Northeast Creek and Newport River Tributaries
Summary of Special Study Results

Prepared by NC Div. of Water Quality, Watershed Assessment Team
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Methods

Study design

Sampling locations and parameters were requested by the White Oak Local Watershed Plan (LWP) technical advisory panel. Twelve sampling sites were requested in the Northeast Cr. watershed, and five in the Newport R. watershed. Locations are shown in Figure 1 and Figure 2 and described in Table 3. The figures also show the NPDES-permitted dischargers and more information on them is provided in Table 2.

Parameters requested for analysis were total dissolved nitrogen (TN, mg/L as N) and total dissolved phosphorus (TP, mg/L as P). Field parameters included water temperature (°C), pH (S.U.), dissolved oxygen (DO) concentration (mg/L), DO saturation (%), specific conductance (uS/cm at 25°C), and salinity (ppt). Identical measurements and analyses were performed at all locations. It was requested that sampling be performed twice: once in winter during low flow regime and again in late winter/early spring when flows are generally higher.

Sampling and analytical methods

All sampling, field measurements, and analyses were performed in accordance with DWQ Standard Operating Procedures (DWQ 2003a, DWQ 2003b).

- Samples: All samples were taken as 500mL grab samples just below the surface (depth = 0.1m). Samples were filtered in the field by vacuum filtration using a combination of a glass-fiber filter followed by a 0.45um mixed cellulose filter. Once filtered, samples were acidified to pH<2.0 using 1:3 H_2SO_4 and placed on ice until delivery to the Div. of Water Quality Laboratory Section in Raleigh for analysis. Holding time for all analyses was 28 days. Analyses included dissolved nitrite+nitrate (NO_2+NO_3) as N (mg/L), dissolved total Kjeldahl nitrogen (TKN) as N (mg/L), and dissolved total phosphorous (TP) as P (mg/L). Dissolved total nitrogen (TN) as N (mg/L) was calculated as (NO_2+NO_3)+TKN and reported as mg/L as N. Analytical methods and reporting limits are shown in Table 1.

Table 1: Analytical methods and reporting limits

Parameter	EPA method	Reporting limit
NO_2+NO_3 as N	353.2	0.02 mg/L
TKN as N	350.1, 351.2	0.20 mg/L
TP as P	365.1	0.02 mg/L

- Field measurements: All field measurements were taken *in situ* near the water surface (depth = 0.1m) using a Hydrolab Quanta, and included water temperature (°C), specific conductance (uS/cm at 25°C), dissolved oxygen (DO) concentration (mg/L), DO saturation (%), pH (standard units, or SU), and salinity (ppt).

- Georeferencing: All sampling locations were georeferenced using a recreational-grade GPS receiver. Accuracy of these types of GPSr's are generally within 15-25 feet. NAD83 datum was used and latitude and longitude were recorded in decimal degrees.
- Digital photographs: Digital photographs were taken at all locations to document conditions during the sampling event.

Quality assurance

- Duplicate samples were collected at a minimum of one out of every ten site visits (generally one set of duplicates per day) to determine total variability due to environmental, sampling, handling, and analytical factors. Duplicates were collected and processed individually (i.e., not split samples) at approximately the same time. Results were used to calculate the Relative Percent Difference (RPD), which provides the end data user an indication of whether or not results from different sites are significantly different.
- Equipment blanks were performed at the beginning and end of each day of sampling to show that the filtration equipment and methods were not a possible source of contamination. If any detectable levels of nitrogen or phosphorus had been reported in the field blanks, results from environmental samples for that day would be discarded.
- The field meter (Hydrolab Quanta) was calibrated at the beginning and end of each day to ensure that the meter was accurate and that no drift occurred during the day. If drift occurred outside of the acceptable range (+/- 10% from the standard), measurements from that day would be discarded.
- Latitudes and longitudes collected in the field were verified by loading them into a basic mapping program (Maptech Terrain Navigator) and reviewing them to ensure that the correct stream was sampled at the correct road crossing.

