A BIOLOGICAL SURVEY OF THE SUSQUEHANNA RIVER IN THE VICINITY OF YORK HAVEN, PA.

1967 PROGRESS REPORT

prepared for

PENNSYLVANIA POWER & LIGHT COMPANY

and

METROPOLITAN EDISON COMPANY

by

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CONCLUSIONS

1. A biological survey based on macroinvertebrate organisms (bottom organisms) produced 149 species and demonstrated that the Susquehanna River in the vicinity of York Haven was biologically normal from above Threemile Island to Haldeman Riffle.

2. There are strong ecological differences between the river above the York Haven Dam and the river below the dam.

3. The biological structure of the river, as measured by a coefficient of variation, reflects a stable community structure in equilibrium with the environment.

4. The biological materials show a high degree of variance as a product of high species diversity due to ecological differences.

5. One station (Station 5) was found to be aberrant due to high variation in flow characteristics. This station will be deleted from subsequent surveys.

6. One station (Station 8) was found to have water temperatures elevated above normal ambient temperatures, but the increased temperature had not appreciably altered the resident fauna at the station.

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INTRODUCTION

This survey was undertaken in the interests of the Pennsylvania Power and Light Company and the Metropolitan Edison Company. The two companies jointly sponsored the work, which included a study of the Susquehanna River in a stretch extending from above Threemile Island downstream to Haldeman Riffle.

The Survey consisted of a study of the macroinvertebrate fauna (bottom organisms) at each of nine stations. Field work was begun August 7, 1967, and continued through August 18, 1967.

The field work was performed by Drs. Charles B. Wurtz and John S. Penny. Mr. Lynn Ratzell of the Pennsylvania Power and Light Company accompanied the consultants during the field work.

Water quality characteristics were measured by laboratory personnel of the Pennsylvania Power and Light Company.

STATIONS

Nine stations (sampling sites) were collected. The location of each station is indicated on Figure 1, a map of the general area

of investigation. The list of stations with pertinent comments follows.

Station 1. This station was in the riffle area above Threemile Island and between the head of Fall Island and the eastern shore. Along the eastern shore the substrate was anaerobic at depths of two or more feet as indicated by the production of hydrogen sulfide.

Station 2. This station was between the northern tips of Threemile Island and Shelley Island. West off Shelley Island a sandy bottom was found to depths of five feet. Fragments of large unionid clam shells were found here, but no living specimens were taken at any station during the survey.

Station 3. This station extended between the southern tip of Shelley Island and the western shor of Threemile Island at the "Bali Lai" summer cottage. Depths reached ten feet at this station. Anaerobic bottom conditions occurred in depths as shallow as two feet.

Station 4. This station extended from the southern tip of Shelley Island to the southern tip of the next island west of Shelley Island. The station had depths to nine feet, and was characterized by extensive aquatic plant growth. One plant, a species of *Vallisneria*, is reputed to have been introduced by the State as a duck food. This plant occurs as a nuisance growth.

Station 5. This station was located across the channel from the southern tip of Threemile Island below the York Haven Dam. The station was aberrant in its physical characteristics because of widely fluctuating water levels. This station will be deleted from further studies.

Station 6. This station was located along the western shore of the river above the mouth of the Conewago Creek. Depths did not exceed one and one-half feet at the time of collecting. Near the shore the river had a mud substrate, while offshore an extensive growth of *Polygonum* was present.

Station 7. This station was located between the northern tip of Haldeman (=Elliot) Island and the eastern shore. Depths reached about five feet.

Station 8. This station was located along the western shore about one mile below the discharge canal of the Brunner Island Plant. Depths did not exceed two feet and heavy silt deposits covered the substrate material.

Station 9. This station was located at the right edge of Haldeman Riffle and included a shoaling mud flat below the riffle. This mud flat supported an extensive growth of emergent aquatic plants. Depths did not exceed one and one-half feet.

WATER QUALITY

On August 18, 1967, one set of water samples was taken for water quality analyses by the laboratory personnel of the Pennsylvania Power and Light Company. No sample was collected at Station 5 because this station was inaccessible on the day of collection.

The analytical work was performed September 15, 1967, after nearly one month of storage. Since some water quality characteristics are unstable it would appear inappropriate to include recorded measurements for these here. Thus results of the hydrogen ion concentration and free carbon dioxide tests are not included here. Phenolphthalein alkalinity (as $CaCO_3$) was reported for Stations 6, 8, and 9. The reported values were 10.0, 2.0, and 5.5 parts per million respectively. We assume this analysis was not performed on the other samples since the submitted data sheet presents a dash (-) in the results column under the other stations. The presence of phenolphthalein alkalinity implies the presence of free hydroxids. This appears unlikely in stored samples and this occurrence must be considered anomalous.

Results of the analytical tests are presented in Table 1 with results expressed as parts per million.

Table 1

Water Quality Characteristics

Station	Methyl Orange Alkalinity (as $CaCO_3$)	Total Hardness (as $CaCO_3$)	Chlorides (as NaCl)	Suspended Matter
1.	34.0	105.0	15.0	12.5
2.	31.0	132.5	14.0	15.5
3.	31.5	119.0	14.0	8.4
4.	28.0	78.5	9.5	4.4
6.	60.0	93.0	14.0	23.7
7.	32.0	110.0	14.5	17.5
8.	65.5	96.5	13.5	16.5
9.	69.5	104.5	15.5	22.8

The samples contributing the data to Table 1 represent single grab samples and would, therefore, be expected to reflect broad variation. Nevertheless, the influence of Conewago Creek water along the western shore can be identified at Stations 6, 8, and 9. Station 7, as expected, appears to be in the flow of above-dam waters and has the characteristics of those waters. This condition would probably be disrupted under conditions of continuous low flow when virtually all above-dam water is discharged through the hydro plant at York Haven.

Station 4 flow represents water passing down the west side of Shelley Island. The quality differences probably reflect the influence of an influx of water from sources other than the main stem of the river.

The water quality was not influenced by the anaerobic bottom conditions observed at Stations 1 and 3. This anaerobiasis is interpreted as a product of cumulative organic debris associated with low velocities.

Water quality characteristics measured in the field included dissolved oxygen concentrations and temperature. These characteristics were measured August 18, 1967, coincident with the collecting of the water samples. Table 2 presents these data.

Table 2

Dissolved Oxygen and Temperature

Station	Time	Depth	Dissolved Oxygen (ppm)	Temperature (°F)
1.	1420	Surface	9.0	80.6
2.	1400	Surface	10.0	80.6
		5'	10.0	80.6
3.	1345	Surface	9.0	80.6
		5'	9.0	78.8
		8'	9.0	78.8
4.	1300	Surface	8.0	78.8
		5'	7.5	77.0
		9'	7.5	77.0
6.	1100	1.5'	9.75	78.8
7.	1035	Surface	7.5	78.8
		3.5'	7.5	78.8
8.	0940	Surface	7.0	98.6
		2'	7.0	98.6
9.	0835	1.5'	6.0	86.0

Biological collections were made at Station 8 on August 16th. On that date the right shoreline water temperature ranged from 96.0 F to 100.0 F at 1:30 PM. Offshore, at the head of the island, the water temperature was 90.0 F at 9:15 AM. Although these elevated temperatures were found at Station 8 all temperatures and dissolved oxygen concentrations at all stations were apparently within biologically acceptable ranges for the resident macroinvertebrate organisms.

The Pennsylvania Power and Light Company provided river flow data for the period preceding and including the field work. River flow diminished almost continuously during the survey; discharge lowering from approximately 35,000 cfs on August 7 to approximately 5,900 cfs on August 18. (A slight, transient, rise occurred August 10.) The peak flow immediately preceding the beginning of the survey was approximately 37,000 cfs on August 6. Average discharge during the 12 days of the survey period was approximately 19,590 cfs. During the 12 days preceding the survey, average discharge was approximately 19,900 cfs.

