



University of New Hampshire
University of New Hampshire Scholars'
Repository

PREP Reports & Publications

Institute for the Study of Earth, Oceans, and Space
(EOS)

6-14-2019

Nitrogen, Phosphorus, and Suspended Solids Concentrations in Tributaries to the Great Bay Estuary Watershed in 2017

Kalle Matso

University of New Hampshire

Follow this and additional works at: <https://scholars.unh.edu/prep>

Recommended Citation

Matso, Kalle, "Nitrogen, Phosphorus, and Suspended Solids Concentrations in Tributaries to the Great Bay Estuary Watershed in 2017" (2019). *PREP Reports & Publications*. 428.

<https://scholars.unh.edu/prep/428>

This Report is brought to you for free and open access by the Institute for the Study of Earth, Oceans, and Space (EOS) at University of New Hampshire Scholars' Repository. It has been accepted for inclusion in PREP Reports & Publications by an authorized administrator of University of New Hampshire Scholars' Repository. For more information, please contact nicole.hentz@unh.edu.

Nitrogen, Phosphorus, and Suspended Solids Concentrations in Tributaries to the Great Bay Estuary Watershed in 2017

Final Report

Submitted by

Kalle Matso
Piscataqua Region Estuaries Partnership
Durham, NH

January 2019

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 constant 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 solids concentrations in tributaries to the Great Bay Estuary in 2017. The study design followed the tributary sampling design, which was implemented by the New Hampshire Department of Environmental Services (NHDES) between 2001 and 2007 and sustained by the University of New Hampshire (UNH) from 2008 to the present, so as to provide comparable data to the previous loading estimates. The purpose of this memorandum is to document the results of quality assurance checks on the 2017 water quality data collected by UNH for the Great Bay Estuary Tidal Tributary Monitoring Program, so that PREP can calculate the nitrogen load from tributaries to the Great Bay Estuary. This program was previously established in the NHDES Environmental Monitoring Database with a project identifier of “GBETTMP.” PREP reviewed these data to ensure that they met data quality objectives for PREP and for Section 305b water quality assessments.

Methods

Sampling and Analytical Methods

The field sampling and laboratory analysis methods have been documented in the approved Quality Assurance Project Plan or QAPP (PREP, 2013): <https://scholars.unh.edu/qapp/1/>.

UNH researchers collected grab samples from the head-of-tide stations in the freshwater portion of eight tributaries to the Great Bay Estuary (Figure 1 & Table 11) on a monthly frequency from March to December. The samples were analyzed for total dissolved nitrogen (TDN), total phosphorus (TP), orthophosphate (PO₄), total suspended solids (TSS), ammonium (NH₄), nitrate/nitrite (NO₃/NO₂), total suspended nitrogen (PN), dissolved organic nitrogen (DON), 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 UNH used USGS Method I-4650-03 (alkaline persulfate digestion) to determine TP and high temperature catalytic oxidation (Merriam et al., 1996) to determine the TDN concentrations in samples. TSS concentrations were calculated using APHA method 2540-D. NO₃/NO₂ concentration was determined using EPA method 353.2 and NH₄ using EPA method 350.1. PN was determined using EPA method 440.0. DOC was determined using EPA method 415.1. PO₄ was measured using EPA method 365.1. DON was calculated by subtracting NO₃/NO₂ and NH₄ from TDN.

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

Physicochemical parameters (water temperature, specific conductance, dissolved oxygen, and pH) were measured in the field using a YSI 556 multi-parameter instrument. A total of ten field

duplicate readings were collected for each parameter (one station per sampling date) for quality assurance.

Quality Assurance Audit

UNH provided the field and laboratory data to PREP to be quality assured; the data was then sent to NHDES to be added to the Environmental Monitoring Database:

<https://www.des.nh.gov/organization/divisions/water/wmb/emd/index.htm>

Field sampling proceeded as planned.

- 84 of the 90 planned samples were collected for laboratory analysis (93%). Five samples were not collected due to high quantities of ice. In addition, there was one incomplete sample (TSS was not taken) due to a broken sampling bottle. This meets the data quality objective for completeness (80% of planned samples).

The results of quality control samples for TDN, TP, TSS, PN, NO₃/NO₂, NH₄, DOC, PO₄, and DON have been summarized in Tables 1 through 9. 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

Below, relative percent difference (RPD) is calculated as:

$$RPD = \frac{|x_1 - x_2|}{\left(\frac{x_1 + x_2}{2}\right)} \times 100\%$$

- Total Dissolved Nitrogen: All data quality objectives met.
- Phosphorus: All data quality objectives met.
- Suspended Solids: One of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). The duplicate pair collected in the Lamprey River (station 05-LMP) on 11/30/2017 had an RPD value of 33% (1.84 and 2.56 mg N/L). Because these concentrations are low, and the RPD was only slightly over the threshold, these data were considered acceptable.
- Total Suspended Nitrogen: Three of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). The duplicate pair collected in the Cocheco River (station 07-CCH) on 10/25/2017 had an RPD value of 56% (0.1 and 0.06 mg N/L). These data were invalidated. The duplicate pair collected in the Lamprey River (station 05-LMP) on 11/30/2017 had an RPD value of 46% (0.04 and 0.03 mg N/L); and the duplicate pair collected in the Exeter River (station 09-EXT) on 12/20/2017 had an RPD value of 40% (0.04 and 0.03 mg N/L). Because these data represent very low concentrations (less than 0.05 mg N/L), these data were considered acceptable.
- Ammonium: All data quality objectives met.
- Dissolved Organic Carbon: All data quality objectives met.
- Orthophosphate: Two of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). The duplicate pair collected in the Bellamy River (station 05-

BLM) on 7/26/2017 had an RPD value of 57% (0.004 and 0.002 mg P/L). Because these data represent very low concentrations (less than 0.05 mg N/L), these data were considered acceptable. The duplicate pair collected in the Salmon Falls River (station 05-SFR) on 9/27/2017 had an RPD value of 49% (0.014 and 0.009 mg P/L). These data were invalidated.

- Dissolved Organic Nitrogen: All data quality objectives met.
- Water Temperature: All data quality objectives met.

Laboratory Quality Control Samples

The results of laboratory QC tests are shown on Tables 1 through 9. All of the instances where QC results did not meet data quality objectives were for low concentrations (<10x minimum detection limit (MDL)) or below the MDL, 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 85 results for TN and TDN, there were no results that had higher TDN values than TN.
- TDN vs. NO₃/NO₂ + NH₄: TDN should be greater than or equal to the sum of NO₃/NO₂ and NH₄. Out of 84 samples for NO₃/NO₂ + NH₄ and TDN, there were no results that had higher NO₃/NO₂ + NH₄ than TDN.
- TP vs. PO₄: TP should be greater than or equal to PO₄. Out of 85 samples for TP and PO₄, there were no results that had higher PO₄ than TP.

Results Below Reporting Limits:

Reporting Limits (RLs) have been established by NH DES. Values lower than the RL are shown as “<[RL]” in Table 10. For example, if the RDL is 0.1 and the returned value was 0.05, the value in Table 10 will show “<0.1.” The RLs for the parameters are as follows: TDN = 0.1 mg N/L; TP = 0.007 mg P/L; TSS = 1.00 mg/L; PN (Total Suspended Nitrogen) = 0.025 mg N/L; NO₃/NO₂ = 0.005 mg N/L; NH₄ = 0.005 mg N/L; DOC = 0.05 mg C/L; PO₄ = 0.05 mg P/L; DON = 0.09 mg N/L.

Twenty-one results (1 for TP; 3 for TSS; 3 for NH₄; 9 for PO₄; 3 for PN and 2 for DON) were flagged (i.e., censored) as being below the RL. These results are noted in Table 10. While results below the RL are not necessarily invalid, they are regarded as less accurate than results at or above the RL.

Consistency/Comparability:

The ranges of concentrations measured in 2017 were consistent with previous sampling efforts at these sites. For most of the parameters, the ranges were narrower than the ranges seen in 2016. Time series plots of the data at different stations were used to identify any unusual results.

Results and Discussion

The quality assured results for TP, TDN, TSS, NO₃/NO₂, NH₄, PN, PO₄, DON, and DOC concentrations, as well as the field parameters for each station visit are shown in Tables 1

through 9. Figures 2 through 10 show the monthly concentrations for each analyte at each station.

