

Appendix II

Water Quality Data Collected by DWQ

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 Biological Assessment Unit'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 (NCDENR, 2001a). The samples are picked "on-site". 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 or 2 specimens), Common (3-9 specimens), or Abundant (≥ 10 specimens).

Benthic macroinvertebrates can also be collected using an EPT sampling procedure. [Note: "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera, insect groups that are generally intolerant of many kinds of pollution.] 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.

Several data-analysis summaries (metrics) can be produced from standard qualitative and EPT samples to detect water quality problems (Tables 1 and 2).

Table 1 Benthos Classification Criteria for Flowing Water Systems in the Piedmont Ecoregion

Metric	Sample Type	Bioclass	Score
EPT S	10-Sample Qualitative	Excellent	>31
		Good	24 - 31
		Good-Fair	16 - 23
		Fair	8 - 15
		Poor	0 - 7
	4-Sample EPT	Excellent	>27
		Good	21 - 27
		Good-Fair	14 - 20
		Fair	7 - 13
		Poor	0 - 6
BI (Range 0 - 10)	10-Sample Qualitative	Excellent	<5.19
		Good	5.19 - 5.78
		Good-Fair	5.79 - 6.48
		Fair	6.49 - 7.48
		Poor	>7.48

Table 2 Benthos Classification Criteria for Freshwater Wadeable and Flowing Water Coastal A 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
BI (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.

For standard qualitative samples, EPT taxa richness (EPT S) is used with the NCDWQ criteria to assign water quality scores. Higher EPT S 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 or BI).

Tolerance values for individual species and the final BI values range between 0 and 10, with higher numbers indicating more tolerant species or more polluted conditions. Water quality scores assigned with the BI are combined with EPT S scores to produce a final bioclassification. EPT abundance (EPT N) and total taxa richness (Total S) calculations also are used to help examine between-site differences in water quality. If the EPT S score and the BI differ by one rating, the EPT N value is used to determine the final site rating.

EPT S and BI values also can be affected by seasonal changes. Criteria for assigning bioclassification are based on summer sampling, June - September. For samples collected at other times, EPT S is adjusted by deleting winter/spring Plecoptera or another adjustment based on resampling of the summer site. The BI values also are seasonally adjusted.

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each 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 freshwater rivers that are deep (nonwadeable) with little or no visible current under normal or low flow conditions. Other characteristics may include open canopy, low pH and low dissolved oxygen. These rivers include the lower sections of the Alligator, Chowan, Meherrin, Neuse, Pasquotank, Perquimans, Roanoke, Tar, South, Black, Waccamaw, Wiccacon, Northeast Cape Fear, and Cape Fear Rivers. A boat is required to sample these rivers and in such places, petite Ponar grab sampling replaces kick-net samples. All other standard qualitative collections techniques are still used.

Ten composite samples are collected per site: 3 Ponar samples; 3 bank sweeps, 1 leafpack sample, 2 epifaunal collections of macrophytes and well-colonized logs, and visual collections from macrophytes, logs along the shore, and logs in the current.

There are limited data on Coastal B rivers, and staff have had a difficult time gathering more data. Criteria have been developed based only on EPT S (Table 3), although using BI and Total S values were also evaluated. The criteria will continue to be evaluated and any bioclassifications derived from them should be considered tentative and not used for use support decisions.

Table 3 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

Swamp Streams

Swamp streams are located in the coastal plain area and cease flowing during summer low flow periods. This seasonal interruption in flow limits the diversity of the fauna, requiring special criteria to properly rate such streams. The swamp stream sampling method utilizes a variety of collection techniques to inventory the macroinvertebrate fauna at a site. A total of nine sweep samples (one series of three by each field team member) are collected from each of the following habitat types: macrophytes, root mats/undercut banks, and detritus deposits. If one of these habitat types is not present, a sweep from one of the other habitats should be substituted. A sweep for the swamp method is defined as the area that can be reached from a given standing location. Three log/debris washes also are collected. Visual collections are the final technique used at each site.

Samples are picked on site. The primary output for this sampling method is a taxa list with an indication of relative abundance (Rare, Common or Abundant) for each taxon. Sampling during

winter flow periods provides the best opportunity for detecting impacts, and only winter benthos (February and March) data can be used to evaluate swamp streams. Criteria were separately developed for five swamp ecoregions, with three of these regions found in the Tar-Pamlico River basin:

- Region C -- This area lies to the east of the Suffolk Scarp, within the Chesapeake-Pamlico Lowlands and Tidal Marshes ecoregion. Sampleable swamp streams have been located only in the Pasquotank River basin. No undisturbed catchments exist in this area. EPT taxa are rare or absent in these swamp streams, although they may be present in the larger rivers and low-salinity estuaries.
- Region B -- This area generally coincides with the Mid-Atlantic Flatwoods ecoregion, bounded on the south by the Neuse River and on the east by the Suffolk Scarp. It also includes some of the Floodplains and Low Terraces. A small section is also located along the southern coast. This ecoregion is generally defined by a lack of Heptageniid mayflies, especially *Stenonema*. *Stenonema modestum*, however, sometimes is found in Coastal A streams within Region B.
- Region A -- This area constitutes the remainder of the swamp streams, located in the Atlantic Southern Loam Plains ecoregion and the Rolling Coastal Plain ecoregion. This area also contains many Coastal A streams.

Swamp stream criteria evaluate a stream based on three benthic macroinvertebrate metrics (Total taxa richness, EPT taxa richness, and Biotic Index) and one habitat metric (overall habitat score).

Metric scores are divided into three groups: Natural conditions, Moderate Stress, and Severe Stress. As with many multi-metric scoring systems, a score of 5 is assigned to Natural, a score of 3 is assigned to Moderate Stress, and a score of 1 is assigned to Severe Stress. The final site score is derived by the formula:

$$\text{Site Score} = [(2 * \text{BI} + \text{ST} + \text{EPT S} + \text{Habitat}) - 5] / 2$$

where BI = Biotic Index score, ST = Total taxa richness score, EPT S = EPT taxa richness score, and Habitat = Habitat score.

The BI is given greater weight than the other metrics (multiplied by 2) because this was shown to be the most reliable way to compare swamp streams. A value of 5 is subtracted from the sum of the scores (so that the lowest score is zero), and the sum is divided by 2 (as there were no odd numbers in the initial scores). This calculation produced a range of site scores from 0 to 10.

Most reference sites (95 percent) had a site score of 9-10, and this range was established as the criterion for Natural conditions. The remaining scores were separated into Moderate Stress (4-8) and Severe Stress (≤ 3). The Severe Stress rating was set so that at least 2 of the 4 metrics must separately indicate severe stress (a score of "1"), unless the BI metric scored a "1".

Corrections for the four metrics are:

- Total taxa richness is corrected (+8) if the stream has a braided channel. Criteria for streams with representative pH values are given in Table 4.

- Biotic Index values generally did not generally show a clear relationship between pH and channel type and did not require any correction (Table 5). Slightly elevated BI values are expected in streams with pH < 4.0. This suggested these streams may be more difficult to evaluate than streams with pH > 4.0.
- EPT taxa richness is corrected (+2) if the streams have a braided channel. EPT S was not clearly related to pH for streams in Region B, so criteria for these streams are independent of pH (Table 6).
- The habitat metric (range = 0-100) did not require any modification for ecoregion or stream type. Based on reference sites, the criteria are: Natural > 79, Moderate Stress 60 – 79, and Severe Stress < 60.

