens collected are shown in Table 1. Crustaceans made up the largest taxonomic group as represented by 11 species; insect larvae were second with 9 species, while annelids and mollusks had only 3 and 2 species, respectively. One species of ribbonworm was found at only 2 stations. This total number of 26 is considerably less when compared to a previous study in an adjacent downbay area where a total of 66 species were found (Pfitzenmeyer, 1970). The only new additions to the earlier study were 4 species of chironomid insect larvae. The reduction in 40 species between the 2 areas may be attributed to the reduced salinity of the present study and the absence of shell substrate. Most of the invertebrate species from these areas are estuarine or saltwater forms which are not tolerant of freshwater of extremely low salinities (2.2 o/oo maximum). The chironomid larvae and the oligochaete worm, *Limnodrilus hoffmeisteri*, which were found in great abundance and widespread, were the only forms more adapted to living in totally fresh water.

A total of 30,584 inidividuals were sampled during the period of study which yielded an average density of 1,396 individuals/m^2 (Table 2). This unusually high density was due to the abundance of the mollusk, *Hydrobia* sp., found only during the June sampling period at 12 stations when over 12,000 individuals of this species were counted. When these are subtracted from the population, a more normal standing crop of 861 individuals/m^2 may be found. This mollusk is a small snail about 5 mm in shell length and apparently recruitment of the new year-class occurs in early summer when tremendous quantities are found. They were not sampled before or after the June period. This was the only species whose abundance varied markedly throughout the sampling periods.

When the species are arranged by order of numerical abundance, Hydrobia sp. dominates all other species by virtue or its sudden appearance in great quantity at one period of the year (Table 3). The next most abundant species, Limnodrilus hoffmeisteri, and the polychaete worm, Scolecolepides viridis, may be considered the true dominant representatives in the benthic community of the area under study. The amphipod, Leptochierus plumulosus, is the fourth most numerically abundant species and along with the three abovementioned species represents 77.49% of the specimens collected (Table 3). This table shows that over 90% of the fauna is represented by only 8 species which apparently conforms with similar studies in temperate areas (Sanders, 1960). More diverse communities are to be found in the tropics and deep seas because of the constancy of these environments (Wade, 1972).

As a further test for dominance, species in each of the 4 sampling periods were ranked separately using the method of Fager (1957) and Sanders (1960). The 10 most abundant species for each sampling period are given a numerical value from 1 to 10 depending on their abundance. The most abundant receives the highest value of 10, the second most abundant is 9, etc. The summation of these scores is called a biological index value (BI) and the highest possible score would be 40, or 10 for ranking first in each of the four sampling periods. The results from this analysis are also given in Table 3. Limnodrilus scored highest of all species with a BI of 37, followed by the polychate worm Scolecolepides (27, and the amphipod Leptochierus (26). The advantage of this method over arranging the species in order of abundance is that it reduces the apparent importance of those species which are found in great numbers in only one or two sampling periods. An example of this is the snail Hydrobia whose numbers far exceeded any of the other species, but only tied for ninth place in importance when ranked according to this method. Chironomid larvae play an important part in the faunal community of Elk River and assumed the fourth, fifth, sixth, and seventh place of the BI ranking. These species are more commonly found in freshwater environments, however, they possess the ability to adapt to a wide range of habitat requirements (Curry, 1965). They apparently are able to withstand periods of low salinity such as occur in this area.

All of the species of invertebrates collected during this study were either deposit-feeders or benthic carnivores with the exception of the clam, Rangia cuneata. Although this species is primarily a filter-feeder, it also is capable of utilizing detrital matter to a limited extent from the bottom sediments (Tenore et al., 1968). In a shallow soft-bottom environment, such as the area where this study was conducted, one would expect to find those species adapted to living in turbid conditions.

The stations were not selected with regards to bottom types, but by choosing them at a variety of depths, different bottom types also were included. The results of the sediment grain-size analysis is shown for each station in Figure 2. The stations in shallow water, 4 ft and less in depth, had a medium-to-fine sand grain size with the exception of Station 117 in the Canal where silt predominated. In the intermediate depth zone, 7 to 13 ft, the major sediment type was very fine sand and silt. The deepwater stations (27 - 40 ft) had a variety of sediment types depending on their locations. The deep station in the Chesapeake Bay, 101, but outside the channel, had sediments consisting mostly of silt. The remaining stations, in the channel where dredging occurred, had bottom types of firm sands even though the water depths were greater.

Most species indicated no preference as far as depth of water was concerned. In the few instances where differences were observed, it was due to bottom type associations. One crustacean species, *Leucon americanus* was found in shallow water but not in deep water of similar bottom type. Other crustaceans, for example, *Chiridotea*, *Edotea*, *Monoculodes*, and *Corophium*, were more abundant in sandy substrates in shallow or deep water but not in fine sediments in the intermediate depths. Because of the slight salinity gradient throughout the area of study, very little preference for specific saline conditions were observed. Table 4 presents the hydrographic data and shows that the salinity did not vary much more than 1 o/oo during any one sampling period. The crustacean, *Melita nitida*, was only found at the downbay stations and probably exhibited some increased saline preference. Also the amphipod, *Leptocheirus plumulosus*, which was the second most ubiquitous species and scored second highest in the biological index values, was found most abundantly at the downbay stations regardless of bottom type.

One major group of organisms, insect larvae, was found most abundantly in shallow and mid-depth stations. Very few were found in deep water, especially within the Canal proper. It is believed that the high water velocity through the Canal, which normally reaches a maximum of 3.6 ft/sec. during a tidal cycle, prohibits the setting of these species. Speed of water currents was found by Lillehammer (1965/66) to affect the distribution of this group of insect larvae. Station 117, during the March sampling period, was located in the Corps of Engineers' boat basin at Chesapeake City. Bottom dredging in this basin necessitated relocating the sampling station across the Canal on a shoal area at the edge of the ship channel for the succeeding sampling periods. Many insect larvae were found in the protected waters of the basin, but at a similar depth and bottom type at the edge of the channel where maximum water velocities would be obtained, no larvae were found.

The number of the brackish-water clam, *Rangia cuneata*, were scarce and variable at most stations in the shoal and intermediate water depths. They were most abundant at 2 areas in the Elk River (Stations 108, 113) located near the western end of the C and D Canal. Here dense populations of several year-classes could be readily obtained in fine sand sediments of shoal water. In the Canal, populations of this bivalve mollusk were scarce; only 2 specimens were found during one sampling period. These were small juvenile clams and were only temporary additions to the deepwater Canal fauna. Shell remains of various aged clams usually could be found at most other stations with the exception of channel stations where dredging had recently occurred.

The only other mollusk collected was the snail *Hydrobia*. This species usually occurs in very shallow brackish-water marsh environments, but during the June sampling period it was found in great numbers at 3 various depths. A previous study indicated that this genera is most abundant and active during the summer months especially in slightly more saline environments (Pfitzenmeyer, 1970).

As stated previously, stations were chosen more with respect to water depth rather than with bottom sediment types. Generally, in the Chesapeake Bay and tributaries, bottom sediments change with increasing and decreasing water depths. It was evident,then,that by sampling at a variety of water depths, different sediment types also would be sampled, and any distinct faunal assemblages which they support would thereby be included in the community of animals from this region. It is difficult to detect small faunal differences between stations by merely comparing the species lists and numbers per station. To fulfill the objectives of the study, it was believed important to be able to measure differences, if there were any, between stations within the Canal and outside the Canal, and over a gradient of stations approaching the Canal. To accomplish these objectives, several methods of analysis were tested and are presented.

Trellis diagram. The percent similarity of species composition was used as an index to compare samples. The 19 stations were compared for their faunal similarity by the trellis diagram method of analysis (Sanders, 1960). This faunal index of affinity was considered by Saila et al. (1927) as more straightforward than other indices using prominence values. It is based on the percentage of fauna shared by each possible pair of stations and is obtained by summing the smaller percentages of each species present at the two stations being compared. After the percent similarity for each pair of stations was determined, the values were placed in a matrix by grouping stations according to bottom types (Fig. 3). This figure represents the faunal composition for the March sampling period. Index values were calculated for each of the other sampling periods but only very limited and unorganized relationships could be found in the June, September, or December sampling periods. These natural fluctuations in faunal composition reflect the unstableness in a secondary trophic level such as the benthic invertebrate fauna. Factors which may bring about changes in the benthic faunal composition after the March sampling period include migration, spawning, completion of life cycle, predation, and death due to environmental changes. It is believed that during late winter or March, before increased water temperatures initiate certain metabolic activities, species and numbers are more truly representative of the true faunal composition of the area.

When the samples are arranged according to bottom types, such as in Fig. 3, a high percent of similarity may be seen between specific pairs of stations. A high percent of station similarity in this study is regarded as any index value of 50% and greater. Sanders (1960) took replicate samples from a single station and obtained an average value of 56%. He also was able to define distinct community types between samples in the 30% to 50% range of similarity.

The group of stations which exhibit a high index of affinity for each other were those from the silt and very-fine-sand sediment types. The only exception was Station 101 which is located farthest removed geographically from the group of similar sediment types. The fauna of this station, which is located in the Chesapeake Bay, apparently is under the influence of higher salinity conditions of this particular area. It is also obvious from this method of analysis that Station 115 is not correctly situated in the matrix and should be more closely related to the group of silt and very-fine-sand stations rather than the medium-sand group. The physical qualities of the sediments at this station had the characteristics of soft bottom, but an error must have occurred during sampling or analysis.

Another group of stations showing a marked similarity of faunal composition were the Canal stations which had related bottom types of fine or medium sand. It is of interest to see their similarity to Station 102, also a medium-sand sediment, but furthest removed from the Canal and under more influence of Chesapeake Bay conditions than other stations. It is believed that the slightly higher salinity water from Delaware Bay, which periodically flows westward through the Canal, has an influence on the fauna within the Canal and creates similar faunal composition as corresponding saline areas in the Chesapeake.