In the 12 days preceding the survey river elevation ranged from 252.18 to 254.88 feet: a range of 2.70 feet. During the 12 days of the survey period river elevations ranged from 251.61 to 254,77 feet: a range of 3.16 feet.

River flow data indicate that the physical characteristics of the river, with the exception of Station 5, were not extreme enough to influence the resident fauna of macroinvertebrate organisms.

Station 5 was physically limiting for bottom organisms because of fluctuating water levels. At times of low flow, when no water spills over the York Haven Dam, Station 5 would have essentially intermittent flow. Any flow that did occur would consist only of the discharge from Conewago Creek* and seepage losses from the impoundment.

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*This would be the small Conewago Creek draining into the eastern side of the river above the community of Falmouth. It is not to be confused with the larger Conewago Creek draining into the western side of the river at York Haven.

BIOLOGICAL COLLECTIONS

A total of 149 species of macroinvertebrate organisms was collected during the survey. These are listed in Appendix A, which also shows the distribution of the species by station.

The collections are summarized in Table 3. Both the number of species at each station as well as the percentage of the total number (149 species) is presented.

Table 3

Macroinvertebrate Collections

Station	Non-insect Species		Insect Species		Total Species	
	Number	Percent	Number	Percent	Number	Percent
1.	20	13	23	15	43	29
2.	18	12	28	19	46	31
3.	19	13	16	11	35	23
4.	20	13	28	19	48	32
5.	4	3	19	13	23	15
6.	12	8	44	30	56	38
7.	13	9	32	21	45	30
8.	7	5	32	21	39	26
9	13	9	57	38	70	47

The macroinvertebrate fauna as presented in Table 3 is split into two facets: non-insects and insects. The non-insect complex (Species 1-41 in Appendix A) repreeent those organisms continuously present in the environment and subject to all the environmental influences of that habitat. The insects, in general, have adult stages that are independent of the aquatic habitat. At such times, of course, they are not subjected to the environmental influences of the river itself. This fundamental difference between the two groups justifies consideration of them as two components of the macroinvertebrate fauna.

In all biological communities the organisms that contribute to species diversity are present in a gradient ranging from most abundant to extremely rare. This ecological concept can be measured by the number of individuals of a species present within a given area, or, as is done here, by the frequency of occurrence of the species among the several stations of a survey. Nine dominant species (6% of the total) are recognized here. Table 4 lists these dominant forms.

Table 4

Dominant Species

Present at all nine stations.
1. Snail, *Physa gatemaensis*
2. Midge larva, *Polypedilum illinoense*

Present at eight stations:
3. Worm, *Limnodrilus* cf. *hoffmeisteri*
4. Limpet (Snail), *Ferrissia tarda*
5. Water strider, *Mesovelia mulsanti*
6. Caddisfly nymph, *Hydropsyche* sp. 1

Present at seven stations:
7. Flatworm, *Dugesia tigrina*
8. Bryozoan, *Plumatella repens*
9. Midge larva, *Tanytarsus exigua*

Within the stretch of the river studied the nine dominant species represent the most characteristic faunal element. Table 5 presents the frequency of dominant species at each station.

Table 5

Distribution of Dominant Species

Station	1	2	3	4	5	6	7	8	9
Number of Dominant Species	9	9	6	7	5	9	9	8	9

Those stations containing less than 25% of the total species collected (Stations 3 and 5) also have the fewest number of species from the dominant group in their community structure. Station 5 included only 15% of the total fauna and is so aberrant (for reasons stated earlier) that it will be dropped from future surveys. In a letter dated August 23, 1967, it was proposed to relocate Station 5. However, the analyses of the data from the 1967 survey show that there is no need to continue sampling in this area.

Of the 149 species collected 56 (38%) occurred as unique species, i.e., occurred at only one of the nine stations. This falls within the range of normal biological structure relative to species diversity.

Figure 2 presents the number of species taken at each station as a percentage of the total number collected. The mean percentage value is represented by a horizontal line.

Figure 3 is an ogive and shows the accumulation of additional species with each succeeding station. Although the curves imply a

linear sequence in the stations, this is not, in fact, the case. Stations 3 and 4 are essentially paired stations and are geographically parallel for all practical purposes.

STATISTICAL ANALYSES

Comprehensive qualitative biological collections, such as is represented by the collections made during this survey. are readily amenable to quantitative techniques. The statistics derived here are descriptive statistics that provide comparative figures for future surveys. Such statistics also invite comparison with comparable surveys from other locations.

The basic statistics developed include the mean ($\bar{x}$), standard deviation ($s=\sqrt{\Sigma d^2/n-1}$), variance (s^2), and the coefficient of variation ($V=100s/\bar{x}$). The first two are common statistics. Variance, widely used in ecology, increases with increasing diversity in the number of species present among the stations of a survey area. The coefficient of variation is a measure of variation about the mean. With increasing biological stability the value of V lowers. Values of less than about 20% to 25% represent long-term biological equilibrium, i.e., the resident population has come into equilibrium with the environmental influences.

Table 6 summarizes the descriptive statistics derived for various aspects of the data.

Table 6

Descriptive Statistics

	$\bar{x}$	s	s^2	V
Total species at all stations	45	13.13	172.50	29.2%
Total species excluding aberrant Station 5	48	10.93	119.43	22.8%
Non-insects at all stations	14	5.79	33.50	41.4%
Non-insects excluding aberrant Station 5	15	4.72	22.29	31.5%
Insects at all stations	31	12.73	162.25	41.1%
Insects excluding aberrant Station 5	33	12.75	162.57	38.6%

When the aberrant Station 5 is delated from the data the total species number reflect biological stability in the stretch of the river studied.

There is a high degree of variance in the collections. This is a reflection of high species diversity among a series of stations that vary ecologically because of physical differences. Obviously, the variance is chiefly associated with the insects. The ecological differences leading to this diversity include variation in substrate material, flow velocity, depth, etc.

When the stations are divided into an above-dam group (Stations 1-4) and a below-dam group (Stations 6-9) the descriptive statistics

reflect greater stability within each group. Table 7 presents these statistics.

Table 7

Descriptive Statistics Relative to York Haven Dam

	$\bar{x}$	s	s^2	V
Total species above the dam	43	5.71	32.66	13.3%
Total species below the dam	56	14.21	202.00	25.4%
Non-insects above the dam	19	1.00	1.00	0.05%
Non-insects below the dam	11	2.88	8.33	26.2%
Insects above the dam	24	5.68	32.33	23.7%
Insects below the dam	41	11.80	139.33	28.8%

From the data in Table 7 it is apparent that ecological conditions differ between the above-dam and below-dam stations. The above-dam stations tend to resemble each other ecologically and biological equilibrium is clear-cut. The stations below the dam differ from each other ecologically and this is reflected in the high variance. At the same time, this part of the river can be considered in biological equilibrium with the environmental influences.

The coefficient of variation of 0.05% for non-insects above the dam is the lowest value for this statistic ever found by the consultant. This is an uncommon degree of stability.

Dayhaw's chi-square test*for comparing two sets of observed data was applied to the data. No significant difference (χ^2=2.26) was found when the total number of species from above the dam was compared with the total number from below the dam (excluding Station 5). The same conditions prevailed in a similar comparison of the non-insect component (χ^2=1.55) and the insect component (χ^2=3.45). However, when the same test was applied to non-insects versus insects for all stations, exclusive of Station 5, a highly significant difference (p=<.01) was found with a chi-square value of 24.56. This significantly different value reflects the ecological differences between above-dam and below-dam stations.