Table 4 Stress Ratings Based on Total Taxa Richness for Swamp Streams (ND = No Data)

Stress	<i>Region</i>						
	<u>A</u>	<u>A</u>	<u>A</u>	<u>B</u>	<u>B</u>	<u>B</u>	<u>C</u>
	pH						
Natural	>25	>36	>51	>20	>28	>38	>34
Moderate	<25	20 - 35	35 - 51	≤20	≤28	25 - 38	≤34
Severe	ND	<20	<35	ND	ND	<25	ND

Table 5 Stress Ratings Based on Biotic Index for Swamp Streams

Stress	<i>Region</i>		
	A	B	C
Natural	<6.8	<7.0	<7.2
Moderate	6.8 - 7.5	7.0 - 7.9	7.2 - 8.1
Severe	>7.5	>7.9	>8.1

Table 6 Stress Ratings Based on EPT Taxa Richness for Swamp Streams (ND = No Data)

Stress	<i>Region</i>			
	<u>A</u>	<u>A</u>	<u>A</u>	<u>B</u>
	pH			
Natural	>4	>8	>17	>5
Moderate	ND	<9	7 - 17	2 - 4
Severe	ND	ND	0 - 6	0 - 1

Table 7

Benthic Macroinvertebrate Data Collected in the Tar-Pamlico River Basin, 1983-2002 (Current basinwide sites are in bold font.)

Subbasin/ Waterbody	Location	County	Index No.	Date	Total S	EPT	BI	EPT BI	BioClass
03-03-01									
Tar R	SR 1138	Granville	28-(1)	2/2/89	---	25	---	3.78	Good
Tar R	SR 1150	Granville	28-(1)	7/21/97	---	14	---	5.60	Good-Fair
				9/9/92	65	12	6.45	4.90	Fair
Shelton Cr	US 158	Granville	28-4	7/27/92	---	15	---	5.02	Good-Fair
N Fk Tar R	US 158	Granville	28-5	7/21/97	---	17	---	5.33	Good-Fair
				7/27/92	---	8	---	6.26	Fair
Tar R	NC 96	Granville	28-(5.7)	7/21/97	73	24	5.74	4.96	Good
				7/27/92	77	18	6.01	5.61	Good-Fair
				7/12/89	86	20	6.18	5.56	Good-Fair
				7/8/86	59	7	6.28	5.92	Fair
				9/7/84	78	25	5.65	5.07	Good
Tar R	SR 1622	Granville	28-(5.7)	7/22/02	78	23	5.74	4.69	Good
				7/21/97	76	28	5.18	4.63	Good
				1/3/97	72	32	5.10	4.17	Good
				7/27/92	89	23	5.44	5.06	Good
Fishing Cr	SR 1649	Granville	28-11	9/19/90	55	11	7.45	6.65	Fair
				6/13/89	27	0	8.97	0.00	Poor
Fishing Cr	be WWTP	Granville	28-11	6/13/89	16	0	9.15	0.00	Poor
Fishing Cr	SR 1608	Granville	28-11	5/18/99	41	5	7.91	6.11	Poor
				9/19/90	54	3	7.96	7.60	Poor
Fishing Cr	SR 1643	Granville	28-11	7/22/02	62	16	5.69	5.13	Good-Fair
				5/18/99	11	11	5.63	5.63	Fair
				7/21/97	61	18	5.77	5.34	Good-Fair
				7/27/92	79	18	6.08	5.35	Good-Fair
				9/19/90	11	11	5.27	5.27	Fair
Coon Cr	SR 1515	Granville	28-11-5	6/13/89	---	19	---	4.32	Good-Fair
Tabbs Cr	SR 1101	Vance	28-17-(4)	5/18/99	22	21	5.06	5.06	Good-Fair
Tar R	SR 1229	Franklin	28-(24.7)	7/22/02	82	24	6.49	5.42	Good-Fair
				7/27/97	74	28	5.48	4.64	Good
Tar R	US 401	Franklin	28-(24.7)	9/10/92	74	27	5.74	4.84	Good
				7/11/86	73	24	6.25	5.08	Good-Fair
				7/13/83	58	17	6.36	4.96	Good-Fair
Tar R	SR 1609	Franklin	28-(24.7)	7/23/02	68	26	5.15	4.65	Good
				8/27/97	73	23	5.23	4.62	Good
Cedar Cr	SR 1116	Franklin	28-29-(2)	7/29/92	---	14	---	5.21	Good-Fair
				9/7/90	72	15	6.31	5.24	Good-Fair
Cedar Cr	ab WWTP	Franklin	28-29-(2)	10/27/94	47	10	6.38	4.60	Good-Fair
	(~SR 1116)								
Cedar Cr	be WWTP	Franklin	28-29-(2)	10/27/94	54	15	5.96	4.02	Good-Fair
	(~SR 1116)								
Cedar Cr	SR 1105	Franklin	28-29-(2)	7/29/92	---	13	---	4.83	Fair
				9/7/90	80	18	5.88	5.26	Good-Fair
Cedar Cr	SR 1109	Franklin	28-29-(2)	7/22/02	---	15	---	4.99	Good-Fair
				7/28/97	---	14	---	4.39	Good-Fair
Crooked Cr	NC 98	Franklin	28-30	7/28/97	---	12	---	5.42	Fair
				7/29/92	16	16	5.06	5.06	Good-Fair
03-03-02									
Tar R	SR 1001	Nash	28-(24.7)	2/2/89	---	15	---	5.24	Fair
Tar R	US 64	Nash	28-(24.7)	9/10/92	---	19	---	4.43	Good-Fair
Tar R	NC 581	Nash	28-(24.7)	5/17/86	79	22	5.05	3.98	Good-Fair
Stoney Cr	SR 1603	Nash	28-68	7/24/02	22	13	6.02	5.68	Good-Fair
				7/23/92	---	9	---	5.30	Fair

