R-WD-19-21

Water Monitoring Strategy Condition Report: Status and trends of water quality indicators from the River Monitoring Network

Ashuelot River, Hinsdale, MA

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

May 2019

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Water Monitoring Strategy Condition Report: Status and trends of water quality indicators from the River Monitoring Network

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EXECUTIVE SUMMARY

New Hampshire's surface waters are vital natural resources that provide habitat for aquatic life, recreational opportunities, tourism, and economic benefits. The New Hampshire Department of Environmental Services (NHDES) is responsible for monitoring and reporting on the condition of the state's surface waters. The Water Monitoring Strategy, published by NHDES in 2016, details the agency's approach for monitoring the condition of the state's inland surface waters. One component of this strategy is to provide regular reports on the status and trends water quality conditions included in the river monitoring network (RMN). The RMN is composed of 40 sampling stations located around the state and in watersheds with low to high levels of development land (Appendices A and B).

In this report, data were analyzed from 2012 through 2016 to provide a status estimate of current conditions at the RMN sites. Additionally, for approximately 40% of sites, data going as far back as 1990 were used to conduct trend analyses to determine if conditions were worsening, improving, or stable. Data from the current reporting period were also compared with data from 2005 through 2011 to determine if short-term changes in water quality conditions have occurred.

The findings of the analyses were as follows:

- Specific conductance is high at over one-third of RMN sites relative to statewide river data and is worsening at four RMN sites. High specific conductance levels tended to occur in rivers lying within watersheds with greater than 6% of developed land.

- Nutrient concentrations, as measured by phosphorus and nitrogen, at RMN sites were higher than statewide concentrations 23% of the time (11 sites – phosphorus; 7 sites – nitrogen) but had improving trends at eight RMN sites. As with specific conductance, sites with high nutrient concentrations tended to occur at RMN sites with a higher percentage of developed watersheds.

- Acidic waters, as measured by pH, continue to be problematic in NH rivers and streams. The statewide median of 6.53 was near the water quality criteria of 6.5 and 40% of RMN sites had medians below the statewide water quality criteria. Five RMN sites had worsening trends for pH.

- Biological condition, as measured by macroinvertebrates, was considered "healthy" for greater than 90% of wadeable RMN sites. For non-wadeable RMN sites, dissolved oxygen was better than the state water quality criteria at all sites.

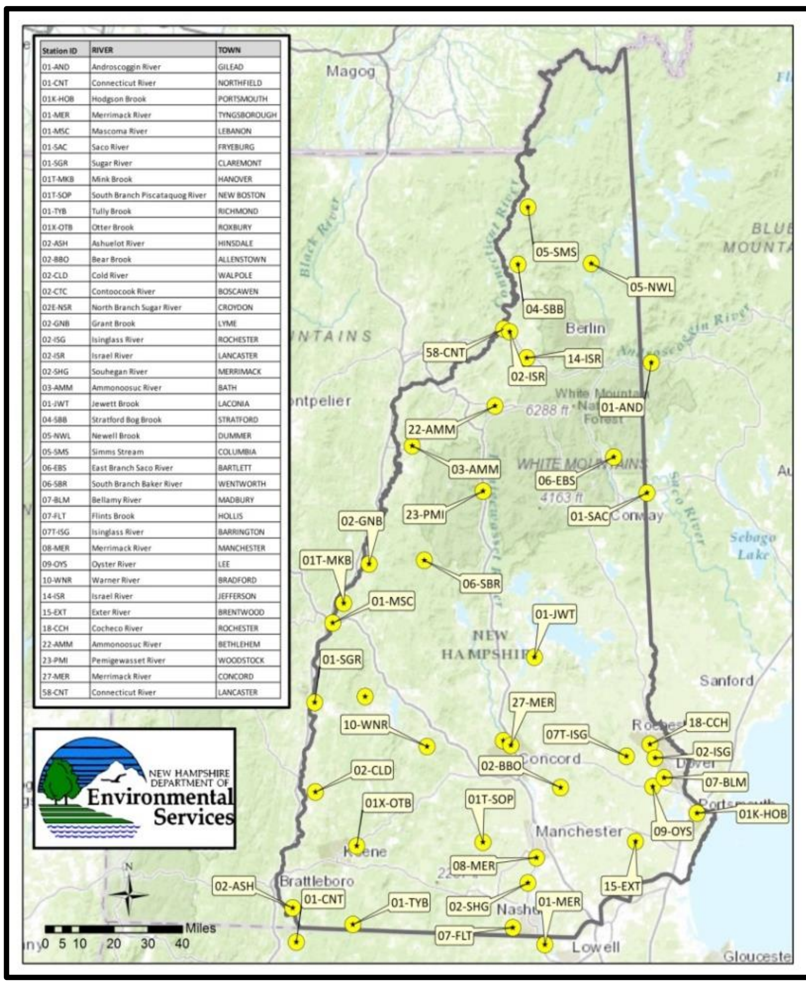
- Daily water temperatures at RMN sites were as expected and rarely exceeded (3.8% of days) benchmarks that could impact aquatic communities.

- Where sites had water quality indicators below expectations the percentage of developed lands tended to be higher than sites with water quality indicators that met or exceeded expectations.

1. INTRODUCTION

There are approximately 17,000 miles of rivers and streams that flow through New Hampshire. They serve as vital ecological resources providing habitat to aquatic organisms and wildlife. They also provide water for drinking, attract tourism, offer recreational opportunities and support economic uses such as agriculture, electrical generation, snowmaking and waste assimilation. In 2016, the New Hampshire Department of Environmental Services (NHDES) published its Water Monitoring Strategy (2016 NHDES Water Monitoring Strategy) outlining the agency's approach for monitoring New Hampshire's inland surface waters through 2026. One of the primary components of the strategy is to report on the status and trends of the state's waterbodies using indicators of water quality conditions.

Map 1. River network monitoring locations.