The purpose of this memorandum is to document the results of quality assurance checks on the 2017 water quality data collected by UNH, so that PREP can calculate the nitrogen load from tributaries to the Great Bay Estuary. The following are some general observations, which can be made based on the quality assured data:

- The concentrations of TDN across stations and dates ranged from 0.23 to 1.20 mg N/L. The maximum concentrations most often occurred in the Cocheco River (station 07-CCH) and the Winnicut River (station 02-WNC).
- The concentrations of TP across stations and dates ranged from 0.009 to 0.126 mg P/L. In past years, total phosphorus concentrations in the Cocheco River (station 07-CCH) were much higher than in other rivers. This pattern is not as evident in 2017, although station 07-CCH continues to have some of the highest concentrations. In 2017, the Great Works River (station 02-GWR) and the Oyster River (station 05-OYS) also had high concentrations at different times in the year.
- The TSS concentrations ranged from 1.00 to 15.24 mg/L. The highest concentrations were in the Bellamy River (station 05-BLM).
- The concentrations of PN across stations and dates ranged from 0.02 to 0.16 mg N/L. The maximum concentrations occurred in the Great Works River (station 02-GWR), the Oyster River (station 05-OYS), and the Bellamy River (station 05-BLM).
- The concentrations of NO₃/NO₂ across stations and dates ranged from 0.040 to 1.042 mg N/L. Concentrations in the Cocheco River (station 07-CCH) were notably higher than other stations, except in early spring and late fall.
- The concentrations of NH₄ across stations and dates ranged from <0.009 to 0.084 mg N/L. The Salmon Falls River (station 05-SFR) and the Winnicut River (station 02-WNC) had the highest concentrations.
- The concentrations of DOC across stations and dates ranged from 3.22 to 15.14 mg C/L. The maximum concentrations occurred in the Winnicut River (station 02-WNC) and the Exeter River (station 09-EXT).
- The average concentrations of PO₄ across stations and dates ranged from <0.001 to 0.074 mg P/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH).
- The concentrations of DON across stations and dates ranged from <0.1 to 0.49 mg N/L. The maximum concentrations occurred in the Winnicut River (station 02-WNC) and the Exeter River (station 09-EXT).

Summary

The 2017 water quality data for the GBETTMP project was checked by PREP for potential errors. All quality control steps and changes to the dataset have been documented in this memo.

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 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 / 1 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	8 Lab Duplicates / 1 Failed DQO The failure was for a sample with a low concentration (<10xMDL).
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	13 CRM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TDN concentrations in 2017 (0.23 – 1.20 mg N/L) was similar to the range from 2008-2015 (0.17 – 2.92 mg N/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	75 routine samples and 10 field duplicates were collected (94% of planned samples)

Table 2: 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	10 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	11 Lab Duplicates / 2 Failed DQO The failures were for samples with low concentrations (<10x MDL).
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	21 CRM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TP concentrations in 2017 (0.009 – 0.126 mg P/L) was similar to the range from 2001-2015 (0.003 – 0.162 mg P/L).
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration at or above the MDL was 0.005 mg P/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	75 routine samples and 10 field duplicates were collected (94% of planned samples)

Table 3: Summary of Quality Control Samples for Total 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
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 2017 (1.00-15.24 mg/L) was similar to the range from 2001-2015 (1-57 mg/L)
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	74 routine samples and 10 field duplicates were collected (93% of planned samples)

Table 4: Summary of Quality Control Samples for Total Suspended 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 Dupes / 4 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	NO DATA
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	18 CRM tests / 0 Failed DQO NO DATA for LFM tests
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of total suspended nitrogen in 2017 (0.02 - 0.16 mg N/L) was similar to the range from 2001-2015 (0.03 - 0.33 mg N/L)
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	74 routine samples and 10 field duplicates were collected (93% 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 / 1 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	5 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	14 CRM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of nitrate/nitrite concentrations in 2017 (0.040 – 1.042 mg N/L) was similar to the range from 2009-2015 (0.005 – 2.52 mg N/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	75 routine samples and 10 field duplicates were collected (94% of planned samples)

Table 6: Summary of Quality Control Samples for Ammonium.

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
Precision-Lab	RPD < 15%	Lab Duplicates	17 Lab Duplicates / 2 Failed DQO The failures were for samples with low concentrations (<10x MDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	28 CRM tests / 0 Failed DQO 5 LFM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of NH ₄ concentrations in 2017 (0.009 – 0.084 mg N/L) was similar to the range for 2009-2015 (0.005 – 0.158 mg N/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	75 routine samples and 10 field duplicates were collected (94% 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	8 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	13 CRM tests / 0 Failed DQO 9 LFM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of dissolved organic carbon in 2017 (3.22-15.14 mg C/L) was similar to the range for 2011-2015 (2.27-15.3 mg C/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	75 routine samples and 10 field duplicates were collected (94% of planned samples)

Table 8: Summary of Quality Control Samples for Orthophosphate.

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 Dupes / 1 Failed DQO
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 orthophosphate in 2017 (<0.001 – 0.074 mg P/L) was similar to the range for 2011-2015 (<0.005 – 0.340 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	75 routine samples and 10 field duplicates were collected (94% of planned samples)

Table 9: Summary of Quality Control Samples for Dissolved Organic 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 Dupes / 2 Failed DQO
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 dissolved organic nitrogen in 2017 (0.04 – 0.49 mg N/L) was similar to the range for 2010-2015 (<0.09 – 0.52 mg N/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	75 routine samples and 10 field duplicates were collected (94% of planned samples)

Table 10: Validated Laboratory Results and Field Data at Tributary Stations

Station Id	Collection Date	TDN (mg N/L)	NH4 (mg N/L)	NO3+NO2 (mg N/L)	DON (mg N/L)	DIN (mg N/L)	PN (mg N/L)	TSS (mg/L)	TP mg P/L	PO4 (mg P/L)	DOC (mg C/L)	pH	Spec_Cond (uS/cm)	DO (mg/L)	DO%	Temp. (°C)
02-GWR	22-Mar-17	Could not obtain sample due to ice														
02-GWR	26-Apr-17	0.287	0.009	0.059	0.220	0.068	0.166	6.82	0.030	0.005	6.669	6.6	114	9.44	85	10.8
02-GWR	24-May-17	0.327	0.018	0.063	0.246	0.081	0.073	2.63	0.071	0.005	7.719	6.5	131	7.62	77	16.3
02-GWR	28-Jun-17	0.450	0.049	0.141	0.260	0.190	0.056	2.22	0.043	0.012	6.677	6.7	159.4	5.93	68	22.1
02-GWR	26-Jul-17	0.361	0.046	0.118	0.197	0.164	0.061	3.75	0.039	0.007	4.853	6.7	170.4	5.34	60.7	21.6
02-GWR	23-Aug-17	0.390	0.018	0.102	0.270	0.120	0.052	3.24	0.046	0.015	5.421	6.8	150.7	6.91	80.4	22.9
02-GWR	23-Aug-17	0.383	0.021	0.116	0.246	0.137	0.057	4.12	0.043	0.015	5.562	6.7	151.5	6.81	78.8	22.7
02-GWR	25-Oct-17	0.234	0.007	0.064	0.163	0.071	0.052	3.85	0.116	0.015	4.810	6.8	167.4	8.03	78.5	14.4
02-GWR	27-Sep-17	0.255	0.006	0.060	0.189	0.066	0.100	<I	0.051	0.007	5.572	6.8	169.4	7.54	89.1	23.6
02-GWR	30-Nov-17	0.357	0.012	0.234	0.111	0.246	0.032	3.06	0.059	0.007	8.092	6.5	149.2	11.47	86.9	3.7
02-GWR	20-Dec-17	Could not obtain sample due to ice														
02-WNC	22-Mar-17	0.632	0.010	0.438	0.184	0.448	0.034	2.93	0.010	<0.005	4.485	6.4	381	14.19	99.8	1.0
02-WNC	26-Apr-17	0.510	0.013	0.152	0.344	0.165	0.058	6.36	0.054	0.011	8.984	6.6	248	9.63	83.5	9.1
02-WNC	24-May-17	0.584	0.033	0.176	0.375	0.209	0.053	4.48	0.049	0.014	10.062	7.1	361	7.86	79	15.6
02-WNC	24-May-17	0.591	0.035	0.173	0.383	0.208	0.054	3.97	0.040	0.014	9.927	6.9	361	7.8	78.7	15.8
02-WNC	28-Jun-17	0.759	0.068	0.326	0.365	0.394	0.058	3.13	0.043	0.024	9.454	7.2	422.9	6.63	71.6	19.2
02-WNC	26-Jul-17	0.705	0.033	0.289	0.382	0.322	0.046	2.67	0.038	0.021	8.381	7.2	437.3	7.64	80.2	17.6
02-WNC	23-Aug-17	0.581	0.060	0.270	0.250	0.331	0.059	3.06	0.036	0.026	7.120	7.1	452.3	5.65	64.6	22.0
02-WNC	25-Oct-17	0.494	0.026	0.222	0.245	0.248	0.071	4.64	0.092	0.014	7.246	7.0	489.5	7.45	74.5	15.5
02-WNC	27-Sep-17	0.568	0.084	0.278	0.205	0.362	0.078	<I	0.033	0.019	7.210	7.0	487.2	5.26	58.9	20.9
02-WNC	30-Nov-17	0.596	0.017	0.352	0.227	0.369	<0.025	1.00	0.047	0.010	7.639	7.0	455.1	11.88	89.3	3.3
02-WNC	20-Dec-17	1.087	0.028	0.575	0.484	0.603	Broken Bottle		0.064	0.006	15.138	6.8	514	10.65	79.4	3.0
05-BLM	22-Mar-17	0.338	0.010	0.154	0.173	0.164	0.035	1.89	0.031	<0.005	5.147	7.1	208	13.29	99.4	3.2
05-BLM	26-Apr-17	0.366	0.012	0.040	0.314	0.052	0.077	3.50	0.052	0.009	6.986	6.8	160	9.8	87.7	10.4
05-BLM	24-May-17	0.364	0.023	0.050	0.291	0.073	0.070	3.81	0.054	0.012	8.692	6.8	157	8.07	86.9	19.0
05-BLM	28-Jun-17	0.521	0.056	0.212	0.253	0.268	0.066	6.00	0.024	0.013	6.832	7.3	250.5	9.23	106.1	22.2

