

MERCURY IN THE FISH AND SEDIMENT
OF THE NORTH FORK HOLSTON RIVER

1981

B75-028

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ABSTRACT

Mercury contaminates the North Fork Holston River. The sources of the contamination are wastes generated from the caustic soda-chlorine process employed by the Olin Corporation from the 1950's until 1971. The mercury gains known access to the river via the drainage of several waste holding ponds and plant site runoff and leaching. All sources have been continuous since the 1950's.

The mercury concentrations in selected species of fish and the sediment in the North Fork Holston River have been monitored by the Virginia State Water Control Board (SWCB) since 1970. The results of the 1981 survey are presented herein.

Six affected stations located between river miles 77 and 8 on the North Fork Holston River and three control stations, one each on the North, Middle and South Fork Holston Rivers, were sampled for mercury in three fish species, Northern Hogsucker, Rockbass, and Sunfish, and in the sediment.

While the proportion of individual fish within each species exceeding the 1.0 ppm total mercury guideline appears to have declined since the 1980 sampling, the mean mercury contents of the fish species collected upstream from affected Station B5 (NFH 22) were at or above the FDA guideline. The mean mercury sediment values at the affected stations were also all in excess of 1 ppm mercury. The results of the laboratory and statistical analyses convincingly show that the fish and sediment of the North Fork Holston River remain contaminated with mercury.

INTRODUCTION

The purpose of this report is to briefly summarize the results of the annual collection and analysis for total mercury of the selected fish species and sediment from the North, Middle, and South Forks Holston River for 1981.

MATERIALS AND METHODS

SAMPLING STATIONS

As in previous years, a total of nine stations were sampled for the total mercury content of the sediment and of selected fish species. Three of the stations were control stations and six were affected stations. The control stations A3 (NFH 98), C1 (MFH 32), and D1 (SFH 102) were located in the North, Middle, and South Forks Holston River, respectively. The affected stations B1-B6, were located in the North Fork Holston River at the river miles listed below and as shown in Figure 1. Sampling occurred over a five day period in mid-July.

<u>Station</u>	<u>River Mile</u>
B1	NFH 77
B2	NFH 72
B3	NFH 59
B4	NFH 36
B5	NFH 22
B6	NFH 8

SAMPLING METHODS

Fish. Three species of fish were collected at each station: Northern Hogsucker (Hypentelium nigricans), Rockbass (Ambloplites rupestris), and Sunfish (Lepomis spp.) The individuals of each species were from a specified size class as listed below. Due to the difficulty in obtaining a sufficient number of fish at each station which fell within the 1980 length ranges for each respective species, the length ranges for the 1981 collection were expanded by 1.5 cm.

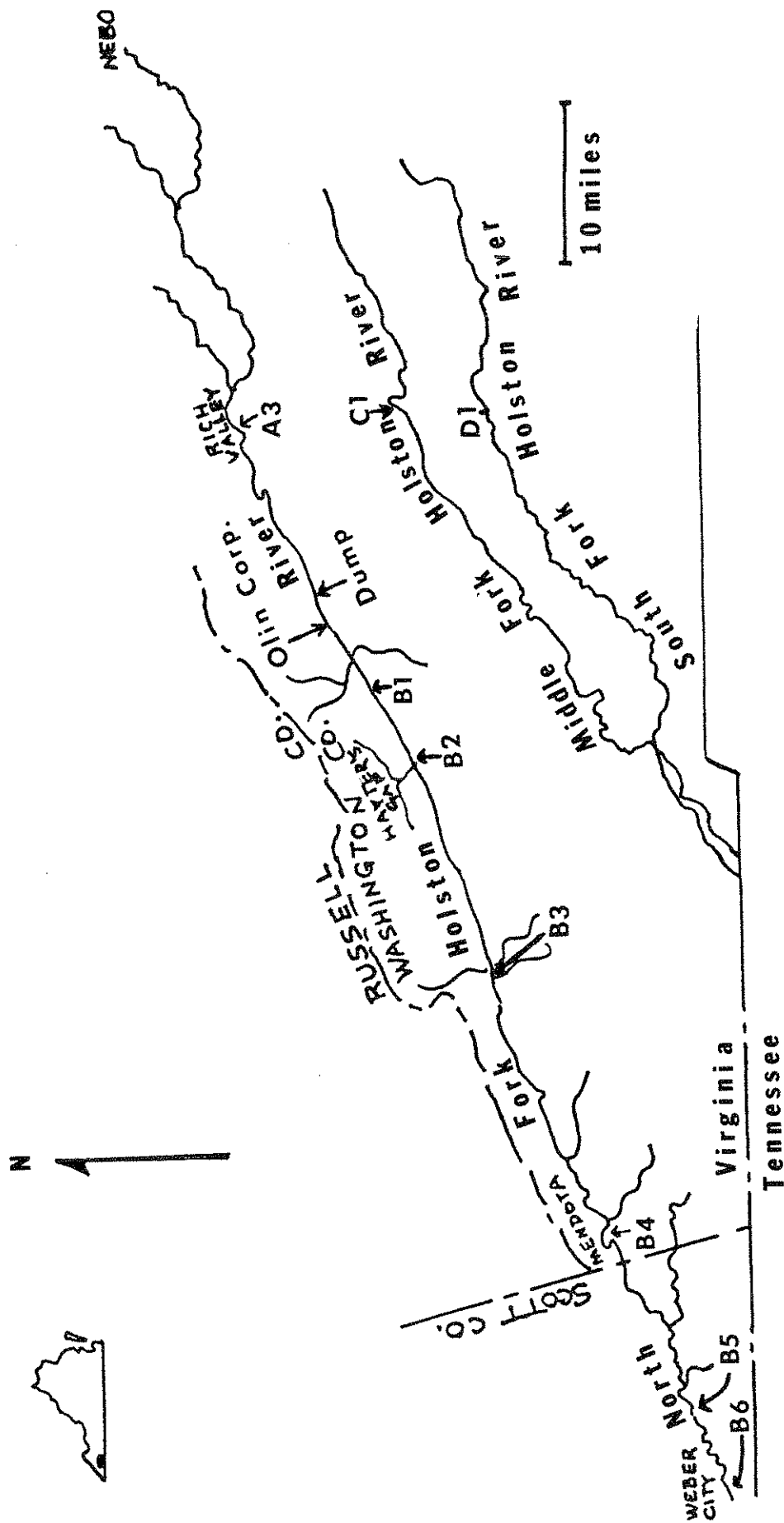
<u>Species</u>	<u>Length (cm)</u>
Sunfish	11.0-20.5
Rockbass	13.5-23.0
Northern Hogsucker	22.5-33.0

