UMBS

Biodisk Filter Systems - Are They Worth the Cost? A Study of the Cheboygan River.

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In 1979, the Cheboygan Sewage Treatment Plant installed a "Biodisk Filter System" for tertiary treatment of city sewage. A technologically advanced system, it has been installed in very few American cities, and cost Cheboygan taxpayers $4, 154,306.00. The biodisk filter has been in operation a little over one year. In order to determine whether the use of this very expensive system has had a significant effect on the water quality of the Cheboygan River, our class undertook this project. Earlier studies of the Cheboygan River done by former members of this class provided a basis for comparison of water quality before installation of the biodisk filter.

Summary of Evidence

On July 15, 1980, rocks at each station were examined for macroinvertebrate fauna. All organisms found were preserved in 95% ethanol and identified at the laboratory to the ordinal or family level. On the same day, three cement tiles were placed at each station to serve as artificial substrates for invertebrate colonization. All substrates were removed on August 5, 1980 and organisms found were preserved and identified as before. For those stations where counts were made of the organisms, the Shannon-Weiner Diversity Index was calculated for the purpose of comparison with previous UMBS studies of the Cheboygan River site. In order to maximize the value of comparative data, all stations sampled were identical to those of the previous studies with the exception of Station 4, which was not sampled this year.

Observational Data

Our group observed a considerable amount of small boat traffic on the river, in addition to a Coast Guard vessel and several barges or tugs. At Stations 1 and 2 we found most of the rocks and fallen logs in the shallow water to be covered with filamentous algae and silt, and the water to be considerably turbid.

Artificial substrates were covered with a fine layer of silt after they were removed from the water, indicating that at least the top layer of the substrate near the shore is composed of fine sediments subject to displacement. Bottom samples were taken with dredges between the shoreline and the center of the river, and showed patches of coarse gravel and clay. No fish or emergent or submergent aquatic macrophytes were observed near the shoreline. Aquatic vegetation was quite absent.

Numerical Data

Counts and identifications of aquatic taxa are presented in Tables 1 and 2.

Analysis and Conclusions

Fauna

Special note should be taken of the following aspects of the faunal data:

1. The greatest numbers of organisms were found at Station 1, the control station, and Station 6, which was out on the jetty and therefore subject to more of a mixture of lake and river water than Stations 2, 3, 5, and 7 along the river. This was true for both natural and artificial substrates with the exception of Station 7, which is discussed below.

2. The largest numbers of taxa were again found at Stations 1 and 6 for artificial substrates, and at Stations 1, 6, and 7 for natural substrates.

3. The smallest numbers of organisms were found at Stations 2, 3, 5, and 7. Stations 2, 3, and 5 are all close to or on the same side and downriver from the sewage outfall. Station 7 is discussed below.

4. Station 7 shows opposite characteristics from natural to artificial substrates (See Tables 1 and 2). This could be due to sampling technique or to a faunal complement which does not like artificial substrates, since none of the taxa found on natural substrates were also found on artificial substrates.

5. At least half of the taxa found in our study are represented by very few individuals, indicating an overall lack of number and diversity of aquatic macroinvertebrates in the Cheboygan River.

We found considerable differences in the total numbers and types of fauna distributed at the study sites in comparison to previous work on the Cheboygan River (See Table 3). Although similar sampling methods were used, the changes in faunal distribution and diversity are a function of several influencing factors. In particular, it is important to cite differences between this year's study and that done in 1979 in order to distinguish the possible influence of the improved sewage effluent from the treatment plant.

The total numbers of organisms and taxa found on artificial substrates were less than those found in the 1979 survey. These differences are probably due to the shorter period of colonization in our study. Total numbers of taxa for for 1980 indicate greater numbers for the natural substrates at least at Stations 1, 5, and 7. Data for the 1979 study show that this difference is not shown, since the colonization of artificial substrates included as many or more taxa than the natural substrates for most stations.