Station ID	RIVER	TOWN
01-AND	Androscoggin River	GILEAD
01-CNT	Connecticut River	NORTHFIELD
01K-HOB	Hodgson Brook	PORTSMOUTH
01-MER	Merrimack River	TYNGSBOROUGH
01-MSC	Mascoma River	LEBANON
01-SAC	Saco River	FRYEBURG
01-SGR	Sugar River	CLAREMONT
01T-MKB	Mink Brook	HANOVER
01T-SOP	South Branch Piscataquog River	NEW BOSTON
01-TYB	Tully Brook	RICHMOND
01X-OTB	Otter Brook	ROXBURY
02-ASH	Ashuelot River	HINSDALE
02-BBO	Bear Brook	ALLENSTOWN
02-CLD	Cold River	WALPOLE
02-CTC	Contoocook River	BOSCAWEN
02E-NSR	North Branch Sugar River	CROYDON
02-GNB	Grant Brook	LYME
02-ISG	Isinglass River	ROCHESTER
02-ISR	Israel River	LANCASTER
02-SHG	Souhegan River	MERRIMACK
03-AMM	Ammonoosuc River	BATH
01-JWT	Jewett Brook	LACONIA
04-SBB	Stratford Bog Brook	STRATFORD
05-NWL	Newell Brook	DUMMER
05-SMS	Simms Stream	COLUMBIA
06-EBS	East Branch Saco River	BARTLETT
06-SBR	South Branch Baker River	WENTWORTH
07-BLM	Bellamy River	MADBURY
07-FLT	Flints Brook	HOLLIS
07T-ISG	Isinglass River	BARRINGTON
08-MER	Merrimack River	MANCHESTER
09-OYS	Oyster River	LEE
10-WNR	Warner River	BRADFORD
14-ISR	Israel River	JEFFERSON
15-EXT	Exter River	BRENTWOOD
18-CCH	Cocheco River	ROCHESTER
22-AMM	Ammonoosuc River	BETHLEHEM
23-PMI	Pemigewasset River	WOODSTOCK
27-MER	Merrimack River	CONCORD
58-CNT	Connecticut River	LANCASTER

The purpose of this report is to evaluate the current status and long-term trends of conditions for sites included in the river monitoring network (RMN). This is the first-of-its-kind report and is scheduled to be produced in five-year increments in order to provide regular updates on water quality conditions. The current reporting period is for 2012 through 2016 but includes analyses of trends going back as far as 1990 where data were available.

1.1 The river monitoring network (RMN)

Data for this report were generated from a fixed network of 40 sampling stations scattered throughout the state (Map 1, Appendix A). Some of these sampling stations have data going as far back as 1990 while other stations were established in 2012 or 2013 when the RMN was formally adopted. Sampling stations are located on streams and rivers with watersheds ranging in size from 4 to 6,721 square miles and levels of land development ranging from 0 to 82% (Appendix B). The sites included in the RMN were selected to represent the range of water quality conditions and river types that exist across the state.

1.2 Indicators of condition

There are many indicators that can be measured to determine water quality conditions. For the RMN, seven indicators were chosen to provide an understanding of the physical, chemical, and biological status and trends for each station (Table 1). The indicators chosen for inclusion reflect conditions related to common water quality stressors and measures of the condition of the aquatic community.

Table 1. River Monitoring Network water quality condition indicators.

Indicator Parameter	Description
Specific Conductance	A measurement of the water's ability to conduct electricity. Compounds such as road salts, fertilizers and other chemical compounds increase the specific conductance of water.
pH	A measure of the water's acidity. In addition to natural processes, the pH of surface water is affected by the precipitation of acidic compounds, such as sulfuric or nitric acid, released into the atmosphere as a result of industrial processes.
Nutrients (Phosphorus and Nitrogen)	The concentration of compounds that facilitate plant and animal growth. Some nutrients are deposited in surface water via atmospheric deposition, however, an excessive build up is often a result of improper use of fertilizers, human waste products, and improper agriculture practices.
Biological Condition (Macroinvertebrates)	An estimate of the composition and diversity of the aquatic community. Aquatic communities, such as macroinvertebrates, are expected to balanced and adapted to natural conditions.
Biological Condition (Dissolved Oxygen)	The concentration of oxygen in water used by plants and animals. Low or highly variable dissolved oxygen concentrations can result from excessive biological activity such as decomposition of organic material.
Water Temperature	Aquatic communities are adapted to specific water temperature conditions. Water temperatures are affected by the amount vegetation that shades surface waters, industrial discharges, upstream damming, and global climate patterns.

Anthropogenic activity within a watershed is known to influence water quality. Road salting, fertilizer use, impervious surfaces, septic systems and landscape modification can influence indicators of site condition. To better understand how indicators differ among sample sites, watershed development was determined using the 2006 National Land Cover Database for the Continuous United States, where <3% developed land was considered low development, 3-6% developed land was considered moderate development, and >6% developed land was considered high development.

For each indicator, a specific set of questions and measures were included in the 2016 Water Monitoring Strategy to guide data analysis. In general, the questions were designed around three major points of emphasis:

1) **What are current conditions with respect to statewide data?**
2) **Are trends stable, improving, or worsening over the long term?**
3) **How do conditions for the current reporting period compare with data from the recent past?**

2.0 STUDY DETAILS AND ANALYSIS

2.1 Data collection

The data included is the report were collected monthly from May – September. In general, these efforts involved the collection of three to four samples per year resulting in 15 to 20 results at each site for the five-year reporting period. In some cases, such as for water temperature and dissolved oxygen, continuous data loggers were installed at various sites and left in place for two weeks to three months and resulted in over 1,000 data points per year. All data were collected following an approved EPA quality assurance project plan (QAPP) and reviewed by NHDES staff for quality and accuracy. Only data meeting quality assurance measures were used in the analysis.

2.2 Data analysis

Data were analyzed for each individual site and then summarized across all sites for a comprehensive view of river water quality statewide. For each site, all data collected within a specified river segment, known as an assessment unit (AU) were included.

