

Appendix II

Water Quality Data Collected by DWQ

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

Appendix A-II Benthic Macroinvertebrate Collections

Freshwater Wadeable Flowing Waters

Benthic macroinvertebrates can be collected using two sampling procedures. DWQ'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. 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. 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 Mountain/Piedmont/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 the DWQ's EPT sampling procedure. Four composite samples are taken at each site instead of the 10 taken for the qualitative sample: 1 kick, 1 sweep, 1 leafpack and visual collections. Only intolerant EPT groups are collected and identified, and only EPT criteria are used to assign a bioclassification.

The expected EPT taxa richness values are lower in small high quality mountain streams, <4 meters in width or with a drainage area <3.5 square miles. For these small mountain streams, an adjustment to the EPT taxa richness values is made prior to applying taxa richness criteria. 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.

Different criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) within North Carolina.

Benthos Classification Criteria by Ecoregion *

EPT taxa richness values

	10-sample Qualitative Samples			4-sample EPT Samples		
	<u>Mountains</u>	<u>Piedmont</u>	<u>Coastal</u>	<u>Mountains</u>	<u>Piedmont</u>	<u>Coastal</u>
Excellent	>41	>31	>27	>35	>27	>23
Good	32-41	24-31	21-27	28-35	21-27	18-23
Good-Fair	22-31	16-23	14-20	19-27	14-20	12-17
Fair	12-21	8-15	7-13	11-18	7-13	6-11
Poor	0-11	0-7	0-6	0-10	0-6	0-5

Biotic Index Values (Range = 0-10) for 10-sample Qualitative Samples

	<u>Mountains</u>	<u>Piedmont</u>	<u>Coastal</u>
Excellent	<4.05	<5.19	<5.47
Good	4.06-4.88	5.19-5.78	5.47-6.05
Good-Fair	4.89-5.74	5.79-6.48	6.06-6.72
Fair	5.75-7.00	6.49-7.48	6.73-7.73
Poor	>7.00	>7.48	>7.73

* These criteria apply to flowing water systems only.

Appendix A-II Benthic Macroinvertebrate Collections in the French Broad River Basin,
1983-1997

FBR 01

Site	Site #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass			
French Broad R, SR 1129, Rosman, Trans.	B-1	6-(1)	07/97	93/51	3.30/2.57	Excellent			
			07/92	108/51	3.74/2.50	Excellent			
			08/90	98/43	3.73/2.63	Excellent			
			03/89	107/57	3.35/2.40	Excellent			
			08/88	96/48	3.99/3.02	Excellent			
			07/86	102/50	3.92/2.79	Excellent			
			08/84	89/38	4.09/2.99	Good			
			08/84	84/32	3.99/2.98	Good			
			W Fk French Broad R, ab trout farms, off NC 281, Transylvania	B-2	6-2-(0.5)	08/90	83/45	2.58/1.97	Excellent
						05/90	96/55	2.55/1.71	Excellent
W Fk French Broad R, be trout farms, SR 1306, Transylvania	B-3	6-2-(0.5)	05/90	72/33	4.82/2.64	Good-Fair			
			08/90	51/15	5.92/3.31	Fair			
W Fk French Broad R, NC 281, Transylvania	B-4	6-2-(0.5)	08/90	78/32	4.84/3.65	Good			
			05/90	97/44	4.41/2.85	Good			
			03/89	-/27	-/3.54	Good-Fair			
W Fk French Broad R, SR 1312, Transylvania	B-5	6-2-(0.5)	02/92	99/53	3.03/1.94	Excellent			
			05/87	-/49	-/2.49	Excellent			
			10/84	94/42	3.81/2.61	Good			
W Fk French Broad R, US 64, ab Mitchell-Bissel Industry, Transylvania	B-6	6-2	07/97	94/50	2.88/2.11	Excellent			
			07/92	87/47	3.52/2.30	Excellent			
			02/92	110/57	3.28/2.27	Excellent			
			03/89	87/50	3.07/2.31	Excellent			
W Fk French Broad R, be M-B Industry, Transyl. Parker Cr, SR 1310, Transylvania	B-7	6-2	02/92	79/45	3.28/2.15	Excellent			
			B-8	6-2-4	03/89	-/44	-/2.56	Good	
N Flat Cr, SR 1319, Transylvania	B-9	6-2-10-1	03/89	-/38	-/2.77	Good			
N Fk French Broad R, NC 215, Transylvania	B-10	6-3-(6.5)	03/89	-/45	-/1.98	Excellent			
N Fk French Broad R, SR 1324, Transylvania	B-11	6-3-(6.5)	03/89	-/36	-/2.83	Good			
N Fk French Broad R, SR 1322, Transylvania	B-12	6-3-(6.5)	07/97	76/41	3.22/2.38	Excellent			
			07/92	85/42	3.28/2.30	Excellent			
			03/89	89/44	3.39/2.49	Excellent			
Tucker Cr, SR 1325, Transylvania	B-13	6-3-10	03/89	-/35	-/2.69	Good-Fair			
M Fk French Broad R, NC 178, Transylvania	B-14	6-5	03/89	-/35	-/1.75	Good			
E Fk French Broad R, SR 1105, Transylvania	B-15	6-6	03/89	-/51	-/1.96	Excellent			
E Fk French Broad R, SR 1007, Transylvania	B-16	6-6	03/89	107/54	2.77/2.08	Excellent			
Glady Fk, SR 1105, Transylvania	B-17	6-6-7	05/87	-/29	-/2.88	Good-Fair			
Galloway Cr, US 64, ab landfill, Transyl.	B-18	6-8	05/87	-/16	-/2.61	Fair			
Galloway Cr, US 64, be landfill, Transyl.	B-19	6-8	05/87	-/10	-/3.00	Poor			
Morgan Mill Cr, SR 1195, Transylvania	B-20	6-10-1	07/97	-/12	-/4.63	Fair			
Catheys Cr, SR 1338, Transylvania	B-21	6-16-(8.5)	03/89	-/58	-/2.02	Excellent			
			05/87	-/49	-/1.79	Excellent			
Norton Cr, US 64, Transylvania	B-22	6-28-2	05/87	-/14	-/4.82	Fair			
Williamson Cr, SR 1541, Transylvania	B-23	6-32	05/87	-/44	-/2.42	Good			
Little R NC 276, Transylvania	B-24	6-38-(1)	05/87	-/38	-/3.02	Good			
Little R, nr Cedar Mt, ab High Falls, off SR 1536, Transylvania	B-25	6-38-(1)	08/87	83/19	6.33/4.69	Fair			
			08/85	82/22	5.83/4.59	Fair			
Little R, nr Cedar Mt, be High Falls, Trans.	B-26	6-38-(1)	07/89	81/32	4.55/3.72	Good			
Little R, SR 1533, Transylvania	B-27	6-38-(20)	07/97	-/25	-/3.90	Good-Fair			
			07/92	-/26	-/4.15	Good-Fair			
Laurel Cr, SR 1536, Transylvania	B-28	6-38-17	05/87	-/44	-/2.10	Good			
Crab Cr, SR 1532, Transylvania	B-29	6-38-23	05/87	-/38	-/2.94	Good			

