3-27-2014

Nitrogen, Phosphorus, and Suspended Solids Concentrations in Tributaries to the Great Bay Estuary Watershed in 2013

Matt A. Wood
N.H. Department of Environmental Services

Philip Trowbridge
N.H. Department of Environmental Services

Nitrogen, Phosphorus, and Suspended Solids Concentrations in Tributaries to the Great Bay Estuary Watershed in 2013

A Final Report to

The Piscataqua Region Estuaries Partnership

Submitted by

Matthew A. Wood &
Philip Trowbridge, P.E.
N.H. Department of Environmental Services
Watershed Management Bureau
Concord, NH

March 27, 2014

This project was funded in part by a grant from the Piscataqua Region Estuaries Partnership as authorized by the U.S. Environmental Protection Agency's National Estuary Program.

Introduction

Nitrogen, phosphorus, and sediment loads to the Great Bay Estuary are a growing concern. The Piscataqua Region Estuaries Partnership (PREP) calculates the nitrogen load from tributaries to the Great Bay Estuary for its State of Our Estuaries reports. Therefore, the purpose of this study was to collect representative data on nitrogen, phosphorus, and suspended sediment concentrations in tributaries to the Great Bay Estuary in 2013. The study design followed the tributary sampling design which was implemented by the New Hampshire Department of Environmental Services between 2001 and 2007 and by the University of New Hampshire between 2008 and 2012, so as to provide comparable data to the previous loading estimates.

Methods

Sampling and Analytical Methods

The field sampling and laboratory analysis methods have been documented in the approved Quality Assurance Project Plan (PREP, 2013).

University of New Hampshire researchers collected grab samples from the head-of-tide stations on eight tributaries to the Great Bay Estuary (Figure 1) on a monthly frequency from March to December. In some cases, samples were not collected every month due to site accessibility. The samples were analyzed for total dissolved nitrogen (TDN), total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), ammonia (NH_4), nitrate/nitrite (NO_3/NO_2), total suspended nitrogen (PN), and non-purgeable organic carbon which is equivalent to dissolved organic carbon (DOC). A total of ten field duplicate samples were collected for each parameter (one station per sampling date) for quality assurance.

The Water Quality Analysis Laboratory at the University of New Hampshire used USGS Method I-4650-03 (alkaline persulfate digestion) to determine TN and TP and high temperature catalytic oxidation (Merriam et al., 1996) to determine the TDN concentrations in samples. Suspended solids concentrations were calculated using APHA method 2540-D. Nitrate concentration was determined using EPA method 353.2 and NH_4 using EPA method 350.1. Dissolved organic carbon was determined using EPA method 415.1. Orthophosphate was measured using EPA method 365.1. Dissolved organic nitrogen (DON) was calculated by subtracting nitrate/nitrite and ammonia from TDN.

DOC is not a required parameter in the approved Quality Assurance Project Plan (PREP, 2013). Measurements of DOC were collected as ancillary data. The DOC results were quality assured using the methods and objectives in PREP (2013).

Physico-chemical parameters (water temperature, specific conductance, dissolved oxygen, and pH) were measured in the field using a YSI 556 multi-parameter instrument.

Quality Assurance Audit

UNH provided the field and laboratory data to the New Hampshire Department of Environmental Services to be quality assured and then added to the Environmental Monitoring Database.

Field sampling proceeded as planned.

- Eighty-nine of the 90 planned samples were collected for laboratory analysis (99%). This meets the data quality objective for completeness (80% of planned samples).

The results of quality control samples for TN, TP, TDN, PN, TSS, NH_4, NO_3, DON and DOC have been summarized in Tables 1 through 8. All of the data quality objectives for laboratory results for the study were substantially met. There were no major deviations from the planned laboratory methods.

Field duplicate samples:

- All of the field duplicate samples for DOC, TN, TDN, NO_3/NO_2, DON and the field parameters were within data quality objectives.
- Ammonia: One of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). The failing duplicate pairs were for low concentrations near the detection limit (<10x MDL), which inflate RPD calculations. The results were considered acceptable.
- Total Suspended Nitrogen: Four of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). The failing duplicate pairs were for low concentrations near the detection limit (<10x MDL), which inflate RPD calculations. The results were considered acceptable.
- Total Phosphorus: four of the nine field duplicates had RPD values greater than the data quality objectives. The failing duplicate pairs were for low concentrations near the detection limit (<10x MDL), which inflate RPD calculations. The results were considered acceptable.
- Suspended Sediments: three of the 10 field duplicates had RPD values greater than the data quality objectives. However, all of the failing duplicate pairs were for low concentrations (<19 mg/L). Given the natural variability of suspended sediment data, and the relative low concentrations observed, the results were considered acceptable.

Laboratory quality control samples:

The results of laboratory QC tests are shown on Tables 1-7. All of the instances where QC results did not meet data quality objectives were for low concentrations (<10x MDL) or below the detection limit, which is acceptable.

Logical tests:

Laboratory results for nitrogen and phosphorus species were checked to verify that dissolved species were not greater than total species.

- TN vs. TDN: TN should be greater than or equal to TDN. Out of the 87 results for TN and TDN, zero results had higher TDN values than TN.
- TDN vs. NO_3/NO_2+NH_4: TDN should be greater than or equal to the sum of NO_3/NO_2 and NH_4. Out of 89 samples, zero results had a higher sum of NO_3/NO_2 and NH_4 than TDN.

Results below detection limits:

Several of the results for ammonia (5), total phosphorus (6) and total suspended solids (5) were reported below the reporting detection levels (0.005, 0.007 and 1 mg/L, respectively). These

results are being reported as less than the reporting detection level (<RDL), not the values reported by the laboratory.

Consistency/Comparability:
The range of concentrations measured in 2012 were consistent with previous sampling efforts at these sites (Tables 1-7). Time series plots of the data at different stations were used to identify any unusual results. Similar to previous years, the nitrogen concentrations in the Cocheco River are much higher than in other rivers.

Results and Discussion

The quality assured results for TN, TP, TDN, TSS, NH_4, NO_3/NO_2, PN, DON and DOC concentrations, as well as the field parameters for each station visit are shown in Table 8. Figures 2 through 10 show the monthly concentrations for each analyte at each station.

The purpose of this report is to publish the results from the PREP sampling program for tributaries to the Great Bay Estuary. The following are some general observations which can be made based on the data:

- The concentrations of TN at each station ranged from 0.295-1.95 mg N/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH) and were consistently higher than the other stations throughout the entire monitoring period. The rest of the stations had TN concentrations between 0.295 and 1.103 mg N/L.

- The concentrations of TP at each station ranged from < 0.007 to 0.162 mg P/L. The maximum concentration (0.162 mg P/L) occurred in the Cocheco River (station 07-CCH).

- The concentrations of TDN at each station ranged from 0.222 to 1.503 mg/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH) and were consistently higher than the other stations throughout the entire monitoring period. The rest of the stations had TDN concentrations between 0.222 and 0.794 mg/L.

- The TSS concentrations ranged from <1.0 to 26.4 mg/L. The highest average concentration was in the Bellamy River (station 05-BLM).

- The concentrations of NO_3/NO_2 at each station ranged from 0.050 to 1.330 mg N/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH) and were consistently higher than the other stations throughout the entire monitoring period. The remaining stations had NO_3/NO_2 concentrations between 0.050 and 0.644 mg N/L.

- The average NH_4 concentration ranged from <0.005 to 0.158 mg N/L. The Salmon Falls River had the highest concentration (station 05-SFR).

- The concentrations of DON at each station ranged from 0.006 to 0.491 mg N/L. The maximum concentrations occurred in the Winnicut River (station 02-WNC).

- The concentrations of DOC at each station ranged from 3.02 to 15.30 mg C/L. The maximum concentrations occurred in the Winnicut River (station 02-WNC).