In a 1967 four-station survey of the Susquehanna River at Sunbury no significant differences were found between non-insects and insects. The stations at the Sunbury location were more closely comparable to the above-dam stations at York Haven than to the below-dam stations. At the Sunbury location 83 species were taken in June while 66 species were taken in September, which was a period of very high water. At Stations 1 through 4 of the York Haven survey 95 species were collected. This larger number of species reflects increased river size and diversity of habitat

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* $\chi^2=(\Sigma b^2/n-B^2/N)N^2/AB$

between Sunbury and York Haven. Stations 6 through 9 of the York Haven survey produced 111 species, reflecting further increases in habitat diversity; particularly at Station9, which supported 18 unique species.

A coefficient of correlation* of 0.542 was found between non-insects and insects for all stations exclusive of Station 5. Figure 4 presents a scatter diagram of these data as well as the line of least squares, for which Y=21.74+(-0.200)X. The two components of the macroinvertebrate fauna reflect, at best, but moderate correlation and tend to be independent of each other.

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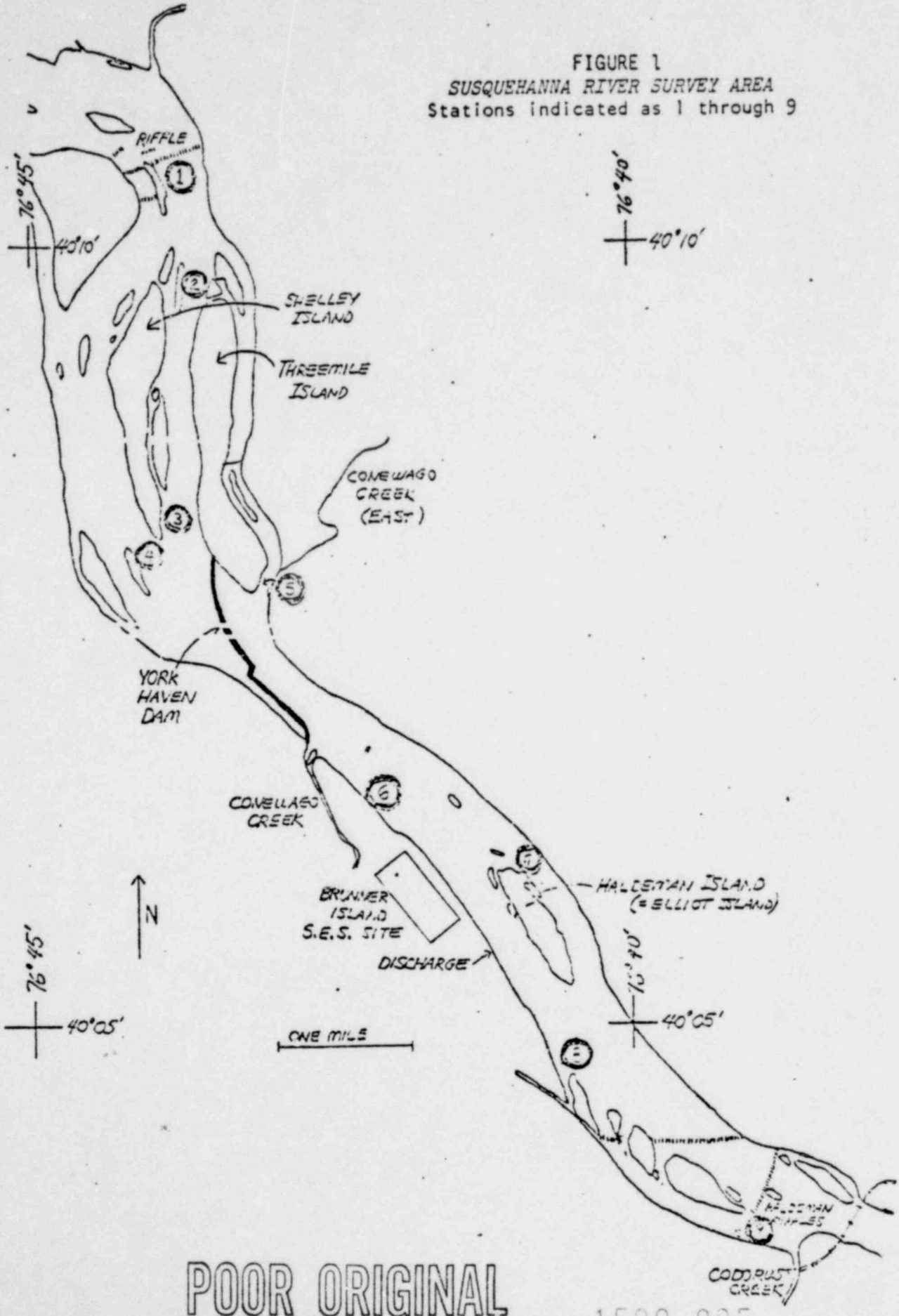
* $r_{xy} = [N\Sigma XY - (\Sigma X)(\Sigma Y)] / \sqrt{[N\Sigma X^2 - (\Sigma X)^2][N\Sigma Y^2 - (\Sigma Y)^2]}$