FBR 02

Site	Site #	Index #	Date	S/EPT S	BI/BI EPT	Bioclass
French Broad R, SR 1503 at Blantyre, Trans.	B-1	6-(38.5)	07/86	57/21	5.76/4.28	Fair
			08/83	55/20	5.85/4.43	Fair
Gash Cr, SR 1322 Henderson	B-2	6-41	09/86	40/5	7.58/5.94	Poor
Gash Cr, US 64, Henderson	B-3	6-41	09/86	21/1	8.07/5.77	Poor
Gash Cr, SR 1203, Henderson	B-4	6-41	09/86	26/1	8.31/6.22	Poor
Gash Cr, SR 1205, Henderson	B-5	6-41	06/96	50/6	7.09/5.16	Poor
			09/86	19/7	6.09/4.45	Fair
Mill Pond Cr, SR 1309, Henderson	B-6	6-51	06/96	47/14	5.98/4.68	Fair
Mud Cr, SR 1126, Henderson	B-7	6-55	09/97	-/2	-/6.99	Poor
Mud Cr, SR 1647 (Seventh Ave), Henderson	B-8	6-55	09/97	40/5	6.65/6.21	Poor
Mud Cr, SR 1508 ab WWTP, Henderson	B-9	6-55	09/97	40/5	6.97/6.12	Poor
			07/92	-/10	-/5.52	Poor
			09/85	53/10	6.88/5.57	Fair
			09/97	47/8	6.89/5.63	Poor
Mud Cr, SR 1508 be WWTP, Henderson	B-10	6-55	07/92	-/7	-/6.36	Poor
			09/85	31/3	7.73/7.09	Poor
			09/97	49/12	6.67/5.58	Fair
Mud Cr, US 25, Henderson	B-11	6-55	09/97	49/12	6.67/5.58	Fair
Bat Fork, SR 1807, Henderson	B-12	6-55-8-1	04/89	-/2	-/2.55	Poor
Bat Fork, US 176, Henderson	B-13	6-55-8-1	04/89	44/6	7.60/5.98	Poor
Bat Fork, SR 1809, Henderson	B-14	6-55-8-1	04/89	19/2	8.61/1.29	Poor
Bat Fork, SR 1803, Henderson	B-15	6-55-8-1	04/89	25/4	7.73/6.65	Poor
Bat Fork, SR 1779, Henderson	B-16	6-55-8-1	09/97	48/7	6.87/6.23	Fair
			04/89	-/2	-/7.64	Poor
Clear Cr, SR 1591, Henderson	B-17	6-55-11-(1)	06/93	38/10	5.50/2.78	NR
Clear Cr, SR 1587, Henderson	B-18	6-55-11-(1)	06/93	35/12	5.47/4.25	Fair
Clear Cr, SR 1586, Henderson	B-19	6-55-11-(1)	06/93	47/12	6.14/4.74	Fair
Laurel Fk, SR 1591, Henderson	B-20	6-55-11-2	06/93	-/31	-/2.16	Good
Cox Cr, SR 1587, Henderson	B-21	6-55-11-3	06/93	-/10	-/3.19	NR
Puncheon Camp Cr, SR 1591, Henderson	B-22	6-55-11-4	06/93	-/22	-/3.12	Good-Fair
Clear Cr SR 1513, Henderson	B-23	6-55-11-(5)	07/97	-/8	-/5.10	Poor
			07/92	-/9	-/5.28	Poor
Cane Cr, SR 1006 nr Fletcher, Henderson	B-24	6-57-(9)	07/97	-/26	-/4.22	Good-Fair
			07/92	-/27	-/4.05	Good-Fair
French Broad R, NC 146 nr Skyland, Buncombe	B-25	6-(54.5)	07/97	77/32	5.24/4.31	Good-Fair
			07/92	86/41	4.97/4.08	Good
			07/90	80/34	5.23/3.88	Good
			08/87	80/30	5.35/4.12	Good-Fair
French Broad R, SR 1348, nr Asheville, Buncombe	B-26	6-(54.5)	07/97	72/32	4.92/3.88	Good
			07/92	73/32	5.13/4.22	Good-Fair
			08/87	71/24	5.11/3.87	Good-Fair
			08/85	53/19	5.55/4.28	Good-Fair
French Broad R, SR 1634, nr Alexander, Buncombe	B-27	6-(54.5)	08/83	56/19	5.97/4.39	Fair
			07/97	55/18	5.38/4.49	Good-Fair
			07/92	54/20	5.96/4.58	Fair
			07/90	61/19	5.61/4.10	Good-Fair
Dingle Cr, US 25, Buncombe	B-28	6-71	08/87	68/26	5.55/4.01	Good-Fair
			02/87	-/10	-/5.22	Poor
Dingle Cr, US 25, Buncombe	B-29	6-71	02/87	-/2	-/4.34	Poor
Dingle Cr, Blue Ridge Pkwy, Buncombe	B-30	6-71	02/87	-/14	-/3.03	Fair
Dingle Cr, Blue Ridge Pkwy, Buncombe	B-31	6-71	02/87	-/16	-/2.12	Good-Fair
Hominy Cr, SR 1141, Luther, Buncombe	B-32	6-76	01/89	-/18	-/3.19	Good-Fair
Hominy Cr, NC 151 at Candler, Buncombe	B-33	6-76	09/97	71/32	4.96/3.55	Good-Fair
			07/92	-/28	-/3.31	Good
Hominy Cr, NC 112 ab Enka Lake, Buncombe	B-34	6-76	09/97	63/16	5.71/4.30	Fair
			07/92	-/11	-/3.94	Fair
Hominy Cr, SR 3412 at Sand Hill, Buncombe	B-35	6-76	09/97	63/13	6.38/4.85	Fair
			07/97	-/13	-/4.12	Fair
			07/92	-/8	-/3.58	Poor
S Hominy Cr, NC 151 at Candler, Buncombe	B-36	6-76-5	09/97	38/8	6.15/4.53	Poor
			07/92	-/20	-/3.21	Good-Fair

FBR 02 (con't)