Table 2: NPDES permitted facilities in the White Oak LWP area

Permit number	Facility name	Latitude (dec deg)	Longitude (dec deg)	Receiving stream	Permitted flow (mgd)
NC0022462	Sherwood MHP WWTP	34.7203	-77.3097	Mott Cr.	0.06
NC0023825	Webb Apartments WWTF	34.7483	-77.3306	L. Northeast Cr.	0.025
NC0031577	White Oak Estates WWTP	34.7514	-77.3542	Northeast Cr.	0.22
NC0032239	Regalwood WWTP	34.7786	-77.3583	Northeast Cr.	0.125
NC0034991	Hickory Grove WWTP	34.7528	-77.3353	L. Northeast Cr.	0.0225
NC0036676	Collins Estates MHP WWTP	34.7347	-77.3153	Rocky Run	0.025
NC0043711	Morton Elementary School WWTP	34.7703	-77.3069	L. Northeast Cr.	0.0075
NC0049387	Hunters Creek WWTP	34.735	-77.3283	Mott Cr.	0.25
NC0062359	Horse Creek Farms WWTP	34.7658	-77.3036	L. Northeast Cr.	0.1

Figure 1: Northeast Cr. watershed sampling locations

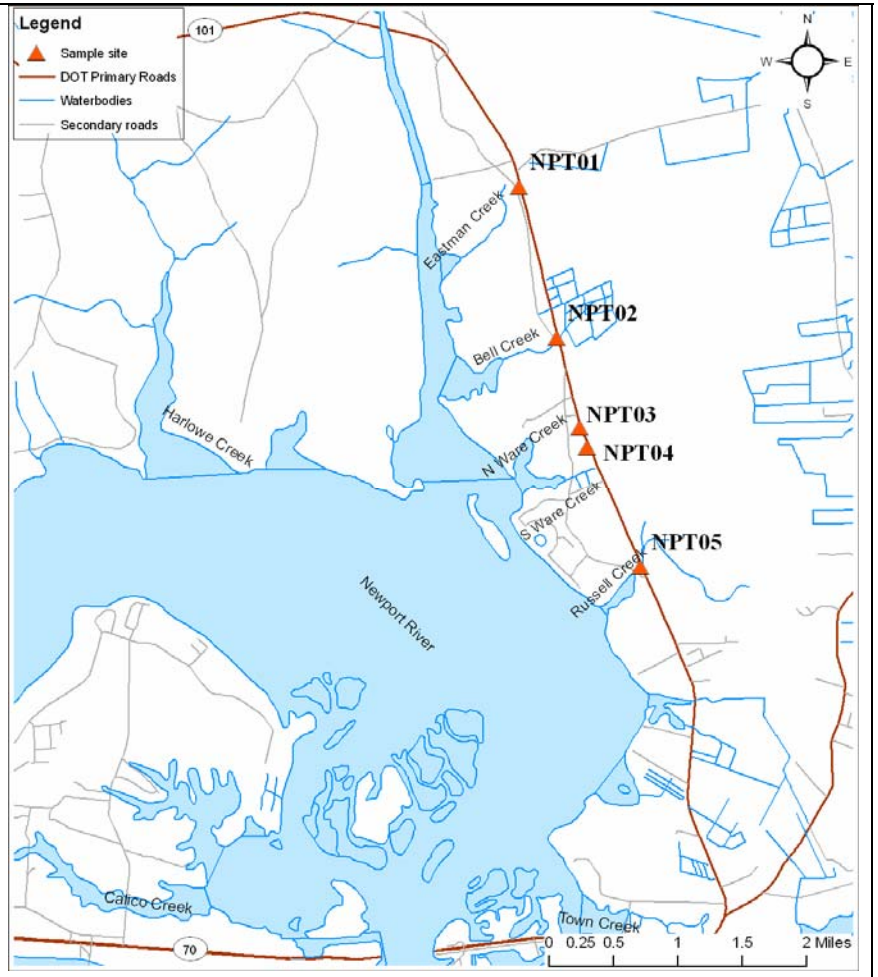

Figure 2: Newport R. tributary sampling locations

Table 3: Northeast Cr. and Newport R. tributary sampling locations

Watershed	Station number	Station description	Latitude (dd.dddd)	Longitude (dd.dddd)	Stream index	Stream class	Station comment
Newport tributaries	NPT01	Eastman Cr at NC 101	34.8071	-76.6733	21-24-1	SA	
	NPT02	Bell Cr at NC 101	34.7901	-76.6687	21-24-2	SA	
	NPT03	N Ware Cr at NC 101	34.7800	-76.6659	N/A	SA	
	NPT04	S Ware Cr at NC 101	34.7777	-76.6649	N/A	SA	
	NPT05	Russell Cr at NC 101	34.7640	-76.6580	21-26	SA	
Northeast Creek	NE01	Northeast Cr at SR 1327	34.8299	-77.3445	19-16	SC NSW	
	NE02	Unnamed tributary to Northeast Cr at SR 1327	34.8155	-77.3421	N/A	C NSW	
	NE03	Northeast Cr at US 17	34.8067	-77.3527	19-16	SC NSW	
	NE04	Northeast Cr off SR 1409 (Thomas Humphrey Rd)	34.7897	-77.3545	19-16	SC NSW	Downstream of confluence with Wolf Cr.
	NE05	Wolf Sw at US 17	34.7978	-77.3640	19-16-1	C NSW	
	NE06	Northeast Cr at SR 1406 (Piney Green Rd)	34.7741	-77.3607	19-16	SC NSW	Inactive AMS station P2900000
	NE07	Unnamed trib. to Poplar Cr at SR 1411 (Waters Rd)	34.7870	-77.3390	N/A	C NSW	
