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EFFECTS OF SCREEN SIZE AND REPLICATION ON THE INFAUNAL TROPHIC INDEX

Most ecologists believe that it is necessary to have multiple samples of benthic organisms to get a statistically reliable evaluation of the populations present at a station. Others prefer to use an exceptionally fine screen that collects organisms smaller than one millimeter. In the experiments cited here, we sampled and analyzed ten replicates from each of four different types of bottoms at the same depth; these were sieved through two sizes of screen to determine the effect on Infaunal Trophic Index (ITI) determinations.

We have found that single benthic samples, properly taken and screened through a 1.0-mm screen, are entirely adequate for one type of evaluation of benthic organisms (Infaunal Trophic Index) and that the statistical variation of the Index with analysis of multiple samples is small. These data indicate that Infaunal Trophic Index numbers are statistically accurate within ±5 units at a confidence level of 95 percent and that the coefficient of variation ranges from 1 to 4 percent. This means that properly taken samples need not be replicated for Infaunal Trophic Index measurements and that the processing of samples can be accomplished at considerable savings in terms of time and effort.

METHODS

In May of 1979, we sampled at four stations in Santa Monica Bay, each at a depth of 60 meters (Figure 1). These stations were selected on the basis of previously determined Infaunal Trophic Index values of about 60, 70, 80, 90, and were located with LORAN C, a navigation system that gives repeatable position to within 20 meters.

An anchored buoy was used to establish the center of the sampling station. The bow of the vessel, M.V. Marine Surveyor, was held at the buoy, and samples were taken from the stern. The vessel was repositioned after each replicate. Ten replicate, 0.1-sq-meter modified Van Veen grab samples were taken at each station.

The description of each benthic grab sample included LORAN C coordinates, water depth, replicate number, qualitative data on sediment texture, color, and odor, and any abnormal sampling characteristic. The biological samples were sieved through a pair of stacked screens--a 1.0-mm mesh diameter container placed on top of a 0.5-mm mesh diameter container. The samples were then gently washed with sea water to remove debris and sediment finer than 0.5 mm in diameter. The remaining debris, composed of animals, sediment, and organic material, was transferred to plastic whirl-pack bags and fixed in a 10 percent borax-buffered formalin/seawater solution. These samples were returned to the laboratory where the formalin was rinsed from the debris with freshwater 2 to 5 days following