Site	Site #	Index #	Date	S/EPT S	BI/BI EPT	Bioclass
Swannanoa R, SR 2500 at Black Mt., Bun.	B-37	6-78	10/87	56/19	5.61/4.45	Fair
Swannanoa R, SR 2727 at Swannanoa, Bun.	B-38	6-78	10/87	50/18	5.14/4.00	Good-Fair
Swannanoa R, SR 2416 at Warren Wilson Buncombe	B-39	6-78	10/87	60/22	5.01/3.91	Good-Fair
			07/87	73/33	5.13/3.96	Good-Fair
Swannanoa R, NC 81/240 at River Rd, Bun.	B-40	6-78	03/88	70/24	5.87/4.14	Fair
			10/87	68/24	5.81/4.24	Good-Fair
			07/87	76/29	5.51/4.32	Good-Fair
Swannanoa R, NC 81 be 240, River Rd, Bun.	B-41	6-78	03/88	56/18	6.26/4.39	Fair
Swannanoa R, US 25 nr Biltmore, Buncombe	B-42	6-78	07/97	62/28	5.24/4.00	Good-Fair
			07/92	72/27	5.65/4.38	Good-Fair
			07/89	60/15	6.30/4.50	Fair
			03/88	47/8	7.02/5.96	Poor
			10/87	54/17	6.34/4.87	Fair
			07/87	73/33	5.13/3.96	Good-Fair
			08/85	41/9	7.38/4.99	Poor
Flat Cr, nr NC 9 ab Big Piney Cr, Buncombe	B-43	6-78-6-(1)	12/91	-/35	-/1.54	Excellent
Flat Cr, US 70, Buncombe	B-44	6-78-6-(4)	10/87	-/15	-/4.02	Good-Fair
Big Slaty Br, nr NC 9, ab Slaty Br, Bun.	B-45	6-78-6-2	12/91	-/34	-/1.50	Excellent
Slaty Br, (Little Slaty Br), nr NC 9 ab Big Piney Cr, Buncombe	B-46	6-78-6-3	12/91	-/37	-/1.54	Excellent
Big Piney Cr, nr NC 9 nr Montreat, Bun.	B-47	6-78-6-5	12/91	-/32	-/1.37	Excellent
Wolfpit Br, nr High Top Colony Rd, Bun.	B-48	6-78-10-(1)	12/91	-/26	-/1.35	Excellent
N Fk Swannanoa R, SR 2576 ab Grovestone, Bun.	B-49	6-78-11-(13)	10/87	-/14	-/3.85	Fair
N Fk Swannanoa, US 70, be Grovestone, Bun.	B-50	6-78-11-(13)	10/87	-/12	4.46	Fair
Laurel Br, nr mouth, Buncombe	B-51	6-78-11-16	02/92	58/32	2.77/1.67	Excellent
Beetree Cr, SR 2427, Buncombe	B-52	6-78-15-(6)	03/86	72/39	3.56/2.83	Excellent
Beetree Cr, SR 2429, Buncombe	B-53	6-78-15-(6)	10/87	-/15	-/3.01	Good-Fair
Beetree Cr, SR 2416, Buncombe	B-54	6-78-15-(6)	10/87	-/19	-/3.72	Good-Fair
Bull Cr, SR 2408, Buncombe	B-55	6-78-18	10/87	-/27	-/3.47	Good
Christian Cr, SR 2838, Buncombe	B-56	6-78-19	10/87	-/17	-/4.53	Good-Fair
Gashes Cr, SR 3071, Buncombe	B-57	6-78-21	05/94	61/20	4.62/2.90	Good-Fair
Sweeten Cr, US 25A, Buncombe	B-58	6-78-24	10/87	-/1	-/5.50	Poor
Newfound Cr, SR 1296, Buncombe	B-59	6-84	06/89	74/38	3.88/3.14	Excellent
			06/88	94/39	4.13/3.30	Excellent
Newfound Cr, SR 1297, Buncombe	B-60	6-84	06/89	56/16	6.53/4.53	Fair
			06/88	62/17	6.45/4.81	Fair
Newfound Cr, SR 1378, Buncombe	B-61	6-84	04/86	50/12	6.73/4.77	Poor
Newfound Cr, SR 1622, Buncombe	B-62	6-84	07/97	-/20	-/4.97	Good-Fair
			07/89	59/17	7.05/5.36	Fair
			06/89	53/8	7.50/5.63	Poor
			04/89	47/7	7.21/5.65	Poor
			02/89	40/3	7.96/6.77	Poor
			06/88	65/13	7.23/5.66	Poor
			04/86	43/10	6.65/5.20	Poor
Reems Cr, NC 251, Buncombe	B-63	6-87-(10)	07/97	-/30	-/3.33	Good
			07/92	-/20	-/3.37	Good-Fair
Flat Cr, SR 1741, Buncombe	B-64	6-88	04/86	75/24	4.91/3.49	Good-Fair
Sandymush Cr, SR 1114, Madison	B-65	6-92-(9)	07/97	-/30	-/3.71	Good
			07/92	-/36	-/4.06	Excellent

FBR 03

Site	DEM #	Index #	Date	S/EPT S	BI/BI EPT	Bioclass
Davidson R, US 276 ab campground, Trans.	B-1	6-54-(15.5)	07/97	113/52	3.60/2.42	Excellent
			07/92	-/44	-/1.83	Excellent
Boylston Cr, SR 1314, Henderson	B-2	6-52-(0.5)	07/97	71/23	5.38/4.08	Good-Fair
			07/92	-/26	-/4.71	Good-Fair

FBR 03 (con't)

Site	Site #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass			
Mills R, SR 1337 at Mills River, Henderson	B-3	6-54-(1)	07/97	115/53	3.32/2.18	Excellent			
			08/94	-/43	-/2.45	Excellent			
			07/92	89/51	3.05/2.14	Excellent			
			07/90	105/51	3.52/2.34	Excellent			
			08/88	-/32	-/2.34	Good			
			08/88	84/37	3.91/2.68	Excellent			
			07/86	90/48	3.51/2.71	Excellent			
			08/84	90/45	3.30/2.42	Excellent			
			N Fk Mills R, FS Rd 5000	B-4	6-54-2-(4)	09/97	54/34	2.84/2.40	Good
			N Fk Mills R, ab Rocky Br, Henderson	B-5	6-54-2-(4)	07/97	-/41	-/1.66	Excellent
06/93	93/47	2.87/1.84				Excellent			
Wash Cr, off SR 1345 (Rec Area Trail), Henderson	B-6	6-54-2-6	06/93	73/47	2.11/1.71	Excellent			
N Fk Mills R, SR 1341, Henderson	B-7	6-54-2-(9)	06/93	103/51	2.85/2.11	Excellent			
			09/85	91/37	4.04/2.90	Excellent			
			Bradley Cr, FSR 1206, Transylvania	B-8	6-54-3-17	04/91	-/55	-/1.58	Excellent
Bradley Cr, FSR 1206 ab State Rock Cr, Henderson	B-9	6-54-3-17	04/91	-/47	-/1.82	Excellent			
Bradley Cr, FSR 1206 ab Yellow Gap Cr, Hender.	B-10	6-54-3-17	07/91	-/38	-/1.52	Excellent			
			04/91	-/60	-/1.61	Excellent			
Bradley Cr, be Laurel Cr	B-11	6-54-3-17	09/97	66/40	2.40/1.74	Excellent			
S Fk Mills R, SR 1340, Henderson	B-12	6-54-3-(17.5)	06/93	113/57	2.95/1.98	Excellent			
Mills R, SR 1353, Henderson	B-13	6-54-(5)	07/97	78/24	5.09/3.28	Good-Fair			
			08/94	31/5	5.82/4.43	Poor			
			06/93	90/40	4.08/2.70	Good			
			07/92	81/35	4.07/3.07	Good			
			UT Mills R, SR 1345, Henderson	B-14	6-54-(5)	10/94	-/19	-/2.65	Good-Fair
Brandy Br, NC 191, Henderson	B-15	6-54-6	10/94	49/10	6.58/5.67	Fair			

FBR 04

Site	DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass			
French Broad R, NC 213 at Marshall, Madison	B-1	6-(67.5)	07/97	52/24	4.68/3.82	Good-Fair			
			07/92	67/25	5.23/4.42	Good-Fair			
			07/90	49/18	5.34/4.53	Good-Fair			
			08/88	71/22	5.82/4.56	Fair			
			07/86	79/31	5.39/3.85	Good-Fair			
			08/85	62/18	5.58/4.28	Good-Fair			
			08/84	41/16	5.18/4.04	Good-Fair			
			08/83	54/19	5.54/4.22	Good-Fair			
			Ivy Cr (R), SR 2153, Buncombe	B-2	6-96-(0.5)	08/93	100/41	4.41/3.59	Good
			Ivy Cr (R), SR 2150, Buncombe	B-3	6-96-(0.5)	07/97	-/27	-/2.78	Good-Fair
						07/92	-/38	-/3.35	Excellent
			Dillingham Cr, SR 2173, ab Stoney Cr, Buncombe	B-4	6-96-1-(1)	08/93	-/31	-/2.32	Good
Dillingham Cr, SR 2173, be Stoney Cr, Buncombe	B-5	6-96-1-(1)	08/93	86/36	4.20/2.85	Good			
Stoney Cr, SR 2178, Buncombe	B-6	6-96-1-5	08/93	77/33	3.15/2.12	Good			
Carter Cr, off SR 2178, Buncombe	B-7	6-96-1-5-1	08/83	-/29	-/1.92	Excellent			
Mineral Cr, off SR 2178, Buncombe	B-8	6-96-1-5-2	08/93	-/29	-/1.39	Excellent			
N Fk Ivy Cr, SR 2027, Buncombe	B-9	6-96-3	09/93	-/35	-/2.70	Good			
Little Ivy Cr, SR 1547, Madison	B-10	6-96-10	01/97	-/24	-/3.63	Good-Fair			
Little Ivy Cr, SR 1610, Madison	B-11	6-96-10	07/97	-/16	-/3.91	Fair			
			08/93	-/27	-/4.21	Good-Fair			
			07/92	-/34	-/3.26	Good			
California Cr, SR 1349, Madison	B-12	6-96-10-2	01/97	-/31	-/2.33	Good			
California Cr, SR 1541, Madison	B-13	6-96-10-2	01/97	53/29	3.71/2.65	Good-Fair			
Gabriel Cr, SR 1559, Madison	B-14	6-96-12	08/93	-/21	-/3.86	Good-Fair			
Bull Cr, NC 213, Madison	B-15	6-96-16	08/93	-/25	-/3.46	Good-Fair			
Ivy Cr, SR 1565, Madison	B-16	6-99-(11.7)	08/93	85/39	4.92/3.86	Good			
Ivy Cr (R), US 25/70., Madison	B-17	6-99-(11.7)	07/97	59/28	4.49/3.26	Good-Fair			
			09/93	-/34	-/3.26	Good			
			07/92	87/36	4.61/3.61	Good			
Hunter Cr, nr Hunter Cr R nr Marshall, Madison	B-18	6-106-2-(1)	12/91	-/30	-/1.65	Excellent			

