10-7-1999

North Fork of the New River Benthic Macroinvertebrate Recruitment Study: Final Report

Charles G. Messing
Nova Southeastern University Oceanographic Center, messingc@nova.edu

North Fork of the New River Benthic Macroinvertebrate Recruitment Study:

Final Report

Submitted by:

Charles G. Messing

Nova Southeastern University Oceanographic Center
8000 North Ocean Drive
Dania Beach, FL 33004

7 October 1999

INTRODUCTION

Over the last several years, the Broward County Department of Natural Resource Protection has identified a series of major environmental problems in the North Fork of the New River, including illegal wastewater sludge discharge and heavy metal contamination of sediments (DNRP 1993 1994). A qualitative survey suggests that benthic macroinvertebrates have been negatively affected (DNRP 1997). Restoration projects have included removal in the summer of 1997 of a remnant sludge blanket from an area of the channel east of Interstate 95 and north of Broward Boulevard. However, the effectiveness of such dredging in terms of habitat restoration has not previously been examined. This report documents the results of four sampling events carried out in order to investigate the response to such dredging of benthic macroinvertebrate assemblages in the North Fork of the New River.

MATERIALS AND METHODS

Benthic samples were collected at four stations by DNRP using a 225 cm^2 Ekman grab. Two stations are located in the area of the sludge blanket: one at the outfall itself and one 300 m east of the outfall (stations 2 and 3, respectively in Figure 1). A third is upstream of the outfall (at Sistrunk Boulevard; station 1 in Figure 1) and a fourth downstream (at the SW 11^{th} Avenue Bridge; station 4 in Figure 1). These stations are referred to below and in the Tables as Outfall, East, Sistrunk and Bridge. DNRP personnel prepared the samples as follows: samples were fixed in 10% formalin solution with rose Bengal stain, sieved through a coarse screen to remove large debris and sieved again through a U.S. Standard No. 30 sieve (0.595 mm openings). The contents retained on the sieve were placed in fresh 10% formalin and rose Bengal solution and delivered to the contractor - Nova Southeastern University Oceanographic Center.

NSU personnel transferred the samples to 70% ethanol and sorted all organisms from the sediment using forceps and stereomicroscopes. Organisms were initially sorted to

major taxonomic group (e.g., insect larvae, oligochaete worms, and bivalve mollusks), enumerated and identified in house or shipped to taxonomic specialists for identification.

Please note that although the project scope of work calls for three replicates at each of the four stations taken quarterly, only the first, third and fourth surveys included three replicates (Tables 1 & 2). The second survey (August 1998) included only four samples, one from each station.

Shannon-Weaver Diversity Indices are calculated for each station and replicate using the following equation:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

where p_i is the relative abundance of species *i*. H' generally increases with increasing number of species *S*. For any given *S*, H' reaches a maximum value (H'_{max}) when all values of *p* are equal ($p_1 = p_2 = p_3...$), and H' equals ln *S*. Because H' is primarily affected by species number rather than by abundances of common or rare species, or by species of moderate abundance, evenness (J') has also been calculated for each station and replicate using the equation:

$$J' = H'/H'_{max} = H'/\ln S$$

As a ratio between the diversity index (H') for a given sample and the maximum possible diversity index (H'_{max}) for the number of species and specimens in that sample, evenness (J') gives an indication of how close the data come to maximum possible diversity.

RESULTS

Figure 1 illustrates station locations. Table 1 lists numbers of specimens by replicate and station. Table 2 documents summary data: numbers of specimens and species, Shannon-Weaver diversity indices and evenness indices for each replicate (where appropriate) and station. Overall, 1499 specimens belonging to 60 distinguishable species-level taxa were recorded across all four surveys (omitting a single unidentifiable

fragment in the May 1998 survey). The dominant organisms are dipteran insect larvae and oligochaete worms. Groups of secondary importance include polychaete worms, bivalve and gastropod mollusks, crustaceans and turbellarian flatworms.