The fish were collected using electrofishing techniques. Depending on the river condition at the time of sampling either a boat or a backpack electrofishing unit was used. The fish were placed in plastic bags, frozen immediately with dry ice, and returned to the laboratory for analysis.

In the lab, samples of the edible fish tissue were removed and prepared for analysis. The tissue was analyzed for total mercury by a cold vapor technique (EPA, 1972) using a flameless atomic absorption apparatus. The results are presented as total mercury in parts per million (ppm).

Sediment. Five sediment cores were taken at each station. The top three inches of sediment were analyzed for total mercury content and particle size distribution.

Figure 1. Sampling stations on the North, Middle, and South Forks Holston River 1981.



The total mercury analysis was done using an atomic adsorption technique similar to that used in the fish tissue analysis. Nitric acid was added in the digestion procedure as well as sulfuric acid. The mercury content is presented in parts per million (ppm) total mercury.

The particle size analysis was done on each of the five replicate cores for each station using a wet sieve method. The cores were analyzed for gravel, sand, and silt and clay size fractions.

STATISTICAL ANALYSIS

The results of the fish and sediment collections were analyzed using the Statistical Analysis System (SAS) analysis of variance program for factorial experiments. Duncan's Multiple Range Test was also used. Pearson product-moment correlations were run using the SAS program. The T-Test was used for comparisons between years using the SAS program. Comparisons between years were made based on the 1981 size class distinctions.

The statistical significance of all results is reported for the 0.05 level (95% confidence level).

RESULTS AND DISCUSSION

MERCURY CONTENT OF THE FISH

Control Stations. As expected, none of the individual fish collected at the control stations exceeded the 1.0 ppm total mercury Federal Drug Administration (FDA) guideline for human consumption.

The mean mercury content of each species within each control station is shown in Table 1. Within stations, differences in mean mercury content of the three species of fish were seen only at Station C₁ (MFH 32). Within the other two control stations, the species did not differ significantly in their mean mercury content. The differences seen at Station C₁ (MFH 32) included no difference in the mercury means for the Northern Hogsucker and the Rockbass, but both species having a significantly larger mean mercury content than the Sunfish. These differences in means are listed below:

<u>Station</u>	<u>Mean Mercury Content of Species</u>
A3 (NFH 98)	No significant differences.
C1 (MFH 32)	Northern Hogsucker, Rockbass > Sunfish.
D1 (SFH 102)	No significant differences.

In the 1980 sampling results, significant differences existed between the mean mercury content of the species within Stations A3 (NFH 98) and D1 (SFH 102). The 1981 samples showed no significant differences in this regard. Station C₁ (MFH 32) did show a change in the differences between the species from 1980 to 1981. In this case both the Rockbass and Northern Hogsucker exceeded the Sunfish in mean mercury content. While these differences from 1980 to 1981 are statistically significant, they may only represent the fluctuations in natural populations.

Table 1. Mean Mercury Content of the Fish Collected at the Control Stations on the North, Middle, and South Forks Holston River, July 1981. (NFH-North Fork Holston River, MFH-Middle Fork Holston River, SFH-South Fork Holston River).

Station	Species	Number Collected	Mean Mercury Content (ppm)	Standard Deviation	Range
D1	No. Hogsucker	9	0.09	+0.03	0.07-0.14
SFH 102	Rockbass	4	0.27	+0.24	0.09-0.62
	Sunfish	10	0.15	+0.10	0.06-0.38
C1	No. Hogsucker	10	0.25	+0.05	0.16-0.35
MFH 32	Rockbass	10	0.24	+0.14	0.08-0.53
	Sunfish	8	0.12	+0.08	0.06-0.26
A3	No. Hogsucker	8	0.19	+0.09	0.12-0.38
NFH 98	Rockbass	10	0.30	+0.12	0.16-0.48
	Sunfish	10	0.27	+0.17	0.10-0.57

Table 2. Mean Mercury Content of the Fish Collected at the Affected Stations on the North, Middle, and South Forks Holston River, July 1981. (NFH-North Fork Holston River, MFH-Middle Fork Holston River, SFH-South Fork Holston River).