FBR 04 (con't)

Site	Site #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Big Laurel Cr, SR 1503, Madison	B-19	6-112	07/97	-/33	-/2.11	Good
Big Laurel Cr, SR 1318/SR 1334, Madison	B-20	6-112	01/97	-/33	-/1.98	Good
Big Laurel Cr, SR 1318, Madison	B-21	6-112	01/97	65/37	2.52/2.14	Excellent
Big Laurel Cr, NC 208, Madison	B-22	6-112	07/97	-/36	-/2.66	Excellent
			08/92	-/38	-/3.00	Excellent
Puncheon Fk, SR 1503, Madison	B-23	6-112-5	07/97	-/31	-/2.14	Good
Shelton Laurel Cr, NC 208/212, Madison	B-24	6-112-26	07/97	-/32	-/2.59	Good
			08/92	-/32	-/2.90	Good
			05/90	-/44	-/2.55	Excellent
Hickory Fk (Hickey Cr), SR 1310, Madison	B-25	6-112-26-7	05/90	-/43	-/1.90	Excellent
W Pr Hickory Fk (W Pr Hickey Cr), SR 1310, Madison	B-26	6-112-26-7-1	05/90	-/38	-/1.62	Excellent
E Pr Hickory Fk (Little Pr E Pr Hickey Cr), FR 465, Madison	B-27	6-112-26-7-2	05/90	-/32	-/1.35	Excellent
Spring Cr, NC 209, Madison	B-28	6-118-27	07/97	-/31	-/3.04	Good
			08/92	-/26	-/2.75	Good-Fair

FBR 05

Site	DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Pigeon R, off NC 215, nr Woodrow, Haywood	B-1	5-(1)	07/84	87/37	4.85/3.49	Good
Pigeon R, NC 215 at Canton, Haywood	B-2	5-(1)	07/97	94/44	3.65/2.74	Excellent
			09/95	74/29	4.45/2.94	Good
			08/94	70/30	4.36/3.31	Good
			01/93	86/34	4.26/3.10	Good
			08/92	84/37	4.38/3.30	Good
			08/88	86/33	5.09/3.66	Good-Fair
			02/88	87/35	4.47/3.52	Good
			07/86	80/38	4.61/3.63	Good
			07/84	82/32	4.20/2.65	Good
			08/83	86/29	4.95/3.44	Good-Fair
W Fk Pigeon R, Burnett Siding, SR 1216, Haywood	B-3	5-2	07/97	-/49	-/1.59	Excellent
			01/93	81/47	2.37/1.70	Excellent
			07/91	-/44	-/1.85	Excellent
			05/90	-/48	-/1.83	Excellent
UT W Fk Pigeon R, nr NC 215, Haywood	B-4	5-2	05/90	-/34	-/1.26	Excellent*
			Tom Cr, nr NC 215, Haywood	B-5	5-2-5	12/91
M Pr W Fk Pigeon R, at mouth, Haywood	B-6	5-2-7	07/91	-/39	-/1.73	Excellent*
			04/91	-/42	-/1.40	Excellent
			05/90	-/42	-/1.70	Excellent
R Pr M Pr W Fk Pigeon R, Haywood	B-7	5-2-7-7	12/91	-/36	-/1.75	Excellent
			07/91	-/34	-/1.65	Excellent
			04/91	-/42	-/1.37	Excellent
			05/90	-/36	-/1.50	Excellent
UT Little E Fk Pigeon R, nr Shining Rock, Hay.	B-8	5-2-12-(0.5)	04/91	-/38	-/1.45	Excellent*
Little E Fk Pigeon R, SR 1129 ab camp, Haywood	B-9	5-2-12-(5.5)	04/91	-/51	-/1.50	Excellent
E Fk Pigeon R, US 276, nr Cruso, Haywood	B-10	5-3-(6.5)	07/97	109/50	3.31/2.13	Excellent
			07/84	87/39	3.96/2.39	Excellent
Pigeon R, SR 1642 at Clyde, Haywood	B-11	5-(7)	07/97	79/25	5.79/4.03	Good-Fair
			09/95	44/16	5.78/5.20	Fair
			08/94	44/13	5.88/4.88	Fair
			08/92	63/16	6.70/4.27	Fair
			09/89	47/7	6.70/4.39	Poor
			08/88	31/4	7.83/5.19	Poor
			02/88	51/12	6.82/4.52	Poor
			07/86	34/2	8.23/3.59	Poor
			08/84	39/5	7.63/4.89	Poor
			Pigeon R, SR 1625, be Richland Cr, Haywood	B-12	5-(7)	08/94
Pigeon R, at Crabtree Cr nr Crabtree, Haywood	B-13	5-(7)	02/88	53/16	6.13/3.97	Fair

FBR 05 (con't)