The most abundant individual taxa overall are the oligochaetes, *Limnodrilus hoffmeisteri* and an unidentified tubificid without hair setae, and larvae of the chironomid midges (Insecta: Diptera), *Chironomus* sp. and *Polypedilum halterale*. However, Michael Milligan, the taxonomic consultant who identified the worms, indicates (personal communication, October 1999) that the unidentified tubificids without hair setae are juveniles, most likely of *L. hoffmeisteri*. Because he notes that he cannot be absolutely certain of their identity, identified specimens and unidentified juveniles are distinguished in Table 1. However, I have also calculated diversity and evenness indices treating them as belonging to a single species (the "Modified" numbers of species, H' and J' in Table 2), which reduces overall species richness to 59. In all cases, as expected, the modified indices are lower than those in which identified *L. hoffmeisteri* and unidentified juveniles without hair setae are treated as separate taxa. The differences are sometimes substantial, pointing up the necessity for identifying organisms as precisely as possible. For example, in May 1998 at the Outfall and East stations, the diversity indices are 1.516 and 1.090, while the modified indices drop to 1.001 and 0.587, respectively.

L. hoffmeisteri (adults and juveniles), *Chironomus* sp. and *Polypedilum halterale* together account for 72.5% of all organisms collected. All are found at every station in the May 1998 and March 1999 surveys and in at least two stations each in the August and November 1998 surveys. Species of secondary importance occur in numbers at fewer stations or in fewer surveys. As examples, the dreissenid bivalve, *Mytilopsis leucophaeta*, and the larvae of the chironomid *Procladius* sp., occur at every station only in the May 1998 survey, while the gastropod, *Neritina virginea*, appears at three stations but only in the March 1999 survey. The polychaete worm, *Laeonereis culveri*, occurs in every survey but chiefly only at the SW 11th Avenue bridge station.

All stations register sharply lower abundance, richness and diversity in November 1998 than in either May 1998 or March 1999. Unfortunately, because the August 1998 survey included only a single replicate per station, little comparison can be made with the other surveys. It is worth noting, however, that organism abundance at Sistrunk in the

single August grab is comparable with that found at the same site in May and March. By contrast, abundance at Outfall is much lower in August than in either May or March. Although abundance is also much lower in August than in May at both East and Bridge sites, at least one March replicate has similarly few organisms.

The following station-by-station descriptions run from the most upstream (Sistrunk Blvd.) to the most downstream (SW 11th Ave. Bridge). Percentages represent relative abundances: numbers of a given species divided by the total number of specimens summed for all replicates in a sample.

SISTRUNK BOULEVARD STATION: Larvae of the chironomid dipteran, *Polypedilum halterale* (34.4%), and the oligochaete *Limnodrilus hoffmeisteri* (32.4%; identified adults and unidentified juveniles together) dominate the May 1998 survey. In the single August sample, *L. hoffmeisteri* is most abundant (52.8%), followed by *Chironomus* sp. (22.2%) and *P. halterale* (15.3%). In November, numbers of all taxa drop substantially. *L. hoffmeisteri* and *Chironomus* sp. account for 62.5% and 31.3% of individuals, respectively, while *P. halterale* almost disappears. In March 1999, *L. hoffmeisteri* (33.7%) and *P. halterale* (14.9%) reappear in increased numbers, but only the former reaches levels recorded in the previous May. They are accompanied by an unidentified hydroid (18.8%). However, the numbers of hydroid specimens recorded may represent pieces of a smaller number of colonies. Omitting this taxon because of the uncertainty of their number and because they are strictly epifauna reduces the unmodified diversity indices by 0.05 to 0.10 and evenness by 0.005 to 0.03.

Species richness and Shannon-Weaver diversity are higher here than at any other station in the May, August and March surveys. The 27 species-level taxa (again treating the unidentified tubificids without hair setae as juvenile *L. hoffmeisteri*) recorded here in May is the highest recorded during the project and includes twelve insects, six annelids and five mollusks.

Minor taxa found only or chiefly at this station include the oligochaete, *Aulodrilus pigueti*, the leeches *Helobdella elongata* and *H. stagnalis*, an unidentified planariid flatworm, larvae of the mayfly, *Caenis* sp., and larvae of the chironomids, *Cryptochironomus* sp. and *Dicrotendipes* sp. Of these, *A. pigueti*, the leeches and

Chironomus sp. larvae account for three of the seven specimens collected. Numbers remain low in November, with *Chironomus* sp. and *L. hoffmeisteri* accounting for 41.7% and 25%, respectively, of organism abundance. In March, although species richness (12) recovers, organism abundance remains less than 20% of that recorded in the previous May. Diversity is now higher than in any of the earlier surveys here and is similar to that at the Outfall station. However, both richness and abundance are well below values reported for the Sistrunk and Outfall sites. *Chironomus* sp. larvae account for 42.4% of organism abundance with *L. hoffmeisteri* contributing only 20.3%.