The average faunal index of affinity for this study was 32.56% which is fairly consistent with other studies and summarized by Wade (1972). The fauna of the area sampled does not show any species preference along the sampling gradient. On the basis of species assemblages, biological index values, and average index of affinity, the benthos of this area probably consists of a single homogeneous community throughout, with preferences exhibited only for specific bottom types.

Species Diversity. Another approach, in the study of natural communities of animals, is to mathematically analyze the number of species and the number of individuals making up that community. This demands not much a critical taxonomic study of all species, but that each species and number of individuals of each species be separated, and that the samples be from a known volume or area. Wilhm (1967) reviewed several of these indices as proposed by various investigators.

Margalef (1956) proposed the following equation derived from the information theory which was the index used in this study.

$$\bar{d} = \frac{1}{N} \log_2 \frac{N!}{N!\ N_2!\ \ldots\ N_n!}$$

The total number of organisms N, number of individuals per species (N!) were used to calculate the diversity per individual $\bar{d}$. Also a theoretical maximum diversity $\bar{d}$ max, and a theoretical minimum diversity, $\bar{d}$ min, were calculated along with redundancy (R), the expression of the unequal abundance of individuals per species. These values were calculated by means of the following equations:

$$\bar{d}\ \max = \log N! - N \log \frac{(N)}{(s)!}$$

$$\bar{d}\ \min = \log N! - \log_{n}-(s-1)$$

$$R = \frac{\bar{d}\ \max - \bar{d}}{\bar{d}\ \max - \bar{d}\ \min}$$

These methods of analysis, species diversity indices, have been expecially useful in detecting stresses in the in the community structure resulting from some form of pollution or mechanical disturbance. In this particular study it was used to determine if the fauna in the Canal was particularly different from that outside the Canal as a result of more recent dredging or through the influence of water received from the Delaware Bay, and to detect any faunal difference at particular stations in the tributaries and approaches to the Canal from the Chesapeake Bay.

Through the use of the formula given above, a numerical value is obtained which ranges from 0 to 4. A value of 4 is obtained if all individuals are equally divided among different species and a value of 0 is obtained if all individuals belong to the same species. The diversity index was calculated for each station at each sampling period (Table 5).

When the stations are grouped according to water depth (shoal, intermediate, and deep water stations) the $\bar{d}$ values in each of these 3 groups are closely related (Table 5). Some exceptions are Stations 105 and 106 at the mouth of the Bohemia River and Station 112 in the Canal at the Delaware-Maryland line. The values at Stations 105 and 106 were low during all sampling periods because of the abundance of the oligochaete worm, *Limnodrilus*, at these stations. Station 112 in the Canal had a low $\bar{d}$ value in March and December because of the relatively large numbers of the polychaete worm, *Scolecolepides viridis*. With the exception of the December period at Station 112 when only 2 species were found, and at Station 106 when only 1 species was found, these stations had an average number of species but the abundance of one of them lowered the $\bar{d}$ value. It is therefore believed that these low diversities were not due from any particular outside interference to the invertebrate community but are due to aberrant faunal assemblages during periods of recruitment or sampling artifacts at these stations.

The $\bar{d}$ values indicated that the fauna was more diverse in shoal water (average $\bar{d}$ value 1.790), less diverse at intermediate depths (1.339) and still less diverse in deep water (1.101). The deepwater stations in the Canal proper showed a decreasing gradient from west to east, while no gradient was observed at the stations in Maryland waters approaching the Canal.

Dry weight. The biomass or amount of living material per unit area of bottom, may be measured by a variety of means. One method employed by some investigators for comparison between areas or as a measure of rates of change in a biological system, is to weigh the number of organisms present in a sample. Depending on the method used, this may be expressed as wet weight, dry weight or ash-free dry weight.

A previous study of the benthic community in an adjacent area to this project, dry weights averaged 0.90 g/m^2 for selected stations during September (Pfitzenmeyer, 1970). The biomass at three deepwater stations in the present study averaged 0.76 g/m^2 (Table 3). Also in this table are the results for the other periods of the year at these stations. The highest average biomass for the four sampling periods during the entire year occurred at the station in the Chesapeake Bay (1.19 g/m^2), the next highest at the station intermediate between the Canal and the Bay (1.00 g/m^2) and the lowest was in the Canal (0.60 g/m^2). These approximate the results of the earlier study but are considerably lower than Sanders (1956) reported for the English Channel (4.0 g/m^2), and for Long Island Sound (15.88 g/m^2). Both of these studies, however, were from high salinity, more stable environments where a greater number of organisms would be expected.

These results tend to indicate what was also suggested by other analytical methods of this study. First, there is considerable seasonal variation in biomass at each station presumably due to the interaction of mortality, movement, and recruitment. Secondly, based on a limited number of observations at three stations, a slight decreasing biomass gradient was observed at deepwater stations as one progressed from the Chesapeake to the Canal.

Benthic invertebrates as fish food. Stomachs from the most common species of fish in the C and D Canal and approaching waterways during March, April, and May were examined for species of organisms consumed as food. The prime objective was to gain some understanding of the relative importance of the invertebrate fauna utilized by fish. Fish specimens were obtained by means of the 30-ft otter trawls used to sample adult fish, as reported upon in another appendix of this report.

Table 7 summarizes the results of the stomach analysis of four species of fish (white perch, striped bass, catfish, and yellow perch) for the 3 sampling periods. Eighteen species of invertebrates were found to be in the stomachs during this period of study. In addition, the remains of fish and 2 species of fish eggs were also found to be consumed. Most of the species in the stomachs were benthic invertebrates which were also found in the bottom samples taken during this study. Usually the most abundant in the stomachs compared with the density found in the benthic samples. One major exception being the oligochaete worm *Limnodrilus*, which was the most abundant species taken in the benthic study, but was not found in any fish stomach. The second most abundant benthic species, the crustacean *Leptochierus plumulosus*, was, however, a major food item for all species of fish except the striped bass. The size-class of striped bass used in this study (200 - 545 mm) were adult specimens and those which had any contents in their stomachs were preying entirely on other fish. This agrees closely with the finding of Bason (1971), who also studied striped bass in the same area.

White perch and catfish were very similar in their food selection, often times obtaining small species not found in the benthic samples.

Three small crustaceans, copepods and cladocerans, which are pelagic, and ostracods, which are commonly benthic in habit, were not retained on the screen used for washing benthic samples but were quite abundant in fish stomachs especially during the May sampling period. Similarly fish eggs, when they are present in the water during April and May, are found in large numbers in the adult fish diet, but due to their smallness or frailty are not seen in the benthic samples. Juvenile clams, *Rangia cuneata*, which were not common in the benthic samples also were quite common in catfish stomachs during April. This species of fish, as indicated by the organisms found in its stomach, was especially selective and efficient in obtaining small food items.

Although stomach samples were taken during March, April, and May (Table 7), only during the March period were corresponding benthic samples made. This offered an opportunity to compare selectivity of available benthic organisms by the bottom feeding fish present at that season. Striped bass stomachs were examined but they contained only fish remains. Food items contained in the stomachs of three other species of fish, white perch, catfish, and yellow perch, were taken during March and are presented separately in Table 7, but were collectively analyzed, since we were not interested in individual fish species preferences. The species of invertebrates found were gathered into larger taxonomic groupings for comparative purposes of presentation. Correspondingly similar species of those groups from the bottom samples were combined for comparison. The data was presented as a percentage of the total number found in either the stomachs or bottom samples (Table 8).

A most striking comparison may be seen in the available abundance of the oligochaete worm in the bottom sediments (45%), and complete absence in the stomachs. In contrast with another class of annelid worms, polychaetes, which were only 25% of the total species in bottom sediments but comprised 76% of the total species found in the stomachs. The reason for these differences is not known but there does exist a very high degree of diet selectivity that not only occurs during March, but April and May also.

In a study of white perch feeding habits and the availability of food in the bottom sediments, Cooper (1941) found some oligochaetes (aquatic earthworms) in the sediments, but similar to this study none were found in the fish stomachs. Although no comparison was made with food in the bottom sediments, Miller (1963) did not report any oligochaetes in the stomachs of white perch. His study area included tributaries of the Delaware Bay where oligochaetes must have been available.

The most abundant forms of invertebrates found in the fish stomachs were annelid worms (76%), crustaceans (18%), and insect larvae (3%). In the sediments,the most abundant were annelid worms (70%), insect larvae (19%), and crustaceans (8%). It should be pointed out that some of the crustaceans are free-swimming forms, or too small to be caught by our benthic sampling methods, and were therefore not included in our study of the invertebrate benthos.

SUMMARY AND CONCLUSIONS

1. Samples of the benthos were taken by means of a van Veen grab and washed through a 0.7-mm mesh-opening screen.

2. Samples were taken at water depths ranging from 2 to 40 ft and from predominately silt, and fine-to-medium sand substrates.

3. A total of 26 invertebrates were found, represented by 11 species of crustaceans, 9 species of insect larvae, 3 species of annelids, 2 species of mollucks, and 1 species of ribbonworm.

4. The most abundant species in numerical order are the snails *Hydrobia*, the oligochaete worms *Limnodrilus hoffmeisteri*, the polychaete worms *Scolecolepides viridis*, and the amphipod crustaceans *Leptochierus plumulosus*. These four species represented over 77% of the specimens collected.

5. The stations were compared for their faunal similarity by a trellis diagram. This faunal index of affinity indicated that stations of similar bottom types exhibited close relationship regardless of water depths and that stations in the Maryland portion of the Canal proper were most similar to the stations located in the Chesapeake Bay.

6. A species diversity index analysis based on the information theory indicated stations located in shoal water to be most diverse in fauna, while those in deep water to be least diverse. At three stations in the Canal proper, the faunal diversity decreased from west to east.

7. Biomass calues at selected stations indicated a reduction in dry weight, progressing from the Chesapeake Bay into the Canal proper.

8. A stomach analysis of white perch, striped bass, catfish and yellow perch indicated that these fish utilized the benthic fauna for food. With the exception of the oligochaete worm Limnodrilus, which was absent from the stomachs, the number of specimens of each species in the stomachs corresponded closely with the density found in the benthic samples.