Diversity Index

The Shannon-Weiner diversity index was calculated for Stations 1, 2, 3, 6, and 7 where counts of organisms had been taken. Diversity for the control station was the lowest of all values cited in previous surveys (See graph Fig. 2). Lowest diversity of all stations was calculated for Station 3, just below the outfall and highest diversities were found at Stations 6 and 7 near the jetty. Diversity indices calculated as such are difficult to interpret for several reasons. Unlike previous studies, extremely small sample sizes were used, and it has been suggested that samples containing less than 100 specimens should be evaluated with caution if at all (EPA, 1973). All samples except Station 6 contained less than 100 individuals. In addition, comparison with last year's study using a simple #taxa/# individuals diversity index was confounded because there was such a great difference in sample size. It is difficult, then, to assess the macroinvertebrate community based on our calculations of the Shannon-Weiner or other indexes, but what data we have shows no considerable change since 1979.

Indicator Species

Evaluations of water quality based on indicator species are not possible as all organisms were identified only to the ordinal or family level. It can be noted, however, that all of the animals found were those that can be considered pollution tolerant. The only representatives of the Ephemeroptera, a fairly intolerant group, were those of Calnis sp., which one author has cited to be the hardiest of mayfly nymphs (Hilsenhoff, 1977).

In general, the number of macroinvertebrate taxa found in the Cheboygan River is considerably less than would be expected in a healthy river system, with little significant change from 1979, when the biodisk filter was not yet in operation.

Recommendation

From our analysis and observations, it is clear that the water quality of the Cheboygan River is quite low. The biodisk filter system may indeed significantly improve the quality of the effluent itself, although we have no information regarding this aspect of the problem. However, any improvement effected by the new system is overridden by the complex set of pollutants introduced by other point and non-point sources such as street sewers and boats. In order for the biodisk filter to improve the quality of the river as a whole, all effluents and storm drains would have to be shunted through the sewage treatment plant. This would involve a massive expenditure which would again decrease the overall efficacy of the biodisk filter system. In addition, it would have no effect on boat traffic, which would persist as a source of pollutants. For these reasons, we come to the conclusion that the money spent on the biodisk filter system is not justified by any tangible improvement in water quality of the Cheboygan River.

Recommendations Concerning Future Installations

Unless the cost of installing biodisk filter systems decreases drastically, we can not recommend them for complex sys tems such as the Cheboygan River. In a simple system where a sewage treatment plant is the major source of pollutants, or when designing an entire city system where all storm sewers and industrial effluents could be shunted through the sewage treatment plant, a biodisk filter should be seriously considered as an alternative for tertiary sewage treatment. However, in a complex, multieffluent system, unless great ghanges are made in industrial effluent quality criterion and control of storm sewers, the improvement effected by tertiary treatment of sewage with a biodisk filter system is nothing more than a drop in the bucket to the tune of a cool four million dollars.

TABLE 1: DISTRIBUTION OF FAUNA ON ARTIFICIAL SUBSTRATES

Taxa	(CONTROL) STATION 1	STATION 2	STATION 3	STATION 5	STATION 6	STATION 7
Chironomidae	2					1
Physa	2					
Dugesia	14			PRESENT		9
Trichoptera	2	3	4		4	1
Ephemeroptera						
Gastropoda				PRESENT		
Amphipoda	6		5	PRESENT		
Isopoda	1		1		2	
Hydrachnellae	2	1			1	
Diptera		1	8		68	
Crustacea		2				
Mollusca		4				
Tricladida					30	
Decapoda					7	
Pelecypoda					1	
Odonata					1	
TOTAL SAMPLE	29	11	18		114	10
S W I					1.91	3.176

TABLE 2: DISTRIBUTION OF FAUNA ON NATURAL SUBSTRATES

Taxa	(CONTROL) STATION 1	STATION 2	STATION 3	STATION 5	STATION 6	STATION 7
Tricladida					10	
Leech						1
Trichoptera	20	2		PRESENT	79	
Arachnida	2					
Diptera	6				30	
Isopoda	11	1		PRESENT	8	5
Gastropoda	4	5		PRESENT	-	
Cladocera	8					
Hemiptera	1					
Amphipoda	5	10		PRESENT	23	18
Chironomidae		1				42
Nematoda						1
Turbellaria				PRESENT		
Decapoda				PRESENT	5	
Ephemeroptera	1			PRESENT	2	5
Coleoptera				PRESENT		1
Odonata					1	
Dugesia						4
TOTAL SAMPLE	58	19			158	77

TABLE 3: DIFFERENCES IN NUMBERS OF TAXA BEFORE (1979) AND AFTER (1980) THE INTRODUCTION OF THE BIODISK FILTER.