Subbasin/ Waterbody	Location	County	Index No.	Date	Total S	EPT	BI	EPT BI	BioClass
Tar R	NC 97	Edgecombe	28-(69)	7/24/02	89	24	6.00	4.96	Good-Fair
				7/22/97	71	26	5.93	4.95	Good
				7/23/92	79	24	5.88	4.81	Good-Fair
				7/12/90	77	23	5.55	4.68	Good
				7/8/87	17	17	5.01	5.01	Good-Fair
				7/6/87	63	18	5.80	5.16	Good-Fair
				5/12/86	78	25	5.84	4.98	Good-Fair
				7/24/85	79	21	6.35	4.85	Good-Fair
				8/26/83	62	17	6.01	4.71	Good-Fair
				Tar R	ab WWTP	Edgecombe	28-(69)	10/27/94	65
3/2/88	66	15	5.95					4.96	Good-Fair
Tar R	be WWTP	Edgecombe	28-(69)	10/27/94	53	7	7.01	5.07	Fair
Tar R	SR 1243	Edgecombe	28-(74)	7/22/92	81	21	6.35	5.27	Good-Fair
Tar R	SR 1252	Edgecombe	28-(74)	8/1/02	79	19	5.80	4.77	Good-Fair
				7/22/97	68	26	5.36	4.39	Good
				3/2/88	66	14	6.91	5.09	Fair
Swift Cr	SR 1004	Nash	28-78-(0.5)	3/5/96	87	39	4.29	3.14	Excellent
Swift Cr	SR 1310	Nash	28-78-(0.5)	7/23/97	62	20	5.25	4.23	Good
				11/12/96	20	20	4.15	4.15	Good-Fair
				3/5/96	87	33	4.66	2.93	Excellent
				7/18/95	71	26	5.13	4.30	Excellent
				9/10/92	54	16	5.27	4.50	Good
				6/11/91	94	27	5.34	3.87	Excellent
				10/22/90	77	29	5.27	4.04	Excellent
				7/12/90	82	28	5.17	4.56	Excellent
				6/8/90	78	31	5.28	4.48	Excellent
				4/24/90	83	33	5.16	3.89	Excellent
				1/18/90	80	32	5.22	4.09	Excellent
				7/11/89	79	22	5.73	4.34	Good
				5/3/88	25	25	4.46	4.33	Excellent
				7/10/86	92	24	5.61	4.18	Good
				7/18/84	63	22	5.11	4.18	Excellent
Swift Cr	ab Wake Stone	Nash	28-78-(0.5)	3/5/96	67	28	4.64	3.50	Good
				6/10/91	85	26	5.26	4.14	Excellent
				6/7/90	68	27	5.08	4.26	Excellent
Swift Cr	E prop. line Wake Stone	Nash	28-78-(0.5)	6/7/90	65	24	5.63	4.77	Good
Swift Cr	be Wake Stone	Nash	28-78-(0.5)	6/12/91	93	28	5.44	4.04	Excellent
				5/10/91	---	28	---	4.11	Excellent
				6/7/90	22	22	4.85	4.79	Good
Swift Cr	SR 1003	Nash	28-78-(0.5)	3/4/96	90	33	4.76	2.95	Excellent
				2/2/89	---	31	---	3.03	Excellent
Swift Cr	I 95	Nash	28-78-(0.5)	7/18/95	69	23	4.69	3.67	Excellent
				5/10/91	---	23	---	4.02	Good
				6/8/90	---	23	---	4.84	Good
Martin Cr	SR 1519	Vance	28-78-1-3	6/10/02	32	9	5.95	5.34	Not Rated
Weaver Cr	SR 1533	Vance	28-78-1-7	6/10/02	44	6	6.72	5.48	Not Rated
				3/29/95	71	23	5.83	4.95	Good-Fair
				5/3/88	27	27	4.52	4.52	Good
Sandy Cr	US 401	Franklin	28-78-1-(8)	7/23/97	11	11	4.67	4.67	Fair
Sandy Cr	SR 1412	Franklin	28-78-1-(8)	7/28/92	20	20	4.92	4.92	Good-Fair
Sandy Cr Devils Cradle Cr	NC 401	Franklin	28-78-1-12-1	11/16/84	71	15	7.15	5.81	Fair
				6/20/84	80	12	7.11	6.02	Fair
				4/2/84	77	14	6.46	5.25	Fair
				1/25/84	60	13	6.43	5.96	Fair
				6/10/02	61	21	5.30	4.18	Good-Fair
Sandy Cr Swift Cr	SR 1253	Edgecombe	28-78-(6.5)	7/25/02	86	24	5.73	4.22	Good
				7/22/97	73	24	4.97	3.68	Excellent
				2/1/89	74	29	5.16	3.76	Excellent

Subbasin/ Waterbody	Location	County	Index No.	Date	Total S	EPT	BI	EPT BI	BioClass
White Oak Swp	SR 1428	Edgecombe	28-78-7-(2)	2/11/02	40	7	6.52	5.58	Moderate Stress
				5/3/88	---	11	---	5.16	Not Rated
03-03-03									
Tar R	US Bus 64	Edgecombe	28-(80)	8/6/02	77	27	5.87	4.70	Good
				8/19/97	79	28	5.35	4.60	Excellent
				7/20/92	81	29	5.79	4.74	Good
				7/20/90	69	28	5.40	4.65	Excellent
				7/11/88	80	21	5.64	4.78	Good
				7/6/87	81	23	5.86	4.98	Good
				7/11/86	92	27	6.10	4.96	Good
				5/12/86	92	27	6.09	5.01	Good
				7/24/85	73	23	5.85	5.11	Good
				7/25/83	78	27	5.88	4.58	Good
Town Cr	SR 1202	Edgecombe	28-83	5/5/92	76	14	6.73	5.73	Fair
Town Cr	SR 1200	Edgecombe	28-83	5/5/92	64	17	6.37	5.37	Good-Fair
Town Cr	SR 1601	Edgecombe	28-83	8/19/97	84	24	5.97	4.78	Good
				7/20/92	64	14	6.13	5.68	Not Rated
Cokey Swp	SR 1141	Edgecombe	28-83-3	4/25/89	36	3	7.89	4.09	Not Rated
Cokey Swp	NC 43	Edgecombe	28-83-3	2/12/02	41	3	7.64	6.4	Severe Stress
Little Cokey Swp	at Branch Cr	Edgecombe	28-83-3-1	4/25/89	26	0	7.66	---	Not Rated
Little Cokey Swp	SR 1614	Edgecombe	28-83-3-1	4/25/89	11	0	8.65	---	Not Rated
Little Cokey Swp	SR 1158	Edgecombe	28-83-3-1	5/1/92	42	0	8.30	---	Not Rated
Little Cokey Swp	be UT	Edgecombe	28-83-3-1	5/1/92	46	1	8.11	6.22	Not Rated
Little Cokey Swp	SR 1141	Edgecombe	28-83-3-1	4/25/89	39	2	8.19	2.95	Not Rated
Sasnett Mill Br	SR 1222	Edgecombe	28-83-4	2/7/01	49	5	6.27	5.50	Not Rated
Bynums Mill Cr	SR 1200	Edgecombe	28-83-4	2/11/02	36	2	8.14	7.45	Severe Stress
				8/16/93	29	2	8.53	7.63	Not Rated
				5/5/93	49	2	8.01	7.97	Not Rated
				2/16/93	51	3	7.92	8.59	Severe Stress
				8/16/92	31	2	8.77	9.23	Not Rated
				5/6/92	44	1	8.09	4.72	Not Rated
				2/19/92	49	4	7.97	7.22	Severe Stress
				9/24/90	51	3	7.47	5.70	Not Rated
Briery Br	NC 124	Edgecombe	28-83-4-1-1	9/24/90	51	3	7.47	5.70	Not Rated
Tar R	NC 42	Edgecombe	28-(84)	8/6/02	---	24	---	4.53	Excellent
				8/19/97	---	26	---	4.63	Excellent
				7/20/92	---	26	---	4.21	Excellent
Otter Cr	SR 1614	Edgecombe	28-86	2/11/02	44	5	7.51	6.36	Moderate Stress
				5/5/93	71	10	7.27	5.68	Not Rated
				2/16/93	62	9	7.15	5.55	Moderate Stress
				8/12/92	31	1	8.38	9.84	Not Rated
				5/6/92	62	9	7.20	5.47	Not Rated
				2/20/92	83	15	6.92	5.45	Moderate Stress
UT Otter Cr	SR 1113	Edgecombe	28-86	9/24/90	51	1	7.69	6.22	Not Rated
Conetoe Cr	SR 1516	Edgecombe	28-87- (0.5)	2/6/01	33	2	7.12	6.29	Not Rated
Conetoe Cr	SR 1510	Edgecombe	28-87- (0.5)	2/22/02	47	2	7.45	7.43	Severe Stress
				11/2/00	56	2	7.47	6.25	Not Rated
Conetoe Cr	NC 42	Edgecombe	28-87- (0.5)	2/22/02	53	1	7.14	7.8	Moderate Stress
Conetoe Cr	US 64 Alt	Edgecombe	28-87- (0.5)	2/6/01	51	5	7.20	5.66	Fair
Conetoe Cr	SR 1409	Pitt	28-87- (0.5)	11/2/00	48	4	7.33	6.06	Poor
				8/19/97	38	4	7.65	4.03	Poor
				7/20/92	51	7	6.77	5.65	Fair
				10/25/89	62	13	6.92	5.05	Fair
				7/11/89	62	8	6.65	5.03	Good-Fair
				7/12/88	55	8	6.54	4.95	Good-Fair
	7/23/85	44	7	6.26	5.27	Fair			