	NE08	Poplar Cr at SR 1411 (Waters Rd)	34.7785	-77.3313	19-16-2-3	C NSW	
	NE09	L Northeast Cr at SR 1406 (Piney Green Rd)	34.7483	-77.3294	19-16-2	C NSW	Tidal
	NE10	Northeast Cr at Northeast Creek Park	34.7437	-77.3503	19-16	SC NSW	Confluence of Northeast and L. Northeast Cr.
	NE11	Northeast Cr at NC 24	34.7346	-77.3540	19-16	SC NSW	Active AMS station P3700000
	NE12	Northeast Cr above Paradise Point	34.7240	-77.3991	19-16-(3.5)	SC HQW NSW	Near mouth. Access by boat.

Results:

Sampling dates and general conditions

"Low flow" sampling was performed January 8-9, 2008 under baseflow conditions, defined as >48 hours since last significant rain event. During "high flow" sampling performed March 4-5, 2008, samples collected on March 4 were under baseflow conditions. Spotty thunderstorms occurred in the area that evening, so samples taken on March 5 should not necessarily be considered baseflow conditions.

All locations were accessible for sampling in January. However, one site (NE12, Northeast Cr. above Paradise Point) was not accessible during the high flow sampling in March. This site was only accessible by boat and Watershed Assessment Team staff were unable to locate a "volunteer" willing to transport staff to this location for sampling. Therefore, only low flow results are available for this location.

In general, very poor or non-existent flow was noted in all freshwater sites during the low flow (January) sampling, and likely contributed to algal blooms noted at several sites. Flow regimes had improved at the majority of sites for the high flow (March) sampling. Though USGS stream gages were not available on any of the sampled reaches, there is a gage located nearby on the New R. (USGS station 02093000). Recent discharge data for this location are shown in Figure 3 (obtained from http://water.usgs.gov). Data confirm that flows in this area of the state were showing the expected pattern of low flows in early January (and well below median flow due to drought conditions) and higher flows (near normal) in early March.