References

PREP. 2013. Great Bay Estuary Tidal Tributary Monitoring Program 2013-2017. Prepared for the Piscataqua Region Estuaries Partnership by the N.H. Department of Environmental Services, Concord, NH. Published Online, http://scholars.unh.edu/qapp/1

Merriam, J.L, W.H. McDowell, and W.S. Currie. 1996. A high-temperature catalytic oxidation technique for determining total dissolved nitrogen. *Soil Science Society of America Journal* 60: 1050-1055.

Table 1: Summary of Quality Control Samples for Total Nitrogen

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	6 Lab Duplicates / 0 Failed DQO 6 Lab Replicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	0 CRM tests conducted 6 LFM tests / 0 Failed DQO The lab accidently failed run the CRM samples
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TN concentrations in 2013 (0.30-1.95 mg/L) was similar to the range from 2001-2012 (0.11-4.17 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.30 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	77 routine samples and 10 field duplicates were collected (97% of planned samples)

Table 2: Summary of Quality Control Samples for Total Dissolved Nitrogen

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	9 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	12 CRM tests / 1 Failed DQO 13 LFM tests / 0 Failed DQO The failures were for a samples with a low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TDN concentrations in 2013 (0.22-1.50 mg/L) matched the range from 2008-2012 (0.17-2.92 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.22 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 3: Summary of Quality Control Samples for Total Phosphorus

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 4 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<10xMDL)
Precision-Lab	RPD < 15%	Lab Duplicates	6 Lab Duplicates / 1 Failed DQO 6 Lab Replicates / 0 Failed DQO The failure was for samples with low concentrations (<10xMDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	1 CRM tests / 0 Failed DQO 6 LFM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TP concentrations in 2013 (0.007-0.162 mg/L) was similar to the range from 2001-2012 (0.003-0.115 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.007 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	76 routine samples and 10 field duplicates were collected (96% of planned samples)

Table 4: Summary of Quality Control Samples for Suspended Solids

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 3 Failed DQO The failures were for samples with a low concentration
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	**NO DATA**
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TSS concentrations in 2013 (1-26.4 mg/L) matched the range from 2001-2012 (0.9-57 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 1.0 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 5: Summary of Quality Control Samples for Nitrate/Nitrite

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	10 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	12 CRM tests / 2 Failed DQO 11 LFM tests / 0 Failed DQO The failures were for samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of nitrate concentrations in 2013 (0.050-1.33 mg/L) was similar to the range from 2009-2012 (0.005-2.52 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.050 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 6: Summary of Quality Control Samples for Ammonia

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 1 Failed DQO The failures were samples with low concentrations (<10xMDL)
Precision-Lab	RPD < 15%	Lab Duplicates	6 Lab Duplicates / 2 Failed DQO The failures were for samples with a low concentration (<10xMDL or BDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	10 CRM tests / 2 Failed DQO 8 LFM tests / 0 Failed DQO The failures were for samples with a low concentration (BDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of ammonia concentrations in 2013 (0.005-0.158 mg/L) was similar to the range for 2009-2012 (0.005-0.100 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.005 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 7: Summary of Quality Control Samples for Dissolved Organic Carbon

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	9 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	11 CRM tests / 2 Failed DQO 12 LFM tests / 0 Failed DQO The failures were for samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of dissolved organic carbon in 2013 (3.02-15.3 mg/L) was similar to the range for 2011-2012 (3.24-12.8 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 3.02 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 8: Validated Laboratory Results and Field Data at Tributary Stations

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	TN (mg N/L)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	TPN (mg N/L)	pH	TP (mg P/L)	TSS (mg/L)	Spec. Cond (umhos/cm)	Temp. (°C)
02-GWR	03/28/2013*	5.10	12.81	95.5	0.456	0.080	0.363	0.148	0.135	0.041	5.96	0.048	1.82	102	3.1
02-GWR	03/28/2013	5.82	13.03	97.5	0.471	0.078	0.375	0.150	0.147	0.045	6.25	0.034	2.13	104	3.2
02-GWR	04/24/2013	5.55	9.77	86.4	0.295	0.011	0.293	0.103	0.179	0.050	6.42	0.013	4.21	94	9.9
02-GWR	05/22/2013	6.07	6.92	69.5	0.454	0.037	0.383	0.111	0.236	0.220	6.46	0.018	4.55	120	15.6
02-GWR	06/19/2013	8.26	6.83	75.2	0.484	0.023	0.350	0.147	0.180	0.056	6.76	0.044	<1.00	102	20.1
02-GWR	07/17/2013	9.43	4.98	66.0	0.611	0.024	0.421	0.134	0.263	0.112	6.92	0.044	5.00	108	30.2
02-GWR	08/21/2013	8.34	5.79	68.8	0.567	0.005	0.308	0.072	0.231	0.158	6.95	0.020	4.78	123	24.1
02-GWR	09/18/2013	12.89	4.84	49.7	0.576	0.005	0.404	0.083	0.316	0.055	6.08	0.047	7.22	95	16.7
02-GWR	10/16/2013	6.43	5.91	55.7	0.445	<0.005	0.222	0.053	0.168	0.039	6.14	0.145	3.04	138	12.8
02-GWR	11/20/2013	4.42	13.50	102.4	0.331	0.007	0.280	0.129	0.143	0.042	6.38	0.017	2.86	113	3.7
02-GWR	12/18/2013	4.44	14.91	101.9	0.451	0.026	0.258	0.133	0.099	0.028	6.63	0.013	2.17	139	0.0
02-WNC	03/28/2013	5.99	12.38	97.4	0.508	0.010	0.422	0.243	0.169	0.038	6.41	<0.007	1.48	293	5.1
02-WNC	04/24/2013*	6.91	10.61	90.1	0.661	0.019	0.589	0.209	0.361	0.164	6.89	0.015	3.20	323	8.2
02-WNC	04/24/2013	6.48	10.58	89.9	0.595	0.022	0.518	0.213	0.283	0.120	6.91	0.027	3.00	323	8.2
02-WNC	05/22/2013	7.48	8.48	84.3	0.818	0.069	0.654	0.256	0.330	0.130	6.91	0.034	10.95	380	15.0
02-WNC	06/19/2013	13.00	8.07	85.3	N/A	0.030	0.559	0.114	0.415	0.055	8.07	N/A	3.81	273	18.1
02-WNC	07/17/2013	11.14	5.59	68.3	0.800	0.055	0.615	0.201	0.359	0.029	7.11	0.028	1.43	342	25.5
02-WNC	08/21/2013	10.47	6.63	75.5	0.566	0.023	0.476	0.063	0.390	0.033	7.15	0.013	1.27	431	21.8
02-WNC	09/18/2013	15.30	6.16	59.8	1.103	0.017	0.590	0.082	0.491	0.045	6.71	0.023	3.50	310	14.1
02-WNC	10/16/2013	5.08	7.03	65.7	0.614	0.029	0.323	0.089	0.205	0.075	6.83	0.035	3.86	798	12.5
02-WNC	11/20/2013	6.23	13.27	100.8	0.725	0.009	0.470	0.233	0.227	0.078	6.65	0.058	4.67	354	4.0
02-WNC	12/18/2013	7.06	14.30	99.4	0.932	0.037	0.794	0.644	0.113	0.046	6.88	0.021	5.65	476	0.5
05-BLM	03/28/2013	6.17	13.68	101.4	0.402	0.021	0.355	0.138	0.196	0.048	6.38	0.010	1.58	128	2.9
05-BLM	04/24/2013	7.27	10.22	92.9	0.505	0.015	0.498	0.075	0.408	0.090	6.62	0.013	4.78	112	11.1
05-BLM	05/22/2013	5.51	10.47	102.1	0.681	0.044	0.389	0.142	0.203	0.225	6.65	0.043	11.67	189	14.2
05-BLM	06/19/2013	7.93	8.08	89.3	0.631	0.051	0.401	0.110	0.240	0.071	6.92	0.023	1.82	139	20.2