SW 11th AVENUE BRIDGE STATION: The Bridge site exhibits the lowest numbers of specimens of any station in the May survey, but greater species richness and diversity than either the Outfall or East sites. The most abundant taxa are larvae of the dipteran insects, *Chironomus* sp. (29.5%) and *Procladius* sp. (28.2%). The presence of nemertine and polychaete worms, and amphipod and isopod crustaceans, albeit in low numbers, reflect elevated salinities relative to the more upstream stations. The polychaete, *Laeonereis culveri*, does account for 14.1% of organism abundance. In August, only three specimens were collected here: two of the polychaete *L. culveri*, and a single chironomid larva of *Coelotanypus* sp. Numbers remain extremely low in November, the lowest of the four sites: four specimens of the amphipod, *Grandidierella bonnieroides*, two each of the polychaetes, *L. culveri* and *Steninonereis martini*, and one *Chironomus* sp. Abundance, richness and diversity increase in the March 1999 survey but do not recover to May 1998 levels. All three parameters also remain lower than at any of the other three sites in this month. The dominant organism is the polychaete, *Laeonereis culveri* (52.2%), followed by larvae of the chironomids, *Polypedilum scalaenum* (19.6%) and *Chironomus* sp. (17.4%).

DISCUSSION

This report attempts to determine whether benthic macroinvertebrate assemblages have been affected by removal of a toxic sludge blanket from the channel of the North Fork of the New River east of Interstate 95 and north of Broward Boulevard. Although

three replicates were taken at each of the four sites over a period spanning nine months following sludge removal, substantial variations in organism abundance, species richness and diversity among replicates limit the robustness of any hypothesis proposed to explain apparent temporal changes. The data do, however, suggest that some important trends exist.

In addition, in the spring of 1994, before the sludge was identified, employees of the Broward County Department of Natural Resource Protection collected and subsequently analyzed benthic macroinvertebrate assemblages at 25 sites throughout the New River Basin in Broward County (DNRP 1997). Four of these NRSED sites roughly correspond to stations sampled during the current project, as follows: NRSED 9 = SW 11th Avenue Bridge; NRSED 11 = 300 m East of Outfall; NRSED 12 =Outfall; NRSED 13 = Sistrunk Boulevard. Although the 1994 survey was qualitative and consisted of a single Ponar grab sample at each site, the data provide a baseline with which to compare the current results, at least to a limited degree. However, in order to understand the possible significance of any differences between habitats before and after sludge removal, the known ecology and habitat preferences of the dominant taxa are briefly outlined first.

Larvae of chironomid midges occur in a wide range of habitats ranging from terrestrial to marine. Some are highly specific, preferring, for example, the water retained by bromeliads or tree holes. Others are highly catholic. Among those found in this study, species of *Polypedilum* occur in a wide range of habitats and conditions; *Chironomus* spp. can be found from extremely polluted to relatively pristine environments; *Procladius* may also be found in heavily polluted habitats where it is subject to numerous deformities, and some species of *Cladopelma* tolerate low oxygen levels (Epler, 1995). The Florida Department of Environmental Protection (DEP) includes three of the chironomids found in this study as Class II organisms in its Florida Index (FI), one of several metrics used to evaluate aquatic macroinvertebrate assemblages as part of its Bioassessment Program. The FI is based on relative pollution tolerances of aquatic organisms (Beck, 1965) and is calculated by adding the numbers of Class I taxa (not numbers of individuals) multiplied by two plus the number of Class II taxa in a sample. The higher the index, the more degraded the habitat. This information plus a list of Class I and II taxa is available online on the Florida DEP web page at

http://www2.dep.state.fl.us/water/Slerp/bio/flaindx.htm. The only species found in this survey that appear on the Florida Index list are larvae of *Polypedilum halterale*, *Procladius* spp. and *Ablabesmyia rhamphe*, indicating that all three may be associated with polluted habitats. Samples taken during this project thus have Florida Indices of at most 2.