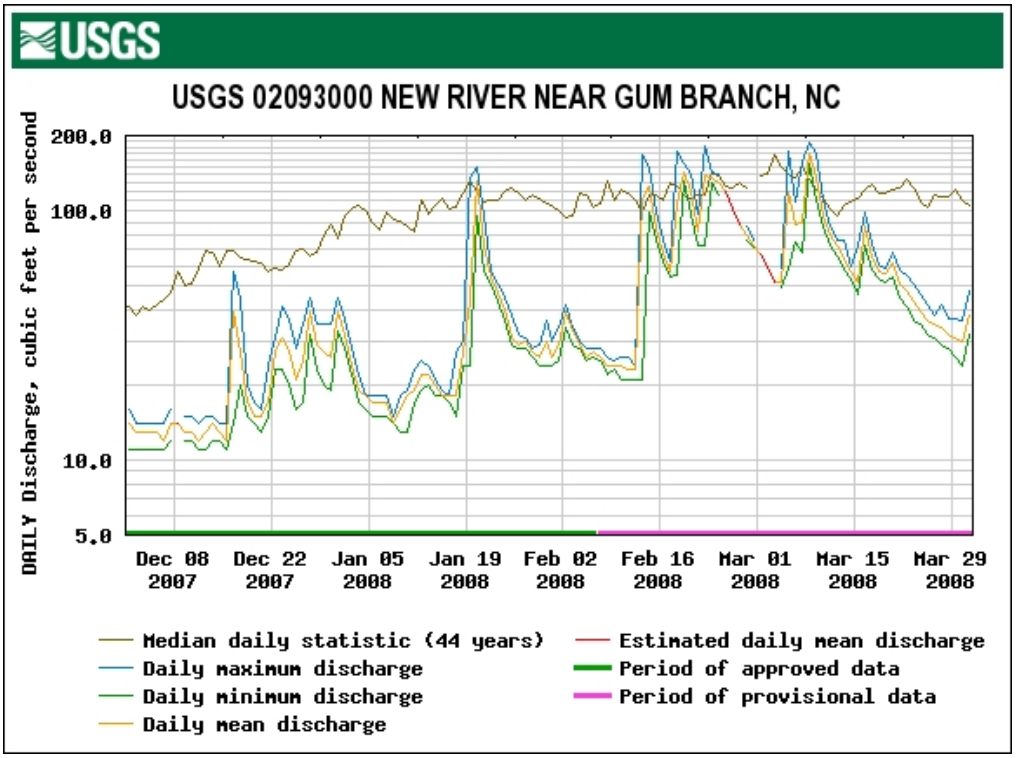

Figure 3: USGS flow data from 02093000, New River near Gum Branch, NC

Analytical results and field measurements summaries

Distributions of nutrient results grouped by sample date (Jan 2008 [low flow] or March 2008 [high flow]) are shown in Figure 4. The only parameter showing a significant difference in distributions between low flow and high flow was TKN.

Distributions of all field measurements grouped by sampling date (Jan 2008 [low flow] or March 2008 [high flow]) are shown in Figure 5. Significant differences were seen for pH and water temperature. The pH readings during low flow were atypically high for coastal swamp streams, partially due to algal blooms noted at several sites. Values dropped to more reasonable levels in March. For DO, distributions were much tighter during high flows, presumably due to better mixing of the water column and the much lower incidence of algal blooms.

Numerical results are shown in Table 4 and Table 5. For sites where duplicate samples were taken, the result shown is the average of the duplicate analyses. Results that were non-detects (i.e., concentration was below the reporting limit) are shown as "<" followed by the reporting limit for that parameter. For TN results, if either of the individual analyses (TKN or NO_2+NO_3) were reported as a non-detect (< reporting limit), the TN result is also shown as a "<" value.