Subbasin/ Waterbody	Location	County	Index No.	Date	Total S	EPT	BI	EPT BI	BioClass
Crisp Cr	SR 1527	Pitt	28-87-1	2/11/02	36	2	7.69	6.34	Severe Stress
				2/7/01	53	4	7.35	5.51	Poor
Ballahack Canal	NC 42	Pitt	28-87-1.2	2/22/02	27	2	8.28	8.9	Severe Stress
03-03-04									
Fishing Creek	Ab Warrenton WWTP	Warren	28-79-(1)	7/28/92	---	10	---	4.80	Fair
Fishing Creek	SR 1600	Warren	28-79-(1)	8/18/97	---	22	---	4.04	Good
				7/28/92	---	18	---	4.22	Good-Fair
Fishing Cr	US 301	Edgecombe	28-79-21	8/5/02	63	15	5.79	4.36	Good-Fair
				8/18/97	86	25	5.73	4.29	Good
				7/22/92	92	26	5.70	4.45	Good
				7/13/88	75	21	6.03	4.72	Good
				7/24/85	88	26	5.48	4.42	Good
				7/25/83	71	27	5.62	4.56	Good
Shocco Cr	SR 1613	Warren	28-97-22	8/18/97	---	16	---	4.61	Good-Fair
				7/28/92	---	15	---	4.28	Good-Fair
Little Fishing Cr	SR 1338	Halifax	28-79-25	8/18/97	85	23	5.36	4.15	Good
				9/10/92	64	18	5.60	4.85	Good-Fair
				7/14/88	89	24	5.34	3.85	Good
Little Fishing Cr	SR 1343	Halifax	28-79-25	8/5/02	86	23	5.58	4.22	Good
Rocky Swp	SR 1002	Halifax	28-79-28-(0.7)	8/18/97	39	13	5.59	4.64	Good-Fair
Fishing Cr	SR 1429	Edgecombe	28-79-29	3/3/89	71	29	4.89	3.44	Good
Fishing Cr	SR 1500	Edgecombe	28-79-29	8/6/02	---	21	---	4.48	Good
				8/18/97	56	28	4.65	3.91	Excellent
				7/22/92	---	23	---	3.79	Good
Beech Swp	SR 1001	Halifax	28-79-30	5/4/92	69	7	7.45	5.47	Not Rated
Beech Swp	US 301	Halifax	28-79-30	5/4/92	34	3	8.70	7.1	Not Rated
Beech Swp	SR 1003	Halifax	28-79-30	2/15/02	37	2	7.2	7.8	Moderate Stress
Deep Cr	SR 1100	Halifax	28-79-32-(0.5)	2/15/02	33	2	8.08	8.8	Moderate Stress
03-03-05									
Tar R	SR 1400	Pitt	28-(84)	11/20/85	75	22	5.72	4.60	Good-Fair
Tar R	SR 1533	Pitt	28-(94)	11/19/85	50	12	6.85	4.30	Fair
Tar R	Rainbow Banks	Pitt	28-(94)	11/20/85	51	9	7.19	4.33	Fair
Tar R	SR 1565	Pitt	28-(94)	8/8/02	43	9	7.92	7.13	Not Rated
				8/21/97	67	13	7.42	5.41	Not Rated
				6/22/92	59	10	7.43	6.26	Good
				7/12/89	66	16	6.92	5.91	Good-Fair
				7/10/86	70	8	7.84	6.91	Good-Fair
				11/19/85	53	10	7.50	4.87	Good-Fair
				7/23/84	74	15	7.17	4.45	Fair
Greens Mill Run	Arlington Rd	Pitt	28-96	5/8/96	44	1	7.69	6.22	Not Rated
Hardee Cr	NC 33	Pitt	28-97	2/19/02	59	7	6.68	5.40	Natural
Hardee Cr	SR 1726	Pitt	28-97	5/8/95	52	6	6.73	5.46	Not Rated
Grindle Cr	US 264	Pitt	28-100	8/7/02	52	12	6.49	4.93	Good-Fair
				8/20/97	67	13	6.68	5.56	Good-Fair
				7/21/92	---	10	---	5.24	Fair
Whichard Br	SR 1521	Pitt	28-100-2	2/12/02	45	6	7	5.75	Moderate Stress
				2/8/01	41	7	6.85	5.47	Not Rated
Chicod Cr	SR 1760	Pitt	28-101	7/15/97	39	2	7.63	7.14	Not Rated
				3/25/97	51	7	7.11	5.87	Fair
				6/29/93	41	4	7.17	6.41	Not Rated
				3/23/93	38	4	7.32	6.23	Fair
				7/21/92	55	4	7.22	6.54	Fair
				7/10/90	42	6	7.20	6.08	Fair

Subbasin/ Waterbody	Location	County	Index No.	Date	Total S	EPT	BI	EPT BI	BioClass
Chicod Cr	SR 1777	Pitt	28-101	7/8/87	---	4	---	7.33	Poor
				3/12/02	51	2	8.30	7.61	Severe Stress
				7/15/97	43	2	7.64	7.45	Not Rated
				3/25/97	45	4	7.03	6	Not Rated
				6/29/93	56	5	6.88	5.58	Fair
Cow Swp	SR 1756	Pitt	28-101-5	3/24/93	31	4	6.67	6.10	Not Rated
				7/15/97	35	4	6.92	5.28	Poor
				3/25/97	30	3	8.14	6.85	Not Rated
				6/29/93	54	4	6.88	5.85	Fair
				3/23/93	45	1	8.34	9.84	Not Rated
Juniper Br	SR 1766	Pitt	28-101-26	7/15/97	35	5	8.14	5.70	Poor
				3/25/97	46	5	6.72	5.51	Not Rated
				6/23/93	47	7	6.85	5.08	Fair
				3/23/93	44	2	7.42	6.41	Not Rated
				03-03-06					
Tranters Cr	SR 1552	Edgecombe	28-103	2/12/02	40	3	7.81	9.22	Moderate Stress
Tranters Cr	SR 1403	Beaufort	28-103	8/21/97	52	7	7.97	6.65	Not Rated
				7/12/89	51	8	7.88	6.62	Good-Fair
				7/9/86	36	3	8.39	6.80	Fair
				7/12/83	43	5	8.10	6.97	Fair
Flat Swp	SR 1152	Beaufort	28-103-2	3/12/02	49	1	7.88	6.2	Moderate Stress
Horsepen Cr	SR 1914	Beaufort	28-103-10	2/26/02	27	4	6.49	6.12	Moderate Stress
Old Ford Swp	US 17	Beaufort	28-103-14-1	2/19/02	29	4	6.75	6.48	Natural
Latham Cr	SR 1410	Beaufort	28-103-14-2	2/26/02	48	7	6.90	6.64	Natural
03-03-07									
<i>Freshwater Sites</i>									
Horse Br	SR 1136	Beaufort	29-6-2-1-6-2	7/15/97	37	1	8.01	6.22	Not Rated
Beaverdam Swp	SR 1523	Beaufort	29-10-02	3/11/02	50	4	7.50	7.25	Moderate Stress
Durham Cr	SR 1949	Beaufort	29-21-(1)	2/20/92	48	5	7.57	6.28	Moderate Stress
				7/7/87	38	3	7.51	5.84	Not Rated
Whitehurst Cr	W Pr, SR 1937	Beaufort	29-28-7-(1)	2/12/92	13	1	8.41	2.52	Not Rated
Whitehurst Cr	S Pr, SR 1937	Beaufort	29-28-7-(1)	2/12/92	18	2	8.41	4.37	Not Rated
Whitehurst Cr	SR 1941	Beaufort	29-28-7-(1)	2/12/92	30	2	8.33	3.48	Not Rated
Van Swp	NC 32	Washington	29-34-2-3	2/19/92	30	5	6.83	4.85	Natural
Acre Swp	SR 1532	Beaufort	29-34-35-1-1	3/11/02	40	1	8.09	9.8	Not Rated
<i>Estuarine Sites</i> ¹									
(Not Rated, Data available on request)	39 locations	Beaufort, Hyde		Mostly 1992 and 1997					Not Rated

¹ Detailed discussions of these sites were given in NCDEHNR (1998).