Station	Species	Number Collected	Mean Mercury Content (ppm)	Standard Deviation	Range
B1	No. Hogsucker	10	1.72	+0.38	1.10-2.13
NFH 77	Rockbass	5	1.14	+0.34	0.61-1.45
	Sunfish	10	1.21	+0.33	0.71-1.70
B2	No. Hogsucker	10	1.15	+0.33	0.75-1.77
NFH 72	Rockbass	10	1.20	+0.37	0.59-1.90
	Sunfish	10	0.97	+0.51	0.46-2.08
B3	No. Hogsucker	10	1.63	+0.35	0.87-1.94
NFH 59	Rockbass	10	1.07	+0.34	0.45-1.63
	Sunfish	10	1.02	+0.53	0.25-2.15
B4	No. Hogsucker	10	1.31	+0.45	0.65-1.93
NFH 36	Rockbass	10	0.92	+0.20	0.57-1.18
	Sunfish	10	0.78	+0.14	0.54-0.99
B5	No. Hogsucker	8	1.68	+0.81	0.97-3.31
NFH 22	Rockbass	9	1.60	+0.34	1.12-2.02
	Sunfish	11	1.10	+0.53	0.32-2.10
B6	No. Hogsucker	10	0.72	+0.26	0.24-1.24
NFH 8	Rockbass	9	0.78	+0.12	0.63-1.00
	Sunfish	10	0.47	+0.28	0.11-0.89

Among stations, differences in mean mercury content were found for the Northern Hogsucker and the Sunfish. The Rockbass did not differ in their mean mercury content among the control stations. The Northern Hogsucker showed significant differences in mean mercury content between all three control stations. The Sunfish mean mercury contents differed between Station A3 (NFH 98), and Stations C1 (MFH 32) and D1 (SFH 102). These differences in means (> indicates "significantly greater than") are shown below:

Northern Hogsucker	C1 (MFH 32) > A3 (NFH 98) > D1 (SFH 102)
Rockbass	No Significant Differences
Sunfish	A3 (NFH 98) > D1 (SFH 102), C1 (MFH 32)

The Sunfish and Rockbass showed no differences in mercury content from the 1980 collection and so maintained their respective differences between control stations. The Northern Hogsucker on the other hand did show a significant increase in mean mercury content at Station C1 (MFH 32) from 1980 to 1981. The reason for this is unknown.

Affected Stations. The mean mercury contents of the three fish species at the affected stations (Table 2) were above or near the 1 ppm FDA guideline with the exception of those collected at Station B6 (NFH 8), the most downstream station, and the Sunfish at Station B4 (NFH 36)(Figure 2). Only 2 of the 29 fish collected at Station B6 (NFH 8) exceeded the FDA guideline. This confirms that mercury contamination above Station B6 (NFH 8) was extensive.

To further illustrate the degree of fish flesh contamination by mercury, Table 3 was prepared. It gives the percentage of individuals by species and station which exceeded the 1 ppm mercury FDA guideline. There is a definite line of demarcation between Stations B5 (NFH 22) and B6 (NFH 8). The percentage of Northern Hogsucker and Rockbass within Stations B1 (NFH 77) through B5 (NFH 22) whose mercury content exceeded the guideline was in excess of 50%. The percentage of Sunfish within these same stations whose mercury content exceeded the guideline was in excess of 30% with the exception of the fish at Station B4 (NFH 36). In contrast, all three species at Station B6 (NFH 8) had less than 11% of their individuals with tissue concentrations exceeding 1 ppm total mercury. The degree of total mercury contamination for the species at Station B6 (NFH 8) was much less than the same species at the other affected stations upstream.

The ranges of total mercury concentration for the species within each affected station are given in Table 2. The overall range for the Northern Hogsucker was 0.45-3.31 ppm mercury, for the Rockbass was 0.45-2.02 ppm mercury and for the Sunfish was 0.11-2.15 ppm mercury.

Significant differences in mean mercury content within a species among the affected stations were few and without major trends. The Northern Hogsucker had significantly higher mean mercury contents at Stations B1 (NFH 77) through B5 (NFH 22) than at Station B6 (NFH 8). The Rockbass collected at Station B5 (NFH 22) showed a significantly higher mean mercury content than those at the remaining affected stations. The Sunfish at Station B6 (NFH 8) had a lower mean mercury content than the Sunfish at the other affected stations except those at B4 (NFH 36). The mean mercury contents of the Northern Hogsuckers and the Sunfish at stations upstream from and including B5 (NFH 22) suggest, by virtue of being significantly greater than their respective means at Station B6 (NFH 8), that some reduction in the magnitude of the mean mercury content of these species may have been occurring at the most downstream station.

Figure 2. Mean Mercury Content of the Fish Species Collected at the Control and Affected Stations on the North Fork Holston River, July 1981.