Station Id	Collection Date	TDN (mg N/L)	NH4 (mg N/L)	NO3+NO2 (mg N/L)	DON (mg N/L)	DIN (mg N/L)	PN (mg N/L)	TSS (mg/L)	TP mg P/L	PO4 (mg P/L)	DOC (mg C/L)	pH	Spec_Cond (uS/cm)	DO (mg/L)	DO%	Temp. (°C)
05-BLM	26-Jul-17	0.493	0.027	0.172	0.295	0.199	0.075	3.64	0.043	<0.005	6.085	7.1	237	9.11	105.9	22.8
05-BLM	26-Jul-17	0.482	0.027	0.182	0.273	0.209	0.080	3.64	0.036	0.002	6.016	7.1	237.1	9.13	106.1	22.7
05-BLM	23-Aug-17	0.421	0.006	0.135	0.280	0.141	0.092	7.06	0.050	0.016	7.609	6.9	200.1	7.89	93.4	23.8
05-BLM	25-Oct-17	0.418	0.019	0.192	0.207	0.211	0.164	15.24	0.073	0.024	6.471	6.8	290.3	7.89	81.2	16.8
05-BLM	27-Sep-17	0.414	0.040	0.175	0.198	0.215	0.040	2.11	0.026	0.011	5.334	7.2	312.7	8.86	106.3	24.4
05-BLM	30-Nov-17	0.455	0.031	0.245	0.179	0.276	0.051	1.92	0.023	0.008	7.735	6.7	193	12.26	93.1	3.7
05-BLM	20-Dec-17	Could not obtain sample due to ice														
05-LMP	22-Mar-17	0.366	0.041	0.191	0.134	0.232	0.030	2.00	0.029	0.014	3.873	6.9	172	15.06	104.4	0.5
05-LMP	22-Mar-17	0.357	0.038	0.210	0.109	0.248	0.030	1.94	0.022	0.013	3.911	6.9	172	15.06	104.1	0.4
05-LMP	26-Apr-17	0.300	0.008	0.059	0.233	0.067	0.043	1.67	0.024	<0.005	5.840	6.8	145	9.38	86	11.4
05-LMP	24-May-17	0.346	0.028	0.079	0.239	0.107	0.075	2.35	0.017	0.006	6.762	6.8	151	7.76	80.9	17.3
05-LMP	28-Jun-17	0.495	0.055	0.168	0.272	0.223	0.044	1.39	0.047	0.010	6.436	6.8	177.1	6.34	73.6	22.8
05-LMP	26-Jul-17	0.450	0.037	0.153	0.261	0.190	0.061	3.20	0.018	0.005	6.301	6.8	170.2	5.76	65.8	21.9
05-LMP	23-Aug-17	0.388	<0.005	0.080	0.305	0.083	0.070	2.81	0.016	0.011	5.893	7.1	217.6	7.67	91.3	24.2
05-LMP	25-Oct-17	0.441	0.016	0.161	0.264	0.177	0.053	2.73	0.049	0.013	5.865	6.8	195.5	8.9	87.9	14.9
05-LMP	27-Sep-17	0.626	0.008	0.218	0.399	0.227	0.073	1.30	0.014	0.009	10.086	7.0	173.7	8.23	95.1	22.6
05-LMP	30-Nov-17	0.396	0.017	0.193	0.185	0.210	<0.025	1.84	0.088	0.007	5.999	6.7	145.3	12.84	98.9	1.9
05-LMP	30-Nov-17	0.409	0.020	0.211	0.178	0.231	0.040	2.56	0.088	0.007	6.092	6.7	139.8	13.45	97	1.9
05-LMP	20-Dec-17	0.710	0.027	0.307	0.376	0.334	0.034	1.00	<0.007	0.005	8.456	6.8	155.7	12.85	96.7	3.4
05-OYS	22-Mar-17	0.407	0.013	0.263	0.131	0.276	0.028	2.50	0.022	0.006	4.146	6.8	269	14.58	103	1.2
05-OYS	26-Apr-17	0.399	0.014	0.096	0.289	0.110	0.067	5.71	0.016	0.007	6.598	7.0	217	10.3	91.9	10.3
05-OYS	24-May-17	0.414	0.034	0.119	0.261	0.153	0.090	5.00	0.054	0.012	7.338	6.9	235	8.2	82.2	15.5
05-OYS	28-Jun-17	0.565	0.065	0.260	0.240	0.325	0.061	2.42	0.045	0.011	6.093	7.0	351.5	5.93	66.1	20.6
05-OYS	26-Jul-17	0.511	0.044	0.185	0.282	0.229	0.078	5.00	0.040	0.022	5.968	6.9	294.1	5.99	64.9	19.2
05-OYS	23-Aug-17	0.571	0.017	0.216	0.337	0.234	0.117	5.42	0.073	0.034	7.540	7.0	268.9	6.93	79.8	22.3
05-OYS	25-Oct-17	0.391	0.014	0.162	0.215	0.176	0.165	6.36	0.096	0.031	11.733	7.1	374	8.61	88.1	16.5
05-OYS	27-Sep-17	0.396	0.011	0.189	0.195	0.201	0.095	1.85	0.032	0.027	6.778	7.0	303.3	7.18	82.3	22.1
05-OYS	30-Nov-17	0.564	0.021	0.416	0.127	0.437	0.039	3.33	0.093	0.011	7.199	6.8	252.5	11.75	87.8	3.6