Site	Site #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Pigeon R, SR 1338 nr Hepco, Haywood	B-14	5-(7)	07/97	78/27	5.23/3.85	Good-Fair
			08/94	57/22	5.08/4.29	Good-Fair
			08/88	49/14	5.95/3.84	Fair
			02/88	46/24	4.79/3.76	Good-Fair
Pigeon R, at Counterfeit Br, Haywood	B-15	5-(7)	04/92	94/43	4.26/2.77	Good
			03/92	77/41	4.02/2.85	Good-Fair
Pigeon R, at Hurricane Cr, Haywood	B-16	5-(7)	04/92	74/28	5.69/4.42	Good-Fair
			03/92	74/30	5.52/3.68	Good-Fair
Pigeon R, off I-40, at Waterville, Haywood	B-17	5-(7)	07/97	81/40	4.51/2.77	Good
			08/94	58/27	4.10/3.26	Good
			07/90	57/22	4.57/3.75	Good-Fair
			07/89	62/28	5.01/3.91	Good-Fair
			08/88	67/24	4.67/3.25	Good-Fair
			08/87	58/25	4.88/3.51	Good-Fair
			07/86	67/28	4.61/3.74	Good-Fair
			08/85	57/17	5.67/3.64	Fair
			08/84	68/30	4.56/3.21	Good
			08/83	66/24	5.29/3.39	Good-Fair
			Rough Cr, nr SR 1616, Haywood	B-18	5-8-4-(1)	09/97
Richland Cr, SR 1184 at Waynesville, Haywood	B-19	5-16-(1)	07/97	-/24	-/3.22	Good-Fair
			08/92	-/26	-/3.38	Good-Fair
			08/88	42/11	6.07/4.87	Fair
			08/85	28/9	5.89/3.54	Poor
Richland Cr, US 23-Bus ab Dayco Corp, Haywood	B-20	5-16-(1)	08/83	42/9	7.15/3.70	Poor
			07/97	-/23	-/2.79	Good-Fair
			08/92	-/17	-/3.51	Fair
Hyatt Cr, SR 1159, Haywood	B-21	5-16-6	04/84	41/17	5.44/3.68	Fair
Hyatt Cr, SR 1159, Haywood	B-22	5-16-6	04/84	30/10	6.20/3.82	Poor
Shiny Cr, ab Allen Res., Haywood	B-23	5-16-7-3	07/97	-/43	-/1.30	Excellent
Rocky Br, SR 1219, Haywood	B-24	5-16-7-9	12/91	-/35	-/1.38	Excellent*
Richland Cr, SR 1519, Haywood	B-25	5-16-(16)	07/97	-/15	-/4.42	Fair
			08/92	-/14	-/4.47	Fair
Jonathans Cr, SR 1306, Haywood	B-26	5-26-(7)	07/97	-/46	-/1.50	Excellent
			08/92	-/41	-/1.85	Excellent
Jonathans Cr, SR 1322, Haywood	B-27	5-26-(7)	07/97	-/41	-/2.67	Excellent
			08/92	-/33	-/3.30	Good
Jonathans Cr, SR 1349, Haywood	B-28	5-26-(7)	07/97	-/39	-/3.11	Excellent
			08/92	-/23	-/3.70	Good-Fair
Fines Cr, SR 1355 nr I-40, Haywood	B-29	5-32	07/97	-/27	-/2.63	Good-Fair
			08/92	-/19	-/3.74	Good-Fair
Cataloochee Cr, SR 1395 (Gov. Rd), Haywood	B-30	5-41	07/97	102/50	2.56/1.55	Excellent
			08/92	84/42	2.93/1.83	Excellent
			07/91	80/48	2.57/1.84	Excellent
			10/90	86/47	2.60/1.73	Excellent
			07/90	95/51	2.97/1.73	Excellent
			04/90	86/56	2.19/1.82	Excellent
			01/90	85/51	2.21/1.80	Excellent
			07/89	101/53	2.85/1.76	Excellent
			07/86	102/47	3.38/1.95	Excellent
			08/84	96/42	3.16/1.72	Excellent
Cataloochee Cr, nr SR 1395 ab Palmer Cr, Hay.	B-31	5-41	01/90	-/45	-/1.52	Excellent
UT Rough Br, nr SR 1395, Haywood	B-32	5-41-1	04/91	-/47	-/1.66	Excellent*
Palmer Cr, nr SR 1395, Haywood	B-33	5-41-2	04/91	-/46	-/1.51	Excellent
Pretty Hollow Cr, nr SR 1395, Haywood	B-34	5-41-2-4	04/91	-/47	-/1.46	Excellent
Lower Double Br, ab Cataloochee Cr nr Gov. Rd., Haywood	B-35	5-41-6	10/90	63/37	2.64/1.48	Excellent*
			07/90	54/31	2.81/1.73	Excellent*
			04/90	57/36	2.09/1.41	Excellent*
			01/90	57/36	1.84/1.31	Excellent*
Little Cataloochee Cr, SR 1397, Haywood	B-36	5-41-10	01/90	-/40	-/1.95	Excellent

* Classified with small-stream criteria (expect lower EPT values)

FBR 06

Site	DWO #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Cold Springs Cr, Gov't. Rd nr cmpg, Haywood	B-37	5-45	04/92	84/48	2.75/1.98	Excellent
			03/92	78/45	2.73/1.71	Excellent
Big Cr, in GSMNP, ab campground, Haywood Nolichucky R, SR 1321 nr Poplar, Mitchell	B-38 B-1	5-59 7	07/97	-/47	-/1.38	Excellent
			07/97	72/38	3.87/3.47	Excellent
			07/92	88/42	4.14/3.37	Good
			07/90	83/38	4.31/3.27	Good
			08/88	93/35	4.86/3.81	Good
			07/86	84/37	4.86/3.57	Good
			08/85	72/28	4.63/3.36	Good
			08/84	68/31	4.47/3.73	Good
			08/83	78/34	4.55/3.86	Good
			02/89	59/35	4.01/2.68	Good
			North Toe R, bel Brushy Cr, Avery North Toe R, US 19E at Ingalls, Avery	B-2 B-3	7-2-(0.5) 7-2-(0.5)	07/97
07/92	99/41	4.13/3.01				Good
08/89	93/34	4.28/3.48				Good
02/89	58/29	4.45/3.14				Good
08/88	-/34	-/2.83				Good
08/87	92/38	4.58/3.23				Good
09/85	85/35	4.78/3.33				Good
08/84	84/36	4.15/2.93				Good
09/85	75/29	3.67/2.27				Good
02/89	-/27	-/2.36				Good-Fair
02/89	-/24	-/3.40				Good-Fair
Jones Cr, SR 1100, Avery Brushy Cr, SR 1101 ab landfill, Avery Brushy Cr, SR 1101 bel landfill, Avery North Toe R, SR 1162 at Penland, Mitchell	B-4 B-5 B-6 B-7	7-2-24 7-2-29 7-2-29 7-2-(38.5)	07/97	70/34	4.62/3.49	Good
			07/92	78/23	5.14/2.98	Good-Fair
			08/89	63/24	5.49/3.27	Good-Fair
			08/88	-/10	-/2.88	Poor
			08/87	62/20	5.97/3.68	Fair
			07/86	70/22	5.89/3.59	Fair
			09/85	46/12	6.20/3.67	Fair
			08/84	63/22	5.36/3.27	Good-Fair
			09/85	77/32	4.94/3.64	Good-Fair
			09/85	62/23	5.40/4.01	Good-Fair
			08/85	61/17	6.29/3.85	Fair
North Toe R, SR 1121 ab Feldspar, Mitchell North Toe R, NC 226 bel Feldspar, Mitchell North Toe R, SR 1551, Mitchell North Toe R be Indusmin, Mitchell North Toe R, SR 1314 at Loafers Glory, Yancey	B-8 B-9 B-10 B-11 B-12	7-2-(38.5) 7-2-(38.5) 7-2-(38.5) 7-2-(38.5) 7-2-(38.5)	09/85	50/18	5.70/3.45	Fair
			07/97	74/40	4.38/3.88	Good
			07/92	92/40	4.65/3.87	Good
			09/85	31/8	4.74/2.76	Fair
			09/85	9/2	7.59/4.29	Poor
			07/92	-/32	-/2.06	Good
			07/97	-/40	-/2.24	Excellent
			01/96	56/44	1.91/1.50	Excellent
			01/96	43/35	1.84/1.55	Excellent
			01/96	71/48	2.15/1.72	Excellent
			01/91	-/51	-/2.01	Excellent
South Toe R, ab NC 80, Yancey South Toe R, be NC 80, Yancey South Toe R, SR 1167 at Celo, Yancey	B-20 B-21 B-22	7-2-52-(1) 7-2-52-(1) 7-2-52-(1)	06/90	-/41	-/2.05	Excellent
			01/91	-/44	-/1.70	Good
			06/90	-/46	-/2.12	Excellent
			07/97	82/40	3.09/2.29	Excellent
			07/92	102/48	3.43/2.44	Excellent
			08/88	113/48	4.02/2.73	Excellent
			08/85	99/42	3.85/2.96	Excellent
			08/83	100/41	4.12/2.92	Good
			07/97	-/34	-/2.38	Good
			07/92	-/44	-/2.73	Excellent