Oligochaetes are chiefly free-burrowing deposit feeders. Of the two families recorded in the current study, naiads tend to be herbivorous on aquatic vegetation in fast-flowing streams. Tubificids, often called sludge worms, are more typical of fine muddy and silty sediments where they graze on the microflora on ingested sediment particles. According to Milligan (1997), as long as sufficient water flow exists for waste removal and occasional oxygenation, tubificid populations can reach extremely high densities in organically polluted areas where frequent anaerobic conditions have excluded potential competitors for food and space. Large numbers of tubificids and naiads therefore tend not to coexist. *Limnodrilus hoffmeisteri*, the most abundant taxon in the current study, is a cosmopolitan species that can be found in pristine habitats but is often one of the most abundant taxa in organically enriched environments (Milligan, 1997). *Aulodrilus pigueti*, though not abundant in the current study, is the next most common oligochaete in Florida after *L. hoffmeisteri*.

Among the other taxa, the corophiid amphipod, *Grandidierella bonnieroides*, though rare in this study, was a consistently important component of benthic assemblages at most of the eleven stations occupied twice yearly from 1991 to 1997 in Southport, Port Everglades, and John U. Lloyd State Park (Messing & Dodge, 1997). This species exhibited a consistent seasonal signal, occurring in greater numbers in January relative to August samples, especially in a shallow mangrove-lined creek. At the same site, the polychaete, *Laeonereis culveri*, appeared in great abundance in a single one of the twelve samples taken over the course of the study (Messing & Dodge, 1997).

The following summarizes differences and similarities between the 1994 survey and the current study and over the course of the current study. Discussion of the current study concentrates on the May 1998 and March 1999 results because only a single replicate was taken at each site in August and because of the apparent seasonal minima found at all sites in November.

Only the easternmost site (NRSED 9: 11th Ave. Bridge) has consistently supported a fauna characteristic of at least somewhat saline conditions. Two species of amphipods (a corophiid and an aorid) together account for 44 of the 51 specimens collected in 1994. The remainder comprises one or two specimens each of isopod, chironomid larva, and arenicolid and capitellid polychaete. By contrast, nereid polychaetes and chironomid larvae dominate the site during the current study. The corophiid, *Grandidierella bonnieroides*, was found here in both the May and November surveys, but only in small numbers. The chironomid *Procladius* sp. and the dreissenid bivalve, *Mytilopsis leucophaeta*, disappear after the May survey and the chironomid, *Polypedilum scalaenum*, appears in the March 1999 survey. Both *Procladius* sp. and *M. leucophaeta* occur at all four stations in the May survey and disappear thereafter although it is not clear why. *Chironomus* sp. and *Laeonereis culveri* remain in numbers here at the beginning and end of the current study.

Station 11 in the 1994 survey recorded 39 chironomid larvae and 22 oligochaetes. This compares reasonably well with the post-removal fauna dominated as well by the same two groups. At the equivalent station (300 m East of the Outfall) during the current study, however, oligochaete abundance declines substantially from May 1998 to March 1999 while the chironomid fauna remains at similar levels of abundance and richness. As a result, although overall abundance declines, the diversity index increases substantially. The great abundance of organisms found at this site in May 1998 is due largely to the 171 *Limnodrilus hoffmeisteri* (117 juveniles, 54 identifiable adults) collected in one of the three replicates, the largest number of any species collected in any replicate during this study. Milligan (1997) notes that tubificids can occur in dense masses under organically enriched conditions.

No organisms were found at station 12 in 1994. This site corresponds to the Outfall station, and the lack of any organisms perhaps reflects the existence of the toxic sludge blanket. The presence of large numbers of *L. hoffmeisteri* plus six different chironomid larvae in May 1998 suggests a significant improvement in the local habitat relative to 1994. A decline in oligochaete numbers accompanied by the appearance of a few crustaceans, mollusks and a hydroid generate a substantially greater diversity index in March 1999 relative to May 1998, suggesting continued improvement. However, the

small number of data points and specimen numbers make any serious statement of trend premature. The faunal change may simply reflect a temporary incursion of water with a slightly elevated salinity.

Station 13 supported only a small number of chironomid larvae (3 specimens) and oligochaetes (6) in the 1994 survey. These two groups dominate the Sistrunk Boulevard station throughout the current study with generally much higher abundances per replicate except in November. Diversity indices and species richness remain similarly high in both May 1998 and March 1999. Overall station abundance declines from May to March by 37%. However, abundance per replicate overlaps substantially and large standard deviations reflect a lack of significant difference between mean abundances per replicate in the two months (81.3 ± 20.4 versus 51.3 ± 21.8).