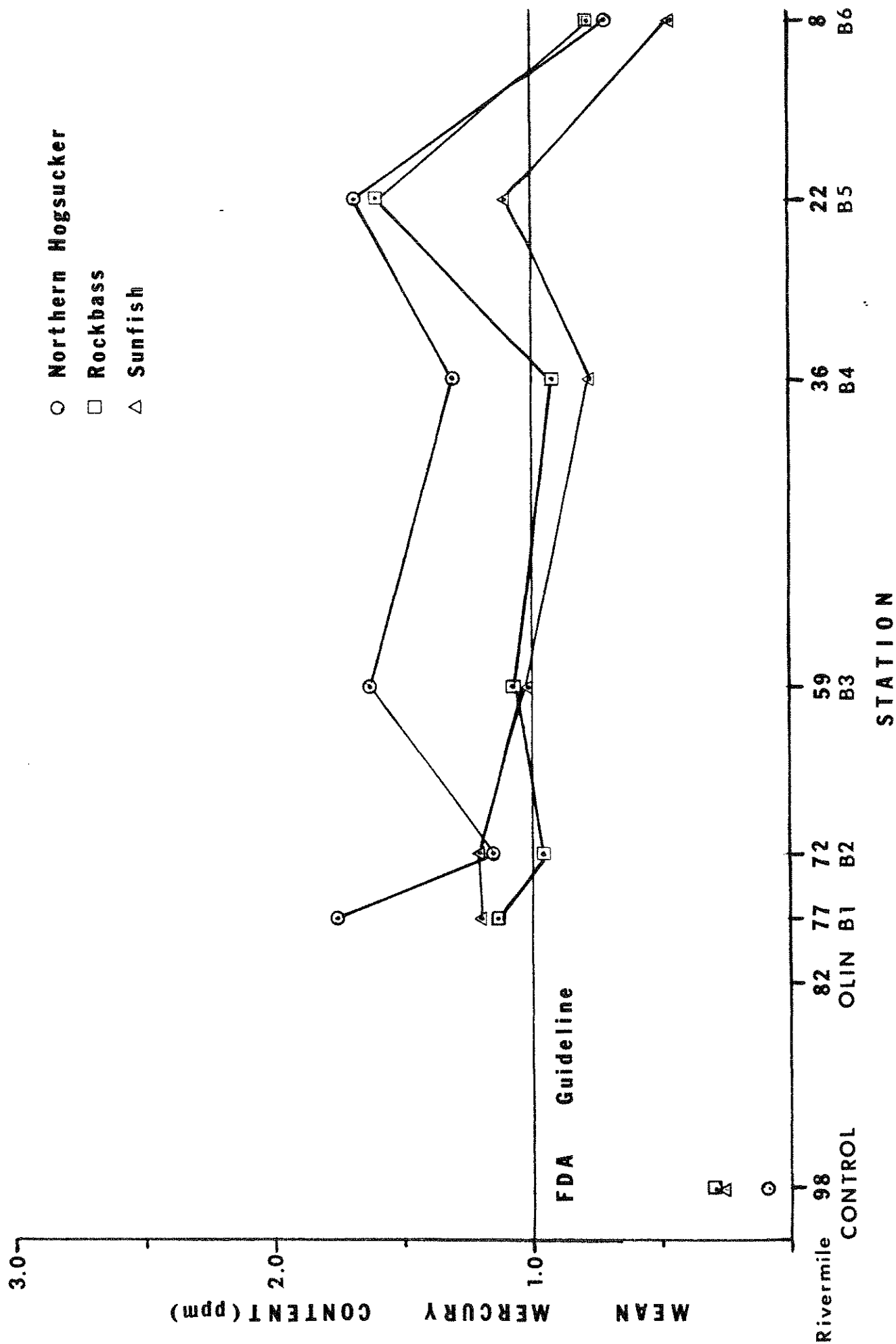


Table 3. Percentage of the Total Number of Individuals of Each Species Collected at Each Station whose Edible Tissue Exceeded 1 ppm Total Mercury, July 1981. (NFH-North Fork Holston River, MFH-Middle Fork Holston River, SFH-South Fork Holston River).

Control Stations	Rivermile	NO. HOGSUCKER	ROCKBASS	SUNFISH
D1	SFH 102	0	0	0
C1	MFH 32	0	0	0
A3	NFH 98	0	0	0
<u>Affected Stations</u>				
B1	NFH 77	100 (10)	80 (4)	70 (7)
B2	NFH 72	70 (7)	70 (7)	30 (3)
B3	NFH 59	90 (9)	60 (6)	50 (5)
B4	NFH 36	70 (7)	50 (5)	0 (0)
B5	NFH 22	75 (6)	100 (9)	55 (6)
B6	NFH 8	10 (1)	11 (1)	0 (0)

() Indicates number of individuals in sample exceeding 1 ppm total mercury.

Some significant differences existed between the mean mercury content of species within stations, but no trend could be detected. No significant differences between species were evident at Station B5 (NFH 22) and B2 (NFH 72). At the remaining stations, the Northern Hogsuckers exceeded the Rockbass and the Sunfish in mean mercury content except at Station B6 (NFH 8) where they exceeded only the Sunfish. With the exception of Station B6 (NFH 8), the Rockbass and Sunfish did not differ in mean mercury content within a station.

The differences noted in the mean mercury content within each species among the affected stations could not be linked to the mean mercury content of the sediment based on the results of the Pearson Product Moment Correlations.

Comparison of Control and Affected Stations. The mean mercury contents of the Northern Hogsucker and Rockbass at all of the affected stations were significantly higher than those at Control Station A3 (NFH 98). The Sunfish results were the same between control and affected stations with the exception that the most downstream affected station, B6 (NFH 8), did not differ significantly from the control station. Mercury contamination of all three species (with the exception of the Sunfish at B6 (NFH 8)) exists throughout the 80 miles of river sampled.

Comparison of Fish Mercury Results for 1979, 1980 and 1981. The T-Test was used to assess differences in mean mercury content of each species within a station for the 1980 and 1981 collections. Some significant changes were found in all three species (Table 4).

The Northern Hogsucker and Sunfish declined in mean mercury content at affected Stations B2 (NFH 72), B3 (NFH 59), and B6 (NFH 8) between the 1980 and 1981 sampling. The Rockbass showed only one decline which was at Station B3 (NFH 59).

While it would appear that a downward trend in mercury content might be occurring in these species within certain stations, this was not found to be true in all cases after the results from 1981 were compared with those of 1979.

The comparisons at Station B1 (NFH 77) showed no change in mercury content from 1980 to 1981, but did show a significant decrease from 1979 to 1981 with the Sunfish and Northern Hogsucker. The Rockbass did not change significantly over this two year period.