Table 8 Water Quality Measurements at Benthic Macroinvertebrate Basinwide Sites in the Tar-Pamlico River Basin, 2002

Subbasin/ Waterbody	Location	County	Date	Temperature (°C)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/l)	pH (s.u.)
03-03-01							
Tar R	SR 1622	Granville	07/22/02	26	131	5.9	7.2
Fishing Cr	SR 1643	Granville	07/22/02	23	139	6.0	7.2
Tar R	SR 1229	Franklin	07/22/02	28	176	6.5	7.4
Tar R	SR 1609	Franklin	07/23/02	27	121	5.7	7.4
Cedar Cr	SR 1109	Franklin	07/22/02	27	300	6.4	7.4
03-03-02							
Stoney Cr	SR 1603	Edgecombe	07/24/02	26	105	3.3	7.0
Tar R	NC 97	Edgecombe	07/24/02	30	105	6.6	7.3
Tar R	SR 1252	Edgecombe	08/01/02	31	204	6.2	7.4
Sandy Cr	SR 1405	Nash	06/10/02	23	69	7.8	7.4
Swift Cr	SR 1253	Edgecombe	07/25/02	---	---	---	---
03-03-03							
Tar R	US Bus 64	Edgecombe	08/06/02	29	164	7.8	7.5
Cokey Swp	NC 43	Edgecombe	02/12/02	6	113	9.3	6.3
Bynum's Mill Cr	SR 1120	Edgecombe	02/11/02	11	84	5.6	6.1
Tar R	NC 42	Edgecombe	08/06/02	30	173	7.3	8.1
Otter Cr	SR 1614	Edgecombe	02/11/02	13	109	9.9	6.4
Conetoe Cr	SR 1510	Edgecombe	02/22/02	12	99	10	6.3
Conetoe Cr	NC 42	Edgecombe	02/22/02	12	131	9.4	6.5
Crisp Cr	SR 1527	Edgecombe	02/11/02	11	124	8.6	6.0
Ballahack Canal	NC 42	Edgecombe	02/22/02	15	187	10.7	5.8
03-03-04							
Fishing Cr	US 301	Edgecombe	08/05/02	29	108	4.6	7.4
Little Fishing Cr	SR 1343	Halifax	08/05/02	27	111	5.0	7.2
Fishing Cr	SR 1500	Edgecombe	08/06/02	28	106	6.8	7.3
Beech Swp	SR 1003	Halifax	02/15/02	6	91	9.7	6.2
Deep Cr	SR 1100	Halifax	02/15/02	9	93	8.2	6.1
03-03-05							
Tar R	SR 1565	Pitt	08/08/02	29	900	6.5	7.1
Hardee Cr	NC 33	Pitt	02/19/02	7	142	12	6.9
Grindle Cr	US 264	Pitt	08/07/02	24	122	6.0	7.1
Whichard Br	SR 1521	Pitt	02/12/02	7	165	7.4	6.3
Chicod Cr	SR 1777	Pitt	03/12/02	12	89	6.4	6.7
03-03-06							
Tranters Cr	SR 1552	Pitt	02/12/02	9	184	7.4	6.3
Flat Swp	SR 1152	Martin	03/12/02	13	282	8.5	7.2
Horsepen Swp	SR 1914	Beaufort	02/26/02	10	94	8.0	6.0
Old Ford Swp	US 17	Beaufort	02/19/02	8	94	6.7	5.7
Latham Cr	SR 1410	Beaufort	02/26/02	14	115	7.3	6.2
03-03-07							
Beaverdam Swp	NC 32	Beaufort	03/11/02	13	115	8.0	6.2
Acre Swp	SR 1532	Beaufort	03/11/02	4.2	119	8.6	4.2

Fish Community Sampling Methods and Criteria

In 2002, fish community assessments were performed at 24 sites in the basin. Thirteen of the 28 sites which had been previously sampled in 1997 were sampled again, including some which were on the impaired streams list (Table 9).

Table 9 Fish Community Sites Monitored in 2002 that are on the State’s 303(d) List of Impaired Waters (NCDENR, 2000a).

Subbasin/ Waterbody	Reach Affected	Suspected Cause
<i>03-03-01</i>		
Fishing Creek	From SR 1608 to Coon Creek	Cause unknown; potential municipal point sources and urban runoff/storm sewers
<i>03-03-02</i>		
Sandy Creek	From NC 401 to NC 561	Cause unknown; potential sources unknown
<i>03-03-05</i>		
Chicod Creek	From source to Tar River	Historical listing for sediment based upon biological impairment, fecal coliform and low dissolved oxygen from potential agriculture sources

The 10 new sites (Beech Branch, Coon, Middle, Pig Basket, Flatrock, Red Bud, Reedy and Parker Creeks; and White Oak and Bear Swamps) were selected to represent typical channelized and natural channel streams draining rural agricultural and forested watersheds and which may be impacted primarily by nonpoint source pollution.

Some sites that were sampled during the second cycle of basinwide monitoring in 1997 were not resampled in 2002 because:

- There were already sufficient data collected since 1999 to assess these streams (North Fork Tar River and Shelton, Lynch, Tabbs and Fishing Creeks).
- The stream was considered Collection Sensitive Waters by the NC Wildlife Resources Commission and sampling is strictly controlled (Shelton and Swift Creeks, and Little Fishing Creek (at SR 1338, Halifax County)).
- The waterbody is considered a swamp and currently not rateable (Horsepen Swamp).
- The stream was too small to sample (UT Turkey Swamp).
- Effective sampling could only be done under low flow conditions (Tar River and Town Creek).
- The hydrologic regime of the stream was altered by beavers or was not flowing (Big Peachtree Creek and Beaverdam, Cokey and Cow Swamps).

Several 2002 fish community sites had been "desnagged" in the summer of 2000 under the US Department of Agriculture’s Emergency Watershed Protection Program: Red Bud, Big Peachtree, Pig Basket, Spony, Parker and Grindle Creeks, and White Oak Swamp.

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 on the website at <http://www.esb.enr.state.nc.us/BAU.html>.

NCIBI Analysis

The assessment of biological integrity using the North Carolina Index of Biotic Integrity (NCIBI) is provided by the cumulative assessment of 12 parameters or metrics. The values provided by the metrics are converted into scores on a 1, 3 or 5 scale. A score of 5 represents conditions which would be expected for undisturbed reference streams in the specific river basin or ecoregion, while a score of 1 indicates that the conditions deviate greatly from those expected in undisturbed streams of the region. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score. Finally, the score (an even number between 12 and 60) is then used to determine the ecological integrity class of the stream from which the sample was collected.

The NCIBI has recently been revised (NCDENR, 2001b). Currently, the focus of using and applying the NCIBI has been restricted to wadeable streams that can be sampled by a crew of four persons. The bioclassifications and criteria have also been recalibrated against regional reference site data (Biological Assessment Unit Memorandum 01052001).