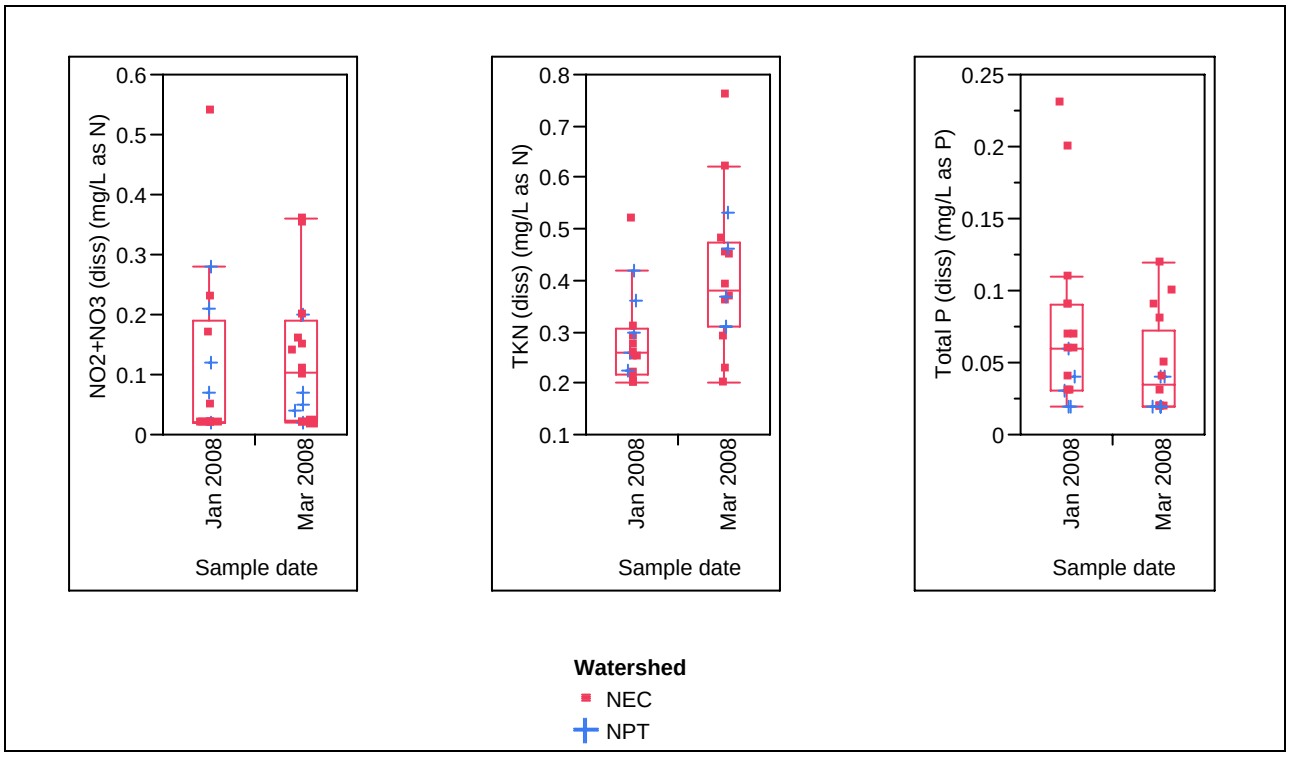

Figure 4: Distributions of nutrient results by sample date.

