BASINWIDE ASSESSMENT REPORT: CHOWAN RIVER BASIN

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Division of Water Quality
Environmental Sciences Section

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INTRODUCTION TO PROGRAM METHODS

The North Carolina Division of Water Quality uses a basinwide approach to water quality management. Activities within the Division, including permitting, monitoring, modeling, nonpoint source assessments, and planning are coordinated and integrated for each of the 17 major river basins within the state. All basins are reassessed every five years. The Pasquotank River basin has been sampled by the Environmental Sciences Section's (ESS) Biological Assessment Unit (BAU) for benthic macroinvertebrates in 1995, 2000, 2005, and 2010. For a complete list of all historic benthic macroinvertebrate samples obtained by the BAU (including data for the Chowan River Basin) please refer to the following link: http://portal.ncdenr.org/web/wq/benthosdata.

The ESS collects a variety of biological, chemical, and physical data that can be used in a myriad of ways within the basinwide planning program. In some areas there may be adequate data from several program areas to allow a fairly comprehensive analysis of ecological integrity or water quality. In other areas, data may be limited to one program area, such as only benthic macroinvertebrate data or only fisheries data, with no other information available. Such data may or may not be adequate to provide a definitive assessment of water quality, but can provide general indications of water quality. The primary program areas from which data were drawn for this assessment of the Chowan River are benthic macroinvertebrates. Details of biological sampling methods (including habitat evaluation) and rating criteria can be found in the appendices to this report. Technical terms are defined in the Glossary.

This document is structured with physical, geographical, and biological data discussions presented in hydrologic units (HUCs). General water quality conditions are given in an upstream to downstream format. Lakes data, ambient chemistry data and aquatic toxicity data, with summaries, are presented in separate reports.

BASIN DESCRIPTION

The Chowan River basin is located in the northeastern coastal plain of North Carolina and includes all or parts of Northampton, Hertford, Gates, Bertie and Chowan Counties (Figure 1). The Chowan River is formed at the border of Virginia and North Carolina by the confluence of the Nottoway and Blackwater Rivers and flows southeastward into Albemarle Sound. Major tributaries to the Chowan River include the Meherrin River and its largest tributary, Potecasi Creek; the Wiccacon River and its largest tributary, Ahoskie Creek. The North Carolina portion of this river basin contains over 2,500 square miles while the Virginia portion encompasses over 3,575 square miles. Primarily a rural river basin, the only notable areas of urbanization include Murfreesboro, Ahoskie and Edenton.

Basinwide sampling for macroinvertebrates in 2010 includes samples in subbasin 02 (HUC 03010204) and subbasins 01, and 04 (HUC 03010203). To date, no suitable benthic macroinvertebrate sampling sites have been found in subbasin 03 (HUC 03010203).

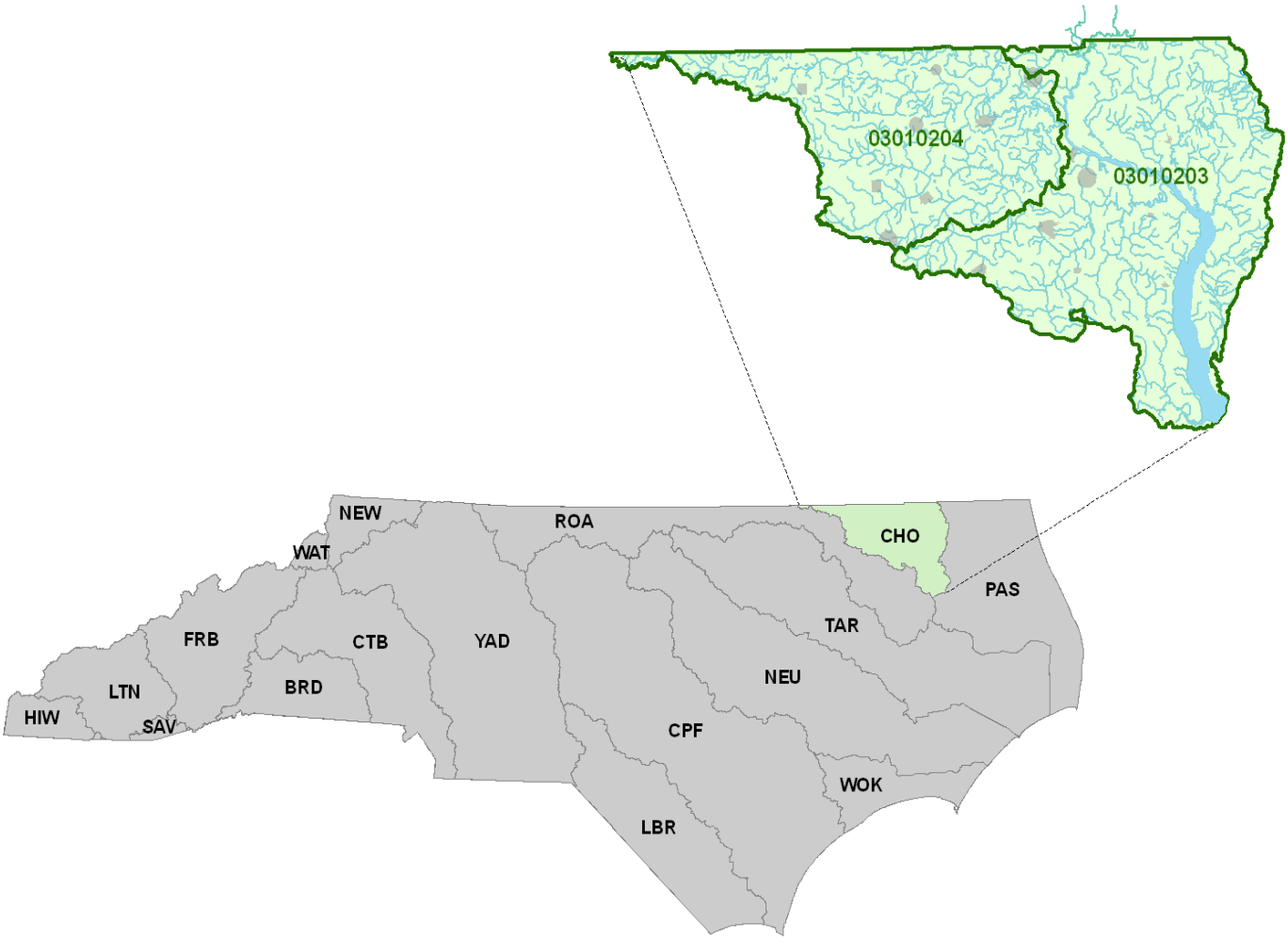


Figure 1. **Geographic relationships and eight-digit hydrologic units of the Chowan River basin.**