The apparent changes in the mercury content of the Sunfish and Northern Hogsucker at Stations B2 (NFH 72) and B6 (NFH 8) from 1980 to 1981 were not substantial enough to make them differ from their respective 1979 means. The mercury content of the Rockbass in 1981 was not different from that of 1980 at Station B2 (NFH 72), but was significantly less than that of 1979. The Rockbass did not differ in mean mercury content at Station B6 (NFH 8) from 1979 to 1981.

The decline seen in the Rockbass and Northern Hogsucker mean mercury content for Station B3 (NFH 59) from 1980 to 1981 held true for the 1979 to 1981 comparison also. The same comparisons for the Sunfish did not hold true. Their 1980 to 1981 decline was significant, but not enough to establish a significant decline in mean mercury content from 1979 to 1981.

At Station B4 (NFH 36), no significant changes were seen in the mean mercury content of any of the species from 1980 to 1981. However, the Northern Hogsuckers did contain on the average less mercury in their edible tissue in 1981 than in 1979.

Table 4. The T-Test Results Comparing Mean Mercury Content for Species-Station Combinations for the Years 1980-1981 and 1979-1981 (NC-No Significant Change, DEC-Significant Decrease, INC-Significant Increase).

<u>Station</u>	<u>Species</u>	<u>1980-1981</u>	<u>1979-1981</u>
B1 NFH 77	Sunfish	NC	DEC
	Rockbass	NC	NC
	No. Hogsucker	NC	DEC
B2 NFH 72	Sunfish	DEC	NC
	Rockbass	NC	DEC
	No. Hogsucker	DEC	NC
B3 NFH 59	Sunfish	DEC	NC
	Rockbass	DEC	DEC
	No. Hogsucker	DEC	DEC
B4 NFH 36	Sunfish	NC	NC
	Rockbass	NC	NC
	No. Hogsucker	NC	DEC
B5 NFH 22	Sunfish	NC	INC
	Rockbass	NC	INC
	No. Hogsucker	NC	NC
B6 NFH 8	Sunfish	DEC	NC
	Rockbass	NC	NC
	No. Hogsucker	DEC	NC

The fish at Station B5 (NFH 22) like those at B4 (NFH 36) did not appear to change significantly in mean mercury content from 1980 to 1981. This was also the case for the Northern Hogsuckers for the 1979-1981 comparisons, but was not true for the other two species. A significant increase in mercury content was noted for both Sunfish and Rockbass over this time period.

The declines in the mean mercury content of the fish species seen from 1980 to 1981 did not reflect a continuing downward trend from 1979 to 1981 with the exception of the Northern Hogsucker and Sunfish at Station B3 (NFH 59). The remaining station-species combinations showing a decrease in mean mercury concentrations from 1980 to 1981 showed no significant change when analyzed over the 1979-1981 period.

In summary, some of the station-species combinations which did not change their mercury content from 1980 to 1981 did show other changes when the 1981 results were compared to those of 1979. All three possibilities for change (increase, decrease, no change) in mean mercury content were noted, but no overall trends in changing mercury content were apparent.

MERCURY CONTENT OF THE SEDIMENT

Control Stations. The mean mercury content of the sediment core replicates is listed by station in Table 5. Sediment collected from control stations A3 (NFH 98) and C1 (MFH 32) did contain more mercury than did that of Station D1 (SFH 102). The difference may be attributed to natural fluctuations in the sediment and sampling methods.

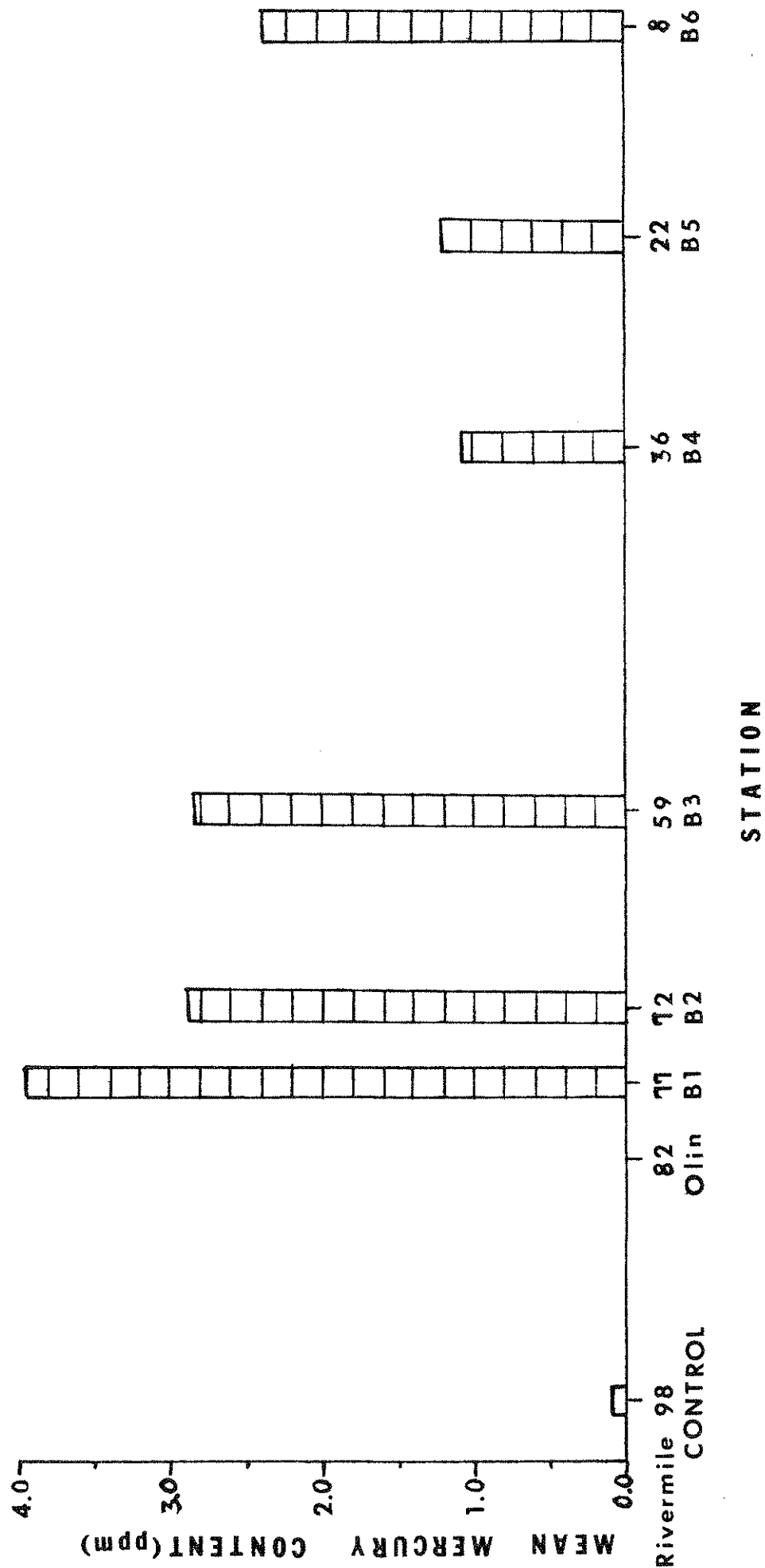
Affected Stations. The means and ranges for the sediment samples taken at the affected stations were large and wide, respectively (Table 5, Figure 3). These numbers illustrate the sizeable variability of the sediment mercury content within a single sampling station and within the entire affected portion of the North Fork Holston River. Two unusually large concentrations of mercury were captured at Station B1 (NFH 77) (9.58 ppm) and Station B6 (NFH 8) (6.08 ppm). The range of mercury values at these two stations was also extremely large. The remaining sediment values fell within reasonable expected limits at each station.