Table 10 Revised Scores and Classes for Evaluating the Fish Community of a Wadeable Stream using the North Carolina Index of Biotic Integrity in the Outer Piedmont (Cape Fear, Neuse, Roanoke and Tar-Pamlico River Basins)

NCIBI Scores	NCIBI Classes
54, 56, 58 or 60	Excellent
46, 48, 50 or 52	Good
40, 42 or 44	Good-Fair
34, 36 or 38	Fair
≤32	Poor

Table 11 Regional Reference Sites/Samples Used in Calibrating the North Carolina Index of Biotic Integrity in the Tar-Pamlico River Basin

Subbasin/ Waterbody	Station	County	Date
03-03-01			
Tar River	US 158	Granville	10/14/99
Tar River	US 158	Granville	06/24/99
Tar River	US 158	Granville	04/27/99
Shelton Creek	US 158	Granville	04/06/99
Shelton Creek	US 158	Granville	04/14/97
Shelton Creek	US 158	Granville	04/07/92
Lynch Creek ¹	SR 1235	Franklin	05/24/99
Lynch Creek ¹	SR 1235	Franklin	04/15/97
Lynch Creek ¹	SR 1235	Franklin	06/18/92
03-03-04			
Fishing Creek ¹	SR 1600	Warren	05/24/99
Fishing Creek ¹	SR 1600	Warren	04/16/97
Fishing Creek ¹	SR 1600	Warren	02/04/93
Little Fishing Creek	SR 1509	Warren	04/11/02
Little Fishing Creek	SR 1509	Warren	04/16/97
Little Fishing Creek	SR 1509	Warren	02/03/93
Rocky Swamp	SR 1002	Halifax	04/03/97
Rocky Swamp	SR 1002	Halifax	02/03/93

¹ Later determined not to be a regional reference site.

Criteria and ratings are applicable only to wadeable streams in the Piedmont region of the basin and are the same as those for the Cape Fear, Neuse, and Roanoke River basins. The definition of the Piedmont for these basins is based on a map of North Carolina watersheds by Fels (1997). Metrics and ratings should not be applied to nonwadeable streams and streams in the Coastal Plain region in each of these basins. These streams are currently not rated.

Table 12 Fish Community Data Collected in the Tar-Pamlico River Basin, 1992-2002
(Current basinwide sites are in bold font.)

Subbasin/ Waterbody	Location	County	Index No.	Date	NCIBI Score	NCIBI Rating
03-03-01						
Tar R	US 158	Granville	28-(1)	10/14/99	54	Excellent
				06/24/99	54	Excellent
				04/27/99	52	Good
Tar R	NC 96	Granville	28-(5.7)	09/09/97	56	Excellent
				09/02/92	56	Excellent
Tar R	US 1	Franklin	28-(15.5)	09/09/97	50	Good
				09/02/92	46	Good
Shelton Cr	US 158	Granville	28-4	04/06/99	56	Excellent
				04/14/97	58	Excellent
				04/07/92	54	Excellent
North Fork Tar R	US 158	Granville	28-5	10/14/99	46	Good
				06/24/99	48	Good
				04/06/99	48	Good
				04/14/97	54	Excellent
				04/07/92	46	Good
Fishing Cr	SR 1643	Granville	28-11	04/08/02	50	Good
				04/14/97	52	Good
				04/07/92	42	Good-Fair
Coon Cr	SR 1609	Granville	28-11-5	04/08/02	54	Excellent
Middle Cr	SR 1203	Franklin	28-15	04/08/02	50	Good
Tabbs Cr	SR 1100	Vance	28-17-(0.5)	10/14/99	46	Good
				06/24/99	48	Good
				04/09/99	50	Good
				04/15/97	56	Excellent
				04/08/92	56	Excellent
Lynch Cr	SR 1235	Franklin	28-21-(0.7)	05/24/99	46	Good
				04/15/97	48	Good
				06/18/92	38	Fair
Cedar Cr	SR 1109	Franklin	28-29-(2)	04/10/02	54	Excellent
				04/16/97	50	Good
				04/08/92	48	Good
Crooked Cr	NC 98	Franklin	28-30	04/10/02	42	Good-Fair
				04/17/97	34	Fair
03-03-02						
Sapony Cr	SR 1145	Nash	28-55-(1)	04/18/02	---	Not Rated
				04/02/97	---	Not Rated
Big Peachtree Cr	SR 1321	Nash	28-68-1	04/03/97	52	Good
				02/04/93	46	Good
Pig Basket Cr	SR 1433	Nash	28-68-3-(2)	04/18/02	---	Not Rated
Beech Br	NC 97	Edgecombe	28-75-(4)	04/17/02	---	Not Rated
Swift Cr	SR 1310	Nash	28-78-(0.5)	04/11/97	60	Excellent
				06/19/96	56	Excellent
Swift Cr	SR 1003	Nash	28-78-(0.5)	06/19/96	50	Good
Sandy Cr	SR 1412	Franklin	28-78-1-(8)	04/09/02	40	Good-Fair
				04/15/97	40	Good-Fair
Flatrock Cr	SR 1412	Franklin	28-78-1-12	04/09/02	48	Good
Red Bud Cr	SR 1407	Nash	28-78-1-17	04/09/02	50	Good
White Oak Swp	SR 1428	Edgecombe	28-79-23	04/17/02	---	Not Rated
03-03-03						
Town Cr	NC 43	Edgecombe	28-83	08/28/97	---	Not Rated
				07/08/92	---	Not Rated

Subbasin/ Waterbody	Location	County	Index No.	Date	NCIBI Score	NCIBI Rating
Cokey Swp	SR 1135	Edgecombe	28-83-3	04/02/97	---	Not Rated
Otter Cr	SR 1614	Edgecombe	28-86-(0.3)	04/17/02	---	Not Rated
				04/02/97	---	Not Rated
				10/29/96	---	Not Rated
				07/08/92	---	Not Rated
03-03-04						
Fishing Cr	SR 1600	Warren	28-79-(1)	05/24/99	54	Excellent
				04/16/97	60	Excellent
				02/04/93	48	Good
Shocco Cr	SR 1613	Warren	28-79-22	04/09/02	54	Excellent
				04/16/97	50	Good
				06/18/92	46	Good
Little Fishing Cr	SR 1509	Warren	28-79-25	04/11/02	50	Good
				04/16/97	50	Good
				02/03/93	54	Excellent
Little Fishing Cr	SR 1338	Halifax	28-79-25	08/28/97	52	Good
Reedy Cr	SR 1511	Warren	28-79-25-5	04/11/02	52	Good
Bear Swp	NC 561	Halifax	28-79-25-7	04/11/02	52	Good
Beaverdam Swp	NC 561	Halifax	28-79-27	04/03/97	---	Not Rated
Rocky Swp	SR 1002	Halifax	28-79-28-(0.7)	04/12/02	50	Good
				04/03/97	---	Not Rated
				02/03/93	---	Not Rated
03-03-05						
Parker Cr	NC 33	Pitt	28-95	04/16/02	---	Not Rated
Hardee Cr	NC 33	Pitt	28-97	04/16/02	---	Not Rated
				04/01/97	---	Not Rated
Grindle Cr	US 264	Pitt	28-100	04/16/02	---	Not Rated
				04/01/97	---	Not Rated
				07/07/92	---	Not Rated
Chicod Cr	SR 1565	Pitt	28-101	04/15/93	---	Not Rated
Chicod Cr	SR 1777	Pitt	28-101	04/16/02	---	Not Rated
				05/06/93	---	Not Rated
				07/07/92	---	Not Rated
Cow Swp	SR 1756	Pitt	28-101-5	04/15/93	---	Not Rated
Juniper Swp	SR 1766	Pitt	28-101-6	04/15/93	---	Not Rated
03-03-06						
UT Turkey Swp	SR 1134	Martin	28-103-5	04/01/97	---	Not Rated
Horsepen Swp	SR 1001	Beaufort	28-103-10	04/01/97	---	Not Rated
03-03-07						
Horse Br	SR 1136	Beaufort	29-6-2-1-6-2	05/06/93	---	Not Rated
Durham Cr	SR 1932	Beaufort	29-21-(1)	04/15/02	---	Not Rated
				03/31/97	---	Not Rated
Acre Swp	NC 32	Beaufort	29-34-35-1-1	04/15/02	---	Not Rated
				03/31/97	---	Not Rated