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	TN (mg N/L)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	TPN (mg N/L)	pH	TP (mg P/L)	TSS (mg/L)	Spec. Cond (umhos/cm)	Temp. (°C)
05-BLM	07/17/2013	8.91	6.59	85.7	0.651	0.019	0.411	0.098	0.295	0.051	7.25	0.039	4.67	163	28.9
05-BLM	08/21/2013	5.45	7.16	87.2	0.612	0.069	0.463	0.210	0.183	0.151	7.20	0.030	26.43	269	25.3
05-BLM	09/18/2013*	8.37	5.71	59.9	0.547	0.026	0.403	0.120	0.256	0.167	6.49	0.012	19.00	131	17.7
05-BLM	09/18/2013	8.01	5.82	61.8	0.564	0.030	0.418	0.098	0.289	0.078	7.01	0.016	5.50	132	18.1
05-BLM	10/16/2013	7.31	7.28	70.7	0.508	0.039	0.374	0.088	0.247	0.057	6.68	N/A	18.30	221	14.0
05-BLM	11/20/2013	5.54	14.32	107.1	0.462	0.046	0.280	0.083	0.150	0.046	6.16	0.028	6.36	141	3.3
05-BLM	12/18/2013	5.57	16.57	113.1	0.554	0.047	0.426	0.176	0.203	0.040	7.15	0.069	6.36	183	0.1
05-LMP	03/28/2013	4.42	13.44	102.5	0.376	0.009	0.347	0.191	0.146	0.039	5.20	0.027	1.35	113	4.0
05-LMP	04/24/2013	4.86	9.96	89.0	0.335	0.012	0.289	0.081	0.196	0.053	6.68	<0.007	2.27	120	10.4
05-LMP	05/22/2013	5.34	8.42	86.4	0.533	0.034	0.370	0.134	0.202	0.107	6.61	0.019	3.64	161	16.7
05-LMP	06/19/2013*	7.27	7.52	81.4	0.567	0.035	0.374	0.096	0.243	0.084	6.62	0.026	2.86	109	19.2
05-LMP	06/19/2013	7.84	7.52	81.4	N/A	0.039	0.360	0.105	0.216	0.064	6.62	N/A	1.82	109	19.2
05-LMP	07/17/2013	8.19	7.02	86.1	0.573	0.031	0.432	0.141	0.260	0.029	7.14	0.028	<1.00	118	26.1
05-LMP	08/21/2013	6.81	7.39	85.9	0.375	0.005	0.311	0.066	0.240	0.042	7.28	<0.007	1.48	143	22.9
05-LMP	09/18/2013	10.65	5.40	55.1	0.494	0.019	0.461	0.072	0.370	0.049	6.07	0.013	2.40	94	16.5
05-LMP	10/16/2013	6.72	7.37	71.2	0.524	0.016	0.409	0.171	0.222	0.082	6.41	0.024	1.08	161	13.9
05-LMP	11/20/2013*	4.77	14.09	106.5	0.896	0.040	0.544	0.311	0.193	0.032	5.56	0.016	2.61	102	3.7
05-LMP	11/20/2013	5.16	14.11	107.2	0.946	0.046	0.574	0.268	0.260	0.044	5.92	0.016	1.94	104	3.9
05-LMP	12/18/2013	5.42	16.09	110.3	0.459	0.027	0.442	0.238	0.177	0.042	6.05	<0.007	4.09	139	0.1
05-OYS	03/28/2013	4.79	9.20	69.6	0.474	0.015	0.400	0.241	0.144	0.060	5.42	0.015	3.67	181	3.4
05-OYS	04/24/2013	5.34	9.80	85.1	0.378	0.023	0.338	0.106	0.209	0.066	6.62	0.007	4.35	190	9.1
05-OYS	05/22/2013	6.05	6.92	68.0	0.632	0.047	0.472	0.149	0.276	0.141	6.44	0.060	10.59	321	14.5
05-OYS	06/19/2013	8.37	7.28	75.6	0.633	0.041	0.551	0.247	0.263	0.135	6.34	0.037	10.67	217	17.1
05-OYS	07/17/2013*	8.90	5.62	70.0	0.683	0.024	0.479	0.165	0.291	0.028	7.22	0.118	2.50	181	26.6
05-OYS	07/17/2013	8.48	5.06	61.6	0.657	0.035	0.451	0.148	0.268	0.049	7.13	0.123	2.00	193	25.4
05-OYS	08/21/2013	7.59	7.19	82.5	0.449	0.008	0.375	0.050	0.317	0.099	7.14	0.020	3.08	253	22.0
05-OYS	09/18/2013	12.87	8.03	73.5	0.831	0.053	0.624	0.130	0.440	0.063	6.18	0.019	6.84	136	15.7

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	TN (mg N/L)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	TPN (mg N/L)	pH	TP (mg P/L)	TSS (mg/L)	Spec. Cond (umhos/cm)	Temp. (°C)
05-OYS	10/16/2013	6.50	6.07	57.4	0.424	0.045	0.423	0.129	0.249	0.059	6.54	0.029	2.09	247	13.0
05-OYS	11/20/2013	5.09	13.20	104.3	0.762	0.009	0.416	0.170	0.237	0.061	7.50	0.046	1.88	201	5.4
05-OYS	12/18/2013*	5.64	11.85	83.5	0.623	0.032	0.545	0.359	0.154	0.040	5.50	0.009	5.91	548	1.0
05-OYS	12/18/2013	5.78	11.97	84.2	0.558	0.029	0.533	0.352	0.153	0.045	5.49	0.009	6.19	546	0.9
05-SFR	03/28/2013	4.62	12.20	98.8	0.431	0.052	0.330	0.171	0.107	0.041	6.17	0.070	<1.00	101	3.3
05-SFR	04/24/2013	4.79	9.18	85.1	0.437	0.058	0.322	0.117	0.147	0.056	6.45	0.031	3.81	85	12.0
05-SFR	05/22/2013	4.24	7.94	82.5	0.785	0.158	0.397	0.120	0.119	0.094	6.67	0.031	4.09	124	17.1
05-SFR	06/19/2013	6.88	7.01	78.8	0.537	0.048	0.369	0.126	0.195	0.064	7.12	0.034	3.64	97	21.1
05-SFR	07/17/2013	8.05	6.11	76.0	0.559	0.009	0.415	0.183	0.223	0.076	6.94	0.029	2.38	94	26.5
05-SFR	08/21/2013	5.72	6.94	83.7	0.496	<0.005	0.347	0.152	0.195	0.098	7.29	<0.007	7.14	126	25.0
05-SFR	09/18/2013	11.67	5.52	62.6	0.560	0.023	0.470	0.126	0.320	0.073	6.29	0.012	6.19	84	21.2
05-SFR	10/16/2013*	5.76	7.22	69.3	0.539	0.017	0.356	0.143	0.197	0.051	6.16	0.050	2.96	121	13.8
05-SFR	10/16/2013	5.36	7.26	70.2	0.410	0.014	0.333	0.110	0.208	0.041	6.15	0.068	2.00	122	13.9
05-SFR	11/20/2013	4.17	13.65	104.2	0.500	0.106	0.415	0.150	0.159	0.048	6.40	0.024	3.57	94	4.1
05-SFR	12/18/2013	4.40	17.02	116.1	0.420	0.044	0.335	0.186	0.105	0.049	6.54	0.008	5.45	110	0.1
07-CCH	03/28/2013	4.04	13.70	129.7	0.809	0.028	0.775	0.621	0.125	0.042	6.69	0.049	<1.00	159	4.5
07-CCH	04/24/2013	4.38	10.01	92.5	0.923	0.037	0.802	0.651	0.114	0.053	6.64	0.067	5.22	137	11.8
07-CCH	05/22/2013	4.74	7.94	79.8	1.950	0.065	1.503	1.330	0.108	0.082	6.69	0.071	10.00	226	15.6
07-CCH	06/19/2013	6.11	7.40	81.2	0.937	0.039	0.810	0.543	0.229	0.059	6.88	0.044	2.50	133	19.9
07-CCH	07/17/2013	7.14	5.90	75.2	1.088	0.017	0.888	0.640	0.231	0.047	7.02	0.052	1.58	142	27.8
07-CCH	08/21/2013*	4.47	7.40	91.1	1.095	<0.005	1.051	0.820	0.227	0.064	7.55	0.059	1.63	224	26.2
07-CCH	08/21/2013	4.73	7.47	91.5	1.182	<0.005	1.045	0.814	0.228	0.063	7.47	0.058	1.36	225	26.1
07-CCH	09/18/2013	8.62	5.56	58.4	0.762	0.026	0.622	0.335	0.261	0.050	6.42	0.076	2.86	135	18.6
07-CCH	10/16/2013	4.78	7.82	75.1	1.463	0.011	1.318	1.301	0.006	0.047	6.70	0.162	3.79	269	13.6
07-CCH	11/20/2013	3.02	14.78	110.0	1.026	0.007	0.970	0.852	0.111	0.030	6.54	0.104	2.22	149	3.1
09-EXT	03/28/2013	5.64	11.84	92.5	0.385	0.010	0.300	0.131	0.159	0.033	6.48	0.009	1.25	158	4.9
09-EXT	04/24/2013	6.57	9.44	84.2	0.375	0.020	0.316	0.067	0.229	0.042	6.59	<0.007	2.08	154	10.3