In order to address an indicator's current condition at each site with respect to statewide data, a statewide frequency distribution was created and the site's "proximity," known as the percentile, on the statewide distribution was determined. The statewide frequency distribution was not restricted to RMN sites, rather it included data from all river sample locations from 1990 through 2016. A tally was kept of those sites that had percentiles greater than 75% or less than 25% of the statewide frequency distribution for each of the indicators. In addition, a median of the statewide frequency distribution was calculated.

Conditions from 2012 through 2016 were compared to conditions from 2005 through 2011 to determine if short-term changes in water quality had occurred. Comparisons for each indicator at individual sites were made using a Kruskal-Wallis test. Significant changes ($p \leq 0.05$) were tallied across all sites for each indicator.

For trend analysis, a Mann-Kendall test was used for each indicator at individual sites to determine if there was significant ($p \leq 0.05$) increase, decrease, or no change (stable) in an indicator over time. In many cases, flow-related adjustments were made to results in order to account for indictors that were directly correlated to estimated streamflow. Indicator-specific streamflow adjustments were applied only when there was a relationship between estimated streamflow and an individual indicator at each site.

Lastly, for many sites, the current reporting period (2012 through 2016) represented the first period of data collection. In these instances, formal statistical analyses were not possible because of limited data. In these cases, summary statistics are presented to provide a baseline of conditions for future analyses.

3.0 RESULTS

3.1 Current Conditions

The comparison of results from 2012 – 2016 for individual RMN sites to statewide data provided a relative indication of water quality condition. Percentiles and medians for statewide data were determined using all river segments (AUIDs) where 10 or more samples were collected from 1990-2016. Statewide summary statistics were the result of thousands of data points and hundreds of river segments (Figure 1, Table 2). For some indicators, such as pH and biological condition, numeric water quality criteria or interpretive numeric thresholds existed and were also used to evaluate conditions.

3.1.1 Specific Conductance

Specific conductance is a measure of the ability for water to conduct an electrical current. Higher specific conductance is an indicator of dissolved ions and is associated with activities on developed lands, such as the application of road salt, septic systems and chemicals used to maintain manicured landscapes. Industrial discharges also have high specific conductance levels. High levels of dissolved salts can interfere with the natural physiology of aquatic organisms. The statewide median for specific conductance based on all river data from 1990 through 2016 was 71 us/cm. There is no numeric water quality criterion for specific conductance.

MEASURE(S) OF CONDITION: Number of sites with median specific conductance levels below the 25th percentile of the statewide distribution of specific conductance data. Number of sites with median specific conductance levels above the 75th percentile of statewide distribution of specific conductance data.

OUTCOME(S): Four (10%) of 40 sites had median specific conductance levels less than the 25th percentile of the statewide distribution. Fourteen of 40 sites (35%) had median specific conductance levels greater than the 75th percentile of the statewide distribution (Figure 2).

Supplementary observation: Of the 14 sites that had median specific conductance levels greater than the 75th percentile of the statewide distribution, 12 were categorized as highly developed (> 6 % developed land; Figure 2).

Figure 1. Water quality indicator statewide data distributions. Curved blue line = cumulative percent of statewide data, 1990-2016. Long dashed grey vertical line = 25th percentile. Short dashed grey vertical line = 75th percentile. Solid vertical red line = water quality critieria or numeric interpretive threshold.