Survey results indicate that, although the fauna at the Sistrunk, Outfall and East stations may be characteristic of organically enriched, disturbed or polluted environments, the substantial increase in abundance, richness and diversity at the Outfall station reflect a significant habitat improvement relative to conditions before sludge removal. Increased diversity and richness at this station over the course of this study suggest that the habitat may have further improved although the data are extremely few. A similar increase in diversity also appears at the station 300 m east of the Outfall, although richness remains the same and organism abundance decreases from March 1998 to May 1999.

REFERENCES

Beck, W.M., Jr. 1954, Studies in Stream Pollution Biology I . A Simplified Ecological Classification of Organisms. *Quarterly Journal Florida Academy of Science* 17(4): 211-227.

Broward County Department of Natural Resources Protection (DNRP), 1993. *New River Study: Final Report.* Technical Report Series, TR-93-06. Fort Lauderdale, FL.

Broward County Department of Natural Resources Protection (DNRP), 1994. *Toxicological Screenings of the Hard-Head Catfish (*Arius felis*) and the Blue Crab (*Callinectes sapidus*) in the North Fork of the New River, Broward County, Florida.* Technical Report Series, TR94-08. Fort Lauderdale, FL.

Broward County Department of Natural Resources Protection (DNRP), 1997. *Sediments of the New River, Broward County, Florida: Microtox® Bioassay and Benthic Macroinvertebrate Initial Survey.* Technical Report Series, TR 97-05. Fort Lauderdale, FL.

Epler, J. H. 1995. *Identification Manual for the Larval Chironomidae (Diptera) of Florida.* (Revised edition) Final Report for Dept. of Environmental Protection Contract # WM579. Department of Environmental Protection, State of Florida, Tallahassee, FL . v + 312 pp.

Messing, C.G. and Dodge, R.E. 1997. *Port Everglades Macroinvertebrate Monitoring: Monitoring of Benthic Macroinvertebrate Assemblages at the Southport Turning Basin and Adjacent Areas of John U. Lloyd State Recreation Area: Final Report.* Report to Port Everglades Authority, Broward Co., FL. 37 pp. + 12 tables.

Milligan, M. R. 1997. *Identification Manual for the Aquatic Oligochaetes of Florida, vol. 1. Freshwater Oligochaetes.* Final Report for Dept. of Environmental Protection Contract # WM550. Department of Environmental Protection, State of Florida, Tallahassee, FL. v + 186 pp.

TAXONOMIC SPECIALISTS CONSULTED

Michael Milligan, Center for Systematics and Taxonomy, Sarasota, FL (annelid worms, mollusks, insect larvae)

Jon Norenburg, division of Worms, Natural History Museum, Smithsonian Institution, Washington, DC (Platyhelminthes, Nemertina, unknowns)

Marilyn Schotte, Division of Crustacea, Natural History Museum, Smithsonian Institution, Washington, DC (isopods)

James Thomas, Nova Southeastern University Oceanographic Center, Dania Beach, FL (amphipods)

Figure 1. Map of the North Fork of the New River between SW 11th Avenue and Sistrunk Blvd. Numbers correspond to stations in the text as follows: 1) Sistrunk Blvd., 2) Outfall, 3) 300 m east of Outfall, 4) SW 11th Avenue Bridge.