FBR 07

Site	DWO #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Cane R, US 19W at Ramseytown nr Sioux, Yancey	B-1	7-3	07/97	84/46	4.19/3.34	Excellent
			07/92	94/49	4.37/3.44	Excellent

FBR 07 (con't)

Site	DWO #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
			08/89	81/37	4.57/3.84	Good
			08/87	77/34	4.71/3.75	Good
			08/85	62/23	5.23/3.65	Good-Fair
			08/83	70/27	5.35/4.05	Good-Fair
Cattail Cr, SR 1102, Yancey	B-2	7-3-9	01/96	39/26	2.25/1.51	Good
Bald Mt Cr, SR 1408, Yancey	B-3	7-3-32	07/97	-/32	-/2.24	Good
			07/92	-/26	-/3.50	Good-Fair

Sampling Methods

At each sample site, a 200-meter section of stream was selected and measured. The fish in the designated stretch of stream were then collected using two backpack electrofishing units. After collection, all readily identifiable fish (usually sport fishes, catfishes and suckers) were examined for sores, lesions, fin damage and skeletal anomalies, measured (total length to the nearest 1 mm), and then released. The remaining fish (i.e., those fish that were not readily identifiable) were preserved in 10% formalin and returned to the laboratory for identification, examination and total length measurement. Young-of-year fish were excluded from all analyses. The resulting data were then analyzed with the North Carolina Index of Biotic Integrity (NCIBI).

NCIBI Analysis

The assessment of biological integrity using the 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 relatively undisturbed 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, as proposed by Karr (1981), of the stream from which the sample was collected Table A-II-1).

Table A-II-1 Scores, Integrity Class and Class Attributes for Evaluating a Wadeable Stream Using the North Carolina Index of Biotic Integrity

NCIBI Scores	Karr's Integrity Classes	Class Attributes ¹
58 or 60	Excellent	Comparable to the best situations without human disturbance. All regionally expected species for the habitat and stream size, including the most intolerant forms are present, along with a full array of size classes and a balanced trophic structure.
54 or 56	Good-Excellent	
48, 50, or 52	Good	Species richness somewhat below expectation, especially due to the loss of the most intolerant species; some species are present with less than optimal abundances or size distributions; and the trophic structure shows some signs of stress.
46	Fair-Good	
40, 42, or 44	Fair	Signs of additional deterioration include the loss of intolerant species, fewer species, and a highly skewed trophic structure.
36 or 38	Poor-Fair	
28, 30, 32, or 34	Poor	Dominated by omnivores, tolerant species, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; and diseased fish often present.
24 or 26	Very Poor-Poor	
12, 14, 16, 18, 20, or 22	Very Poor	Few fish present, mostly introduced or tolerant species; and disease fin damage and other anomalies are regular.
-----	No fish	Repeated sampling finds no fish.

¹ Over-lapping classes share attributes with classes greater than and less than the respective NCIBI score.

The NCIBI has been revised since the initial French Broad River basinwide monitoring was conducted in 1992 and 1993 (NCDEHNR, 1994). The focus of using and applying the NCIBI is now restricted to wadeable streams that can be sampled by a crew of four persons and following the DWQ Standard Operating Procedures (NCDEHNR, 1997). Further refinements have been made to the number of fish, species and pool dwelling species as functions of a stream's watershed size (Metrics 1, 2 and 4), tolerance rankings (Metrics 6 and 7), trophic guild classifications (Metrics 8-10), and percentage of species with multiple age groups (Metric 12).

These refinements in the metrics and classification scheme resulted in substantial changes in the French Broad River basin fish community assessments previously reported in NCDEHNR (1994). For example, for the 15 wadeable stream sites monitored in 1992-1993, the NCIBI scores decreased by 4-14 units as shown in Table A-II-2.

Table A-II-2 Differences in Scoring of NCIBI as Previously Reported in Versus Current Score

Site	Old	New
	NCIBI Score	NCIBI Score
Hominy Creek	48	44
South Hominy Creek	48	38
Swannanoa River	46	34
Reems Creek	56	50
Sandymush Creek	52	40
Boylston Creek	44	38
Mills River - SR 1337 - 1993	54	48
Mills River - SR 1337 - 1994	58	44
Mills River - SR 1353	56	46
Big Ivy Creek	58	48
Ivy River	52	40
Shelton Laurel Creek	50	42
Richland Creek - Bus. US 23	42	36
Richland Creek - SR 1184	38	32
Jonathans Creek	50	40

In an effort to simplify and standardize the evaluation of a stream's ecological integrity and water quality bioclassification, whether using a fish community or benthic invertebrate assessment, the fish community integrity classes were also modified. The revised scores and classes for evaluating the fish community of a wadeable stream using the North Carolina Index of Biotic Integrity were also modified (Table A-II-3).

Table A-II-3 Revised Scores and Classes for Evaluating the Fish Community of a Wadeable Stream Using the NCIBI

NCIBI Scores	NCIBI Classes
56-60	Excellent
50-54	Good
44-48	Good-Fair
38-42	Fair
< 36	Poor

Even though NCIBI classes are given in this appendix, NCIBI scores only are given in the report, so that the data will not be used for use support evaluations. One primary reason for this are that many of the streams sampled in the French Broad basin had high numbers of trout with corresponding low NCIBI scores and should not be rated. The second reason is that a survey of mountain reference streams in September 1998 found that none of the streams sampled could achieve the Excellent NCIBI class expected at such sites. A review of the revisions made to the metrics will be done, and metrics will be further modified to allow reference sites to reflect an Excellent NCIBI class.

The same warning should be applied to the TVA classes as shown later. Many of their Poor streams had a high number of trout and would not be rated using the NCIBI. Overall, the TVA data suggest fish community problems throughout the basin, which is in disagreement with DWQ benthos and other data.

TVA fishery biologists sampled the fish communities at 44 sites within the river basin in 1997 and applied their version of the Index of Biotic Integrity (TVA, 1995). Some of the TVA metrics are different than the NCIBI metrics although the scoring and integrity classes are similar to those found in Table A-II-1. The watershed sizes for these 44 monitored streams ranged across two order of magnitude from 15.8 (Little Crabtree Creek in Yancey County) to 1,565 mi² (French Broad River in Madison County); the median watershed size was 65.3 mi². The TVA IBI scores and IBI classifications ranged from 26 to 54 and from Very Poor-Poor to Good-Excellent.

Eight of the streams monitored in 1997 by the NCDWQ were also monitored by the TVA. These streams were sampled at either the same bridge crossing or the watersheds of a specific stream at the two sample sites differed by less than 8 mi² (e.g., Richland Creek). The TVA classification system (Table A-II-1) was adjusted to the NCDWQ classification system (Table A-II-3) to compare the two methods in their ability to assess the same fish community (Table A-II-4). The number of fish and the number of native species collected per site and the catch per unit effort were all positively correlated between the TVA and NCDWQ methods (Pearson product moment correlations = $r = 0.750, 0.822$ and 0.477 , respectively). The differences in scores ranged from 8 lower for TVA at Flat Creek to 10 higher for TVA at Newfound Creek. There was no consistent pattern to the differences between TVA and DWQ scores.