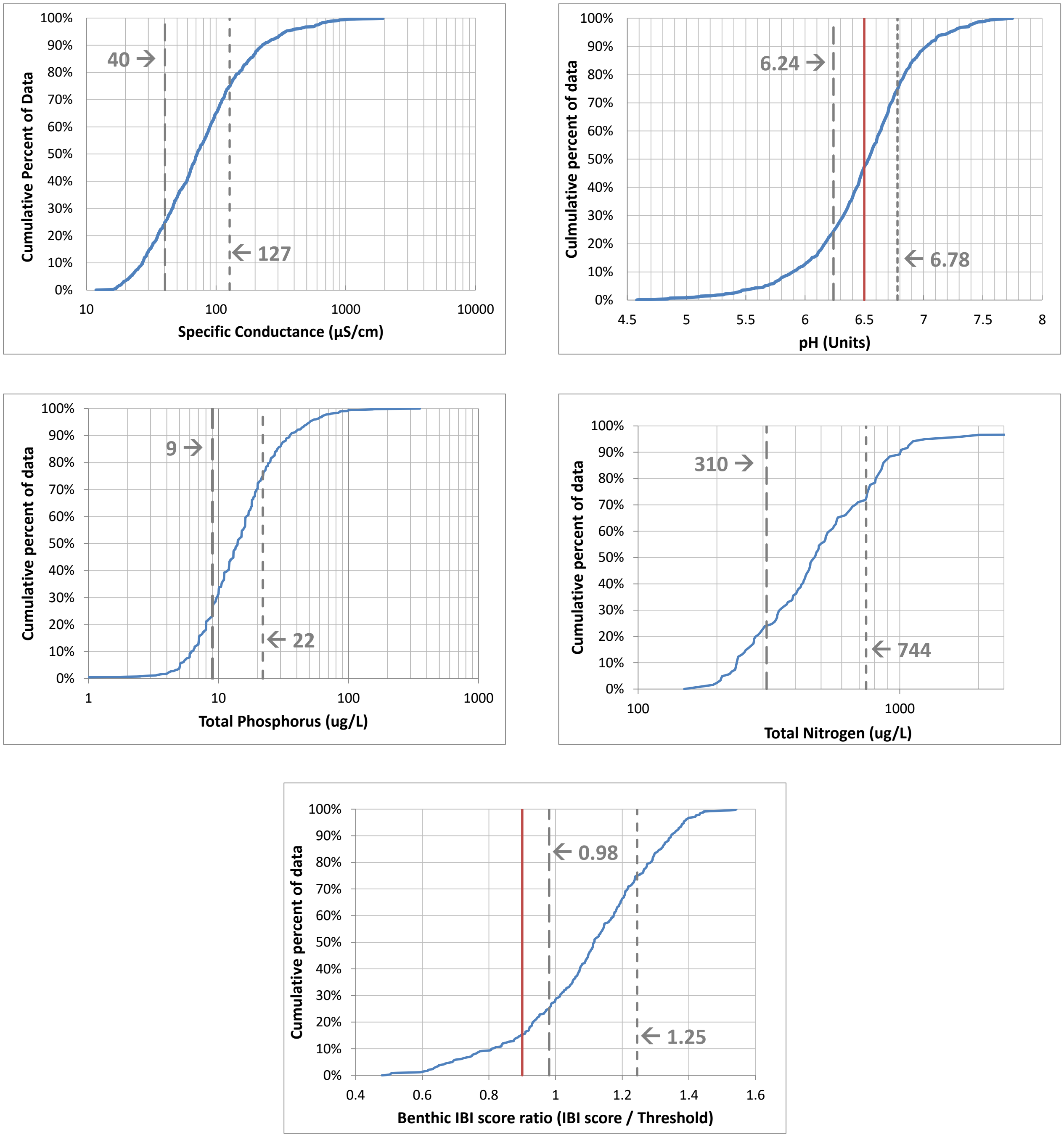
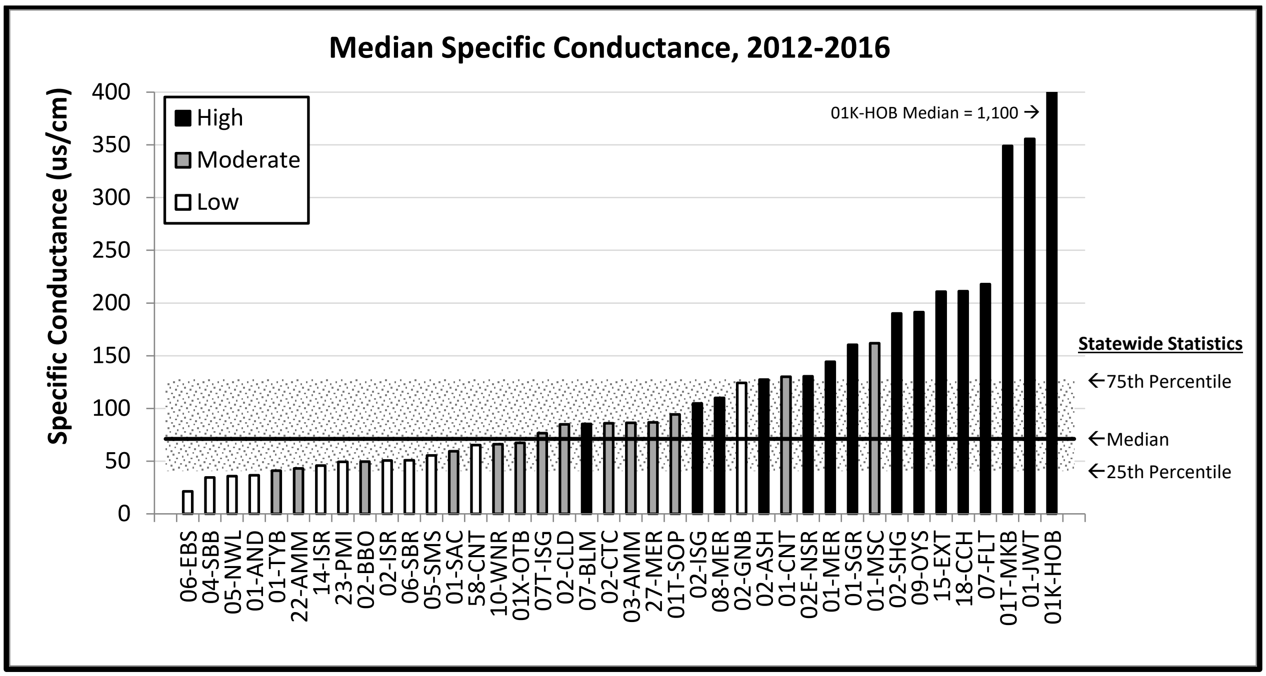


Table 2. Statewide median, number of river segments, and number of samples from 1990-2016 for water quality condition indicators.

Parameter	Statewide median	Number of river segments	Number of samples
Specific conductance (µs/cm)	71.1	931	49,926
pH (units)	6.53	855	41,204
Total Phosphorus (µg/L)	14.0	710	32,422
Total Nitrogen (µg/L)	457.8	122	4,325
Benthic Macroinvertebrate Index of Biotic Integrity ratio (B-IBI ratio)	1.12	342	548

Figure 2. RMN median specific conductance levels, 2012-2016, by site and statewide summary statistics. Watershed development: open bars = sites with < 3% developed land (low); grey bars = sites with 3-6% developed land (moderate); black bars = sites with >6% developed land (high).



3.1.2 Nutrients

High nutrient concentrations, as measured by phosphorus and nitrogen, are associated with the discharge of wastewater, fertilizer application, and animal waste common in developed areas with high population densities or areas with high levels of agriculture. High nutrient concentrations can promote excessive algal growth which impacts aquatic communities and recreational opportunities. The statewide median for total phosphorus and total nitrogen based on all river data from 1990 through 2016 was 14 µg/L and 458 µg/L, respectively. There are no numeric water quality criteria for total phosphorus or total nitrogen.

MEASURE(S) OF CONDITION:

Total Phosphorus: Number of sites with median concentrations below the 25th percentile of the statewide distribution of total phosphorus data. Number of sites with median total phosphorus concentrations above the 75th statewide distribution of total phosphorus data.

Total Nitrogen: Number of sites with median concentrations below the 25th percentile of the statewide distribution of total nitrogen data. Number of sites with median concentrations above the 75th statewide distribution of total nitrogen data.