CHOWAN RIVER HUC 03010203

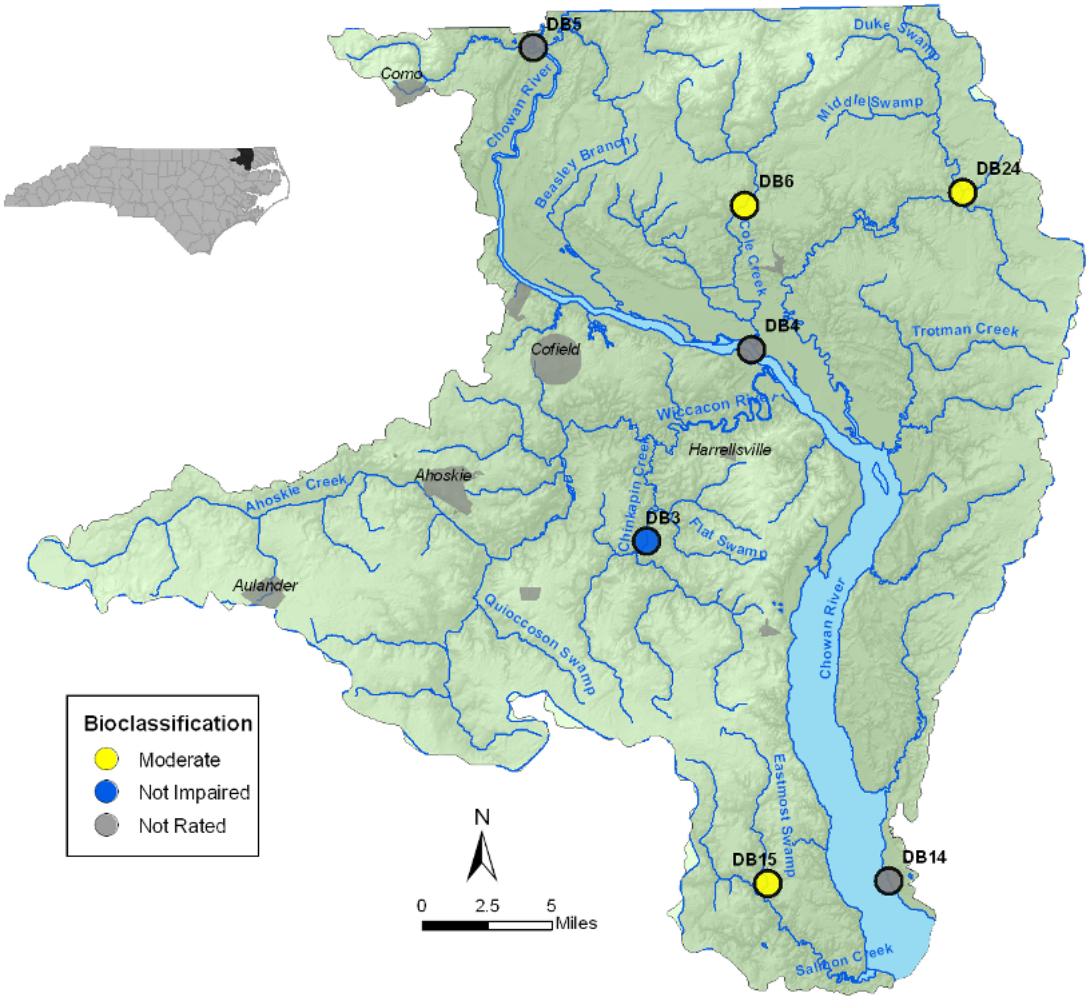


Figure 2. Sampling sites in HUC 03010203

River and Stream Assessment

To date, no suitable benthic macroinvertebrate sampling sites have been found in subbasin 03 within this HUC and all samples have thus far been restricted to subbasins 01 and 04. Numerous sites sampled during the 2005 basinwide cycle were not assessed in 2010 due to staffing reductions. These sites included the Wiccacon River at SR 1433 (Hertford County), Ahoskie Creek at NC 42 (Hertford County), and Stony Creek at SR 1235 (Bertie County). In 2010, a previously sampled site (Bennetts Creek at SR 1400 in Gates County) was dropped due to its close downstream proximity to Merchants Mill Pond. However, a new basinsite (Duke Swamp at SR 1400 in Gates County) was added in 2010. The Duke Swamp catchment represents a significant increase in bioassessment monitoring in this HUC and should be re-sampled during the next basinwide monitoring cycle if resources permit.

Table 1. Waterbodies Monitored in HUC 03010203.

Site ID	Waterbody	County	Location	2005	2010
DB5	Chowan R	Hertford	SR 1319	Good	Not Impaired
DB4	Chowan R	Hertford	Near New Ferry Road	Fair	Not Impaired
DB14	Chowan River	Chowan	US 17	Good	Not Impaired
DB6	Cole Cr	Gates	US 158	Moderate	Moderate
DB3	Chinkapin Cr	Hertford	SR 1432	Natural	Natural
DB24	Duke Swamp	Gates	US 158	---	Moderate
DB15	Eastmost Swamp	Bertie	SR 1361	Moderate	Moderate

SPECIAL STUDIES

No special studies have been conducted in this HUC between 2005-2010.