NEC = Northeast Cr watershed
NPT = Newport R tributaries

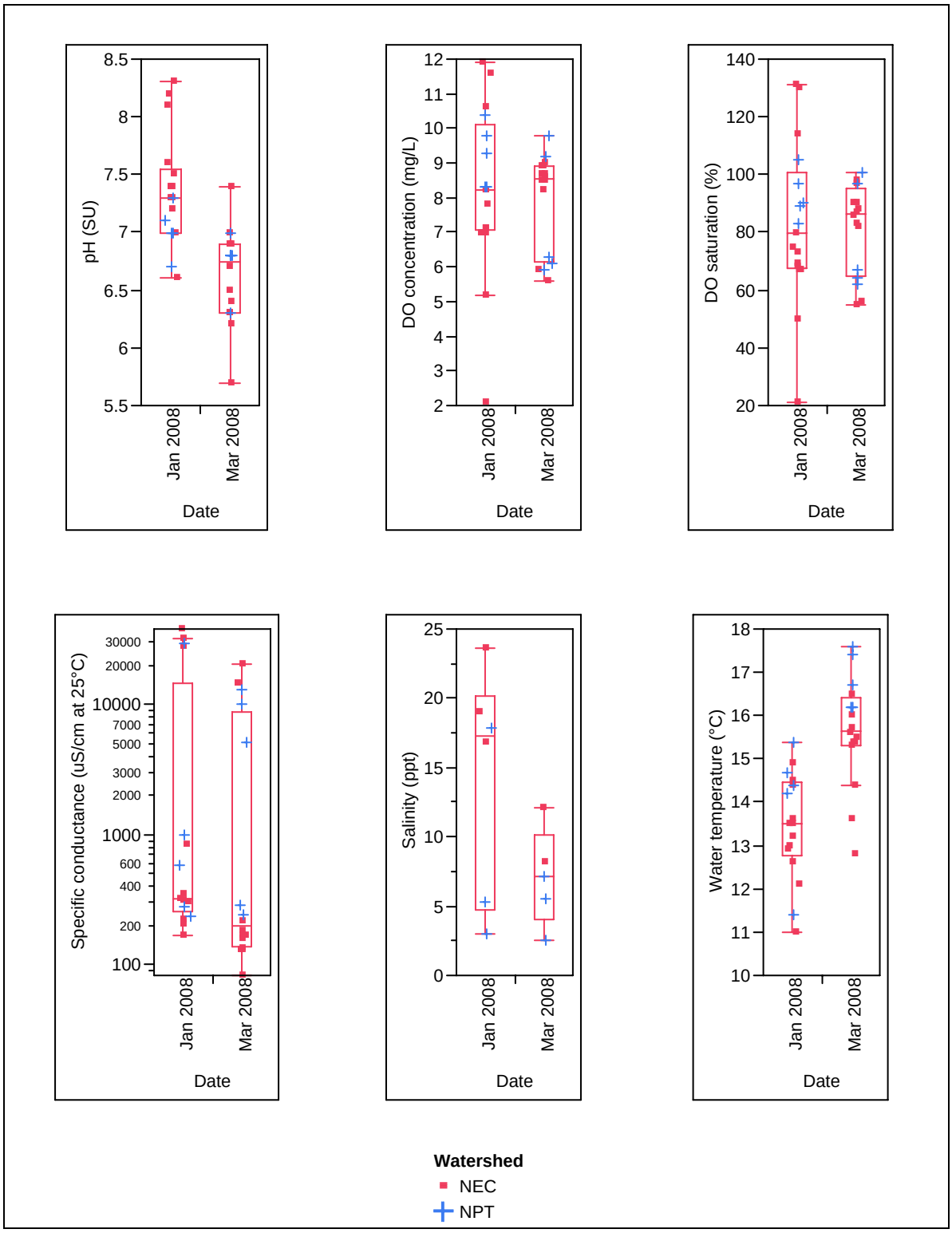

Figure 5: Distributions of field measurements by sample date

NEC = Northeast Cr watershed
NPT = Newport R tributaries

Table 4: Analytical results from Northeast Creek and Newport River Tributary watersheds. "Low flow" samples were taken January 8-9, 2008. "High flow" samples were taken March 4-5, 2008. Non-detects are indicated by "<" followed by the laboratory reporting limit. TN was calculated as the sum of NO2+NO3 and TKN.