9. The present enlargement of the Canal is expected to have no measurable effect on the benthic invertebrate fauna under the predicted flow conditions. Large volumes of water passing in either direction through the Canal as a result of unusual hydrographic conditions may have a drastic but temporary effect.

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Table 1. List of species collected at the 19 sampling stations which are arranged according to water depth. Four numbers following each species and under each station represent number found during March, June, September, December sampling periods. Blank space represents none found; Dash represents no sample taken.

	Shoal Water 2-4 ft															
	Sta. 102		Sta. 118		Sta. 119		Sta. 115		Sta. 113		Sta. 116		Sta. 114		Sta. 117	
Nemertean																
Tubulanus pellucidus	0	3	-	0	-	0	0	0	0	0	0	0	0	0	0	0
	0	3	0	-	0	0	0	0	0	0	0	0	0	0	0	0
Annelids																
Limnodrilus hoff-	7	1	-	29	-	23	71	17	0	31	8	1	30	32	192	345
meisteri	8	55	0	-	0	135	11	18	11	101	2	35	28	11	41	-
Scolecolepides	63	22	-	14	-	47	11	16	35	0	49	29	34	29	0	51
viridis	7	24	0	-	4	12	1	3	0	0	11	2	5	6	8	-
Hypaniola grayi	11	1	-	0	-	0	0	0	0	0	0	0	0	0	0	1
	8	30	0	-	0	0	0	0	0	4	5	89	0	0	0	-
Crustaceans																
Neomysis americana	0	0	-	0	-	0	0	0	0	0	0	0	0	2	0	0
	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	-
Leucon americanus	0	0	-	0	-	1	6	0	0	0	5	0	8	2	0	0
	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	-
Cyathura polita	17	14	-	2	-	1	18	25	35	0	53	2	9	37	0	17
	38	7	7	-	1	0	2	8	0	1	19	45	34	34	8	-
Chiridotea almyra	7	14	-	11	-	-	0	0	0	0	2	0	0	0	0	0
	7	1	5	-	1	1	0	0	0	0	2	2	0	1	0	-
Edotea triloba	0	2	-	0	-	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	-	0	0	0	0	0	0	3	0	0	0	1	-
Monoculodes edwardsi	2	20	-	17	-	0	0	8	0	1	0	0	0	7	0	7
	5	1	2	-	0	0	0	0	0	0	1	0	0	0	0	-
Gammarus sp.	0	27	-	6	-	0	0	6	0	0	0	1	1	4	0	11
	2	2	1	-	0	5		0	7	0	8	1	1	0	0	-
Melita nitida	0	0	-	0	-	0	0	0	0	0	0	0	0	0	0	0
	0	7	0	-	0	0	0	0	0	0	0	0	0	0	0	-
Leptochierus	8	39	-	25	-	1	0	1	0	3	0	3	0	2	0	37
plumulosus	14	242	47	-	0	0	0	6	55	14	5	0	0	0	7	-
Corophium lacustre	1	1	-	0	-	0	0	1	0	0	0	0	0	0	0	0
	1	6	0	-	0	0	0	0	1	1	0	10	0	0	0	-

Table 1. (Continued)

	Shoal Water 2-4 ft															
	Sta. 102		Sta. 118		Sta. 119		Sta. 115		Sta. 113		Sta. 116		Sta. 114		Sta. 117	
Rithropanopeus	0	0	-	0	-	0	0	0	0	0	0	0	0	0	0	0
harrisii	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	-
Insect larvae																
Coelotanypus	2	20	-	0	-	2	1	7	7	25	0	0	0	20	16	0
scapularis	0	0	0	-	0	10	10	21	3	33	0	0	99	54	0	-
Procladius sp.	1	4	-	0	-	0	8	12	29	6	0	0	5	44	22	0
	1	3	1	-	642	1	0	2	0	5	0	0	3	13	0	-
Cryptochironomus	0	0	-	0	-	52	0	5	0	0	0	0	0	0	0	0
fulrus	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	-
Xenochironomus	0	0	-	0	-	29	0	0	0	0	0	0	0	0	0	0
taenionotus	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum halterale	0	0	-	0	-	0	0	0	0	0	0	0	0	21	0	0
	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	-
Chironomus attenuatus	0	0	-	0	-	240	1	12	1	5	1	0	88	220	1	0
	0	0	0	-	0	194	0	3	0	4	0	0	8	162	0	-
Palpomyia sp.	0	0	-	0	-	0	2	1	2	0	0	0	0	0	2	0
	0	0	0	-	0	0	0	0	0	4	0	0	0	0	0	-
Cryptochironomus	0	3	-	1	-	0	15	0	9	4	31	1	30	42	1	0
argus	0	0	4	-	0	42	0	4	0	16	0	7	4	7	0	-
Chaoborus punctipennis	0	0	-	0	-	0	0	0	0	1	0	0	0	0	1	0
	0	2	0	-	0	0	2	0	1	0	0	1	0	0	0	-
Unidentified	0	0	-	3	-	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	-	0	0	0	0	0	0	0	0	2	0	0	-
Mollusks																
Rangia cuneata	0	0	-	0	-	0	2	3	32	37	0	0	1	0	0	0
	0	0	0	-	0	0	4	0	65	211	0	0	0	0	2	-
Hydrobia sp.		9000	-	0	-	0	0	2	0	0	0	0	0	0	0	0
	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	-
	Intermediate Water 7-13 ft															
	103		104		106		107		108		109					
Nemertean																
Tubulanus pellucidus	0	0	0	0	0	0	0	0	0	0	0	0				
	0	0	0	0	0	0	0	0	0	0	0	0				
Annelids																
Limnodrilus hoff-	650	330	660	245	135	175	282	235	225	0	126	290				
meisteri	64	135	-	98	0	0	23	60	0	105	3	34				

Table 1. (Continued).

	Intermediate Water 7-13 ft													
	Sta. 103		Sta. 104		Sta. 106		Sta. 107		Sta. 108		Sta. 109		Sta.	Sta.
Scolecolepides	29	0	0	7	4	0	81	0	3	0	1	0		
viridis	0	9	-	12	0	0	0	3	0	1	0	1		
Hypaniola gravi	13	1	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0		
Crustaceans														
Neomysis americana	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	-	0	0	0	0	0	0	0	0	0		
Leucon americanus	0	0	0	0	0	0	3	0	0	0	0	0		
	0	0	-	0	0	0	0	0	0	0	0	0		
Cyathura polita	0	1	7	11	2	1	0	0	3	2	0	0		
	3	5	-	5	0	2	0	0	0	1	1	0		
Chiridotea almyra	0	0	0	0	0	0	0	0	0	1	0	0		
	0	2	-	0	0	4	0	0	0	0	0	0		
Edotea triloba	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	-	0	0	0	0	0	0	0	0	0		
Monoculodes edwardsi	2	2	0	2	0	0	0	0	0	0	0	0		
	0	0	-	0	0	0	0	0	0	0	0	0		
Gammarus sp.	0	6	2	63	0	3	1	1	1	2	0	4		
	0	0	-	0	0	0	1	0	0	3	0	1		
Melita nitida	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	-	0	0	0	0	0	0	0	0	0		
Leptochierus	162	20	1	1	0	9	4	0	31	2	44	6		
plumulosus	5	20	-	29	52	0	0	0	0	21	7	52		
Corophium lacustre	0	0	1	4	0	0	0	0	0	0	0	0		
	0	0	-	0	1	0	0	0	0	1	0	1		
Rithropanopeus	0	-	0	0	0	0	0	0	0	0	0	0		
harrisii	0	0	-	0	0	0	0	0	0	0	0	0		
Insect larvae														
Coelotanypus	94	21	56	14	8	8	0	42	58	7	41	19		
scapularis	8	13	-	16	0	7	44	95	0	15	0	24		
Procladius sp.	30	18	30	18	3	16	16	20	13	5	15	4		
	0	2	-	3	0	2	0	0	0	2	1	7		
Cryptochironomus	0	0	0	0	0	0	0	0	0	0	0	0		
fulvus	0	0	-	0	0	0	0	0	0	0	0	0		
Xenochironomus	0	0	0	0	0	0	0	0	0	0	0	0		
taenionotus	0	0	-	0	0	0	0	0	0	0	0	0		

Table 1. (Continued).

	Intermediate Water 7-13 ft													
	Sta. 103		Sta. 104		Sta. 106		Sta. 107		Sta. 108		Sta. 109			
Polypedilum halterale	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	-	0	0	0	0	0	0	0	0	0		
Chironomus attenuatus	103	23	0	0	0	0	175	0	2	0	6	0		
	1	0	-	0	0	0	1	34	0	0	0	0		
Palpo[illegible] sp.	0	0	0	0	0	0	0	0	2	0	0	0		
	0	0	-	0	0	0	0	0	0	0	0	0		
Cryptochironomus argus	8	7	11	11	3	7	3	0	12	2	1	3		
	0	3	-	0	0	3	1	0	0	0	0	0		
Chaoborus punctipennis	1	1	0	0	0	0	5	3	0	0	0	0		
	4	2	-	1	0	1	4	4	0	0	1	0		
Unidentified	0	3	0	0	0	0	0	0	0	0	0	0		
	0	0	-	0	0	0	0	0	0	0	0	0		
Mollusks														
Rangia cuneata	0	0	15	46	0	0	5	0	13	13	1	0		
	0	0	-	0	1	0	0	0	30	3	3	0		
Hydrobia sp.	0	0	0	0	0	0	0	3056	0	7	0	2		
	0	0	-	0	0	0	0	0	0	0	0	0		
	Deep Water 27-40 ft													
	101		105		110		111		112				Totals	
Nemertean														
Tubulanus pellucidus	4	0	0	0	0	0	0	0	0	0			7	0
	2	0	0	0	0	0	0	0	0	0			5	0
Annelids														
Limnodrilus hoffmeisteri	0	2	176	1200	14	0	0	0	0	0			2576	2956
	0	19	98	595	0	35	0	0	0	0			289	1436
Scolecolepides viridis	6	30	4	11	721	455	208	49	165	29			1414	789
	26	4	1	0	20	260	34	11	24	52			105	353
Hypaniola grayi	0	1	0	3	0	0	0	1	0	0			24	8
	2	29	1	0	0	0	0	0	0	0			16	152
Crustaceans														
Neomysis americana	0	0	0	1	0	0	0	0	0	2			0	5
	0	0	0	0	0	0	0	0	0	0			0	0
Leucon americanus	0	0	0	0	0	0	0	0	0	0			22	3
	0	0	0	0	0	0	0	0	0	0			0	1
Cyathura polita	40	38	1	5	4	6	0	0	1	7			190	169
	8	26	0	0	39	19	0	0	0	0			160	153

Table 1. (Continued).