OUTCOME(S):

Total Phosphorus: Eleven out of 40 sites (28%) had median total phosphorus concentrations greater than the 75th percentile of the statewide distribution. Six sites (15%) had median total phosphorus concentrations less than the 25th percentile of the statewide distribution (Figure 3).

Total Nitrogen: Seven out of 40 sites (18%) had median total nitrogen concentrations greater than the 75th percentile of the statewide distribution. Eighteen sites (45%) out of 40 sites had median total nitrogen concentrations less than the 25th percentile of the statewide distribution (Figure 4).

Supplementary observation: Of the 11 sites that had median total phosphorus concentrations greater than the statewide 75th percentile, nine were categorized as highly developed. Of the seven sites that had median total nitrogen concentrations greater than the statewide 75th percentile, five were categorized as highly developed (>6 % developed land; Figures 3 and 4).

Figure 3. RMN median total phosphorus concentrations, 2012-2016, by site and statewide summary statistics. Watershed development: open bars = sites with < 3% developed land (low); grey bars = sites with 3-6% developed land (moderate); black bars = sites with >6% developed land (high).

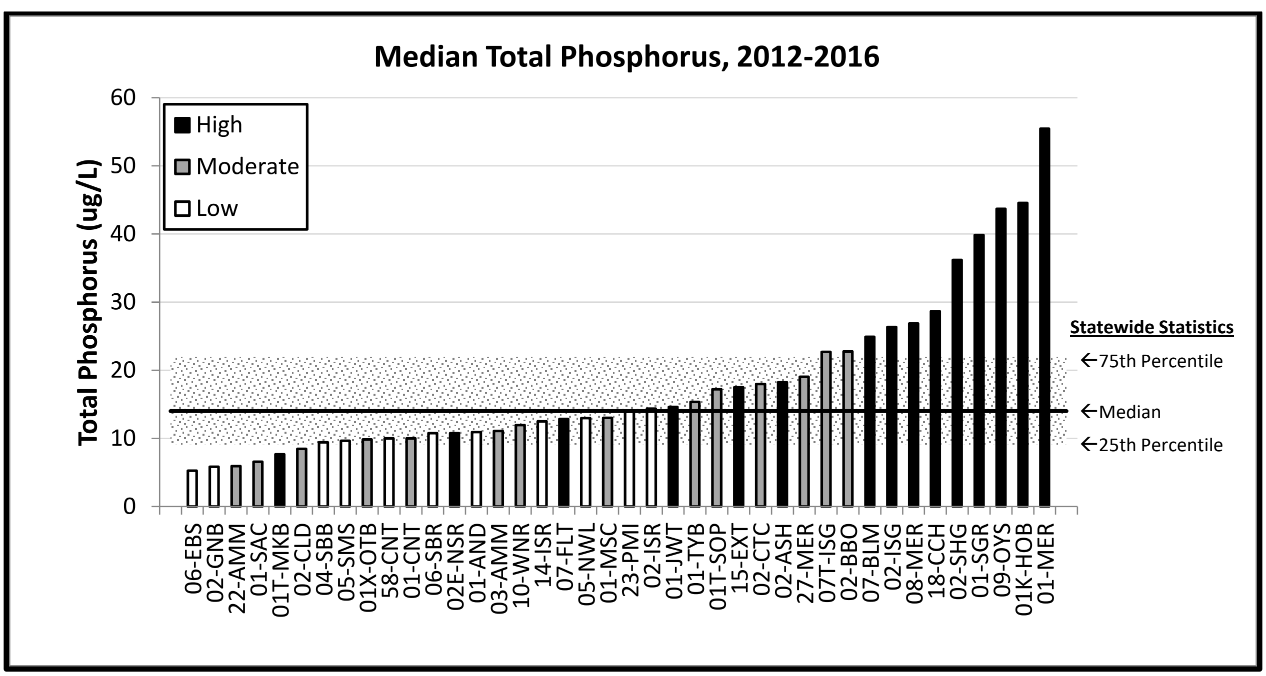
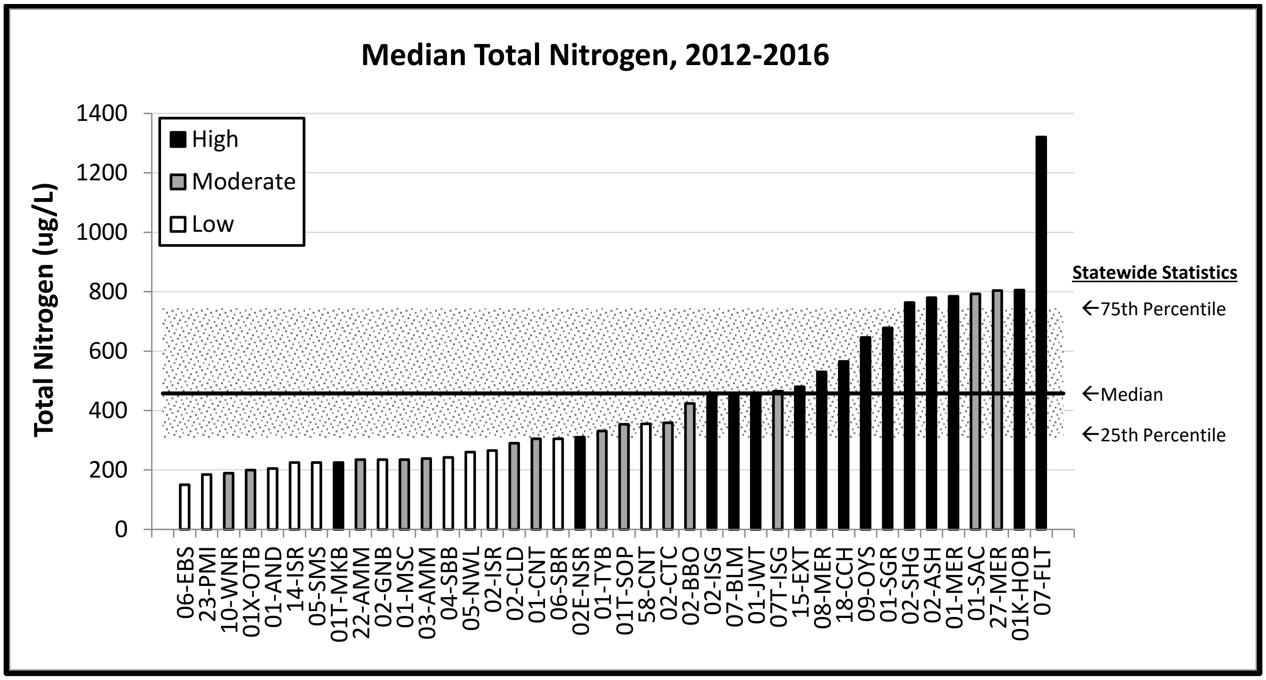