CHOWAN RIVER HUC 03010204

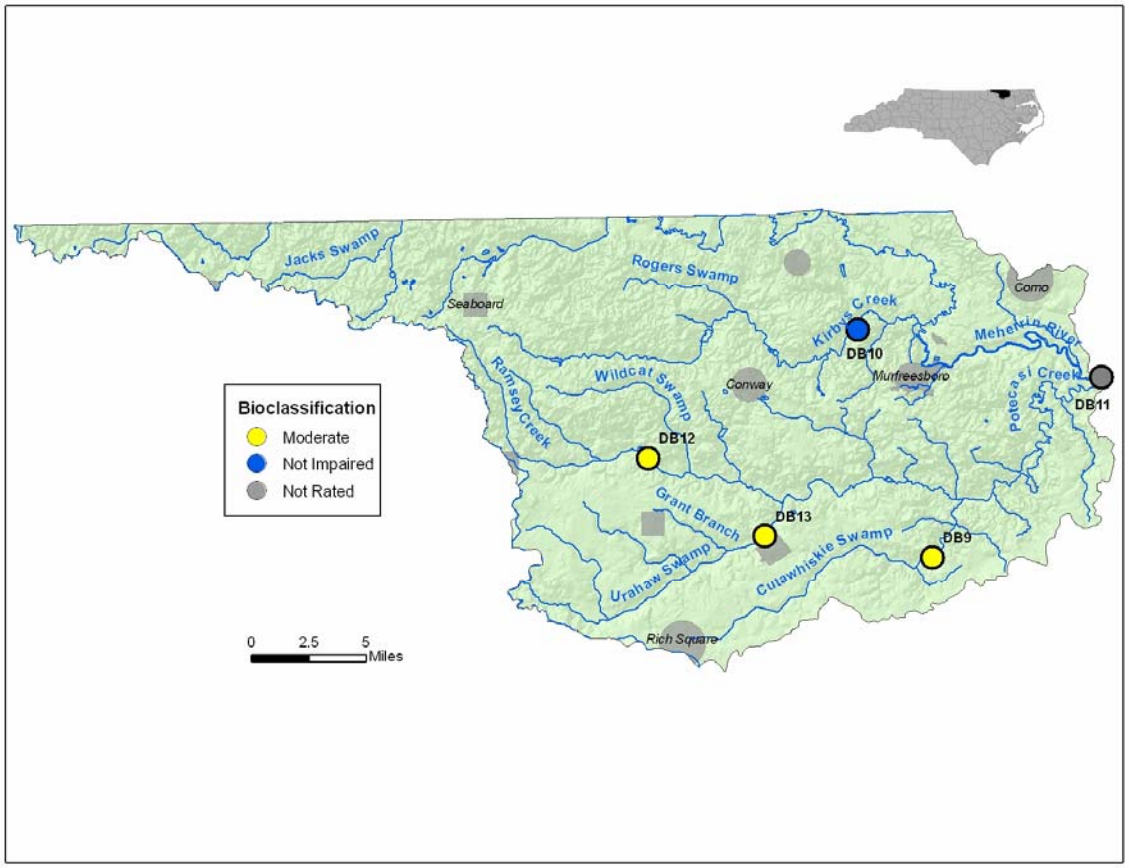


Figure 3. Sampling sites in HUC 03010204

River and Stream Assessment

Unlike sites in HUC 03010203, all previously sampled benthic macroinvertebrate monitoring locations were resampled here in 2010. Nevertheless, there continues to be an overall paucity of benthic macroinvertebrate sampling sites in this HUC due to a lack of wadeable waterbodies and summer flow.

Table 2. Waterbodies Monitored in HUC 03010204.

Site ID	Waterbody	County	Location	2005	2010
DB10	Kirbys Creek	Northampton	SR 1362	Moderate	Natural
DB12	Potecasi Creek	Northampton	SR 1504	Moderate	Moderate
DB13	Urahaw Creek	Northampton	NC 35	Moderate	Moderate
DB9	Cutawhiskie Swamp	Hertford	SR 1141	Not Rated	Moderate
DB11	Meherrin River	Hertford	SR 1175	Good-Fair	Not Impaired

SPECIAL STUDIES

On March 14, 2011 two benthic macroinvertebrate samples were taken from Northampton County in support of a request from the Raleigh Regional Office (RRO). The RRO was conducting an investigation into the possible effects on surface water from runoff associated with a mulching operation. Results of the benthic macroinvertebrate assessment indicate that the receiving stream (Ivy Creek off Williams Street near the town of Seaboard) was being adversely affected by this operation and received a Severe bioclassification. Conversely, the reference site (UT Corduroy Swamp at SR 1333) received a Moderate bioclassification.

GLOSSARY

Bioclass	Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups (EPT) and the Biotic Index value.
CHL *a*	Chlorophyll *a*.
Conductivity	In this report, synonymous with specific conductance and reported in the units of μmhos/cm at 25 ^{o}C. Conductivity is a measure of the resistance of a solution to electrical flow. Resistance is reduced with increasing content of ionized salts.
Division	The North Carolina Division of Water Quality.
D.O.	Dissolved Oxygen.
Ecoregion	An area of relatively homogeneous environmental conditions, usually defined by elevation, geology, and soil type. Examples include Southern Outer Piedmont, Carolina Flatwoods, Sandhills, and Slate Belt.
EPT	The insect orders (Ephemeroptera, Plecoptera, Trichoptera); as a whole, the most intolerant insects present in the benthic community.
EPT N	The abundance of Ephemeroptera, Plecoptera, Trichoptera insects present, using values of 1 for Rare, 3 for Common and 10 for Abundant.
EPT S	Taxa richness of the insect orders Ephemeroptera, Plecoptera and Trichoptera. Higher taxa richness values are associated with better water quality.
HQW	High Quality Waters. Waters which are rated as excellent based on biological and physical/chemical characteristics through Division monitoring or special studies; primary nursery areas designated by the Marine Fisheries Commission; and all Class SA waters.
Major Discharger	Greater than or equal to one million gallons per day discharge (≥ 1 MGD).
MGD	Million Gallons per Day, generally the unit in which effluent discharge flow is measured.
Minor Discharger	Less than one million gallons per day discharge (< 1 MGD).
NPDES	National Pollutant Discharge Elimination System.
NCBI (EPT BI)	North Carolina Biotic Index, EPT Biotic Index. A summary measure of the tolerance values of organisms found in the sample, relative to their abundance. Sometimes noted as the NCBI or EPT BI.
NCIBI	North Carolina Index of Biotic Integrity (NCIBI); a summary measure of the effects of factors influencing the fish community.

NSW	Nutrient Sensitive Waters. Waters subject to growths of microscopic or macroscopic vegetation requiring limitations on nutrient inputs.
ORW	Outstanding Resource Waters. Unique and special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses.
Total S (or S)	The number of different taxa present in a benthic macroinvertebrate sample.
UT	Unnamed tributary.
WWTP	Wastewater treatment plant.

Appendix 1. Summary of Benthic Macroinvertebrate Data in the Chowan River Basin

Since 1995, the largest trend noted among the river and stream samples was an increase in the number of Not Impaired designations (Figure 4). The sources of these changes included the Meherrin River at SR 1175 (Hertford County), the Chowan River at US 17 (Chowan County), Chowan River near New Ferry Road (Gates County) and the Chowan River at SR 1319 (Hertford County). All of these stations were previously assigned a bioclassification (i.e., Poor, Fair, Good-Fair, Good, Excellent) in 1995 based on provisional biocriteria which was derived from EPT species richness (EPTS). However, upon a more rigorous review of existing data and biocritiera for Coastal B rivers, it was determined in 2010 that all subsequent Coastal B river samples should not be assigned a bioclassification (i.e., Poor, Fair, Good-Fair, Good, Excellent) and were instead designated as Not Rated or Not Impaired. Not Rated is equivalent to a Fair bioclassification or worse based on the provisional (EPTS) Coastal B river criteria, while a Not Impaired designation is equivalent to a bioclassification of Good-Fair or better. From 1995 to 2010, all of these sites (excluding the Meherrin River) have increased in EPTS (Figure 5) with only the Meherrin River showing a very slight decrease in EPTS over the same time. Excluding the Meherrin River, the steady increase in pollution intolerant EPT taxa at these sites suggests an improvement in physico-chemical conditions in these waterbodies since 1995. Conversely, the slow decline in EPTS at the Meherrin River may suggest a slight deterioration in physico-chemical conditions here since 1995.

Figure 4. Bioclassification Trends in the Chowan River: 1995-2010. Stream and River Samples.