FIGURES

FIGURE 1
SUSQUEHANNA RIVER SURVEY AREA
Stations indicated as 1 through 9



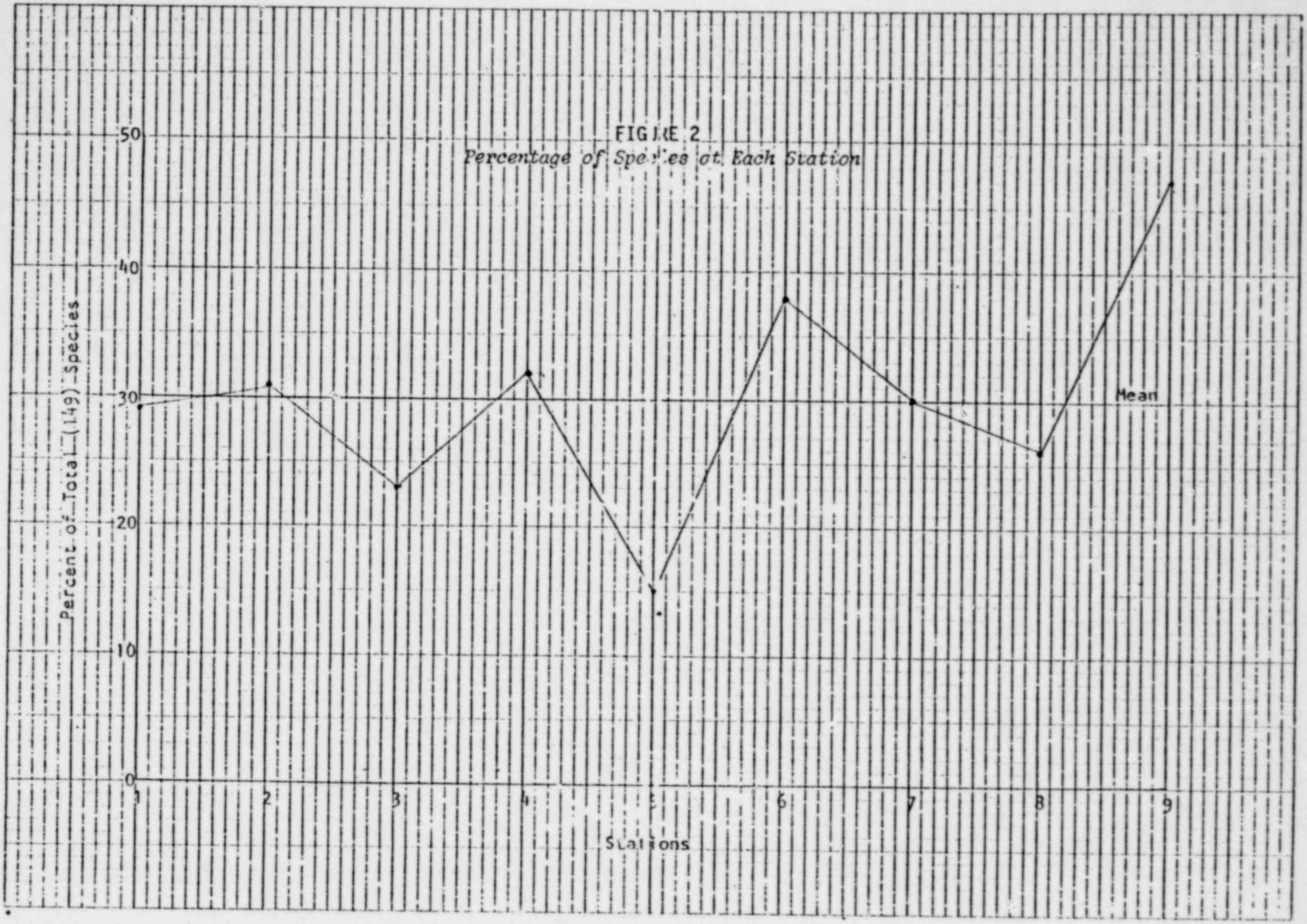


FIGURE 2
Percentage of Species at Each Station

FIGURE 3

Cumulative Species with Successive Stations

Station	Number
1	43
2	68
3	85
4	95
5	103
6	123
7	128
8	131
9	149

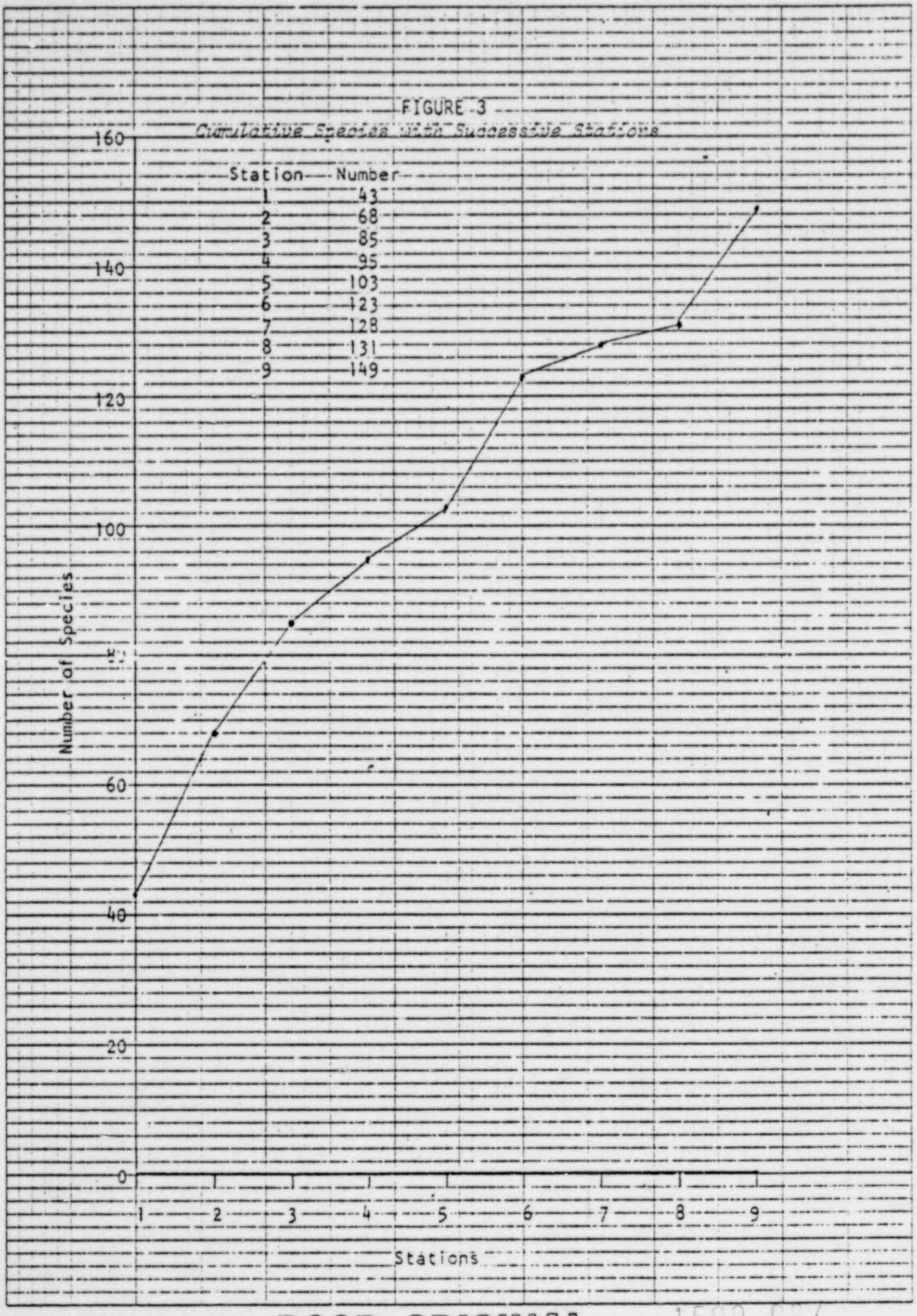
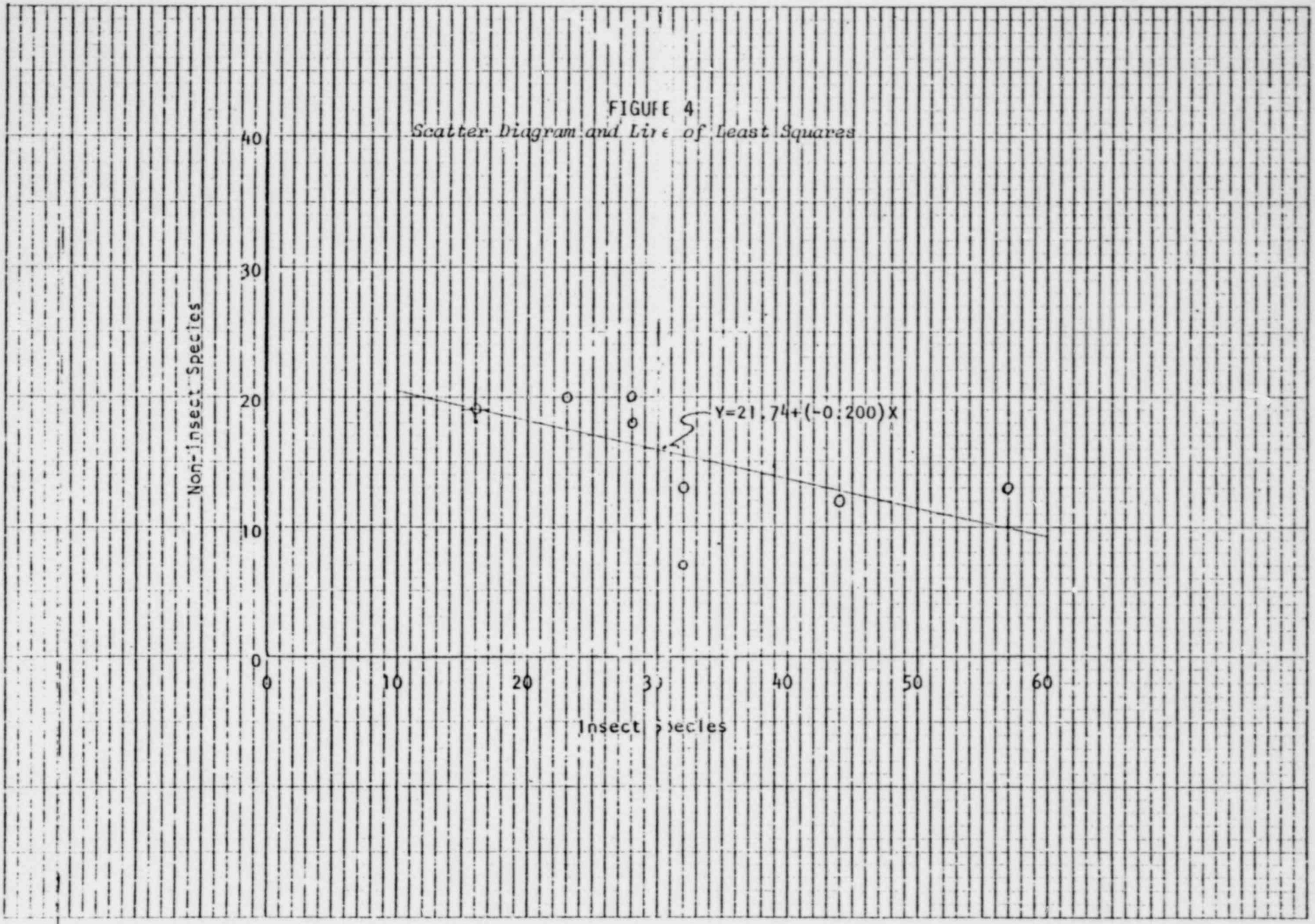