TOTAL NUMBER OF TAXA 1979			TOTAL NUMBER OF TAXA 1980		
SITE NO.	ARTIFICIAL SUBSTRATE	NATURAL SUBSTRATE	SITE NO.	ARTIFICIAL SUBSTRATE	NATURAL SUBSTRATE
1	13	11	1	7	9
2	13	9	2	5	5
3	13	9	3	4	—
4	6	10	—	—	—
5	10	12	5	3	8
6	10	9	6	8	8
7	10	10	7	2	8

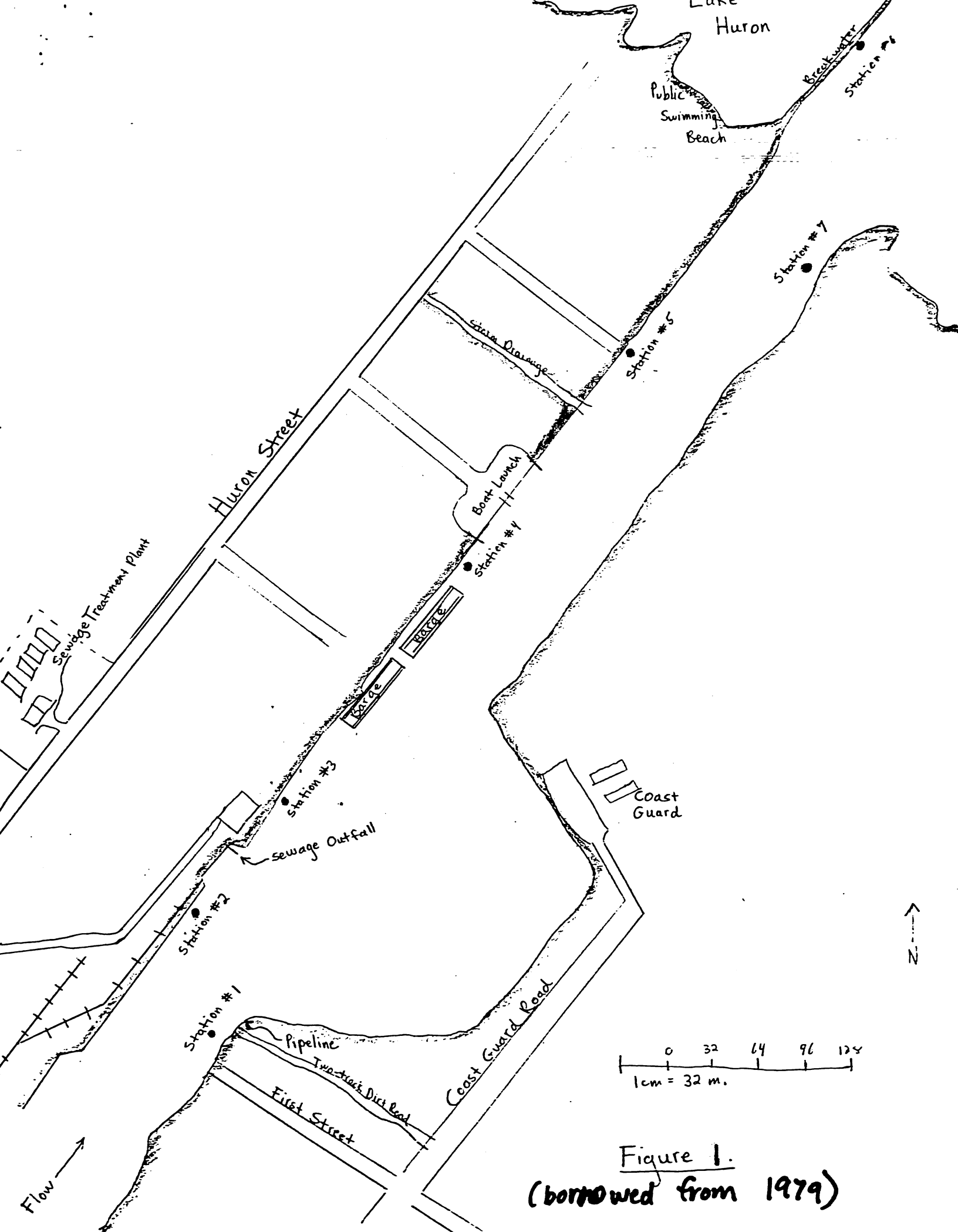

Figure 1.
(borrowed from 1979)