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	TN (mg N/L)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	TPN (mg N/L)	pH	TP (mg P/L)	TSS (mg/L)	Spec. Cond (umhos/cm)	Temp. (°C)
09-EXT	05/22/2013*	7.30	7.10	73.1	0.523	0.035	0.469	0.127	0.306	0.094	6.64	0.033	8.00	206	16.8
09-EXT	05/22/2013	7.34	7.11	73.3	0.505	0.040	0.427	0.118	0.270	0.087	6.61	0.037	7.64	206	16.9
09-EXT	06/19/2013	9.72	6.44	70.2	0.558	0.040	0.426	0.084	0.301	0.037	6.68	0.029	1.60	147	19.6
09-EXT	07/17/2013	9.62	4.74	58.9	0.535	0.036	0.466	0.124	0.306	0.029	6.92	0.024	1.89	163	26.3
09-EXT	08/21/2013	9.09	6.53	75.8	0.503	<0.005	0.380	0.161	0.215	0.065	7.01	0.012	<1.00	174	22.9
09-EXT	09/18/2013	10.65	4.87	50.7	0.608	0.015	0.398	0.071	0.312	0.035	6.15	0.028	2.57	137	16.8
09-EXT	10/16/2013	8.74	5.73	55.8	0.772	0.020	0.417	0.107	0.291	0.055	6.32	0.028	3.28	186	14.1
09-EXT	11/20/2013	5.24	12.36	95.5	0.454	0.018	0.364	0.153	0.192	0.055	6.14	0.012	3.23	185	4.6
09-EXT	12/18/2013	7.15	16.74	114.7	0.563	0.058	0.486	0.179	0.249	0.069	6.85	0.010	7.73	216	0.1