FIGURE 4

Scatter Diagram and Line of Least Squares



APPENDIX A

APPENDIX A

MACROINVERTEBRATE SPECIES

	Stations								
	1	2	3	4	5	6	7	8	9
FLATWORMS									
1. *Dugesia tigrina*	x	x	x	x		x	x		x
2. cf. *Curtisia foremani*	x						x		
3. *Prostoma rubrum*		x							
WORMS									
4. *Limnodrilus* cf. *hoffmeisteri*	x	x	x	x		x	x	x	x
5. *Tubifex*			x						
6. *Branchiura sowerbyi*	x	x						x	
7. Lumbriculidae g. sp. 1		x	x				x		
8. Lumbriculidae g. sp. 2			x						
9. Megascolecidae g. sp. 1		x							
10. Megascolecidae g. sp. 2		x							
11. Oligochaeta f. g. sp. 1			x						
LEECHES									
12. *Helobdella triserialis*			x	x				x	
13. *Placobdella rugosa*	x		x	x		x			
14. *Placobdella montifera*			x						
15. *Erpobdella punctata*		x	x	x					
16. Hirudinea f. g. sp. 1						x			
BRYOZOANS									
17. *Fredericella sultana*	x								
18. *Plumatella repens*	x	x	x			x	x	x	x
19. *Paludicella articulata*			x			x			
20. *Urnatella gracilis*	x						x		x
21. *Lophopodella carteri*									x
CLAMS									
22. *Sphaerium* sp. 1	x	x							
23. *Pisidium* sp. 1	x	x	x	x					
SNAILS									
24. *Campeloma integrum*			x	x					
25. *Amnicola limosa*	x	x	x	x			x		x
26. *Amnicola* sp. 1				x			x		
27. *Valvata tricarinata*				x					

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MACROINVERTEBRATE SPECIES

	Stations								
	1	2	3	4	5	6	7	8	9
FLATWORMS									
1. *Dugesia tigrina*	x	x	x	x		x	x		x
2. cf. *Curtisia foremani*	x						x		
3. *Prostoma rubrum*		x							
WORMS									
4. *Limnodrilus* cf. *hoffmeisteri*	x	x	x	x		x	x	x	x
5. *Tubifex*			x						
6. *Branchiura sowerbyi*	x	x						x	
7. Lumbriculidae g. sp. 1		x	x				x		
8. Lumbriculidae g. sp. 2			x						
9. Megascolecidae g. sp. 1		x							
10. Megascolecidae g. sp. 2		x							
11. Oligochaeta f. g. sp. 1			x						
LEECHES									
12. *Batobdella nephelaidea*			x	x				x	
13. *Placobdella rugosa*	x		x	x		x			
14. *Placobdella montifera*			x						
15. *Erpobdella punctata*		x	x	x					
16. Hirudinea f. g. sp. 1						x			
BRYOZOANS									
17. *Fredericella sultana*	x								
18. *Plumatella repens*	x	x	x			x	x	x	x
19. *Paludicella articulata*			x			x			
20. *Urnatella gracilis*	x						x		x
21. *Lophopodella carteri*									x
CLAMS									
22. *Sphaerium* sp. 1	x	x							
23. *Pisidium* sp. 1	x	x	x	x					
SNAILS									
24. *Campeloma integrum*			x	x					
25. *Amnicola limosa*	x	x	x	x			x		x
26. *Amnicola* sp. 1				x			x		
27. *Valvata tricarinata*				x					

	Stations								
	1	2	3	4	5	6	7	8	9
SNAILS, cont'd.									
28. *Goniobasis virginica*	x	x	x	x					
29. *Nitocris carinatus*	x	x		x					
30. *Physa heterostropha*	x	x	x	x	x	x	x	x	x
31. *Ferrissia tarda*	x	x		x	x	x	x	x	x
32. *Helisoma anceps*	x		x	x					
33. *Helisoma trivolvis*			x	x					
34. *Gyraulus* sp. 1	x					x	x		x
35. *Gyraulus* sp. 2	x			x		x	x		x
36. *Lymnaea humilus*					x		x		
CRAYFISH									
37. *Orconectes* sp. 1		x			x				x
SOWBUG									
38. *Asellus communis*				x					
SCUDS									
39. *Hyalella azteca*	x			x		x		x	x
40. *Gammarus fasciatus*						x			x
41. *Crangonyx gracilis*	x	x		x					
MAYFLIES									
42. *Hexagenia* sp. 1								x	
43. *Stenonema* sp. 1	x	x				x	x		x
44. *Stenonema* sp. 2	x	x		x		x			x
45. *Stenonema* sp. 3					x	x			x
46. *Stenonema* sp. 4						x			x
47. *Stenonema* sp. 5						x			x
48. *Stenonema* sp. 6							x		
49. *Isonychia* sp. 1					x				
50. *Tricorythodes* sp. 1	x								
51. *Tricorythodes* sp. 2						x		x	
52. *Tricorythodes* sp. 3						x		x	
53. *Tricorythodes* sp. 4									x
54. *Tricorythodes* sp. 5									x
55. *Tricorythodes* sp. 6									x
56. *Leptohyphes* sp. 1						x			
57. *Caenis* sp. 1						x			x
58. *Caenis* sp. 2						x			
59. *Caenis* sp. 3						x			x
60. *Caenis* sp. 4						x			x
61. *Caenis* sp. 5									x
62. *Pseudocloeon* sp. 1									x
63. Baetinae g. sp. 1	x			x	x	x		x	