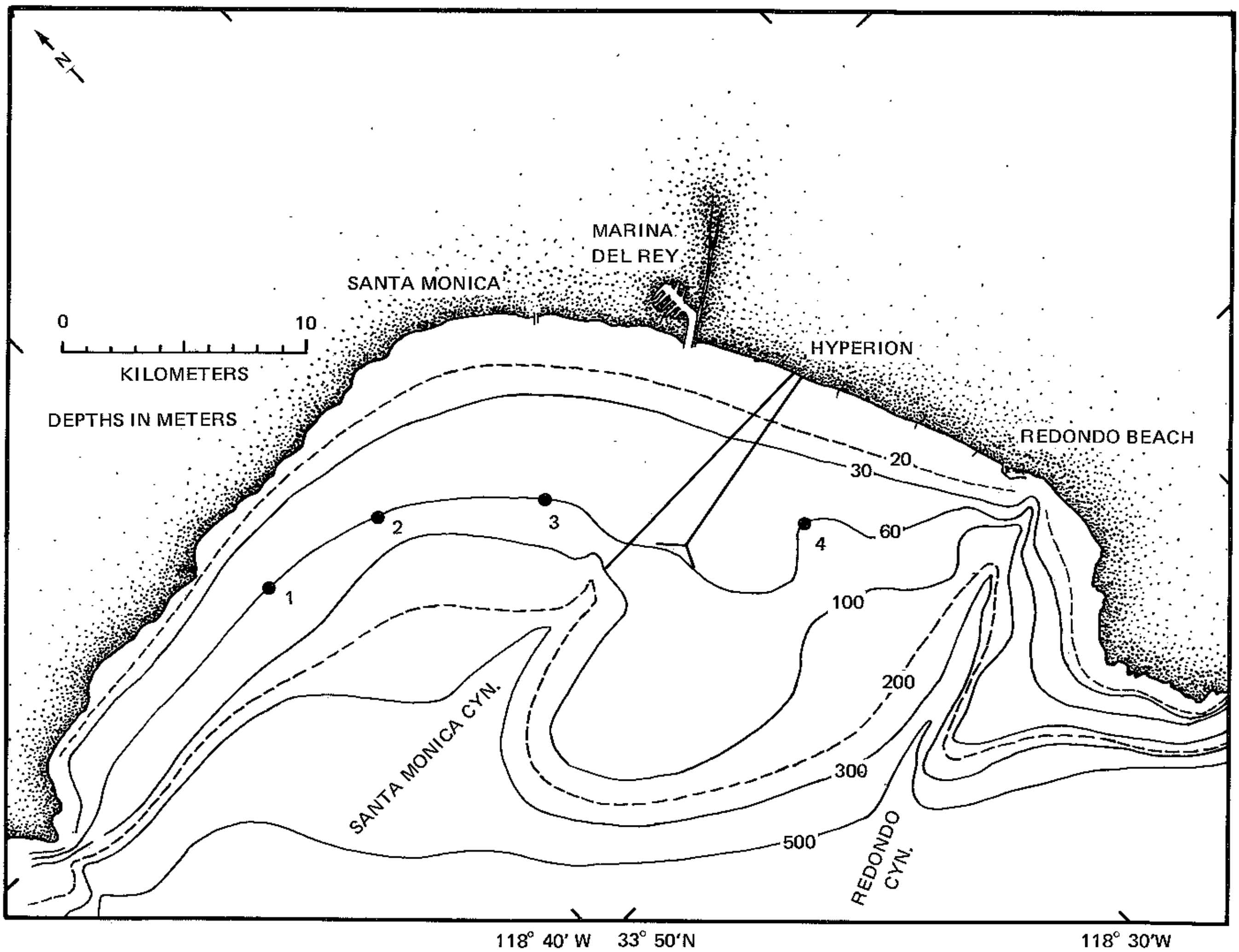

Figure 1. Station locations for study of the effects of screen size and replication on Infaunal Trophic Index values, 1979.

fixation. The samples were preserved in 70 percent ethanol until they were sorted and identified in the laboratory.

Sediment samples for chemical analysis were removed from the upper 2 cm of the sediment from an eleventh grab sample and placed into appropriately cleaned containers. Samples for trace metals and sediment-bound organic materials were place into acid-rinsed plastic containers; samples for chlorinated hdyrocarbons were placed in kiln-dried, acetone-rinsed, foil-capped glass containers. Both types of samples were rapidly frozen on dry ice in the field and retained in freezers until ready for analysis.

The samples were processed in the standard fashion described by Word and Mearns (1979). The animals were identified to Infaunal Trophic Index categories, completely enumerated, and weighed.

RESULTS

Mean Infaunal Trophic Index values at these stations ranged from 54.7 to 91.9 on the 1.0-mm sieve and from 56.2 to 82.3 on the combined 1.0-mm and 0.5-mm sieve (Table 1). The values for Station 1 and Station 2 on the 1.0-mm sieve were significantly different from the values on the combined 1.0-mm and 0.5-mm sieves. The average Index value of three of the four stations was less on the combined screens than on the 1.0-mm sieves; at the remaining station, the value on the combined screens was greater. The coefficients of variation were sufficiently low so that one sample at each station adequately represents that station for comparisons of ±5 Infaunal Trophic Index units at a 95 percent confidence level.

Table 1. Infaunal Trophic Index values for four stations in Santa Monica Bay, May 1979. Values are means and standard errors; coefficients of variation are given in parentheses. A total of 40 samples were taken; all were screened through a 1.0-mm screen, and 20 were screened through a 0.5-mm screen.

	Screen Size	
	1.0 mm (N = 10)	1.0 + 0.5 mm (N = 5)
Station 1	91.0 ± 1.0 (3.3%)	82.3 ± 1.4 (2.3%)
Station 2	86.1 ± 0.8 (2.8%)	82.2 ± 0.9 (2.3%)
Station 3	54.7 ± 0.7 (3.8%)	56.2 ± 0.3 (1.4%)
Station 4	66.5 ± 0.2 (1.0%)	64.9 ± 0.3 (0.9%)

The differences in relative percentages of each group of Index species on the 1.0-mm and combined screens were not significant at two of the four locations. The two stations that did show significant differences were those with the higher Infaunal Trophic Index values. In both cases, the relative importance of Group I species decreased while the relative importance of Group II species increased; this was especially evident at Station 1 (Table 2). We found that these differences were due to the increased abundances of Group II organisms and decreased abundances of Group I organisms when screen sizes of 0.5 mm were used (Table 3). We also found that Group IV taxa were more abundant on the 0.5-mm sieve, and Group III taxa remained relatively the same or were slightly less abundant.