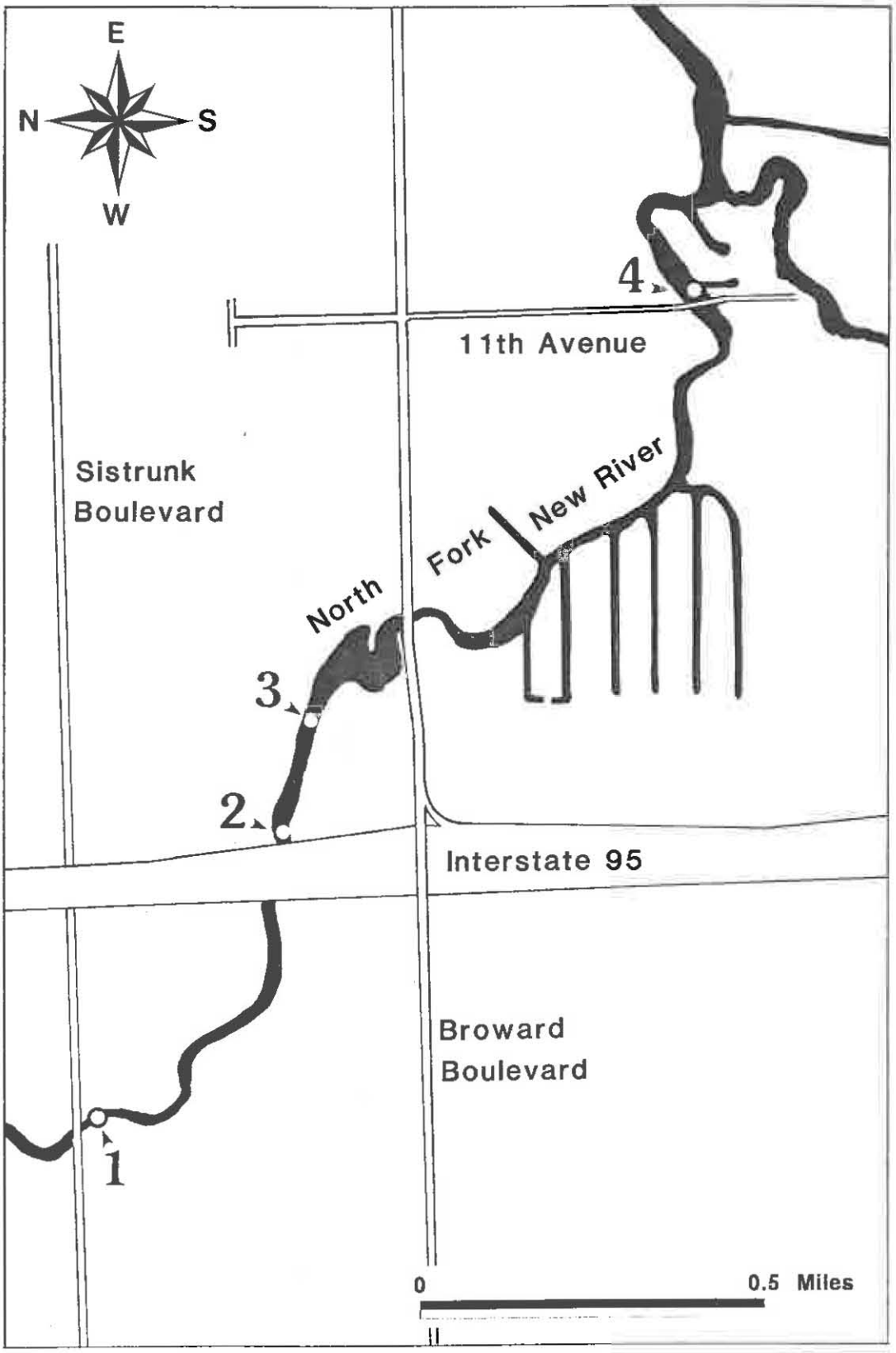

Table 1. Benthic macroinvertebrates collected during all four surveys of the North Fork of the New River.

TAXON	May 1998												August 1998				November 1998												March 1999												Total
	Sistrunk			Outfall			East			Bridge			S	O	E	B	Sistrunk			Outfall			East			Bridge			Sistrunk			Outfall			East			Bridge			
	1	2	3	1	2	3	1	2	3	1	2	3	1	1	1	1	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
Phylum CNIDARIA																																									
Class HYDROZOA																																									
Unidentified hydroids			1				1		1																				14		15	1	21								54
Phylum PLATYHELMINTHES																																									
Class TURBELLARIA																																									
Order PROSERIATA																																									
Family ?NEMATOPLANIDAE																																									
?Nematoplana sp.							1																																		1
Order TRICLADIDA																																									
Family PLANARIIDAE																																									
Unidentified planariid		8								2																			2	4											16
Phylum NEMERTINA																																									
Order HOPLONEMERTEA																																									
Family TETRASTEMMIDAE																																									
?Tetrastemma sp.										1																															1
Phylum MOLLUSCA																																									
Class GASTROPODA																																									
Family ANCYLIDAE																																									
Hebetancylus excentricus																				1			1			1															3
Family HYDROBIIDAE																																									
Littoridinops monroensis																															1		2			1			1		5
Pyrgophorus platyrachis																													1												1
Unidentified hydrobiid	1	3												1																											5
Family THIARIDAE																																									
Melanoides tuberculata	1																																								1
Family NERITIDAE																																									
Neritina virginea																													4	5		1		9	2						21
Class BIVALVIA																																									
Family DREISSENIDAE																																									
Mytilopsis leucophaeta	2	4			1		3	1		3	1	2																													17
Family SPHAERIIDAE																																									
Byssanodonta cubensis		1																																							1
Unidentified sphaeriid		1																																							1
Family CORBICULIDAE																																									
Corbicula fluminialis																																	1								1

Table 1. Benthic macroinvertebrates collected during all four surveys of the North Fork of the New River.