* Field duplicate sample

Figure 1: Sampling locations in the Great Bay Estuary, Coastal Basin

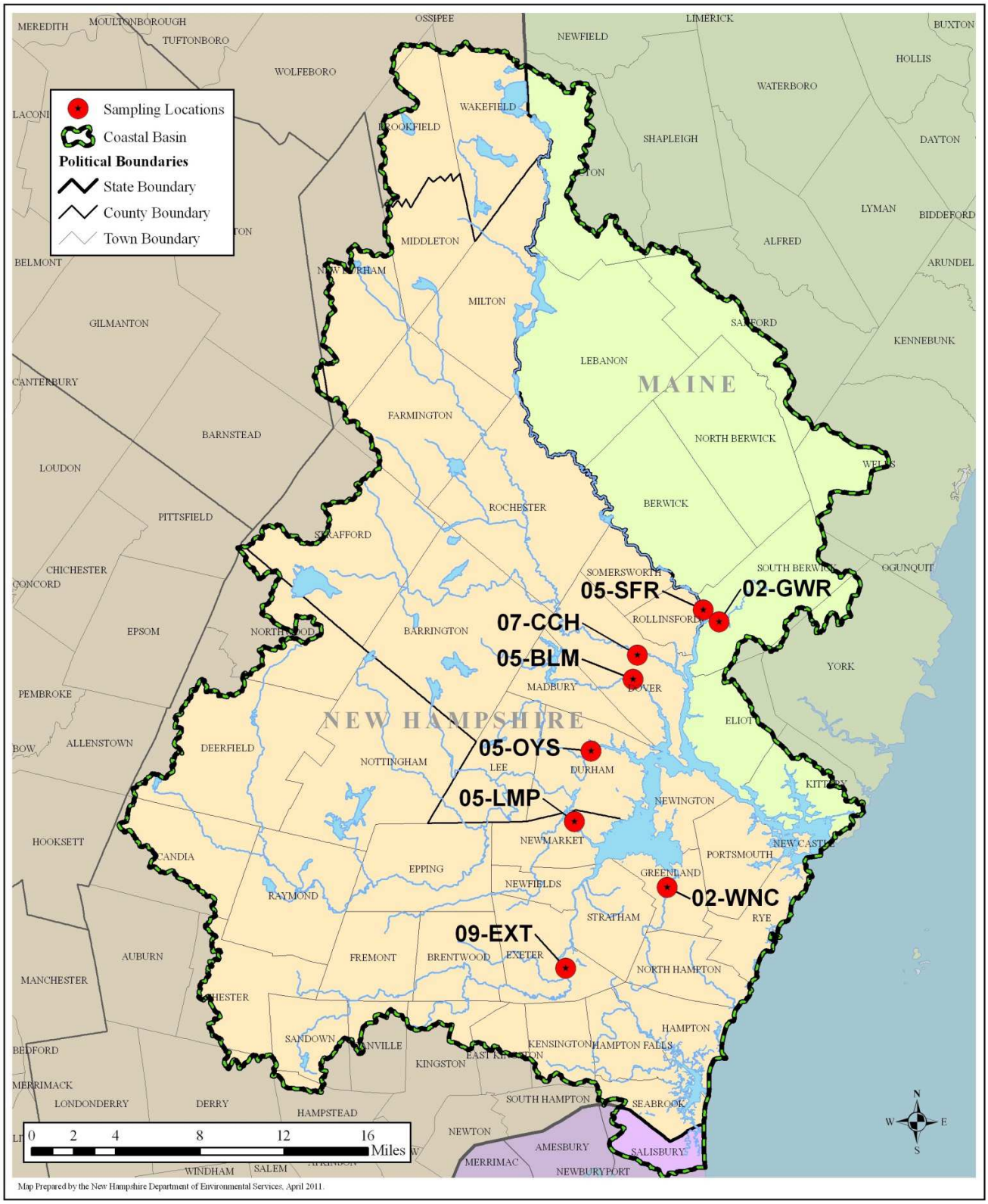

Figure 2: Total Nitrogen Concentrations (in mg N/L) at Tributary Stations

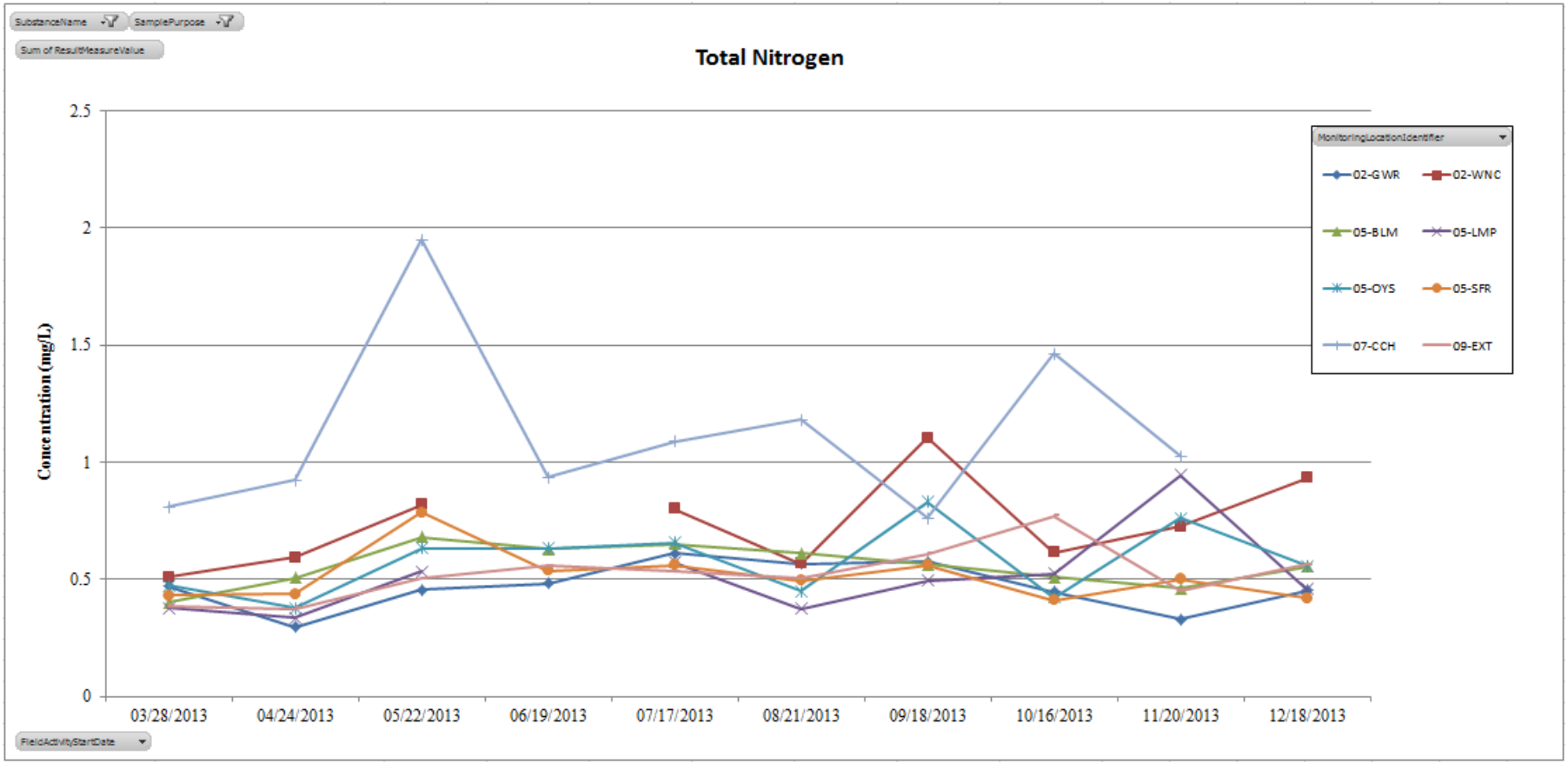

Figure 3: Total Phosphorus in Concentrations (mg P/L) at Tributary Stations

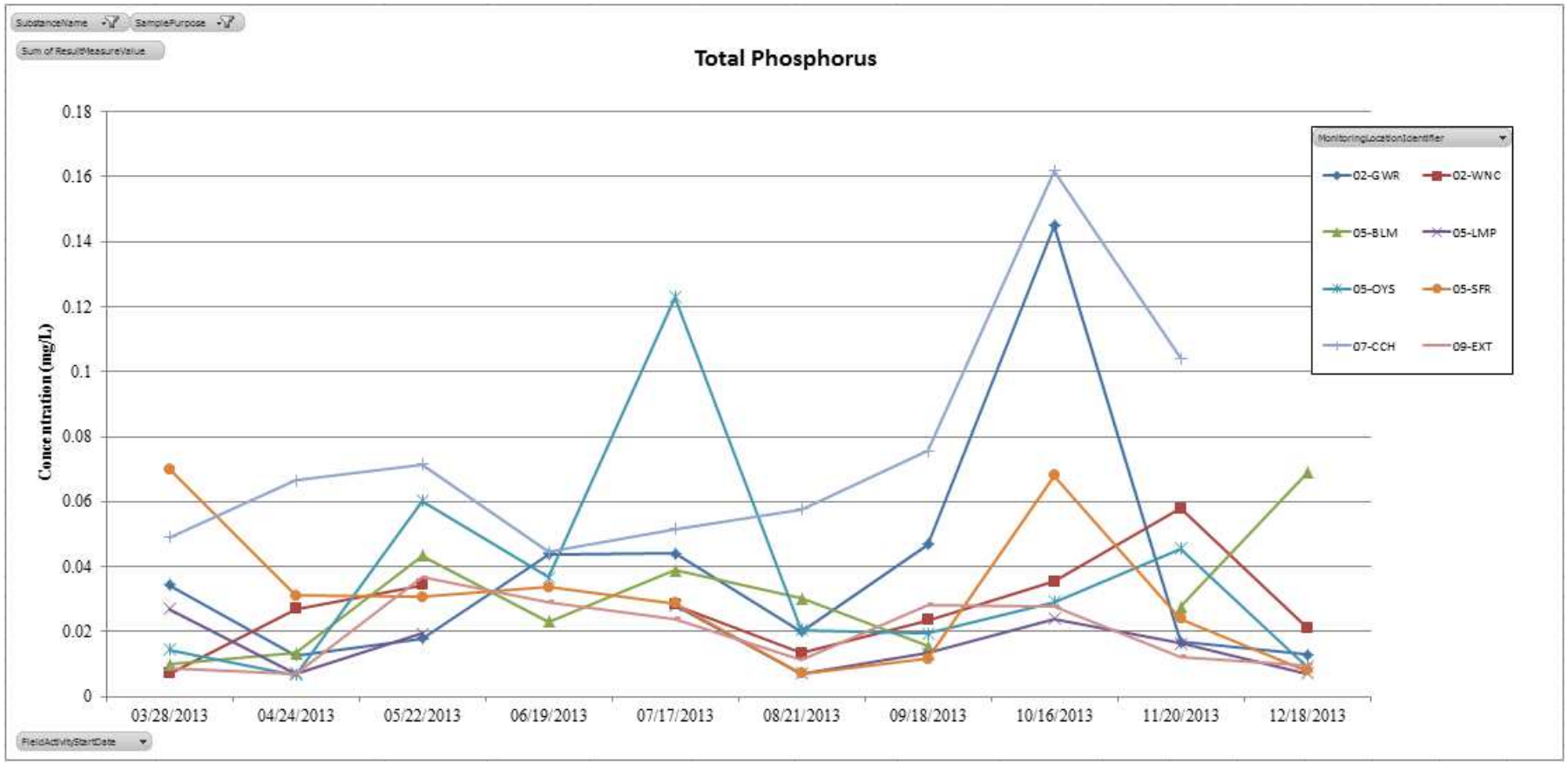

Figure 4: Total Dissolved Nitrogen Concentrations (in mg N/L) at Tributary Stations