Figure 4. RMN median total nitrogen concentrations, 2012-2016, by site and statewide summary statistics. Watershed development: open bars = sites with < 3% developed land (low); grey bars = sites with 3-6% developed land (moderate); black bars = sites with >6% developed land (high).



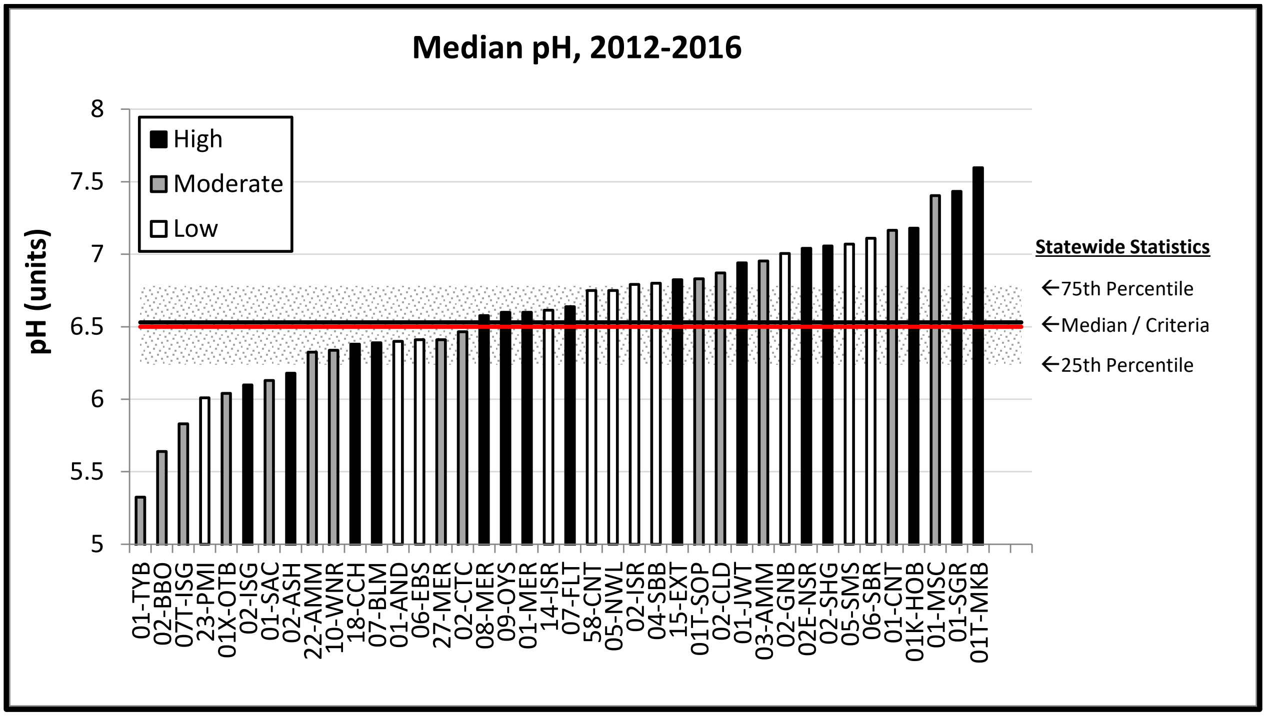
3.1.3 pH

The pH in surface waters is a complex result of the geology, soil chemistry and atmospheric deposition. The statewide median for pH of all river data from 1990 through 2016 was 6.53 units. The water quality criteria for pH in New Hampshire are less than 6.5 or greater than 8.0 units. Values below 6.5 or above 8.5 may negatively influence aquatic life and do not meet state water quality criteria.

MEASURE(S) OF CONDITION: Number of sites that do not meet water quality criteria. Number of sites below the 25th percentile of the statewide distribution of pH data. Number of sites above the 75th percentile of the statewide distribution of pH data.

OUTCOME(S): Sixteen (40%) of 40 sites had median pH values less than the state water quality criteria (< 6.5 units). No sites had a median that exceed the upper range (8.0 units) of the state water quality criterion for pH. Eight sites (20%) had a median pH value less than the statewide 25% percentile. Seventeen sites (43%) had a median pH value greater than the statewide 75th percentile (Figure 5).

Figure 5. RMN median pH values, 2012-2016, by site and statewide summary statistics. Watershed development: open bars = sites with < 3% developed land; grey bars = sites with 3-6% developed land; black bars = sites with >6% developed land.