Duncan's Multiple Range Test was used to elucidate significant differences between stations with respect to the mean mercury content of their sediment. The test was done using the entire data set and the data set minus the two large mercury concentrations previously mentioned. Using the entire sediment data set, Station B1 (NFH 77) (Hg - 3.95 ppm) was found to exceed Stations B4 (NFH 36) (Hg - 1.20 ppm) and B5 (NFH 22) (Hg - 1.08 ppm) in mean mercury content. No other significant differences between stations were noted. However, when the data set minus the two extreme sediment mercury values was used the results were similar, but also provided more information for interpretation. The three upstream stations, B1 (NFH 77), B2 (NFH 72), and B3 (NFH 59), did not differ significantly from each other in mean mercury content of the sediment. Likewise, the three most downstream stations, B4 (NFH 36), B5 (NFH 22), and B6 (NFH 8), did not differ in mean mercury content. Station B1 (NFH 77) also did not differ from B5 and B6. Significant differences in mean mercury content of the sediment then were seen between upstream stations (B2 (NFH 72), B3 (NFH 59)) closest to the area of contamination and the downstream stations (B4 (NFH 36), B5 (NFH 22), B6 (NFH 8)). Both data sets suggest that the bulk of the mercury in the river sediment exists upstream from Station B4 (NFH 36).

Table 5. Mean Total Mercury Content of the Sediment Collected from the North, Middle, and South Forks Holston River, July 1981. (NFH-North Fork Holston River, MFH-Middle Fork Holston River, SFH-South Fork Holston River).

Control Stations	Rivermile	Number Collected	Mean Mercury (ppm)	Standard Deviation	Range
D1	SFH 102	5	0.05	± 0.01	0.04-0.06
C1	MFH 32	5	0.11	± 0.06	0.06-0.09
A3	NFH 98	5	0.10	± 0.02	0.09-0.12
<u>Affected Stations</u>					
B1	NFH 77	5	3.95	± 3.44	0.32-9.58
B2	NFH 72	5	2.87	± 0.99	1.85-4.11
B3	NFH 59	5	2.82	± 0.49	2.32-3.45
B4	NFH 36	5	1.08	± 0.48	0.33-1.65
B5	NFH 22	5	1.20	± 0.60	0.64-2.21
B6	NFH 8	5	2.36	± 2.24	0.19-6.08

Figure 3. Mean Mercury Content of the Sediment Collected from the Control and Affected Stations on the North Fork Holston River, July 1981.



Comparison of Control and Affected Stations. The T-Test was used to compare the mean mercury content of the sediment at Control Station A3 (NFH 98) to that of each of the affected stations. Affected Stations B2 (NFH 72) through B5 (NFH 22) exceeded the control station in mean mercury content of the sediment. This provides additional confirmation of the mercurial contamination in this portion of the North Fork Holston River. The T-Test was applied to Stations B1 (NFH 77) and B6 (NFH 8) for both of the previously mentioned sediment data sets. In both instances, no significant difference ($\alpha = 0.05$) in mean mercury content was noted between the control and affected stations. The extremes in mercury content of the replicate cores taken within Stations B1 and B6, respectively, contributed to large standard deviations which during the calculation of the t-statistic yielded a low and consequently nonsignificant t-value at the 0.05 level of significance. None the less, when viewing the mercury contents of the individual cores for each station it becomes apparent that both stations are heavily contaminated with mercury.