Table 2. Contribution of each Infaunal Trophic Index group (average percent) to the total number of ITI species taken at four stations in Santa Monica Bay, May 1979. Group I species decrease in importance and Group II species increase in importance when samples are sorted through a 0.5-mm screen rather than a 1.0-mm screen.

	Group I	Group II	Group III	Group IV
1.0-mm Screen (N = 10)				
Station 1	72 ± 4	27 ± 4	0.4 ± 0.1	0
Station 2	60 ± 2	38 ± 2	2.0 ± 0.2	0
Station 3	9.0 ± 1	45 ± 1	45 ± 2	0.1 ± 0.1
Station 4	8.0 ± 2	81 ± 3	10 ± 2	1.0 ± 0.3
1.0- and 0.5-mm Screen (N = 5)				
Station 1	50 ± 4	48 ± 4	2.0 ± 0.2	1.0 ± 0.3
Station 2	50 ± 2	44 ± 2	3.0 ± 0.1	1.0 ± 0.3
Station 3	10 ± 0.6	50 ± 1	39 ± 1	1.0 ± 0.3
Station 4	8.0 ± 2	81 ± 3	10 ± 2	1.0 ± 0.2

Table 3. Abundance of organisms (mean ± std. error) in Infaunal Trophic Index groups taken at four stations in Santa Monica Bay, May 1979.

	Group I	Group II	Group III	Group IV
1.0-mm screen (N = 10)				
Station 1	234 ± 28	74 ± 21	1.0 ± 0.7	0 ± 0
Station 2	235 ± 14	160 ± 22	7 ± 1	0.8 ± 0.9
Station 3	76 ± 6	394 ± 13	386 ± 48	2 ± 2
Station 4	57 ± 4	975 ± 94	58 ± 10	2 ± 1
0.5-mm screen (N = 5)				
Station 1	28 ± 4	180 ± 11	7 ± 2	3 ± 2
Station 2	72 ± 11	111 ± 9	9 ± 0.9	5 ± 1
Station 3	45 ± 11	237 ± 55	103 ± 14	14 ± 2
Station 4	52 ± 18	194 ± 9	83 ± 13	18 ± 4

Several taxa contributed most to the observed differences. Abundances of the polychaete *Mediomastus* sp. were enhanced on the 0.5-mm sieve; in contrast, the ophiuroid *Amphiodia* sp., tube-dwelling polychaetes, and the pelecypod *Axmopseda serricata* normally decreased in relative abundances. Past studies have also shown this in that certain polychaete taxa are more abundant on 0.5-mm sieves, but ophiuroids and most molluscs are more abundantly found on the 1.0-mm fraction of the sample (Word et al. 1975).

DISCUSSION

Replication

Current and proposed governmental monitoring requirements for the number of replicates needed to characterize a benthic community range from three to five. Most benthic ecologists agree that this is an acceptable number of replicates. However, based on an equation to determine the number of replicates needed to adequately sample a population (Sokel and Rohlf 1973), we feel that the data presented here show that single samples of 0.1 sq meter of the bottom are sufficient to statistically characterize these four very different kinds of stations within a range of 5 Infaunal Trophic Index units at the 95 percent confidence level. This statement was found to be true using either of two screen sizes (1.0 mm and 0.5 mm) and indicates that single samples at stations with soft sediments and with Infaunal Trophic Index values ranging from 54 to 91 can be contoured on charts at intervals of 10 index units.

Bascom (1978) contoured intervals of 10 index units on data for over 300 benthic stations using a single sample per station. He identified only three stations that appeared unusual on the basis of these contours, and further research at those stations indicated that rocky substrates rather than sampling techniques were responsible for the variation (see Bascom 1978).