	Deep Water 27-40 ft											
	Sta. 101		Sta. 105		Sta. 110		Sta. 111		Sta. 112		Totals	
Chiridotea almyra	4	14	0	0	1	9	2	104	4	169	20	322
	0	1	1	2	51	5	80	7	212	3	354	29
Edotea triloba	3	1	0	0	0	0	0	0	0	0	3	3
	0	0	0	1	0	0	0	0	0	0	4	1
Monoculodes edwardsi	2	4	0	1	0	1	0	1	0	6	6	77
	0	1	2	1	2	0	0	0	0	0	12	3
Gammarus sp.	0	60	0	11	0	9	0	24	4	5	9	243
	0	1	2	0	45	0	71	0	62	0	201	13
Melita nitida	0	0	0	0	0	0	0	0	0	0	0	0
	0	2	0	0	0	0	0	0	0	0	2	7
Leptochierus plumulosus	27	476	0	2	0	0	0	1	0	0	277	628
	24	18	0	0	0	9	0	0	0	0	164	463
Corophium lacustre	1	0	0	0	0	0	1	0	0	0	4	6
	0	0	0	2	238	6	1	1	1	0	242	29
Rithropanopeus harrisii	0	1	0	0	0	0	0	0	1	0	1	1
	0	0	0	0	3	0	0	0	0	0	3	0
Insect larvae												
Coelotanypus scapularis	4	11	1	5	0	0	0	1	0	0	289	201
	0	0	1	4	1	0	1	0	0	0	167	292
Procladius sp.	7	3	0	1	0	0	0	0	0	0	179	151
	0	0	0	2	0	0	0	0	0	0	648	42
Cryptochironomus fulrus	0	0	0	0	0	0	0	0	0	0	0	57
	0	0	0	0	0	0	0	0	0	0	0	0
Xenochironomus taenionotus	0	0	0	0	0	0	0	0	0	0	0	29
	C	0	0	0	0	0	0	0	0	0	0	0
Polypedilum halterale	0	0	0	0	0	0	0	0	0	0	0	21
	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus attenuatus	0	0	0	0	0	0	0	0	0	0	379	500
	0	0	0	0	0	0	0	0	0	0	10	397
Palpomyia sp.	0	0	0	0	0	0	0	0	0	0	8	1
	0	0	0	0	0	0	0	0	0	0	0	4
Cryptochironomus argus	3	2	0	6	0	0	0	0	0	0	227	88
	0	3	0	0	0	0	2	0	0	0	9	85
Chaoborus punctipennis	0	0	0	0	0	0	0	0	0	0	7	5
	0	0	1	0	0	0	0	0	0	0	13	11
Unidentified	0	0	0	1		0	0		0	0	0	4
	0	0	0	0	0	0	0	0	0	0	2	0
Mollusks												
Rangia cuneata	10	3	0	0	0	0	0	0	0	0	79	102
	22	3	0	0	0	2	0	0	0	0	107	219
Hydrobia sp.	0	0	0	100	0	0	0	0	0	0	0	[illegible]

Table 2. Total specimens of each species collected during the four sampling periods. Each figure represents the number from .3m^2.

	1971				
Species	Mar	June	Sep.	Dec.	Total
T. pellucidus	4	3	2	3	12
L. hoffmeisteri	2576	2956	289	1436	7257
S. viridis	1414	789	141	400	2744
H. grayi	24	8	16	152	200
N. americana	0	0	0	0	5
L. americanus	22	3	0	1	26
C. polita	190	169	160	153	672
C. almyra	20	322	359	29	730
E. triloba	3	3	4	1	11
M. edwardsi	6	77	12	3	98
Gammarus sp.	9	243	201	13	466
M. nitida	0	0	0	9	9
L. plumulosus	277	628	164	463	1523
C. lacustre	4	6	242	29	281
R. harrisii	1	1	3	0	5
C. scapularis	289	201	167	292	949
Procladius sp.	179	151	648	42	1020
C. fulvus	0	99	0	0	99
X. taenionotus	0	29	0	0	29
P. halterale	0	21	0	0	21
C. attenuatus	378	500	10	397	1285
Palpomyia sp.	8	1	0	4	13
C. argus	227	88	9	87	411
C. punctipennis	6	5	13	11	35
R. cuneata	79	102	107	219	507
Hydrobia sp.	0	12167	0	0	12167
TOTAL	5716	18577	2547	3744	30584
No. stations	17	19	18	17	
Av/sta	336	978	142	220	
Est. Org./m^2	1119	3257	473	733	

Table 3. The species of macroinvertebrates making up the benthic community of the Elk River and C and D Canal based on number of individuals collected in March, June, September, and December samples.

Rank	Species	Total No.	Cum % by No.	% Fauna by No.	Rank by Number Mar.	June	Sept.	Dec.	B.I. Value
1.	*Hydrobia* sp.	12167	39.78	39.78	20	1	19	19	10
2.	*Limnodrilus hoffmeisteri*	7257	63.51	23.73	1	2	3	1	37
3.	*Scolecolepides viridis*	2744	72.48	8.97	2	3	9	3	27
4.	*Leptochierus plumulosus*	1534	77.49	5.01	5	4	7	2	26
5.	*Chironomus attenuatus*	1285	81.69	4.20	3	5	14	4	21
6.	*Procladius* sp.	1020	85.03	3.34	8	10	1	10	15
7.	*Coelotanypus scapularis*	949	88.13	3.10	4	8	6	5	21
8.	*Chiridotea almyra*	730	90.52	2.39	12	6	2	11	14
9.	*Cyathura polita*	672	92.72	2.20	7	9	8	7	13
10.	*Rangia cuneata*	507	94.38	1.66	9	11	10	6	8
11.	*Gammarus* sp.	466	95.90	1.52	13	7	5	13	10
12.	*Cryptochironomus argus*	411	97.24	1.34	6	13	15	9	7
13.	*Corophium lacustre*	281	98.16	.92	17	18	4	12	7
14.	*Hypaniola grayi*	200	98.81	.65	10	17	11	8	4
15.	*Cryptochironomus fulvus*	99	99.13	.32	20	12	19	19	0
16.	*Monoculodes plumulosus*	98	99.45	.32	16	14	13	17	0
17.	*Chaoborus punctipennis*	35	99.56	.11	16	19	12	14	0
18.	*Xenochironomus taenionotus*	29	99.65	.09	20	15	19	19	0
19.	*Leucon americanus*	26	99.73	.08	11	20	19	18	0
20.	*Polypedilum halterale*	21	99.80	.07	20	16	19	19	0
21.	*Tubularius pellucidus*	13	99.85	.05	15	21	18	17	0
22.	*Palpomyia* sp.	13	99.89	.04	14	21	19	16	0
23.	*Edotea triloba*	11	99.93	.04	18	20	16	18	0
24.	*Melita nitida*	9	99.96	.03	20	22	19	19	0
25.	*Neomysis americana*	5	99.98	.02	20	19	19	19	0
26.	*Rithropanopeus harrisii*	5	100.00	.02	19	21	17	19	0

Table 4. Sampling Station Hydrographic Data

Shoal Water Stations	H_2O Depth	Sediment	Bot. H_2O Temp. °C				Bot. Salinity o/oo			
			M	J	S	D	M	J	S	D
102	4	Med/Sand	4.8	24.5	25.3	3.9	1.3	2.7	2.2	2.1
118	2	Med/Sand	-	-	-	-	-	-	-	-
119	3	Fine/Sand	-	-	-	-	-	-	-	-
115	2	Med/Sand	-	-	-	-	-	-	-	-
113	2	Fine/Sand	-	-	-	-	-	-	-	-
116	2	Med/Sand	-	-	-	-	-	-	-	-
114	2	Fine/Sand	-	-	-	-	-	-	-	-
117	3	Silt	-	-	-	-	-	-	-	-
Intermediate Stations										
103	13	V.Fine/Sand	6.0	25.6	25.0	3.7	.5	0.8	1.6	0.9
104	13	V.Fine/Sand	6.0	26.5	25.1	3.9	.4	1.2	1.2	1.4
106	7	Silt	6.3	27.8	-	4.2	.9	1.5	-	1.0
107	11	Silt	6.9	28.9	-	4.0	.5	1.1	-	1.1
108	12	Silt	5.5	25.8	26.0	4.1	1.0	1.9	.7	1.2
109	10	Silt	5.9	26.1	25.8	4.1	.6	1.7	.7	0.7
Deep Stations										
101	27	Silt	5.4	24.6	-	5.5	.7	2.2	-	2.6
105	38	V.Fine/Sand	6.2	25.8	-	4.5	1.1	1.8	-	1.3
110	40	Fine/Sand	5.9	24.9	24.8	5.1	1.0	1.8	.7	1.5
111	36	Med/Sand	6.2	25.4	24.5	5.1	1.0	1.9	1.0	1.3
112	7	Fine/Sand	6.2	25.0	25.1	4.8	1.0	2.0	1.3	1.2

Table 5. Species diversity index analysis results for each period per individual at each station. (S = number of species, N = numbers of individuals, $\bar{d}$ = diversity $\bar{d}$ max = maximum diversity, $\bar{d}$ min = minimum diversity, and R = redundancy.