Station Id	Collection Date	TDN (mg N/L)	NH4 (mg N/L)	NO3+NO2 (mg N/L)	DON (mg N/L)	DIN (mg N/L)	PN (mg N/L)	TSS (mg/L)	TP mg P/L	PO4 (mg P/L)	DOC (mg C/L)	pH	Spec_Cond (uS/cm)	DO (mg/L)	DO%	Temp. (°C)
05-OYS	20-Dec-17	0.775	0.026	0.431	0.318	0.457	0.034	3.00	0.054	0.006	11.524	6.8	280.5	11.16	87.5	4.8
05-OYS	28-Jun-17	0.577	0.062	0.264	0.251	0.326	0.056	2.29	0.038	0.014	6.263	7.0	350.5	6.1	68.1	20.8
05-SFR	22-Mar-17	0.396	0.083	0.166	0.147	0.249	0.030	1.84	0.015	0.014	3.992	7.0	135	14.71	107.1	2.3
05-SFR	26-Apr-17	0.350	0.043	0.098	0.208	0.141	0.049	2.92	0.009	0.007	5.427	6.7	94	10.3	92.8	10.7
05-SFR	24-May-17	0.366	0.037	0.139	0.190	0.176	0.082	3.68	0.021	<0.005	6.000	6.7	119	8.28	86	17.2
05-SFR	28-Jun-17	0.432	0.042	0.182	0.208	0.224	0.095	5.00	0.043	0.010	5.390	7.0	123.2	8.18	96.4	23.6
05-SFR	26-Jul-17	0.565	0.046	0.304	0.215	0.350	0.104	3.33	0.017	<0.005	4.674	7.1	180	7.8	92.8	24.1
05-SFR	23-Aug-17	0.647	0.010	0.376	0.261	0.386	0.113	2.96	0.018	0.017	4.554	7.9	200	9.41	114.2	25.2
05-SFR	25-Oct-17	0.389	0.019	0.199	0.171	0.218	0.043	1.29	0.073	0.021	3.993	6.9	145.5	9.42	94.9	15.7
05-SFR	27-Sep-17	0.573	<0.005	0.488	<0.09	0.493	0.097	1.05	0.017	<u>0.009</u>	4.862	7.1	198.5	8.9	103.3	23.0
05-SFR	27-Sep-17	0.570	<0.005	0.461	0.105	0.465	0.116	1.00	0.016	<u>0.014</u>	4.954	7.1	199	8.9	103.3	22.8
05-SFR	30-Nov-17	0.402	0.036	0.257	0.109	0.293	0.049	1.85	0.035	0.010	6.254	6.8	120.1	12.8	97.2	3.8
05-SFR	20-Dec-17	Could not obtain sample due to ice														
07-CCH	22-Mar-17	0.602	0.025	0.458	0.119	0.483	0.030	1.89	0.067	0.042	3.224	6.5	213	15.28	106	0.5
07-CCH	26-Apr-17	0.454	0.017	0.251	0.186	0.268	0.065	1.20	0.084	0.014	4.942	6.8	166	10.09	91.3	10.9
07-CCH	24-May-17	0.500	0.032	0.431	<0.09	0.463	0.074	2.63	0.059	0.041	5.456	6.8	189	8.72	88.5	16.2
07-CCH	28-Jun-17	0.734	0.049	0.456	0.229	0.505	0.065	3.70	0.055	0.020	5.923	7.0	211.4	7.82	89.8	22.3
07-CCH	26-Jul-17	0.816	0.070	0.525	0.221	0.595	0.083	3.68	0.032	0.015	4.654	6.9	303.7	6.6	74.8	21.5
07-CCH	23-Aug-17	1.200	0.011	1.042	0.148	1.052	0.059	2.00	0.021	0.019	4.547	7.4	348.9	8.38	99.8	24.1
07-CCH	25-Oct-17	0.743	0.021	0.622	0.099	0.644	<u>0.055</u>	3.00	0.068	0.015	4.189	6.9	257.3	9.3	91.8	14.7
07-CCH	25-Oct-17	0.756	0.020	0.623	0.113	0.643	<u>0.097</u>	2.84	0.068	0.020	4.356	6.9	256.1	9.29	91.8	14.8
07-CCH	27-Sep-17	0.736	0.018	0.564	0.155	0.581	0.080	<1	0.063	0.013	5.131	7.1	291.8	8.21	97.5	24.0
07-CCH	30-Nov-17	0.569	0.014	0.411	0.144	0.425	0.025	1.33	0.126	0.074	4.997	6.8	156.7	12.83	97	3.5
07-CCH	20-Dec-17	Could not obtain sample due to ice														
09-EXT	22-Mar-17	0.349	0.009	0.199	0.141	0.208	<0.025	1.75	0.026	<0.005	5.090	6.0	238	14.82	103.3	0.7
09-EXT	26-Apr-17	0.397	0.013	0.054	0.331	0.067	0.081	7.27	0.045	0.026	8.637	6.6	189	8.93	81.2	11.2
09-EXT	26-Apr-17	0.379	0.012	0.052	0.314	0.064	0.071	7.64	0.051	0.020	8.560	6.5	188	8.73	79.3	11.1

Station Id	Collection Date	TDN (mg N/L)	NH4 (mg N/L)	NO3+NO2 (mg N/L)	DON (mg N/L)	DIN (mg N/L)	PN (mg N/L)	TSS (mg/L)	TP mg P/L	PO4 (mg P/L)	DOC (mg C/L)	pH	Spec_Cond (uS/cm)	DO (mg/L)	DO%	Temp. (°C)
09-EXT	24-May-17	0.470	0.028	0.085	0.358	0.113	0.063	4.23	0.028	0.008	9.765	6.8	214	7.7	78.8	16.6
09-EXT	28-Jun-17	0.648	0.058	0.219	0.371	0.277	0.068	5.77	0.044	0.015	9.272	6.9	242.5	6.34	71.4	21.2
09-EXT	26-Jul-17	0.537	0.023	0.179	0.335	0.202	0.060	5.83	0.026	0.008	7.381	7.0	256.1	7.09	77.5	19.6
09-EXT	23-Aug-17	0.510	0.009	0.133	0.368	0.142	0.075	4.17	0.033	0.021	7.318	6.9	244.3	7.03	81.9	23.0
09-EXT	25-Oct-17	0.457	0.036	0.178	0.243	0.214	0.072	4.84	0.094	0.020	6.828	6.8	279	7.58	77.5	16.4
09-EXT	27-Sep-17	0.724	0.025	0.209	0.490	0.234	0.028	1.36	0.018	0.013	13.877	6.9	262.7	7.42	85.2	22.2
09-EXT	30-Nov-17	0.411	0.016	0.250	0.146	0.266	0.030	2.17	0.090	0.007	8.362	6.7	228.3	12.04	91.1	3.5
09-EXT	20-Dec-17	0.551	0.025	0.278	0.249	0.302	0.044	2.59	0.046	<0.005	11.251	6.7	259	12.68	93.8	2.4
09-EXT	20-Dec-17	0.566	0.023	0.269	0.274	0.291	0.029	2.71	0.048	0.006	11.129	6.7	259	12.68	93.8	2.4

Bold and underlined values were invalidated through the QA/QC process.

Cells highlighted in yellow indicate duplicate samples.

Red italicized values were below the Reporting Limit (RL). The value is shown as being less than the given RL.

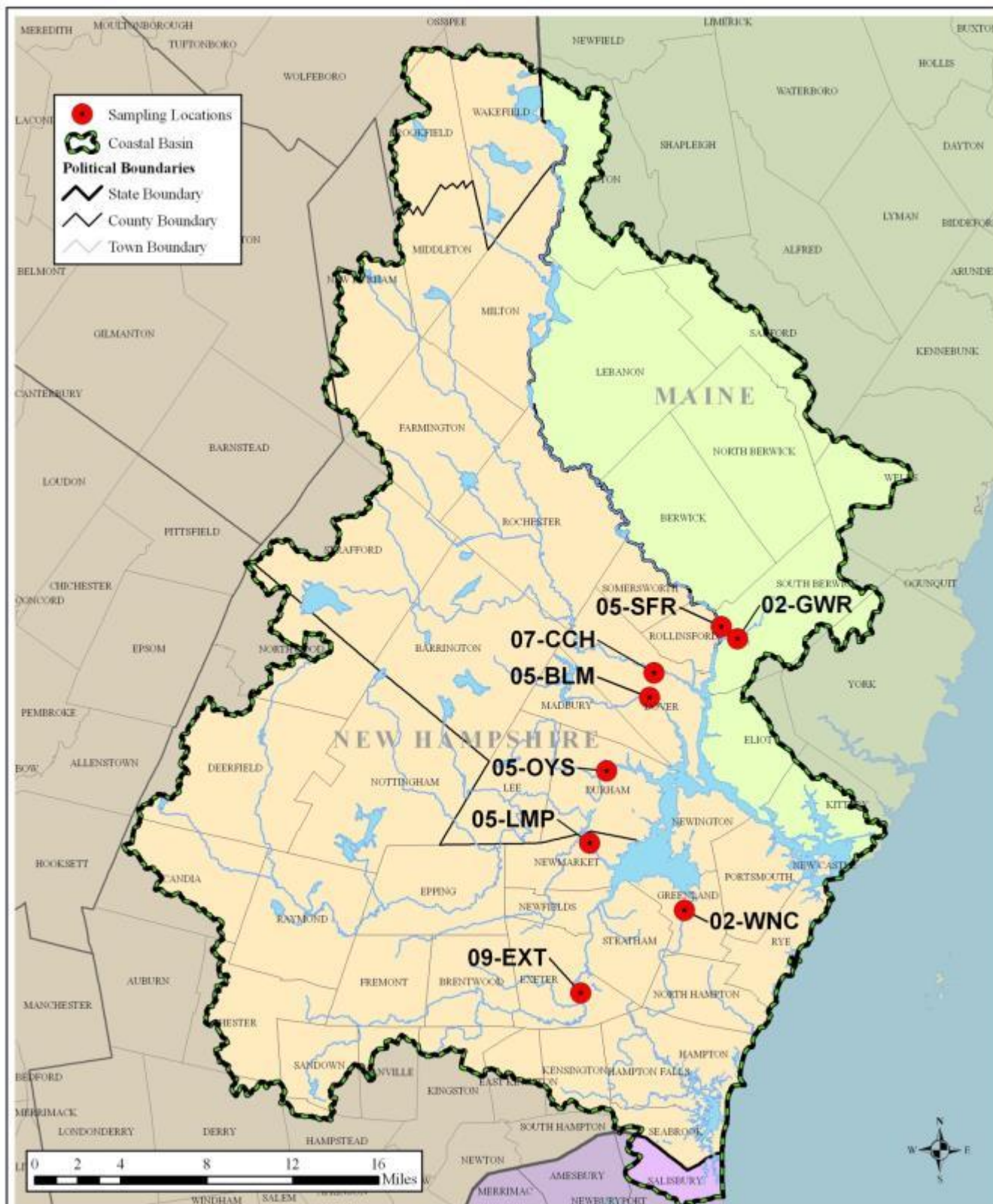


Figure 1: Sampling locations in the Great Bay Estuary Coastal Basin

Table 11: Sampling locations in the Great Bay Estuary, Coastal Basin.

