Appendix II

Water Quality Data Collected by DWQ

- **Benthic Macroinvertebrate Collections**
- **Fish Community Assessments**

Benthic Macroinvertebrate Sampling Methods and Criteria

Freshwater Wadeable and Flowing Waters

Benthic macroinvertebrates can be collected from wadeable, freshwater, flowing waters using two sampling procedures. The NC Division of Water Quality's standard qualitative sampling procedure includes 10 composite samples: two kick-net samples, three bank sweeps, two rock or log washes, one sand sample, one leafpack sample, and visual collections from large rocks and logs (NCDEHNR, 1997). The purpose of these collections is to inventory the aquatic fauna and produce an indication of relative abundance for each taxon. Organisms are classified as Rare (1-2 specimens), Common (3-9 specimens), or Abundant (≥10 specimens).

Several data-analysis summaries (metrics) can be produced from standard qualitative samples to detect water quality problems (Table A-II-1).

Table A-II-1 Benthos Classification Criteria for Freshwater Wadeable and Flowing Water Systems in the Coastal Plain Ecoregion

Metric	Sample Type	Bioclass	Score
EPT S	10-sample Qualitative	Excellent	> 27
		Good	21 - 27
		Good-Fair	14 - 20
		Fair	7 - 13
		Poor	0 - 6
	4-sample EPT	Excellent	> 23
		Good	18 - 23
		Good-Fair	12 - 17
		Fair	6 –11
		Poor	0 - 5
Biotic Index (range 0 – 10)	10-sample Qualitative	Excellent	< 5.47
		Good	5.47 - 6.05
		Good-Fair	6.06 - 6.72
		Fair	6.73 - 7.73
		Poor	> 7.73

These metrics are based on the idea that unstressed streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts; the tolerance of the stream community is evaluated using a biotic index.

EPT taxa richness (EPT S) is used with DWQ criteria to assign water quality ratings (bioclassifications). "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera, insect groups that are generally intolerant of many kinds of pollution. Higher EPT taxa richness values usually indicate better water quality. Water quality ratings also are based on the relative tolerance of the macroinvertebrate community as summarized by the North Carolina Biotic Index (NCBI).

Both tolerance values for individual species and the final biotic index values have a range of 0-10, with higher numbers indicating more tolerant species or more polluted conditions. Water quality ratings assigned with the biotic index numbers are combined with EPT taxa richness ratings to produce a final bioclassification, using criteria for coastal plain streams. EPT abundance (EPT N) and total taxa richness calculations also are used to help examine between-site differences in water quality. If the EPT taxa richness rating and the biotic index differ by one bioclassification, the EPT abundance value is used to determine the final site rating.

Benthic macroinvertebrates can also be collected using an EPT sampling procedure. Four rather than 10 composite qualitative samples are taken at each site: 1 kick, 1 sweep, 1 leafpack and visual collections. Only EPT groups are collected and identified, and only EPT criteria are used to assign a bioclassification.

Both EPT taxa richness and biotic index values also can be affected by seasonal changes. DWQ criteria for assigning bioclassification are based on summer sampling: June - September. For samples collected outside summer, EPT taxa richness can be adjusted by subtracting out winter/spring Plecoptera or other adjustment based on resampling of summer site. The biotic index values also are seasonally adjusted for samples outside the summer season.

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is not assessed as well by a taxa richness analysis.

Boat Sampling and Coastal B Criteria

Coastal B rivers are defined as waters in the coastal plain that are deep (nonwadeable) with little or no visible current under normal or low flow conditions and that have freshwater. Other characteristics may include open canopy, low pH and low dissolved oxygen. These waters require a boat for sampling. These are usually large coastal plain rivers, including the lower sections of the Alligator, Chowan, Meherrin, Neuse, Pasquotank, Perquimans, Roanoke, Tar, South, Black, Waccamaw, Wiccacon, Northeast Cape Fear and Cape Fear Rivers. In such habitats, petite Ponar dredge sampling replaces kick-net samples, but all other standard qualitative collection techniques are still useable.

The standard boat method still aims at a total of 10 composite samples per site:

- Dredges - 3 composite samples using a petite Ponar.
- Sweeps - 3 samples collected from bank habitats, sampling as much of the edge habitat as possible, including aquatic macrophytes, roots and areas of debris.
- Leaf packs/Debris wash -1 composite sample of leaves and other large particulate organic matter are to be rinsed in a wash bucket.
- Epifaunal collections - 2 composite samples of macrophytes and well-colonized logs (both in the current and along the shore.
- Visuals - should cover macrophytes, logs along the shore, and especially logs in the current.

The Biological Assessment Unit has limited data on Coastal B rivers and has had a difficult time gathering more data. Criteria have been developed based only on EPT taxa richness (Table A-II-2), although using biotic index values and total taxa richness values were also evaluated. The

criteria that are presented here will continue to be evaluated, and any bioclassifications derived from them should be considered tentative and not used for use support decisions.