Table A-II-4 A Comparison of Fish Community Scores by TVA and DWQ Index of Biological Integrity, French Broad River Basin, 1997¹

Stream	TVA IBI Score	TVA IBI Class	NCDWQ Equivalent IBI Class	NCDWQ IBI Score	IBI Score Difference
Cane Creek	46	Fair-Good	Good-Fair	46	0
Flat Creek	42	Fair	Fair	50	-8
Ivy Creek	52	Good	Good	50	+2
Jonathan Creek	36	Poor-Fair	Poor	42	-6
Mills River	48	Good	Good-Fair	46	+2
Newfound Creek	40	Fair	Fair	30	+10
Richland Creek	30	Poor	Poor	32	-2
South Hominy Creek	44	Fair	Good-Fair	40	+4

¹ The data from the two Reems Creek sites were not included. Although the watersheds differed by only 4.3 mi², the two sites differed too greatly in their instream physical characteristics and stream gradients to compare.

Appendix A-II Fish Community Assessments in the French Broad River Basin, 1992-1997

Stream	Road	County	Map F#	Index #	D.A. (mi ²)	Date	NCIBI Score
Subbasin 040301							
W Fk French Broad R	SR 1309	Transylvania	1	6-2-(7.5)	18.8	10/23/97	36
Little R	SR 1533	Transylvania	2	6-38-(20)	60.1	10/23/97	44
Subbasin 040302							
Mud Cr	SR 1647	Henderson	1	6-55-(1)	23.6	09/16/97	36
Bat Fork	SR 1779	Henderson	2	6-55-8-1	6	09/16/97	38
Cane Cr	US 25	Henderson	3	6-57-(9)	82.1	09/16/97	46
Hominy Cr	NC 151	Buncombe	4	6-76	30.2	09/17/97	42
						07/23/92	44
S Hominy Cr	NC 151	Buncombe	5	6-76-5	38.3	04/09/97	38
						07/23/92	38
Swannanoa R	SR 2435	Buncombe	6	6-78	62.7	09/19/97	38
	US 25	Buncombe	7	6-78	130	06/28/93	34
Beetree Cr	SR 2427	Buncombe	8	6-78-15-(6)	9.3	06/25/97	36
Newfound Cr	SR 1641	Buncombe	9	6-84	34.2	04/09/97	30
Reems Cr	NC 251	Buncombe	10	6-87-(10)	36.3	09/17/97	48
						11/17/93	50
Flat Cr	SR 1742	Buncombe	11	6-88	24.5	04/10/97	50
Sandymush Cr	SR 1107	Madison	12	6-92-(9)	79.5	09/17/97	42
						11/16/93	40
Subbasin 040303							
Boylston Cr	SR 1314	Henderson	1	6-52-(10.5)	15.3	09/15/97	46
						07/23/92	38
Mills R	SR 1337	Henderson	2	6-54-(1)	66.7	09/15/97	44
						10/19/94	44
						06/29/93	48
	SR 1353	Henderson	3	6-54-(5)	73	10/19/94	46
Subbasin 040304							
Ivy Cr (River)	SR 2150	Buncombe	1	6-96-(0.5)	60	09/18/97	50
						11/17/93	48
Ivy Cr (River)	US 25/70	Madison	2	6-99-(11.7)	161	11/16/93	40
Big Laurel Cr	NC 208	Madison	3	6-112	75	09/18/97	42
Shelton Laurel Cr	NC 208	Madison	4	6-112-26	40	06/03/97	48
						07/24/92	42
Subbasin 040305							
Richland Cr	US 23	Haywood	1	5-16-(1)	13.2	07/23/92	36
	SR 1184	Haywood	2	5-16-(1)	58	07/23/92	32
	Walnut Trail	Haywood	3	5-16-(16)	64.7	10/22/97	32
Crabtree Cr	NC 209	Haywood	4	5-22	25.8	06/03/97	32
Jonathan Cr	US 276	Haywood	5	5-26-(7)	55.8	10/22/97	42
						11/16/93	40
Fines Cr	SR 1355	Haywood	6	5-32	27.2	10/22/97	42
Subbasin 040306							
N Toe River	SR 1121	Avery	1	7-2-(0.5)	29.5	06/23/97	48
Big Crabtree Cr	SR 1002	Mitchell	2	7-2-48	16.4	06/24/97	54
Cane Cr	SR 1211	Mitchell	3	7-2-59	16.2	06/24/97	40
Jacks Cr	SR 1337	Yancey	4	7-2-63	20.2	10/20/97	40
Pigeonroost Cr	SR 1349	Mitchell	5	7-2-69	14.1	10/20/97	50
Subbasin 040307							
Price Cr	SR 1126	Yancey	1	7-3-21	22.1	10/21/97	46
Bald Mountain Cr	SR 1408	Yancey	2	7-3-32	15	10/21/97	40

¹ The NCIBI Classifications are: G = Good, G-F = Good-Fair, F = Fair, P = Poor, and NR = Not Rated.

Appendix A-II Fish Community Assessments Conducted by the Tennessee Valley Authority
in the French Broad River Basin, 1997

Subbasin	Stream	Road	County	D.A. (mi ²)	Date	TVA IBI Score	TVA IBI Class	NCDWQ Equivalent Class
040301	French Broad R	US 178	Transylvania	67.9	07/15/97	50	Good	Good
	Little R	SR 1536	Transylvania	43.2	08/13/97	54	Good-Excellent	Good
040302	Clear Cr	SR 1513	Henderson	41.2	06/24/97	42	Fair	Fair
	Mud Cr	SR 1508	Henderson	52.1	06/24/97	36	Poor-Fair	Poor
	Mud Cr	US 25	Henderson	110	04/16/97	36	Poor-Fair	Poor
	Cane Cr	US 25	Henderson	82.4	04/17/97	46	Fair-Good	Good-Fair
	French Broad R	SR 3495	Buncombe	652	07/16/97	42	Fair	Fair
	Hominy Cr	NC 191	Buncombe	104	04/16/97	44	Fair	Good-Fair
	South Hominy Cr	NC 151	Buncombe	38.3	04/09/97	44	Fair	Good-Fair
	Swannanoa R	US 25	Buncombe	130	04/15/97	42	Fair	Fair
	Flat Cr	SR 1742	Buncombe	24.5	04/10/97	42	Fair	Fair
	Reems Cr	SR 1740	Buncombe	32	04/09/97	26	Very Poor-Poor	Poor
	French Broad R	SR 1348	Buncombe	945	07/28/97	42	Fair	Fair
	Newfound Cr	SR 1641	Buncombe	34.2	04/07/97	40	Fair	Fair
Sandymush Cr	SR 1629	Madison	47	04/08/97	44	Fair	Good-Fair	
040303	Mills R	SR 1353	Henderson	75	04/17/97	48	Good	Good-Fair
	Davidson R	US 276	Transylvania	48	06/11/97	46	Fair-Good	Good-Fair
040304	French Broad R	SR 1001	Madison	1339	07/29/97	46	Fair-Good	Good-Fair
	Ivy Cr	SR 2150	Buncombe	59.5	06/26/97	52	Good	Good
	Ivy Cr	Bus US 25/70	Madison	160	06/12/97	46	Fair-Good	Good-Fair
	Little Ivy Cr	SR 1610	Madison	45.9	06/25/97	46	Fair-Good	Good-Fair
	French Broad R	NC 209	Madison	1565	07/30/97	44	Fair	Good-Fair
	Spring Cr	NC 209	Madison	71	04/21/97	36	Poor-Fair	Poor
	Big Laurel Cr	NC 208	Madison	127.5	04/22/97	44	Fair	Good-Fair
	Shelton Laurel Cr	NC 208	Madison	53	07/07/97	48	Good	Good-Fair
040305	E Fk Pigeon R	US 276	Haywood	44.8	07/09/97	32	Poor	Poor
	W Fk Pigeon R	NC 215	Haywood	33.9	07/17/97	44	Fair	Good-Fair
	Pigeon R	NC 215	Haywood	132	07/23/97	48	Good	Good-Fair
	Pigeon R	SR 1642	Haywood	168	07/22/97	38	Poor-Fair	Fair
	Pigeon R	SR 1338	Haywood	381	07/21/97	34	Poor	Poor
	Big Cr	SR 1332	Haywood	36.5	08/04/97	28	Poor	Poor
	Jonathan Cr	SR 1338	Haywood	65.3	07/08/97	36	Poor-Fair	Poor
	Richland Cr	SR 1184	Haywood	60	04/15/97	30	Poor	Poor
040306	North Toe R	NC 80	Yancey	180	08/05/97	40	Fair	Fair
	North Toe R	SR 1314	Mitchell	282	08/14/97	40	Fair	Fair
	North Toe R	SR 1336	Yancey	295	08/15/97	48	Good	Good-Fair
	South Toe R	NC 80	Yancey	60.8	08/04/97	48	Good	Good-Fair
	Little Crabtree Cr	US 19E	Yancey	15.8	08/06/97	44	Fair	Good-Fair
	Cane Cr	NC 80	Mitchell	27.1	06/05/97	32	Poor	Poor
	Big Rock Cr	NC 197	Mitchell	62.7	08/05/97	50	Good	Good
040307	Cane R	US 19E	Yancey	61	06/04/97	44	Fair	Good-Fair
	Cane R	US 19W	Yancey	117	08/07/97	40	Fair	Fair
	Cane R	US 19W	Yancey	145	06/24/97	46	Fair-Good	Good-Fair
	Nolichucky R	SR 1321	Mitchell	608	08/13/97	50	Good	Good