Project ID	Station ID	Town	Station Description	Latitude	Longitude
GBETTMP	05-BLM	Dover	Route 108 bridge	43.179894	-70.878219
GBETTMP	05-LMP	Newmarket	Route 108 bridge	43.082056	-70.934961
GBETTMP	05-OYS	Durham	Route 108 bridge	43.130853	-70.918606
GBETTMP	05-SFR	Rollinsford	Route 4 bridge	43.227206	-70.811456
GBETTMP	07-CCH	Dover	Route 9 bridge	43.196489	-70.874139
GBETTMP	09-EXT	Exeter	High Street bridge	42.980923	-70.944114
GBETTMP	02-WNC	Greenland	Route 33 bridge	43.036067	-70.847983
GBETTMP	02-GWR	South Berwick	Brattle Street bridge	43.218870	-70.796660

Figure 2: Total Phosphorus in Concentrations (mg P/L) at Tributary Stations. (Some data missing due to ice.)

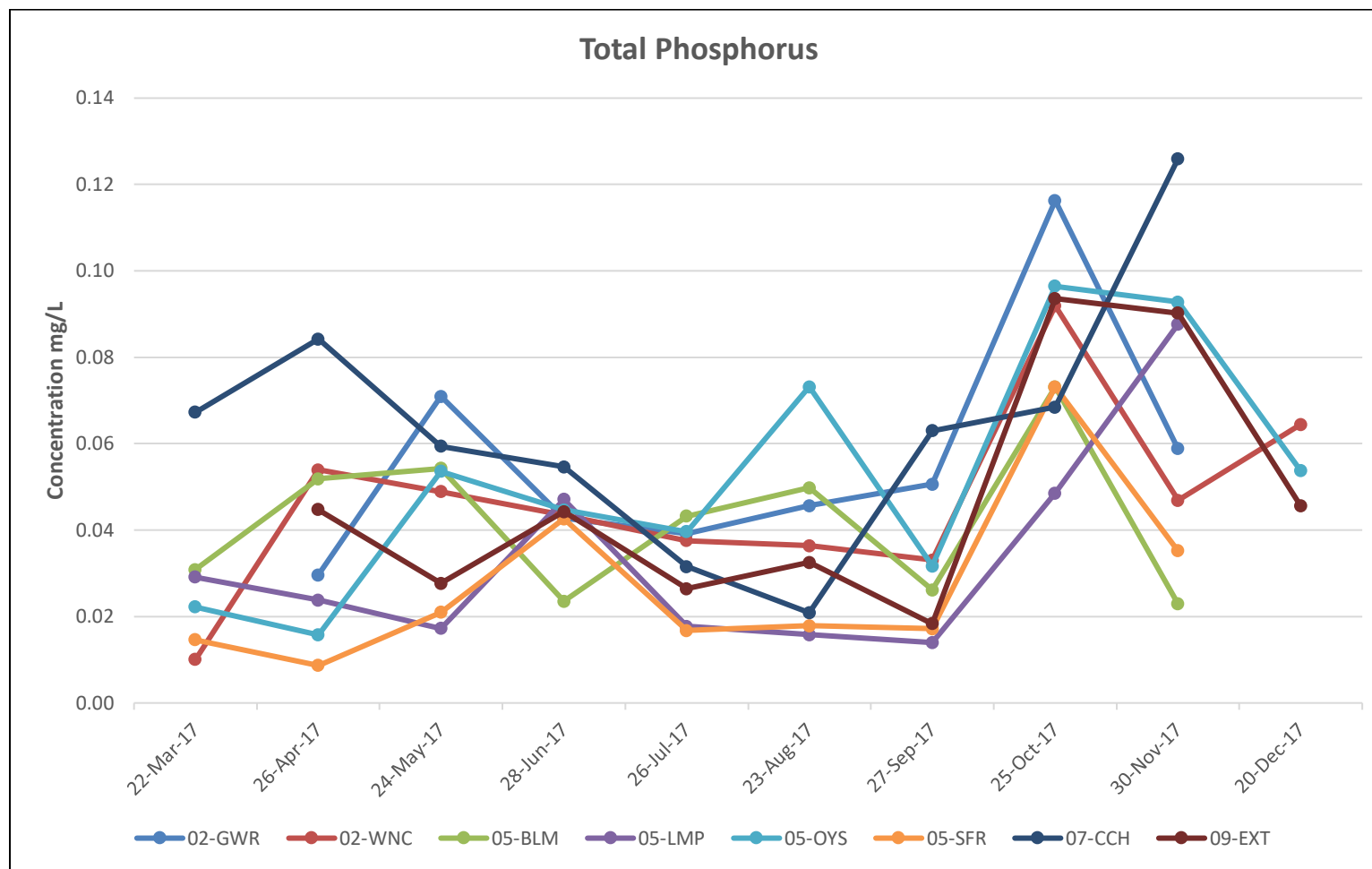


Figure 3: Total Dissolved Nitrogen Concentrations (in mg N/L) at Tributary Stations. (Some data missing due to ice and failure to pass data objectives.)