Comparison of Sediment Mercury Results for 1979, 1980, and 1981. Sediment mercury changes between the 1980 and 1981 samplings were noted for two control stations (A3 and D1) and two affected stations (B2 and B5) using the T-test. An increase was noted in the mean mercury content of the sediment at Control Stations A3 (NFH 98) and D1 (SFH 102). Neither increase was significant enough to indicate sediment contamination. They were most probably due to natural local fluctuations in the distribution of the sediment.

The changes in mean mercury content which occurred at the affected stations were an increase at B2 (NFH 72) from 1.12 ppm to 2.87 ppm and a decrease at B5 (NFH 22) from 2.20 ppm to 1.20 ppm.

The T-Test was performed again on Stations B1 (NFH 77) and B6 (NFH 8) using the sediment data without the two large mercury values. Even without the high values, the mean mercury content at those stations did not vary from 1980 to 1981.

Comparisons within each station between the 1979 and 1981 sediment mercury data using the T-Test revealed two pieces of information. First, the mean mercury content of the sediment at each affected station did not differ significantly when comparing the 1979 results to those of 1981. Secondly, all the control stations declined significantly in their mean mercury content. This decline as in last year's report has been attributed to the laboratory's lowering of the detection limit after 1979.

In summary, the sediment below Olin remains contaminated with mercury with the bulk of the mercury in 1981 existing from rivermile 72 to rivermile 36.

PARTICLE SIZE ANALYSIS

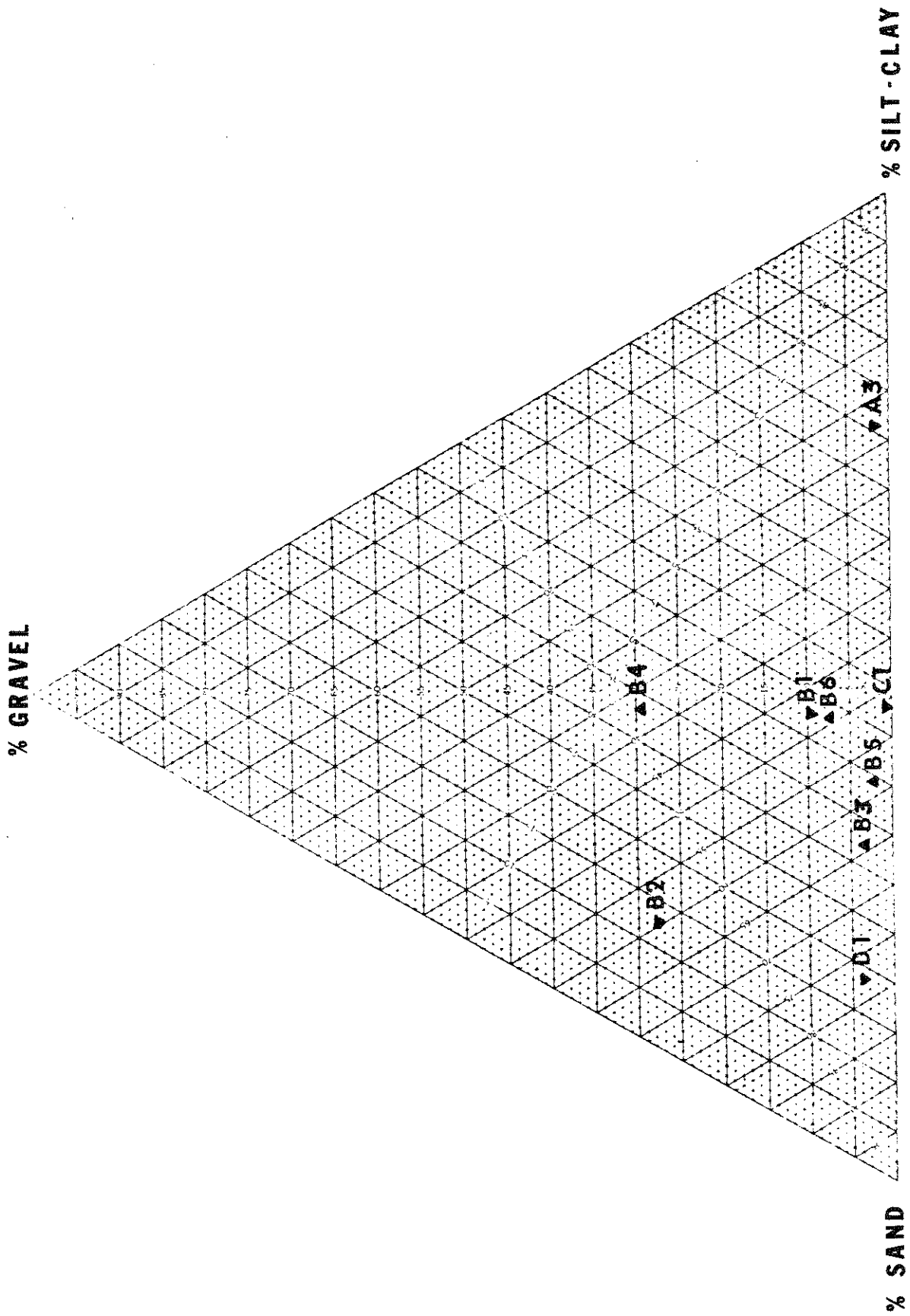
The mean percentage gravel, sand, and silt and clay found in the sediment cores from each station are listed in Table 6 and illustrated in Figure 4. The cores appeared to be dominated by sand, and silt and clay. The 1981 samples appeared to contain more sand and less silt and clay than the 1980 samples.

Pearson product-moment correlations were used to assess the presence of any relationships between the mean mercury content and mean percentages of gravel, sand, and silt and clay in the sediment. No significant correlations were found between the mean mercury content and any of the sediment particle sizes.