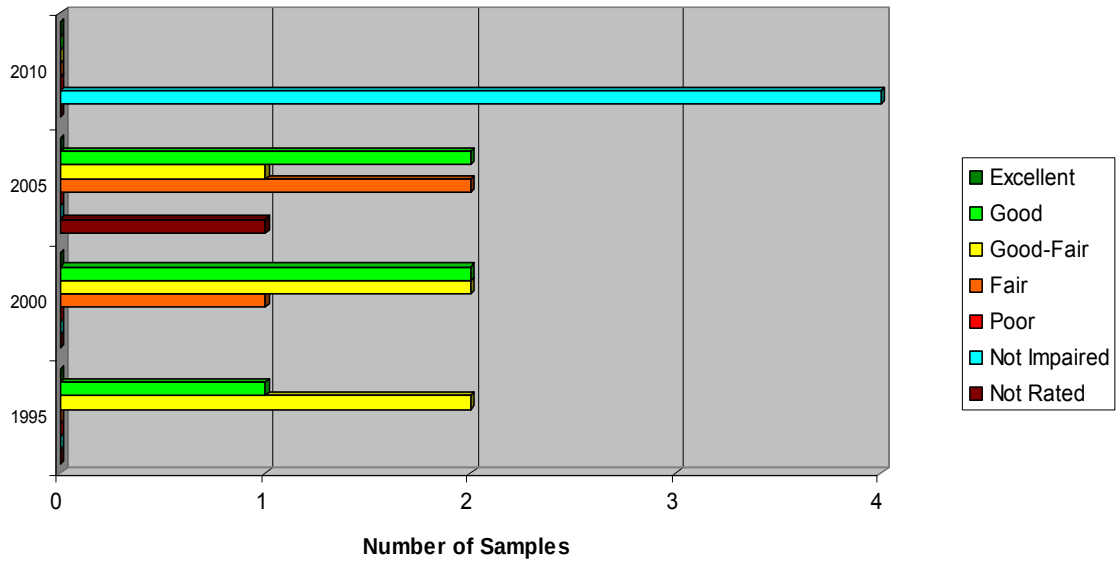
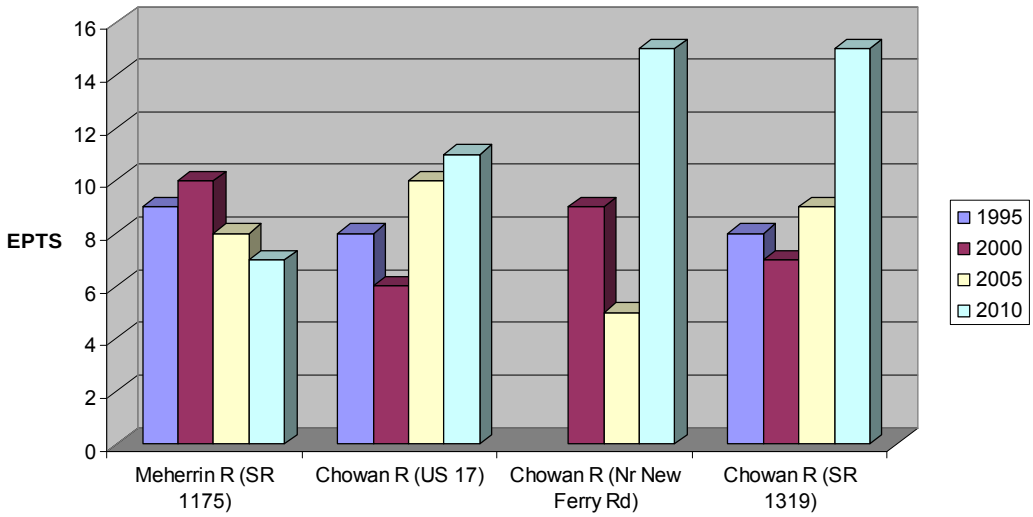
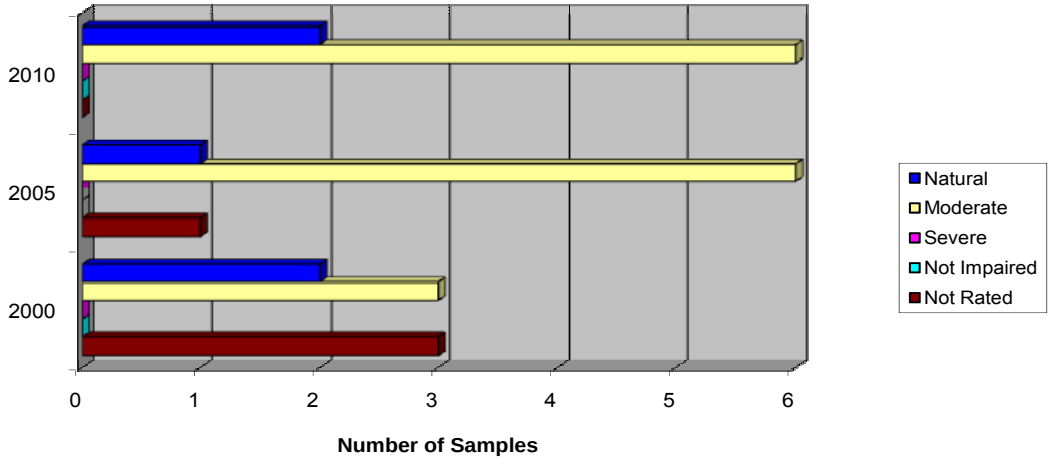


Figure 5. EPT Taxa Richness (EPTS) at Non-Wadeable River Stations. Chowan River Basin 1995-2010.



Although swamp samples were obtained in 1995 there were no swamp criteria in place at that time to assign these samples bioclassifications. As a result, these samples are not discussed and are not included in Figure 6. Overall, bioclassifications in swamp waters has been very stable since 2000 with four out of the seven total swamp sites monitored from 2000-2010 (excluding Duke Swamp which was sampled for the first time in 2010) receiving a Moderate bioclassification from each sample period. These sites include Potecasi Creek, Urahaw Creek, Cole Creek and Eastmost Swamp. Kirbys Creek rated Natural in 2000 and 2010 but declined to Moderate in 2005. This temporary decline was like due to drought induced flows noted in 2005. Chinkapin Creek received a Natural bioclassification in 2000, 2005, and 2010 while Cutawhiskie Swamp was assigned Not Rated in 2000 and 2005 but was rated as Moderate in 2010. Cutawhiskie Creek is a borderline swamp system as summer flow has been observed here in 2000 and 2005. Summer flows were not noted 2010 and therefore was sampled at that time and was rated using only swamp biocriteria as it was sampled as a swamp system in 2010.

Figure 6. Bioclassification Trends in the Chowan River Basin: 2000-2010. Swamp Samples.



Appendix 2. Benthic Macroinvertebrate Sampling Methods

Boat Sampling

Most collections are in wadeable streams, but there are some locations where a boat is required. These are usually large coastal plain rivers, like the Chowan River Basin. In such habitats, petite ponar dredge sampling replaces kick-net samples, but all other standard qualitative collection techniques are still useable. Most of these localities have little or no visible current. Coastal B criteria are used to evaluate such sampling sites.

The standard boat method still aims at a total of 10 composite samples per site. Sweeps, epifaunal collections, visuals, part of leaf-pack/debris sample are preformed along the edges in wadeable depths, while the petite ponar samples are collected from deeper areas using the boat, along with at least part of leaf-pack/debris sample, part of one epifaunal wash, and part of visuals (logs in the current). Petite ponars are collected at thee locations between midstream and the bank, with three replicates at each locations (a total of nine samples). The three locations should include a variety of depths, with at least one location in the 2-3 meter range. No petite ponars are collected from the area normally sampled during shore work, i.e., <2 meters in depth.