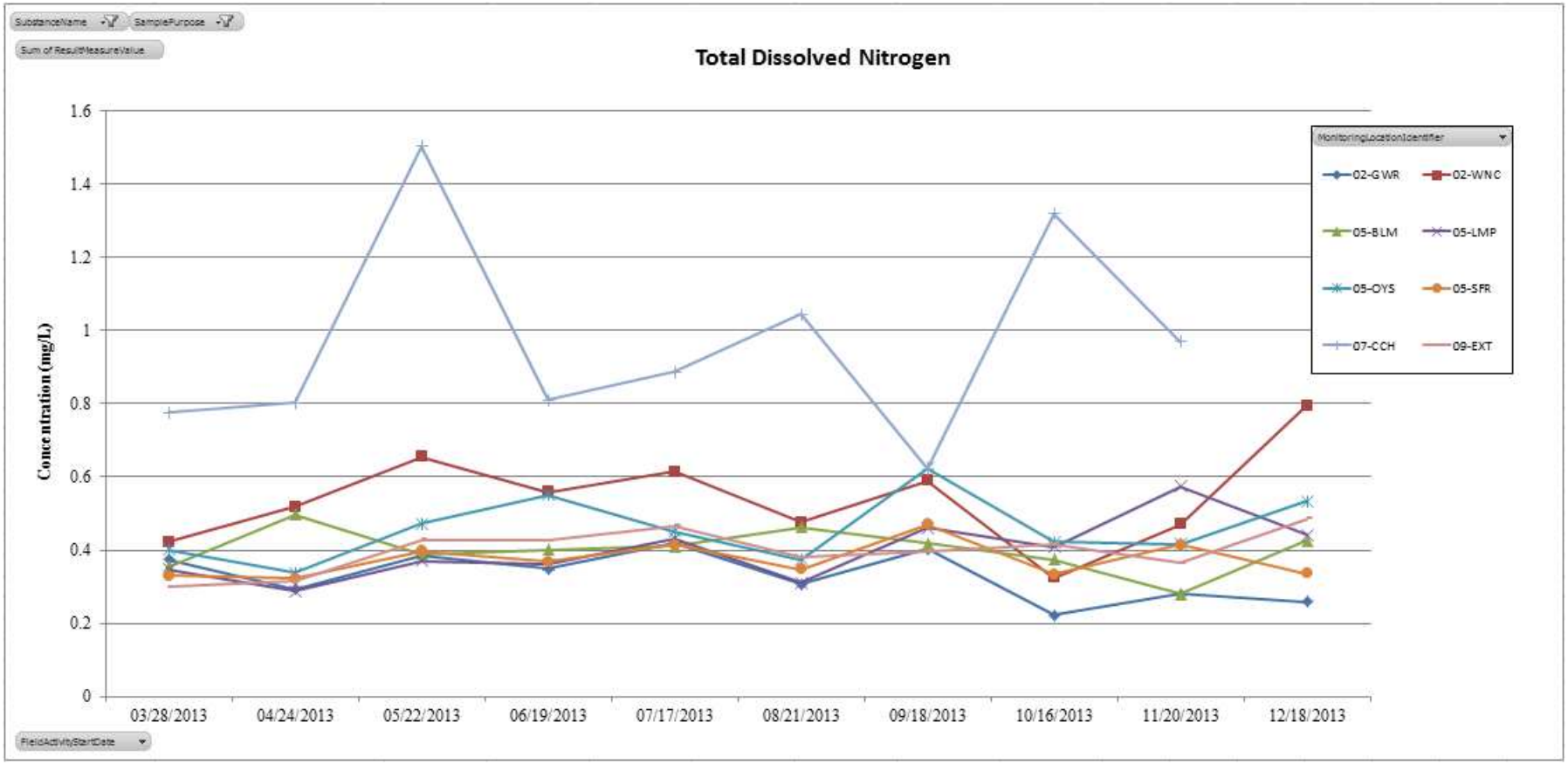

Figure 5: Total Suspended Solids Concentrations (in mg/L) at Tributary Stations

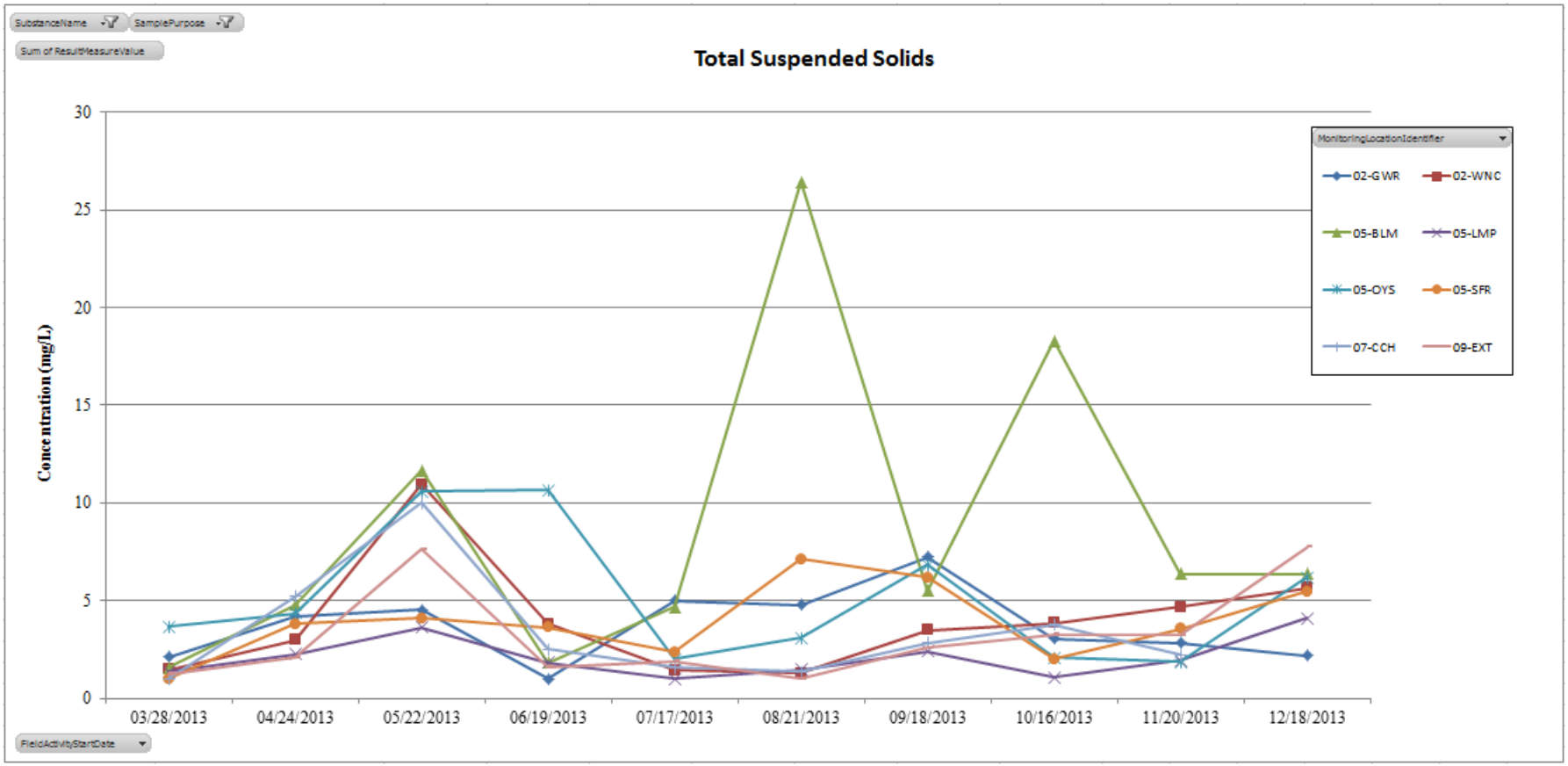

Figure 6: Nitrate/Nitrite Concentrations (in mg N/L) at Tributary Stations