Table A-II-2 Benthos Classification Criteria for Freshwater Nonwadeable, Coastal B Systems in the Coastal Plain Ecoregion

Bioclassification	EPT S
Excellent	> 11
Good	9 - 11
Good-Fair	6 - 8
Fair	3 - 5
Poor	> 3

Estuaries

Shallow (<1.5 m) estuarine waters are sampled using a D-frame dip net with a 600-700 μm mesh bag. All available subtidal benthic habitats were swept for a total of ten minutes. Some elutriation of the sample usually took place in the field to reduce sample volume, then the sample was preserved in 10% formalin with rose bengal added as a tissue stain.

At the laboratory, macroinvertebrates were separated from the sediment by visual examination. Macroinvertebrates were identified to the lowest practical taxonomic level, usually species. Abundance was recorded semi-quantitatively, with only a general indication of a taxon's abundance: Rare = 1 - 2; Common = 3 - 9; Abundant = 10 - 29; Very Abundant = 30 - 99; and Dominant >100. No more than 100 individuals of any taxon were counted since the presence of a greater number of individuals of a particular taxa at a site was no more informative, but much more costly to enumerate.

A biotic index is calculated from the individual taxon's sensitivity values (ranging from 1 to 5) and weighted for abundance using a formula commonly used in calculating freshwater biotic indices (Chutter, 1972; Hilsenhoff, 1977; Lenat, 1993):

$$BI = (\sum SV_i * N_i)/\text{Total N}$$

where SV_i is the sensitivity value of the i^{th} taxa; N_i is the abundance of the i^{th} taxa; and Total N is the number of individuals in the sample. A high Estuarine Biotic Index (EBI) value indicates many intolerant taxa and good water quality at a location, while a low EBI is indicative of stressed conditions.

References

Chutter, F. M. 1972. *An Empirical Biotic Index of the Quality of Water in South African Streams and Rivers*. Water Research. 6: 19-30.

Hilsenhoff, W. L. 1977. *Use of Arthropods to Evaluate Water Quality in Streams*. Wisconsin Department of Natural Resources. Technical Bulletin No. 100.

Lenat, D. L. 1993. *A Biotic Index for the Southeastern United States: Derivation and List of Tolerance Values, with Criteria for Assigning Water-Quality Ratings*. J. North American Benthological Society. 12: 279-290.

Flow Measurement

Changes in the benthic macroinvertebrate community are often used to help assess between-year changes in water quality. Some between-year changes in the macroinvertebrates, however, may be due largely to changes in flow. High flow years magnify the potential effects of nonpoint source runoff, leading to scour, substrate instability and reduced periphyton. Low flow years may accentuate the effect of point source dischargers by providing less dilution of wastes.

For these reasons, all between-year changes in the biological communities are considered in light of flow conditions (high, low or normal) for one month prior to the sampling date. Daily flow information is obtained from the closest available USGS monitoring site and compared to the long-term mean flows. High flow is defined as a mean flow >140% of the long-term mean for that time period, usually July or August. Low flow is defined as a mean flow <60% of the long-term mean, while normal flow is 60-140% of the mean. While broad scale regional patterns are often observed, there may be large geographical variation within the state, and large variation within a single summer period.

Habitat Evaluation

The NCDWQ has developed a habitat assessment form to better evaluate the physical habitat of a stream. The habitat score has a potential range of 1-100, based on evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed to assign impairment ratings.

Table A-II-3 Benthic Macroinvertebrate Data Collected in the Chowan River Basin, 1983-1999 (Basinwide monitoring sites are in bold.)