Table 6. Particle Size Analysis Results for Sediment Samples Collected from the North, Middle, and South Forks Holston River, July 1981. (NFH-North Fork Holston River, MFH-Middle Fork Holston River, SFH-South Fork Holston River).

Control Station	River-mile	Mean Percentage Gravel	Standard Deviation	Mean Percentage Sand	Standard Deviation	Mean Percentage Silt/Clay	Standard Deviation
D1	SFH 102	3.80	+ 4.12	77.78	+16.76	18.42	+19.56
C1	MFH 32	0.90	+ 1.69	51.84	+32.14	47.25	+31.67
A3	NFH 98	1.33	+ 1.72	23.43	+12.19	75.23	+12.77
<u>Affected Station</u>							
B1	NFH 77	9.96	+10.90	47.73	+28.32	42.30	+34.42
B2	NFH 72	27.38	+34.89	59.68	+31.67	12.93	+23.34
B3	NFH 59	3.06	+ 4.25	64.45	+ 3.79	32.48	+ 6.53
B4	NFH 36	28.91	+22.68	37.71	+19.51	33.35	+25.22
B5	NFH 22	1.75	+ 2.41	58.99	+36.02	39.29	+33.98
B6	NFH 8	7.60	+ 8.98	43.40	+22.21	49.00	+23.21

Figure 4. Percentage Gravel, Sand and Silt-Clay Found in Sediment Cores from the North, Middle, and South Forks Holston River, July 1981.



SUMMARY OF THE RESULTS OF THE 1981 HOLSTON RIVER
FISH AND SEDIMENT COLLECTION

FISH

Control Stations

1. None of the fish exceeded the 1 ppm total mercury FDA guideline.
2. Significant differences in mean mercury content were evidenced only at Station C1 (MFH 32), where the Northern Hogsucker and Rockbass exceeded the Sunfish in mean mercury content.
3. Among stations, differences in mean mercury content within each species were noted for the Northern Hogsucker and Sunfish. The relationships between station means for the Sunfish were the same as those of 1980. The Northern Hogsucker's mean mercury content differed as follows:
C1 (MFH 32) > A1 (NFH 98) > D1 (SFH 102)

Affected Stations

1. With the exception of the fish collected at Station B6 (NFH 8), the most downstream station, and the Sunfish at Station B4 (NFH 36), the mean mercury content of each of the three fish species within the five remaining affected stations, was above or very near the 1 ppm mercury FDA guideline.
2. The percentage of individuals of each species within each station which exceeded the guideline varied with the species. Over 50% of the Northern Hogsuckers and Rockbass, collected within Stations B1 (NFH 77) through B5 (NFH 22) contained at least 1 ppm total mercury in their edible tissue. The Sunfish among the same 5 stations had over 30% of their individuals at each station containing 1 ppm total mercury or more.
3. Significant differences in mean mercury content within a species among the affected stations were few and without trends.
4. While significant differences existed between the mean mercury content of the species with stations, no trends could be detected.
5. There were no correlations between mean mercury content of the sediment and the mean mercury content of any of the fish species.

Comparisons of Control and Affected Stations

1. The fish at the affected stations had significantly greater mean mercury contents than did their respective species at the control station (A3, NFH 98) with the exception of the Sunfish at Station B6 (NFH 8).

Comparison of Fish Mercury Results for 1979, 1980 and 1981

1. Some of the station-species combinations which did not change their mercury content from 1980 to 1981 did show other changes when the 1981 results were compared to those of 1979. All three possibilities for change (increase, decrease, no change) in mean mercury content were noted, but no overall trends in changing mercury content were apparent.

SEDIMENT

Control Stations

1. Differences between Stations A3, C1, and D1 of the sediment could be attributed to natural fluctuations in the sediment.

Affected Stations

1. Large means and wide ranges were seen for sediment samples collected at the affected station.
2. Without the two extreme sediment mercury values, the mean mercury values suggest that the bulk of the mercury exists in those sediments upstream from Station B4 (NFH 36).

Comparison of Control and Affected Stations

1. Stations B2 (NFH 72) through B5 (NFH 22) exceeded the control station A3 (NFH 98) in mean mercury content of the sediment, thereby providing additional confirmation of substantial mercurial contamination of the river.

Comparison of Sediment Mercury Results for 1979, 1980, and 1981.

1. Few changes in mean mercury content of the sediment were noted in comparing results from 1980 and 1981. No significant changes were noted when the 1979 results were compared to those of 1981.

Particle Size Analysis.

1. The cores were dominated by either sand or silt and clay.
2. No significant correlations (relationships) were found between the mean mercury content of the sediment and either of the three sediment particle sizes.

CONCLUSIONS

The fish (Sunfish, Rockbass and Northern Hogsucker) and sediment of the North Fork Holston River in Virginia remain contaminated with mercury over at least 80 river miles. The contamination, as expressed by the number of individuals of a fish species which exceeded the 1 ppm total mercury FDA guideline, indicated that over 50% of the Rockbass and Northern Hogsucker collected within each of the five most upstream stations, exceeded the guideline. The Sunfish results were more variable; but, this species still had at least 30% of the individuals at four of the six affected stations whose mercury content exceeded the guideline.

While declines in mean mercury content were seen within some species-station combinations for the year 1980-1981, these trends did not hold over-all for the time period 1979-1981.

The bulk of the sediment mercury lies between rivermiles 72 and 36. The sediment did not show changes in mean mercury content between years 1980-1981 and 1979-1981. Sediment particle size did not correlate with mean mercury content.

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