Swamp Stream Method

The Biological Assessment Unit defines “swamp streams” as those streams that are within the coastal plain ecoregion and that normally have no visible flow during a part of the year. This low flow period usually occurs during the summer, but flowing water should be present in swamp streams during the winter. Sampling during winter, high flow periods provides the best opportunity for detecting differences in communities from what is natural, and only winter (February to early March) benthos data can be used when evaluating swamp streams. The swamp stream must have visible flow in this winter period, with flow comparable to a coastal plain stream that would have acceptable flow for sampling in summer. Swamp streams with pH values of 4 s.u. or lower cannot be rated, and even those below 4.5 s.u. are difficult to evaluate.

The swamp sampling method utilizes a variety of collection techniques to inventory the macroinvertebrate fauna at a site. Nine sweep samples (1 series of 3 by each field team member) are collected from each of the following habitats: 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 is substituted. A sweep is defined as the area that can be reached from a given standing location. Each sweep should be emptied into a tub before the next sweep is collected, to prevent clogging of the net, but all three sweeps can be combined in the same tub. Three log/debris washes are also 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, Abundant) for each taxon.

Habitat Evaluation

Assessment forms have been developed by the Biological Assessment Unit to better evaluate the physical habitat of mountain/ piedmont and coastal streams. The habitat score, which ranges between 1 and 100, is based on the evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration, and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed to assign impairment ratings.

Appendix 3. Benthic Macroinvertebrate Criteria

Boat Samples, Coastal B Rivers Criteria

The Biological Assessment Unit has limited data on Coastal B, thus, draft criteria have been developed based only on EPT taxa richness. However, biotic index values and total taxa richness values were also evaluated for between year and among site comparisons. The criteria that are presented here will continue to be evaluated, and any bioclassifications derived from them should be considered tentative and not used for use support decisions.

Table 3. Draft Criteria for Coastal B Rivers

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

Swamp Stream Criteria

Swamp stream criteria are used to evaluate a stream based on three benthic macroinvertebrate metrics (total taxa richness, EPT taxa richness, and the Biotic Index) and the coastal plain habitat score.

In the following, raw measures for total taxa richness, EPT richness, biotic index, and habitat are referred to as “values.” After adjustments are made for swamp criteria, the measures are referred to as “scores.” The convention is made to reduce confusion.

Swamps in the Chowan and Pasquotank basins are classified as A, B, or C depending on geographic location. The metric scores derived below depend on the swamp classification and, in some cases, pH.

If the stream channel is braided, the value for total taxa richness is increased by eight. Corrected total taxa richness is determined from Table B-4 for Swamp A and Swamp B streams. Find the pH for the collection on the left. Find the set of three columns which correspond to the stream type (Swamp A or Swamp B), the find the range which corresponds to the total taxa richness for the site (corrected for a braided stream as indicated above, if necessary). Find the corrected total taxa richness score at the top of the appropriate column.

Table 4. Determination of Corrected Taxa Richness Scores for Swamp A and B Streams Adjusted for pH.

	Corrected Total Taxa Richness Score					
	Swamp A			**Swamp B**		
	5	**3**	**1**	**5**	**3**	**1**
pH						
≥5.5	>51	35-51	<35	>38	25-38	<25
5.4	>49	32-49	<32	>36	23-36	<23
5.3	>46	29-46	<29	>34	21-34	<21
5.2	>43	26-43	<26	>32	19-32	<19
5.1	>40	23-40	<23	>30	17-30	<17
5.0	>37	20-37	<20	>28	≤28	ND
4.9	>35	17-35	<17	>26	≤26	ND
4.8	>33	13-33	<13	>24	≤24	ND
4.7	>30	10-30	<10	>22	≤22	ND
4.6	>28	0-28	ND	>20	≤20	ND
4.5	>26	0-26	ND	>18	≤18	ND
4.4	>23	0-23	ND			
4.3	>20	0-20	ND			
4.2	>17	0-17	ND			
4.1	>14	0-14	ND			

Corrected total taxa richness scores are assigned as follows for Swamp C streams:

if the total taxa richness > 34, total taxa richness score = 5
if the total taxa richness is ≤ 34, total taxa richness score = 3

Biotic index scores for Swamp A, B, and C streams are derived using table B-5.

Table 5. Determination of Biotic Index Scores for Swamp A, B, and C Streams

	Swamp A	Swamp B	Swamp C
BI Score			
5	<6.8	<7.0	<7.2
3	6.8-7.5	7.0-7.9	7.2-8.1
1	>7.5	>7.9	>8.1

For EPT taxa richness add two to the value if the channel is braided, no matter the stream type.

For Swamp A streams, the EPT richness score is determined from table B-6. Find the pH for the collection in the left column. Move to the right to find the appropriate range for the EPT Richness value. Read the corrected EPT richness score from the top of the column.

Table 6. EPT Richness Scores for Swamp A streams adjusted for pH.

	Corrected EPT Richness Value		
	5	**3**	**1**
pH			
≥5.5	>17	7-17	0-6
5.4	>15	6-15	0-5
5.3	>13	5-13	0-4
5.2	>11	4-11	0-3
5.1	>9	3-9	0-2
5.0	>8	0-8	ND
4.9	>7	0-7	ND
4.8	>6	0-6	ND
4.7	>5	0-5	ND
4.6	>4	0-4	ND
4.5	>4	ND	ND

For Swamp B streams, the EPT richness score is not dependant on pH; scores are assigned as follows:

if EPT richness value > 5, EPT richness score = 5
if EPT richness value is between 2 and 4 inclusive, EPT richness score = 3
if EPT richness value is 0 or 1, EPT richness score = 1

For all Swamp C streams the EPT richness score is assigned a 1. An adjustment for very low numbers of EPT taxa in Swamp C streams will be made after the site score is determined.

Habitat scores are assigned irrespective of stream type:

if habitat value > 79, habitat score = 5
if habitat value is between 60 and 79 inclusive, habitat score = 3
if habitat value is < 60, habitat score = 1

The site score is calculated from the following:

Site Score = [(2xBI score + habitat score + EPT S score + Taxa Richness score) – 5]/2

For Swamp C streams, add two to the site score.

Stress ratings based on the scores are: Natural (9 - 10), Moderate (4 - 8) and Severe (1 - 3).