	Stations								
	1	2	3	4	5	6	7	8	9
MAYFLIES, cont'd.									
64. Baetinae g. sp. 2	x							x	
65. Baetinae g. sp. 3						x			
66. Baetinae g. sp. 4						x	x	x	
67. Baetinae g. sp. 5									x
DRAGONFLIES									
68. *Macromia* sp. 1									x
69. *Neurocordulia* sp. 1									x
DAMSELFLIES									
70. *Argia* sp. 1						x		x	x
71. *Enallagma* sp. 1		x							
72. *Enalagma* sp. 2				x			x		
73. *Enallagma* sp. 3							x		x
74. *Enallagma* sp. 4								x	
75. cf. *Teleallagma* sp. 1				x					
76. *Ischnura* sp. 1	x					x	x	x	x
77. *Ischnura* sp. 2			x			x	x	x	x
78. *Ischnura* sp. 3			x					x	x
79. *Ischnura* sp. 4			x			x		x	x
80. *Ischnura* sp.5		x				x	x	x	x
81. *Haeterina* sp. 1	x	x		x		x		x	x
WATER STRIDERS AND WATER BUGS									
82. *Gerris* sp. 1		x		x		x	x	x	
83. *Metrobates* sp. 1	x								x
84. *Rheumatobates* sp. 1		x				x	x		x
85. *Trepobates* sp. 1		x		x				x	x
86. *Trepobates* sp. 2			x		x	x	x	x	x
87. *Trepobates* sp. 3									x
88. *Mesovelia mulsanti*	x	x		x	x	x	x	x	x
89. *Belostoma* sp. 1					x				x
90. *Microvelia* sp. 1					x				
91. Corixinae g. sp. 1					x				
CADDISFLIES									
92. *Hydropsyche* sp. 1	x	x		x	x	x	x	x	x
93. *Triaenodes* sp. 1	x		x	x				x	x
94. *Oecetis* sp. 1			x	x					
95. *Oecetis* sp.2							x		
96. *Athripsodes* sp. 1				x		x			
97. *Rhyacophila* sp. 1						x			
98. *Neureclipsis* sp. 1									x

	Stations								
	1	2	3	4	5	6	7	8	9
MIDGE LARVAE, cont'd.									
130. *Cricotopus fugax*				x					
131. *Cricotopus slossonae*		x			x				
132. *Cricotopus* sp. 1		x	x	x	x	x		x	
133. *Orthocladius dorenus*		x							
134. *Orthocladius carlatus*		x			x				x
135. *Thalassomyia obscurus*						x			x
136. *Tanytarsus exigua*	x	x	x			x	x	x	x
137. *Tanytarsus flavipes*					x	x			
138. *Tanytarsus* sp. 1		x							x
139. *Polypedilum illinoense*	x	x	x	x	x	x	x	x	x
140. *Stictochironomus* sp. 1						x			
141. *Chironomus jucundus*				x					
142. *Chironomus riparius*		x				x	x	x	x
143. *Chironomus abortiva*	x								
144. *Chironomus nais*							x		
145. *Chironomus* nr. *fulvus*		x	x	x				x	
146. *Chironomus* sp. 1			x	x		x	x		
147. *Glyptotendipes dreisbachi*	x				x		x		x
148. *Glyptotendipes polytomus*	x						x	x	x
149. *Glyptotendipes senilis*						x	x	x	x

****

	Stations								
	1	2	3	4	5	6	7	8	9
MOTHS									
99. *Parapoynx* sp. 1	x						x		
100. *Parargyractis* sp. 1									x
LARVAL BEETLES									
101. *Berosus* sp. 1	x		x					x	
102. Elmidae g. sp. 1	x			x		x			
103. Elmidae g. sp. 2		x		x			x		
104. Elmidae g. sp. 3		x							
105. Elmidae g. sp. 4				x					
106. Elmidae g. sp. 5									x
107. *Eubrianax* sp. 1						x			x
ADULT BEETLES									
108. Berosinae g. sp. 1						x			x
109. *Hydrochus* sp. 1		x		x	x		x	x	x
110. *Tropisternus* sp. 1									x
111. *Laccophilus* sp. 1									x
112. *Peltodytes* sp. 1					x				
113. *Stenelmis* sp. 1	x			x			x		x
114. *Stenelmis* sp. 2				x		x	x		x
115. *Stenelmis* sp. 3								x	
116. *Stenelmis* sp. 4									x
117. *Stenelmis* sp. 5									x
118. *Stenelmis* sp. 6									x
119. *Donacia* sp. 1			x						
BLACKFLY									
120. *Simulium* sp. 1	x			x	x	x	x		x
DANCEFLY									
121. Empididae g. sp. 1	x	x				x	x		x
HORSEFLY									
122. *Chrysops* sp. 1							x		
MIDGE LARVAE									
123. *Tanypus melanops* grp.	x	x		x					x
124. *Tanypus monilis* grp.			x	x	x			x	
125. *Tanypus carnea*		x							
126. *Procladius culiciformis*		x					x		
127. *Procladius riparius*			x	x		x	x		
128. *Clinotanypus thoracius*		x							
129. *Psectrocladius nigrus*	x	x	x					x	

A BIOLOGICAL SURVEY OF THE SUSQUEHANNA RIVER IN THE VICINITY OF YORK HAVEN, PA.

1968 PROGRESS REPORT

prepared for

PENNSYLVANIA POWER & LIGHT COMPANY

and

METROPOLITAN EDISON COMPANY

by

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submitted

24 January 1970

CONCLUSIONS

1. The York Haven area of the Susquehanna River produced 119 species of macroinvertebrate species (bottom organisms) in 1968. The comparable 1967 survey produced 145 species.

2. Differences in biological structure between 1967 and 1968 are presented, and these generally indicate statistically significant differences between the two years.

3. In 1968 the river appeared biologically depressed over 1967, and this was chiefly associated with a reduction in the insect fauna.

4. One cause for the observed changes would be the continuous low flow to the river for an extended period of time during 1968.

5. There are strong indications that the river suffered from the introduction of a toxicant during the summer of 1968.

6. The area of biological depression extended from Station 2 through Station 8. Station 9, the west end of Haldeman Riffle, did not appear strongly affected.

A BIOLOGICAL SURVEY OF THE SUSQUEHANNA RIVER IN THE VICINITY OF YORK HAVEN, PA.

INTRODUCTION

This survey was the second biological survey undertaken in the interest of the Pennsylvania Power & Light Company and the Metropolitan Edison Company. The survey represents a study of the macroinvertebrate fauna (bottom organisms) at each of a series of eight stations. Field work extended from August 12 through August 20, 1968.

STATIONS

Eight stations (sampling sites) were collected. The location of each station was indicated on Figure 1 of the first progress report submitted August 9, 1968. The stations studied are listed below.

Station 1. This station was in the riffle area above Three Mile Island and between the head of Fall Island and the eastern shore. Along the eastern shore the substrate contained anaerobic pockets.

Station 2. This station was between the northern tips of Three Mile Island and Shelley Island.

Station 3. This station extended from the southern tip of Shelley Island to the western shore of Three Mile Island at the "Bali Lai" summer cottage.

Station 4. This station extended from the southern tip of Shelley Island to the southern tip of the next island west of Shelley Island.

Station 5. This station, included in the first survey, has been deleted from the program. However, the original station numbers are retained to facilitate comparisons between the reports to date.

Station 6. This station was located along the western shore of the river above the mouth of the Conewago Creek diversion channel that skirts the northern edge of the Brunner Island Plant site.

Station 7. This station was located between the northern tip of Haldeman (=Elliot) island and the eastern shore.

Station 8. This station was located along the western shore of the river about one mile below the discharge canal of the Brunner Island Plant.

Station 9. This station was located at the western edge of Haldeman Riffle above the mouth of Codorus Creek.

WATER QUALITY

On August 20, 1968 one set of water samples was taken for water quality analyses. These analyses were performed by the laboratory personnel of the Pennsylvania Power & Light Company. Results of these analyses, expressed as parts per million, are presented in Table 1.