		S	N	$\bar{d}$		$\bar{d}$ max	$\bar{d}$ min	R
Shoal Water Stations								
102	March	10	119	2.088		3.100	.518	.392
	June	15	9171	.188		3.898	.020	.957
	September	10	91	2.394		3.051	.637	.272
	December	13	383	1.622	1.622	3.587	.270	.533
118	M	–	–	–		–	–	–
	J	9	108	2.493		2.954	.497	.187
	S	7	67	1.378	1.935	2.564	.538	.585
	D	–	–	–		–	–	–
119	M	–	–	–		–	–	–
	J	9	396	1.753		3.092	.174	.459
	S	4	648	.080		1.978	.043	.981
	D	8	400	1.735	1.189	2.931	.151	.430
115	M	10	135	2.092		3.121	.469	.388
	J	14	116	3.034		3.504	.760	.171
	S	7	31	1.917		2.388	.935	.324
	D	8	65	2.288	2.332	2.718	.641	.207
113	M	8	150	2.367		2.849	.336	.192
	J	9	113	2.208		2.961	.480	.303
	S	7	143	1.663		2.670	.299	.425
	D	11	394	1.902	2.035	3.365	.218	.465
116	M	7	149	1.947		2.675	.290	.305
	J	5	36	.890		2.049	.568	.782
	S	9	56	2.380		2.820	.816	.220
	D	9	192	1.964	1.795	3.031	.315	.393
114	M	9	306	2.087		3.074	.215	.345
	J	14	504	2.724		3.710	.231	.283
	S	9	184	1.902		3.026	.326	.416
	D	9	289	1.891	2.151	3.069	.226	.414
117	M	7	235	.928		2.715	.201	.711
	J	7	469	1.334		2.755	.113	.538
	S	6	67	1.581		2.375	.449	.412
	D	–	–	–	1.281	–	–	–
Intermediate Water Stations								
103	March	10	1092	1.887		3.285	.083	.437
	June	12	433	1.396		3.490	.222	.641
	September	6	85	1.195		2.410	.375	.597
	December	9	191	1.503	1.495	3.025	.329	.564

Table 5 (cont'd.)

		S	N	d		$\bar{d}$ max	$\bar{d}$ min	R
104	M	9	783	.936		3.125	.098	.723
	J	11	422	1.995		3.370	.206	.435
	S	–	–	–		–	–	–
	D	7	164	1.697	1.542	2.684	.268	.409
106	M	6	155	.760		2.475	.234	.765
	J	7	219	.947		2.709	.213	.706
	S	1	1	0				
	D	8	72	1.363	.767	2.738	.594	.641
107	M	10	576	1.789		3.258	.144	.472
	J	6	3357	.523		2.577	.017	.802
	S	6	74	1.321		2.390	.417	.542
	D	5	196	1.613	1.311	2.247	.155	.303
108	M	11	363	1.808		3.358	.234	.496
	J	10	42	2.438		2.856	1.124	.241
	S	1	30	0				
	D	9	152	1.433	1.419	3.003	.380	.599
109	M	8	235	1.789		2.894	.234	.415
	J	7	328	.718		2.737	.153	.781
	S	6	16	1.701		2.030	1.188	.391
	D	7	120	1.801	1.502	2.650	.344	.368
Deep Water Stations:								
101	M	12	111	1.553		3.311	.667	.287
	J	14	646	1.471		3.728	.188	.565
	S	6	64	1.726		2.368	.465	.337
	D	11	107	2.439	2.047	3.196	.629	.295
105	M	4	182	.223		1.938	.124	.945
	J	13	1347	.679		3.660	.093	.836
	S	8	107	.550		2.805	.438	.953
	D	7	607	.171	.405	2.765	.091	.970
110	M	4	740	1.892		1.981	.039	.046
	J	5	480	.366		2.286	.074	.868
	S	8	399	1.785		2.931	.151	.412
	D	8	338	1.228	1.317	2.921	.175	.616
111	M	3	211	.106		1.547	.073	.978
	J	6	180	1.418		2.487	.208	.469
	S	5	187	1.527		2.244	.161	.344
	D	3	19	1.018	1.017	1.347	.443	.364
112	M	6	176	.414		2.485	.211	.911
	J	6	218	1.100		2.501	.178	.603
	S	4	299	1.112		1.959	.082	.451
	D	2	55	.268	.723	.942	.105	.805

Table 6. Dry weight, g/m^2, of benthic vertebrates at three selected stations.

Period	Stations			Average
	101	105	111	
March	1.53	.25	1.47	1.08
June	1.21	2.31	.44	1.32
September	1.77	.16	.35	.76
December	.24	1.27	.14	.55
Average	1.19	1.00	.60	

Table 7. Percent frequency of occurrence and average number of organisms per stomach. Fish samples obtained by trawl from Elk River and C and D Canal.

	March Sampling Period							
Item	White perch TL. 110-255mm		Striped bass TL. 210-545mm		Catfish TL. 145-430mm		Yellow perch TL. 150-180mm	
No. Fish Examined	46		5		9		10	
No. Empty Stomachs	16		2		2		0	
Species	%	Av.#	%	Av.#	%	Av.#	%	Av.#
Annelid Worms								
Scolecolepides viridis	39	54			11	50	80	53
Hypaniola grayi	2	4						
Ribbon Worm								
Tubulanus pellucidus	4	1			11	1	10	1
Crustaceans								
Neomysis americana	2	7					10	1
Leucon americanus								
Cyathura polita	2	1			11	1		
Chiridotea almyra					11	4	10	1
Edotea triloba	2	1					10	4
Gammarus sp.	17	2			11	1		
Leptochierus plumulosus	15	2			22	9		
Corophium lacustre	4	1						
Rithropanopeus harrisi					1	2		
Amphipod (unid.)	7	9			11	2		
Copepod							10	135
Cladocera								
Ostracod	2	5					50	26
Insect								
Chironomid larvae	24	2			33	6	50	3

Table 7. (Continued)

	March Sampling Period							
	White perch TL. 110-255mm		Striped bass TL. 210-545mm		Catfish TL. 145-540mm		Yellow perch TL. 150-180mm	
Item	%	Av.#	%	Av.#	%	Av.#	%	Av.#
Chironomid pupae	2	2						
Mollusk								
Rangia cuneata					11	1		
Fish and Fish parts	7	3	60	1				
Fish Eggs								
Herring								
White perch								
Detritus	22						20	
Unid. material	22				55		10	
Unid. parasitic worms							10	1

	April Sampling Period					
Item	White perch TL. 110-260mm		Striped bass TL. 200-310mm		Catfish TL. 200-340mm	
No. Fish Examined	30		14		14	
No. Empty Stomachs	9		14		1	
Species	%	Av.#	%	Av.#	%	Av.#
Annelid Worms						
Scolecolepides viridis	27	7			21	20
Hypaniola grayi						
Ribbon Worm						
Tubulanus pellucidus						
Crustaceans						
Neomysis americana						
Leucon americanus	7	3			7	1
Cyathura polita	17	2			14	1

Table 7. (Continued)

	April Sampling Period					
	White perch TL. 110-260 mm		Striped bass TL. 200-310mm		Catfish TL. 200-340mm	
Item	%	Av.#	%	Av.#	%	Av.#
Chiridotea almyra						
Edotea triloba						
Gammarus sp.	7	2				
Leptochierus plumulosus					14	3
Corophium lacustre	33	3			29	3
Rithropanopeus harrisi						
Amphipod (unid.)						
Copepod	20	4			57	12
Cladocer						
Ostracod					36	7
Insect						
Chironomid larvae	27	4			86	34
Chironomid pupae	10	4			29	2
Mollusk						
Rangia cuneata	7	1			36	25
Fish and Fish parts					14	1
Fish Eggs						
Herring	33	107			7	4
White perch	27	26			21	3
Detritus	40				43	
Unid. material	7					
Unid. parasitic worm	7	1			21	3

Table 7. (Continued)

	May Sampling Period			
	White perch TL. 150-260mm		Catfish TL. 230-620mm	
Item				
No. Fish Examined	32		12	
No. Empty Stomachs	11		2	
Species	%	Av.#	%	Av.#
Annelid Worms				
Scolecolepides viridis	19	6	42	15
Hypaniola grayi				
Ribbon Worm				
Tubulanus pellucidus				
Crustaceans				
Neomysis americana				
Leucon americanus	9	3	25	1
Cyathura polita	13	2	58	5
Chiridotea almyra	6	6	17	4
Edotea triloba				
Gammarus sp.	33	54	42	54
Leptocheirus plumulosus	19	4	25	3
Corophium lacustre			42	5
Rithropanopeus harrisi				
Amphipod (unid.)	3	1	8	1
Copepod	33	83	8	3
Cldocera	6	12		
Ostracod	6	16		
Insect				
Chironomid larvae	22	17	67	3
Chironomid pupae	13	2	25	1

Table 7. (Continued)