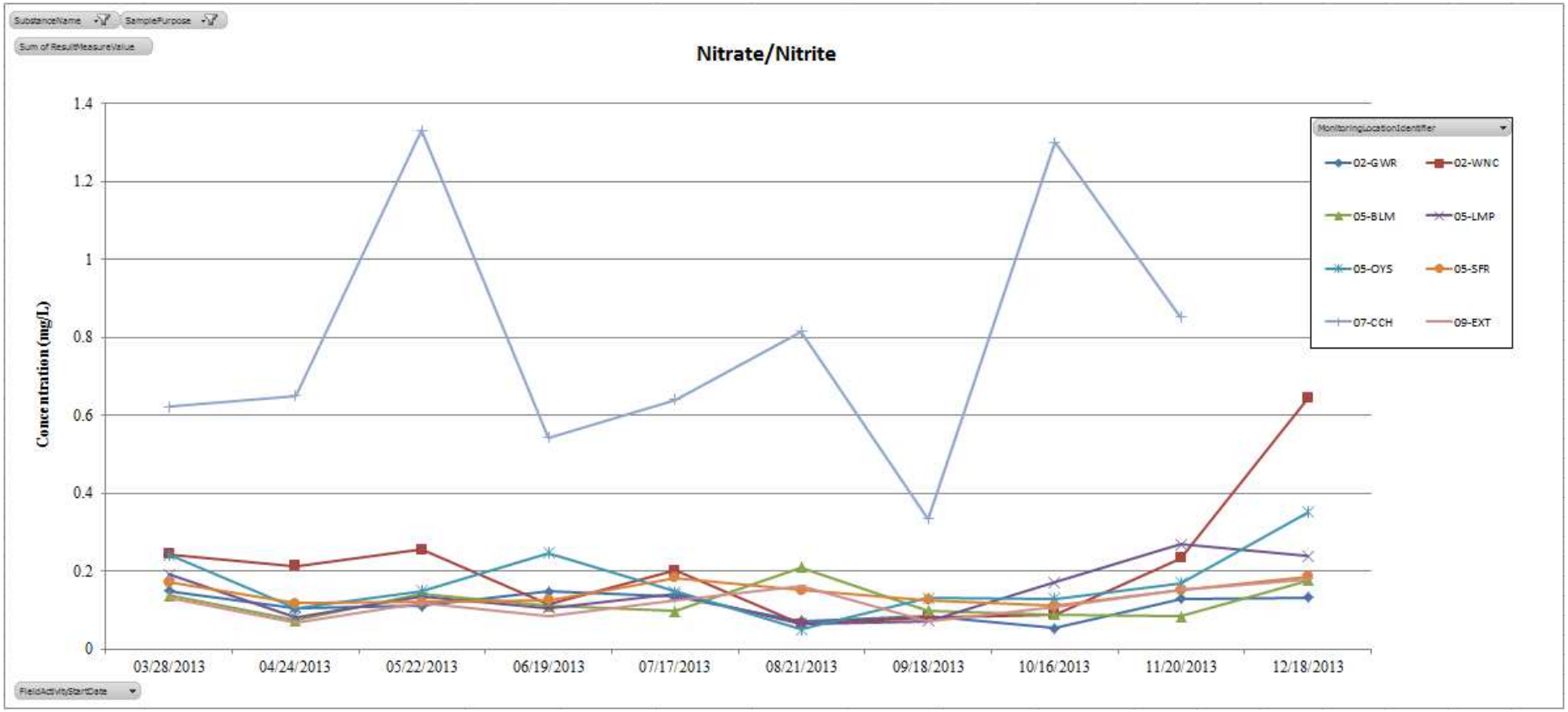

Figure 7: Ammonia Concentrations (in mg N/L) at Tributary Stations

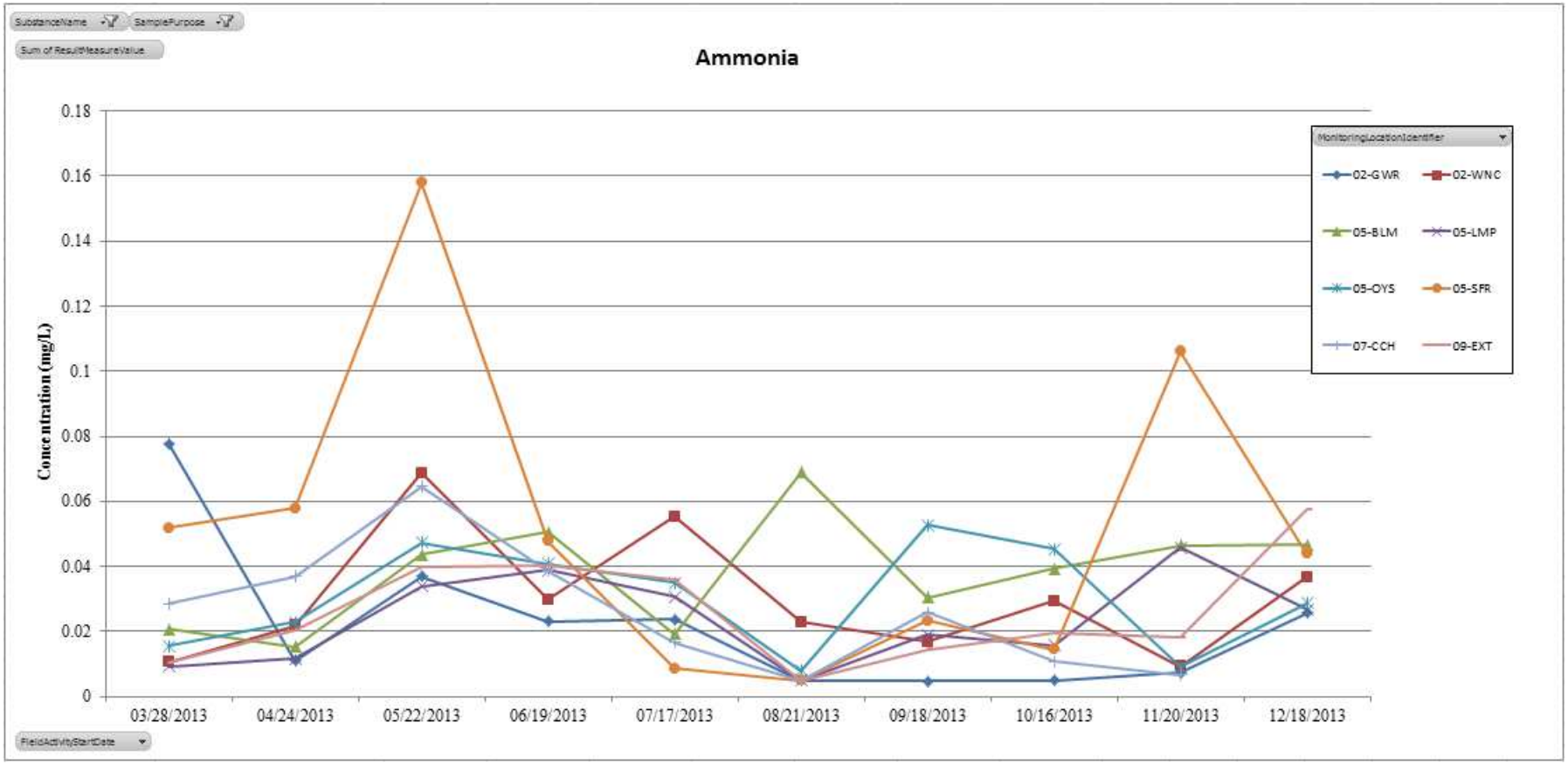

Figure 8: Dissolved Organic Nitrogen Concentrations (in mg N/L) at Tributary Stations