Screen Size

The effect of using 0.5-mm sieve screens on Infaunal Trophic Index values was to push the resultant Index value toward 67. The Infaunal Trophic Index value at Station 4 decreased from 67 to 65, when the 0.5-mm screen was used. This difference is not significant ($t = 0.4$, $p \leq 0.05$) and is well within the 95 percent confidence limits of ± 5 units. Infaunal Trophic Index values of 67 are dominated by Group II taxa; these species become relatively more abundant on the 0.5-mm sieve because (1) the dominant Group I organisms (*Amphiodia* sp.) are too large to pass through the 1.0-mm sieve and (2) certain small polychaetes (e.g., *Mediomastus* sp.) are more abundant on the smaller screens.

A special core sample was taken at one station (Table 4). This core sample was unscreened, and a determination of the number of organisms present in this type of sample was made. The objective of this effort was to determine the number of organisms lost by the normal activities of sieving samples for biological analysis. Table 4 presents data on the abundance of organisms recovered at this station using sieve diameters of 1.0 mm and 0.5 mm and unscreened samples.

To answer the question of which screen size should be used during benthic studies of Infaunal Trophic Index values, we must assess the effect of the two screen sizes on sampling variability, the time and cost required to process the sample, and the sensitivity of the Index value for the interpretation of the data.

We found that the effect of screen size (1.0 and 0.5 mm) on sampling variability was detectable but not statistically significant. The costs and time required to process and identify the organisms on a 0.5-mm sieve are normally three

Table 4. Number of organisms per square meter found at one station in Santa Monica Bay and percentage used in calculating the Infaunal Trophic Index (in parentheses).

	1.0-mm Screen	1.0-and 0.5-mm Screen	Unscreened
Mollusca	3,320 (82.8%)	3,470 (88.5%)	5,380
Crustacea	3,335 (92.9%)	7,485 (82.7%)	18,038
Polychaeta	2,150 (92.5%)	4,370 (81.7%)	18,354
Ophiuroidea	20 (100%)	20 (100%)	-
Echinodermata	10 (0%)	10 (0%)	-
Misc. Phyla	100 (10%)	210 (4.7%)	2,400,000*
Total	6,930 (84.8%)	15,880 (80.8%)	2,450,000*

*Estimate

times those that would have been expended on a 1.0-mm sieve. Therefore, to be cost effective, samples collected on a 0.5-mm sieve must provide a more sensitive tool for assessing community feeding changes. Instead, a decreased sensitivity is observed because Index values are pushed toward 67 due to the increased abundances of the smaller Group II taxa. It also appears that Group IV taxa become more abundant on a 0.5-mm sieve and would therefore push the lower values (<33) towards a value of 0. Thus we decrease the sensitivity at the higher Index levels (67 to 100) and also at the medium low values (0 to 40).

IMPLICATIONS

The Infaunal Trophic Index is based on the abundance of organisms. Many species have varying numbers of successful recruits, different sizes at recruitment, different life spans, and growth rates. These parameters can provide vastly different maximum abundances of each species. The situation is further complicated by the size of the infauna in that smaller organisms are normally more abundant than the larger ones. These smaller organisms are primarily Group II and IV species and generally have a much shorter life span, growth period, and maximum size. Because the quantity of organic material required to grow a smaller organism to adult size is less than for a larger organism, it seems likely that more smaller individuals will be supported per unit of organic material than large ones. Thus an Infaunal Trophic Index using biomass of tissue would likely be a better, more sensitive index of the communities feeding relationships than their abundances.

Another technique would be to use screen sizes that will filter out the numerous smaller individuals so that the abundances of these taxa are more nearly comparable to the larger species. The selection of the screen size for this work should be based upon the applicability of the Index values to field studies in explaining patterns of occurrences. At the present time, 1.0-mm sieves seem to give better, more sensitive measures of communities than do 0.5-mm sieves.

Benthic studies that monitor changes in the environment due to man or large-scale natural phenomena are extremely expensive. This is in part because of the large number of specimens requiring identification and the large number of replicates required to statistically compare one station to another. Both of these factors can be decreased when using the Infaunal Trophic Index. Single samples per station can be analyzed, and 1.0-mm sieve screens can be used. Present day sampling requirements are for up to 3 to 5 replicates per station, and trends are toward using smaller sieve diameters (e.g., 0.5 mm). A 93 percent savings can be realized or up to 15 times as many stations can be sampled for the same amount of time and effort expended when the Infaunal Trophic Index is used, without loss of sensitivity to functional changes in benthic communities.

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