TABLE 1

Water Quality Characteristics

Station	Methyl Orange Alkalinity (as $CaCO_3$)	Total Hardness (as $CaCO_3$)	Chlorides (as NaCl)	Suspended Matter
1.	60.0	247.0	29.5	15.7
2.	42.0	249.0	25.5	8.9
3.	44.0	204.5	23.5	7.4
4.	48.0	135.0	21.5	10.4
6.	76.5	118.5	22.5	24.0
7.	58.0	193.5	24.5	17.0
8.	70.0	143.0	23.0	8.5
9.	66.5	150.0	23.5	7.2

Water quality characteristics measured in the field included dissolved oxygen concentrations and temperature. These were measured August 20, 1968 coincident with the collection of the water samples taken for analysis. Table 2 presents the data from the field measurements.

TABLE 2

Dissolved Oxygen (ppm) and Temperature (^{o}F)

Station	Time	Depth	Dissolved Oxygen	Temperature
1	1505	Surface	8.0	88.7
		Bottom (3 ft.)	8.0	88.7
2	1450	Surface	8.5	82.4
		Bottom (3 ft.)	8.5	81.5
3	1435	Surface	8.0	79.7
		5 feet	8.0	78.8
		Bottom (7 ft.)	8.0	78.8
4	1425	Surface	7.5	80.6
		5 feet	6.5	78.8
		Bottom (7 feet)	6.5	78.8
6	1345	Surface	8.0	85.1
7	1110	Surface	7.0	78.8
		Bottom (3 ft.)	7.0	78.8
8	1030	Surface	5.5	93.2
		Bottom (2 ft.)	5.5	93.2
9	0835	Surface	5.5	83.3

During the time of the survey river flow was falling. Flow August 12th was 6,500 cfs; August 20th, 5,200 cfs. Flows of less than 10,000 cfs had persisted in the river since July 21, 1968. During the 12 days preceding the survey river flow averaged 7,490 cfs/day. River flow for the 12 days preceding the 1967 survey averaged 19,590 cfs/day. During the survey period river elevation ranged from 251.37 to 251.65: a range of 0.28 foot.

BIOLOGICAL COLLECTIONS

A total of 119 species of macroinvertebrates was collected during the 1968 survey. During the 1967 survey a total of 145 species was collected from these eight stations. The species collected in 1968 are presented in Appendix A along with their distribution among the eight stations. Table 3 summarizes the 1967 and 1968 collections.

TABLE 3

Numbers of Macroinvertebrate Species

Station	Non-Insects		Insects		Total	
	'67	'68	'67	'68	'67	'68
1	20	23	23	31	43	54
2	18	20	28	22	46	42
3	19	15	16	12	35	27
4	20	13	28	13	48	26
6	12	14	44	24	56	38
7	13	10	32	29	45	39
8	7	3	32	7	39	10
9	13	19	57	35	70	54

Six dominant species (5% of the total) are recognized herein. The first of these is a snail, Physa heterostropha, which was found at all eight stations. The remaining five dominants were absent from Station 8. These latter five included a limpet, Ferrissia tarda, a fingernail clam, Sphaerium sp. 1, a sludge worm, Limnodrilus cf. hoffmeisteri, and two midge larvae, Polypedilum illinoense and Chironomus sp. 1.

Of the 119 species collected, 52 (44%) occurred as unique species, i.e., occurred at only one of the eight stations. Of the 145 species taken at these stations in 1967 there were 53 (37%) unique species found.

Basic descriptive statistics developed from the biological data include the mena ($\bar{x}$), standard deviation (s), variance (s^2), and the coefficient of variation (V). Table 4 presents these descriptive statistics for both 1967 and 1968.

TABLE 4

Descriptive Statistics

	$\bar{x}$	s	s^2	V
1967				
Non-insects	15	4.72	22.29	31.5%
Insects	33	12.75	162.57	38.6%
Total	48	10.93	119.43	22.8%
1968				
Non-insects	15	6.31	39.86	42.1%
Insects	22	10.05	101.29	45.7%
Total	36	14.89	222.00	41.4%

It is apparent from Tables 3 and 4 that the biological structure of the study area differed appreciably between 1967 and 1968. The fewer number of species found in 1968 along with a greater variance and higher coefficient of variation values reflect the differences.

A chi square analysis for comparing two sets of observed data was made comparing the 1967 and 1968 collections. A chi

square value of 19.93 was found with p=0.005-0.010. This is statistically significant. A chi square test was also done comparing the insect fauna of 1967 with that of 1968. The derived chi square value was 18.59 with p=0.005-0.010, which is also statistically significant. A chi square test done to compare the 1967 non-insect fauna with the 1968 non-insect fauna produced a chi square value of 5.44 with p=0.500-0.750. Obviously, no significant difference occurred between these two collections.

Using rank order correlation analysis (Spearman rho) no correlation was found between the non-insects and insects for either 1967 (rho=-0.683) or 1968 (rho=0.524).

Correlation analyses were made comparing the distribution of organisms among the stations for the two years. No correlation was found (rho=0.375) for the total number of species taken at the stations for 1967 versus 1968. Further, no correlation was found for the insects alone (rho=0.393) or the non-insects alone (rho=0.548).

It is apparent that the chief difference between the 1967 and 1968 collections rests with the insect component of the fauna rather than the non-insect component (Species 1-38 of Appendix A).

In 1967 river flows were such that water cascaded over the spillway of the York Haven Dam. In 1968 low river flows prevented spillway loses, and releases to flow below the dam was affected through the York Haven Hydro Plant. Comparisons have been made between the group of four stations above the dam and the four stations below the dam. These two groups are Stations 1-4 and Stations 6-9 respectively. In 1967 no significant difference was found (chi square=2.26; p=0.500-0.750) between these two groups of stations. In 1968, however, a significant difference was found (chi square=20.30; p=<0.005). This change in biological structure is associated with a reduced diversity in the insect fauna. Table 5 presents the descriptive statistics for the above-dam and below-dam station groups.

TABLE 5

Descriptive Statistics

Above Dam, 1967

	$\bar{x}$	s	s^2	V
Non-insects	19	1.00	1.00	0.05%
Insects	24	5.68	32.53	23.7%
All species	43	5.71	52.66	13.3%

Above Dam, 1968

Non-insects	18	4.58	21.00	25.4%
Insects	20	8.91	79.33	44.6%
All species	37	13.35	178.33	36.1%

TABLE 5, cont'd.

Below Dam, 1967

	$\bar{x}$	s	s^2	V
Non-insects	11	2.88	8.33	26.2%
Insects	41	11.80	139.33	28.8%
All species	56	14.21	202.00	25.4%

Below Dam, 1968

Non-insects	12	6.97	48.67	58.1%
Insects	24	12.04	145.00	50.2%
All species	35	18.36	337.00	52.5%

The sharply increased variance (s^2) of 1968 over 1967 is very striking. This, of course, reflects the greater diversity among the stations sampled. The increased coefficient of variation (V) reflects a loss of biological stability and the resident fauna was apparently in a state of flux during the 1968 survey.

The biological structure of the river found in 1968 reflects environmental influences not present in 1967. These influences were widespread, extending from above the York Haven Dam downstream to Haldeman Riffle. These influences could be considered as adverse for the community of species characteristic of the river in 1967 since there was an 18% reduction in species diversity between 1967 and 1968.

It is suggested here that one of the chief environmental influences exerted during 1968 was the continuous low flow conditions of the river during 1968.