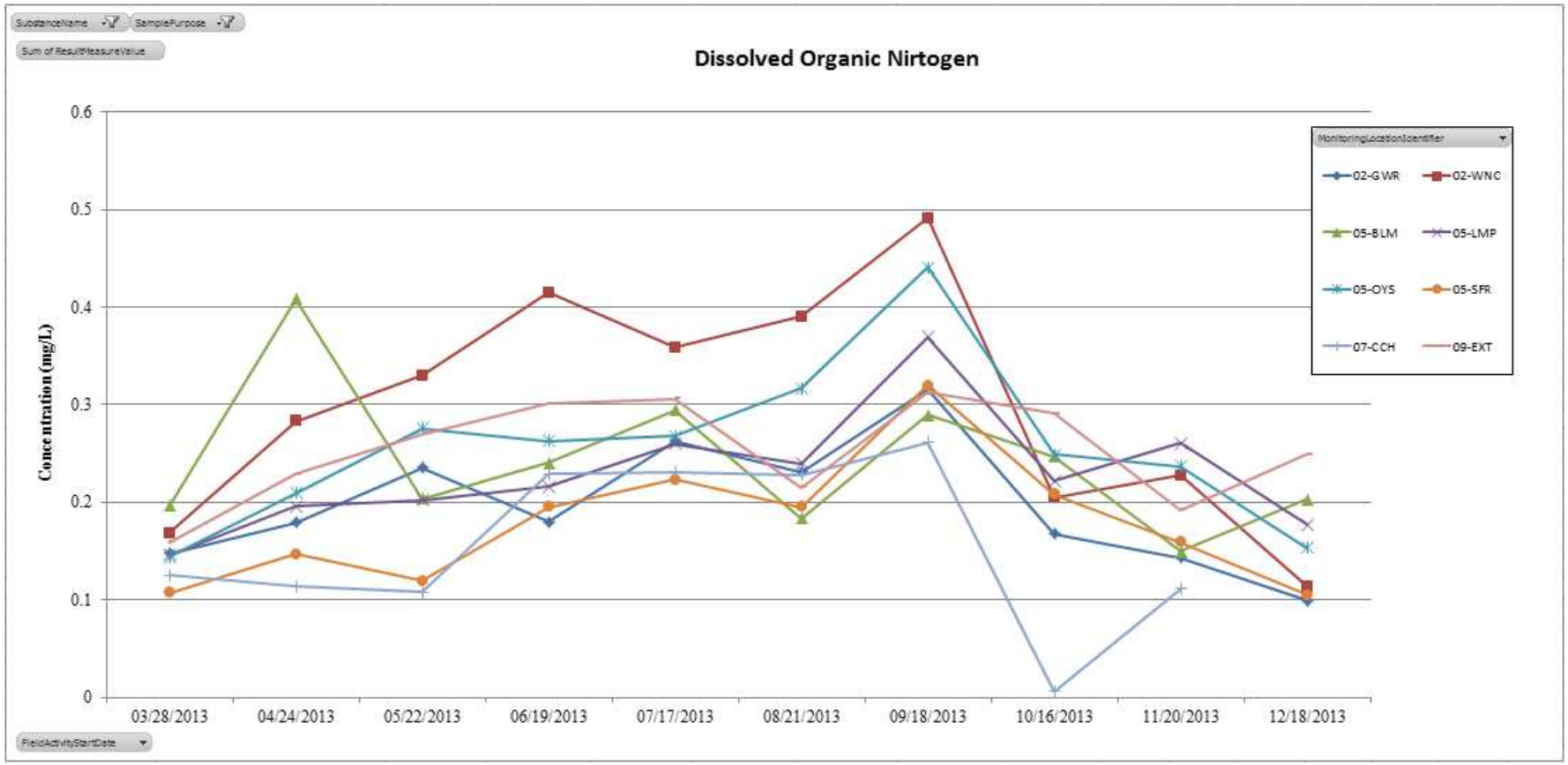

Figure 9: Dissolved Organic Carbon Concentrations (in mg C/L) at Tributary Stations

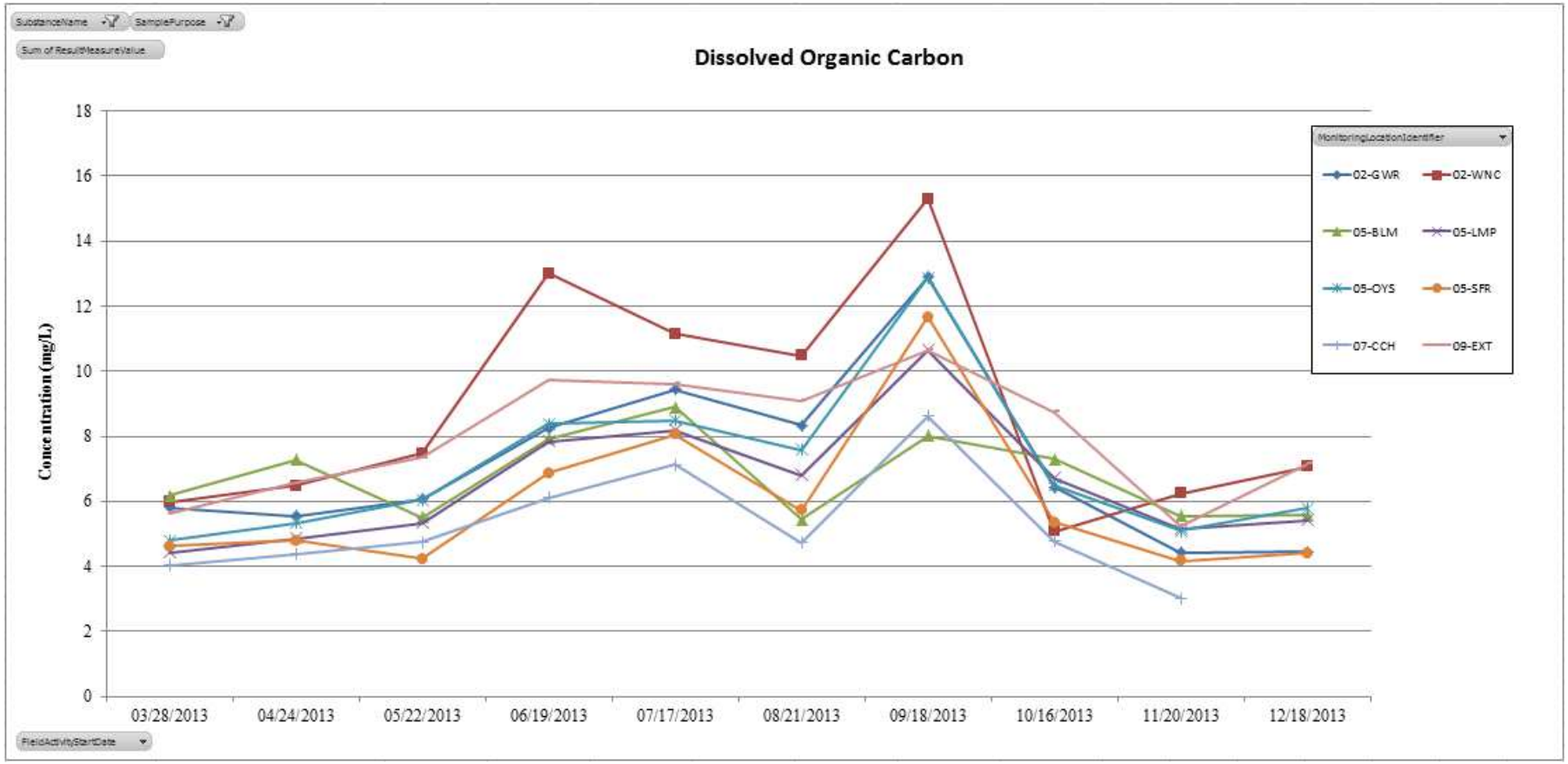

Figure 10: Total Suspended Nitrogen Concentrations (in mg N/L) at Tributary Stations