3.1.4 Biological Condition

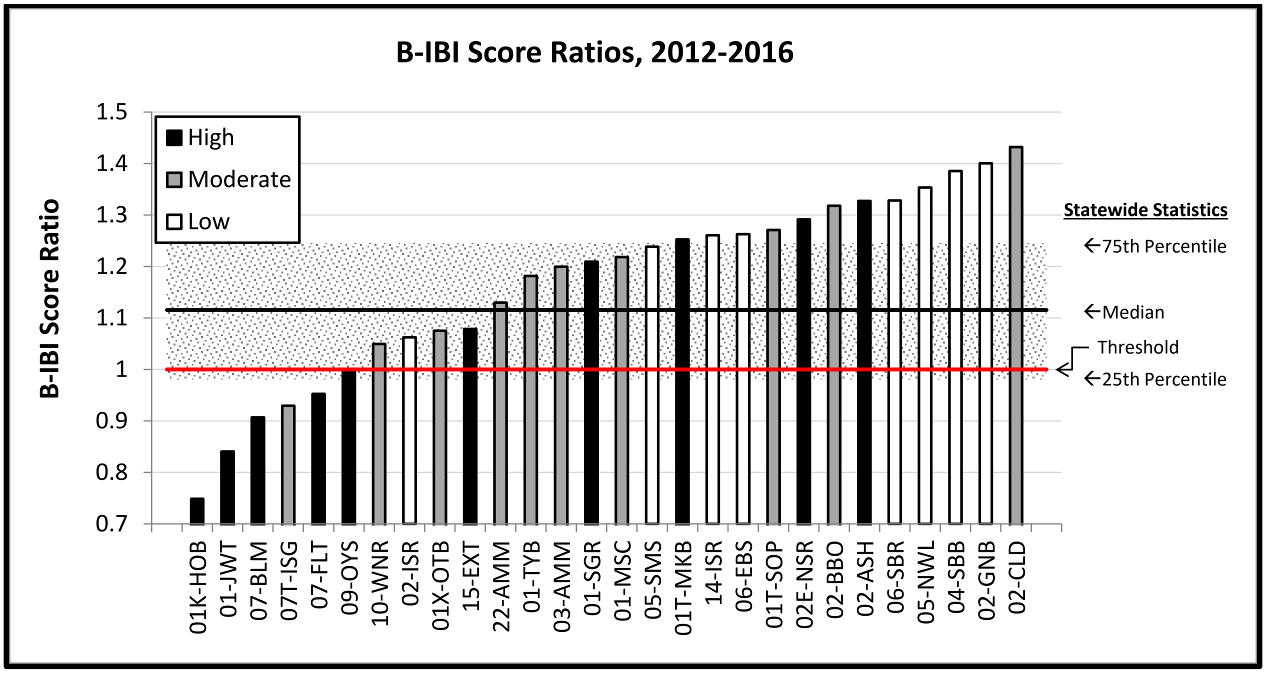
In order to estimate the health of the biological community, NHDES used benthic macroinvertebrates and dissolved oxygen. For wadeable streams, the measure of condition was the score of the benthic index of biotic integrity (B-IBI), a compilation of seven independent measures of aquatic macroinvertebrate community composition. The B-IBI applies to 28 sites in the RMN. Individual site scores are referred to as B-IBI score ratios and reflect a site's "biologic health." A site with a higher score ratio reflects a macroinvertebrate community in better condition than a site with a lower score ratio. The interpretive numeric threshold B-IBI score ratio is 1.0. Sites with ratios below 1.0 indicate a departure from "healthy" expectations and scores equal to or above 1.0 meet or exceed expectations. The median B-IBI score ratio for all previous sampled rivers in New Hampshire from 1997 through 2016 was 1.12. Macroinvertebrate communities in poor condition can be the result of multiple water quality stressors including nutrients, road salt, acidic conditions, poor habitat, unnatural temperature or flow regimes, low dissolved oxygen and toxic contaminants.

MEASURE(S) OF CONDITION: The number of sites that do not meet the biological condition threshold (B-IBI score ratio < 1.0). Number of sites below the 25th percentile of the statewide distribution of B-IBI score ratios. Number of sites above the 75th percentile of the statewide distribution of B-IBI score ratios.

OUTCOME: Six (21%) of 28 sites had B-IBI score ratios below the 1.0 score ratio threshold. Five (18%) of 28 sites had scores below the 25th percentile. Twelve (43%) of 28 sites had B-IBI score ratios above the 75th percentile (Figure 6).

Supplementary observation: Of the five sites that B-IBI score ratios less than the statewide 25th percentile, four sites were categorized as highly developed (Figure 6).

Figure 6. RMN median B-IBI score ratios, 2012-2016, by site and statewide summary statistics. Watershed development: open bars = sites with < 3% developed land (low); grey bars = sites with 3-6% developed land (moderate); black bars = sites with >6% developed land (high).



For non-wadeable streams, dissolved oxygen was used as a surrogate measure for biological condition since sufficient oxygen is necessary to support a healthy biological community. The New Hampshire dissolved oxygen criteria is 6.0 mg/L for Class A waterbodies and 5.0 mg/L for Class B waterbodies. There are 12 non-wadeable rivers in the RMN and all are Class B. For each of these waterbodies, a continuous data logger was deployed at least once from 2012-2016 for a minimum of seven days, and dissolved oxygen concentration measures were taken at 15-minute increments. Grab samples were also collected during monthly field trips. Low dissolved oxygen readings can interfere with reproductive success and physiological processes of macroinvertebrates and fish, and can lead to death in cases when dissolved oxygen is suppressed to low levels for an extended period. Low dissolved oxygen levels typically result from excessive algal growth, the decomposition of large amounts of organic material, or the breakdown of certain compounds, such as ammonia.

MEASURE(S) OF CONDITION: Number sites with average daily means below water quality criteria (Class B: <5 mg/L DO). Number sites with average daily minimums below water quality criteria. Number of sites with grab samples below water quality criteria.

OUTCOME: For the continuous data records, all average daily means and average daily minimums were above water quality criteria. For grab samples, three sites had a single sample with a minimum reading below water quality criteria and the average readings across sites ranged from 7.78 to 9.55 mg/L (Table 3).

Table 3. RMN non-wadeable site dissolved oxygen continuous logger and monthly grab sample results.