Appendix A-II 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, US Environmental Protection Agency (EPA) recommended screening values, and criteria adopted by the North Carolina State Health Director.

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. A list of fish tissue analytes accompanied by their FDA criteria are presented below (USFDA, 1980). At present, the FDA has only developed metals criteria for mercury. Individual parameters which appear to be of potential human health concern are evaluated by the NC Division of Occupational and Environmental Epidemiology by request of the Water Quality Section.

In the guidance document, *Fish Sampling and Analysis: Volume 1* (USEPA, 1993), EPA has recommended screening values for target analytes which are formulated from a risk assessment procedure. These are the concentrations of analytes in edible fish tissue that are of potential public health concern. The DWQ compares fish tissue results with EPA screening values to evaluate the need for further intensive site-specific monitoring. A list of target analytes and EPA recommended screening values for the general adult population is presented below.

The North Carolina State Health Director has adopted a selenium limit of 5 ppm for issuing fish consumption advisories. Total DDT includes the sum of all its isomers and metabolites (i.e., p,p DDT, o,p DDT, DDE and DDD). Total chlordane includes the sum of cis- and trans- isomers as well as nonachlor and oxychlordane. Although the EPA has suggested a screening value of 7.0×10^{-7} ppm for dioxins, the State of North Carolina currently uses a value of 3.0 ppt (3×10^{-3}) in issuing fish consumption advisories.

Food and Drug Administration (FDA) Action Levels			
	Mercury	Metals	1.0 ppm
		Organics	
Aldrin	0.3 ppm	p,p DDE	5.0 ppm
Dieldrin	0.3 ppm	o,p DDT	5.0 ppm
Endrin	0.3 ppm	p,p DDT	5.0 ppm
o,p DDD	5.0 ppm	PCB-1254	2.0 ppm
p,p DDD	5.0 ppm	cis-chlordane	0.3 ppm
o,p DDE	5.0 ppm	trans-chlordane	0.3 ppm

Environmental Protection Agency (EPA) Screening Values

Metals			
Cadmium			10.0 ppm
Mercury			0.6 ppm
Selenium			50.0 ppm
Organics			
Chlorpyrifos	30.0 ppm	Heptachlor epoxide	0.01 ppm
Total chlordane	0.08 ppm	Hexachlorobenzene	0.07 ppm
Total DDT	0.3 ppm	Lindane	0.08 ppm
Dieldrin	0.007 ppm	Mirex	2.0 ppm
Dioxins	7.0×10^{-7} ppm	Total PCB's	0.01 ppm
Endosulfan (I and II)	20.0 ppm	Toxaphene	0.1 ppm
Endrin	3.0 ppm		

* Total DDT includes the sum of all its isomers and metabolites (i.e., p,p DDT, o,p DDT, DDE and DDD).
 Total chlordane includes the sum of cis-and trans- isomers as well as nonachlor and oxychlordane.

Lakes Assessment Program

Numerical indices are often 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, 1982). 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 $\mu\text{g/l}$). Lakewide means for these parameters are used to produce a NCTSI score for each lake, using the following equations:

$$\text{TON}_{\text{Score}} = \frac{\text{Log}(\text{TON}) + 0.45}{0.24} \times 0.90$$

$$\text{TP}_{\text{Score}} = \frac{\text{Log}(\text{TP}) + 1.55}{0.35} \times 0.92$$

$$\text{SD}_{\text{Score}} = \frac{\text{Log}(\text{SD}) - 1.73}{0.35} \times -0.82$$

$$\text{CHL}_{\text{Score}} = \frac{\text{Log}(\text{CHL}) - 1.00}{0.48} \times 0.83$$

$$\text{NCTSI} = \text{TON}_{\text{Score}} + \text{TP}_{\text{Score}} + \text{SD}_{\text{Score}} + \text{CHL}_{\text{Score}}$$

In general, NCTSI scores relate to trophic classifications as follows: less than -2.0 is oligotrophic, -2.0 to 0.0 is mesotrophic, 0.0 to 5.0 is eutrophic, and greater than 5.0 is hypereutrophic. When scores border between classes, best professional judgment is used to assign an appropriate classification. NCTSI scores may be skewed by highly colored water

typical of dystrophic lakes. Some variation in the trophic state of a lake between years is not unusual due to the potential variability of data collections which usually involve sampling on a limited number of times during the growing season.

Two lakes were sampled for their potential of supporting algal blooms with the Algal Growth Potential Test (AGPT). The results of the Algal Growth Potential Test is discussed in the appropriate subbasin sections. The objective of the Algal Growth Potential Test is to assess a waterbody's potential for supporting algal biomass and to determine whether algal growth is limited by nitrogen, by phosphorus, or co-limited by both nutrients. When a waterbody supports algal growth at bloom levels without additional increases in nitrogen and/or phosphorus, the system may be subject to frequent nuisance algal blooms. The test exposes a standard alga, *Selenastrum capricornutum*, to the test water (this constitutes the control). Additional test samples are enriched with nitrogen or phosphorus. When one of these nutrients is added to a water sample which is growth limiting to that nutrient, the resulting mean standing crop (MSC) will generally reflect the level of added nutrient. In some cases, the bioavailable nitrogen and phosphorus in a sample may approach their optimum ratio for growth of the test alga and the addition of nutrients may not clearly identify the limiting nutrient. A waterbody may be protected from nuisance algal blooms if an AGPT value is consistently less than or equal to 5 mg/l.

References

- Karr, J.R. 1981. *Assessment of Biotic Integrity Using Fish Communities*. Fisheries. 6:21-27.
- NCDEHNR. 1997. *Standard Operating Procedures*. Biological Monitoring. Environmental Sciences Branch. Ecosystems Analysis Unit. Biological Assessment Group. North Carolina Department of Environment, Health and Natural Resources. Division of Water Quality. Water Quality Section. Raleigh, NC.
- TVA. 1995. *Protocol for Conducting an Index of Integrity Biological Assessment, 1995 (Draft)*. Tennessee Valley Authority. Norris, TN.