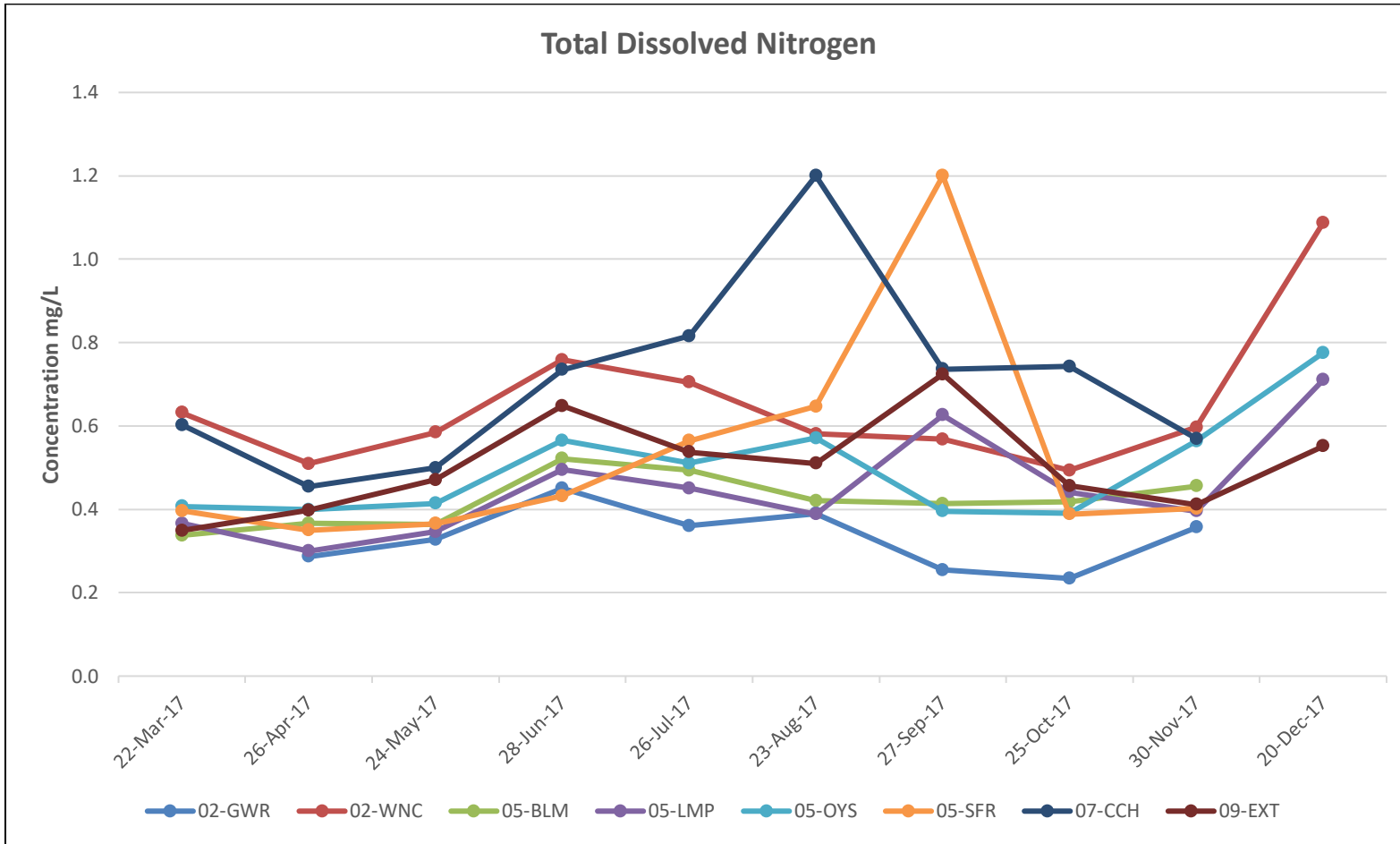


Figure 4: Total Suspended Solids Concentrations (in mg/L) at Tributary Stations. (Some data missing due to ice, broken sample bottles, and failure to meet data objectives.)

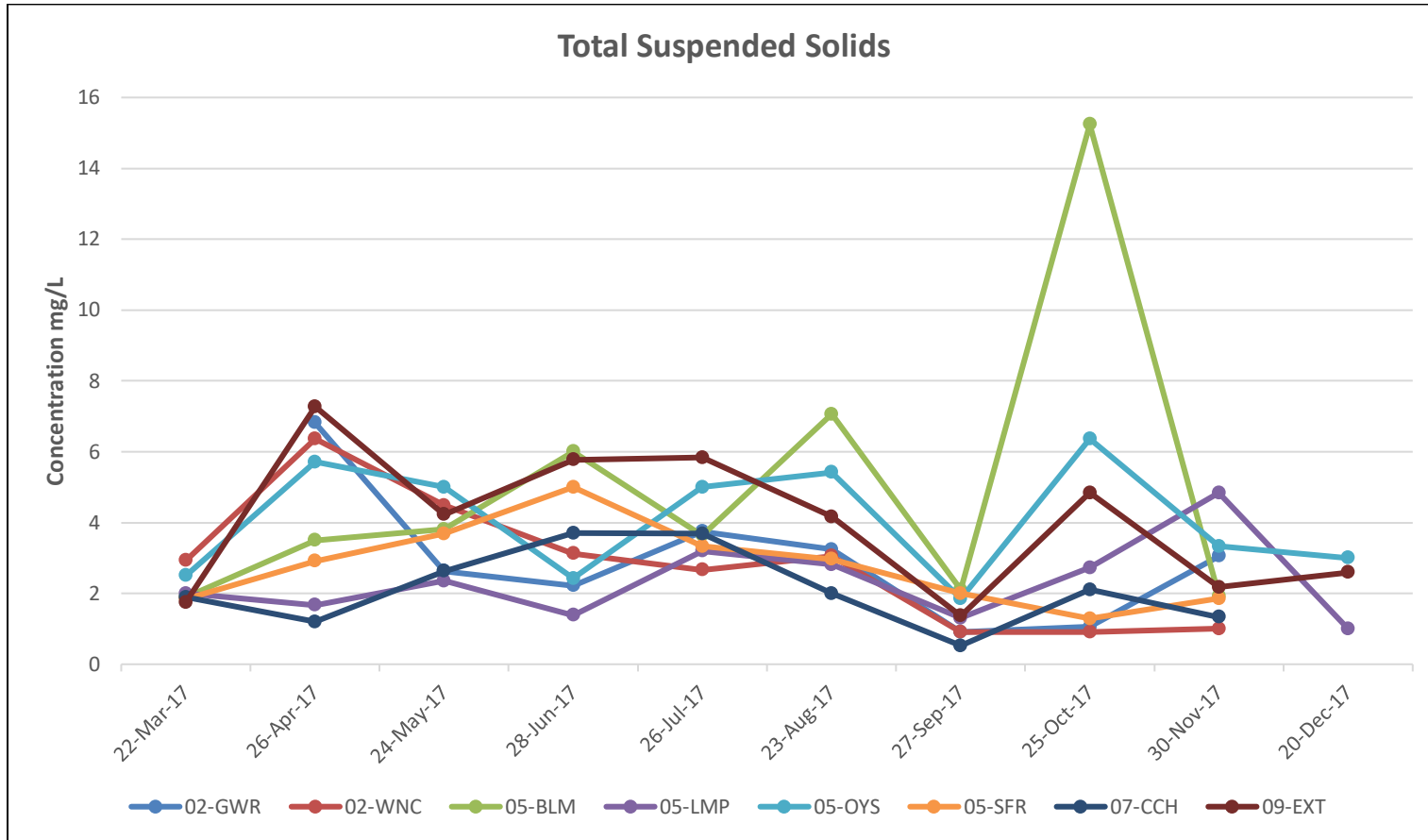


Figure 5: Nitrate/Nitrite Concentrations (in mg N/L) at Tributary Stations. (Some data missing due to ice and failure to meet data objectives.)

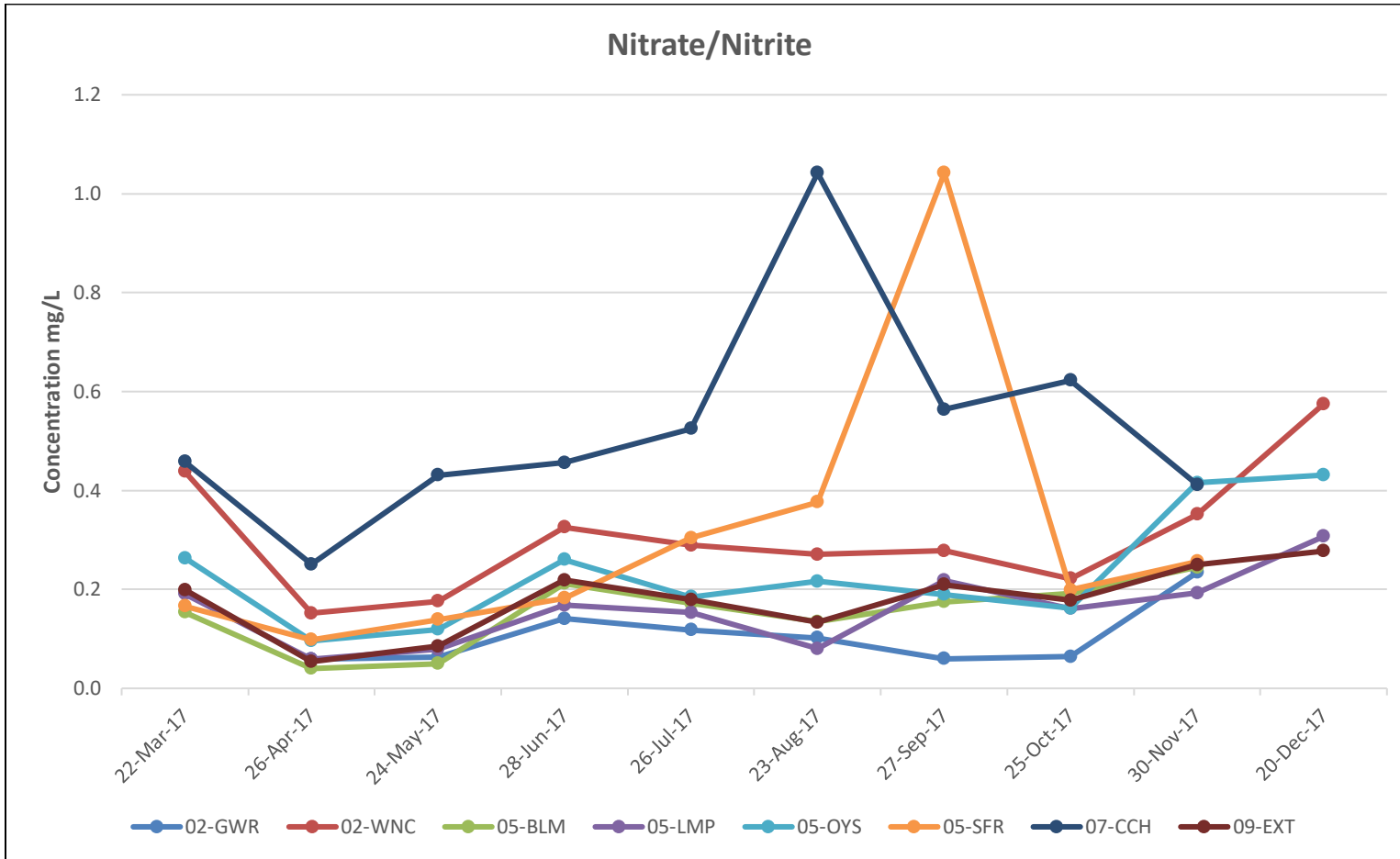


Figure 6: Ammonium Concentrations (in mg N/L) at Tributary Stations. (Some data missing due to ice and failure to meet data objectives.)