With low-flow conditions the scouring of substrate material is much reduced. This permits the deposition of silt, which is physically limiting to many bottom organisms. In addition, continuous low flow would severely limit the transport and distribution of organisms.

Low flow conditions would also permit stronger local effects from discharges entering the river. For example, the discharge from the Brunner Island Plant would more continuously inundate Station 8, which is in the mixing zone. At the time of this survey, however, lethal temperatures were not found at Station 8. Reference to Table 2 shows that on August 20, 1968 there was a ten-degree drop between Stations 8 and 9, indicating that the west end of Haldeman Riffle is not subject to abnormally high temperatures that would be biologically limiting. Station 9 had the same diversity (54 species) found at Station 1 above Threemile Island.

Some field observations seemed to indicate a recent toxic affect in the river. For example, at Station 4 on August 14th numerous unionid clams (Anodonta cataracta) were found dead. A few of these had died so recently that muscle tissue was still attached to the inner surface of the shell valves. Such tissues usually decompose within a few days after death.

Stations 2 through 4, located in the pool of the York Haven Dam, had some oil or oil-like substance entrained in bottom materials. The exact nature of this material, and its extent over the bottom of the pool, was not investigated. Extensive stands of rooted aquatic vegetation indicated that much of the bottom was not affected by this material.

APPENDIX A

APPENDIX A

MACROINVERTEBRATE SPECIES

	Stations							
	1	2	3	4	6	7	8	9
FLATWORMS								
1. Dugesia tigrina	x	x	x		x	x		
2. Prostoma rubrum		x			x			
SPONGE								
3. Spongillidae g. sp. 1	x							
WORMS								
4. Limnodrilus cf. hoffmeisteri	x	x	x	x	x	x		x
5. Tubifex sp. 1								x
6. Branchiura sowerbyi								x
7. Lumbriculidae g. sp. 1		x						x
8. Lumbriculidae g. sp. 2		x						
9. Megascolecidae g. sp. 1		x		x				x
10. Megadriline							x	
LEECHES								
11. Helobdella nepheloidea		x	x					x
12. Placobdella rugosa	x	x			x			
13. Placobdella parasitica	x					x		
14. Erpobdella punctata		x	x					
BRYOZOANS								
15. Plumatella repens	x	x			x	x	x	x
16. Paludicella articulata					x			
17. Urnatella gracilis	x		x		x			x
18. Lophopodella carteri	x	x				x		x
CLAMS								
19. Sphaerium sp. 1	x	x	x	x	x	x		x
20. Pisidium sp. 1	x	x	x	x		x		
21. Elliptio complanata					x			x
22. Anodonta cataracta								x
23. Immature unionids	x	x	x					

	Stations							
	1	2	3	4	6	7	8	9
SNAILS								
24. Campeloma integrum	x		x	x				
25. Amnicola cf. limosa	x	x	x	x				x
26. Goniobasis virginica	x	x	x	x				
27. Nitocris carinata	x							
28. Physa heterostropha	x	x	x	x	x	x	x	x
29. Ferrissia cf. tarda	x	x	x	x	x	x		x
30. Helisoma cf. trivolvis	x		x	x				x
31. Gyraulus sp. 1	x			x				x
32. Gyraulus sp. 2	x							
33. Lymnaea humilus		x			x	x		x
CRAYFISH								
34. Orconectes sp. 1	x			x	x			
SOWBUG								
35. Asellus communis		x						
SCUDS								
36. Hyalella azteca	x							
37. Gammarus fasciatus			x	x	x			x
38. Crangonyx gracilis	x							
MAYFLIES								
39. Hexagenia sp. 1			x	x				
40. Stenonema sp. 1	x		x			x		x
41. Stenonema sp. 2	x	x	x		x	x		x
42. Stenonema sp. 3					x			
43. Stenonema sp. 4	x				x			
44. Stenonema sp. 5	x				x	x		x
45. Isonychia sp. 1								x
46. Tricorythodes sp. 3					x			x
47. Tricorythodes sp. 6								x
48. Caenis sp. 1					x			
49. Caenis sp. 4								x
50. Pseudocloeon sp. 2	x							
51. Baetinae g. sp. 1	x							
DRAGONFLIES								
52. Gomphus sp. 1	x			x				
53. Gomphus sp. 2						x		
54. Boyeria sp. 1	x							
55. Macromia sp. 1								x

	Stations							
	1	2	3	4	6	7	8	9
DAMSELFLIES								
56. Argia sp. 1	x				x	x		x
57. Enallagma sp. 1	x							
58. Enallagma sp. 5	x	x						x
59. Enallagma sp. 6								x
60. Enallagma sp. 7								x
61. Ischnura sp. 1	x	x						x
62. Ischnura sp. 4				x				x
63. Hetaerina sp. 1	x	x						
WATER STRIDERS AND WATER BUGS								
64. Gerris sp. 1	x			x				
65. Metrobates sp. 1								x
66. Trepobates sp. 1	x			x				
67. Trepobates sp. 2					x	x	x	x
68. Trepobates sp. 3						x	x	
69. Rheumatobates sp. 1						x		
70. Mesovelia cf. mulsanti	x	x			x	x	x	x
71. Nepa apiculata					x			
72. Corixinae g. sp. 1								x
73. Hemiptera fam. g. sp. 1					x			x
CADDISFLIES								
74. Hydropsyche sp. 1	x	x	x		x	x		x
75. Hydropsyche sp. 2	x							
76. Psychomyia sp. 1		x			x	x		
77. Fam. g. sp. 1					x			x
LARVAL BEETLES								
78. Berosus sp. 1								x
79. Elmidae g. sp. 2	x							
80. Eubrianax sp. 1	x							
ADULT BEETLES								
81. Berosinae g. sp. 1					x			x
82. Hydrochus sp. 1		x	x	x		x	x	x
83. Tropisternus sp. 2							x	
84. Laccophilus sp. 1							x	
85. Stenelmis sp. 1						x		
86. Stenelmis sp. 2								x
87. Stenelmis sp. 3	x						x	
88. Stenelmis sp. 4					x	x		x
89. Stenelmis sp. 5								x
90. Stenelmis sp. 7						x		

	Stations							
	1	2	3	4	6	7	8	9
ADULT BEETLES, cont'd.								
91. cf. Peolonomus sp. 1						x		
92. cf. Pelonomus sp. 2	x				x	x		x
93. Gyrinus sp. 1						x		
94. cf. Anthicidae g. sp. 1						x		
95. Curculionidae g. sp. 1		x						
DANCEFLY								
96. Empididae g. sp. 1						x		
MIDGE LARVAE								
97. Procladius sp. 1	x			x				
98. Tanypus sp. 1								x
99. Conchapelopia sp. 1		x						
100. Ablabesmyia mallochi	x	x	x		x	x		
101. Ablabesmyia auriensis	x				x			
102. Ablabesmyia ornata		x						
103. Labrundia virescens		x						
104. Cricotopus sp. 2 (Roback)		x						
105. Nanocladius sp. 1		x	x					
106. Polypedilum illinoense	x	x	x	x	x	x		x
107. Polypedilum sp. 1	x					x		
108. Polypedilum halterale			x	x		x		
109. Cryptochironomus fulvus		x	x	x				x
110. Cryptochironomus blarina		x		x				
111. Cryptochironomus soxew		x						
112. Dicrotendipes nervosus	x							
113. Dicrotendipes nr. neomodestus	x	x				x		
114. Dicrotendipes sp. 1		x	x			x		x
115. Glyptotendipes lobiferus					x	x		
116. Chironomus sp. 1	x	x	x	x	x	x		x
117. Chironomus sp. 2						x		
118. Rheotanytarsus sp. 1	x			x	x			
119. Chironominae g. sp. 1					x			