APPENDIX 4 : CHOWAN BASIN TEMPLATE SUMMARY REPORTS

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
CHOWAN R	**SR 1319**	**DB5**	**09/28/05**	**Good**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
HERTFORD	1	03010203	36.531667	-76.921389	25a1	Mid-Atlantic Floodplains and Low Terraces

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
B;NSW	Incalculable	0	120	9.0

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	100	0	0	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	N/A	N/A

Water Quality Parameters

Temperature (°C)	25.0
Dissolved Oxygen (mg/L)	2.9
Specific Conductance (µS/cm)	187
pH (s.u.)	5.9

Water Clarity	tannic

Habitat Assessment Scores (max)

Channel Modification (5)	0
Instream Habitat (20)	0
Bottom Substrate (15)	0
Pool Variety (10)	0
Riffle Habitat (16)	0
Bank Erosion (7)	0
Bank Vegetation (7)	0
Light Penetration (10)	0
Left Riparian Score (5)	0
Right Riparian Score (5)	0
Total Habitat Score (100)	0

Site Photograph

Substrate silt, sand, detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/21/10	11036	80	15	6.92	4.65	Not Impaired
09/28/05	9726	71	9	6.75	5.39	Good
07/31/00	8230	46	7	6.96	5.27	Good-Fair
08/10/95	6911	52	8	7.44	5.36	Good-Fair
07/11/90	5357	58	14	6.57	4.88	Excellent
07/13/88	4597	66	10	6.70	5.45	Good
07/07/86	3783	63	10	6.82	5.55	Good
07/17/84	3256	65	9	6.43	4.96	Good

Data Analysis

Compared to the previous two samples, the 2010 collection produced a slight increase in the richness of intolerant and facultative EPT taxa. Indeed, this (along with a decrease in the EPTBI) was the most notable change in this community from the previous two samples. Specifically, the 2010 sample resulted in two new caddisfly records for this location: *Oecetis Sp A* and *Oecetis Sp D*. The increase in EPT richness observed in 2010 suggests improved physico-chemical conditions in this waterbody from pervious years. This conclusion is supported by the improvement noted in the specific conductance data which was 157 µS/cm in 2005 but decreased to 98 µS/cm in 2010**.** Samples obtained from this site have previously been assigned bioclassifications. However, these bioclassifications were based on provisional biocriteria. Given the provisional status of biocriteria for large, non wadeable coastal plain rivers, the 2010 sample was assigned a Not Impaired rating. However, for purposes of inter-year comparison, the 2010 collection would have received an Excellent bioclassification based on the provisional criteria.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
CHOWAN R	NR NEW FERRY RD	DB4	09/27/05	Not Impaired

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
GATES	1	03010203	36.359444	-76.774167	25a2b	Mid-Atlantic Floodplains and Low Terraces

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
B;NSW	Incalculable	0	400	10.0

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	100	0	0	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	N/A	N/A

Water Quality Parameters

Temperature (°C)	26.3
Dissolved Oxygen (mg/L)	4.1
Specific Conductance (µS/cm)	157
pH (s.u.)	6.5

Water Clarity	tannic

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	18
Bottom Substrate (15)	4
Pool Variety (10)	4
Riffle Habitat (16)	0
Bank Erosion (7)	10
Bank Vegetation (7)	10
Light Penetration (10)	6
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	77

Site Photograph

Substrate silt, sand, detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/23/10	11039	64	15	6.92	5.12	Not Impaired
09/27/05	9719	49	5	6.50	4.83	Fair
08/01/00	8233	62	9	6.69	4.33	Good

Data Analysis

Compared to the previous two samples, the 2010 collection produced a significant increase in the richness of intolerant and facultative EPT taxa. Indeed, this was the most notable change in this community from the previous two samples. Specifically, the 2010 sample resulted in several new caddisfly records for this location: *Hydroptila spp* , *Oecetis persimilis* , *Oecetis Sp A* , *Triaenodes ignitus* , *T. perna/helo* and *Polycentropus spp* . The increase in EPT richness observed in 2010 suggests improved physico-chemical conditions in this waterbody from pervious years. This conclusion is supported by the large improvement noted in the specific conductance data which was 157 µS/cm in 2005 but decreased to 98 µS/cm in 2010. Samples obtained from this site have previously been assigned bioclassifications. However, these bioclassifications were based on provisional biocriteria. Given the provisional status of biocriteria for large, non wadeable coastal plain rivers, the 2010 sample was assigned a Not Impaired rating. However, for purposes of inter-year comparison, the 2010 collection would have received an Excellent bioclassification based on the provisional criteria.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
CHOWAN R	**US 17**	**DB14**	**08/22/05**	**Good**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
CHOWAN	4	03010203	36.059444	-76.687500	25c	hesapeake-Pamlico Lowlands and Tidal Marsh

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
B;NSW	Incalculable	0	2500	4.0

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	100	0	0	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	N/A	N/A

Water Quality Parameters

Temperature (°C)	30.9
Dissolved Oxygen (mg/L)	5.6
Specific Conductance (µS/cm)	400
pH (s.u.)	6.9

Water Clarity	clear/tannic

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	15
Bottom Substrate (15)	7
Pool Variety (10)	0
Riffle Habitat (16)	0
Bank Erosion (7)	10
Bank Vegetation (7)	10
Light Penetration (10)	8
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	75

Site Photograph

Substrate	sand, silt, detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/20/10	11042	43	11	5.79	5.22	Not Impaired
08/22/05	9633	41	10	6.33	5.19	Good
08/01/00	8232	29	6	6.13	4.15	Good-Fair
08/08/95	6907	34	8	5.85	4.90	Good-Fair
06/11/90	5355	41	11	5.85	4.58	Good
07/13/88	4595	45	7	6.22	5.14	Good-Fair
07/08/86	3784	38	6	6.38	5.24	Good-Fair
07/19/85	3510	37	5	6.47	4.59	Fair
07/17/84	3255	41	8	6.04	4.66	Good-Fair

Data Analysis

The 2010 collection produced the lowest biotic index on record for this location and the EPT richness of 11 repeated the previous high for his metric observed in 1990. Of note, the caddisfly *Oecetis nocturna* was collected here for the first time in 2010. The all-time low BI and high EPT richness suggest that physico-chemical conditions may have improved here slightly since 2005. This is supported by the improved water chemistry parameters as conductivity decreased from 400 µS/cm in 2005 to 126 µS/cm in 2010. This site have previously been assigned bioclassifications. However, these bioclassifications were based on provisional biocriteria. Given the provisional status of biocriteria for large, non wadeable coastal plain rivers, the 2010 sample was assigned a Not Impaired rating. However, for purposes of inter-year comparison, the 2010 collection would have received a Good bioclassification based on the provisional criteria.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
COLE CR	**US 158**	**DB6**	**02/24/10**	**Moderate**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
GATES	1	03010203	36.440833	-76.776389	25-12-7	Mid-Atlantic Flatwoods

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; NSW	32.1	13	6	0.4

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	70	---	---	10	20 (fallow fields)

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	7.3
Dissolved Oxygen (mg/L)	8.3
Specific Conductance (µS/cm)	90
pH (s.u.)	6.0

Water Clarity	clear/tannic

Habitat Assessment Scores (max)

Channel Modification (15)	12
Instream Habitat (20)	15
Bottom Substrate (15)	4
Pool Variety (10)	10
Bank Erosion (10)	10
Bank Vegetation (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	4
Total Habitat Score (100)	80