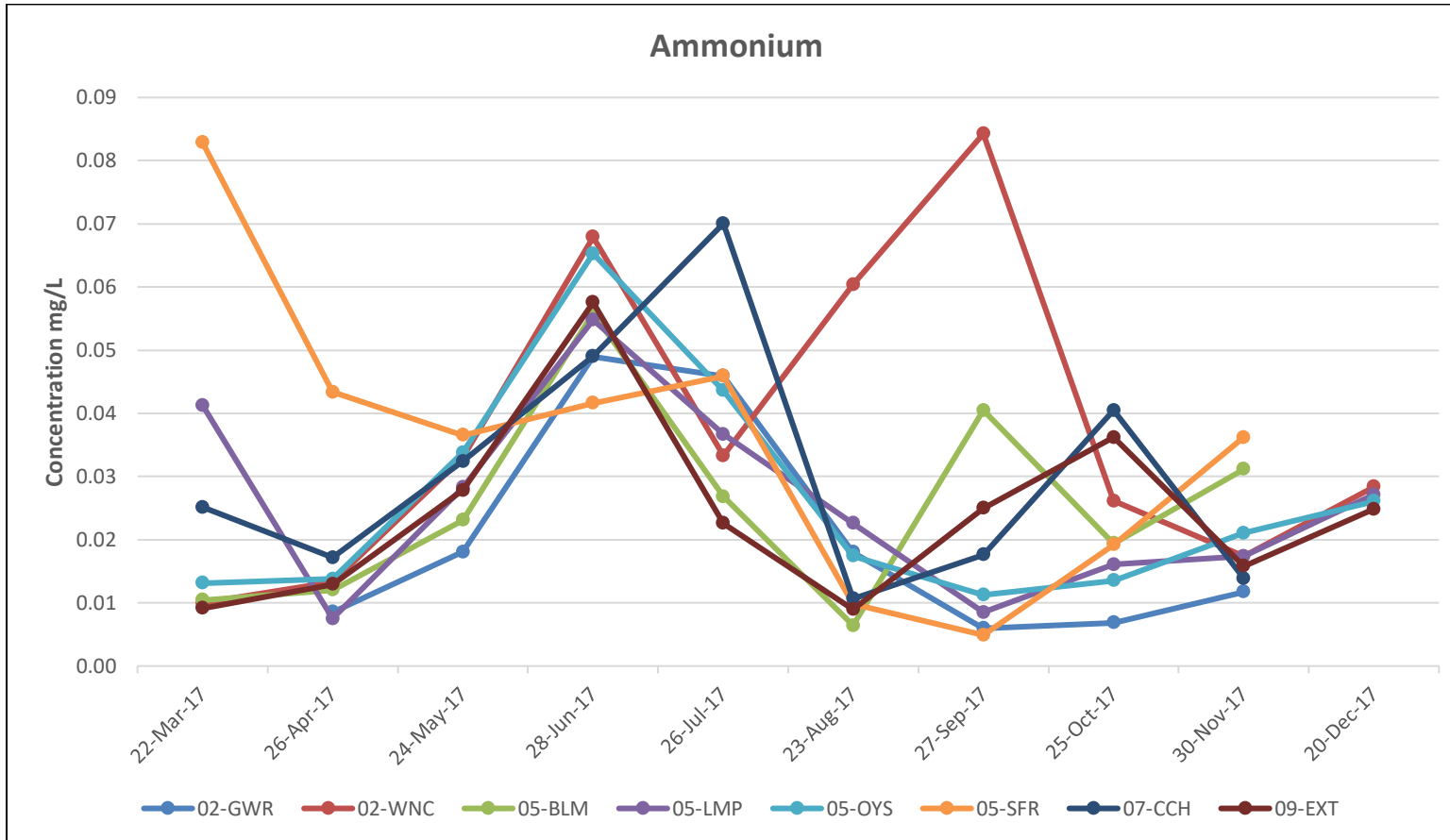


Figure 7: Dissolved Organic Nitrogen Concentrations (in mg N/L) at Tributary Stations. (Some data missing due to ice and failure to meet data objectives.)

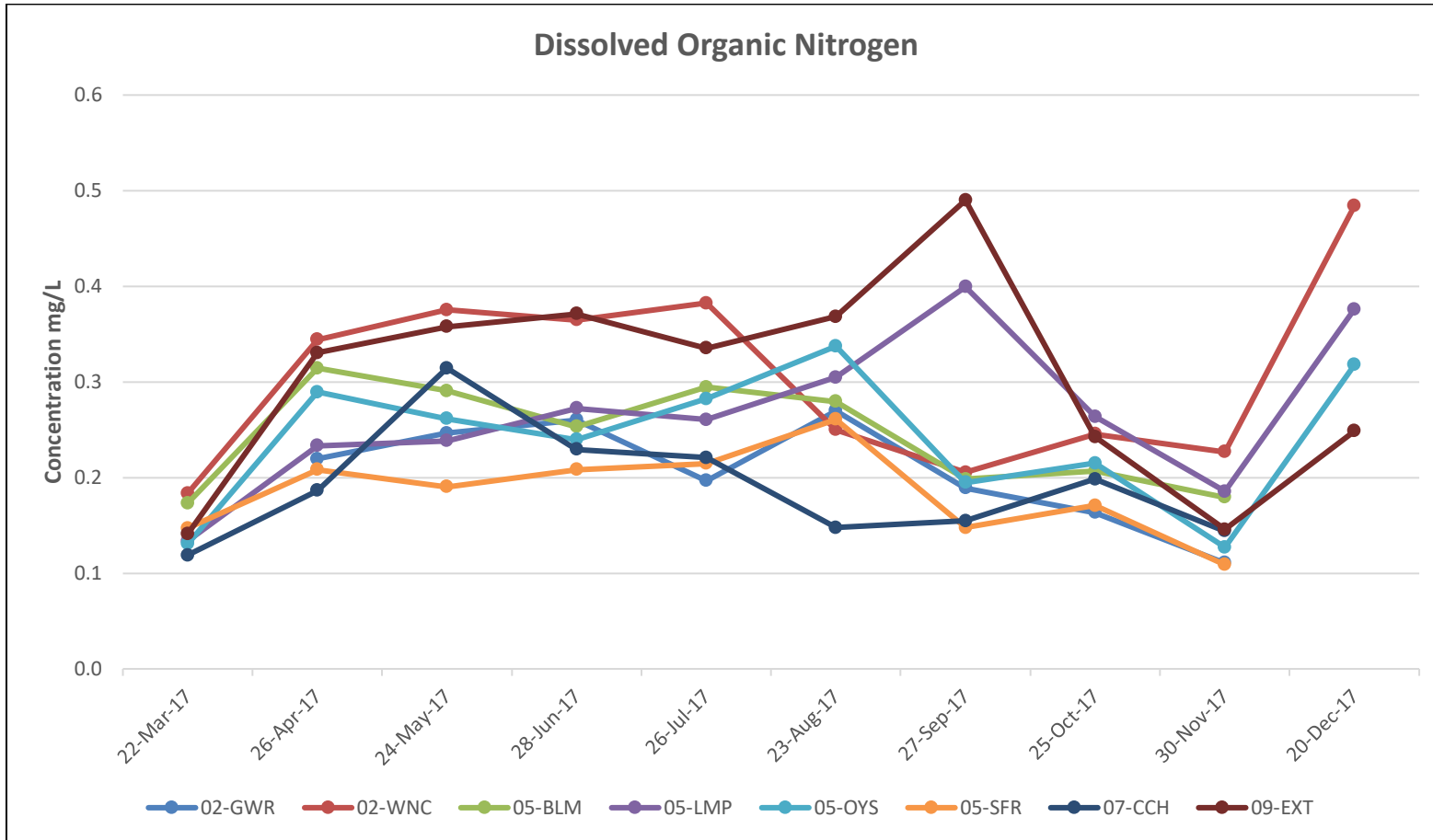


Figure 8: Dissolved Organic Carbon Concentrations (in mg C/L) at Tributary Stations. (Some data missing due to ice and broken sample bottles.)