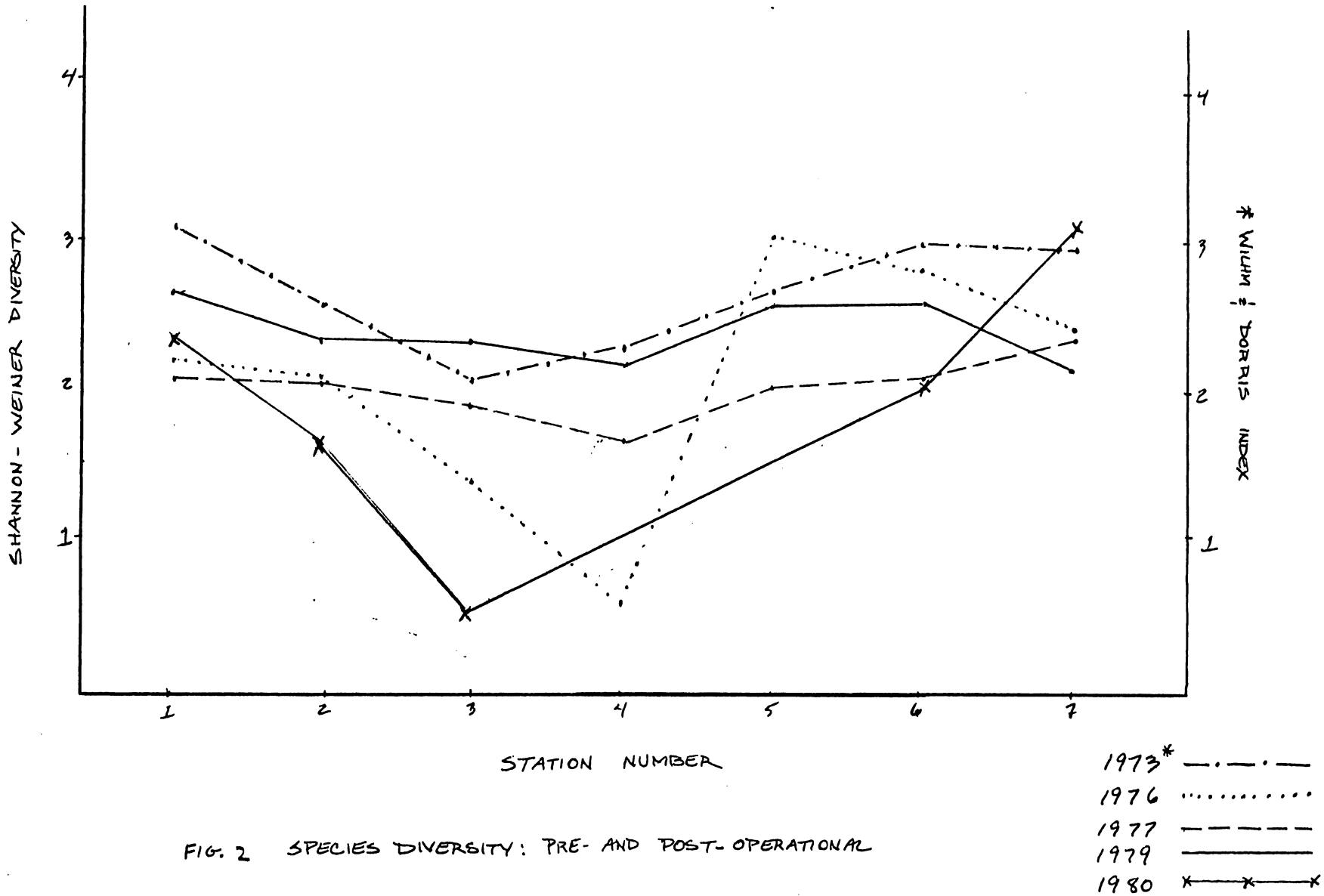

FIG. 2 SPECIES DIVERSITY: PRE- AND POST-OPERATIONAL

References

EPA, 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents

Hilsenhoff, W.L. 1977. Use of arthropods to evaluate water quality of streams. Tech. Bull. No. 100, Dept. Nat. Res., Madison, Wisconsin.