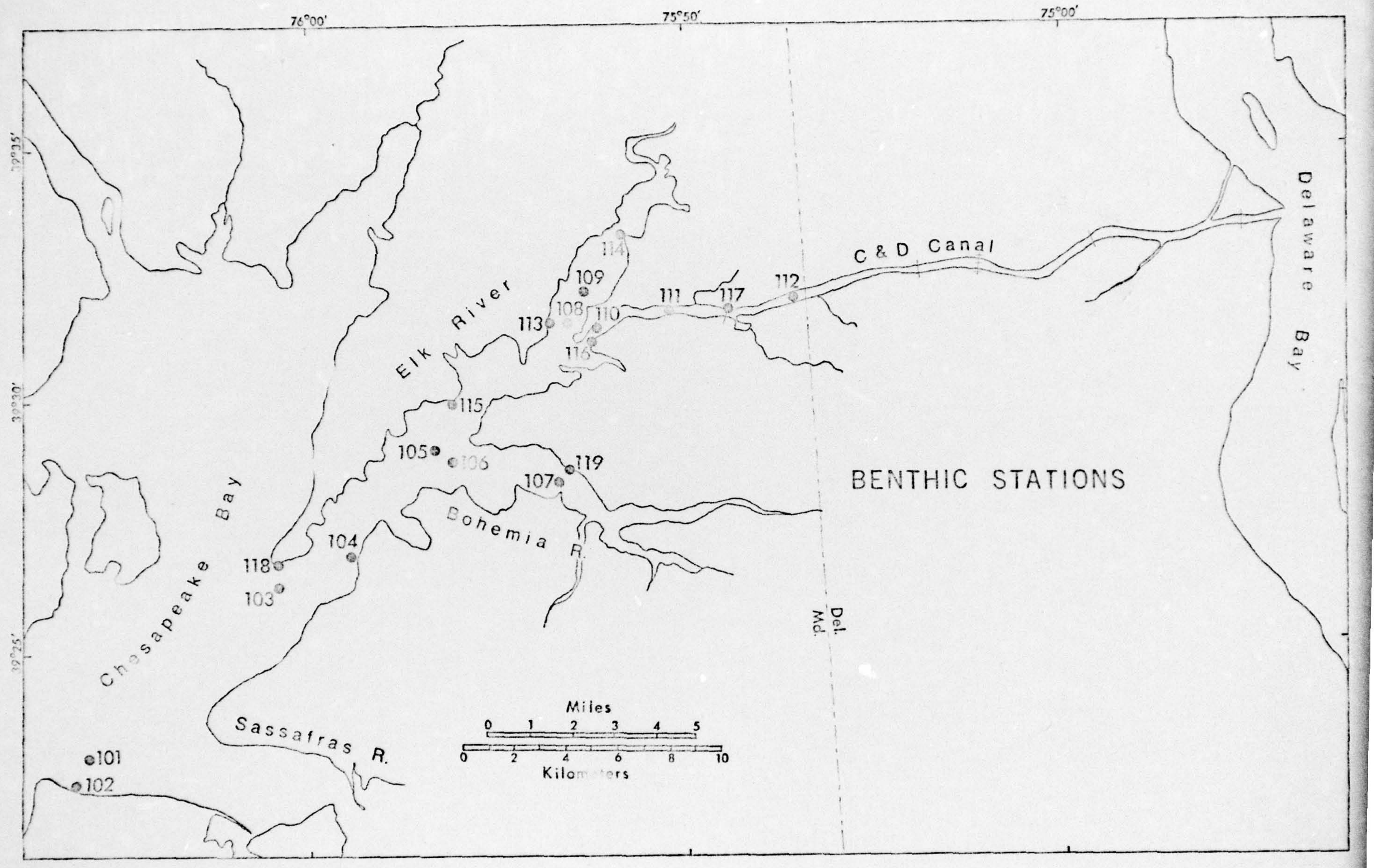
May Sampling Period

Item	White perch TL. 150-260mm		Catfish TL. 230-620mm	
Mollusk				
Rangia cuneata	6	1		
Fish and Fish parts				
Fish eggs				
Herring	3	2	8	5
White perch			8	16
Detritus	17		58	
Unid. Material	13			
Unid. Parasitic Worm	6	8		

Table 8. Percentage of numbers of different food items found in 46 white perch, 9 catfish, and 10 yellow perch stomachs. Also shown are percentage of comparative groups invertebrates found in bottom sediments from the 19 sampling stations. Detrital and unidentified material not presented.

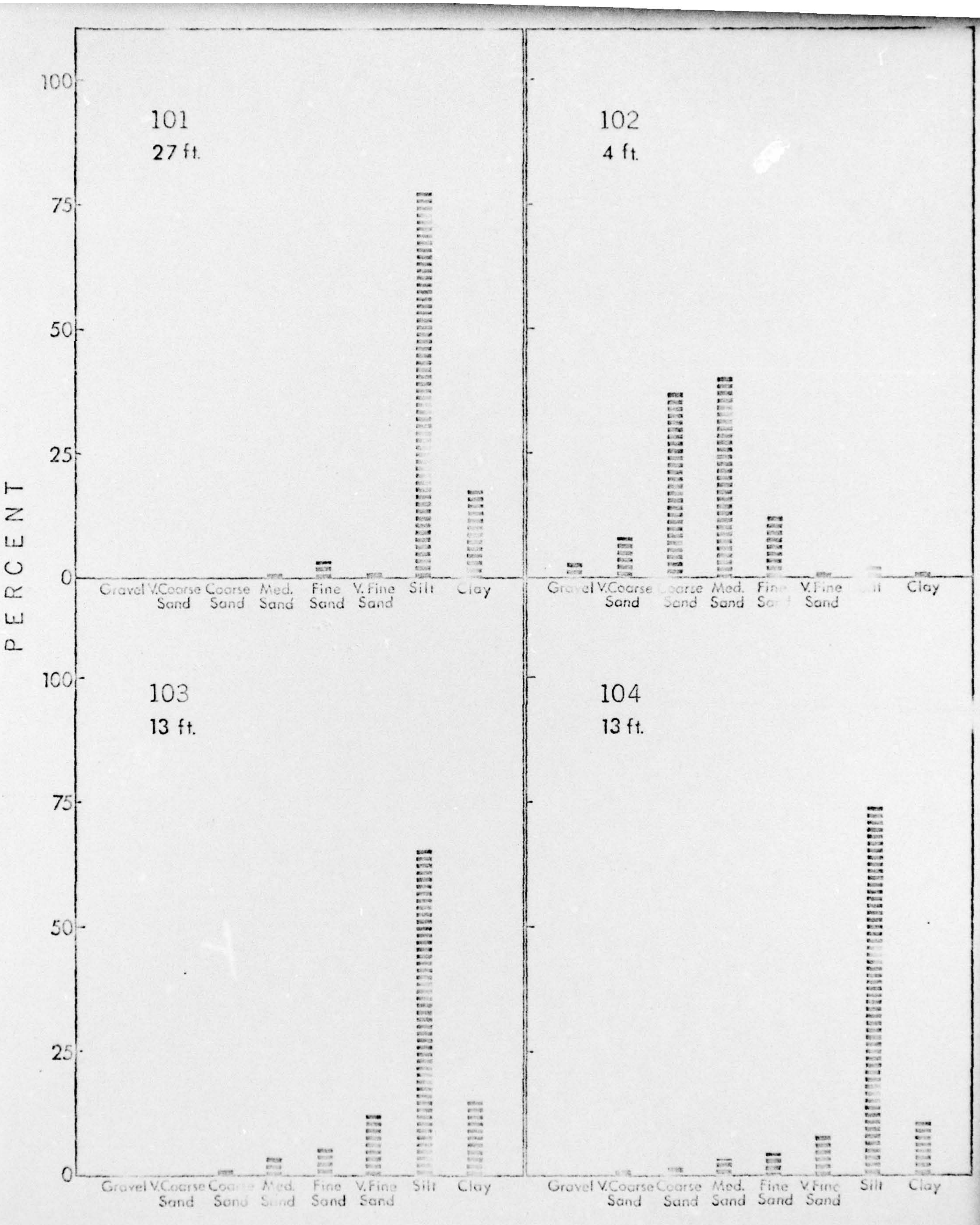
Food	Stomachs	Bottom Sediments
Ribbon worms		
1. Nemertean	.16	.07
Total	.16	.07
Annelid worms		
2. Oligochaetes	-0-	45.
3. Polychaetes	76.	25.
Total	76.	70.
Crustaceans		
4. Mysids	.37	-0-
5. Cumaceans	.05	.39
6. Isopods	.63	3.
7. Amphipods	3.	5.
8. Copepods	7.	-0-
9. Ostracods	7.	-0-
10. Decapods	.11	.02
Total	18.10	8.41
Insect larvae		
11. Chironomid	3.	19.
Total	3.	19.
Mollusks		
12. Rangia	.05	1.
Total	.05	1.

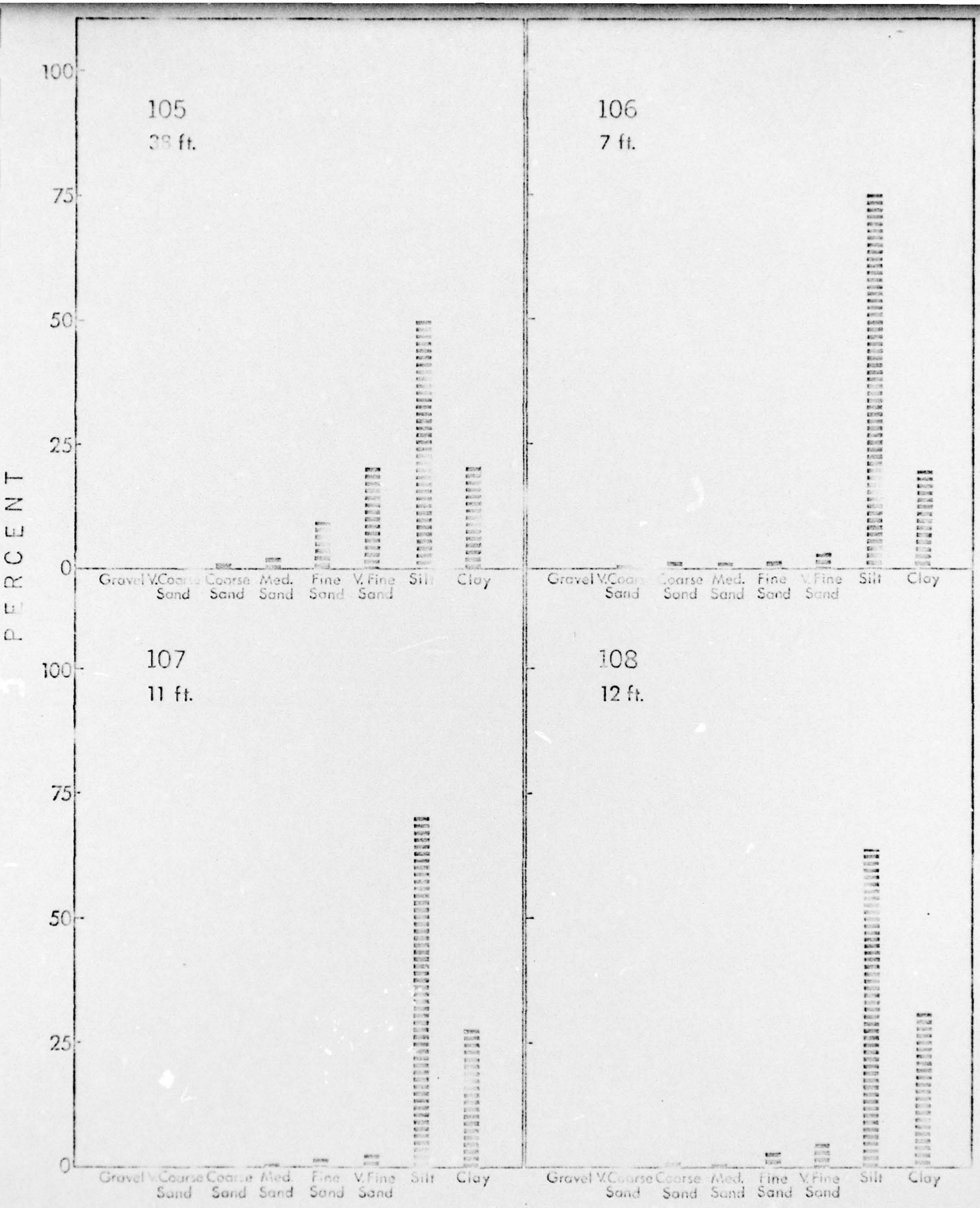
Fig. 1. Benthic sampling stations in Maryland waters of the C and D Canal region.