Fish Tissue Criteria

In evaluating fish tissue analysis results, several different types of criteria are used. Human health concerns related to fish consumption are screened by comparing results with federal Food and Drug Administration (FDA) action levels (USFDA, 1980), Environmental Protection Agency (USEPA) recommended screening values, and criteria adopted by the North Carolina State Health Director (Table 13). Individual parameter results, which seem to be of potential human health concern, are evaluated by the NC Division of Occupational and Environmental Epidemiology by request from the Water Quality Section.

The FDA levels were developed to protect humans from the chronic effects of toxic substances consumed in foodstuffs, and thus, employ a "safe level" approach to fish tissue consumption. Presently, the FDA has only developed metals criteria for mercury.

The USEPA has recommended screening values for target analytes formulated from a risk assessment procedure (USEPA, 1995). These are the concentrations of analytes in edible fish tissue that are of potential public health concern. The DWQ compares fish tissue results with USEPA screening values to evaluate the need for further intensive site specific monitoring.

The North Carolina State Health Director has adopted a selenium limit of 5 µg/g and a mercury limit of 0.4 µg/g for issuing an advisory. Although the USEPA has suggested a screening value of 0.7 ppt (pg/g) for dioxins, the State of North Carolina currently uses a value of 4.0 ppt in issuing an advisory.

Table 13 Fish Tissue Criteria (All wet weight concentrations are reported in parts per million (ppm, µg/g), except for dioxin which is in parts per trillion (ppt, pg/g)).

Contaminant	FDA Action Levels	USEPA Screening Values	NC Health Director
<i>Metals</i>			
Cadmium		10.0	
Mercury	1.0	0.6	0.4
Selenium		50.0	5.0
<i>Organics</i>			
Aldrin	0.3		
Chlorpyrifos		30	
Total chlordane		0.08	
Cis-chlordane	0.3		
Trans-chlordane	0.3		
Total DDT ¹		0.3	
o, p DDD	5.0		
p, p DDD	5.0		
o, p DDE	5.0		
p, p DDE	5.0		
o, p DDT	5.0		
p, p DDT	5.0		
Dieldrin		0.007	
Dioxins (total)		0.7	4.0
Endosulfan (I and II)		60.0	
Endrin	0.3	3.0	
Heptachlorepoxide		0.01	
Hexachlorobenzene		0.07	
Lindane		0.08	
Mirex		2.0	
Total PCBs		0.01	
PCB-1254	2.0		
Toxaphene		0.1	

¹ Total DDT includes the sum of all its isomers and metabolites (i.e., p, p DDT; o, p DDT, DDE and DDD).

² Total chlordane includes the sum of cis-and trans- isomers as well as nonachlor and oxychlordane.

Table 14 Wet Weight Concentrations of Mercury (Hg), Arsenic (As), Total Chromium (Cr), Cadmium (Cd), Copper (Cu), Nickel (Ni), Lead (Pb) and Zinc (Zn) in Fish Tissue from the Tar-Pamlico River Basin, 2000¹

Location/ Species	Date	Length (cm)	Weight (g)	Hg (µg/g)	As (µg/g)	Cr (µg/g)	Cu (µg/g)	Ni (µg/g)	Zn (µg/g)
Tar River at Rocky Mount									
<i>Ictalurus catus</i>	05/03/2000	42.0	1780	0.37	ND	ND	0.21	ND	4.5
<i>Lepomis macrochirus</i>	05/03/2000	18.1	150	0.12	ND	ND	0.27	ND	5.3
<i>Lepomis macrochirus</i>	05/03/2000	16.0	94.3	0.10	ND	ND	0.24	0.13	5.8
<i>Lepomis macrochirus</i>	05/03/2000	16.9	113.5	0.10	ND	ND	0.24	0.13	5.8
<i>Lepomis microlophus</i>	05/03/2000	21.5	243	0.13	0.14	ND	0.26	ND	6.1
<i>Lepomis microlophus</i>	05/03/2000	29.0	592	0.22	0.10	ND	0.23	ND	5.2
<i>Micropterus salmoides</i>	05/03/2000	28.4	298	0.26	ND	ND	0.33	ND	4.5
<i>Micropterus salmoides</i>	05/03/2000	31.5	418	0.31	ND	ND	0.27	ND	4.0
<i>Micropterus salmoides</i>	05/03/2000	29.5	393	0.33	ND	ND	0.46	ND	5.4
<i>Micropterus salmoides</i>	05/03/2000	32.0	435	0.35	ND	ND	0.29	ND	4.0
<i>Micropterus salmoides</i>	05/03/2000	32.5	467	0.49	ND	ND	0.44	ND	7.7
<i>Micropterus salmoides</i>	05/03/2000	33.0	574	0.62	ND	ND	2.1	ND	3.2
<i>Micropterus salmoides</i>	05/03/2000	41.2	1025	0.81	ND	0.12	0.22	ND	2.8
<i>Micropterus salmoides</i>	05/03/2000	31.1	431	0.30	ND	0.13	0.41	ND	6.1
<i>Micropterus salmoides</i>	05/03/2000	33.0	570	0.72	ND	0.13	0.39	ND	2.7
<i>Micropterus salmoides</i>	05/03/2000	28.0	287	0.33	ND	0.11	0.46	0.16	6.2
<i>Micropterus salmoides</i>	05/03/2000	37.5	635	0.49	ND	0.38	1.6	0.21	4.7
<i>Micropterus salmoides</i>	05/03/2000	28.2	277	0.28	ND	0.14	0.95	0.36	7.4
<i>Moxostoma collapsum</i>	05/03/2000	40.5	857	0.12	ND	ND	0.18	ND	4.2
<i>Moxostoma collapsum</i>	05/03/2000	45.0	1414	0.09	ND	ND	0.51	ND	16.0
<i>Moxostoma collapsum</i>	05/03/2000	45.0	1414	0.13	ND	0.10	0.32	ND	4.2
<i>Moxostoma collapsum</i>	05/03/2000	41.5	916	0.15	ND	0.11	0.24	ND	4.3
<i>Moxostoma collapsum</i>	05/03/2000	45.0	1092	0.19	ND	0.13	0.35	ND	6.3
Tar River below Tarboro									
<i>Ictalurus punctatus</i>	05/03/2000	33.3	481	0.26	ND	0.11	0.21	ND	2.5
<i>Lepomis macrochirus</i>	05/03/2000	18.5	161	0.37	ND	ND	0.60	0.12	7.6
<i>Lepomis macrochirus</i>	05/03/2000	16.5	106.3	0.15	ND	ND	0.41	0.18	7.3
<i>Lepomis macrochirus</i>	05/03/2000	16.8	102.6	0.19	ND	0.24	0.77	0.58	6.9
<i>Lepomis microlophus</i>	05/03/2000	22.1	199	0.11	ND	ND	0.62	ND	8.4
<i>Lepomis microlophus</i>	05/03/2000	19.1	132.7	0.07	ND	0.11	1.1	ND	7.2
<i>Micropterus salmoides</i>	05/03/2000	31.5	470	0.33	ND	ND	0.84	ND	5.1
<i>Micropterus salmoides</i>	05/03/2000	33.0	527	0.41	ND	ND	0.18	ND	4.7
<i>Micropterus salmoides</i>	05/03/2000	34.5	658	0.33	ND	ND	0.18	ND	3.4
<i>Micropterus salmoides</i>	05/03/2000	35.2	651	0.42	ND	ND	0.17	ND	2.5
<i>Micropterus salmoides</i>	05/03/2000	39.6	1057	0.74	ND	ND	0.20	ND	2.8
<i>Micropterus salmoides</i>	05/03/2000	45.2	1305	0.73	ND	ND	0.26	ND	3.4
<i>Micropterus salmoides</i>	05/03/2000	36.2	714	0.28	ND	0.11	0.19	ND	2.9
<i>Micropterus salmoides</i>	05/03/2000	35.5	617	0.48	ND	0.23	0.18	ND	3.3
<i>Micropterus salmoides</i>	05/03/2000	31.0	428	0.29	ND	ND	0.52	0.25	7.0
<i>Moxostoma anisurum</i>	05/03/2000	46.0	1023	0.45	ND	ND	0.17	ND	3.7
<i>Moxostoma anisurum</i>	05/03/2000	42.0	873	0.24	ND	0.14	0.19	ND	2.5
<i>Moxostoma anisurum</i>	05/03/2000	49.0	1417	0.57	ND	0.14	0.24	ND	3.8
<i>Moxostoma anisurum</i>	05/03/2000	45.0	1067	0.43	ND	ND	0.22	ND	5.3
Tar River off NC 33 near Greenville									
<i>Esox niger</i>	06/01/2000	50.1	858	0.58	ND	ND	0.29	ND	6.5
<i>Lepomis macrochirus</i>	06/01/2000	18.4	133.5	0.16	ND	ND	0.23	ND	5.7
<i>Lepomis macrochirus</i>	06/01/2000	20.5	172.5	0.14	ND	ND	0.41	0.25	6.3
<i>Lepomis microlophus</i>	06/01/2000	21.7	223	0.23	ND	0.10	0.65	ND	6.4
<i>Lepomis microlophus</i>	06/01/2000	23.1	250.3	0.27	ND	0.10	0.40	0.19	7.4
<i>Lepomis microlophus</i>	06/01/2000	22.3	242	0.29	ND	0.19	0.32	0.29	7.3
<i>Lepomis microlophus</i>	06/01/2000	24.2	297	0.39	ND	ND	0.42	0.48	5.5
<i>Micropterus salmoides</i>	06/01/2000	45.1	1381	0.93	ND	ND	0.23	ND	3.5
<i>Micropterus salmoides</i>	06/01/2000	42.0	1071	0.88	ND	ND	0.20	ND	3.0
<i>Micropterus salmoides</i>	06/01/2000	34.5	647	0.57	ND	ND	0.14	ND	3.6
<i>Micropterus salmoides</i>	06/01/2000	36.8	746	0.76	ND	ND	0.15	ND	3.3
<i>Micropterus salmoides</i>	06/01/2000	33.7	462	0.63	ND	ND	0.15	ND	5.0
<i>Micropterus salmoides</i>	06/01/2000	32.2	468	0.56	ND	ND	0.27	ND	4.0
<i>Micropterus salmoides</i>	06/01/2000	32.0	465	0.54	ND	ND	0.30	ND	3.4