TAXON	May 1998												August 1998				November 1998												March 1999												Total
	Sistrunk			Outfall			East			Bridge			S	O	E	B	Sistrunk			Outfall			East			Bridge			Sistrunk			Outfall			East			Bridge			
	1	2	3	1	2	3	1	2	3	1	2	3	1	1	1	1	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
Phylum ANNELIDA																																									
Class POLYCHAETA																																									
Family NEREIDAE																																									
Laeonereis culveri										2	4	5				2							1	1		1	1			1					1			22	2	43
Steninonereis martini																											1	1													2
Family SPIONIDAE																																									
Polydora socialis																															1										1
Class OLIGOCHAETA																																									
Family NAIDIDAE																																									
Bratislava unidentata																		1											1												2
Dero botrytis		1																																							1
Dero digitata					1																								6												7
Dero furcata																																1										1
Haemonais waldvogeli																														1												1
Family TUBIFICIDAE																																									
Aulodrilus piqueti	4	2	3	1																																					10
Limnodrilus hoffmeisteri	2	7	15	43	32	27	54	9	7			1		17			1	5	1	2					1	1				9	4	1	8	14	10	1	4		1		1	278
Limnodrilus udekemeianus	1																																								1
Unident. tubificid w/o hair setae	16	18	21	50	29	34	117	34	53	1		1		21	1	1		5	6	1					2	2				22	14	2	5	16	24	3	4				1	504
Unident. tubificid with hair setae							1		1																																	2
Class HIRUDINEA																																									
Family GLOSSIPHONIDAE																																									
Helobdella elongata		2	2																																						4
Helobdella stagnalis		4																																							4
Family PISCICOLIDAE																																									
Myzobdella lugubris																																				1					1

Table 1. Benthic macroinvertebrates collected during all four surveys of the North Fork of the New River.

TAXON	May 1998												August 1998				November 1998												March 1999												Total
	Sistrunk			Outfall			East			Bridge			S	O	E	B	Sistrunk			Outfall			East			Bridge			Sistrunk			Outfall			East			Bridge			
	1	2	3	1	2	3	1	2	3	1	2	3	1	1	1	1	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
Phylum ARTHROPODA																																									
Subphylum HEXAPODA																																									
Class INSECTA																																									
Order EPHEMEROPTERA																																									
Family CAENIDAE																																									
Caenis sp.		4	1		1								1																3	2			1									13
Order DIPTERA																																									
Family CERATOPOGONIDAE																																									
Palpomyia/Bezzia sp.			1							1																															2
Family CHAOBORIDAE																																									
Chaoborus sp.														2																												2
Family CHIRONOMIDAE																																									
Ablabesmyia rhamphe																													1													1
Asheum beckae													1																1	2												4
Chironomus sp.			1	1	2	3	4			10	6	7	16	7	3		5	2	3		4	5		5	5			1	1			1	2	2	8	16	1		7	1	129
Cladopelma sp.	1	1	4		5		1						2																1	4	2						1				22
Coelotanypus sp.									1	1		1			1	1																										5
Cryptochironomus sp.	3		1																																						4
Dicrotendipes sp.	1	1	3																										2													7
Glyptotendipes sp.													3																	1		2	1								7
Nanocladius sp.		1																														2									3
Natarsia sp.																																					1				1
Parachironomus sp.																																		1							1
Polypedilum halterale	25	35	24	14	13	7	2		6		1		11	3			1				1	1		2	2				6	7	10		2	2						1	176
Polypedilum scalaenum																																			1	3			9		13
Procladius sp.		1	6	2	2	4	4	2	5	9	7	6																													48
Tanytarsus sp.	1	3	1	4	10		1		1	2																						3		4	4	4					38
Unidentified chironomini	1		1		1																																				3
Unidentified tanytarsini		1																																							1

Table 1. Benthic macroinvertebrates collected during all four surveys of the North Fork of the New River.