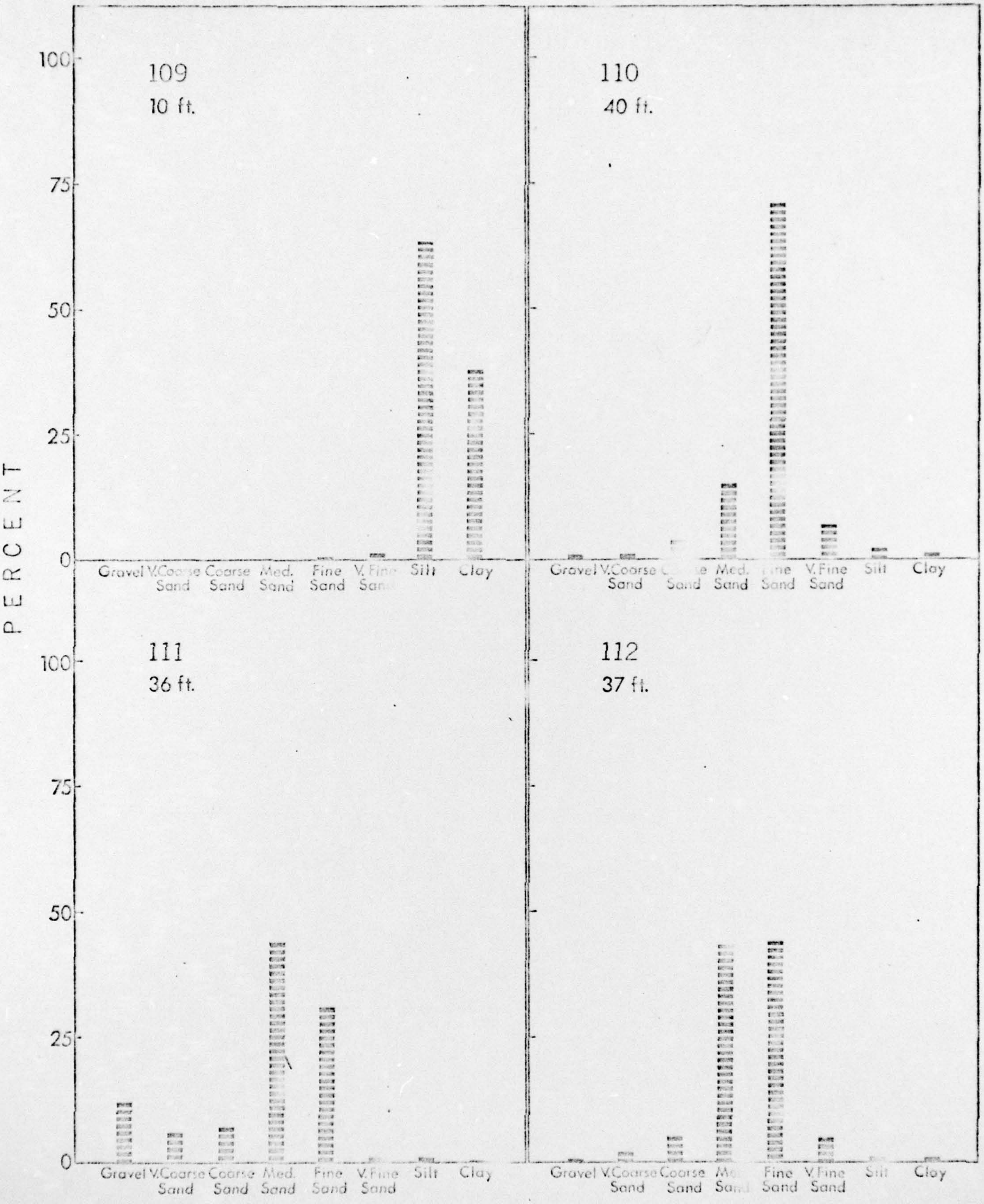


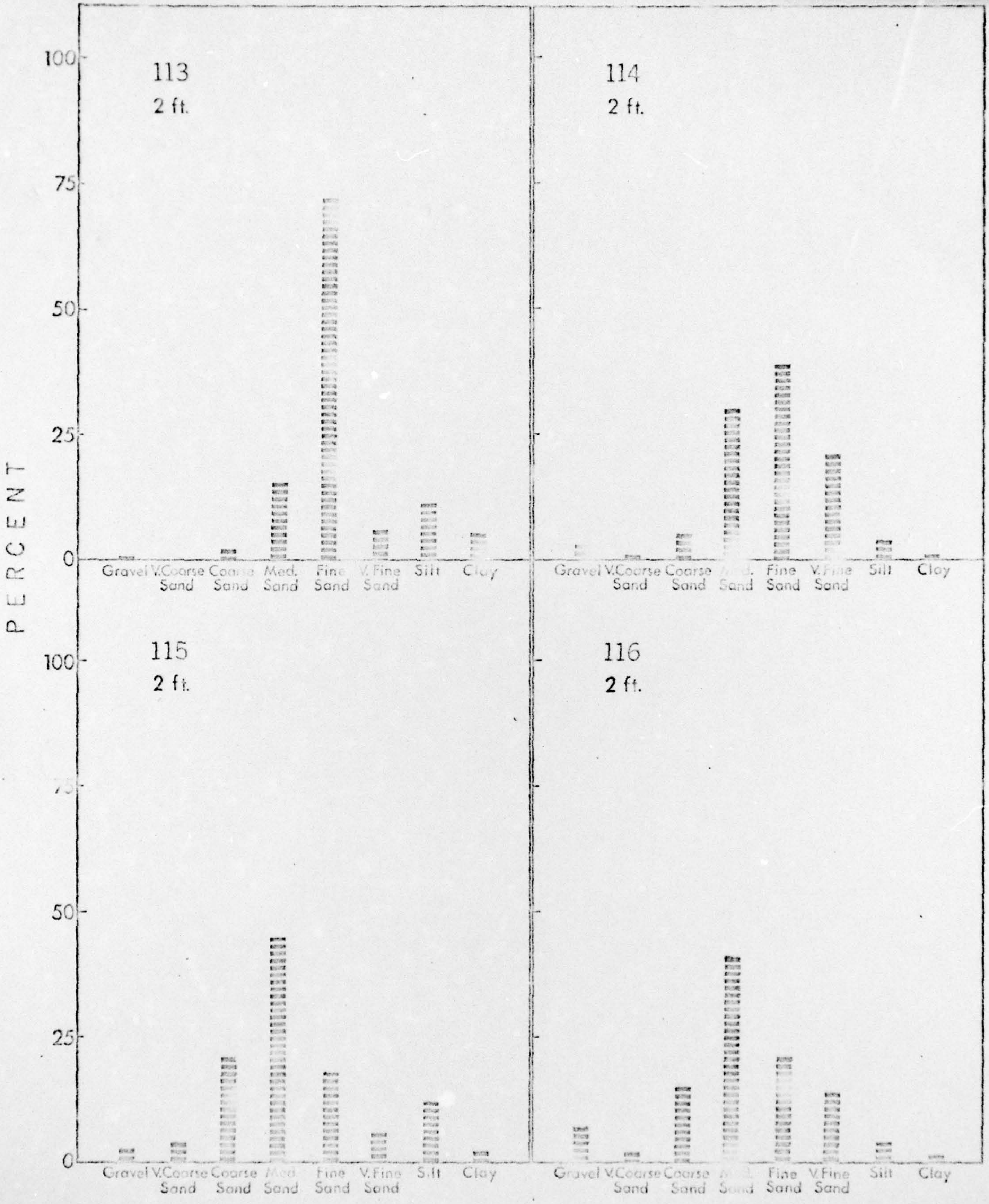
BENTHIC STATIONS

Fig. 2. Results of bottom sediment grain-size analysis for each sampling station (101-119). Water depth for each station is given below the station designation.