¹ Cadmium and lead were non-detectable in all samples.

ND = non detect; detection level for arsenic = 1.0 µg/g, and nickel = 0.5 µg/g.

Lake Assessment Program

Three lakes were monitored as part of the 2002 Lakes Assessment Program (Table 15).

Table 15 Lakes Monitored in the Tar-Pamlico River Basin, 2002

Variable	<u>Lake</u>		
	Lake Devin	Tar River Reservoir	Lake Mattamuskeet
Subbasin	01	02	08
County	Granville	Nash	Hyde
Classification	WS-II, NSW, CA	WS-IV, B, NSW, CA	SC
Surface area (Ac)	125	1,860	42,000
Mean Depth (ft.)	16	17	2
Volume (X10 ⁶ m ³)	1.6	16.0	10.2
Watershed (mi ²)	1.2	775	--- ¹

¹ Lake Mattamuskeet has no watershed; it receives inflow from precipitation and occasional saltwater intrusion.

Sampling Methods

Monitoring stations are sited to provide representative samples of lake water quality based on morphology, size, and site-specific features such as coves and tributaries. Dissolved oxygen, pH, water temperature and conductivity are made with a calibrated HydrolabTM. Readings are taken at the surface (0.15 meters) and at one-meter increments to the bottom. Secchi depth is measured at each station with a weighted Secchi disk attached to a rope marked off in centimeters. Surface water samples are collected for chloride, hardness, fecal coliform bacteria, and metals.

A LablineTM sampler is used to composite water samples within the photic zone (a depth equal to twice the Secchi depth). Nutrients, chlorophyll *a*, solids, turbidity and phytoplankton are collected at this depth. The sampler is also used to collect a sample near the bottom for nutrients. Samples are collected and preserved in accordance with specified protocols (NCDEHNR, 1996 and subsequent updates).

Data Interpretation

The North Carolina water quality standards (NCAC, 2002) are used in determining if a lake is meeting its designated uses. Lake water quality assessments are also based on information obtained from other lake monitoring programs such as those implemented by municipalities and major hydroelectric companies. Observations and comments from citizens, local government personnel, water treatment facility staff and others are also considered in the assessment process.

In addition to determining use support, data are used to evaluate the trophic state of lakes. An index was developed specifically for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NCDNRCD, 1983). The North Carolina Trophic State Index (NCTSI) is based on total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), Secchi

depth (SD in inches), and chlorophyll *a* (CHL in µg/l). Lakewide means for these parameters are used to produce a NCTSI score for each lake, using the equations:

$$\begin{aligned} \text{TON}_{\text{Score}} &= ((\text{Log}(\text{TON}) + 0.45)/0.24)*0.90 \\ \text{TP}_{\text{Score}} &= ((\text{Log}(\text{TP}) + 1.55)/0.35)*0.92 \\ \text{SD}_{\text{Score}} &= ((\text{Log}(\text{SD}) - 1.73)/0.35)*-0.82 \\ \text{CHL}_{\text{Score}} &= ((\text{Log}(\text{CHL}) - 1.00)/0.48)*0.83 \\ \text{NCTSI} &= \text{TON}_{\text{Score}} + \text{TP}_{\text{Score}} + \text{SD}_{\text{Score}} + \text{CHL}_{\text{Score}} \end{aligned}$$

In general, NCTSI scores relate to trophic classifications (Table 16). When scores border between classes, best professional judgment is used to assign an appropriate classification. Scores may be skewed by highly colored water typical of dystrophic lakes. Some variation in the trophic state between years is not unusual because of the variability of data, which usually involve sampling a limited number of times during the growing season.

Table 16 Lakes Classification Criteria

NCTSI Score	Trophic Classification
< -2.0	Oligotrophic
-2.0 – 0.0	Mesotrophic
0.0 – 5.0	Eutrophic
> 5.0	Hypereutrophic

Oligotrophic lakes are characteristically found in the mountains or in undisturbed watersheds. Many mesotrophic and eutrophic lakes are found in the central piedmont. There are a few hypereutrophic lakes where point or nonpoint sources of pollution contribute to high levels of nutrients.