TAXON	May 1998												August 1998				November 1998												March 1999												Total
	Sistrunk			Outfall			East			Bridge			S	O	E	B	Sistrunk			Outfall			East			Bridge			Sistrunk			Outfall			East			Bridge			
	1	2	3	1	2	3	1	2	3	1	2	3	1	1	1	1	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
Subphylum CRUSTACEA																																									
Class OSTRACODA																																									
Unidentified ostracode			1							1																															2
Class MALACOSTRACA																																									
Order AMPHIPODA																																									
Family COROPHIIDAE																																									
Grandidierella bonnieroides											2				1										2		2														7
Order TANAIDACEA																																									
Family TANAIDAE																																									
Sinelobus stanfordi																															4	2									6
Order ISOPODA																																									
Family IDOTEIDAE																																									
Edotea montosa										1																															1
Order MYSIDACEA																																									
Family MYSIDAE																																									
Mysidopsis bahia																														2					2	1					5
Unidentified mysid																															2										2
Order DECAPODA																																									
Family GRAPSIDAE																																									
Pachygrapsus sp.																													1			1	1								3
Family PORTUNIDAE																																									
Unidentified portunid (frags)																																1									1
Unident. decapod fragments					2																																				2
UNKNOWN																																									
Unidentifiable fragment		1																																							1

Table 2. Summary statistics for the North Fork of the New River Monitoring Surveys. Total numbers of specimens and species, diversity (H') and evenness (J') indices, for all replicates and stations.

	May 1998												August 1998							
	Sistrunk			Outfall			East			Bridge			Sistrunk		Outfall		East		Bridge	
	1	2	3	1	2	3	1	2	3	1	2	3	1		1		1		1	
Total # specimens (by replicate)	59	99	86	115	99	75	189	46	75	34	22	22								
Total # species (by replicate)	13	20	16	7	12	5	11	4	8	12	7	6								
H' (by replicate)	1.765	2.244	2.069	1.256	1.796	1.233	1.071	0.762	1.08	2.048	1.668	1.554								
J' (by replicate)	0.688	0.749	0.746	0.646	0.723	0.766	0.446	0.55	0.519	0.824	0.857	0.868								
Total # specimens (by station)		244			289			310			78		72		14		7		3	
Total # species (by station)		28			13			12			15		8		5		5		2	
H' (by station)		2.267			1.516			1.090			1.995		1.672		1.332		1.475		0.637	
J' (by station)		0.68			0.591			0.438			0.737		0.804		0.827		0.917		0.918	
Modified # spp. (by station: see text)		27			12			11			14		7				6			
Modified H' (by station: see text)		2.068			1.001			0.587			1.971		1.309				1.277			
Modified J' (by station: see text)		0.628			0.403			0.245			0.747		0.673				0.713			

	November 1998												March 1999											
	Sistrunk			Outfall			East			Bridge			Sistrunk			Outfall			East			Bridge		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Total # specimens (by replicate)	16	10	6	0	6	6	1	11	12	3	2	4	75	47	32	26	65	56	22	34	3	1	39	6
Total # species (by replicate)	4	4	3	0	3	2	1	5	6	2	2	3	16	12	7	10	11	10	8	8	3	1	4	5
H' (by replicate)	1.26	1.09	1.01	0.00	0.87	0.45	0.00	1.41	1.58	0.64	0.69	1.04	2.21	2.16	1.39	2.02	1.79	1.73	1.81	1.64	1.10	0.00	1.06	1.56
J' (by replicate)	0.91	0.79	0.92	0.00	0.79	0.65	0.00	0.88	0.88	0.92	1.00	0.95	0.80	0.87	0.71	0.88	0.75	0.75	0.87	0.79	1.00	0.00	0.77	0.97
Total # specimens (by station)		32			12			24			9			154			147			59			46	
Total # species (by station)		5			3			6			4			22			18			12			7	
H' (by station)		1.294			0.721			1.583			1.273			2.349			2.133			1.891			1.349	
J' (by station)		0.804			0.657			0.884			0.918			0.760			0.738			0.761			0.693	
Modified # spp. (by station: see text)		4						5						21			17			11			6	
Modified H' (by station: see text)		0.874						1.424						2.152			1.777			1.753			1.307	
Modified J' (by station: see text)		0.630						0.885						0.707			0.627			0.731			0.730	

Modified data are given only where combining identified *L. hoffmeisteri* and unidentified tubificids without hair setae reduces the number of species.