Subbasin/Waterbody	Location	County	Index No.	Date	S	EPT S	BI	EPT BI	BioClass
03-01-01									
Chowan R	nr Riddicksville	Hertford	25	07/31/00	46	7	7.33	5.84	Good-Fair
				08/10/95	52	8	7.79	5.89	Good-Fair
				07/11/90	58	14	7.28	5.34	Excellent
				07/13/88	66	10	7.16	6.15	Good
				07/07/86	63	10	7.51	6.27	Good
				07/17/84	65	9	6.77	5.37	Good
Chowan R	nr Gatesville	Gates	25	08/01/00	62	9	7.22	4.70	Good
Cole Cr	NC 58	Gates	25-12-7	02/10/00	47	4	7.60	7.00	Not Rated
Wiccacon R	SR 1433	Hertford	25-14	08/01/00	66	6	7.88	6.80	Fair
				08/06/95	55	5	7.72	7.44	Fair
				02/16/95	27	2	8.55	6.82	Not Rated
				07/10/89	47	2	7.93	7.34	Poor
				07/09/87	60	3	7.99	7.95	Fair
				07/26/85	59	5	7.91	7.02	Fair
				07/20/83	56	4	7.87	6.72	Fair
Ahoskie Cr	NC 42	Hertford	25-14-1	08/09/95	61	7	7.67	6.19	Not Rated
				02/28/95	59	8	6.94	5.66	Not Rated
Stony Cr	SR 1235	Bertie	25-14-1-6	02/10/00	43	2	7.21	6.34	Not Rated
Chinkapin Cr	SR 1432	Hertford	25-14-3	02/10/00	60	8	6.98	6.22	Not Rated
UT Chinkapin Cr	SR 1432	Hertford	25-14-3	04/03/86	36	1	8.02	5.78	Not Rated
03-01-02									
Jacks Swp	SR 1301	Northampton	25-4-2-3	11/08/84	45	10	6.95	2.92	Not Rated
Kirbys Cr	SR 1362	Northampton	25-4-4	02/17/00	54	12	6.25	5.10	Not Rated
				03/11/97	53	18	5.71	4.65	Not Rated
				02/28/95	62	11	6.69	5.86	Not Rated
Meherrin R	SR 1175	Hertford	25-4-(5)	07/31/00	59	10	7.68	6.41	Good
			25-4-(1)	08/10/95	47	9	6.98	5.59	Good
				02/15/95	48	9	6.95	5.46	Good
				07/10/89	59	9	7.26	6.15	Good
				07/09/87	73	10	7.47	5.84	Good
				07/25/85	74	12	7.63	6.36	Excellent
				07/21/83	60	9	7.28	6.04	Good
Potecasi Cr	SR 1504	Northampton	25-4-8	02/09/00	24	1	6.97	7.78	Not Rated
Potecasi Cr	NC 11	Hertford	25-4-8	07/10/89	66	11	7.18	6.07	Not Rated
				07/07/86	53	6	7.34	5.95	Not Rated
				07/17/84	53	7	6.88	5.12	Not Rated
Urahaw Swp	NC 35	Northampton	25-4-8-4	02/09/00	20	0	6.83		Not Rated
Cutawhiskie Swp	SR 1141	Hertford	25-4-8-7	02/02/00	49	3	6.88	5.80	Not Rated
				02/28/95	46	3	7.20	5.70	Not Rated
				08/09/95	49	4	6.83	6.13	Not Rated
03-01-04									
Chowan R	US 17	Chowan	25	08/01/00	29	6	6.61	4.65	Good-Fair
				08/08/95	34	8	6.50	5.40	Good-Fair
				06/11/90	41	11	6.32	4.87	Good
				07/13/88	45	7	6.72	5.55	Good-Fair
				07/08/86	38	6	6.81	5.55	Good-Fair
				07/19/85	37	5	7.04	4.91	Fair
				07/17/84	41	8	6.61	4.91	Good-Fair
				07/13/83	42	8	7.08	5.06	Good-Fair
Eastmost Swp	SR 1361	Bertie	25-24-1	02/22/00	56	5	7.42	6.68	Not Rated

Fish Community Sampling Methods and Criteria

Sampling Methods

At each sample site, a 600-foot section of stream was selected and measured. The fish in the delineated stretch of stream were then collected using two backpack electrofishing units and two persons netting the stunned fish. After collection, all readily identifiable fish were examined for sores, lesions, fin damage or skeletal anomalies, measured (total length to the nearest 1 mm), and then released. Those fish that were not readily identifiable were preserved and returned to the laboratory for identification, examination and total length measurement. Detailed descriptions of the sampling methods may be found at http://www.esb.enr.state.nc.us/BAU.html.

Nonwadeable Streams - Small Boat Sampling Methods

At each site, a 400 m section of stream is measured off into 100 m segments. There are four segments along each shoreline and two segments down the center of the stream, for a total of 10 segments. For each of the 100 m segments, fish are collected and processed the same as those collected using the wadeable stream method. The last collection technique used at each location is a timed catfish collection effort outside the measured stream reach. Data from each of the 100 meter segments and the catfish sampling are currently treated as a separate subsample.

Evaluation and Scoring Criteria

The scoring criteria, metric performance and fish community ratings are currently being revised for wadeable streams in the coastal plain. Evaluation protocols for nonwadeable streams sampled with the small electrofishing boat are currently in development.

Table A-II-4 Fish Community Structure Data Collected in the Chowan River Basin, 1995-2000 (Current basinwide sites are bold.)

Subbasin/Waterbody	Location	County	Index No.	Date	NCIBI Score	NCIBI Rating
03-01-01						
Sarem Cr	Above Cole Cr	Gates	25-12	08/29/00	---	Not Rated
Ahoskie Cr	NC 42	Hertford	25-14-1	05/23/00	---	Not Rated
				02/28/95	---	Not Rated
Chinkapin Cr	SR 1432	Hertford	25-14-3	05/24/00	---	Not Rated
03-01-02						
Cutawhiskie Swp	SR 1141	Hertford	24-4-8-8	05/24/00	---	Not Rated
				02/28/95	---	Not Rated