PERCENT
100
75
50
25
0
101
27 ft.
102
4 ft.
103
13 ft.
104
13 ft.
Gravel
V.Coarse Sand
Coarse Sand
Med. Sand
Fine Sand
V. Fine Sand
Silt
Clay


PERCENT
100
75
50
25
0
105
38 ft.
106
7 ft.
107
11 ft.
108
12 ft.
Gravel
V. Coarse Sand
Coarse Sand
Med. Sand
Fine Sand
V. Fine Sand
Silt
Clay


PERCENT
100
75
50
25
0
109
10 ft.
110
40 ft.
111
36 ft.
112
37 ft.
Gravel
V.Coarse Sand
Coarse Sand
Med. Sand
Fine Sand
V.Fine Sand
Silt
Clay


PERCENT
100
75
50
25
0
113
2 ft.
114
2 ft.
115
2 ft.
116
2 ft.
Gravel
V.Coarse Sand
Coarse Sand
Med. Sand
Fine Sand
V.Fine Sand
Silt
Clay

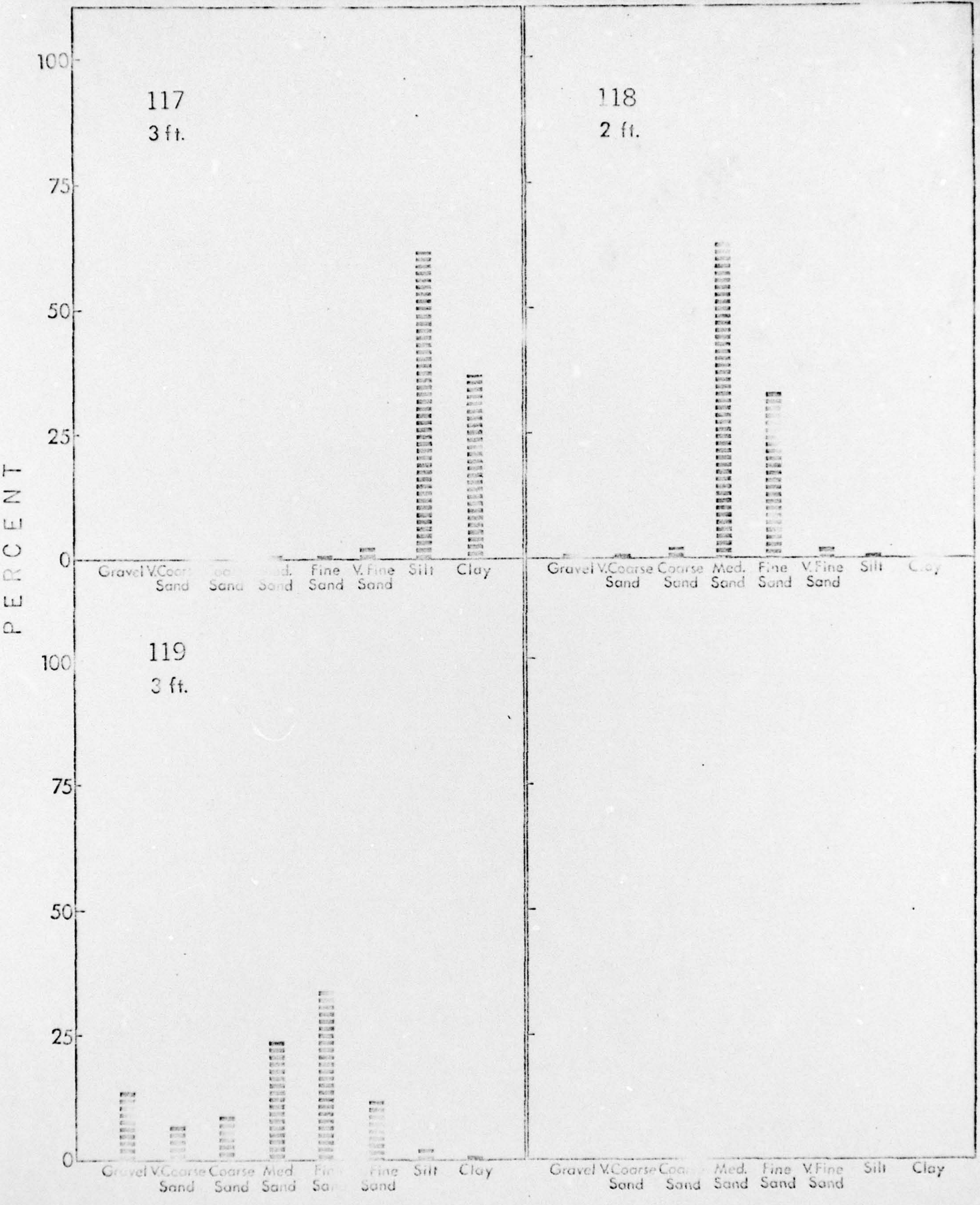
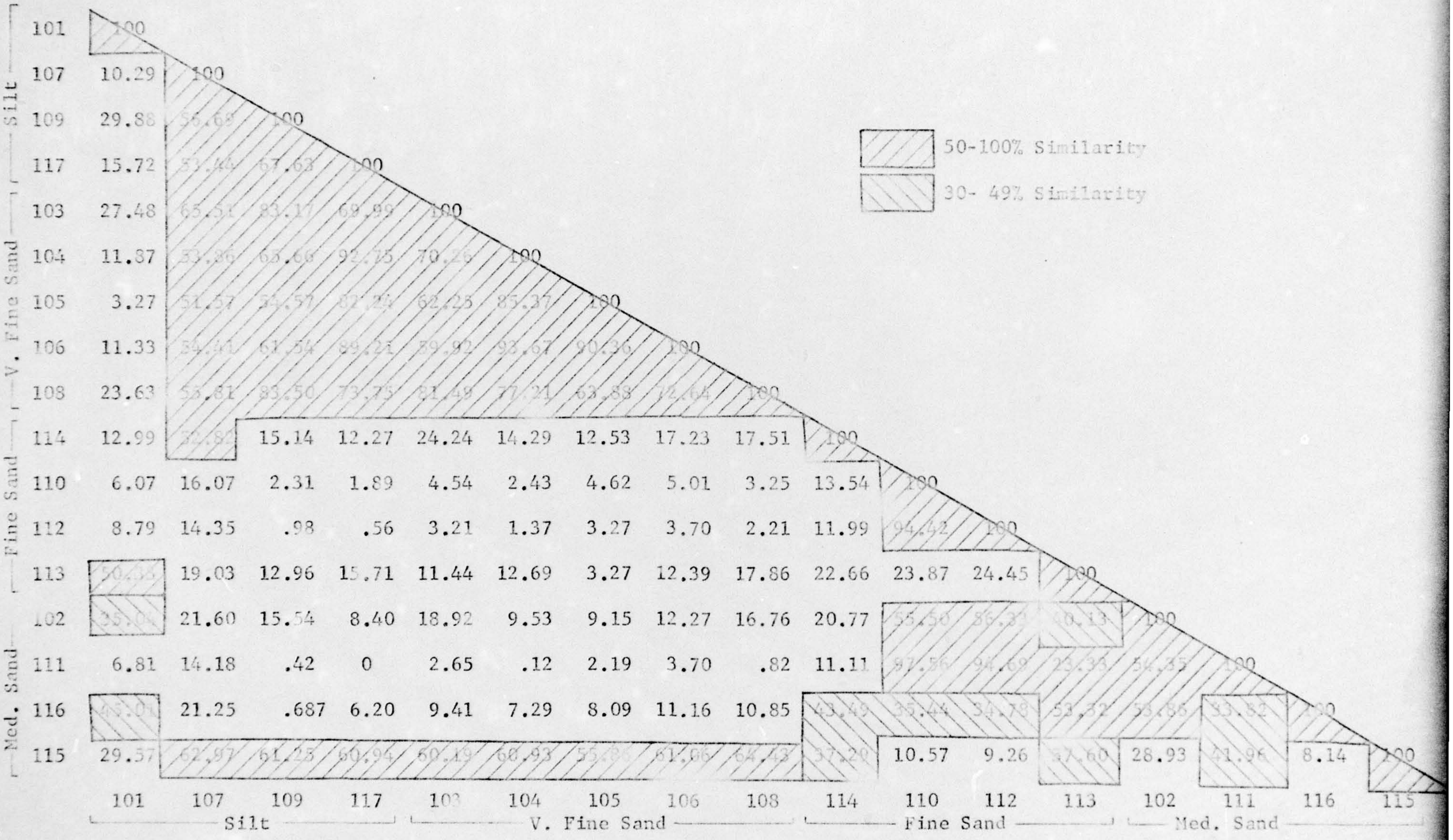

PERCENT
100
75
50
25
0
117
3 ft.
118
2 ft.
119
3 ft.
Gravel
V.Coarse Sand
Coarse Sand
Med. Sand
Fine Sand
V. Fine Sand
Silt
Clay

Figure 3. Trellis diagram showing average faunal index of affinity for each pair of sampling stations for March. Stations 118 and 119 are omitted because no samples were taken.



Silt	101	100																
	107	10.29	100															
	109	29.88	56.68	100														
	117	15.72	53.44	67.63	100													
V. Fine Sand	103	27.48	65.51	83.17	69.99	100												
	104	11.87	53.86	65.66	92.75	70.26	100											
	105	3.27	51.57	54.57	82.24	62.25	85.37	100										
	106	11.33	54.41	61.54	89.21	59.92	93.67	90.36	100									
	108	23.63	55.81	83.50	73.75	81.49	77.21	63.88	72.64	100								
Fine Sand	114	12.99	32.82	15.14	12.27	24.24	14.29	12.53	17.23	17.51	100							
	110	6.07	16.07	2.31	1.89	4.54	2.43	4.62	5.01	3.25	13.54	100						
	112	8.79	14.35	.98	.56	3.21	1.37	3.27	3.70	2.21	11.99	94.42	100					
	113	50.38	19.03	12.96	15.71	11.44	12.69	3.27	12.39	17.86	22.66	23.87	24.45	100				
Med. Sand	102	35.04	21.60	15.54	8.40	18.92	9.53	9.15	12.27	16.76	20.77	55.50	86.33	40.13	100			
	111	6.81	14.18	.42	0	2.65	.12	2.19	3.70	.82	11.11	97.56	94.69	23.33	54.35	100		
	116	45.01	21.25	.687	6.20	9.41	7.29	8.09	11.16	10.85	43.49	35.44	34.78	53.32	53.86	33.82	100	
	115	29.57	62.97	61.25	60.94	60.19	68.93	55.86	61.06	64.43	37.20	10.57	9.26	37.60	28.93	41.96	8.14	100
		101	107	109	117	103	104	105	106	108	114	110	112	113	102	111	116	115
		Silt				V. Fine Sand					Fine Sand				Med. Sand			

▨ 50-100% Similarity

▧ 30- 49% Similarity