Site Photograph

Substrate	100% detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/24/10	10777	39	4	7.43	6.56	Moderate
02/08/05	9542	46	3	7.08	6.73	Moderate
02/10/00	8066	47	4	7.21	6.42	Moderate

Data Analysis

Cole Creek, a tributary of Sarem Creek, drains a portion of east-central Gates County. Likely influences on water quality appear to come from agriculture and forestry practices, although there are a few very small municipalities located within the watershed. Cole Creek has maintained its Moderate rating and appears to have stable water quality. There are no severe habitat issues for this waterbody and the riparian appears intact. This site is one of the few swamps in the region where the caddisfly *Platycentropus* can be found and has been collected each time since 2000.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
CHINKAPIN SWP	**SR 1432**	**DB3**	**02/25/10**	**Natural**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
HERTFORD	1	03010203	36.253056	-76.849444	25-14-3	Mid-Atlantic Flatwoods

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; NSW	50.0	10	9	0.8

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	100	---	---	---	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	6.8
Dissolved Oxygen (mg/L)	10.0
Specific Conductance (µS/cm)	93
pH (s.u.)	6.0

Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	17
Bottom Substrate (15)	10
Pool Variety (10)	10
Bank Erosion (10)	10
Bank Vegetation (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	92

Site Photograph

Substrate mix of detritus, silt, and sand

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/25/10	10904	50	5	6.54	6.41	Natural
02/10/05	9546	52	8	6.18	5.39	Natural
02/10/00	8065	60	8	6.59	6.09	Natural

Data Analysis

Chinkapin Swamp has a more forested catchment than other swamps in the Chowan basin although agricultural activities still occur in the upper portions of the watershed. Habitat at this site was the best noted for any streams in the Chowan River Basin. The stream channel was braided and unaltered an the riparian was mature forest on either side of the stream. Flows were good and colonizable substrate (coarse woody debris) was prevalent. Despite having a lower EPT richness (with 3 fewer mayfly taxa) than previous samplings the fauna present indicated no water quality issues. Chinkapin Swamp rated Natural for the third straight time.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
Duke Swp	**US 158**	**DB24**	**02/24/10**	**Moderate**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
Gates	1	03010203	36.444880	-76.624790	25-17-1	Mid-Atlantic Flatwoods

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; NSW	Incalculable	19	15	0.4

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	80	20	---	---	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	7.1
Dissolved Oxygen (mg/L)	9.0
Specific Conductance (µS/cm)	86
pH (s.u.)	5.5

Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	13
Bottom Substrate (15)	7
Pool Variety (10)	8
Bank Erosion (10)	10
Bank Vegetation (10)	7
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	80

Site Photograph

Substrate	primarily detritus with some sand and silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/24/10	10778	28	2	7.23	6.30	Moderate

Data Analysis

The Duke Swamp watershed lays in the northeastern Gates County and flows onto Bennets Creek upstream of Merchants Millpond. The upper watershed of Duke Swamp is overwhelmingly agricultural with few residences or municipalities. Duke Swamp was added as a Basinwide Site in 2010 to complement Cole Creek as the only basinwide swamp sites within Gates County and has not been sampled prior to 2010. The upper portion of the sampling reach was shallow due to extensive braiding. Habitat and physico-chemical parameters were favorable for macroinvertebrate colonization. however only 2 EPT taxa were collected indicating some level of stress on the stream. Duke Swamp rated Moderate.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
EASTMOST SWP	**SR 1361**	**DB15**	**02/25/10**	**Moderate**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
BERTIE	4	03010203	36.059167	-76.774167	25-24-1	Mid-Atlantic Flatwoods

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; NSW	12.0	3	6	1.0

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	100	---	---	---	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	7.0
Dissolved Oxygen (mg/L)	9.4
Specific Conductance (µS/cm)	89
pH (s.u.)	6.5

Water Clarity	clear/tannic

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	10
Pool Variety (10)	8
Bank Erosion (10)	10
Bank Vegetation (10)	7
Light Penetration (10)	7
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	82

Site Photograph

Substrate mostly detritus with some sand and silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/25/10	10903	39	3	7.04	6.54	Moderate
02/10/05	9545	47	3	6.80	6.50	Moderate
02/22/00	8085	56	5	7.48	6.16	Moderate

Data Analysis

Situated in the extreme eastern portion of Bertie County, Eastmost Swamp joins Salmon Creek which empties directly into Albemarle Sound. This stream has successional forest on either side of the stream and matures trees were absent in areas directly adjacent to the channels. An extremely large beaver dam exists upstream which has impounded and impressive amount of water and an old, breached beaver dam is present nearer the bridge at SR 1361. Macroinvertebrate habitat was favorable and physico-chemical parameters were within tolerable ranges. A small EPT community was present with a richness of 3 taxa and a relatively tolerant community of midges and crustaceans was also present. Eastmost Swamp maintains it's Moderate water quality rating.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
KIRBYS CR	SR 1362	DB10	02/25/10	Natural

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
NORTHAMPTON	2	03010204	36.470833	-77.143333	25-4-4	Rolling Coastal Plain

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; NSW	62.0	20	8	1.0

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	100	---	---	---	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	7.1
Dissolved Oxygen (mg/L)	10.2
Specific Conductance (µS/cm)	107
pH (s.u.)	6.1

Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	10
Pool Variety (10)	6
Bank Erosion (10)	10
Bank Vegetation (10)	8
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	4
Total Habitat Score (100)	83

Site Photograph

Substrate mostly sand and detritus with some silt.

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/25/10	10905	44	14	5.60	5.38	Natural
02/07/05	9540	49	9	6.19	5.60	Moderate
02/17/00	8068	54	12	6.20	5.31	Natural
03/11/97	7256	53	18	5.59	5.06	Natural
02/28/95	6761	62	11	6.36	5.89	Not Rated

Data Analysis

Kirbys Creek, a tributary to the Menherrin River, is a fast flowing swamp stream that lies in the northeastern portion of Northampton County. It has exposed portions of the Yorktown Formation (with approximately 4 million year old fossilized scallops) along some portions of its banks due to high energy flows. Kirbys Creek is a Coastal A transition site but may have severely reduced flows during drought years and is thus sampled during the winter. However, the presence of some summer taxa, such as the caddisfly *Ptilostomis* , suggests that it may not dry up until late in the summer season. Habitat is good and physico-chemical parameters are within normal ranges for benthos. Because of its historical natural rating, Kirbys Creek is a swamp stream reference site. This stream retains a Natural rating in 2010 after a Moderate rating in 2005.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
MEHERRIN R	**SR 1175**	**DB11**	**09/27/05**	**Good-Fair**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
HERTFORD	2	03010204	36.437778	-76.953333	25-4-(5)	Mid-Atlantic Floodplains and Low Terraces

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
B;NSW	???	0	100	8.0

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	100	0	0	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	N/A	N/A

Water Quality Parameters

Temperature (°C)	27.0
Dissolved Oxygen (mg/L)	4.4
Specific Conductance (µS/cm)	101
pH (s.u.)	6.4