			Dissolved NO2+NO3 as N (mg/L) [1]		Dissolved TKN as N (mg/L) [1]		Dissolved TN as N (mg/L) [1]		Dissolved TP as P (mg/L) [1]	
Watershed	Station number	Station description	Low flow	High flow	Low flow	High flow	Low flow	High flow	Low flow	High flow
Northeast Creek	NE01	Northeast Cr at SR 1327	0.02	0.14	0.52	0.76	0.54	0.90	0.07	0.02
	NE02	UT to Northeast Cr at SR 1327	<0.02	0.11	<0.20	0.37	<0.22	0.48	0.06	0.03
	NE03	Northeast Cr at NC 17	0.02	0.15	0.25	0.62	0.27	0.79	0.20	0.09
	NE04	Northeast Cr off SR 1409	0.05	0.16	<0.20	0.45	<0.25	0.61	0.09	0.08
	NE05	Wolf Sw at US 17	0.17	0.36	0.21	0.39	0.38	0.75	0.07	0.04
	NE06	Northeast Cr at SR 1406	0.23	0.20	0.26	0.48	0.49	0.68	0.23	0.12
	NE07	Unnamed tributary to Poplar Cr at SR 1411	<0.02	<0.02	0.31	0.23	<0.33	<0.25	0.11	0.05
	NE08	Poplar Cr at SR 1411	<0.02	<0.02	<0.20	<0.20	<0.22	<0.22	0.04	0.02
	NE09	L Northeast Cr at SR 1406	0.54	0.36 [2]	0.22	0.46 [2]	0.76	0.82 [2]	0.09	0.10 [2]
	NE10	Northeast Cr at Northeast Creek Park	<0.02 [2]	0.10	0.28 [2]	0.36	<0.30 [2]	0.46	0.03 [2]	0.02
	NE11	Northeast Cr at NC 24	<0.02	<0.02	0.25	0.29	<0.27	<0.31	0.03	0.02
	NE12	Northeast Cr above Paradise Point	<0.02	-- [3]	0.29	-- [3]	<0.31	-- [3]	0.06	-- [3]
Newport tributaries	NPT01	Eastman Cr	0.28 [2]	0.20	0.23 [2]	0.31	0.51 [2]	0.51	<0.02 [2]	<0.02
	NPT02	Bell Cr	0.07	0.07	0.36	0.46	0.43	0.53	0.06	0.04
	NPT03	N Ware Cr	0.21	<0.02	0.30	0.31	0.51	<0.33	0.02	<0.02
	NPT04	S Ware Cr	<0.02	0.04	0.42	0.53	<0.44	0.57	0.04	0.04
	NPT05	Russell Cr	0.12	0.05 [2]	0.26	0.37 [2]	0.38	0.42 [2]	0.03	0.02 [2]

[1] All results are from filtered samples (i.e., dissolved fractions)
[2] Result shown is the average of two duplicate samples.
[3] No High flow samples taken; boat access not available in March

Table 5: Field measurements from Northeast Creek and Newport River Tributary watersheds. "Low flow" samples were taken January 8-9, 2008. "High flow" samples were taken March 4-5, 2008.

			Water temperature (°C)		Specific conductance (uS/cm at 25°C)		pH (SU)		DO concentration (mg/L)		DO saturation (%)		Salinity (ppt)	
Watershed	Station number	Station description	Low flow	High flow	Low flow	High flow	Low flow	High flow	Low flow	High flow	Low flow	High flow	Low flow	High flow
Northeast Creek	NE01	Northeast Cr at SR 1327	13.0	15.4	206	83	7.5	5.7	7.0	8.6	67	87	<1	<1
	NE02	UT to Northeast Cr at SR 1327	14.5	16.0	313	169	7.2	7.0	7.0	8.7	69	88	<1	<1
	NE03	Northeast Cr at US 17	13.2	15.4	306	133	7.3	6.2	7.1	8.2	68	83	<1	<1
	NE04	Northeast Cr off SR 1409	12.6	15.3	316	166	7.6	6.4	7.8	8.9	73	90	<1	<1
	NE05	Wolf Sw at US 17	11.0	13.6	225	160	7.4	7.4	8.2	8.5	75	82	<1	<1
	NE06	Northeast Cr at SR 1406	13.5	15.5	353	183	7.4	6.7	8.2	8.5	80	86	<1	<1
	NE07	UT to Poplar Cr at SR 1411	13.5	14.4	167	130	6.6	6.3	2.1	5.6	21	55	<1	<1
	NE08	Poplar Cr at SR 1411	13.6	15.6	325	131	7.0	6.5	5.2	8.9	50	90	<1	<1
	NE09	L Northeast Cr at SR 1406	12.9	12.8	830	215	7.3	6.9	7.1	5.9	67	56	<1	<1
	NE10	Northeast Cr at Northeast Creek Park	14.9	16.5	27,900	14,400	8.2	6.9	11.6	9.0	130	98	16.8	8.2
	NE11	Northeast Cr at NC 24	14.4	15.7	32,000	20,500	8.3	6.3	11.9	8.7	131	97	19.0	12.1
	NE12	Northeast Cr above Paradise Point	12.1	-- [1]	37,900	-- [1]	8.1	-- [1]	10.6	-- [1]	114	-- [1]	23.6	-- [1]
Newport tributaries	NPT01	Eastman Cr	11.4	17.4	1000	5100	6.7	7.0	9.3	9.2	89	97	5.3	2.5
	NPT02	Bell Cr	14.2	17.6	580	10,000	7.1	6.8	8.3	5.9	83	64	3.0	5.5
	NPT03	N Ware Cr	14.7	16.7	281	288	7.3	6.8	9.8	9.8	105	101	<1	<1
	NPT04	S Ware Cr	15.4	16.2	235	245	7.0	6.8	10.4	6.1	105	62	<1	<1
	NPT05	Russell Cr	14.4	16.2	29,600	13,000	7.0	6.3	8.3	6.3	90	67	17.8	7.2