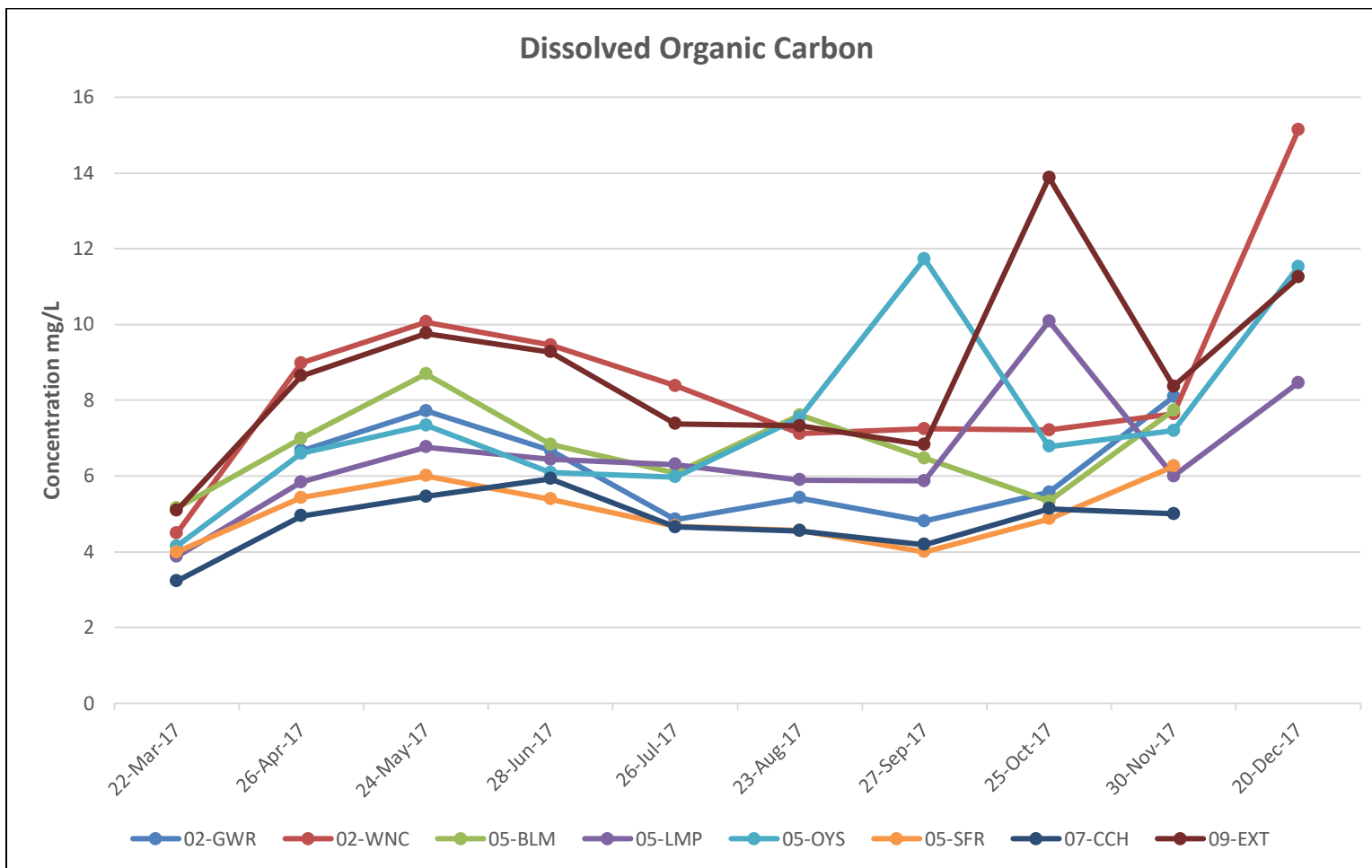


Figure 9: Total Suspended Nitrogen Concentrations (in mg N/L) at Tributary Stations. (Some data missing due to ice and failure to meet data objectives.)

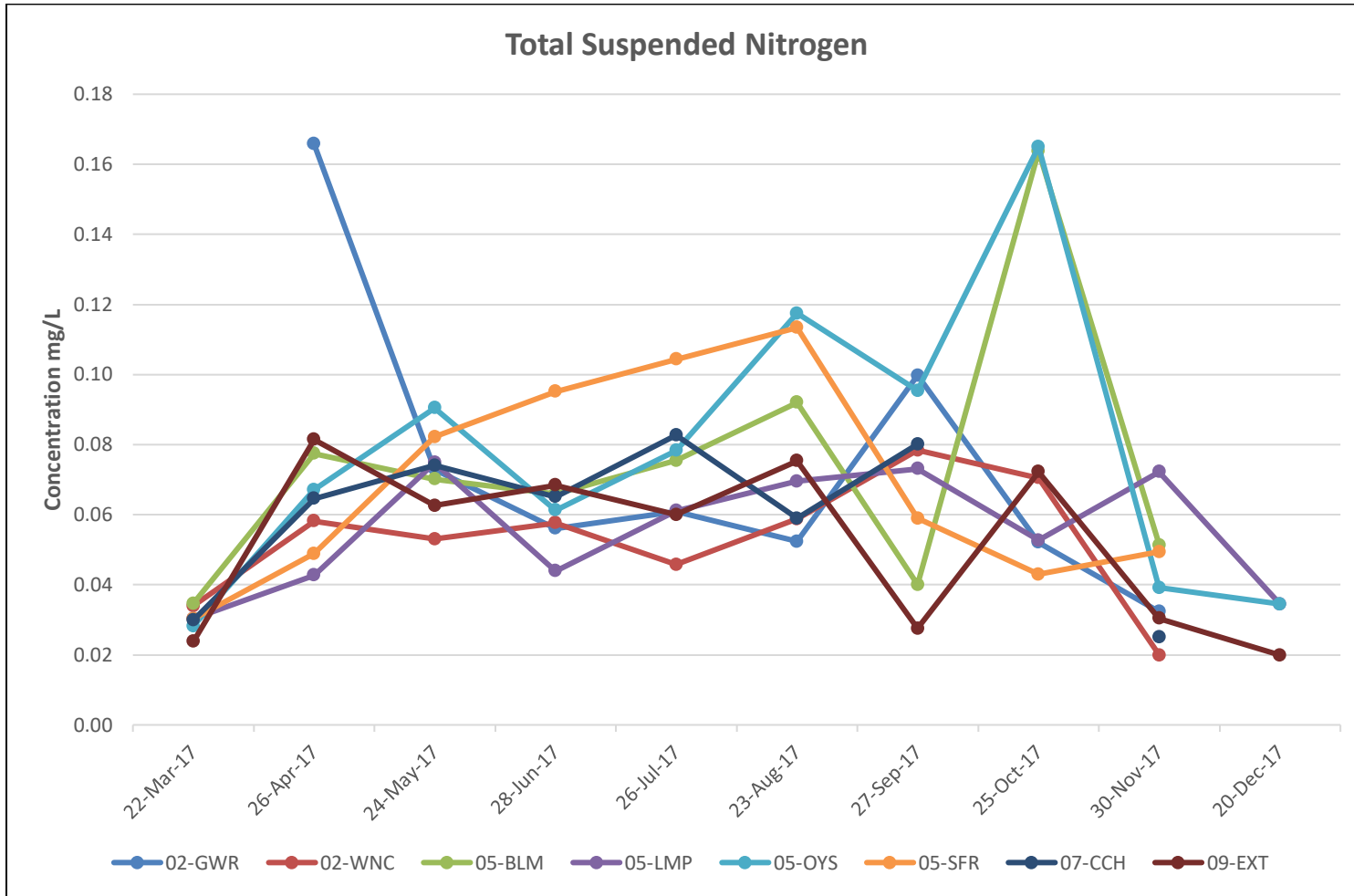


Figure 10: Orthophosphate Concentrations (in mg P/L) at Tributary Stations. (Some data missing due to ice.)