Water Clarity	tannic

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	18
Bottom Substrate (15)	13
Pool Variety (10)	4
Riffle Habitat (16)	0
Bank Erosion (7)	10
Bank Vegetation (7)	10
Light Penetration (10)	6
Left Riparian Score (5)	5
Right Riparian Score (5)	4
Total Habitat Score (100)	75

Site Photograph

Substrate	silt, sand

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/21/10	11037	54	7	7.08	5.45	Not Impaired
09/27/05	9725	45	8	6.83	5.45	Good-Fair
07/31/00	8229	59	10	7.12	5.69	Good
08/10/95	6910	47	9	6.53	5.26	Good
02/15/95	6767	48	9	6.77	5.20	Good
07/10/89	4966	59	9	6.73	5.64	Good
07/09/87	4150	73	10	6.85	5.13	Good
07/25/85	3612	74	12	7.02	5.35	Excellent
07/21/83	3063	60	9	6.85	5.57	Good

Data Analysis

Although specific conductance (101 µS/cm in 2005, 106 µS/cm in 2010) and pH (6.4 in 2005 and 6.5 in 2010) have remained essentially unchanged here since 2005 the overall trend since monitoring initiated in 1983 suggests that the macroinvertebrate community appears to be mildly declining in quality. Indeed, the 2010 collection resulted in the lowest EPT richness value yet recorded and the second highest BI. This site has previously been assigned bioclassifications. However, these bioclassifications were based on provisional biocriteria. Given the provisional status of biocriteria for large, non wadeable coastal plain rivers, the 2010 sample was assigned a Not Impaired rating. However, for purposes of inter-year comparison, the 2010 collection would have received a Good-Fair bioclassification based on the provisional criteria.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
POTECASI CR	**SR 1504**	**DB12**	**02/23/10**	**Moderate**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
NORTHAMPTON	2	03010204	36.391944	-77.308889	25-4-8	Mid-Atlantic Flatwoods

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; NSW	32.0	58	6	0.8

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	70	---	20	10	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	7.3
Dissolved Oxygen (mg/L)	5.8
Specific Conductance (µS/cm)	49
pH (s.u.)	5.9

Water Clarity: slightly turbid

Habitat Assessment Scores (max)

Channel Modification (15)	13
Instream Habitat (20)	15
Bottom Substrate (15)	4
Pool Variety (10)	10
Bank Erosion (10)	10
Bank Vegetation (10)	7
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	3
Total Habitat Score (100)	77

Site Photograph

Substrate: mostly detritus mixed with some silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/23/10	10699	32	3	7.26	5.23	Moderate
02/07/05	9538	44	1	6.30	5.90	Moderate
02/09/00	8063	24	1	6.50	6.70	Moderate

Data Analysis

Potecasi Creek's catchment is located in central Northampton County and drains into the Meherrin River close to the Meherrin's confluence with the Chowan. The macroinvertebrate habitat of Potecasi Creek was typical of a slow moving swamp with bottom substrate a limiting factor in EPT colonization. However, physico-chemical parameters were within normal ranges for benthos. Aside from some channelized braids of the swamp, little human influence was noted although a beaver dam upstream was present. EPT taxa richness was higher than historical levels and consisted of typical lentic/slow moving water taxa. Water quality appears stable and Potecasi Creek rated Moderate for the third straight time.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
URAHAW SWP	**NC 35**	**DB13**	**02/23/10**	**Moderate**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
NORTHAMPTON	2	03010204	36.341389	-77.218889	25-4-8-4	Mid-Atlantic Flatwoods

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; NSW	Incalculable	45	5	0.4

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	---	20	---	---	70 (logged, fallowfields)

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	9.1
Dissolved Oxygen (mg/L)	8.0
Specific Conductance (µS/cm)	42
pH (s.u.)	5.7

Water Clarity	turbid

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	4
Pool Variety (10)	9
Bank Erosion (10)	6
Bank Vegetation (10)	4
Light Penetration (10)	9
Left Riparian Score (5)	2
Right Riparian Score (5)	0
Total Habitat Score (100)	64

Site Photograph

Substrate	mostly detritus mixed with some silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/23/10	10775	20	4	6.88	5.23	Moderate
02/07/05	9539	52	5	6.79	6.36	Moderate
02/09/00	8061	20	0	7.21	---	Moderate

Data Analysis

Urahaw Swamp is a tributary of Potecasi Creek and drains the southeastern part of Northampton County. At the time of sampling, the entire right bank (looking upstream), including some trees within some of the side channels, had been recently logged. Other areas around the swamp were regenerating from earlier logging events. Effectively, Urahaw Swamp had little to no extensive riparian vegetation. The water was very turbid from the recent activities and some large silty pools were present in the backwater areas. Water quality has remained stable at Moderate. However, it is notable that in 2010 less than half the total taxa were collected than were found from the previous sampling effort in 2005.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
CUTAWHISKIE CR	**SR 1141**	**DB9**	**02/24/10**	**Moderate**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
HERTFORD	2	03010204	36.325833	-77.088056	25-4-8-8	Mid-Atlantic Flatwoods

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; NSW	36.4	29	8	1.0

	Forested/Wetland	Urban	Agriculture	Road	Other (describe)
Visible Landuse (%)	60	---	20	10	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	7.8
Dissolved Oxygen (mg/L)	8.1
Specific Conductance (µS/cm)	75
pH (s.u.)	6.2

Water Clarity	turbid

Habitat Assessment Scores (max)

Channel Modification (15)	5
Instream Habitat (20)	10
Bottom Substrate (15)	7
Pool Variety (10)	4
Bank Erosion (10)	4
Bank Vegetation (10)	7
Light Penetration (10)	10
Left Riparian Score (5)	4
Right Riparian Score (5)	4
Total Habitat Score (100)	55

Site Photograph

Substrate	mostly sand with some overlaying silt and detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/24/10	10776	61	7	6.59	5.84	Moderate
08/26/05	9724	71	8	6.52	5.66	Not Rated
02/08/05	9541	59	5	6.64	5.59	Not Rated
02/02/00	8062	49	3	7.07	6.13	Not Rated
08/09/95	6909	49	4	6.75	6.14	Not Rated

Data Analysis

Cutawhiskie Creek's (previously referred to as Cutawhiskie Swamp) catchment drains an east-central portion of Hertford County which is primarily composed of agricultural fields interspersed with small animal operations. This stream has been extensively channelized and has had much of its natural habitat modified or removed. Cutawhiskie Creek may also flow during the summer months but may cease during dry years. Because of this, Cutawhiskie Creek has been sampled both in the winter and summer to best assess the type of stream (Coastal A or B) it most resembles and the subsequent sampling effort needed to rate the stream. Cutawhiskie Creek has therefore not been rated for the past 15 years. It has been determined that the stream is best sampled during the peak flowing season (winter) to mitigate taxa losses that may occur with minimal flows. Taxonomic data suggests little to no improvements occur to water quality in the summer months as evidenced by both similar EPT richness and the BI over the past few samples. Cutawhiskie Creek rates Moderate.