[1] No High flow samples taken; boat access not available in March

QA/QC results

Results from all field and equipment blanks were non-detects (less than reporting limits) so it is assumed that no measurable contamination was provided by filtration equipment or methods. All pre- and post-sampling calibrations of the Hydrolab Quanta met standard DWQ QA targets, which implies that the meter functioned properly during all sampling days.

Results from the four sets of duplicate samples are shown Table 6. Relative percent difference (RPD) for NO2+NO3 and TP were very low. RPD for TKN analyses showed much more variability, which in turn affected TN RPDs. When interpreting results, this total variability from all sources (environmental, sampling methods, sample handling, and analysis) should be kept in mind. For example, a difference of 10% between two TKN results may be attributable simply to the total error of the system and methods under study and may not represent an actual difference in instream concentrations.

It should be kept in mind that these QA results are based on an extremely small sample size, and there are significant differences in chemistries between the sites, particularly in terms of salinity. Distributions of RPDs for WAT duplicate samples for previous projects are shown in Table 7 for comparison.

Table 6: Relative Percent Difference (RPD) of duplicate samples collected from Northeast Cr. and Newport R. tributary sites

Date	Site Number	TKN1	TKN2	TKN RPD (%)	NOx1	NOx2	NOx RPD (%)	TP1	TP2	TP RPD (%)	TN1	TN2	TN RPD (%)
1/8/2008	NPT01	0.21	0.24	13.3	0.28	0.28	0	0.02	0.02	0	0.49	0.52	5.9
1/9/2008	NE10	0.30	0.25	18.2	0.02	0.02	0	0.03	0.03	0	0.32	0.27	16.9
3/4/2008	NE09	0.45	0.46	2.2	0.35	0.35	2.8	0.1	0.1	0	0.80	0.82	2.5
3/5/2008	NPT05	0.36	0.38	5.4	0.05	0.05	0	0.02	0.02	0	0.41	0.40	2.5
		Mean TKN RPD: 9.8%			*Mean NOx RPD: 0.7%*			*Mean TP RPD: 0%*			*Mean TN RPD: 7.0%*		

Table 7: Relative Percent Difference (RPD) of duplicate nutrient samples from WAT database

Analysis	N pairs	Min(RPD)	Mean(RPD)	Max(RPD)
NO2+NO3 as N	26	0.0	1.2	7.2
TKN	26	0.0	7.1	15.8
TN	26	0.0	5.5	15.0
TP	26	0.0	4.5	28.6

References

NC DENR-DWQ. 2003a. Intensive Survey Unit Standard Operating Procedures. Environmental Sciences Section, Intensive Survey Unit. http://h2o.enr.state.nc.us/esb/isu.html

NC DENR-DWQ. 2003b. Quality Assurance Manual for the North Carolina Division of Water Quality Laboratory Section. Laboratory Section. http://h2o.enr.state.nc.us/esb/qapp/labqam.pdf

NC DENR-DWQ. 2001. Standard Operating Procedures for Chemical, Physical, and Toxicity Monitoring, Watershed Assessment and Restoration Project. Planning Branch.