Site	Continuous Data		Grab Samples	
	Average Daily Mean	Average Daily Minimum	Average	Minimum
01-AND	9.03	8.85	8.56	7.00
01-CNT	8.58	8.24	8.26	6.58
01-MER	9.42	9.06	8.09	5.42
01-SAC	9.92	9.54	8.76	6.00
02-CTC	8.06	7.69	8.07	6.00
02-ISG	8.22	7.52	8.02	4.52
02-SHG	8.89	8.07	8.69	4.80
08-MER	8.25	7.65	8.38	4.60
18-CCH	8.47	8.16	7.78	6.20
23-PMI	9.30	8.67	9.55	6.06
27-MER	No Data		7.78	6.20
58-CNT	8.15	8.02	8.43	6.25

3.1.5 Temperature

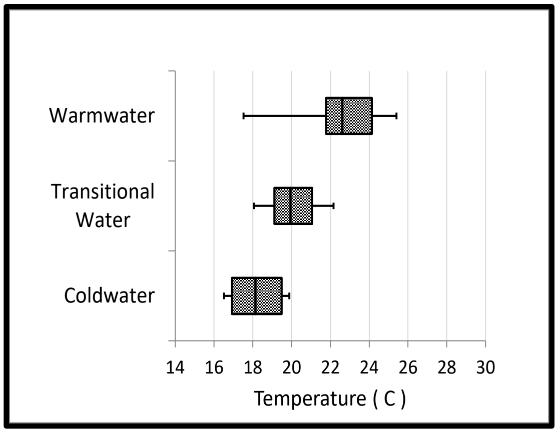
Water temperature is an important physical characteristic that structures aquatic communities. A loss of riparian vegetation, upstream damming, industrial discharges and global climate change can influence a river's natural thermal regime. High water temperatures increase the respiration rate of aquatic organisms, which in turn, increases their consumption of dissolved oxygen. As water temperatures warm, the amount of dissolved oxygen water it can contain is reduced.

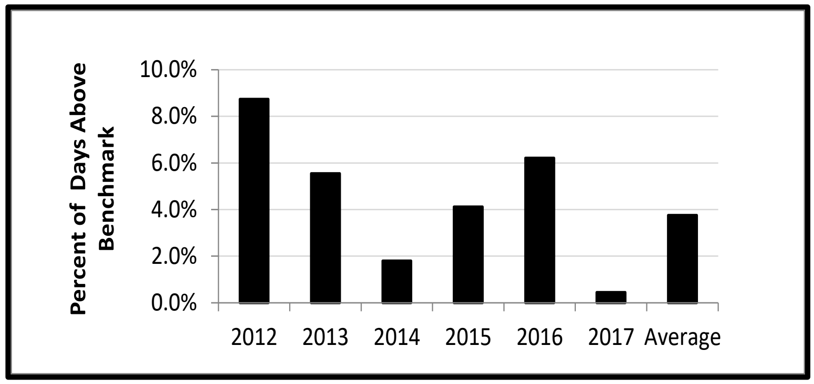
Water temperature was measured at all RMN sites during monthly field trip visits; however, data analysis was restricted to wadeable sites where continuous data loggers were deployed throughout the summer. Continuous data loggers deployed from 2012 to 2016 provided hourly data for individual sites for 90 to 120 days resulting in 2,000 to 3,000 data points annually. RMN sites were classified by their natural expected water temperatures as coldwater, transitional water, or warmwater. High temperature benchmarks used for coldwater, transitional water and warmwater streams were 18, 20 and 24 degrees Celsius, respectively, and are based on a consolidation of known thermal limits for fish and previous analysis of water temperature data from New Hampshire rivers and streams.

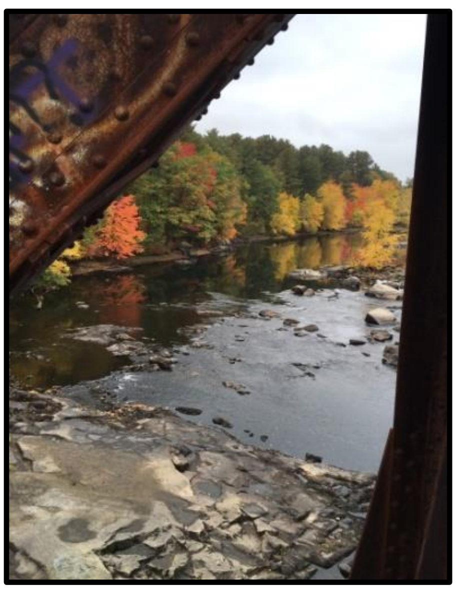
MEASURE(S) OF CONDITION: The 7-day maximum average daily water temperature. Percentage of days average daily water temperature exceeded water temperature benchmarks.

OUTCOME: The 7-day maximum average daily water temperature was 18^{o}C for coldwater streams, 20^{o}C for transitional water streams, and 23^{o}C for warmwater streams (Figure 7). The percentage of days average daily water temperature exceeded water temperature benchmarks was 3.8% (Figure 7).

Figure 7. The 7-day maximum average daily water temperature summary (left) and percent of days average daily water temperature exceeded water temperature benchmarks (right) for wadable RMN sites. For left graph: Leftmost whisker=5th percentile, rightmost whisker =95th percentile, left side of box=25th percentile, right side of box=75th percentile, line through middle of box=median.







3.2 Long-term condition changes

Trend analyses were completed for specific conductance, pH, total phosphorus, and total nitrogen only for sites where 10 or more years of data were available (Table 4). Data for these sites spanned from 1990 to 2016. An annual median was computed for each year based on grab sample data collected monthly from May through September. The trend analysis was used to determine if each parameter was stable, increasing, or decreasing over time. For specific conductance, total nitrogen, and total phosphorus, an increasing trend represents worsening conditions. For pH, an increasing trend represents improving conditions.

Measure(s) of condition: For each indicator, the number and percentage of sites with stable, increasing and decreasing trends.

Outcomes:

Specific conductance – Twelve sites (30%) had a no trend (stable), five sites (13%) had an increasing (worsening) trend and one site (3%) had a decreasing (improving) trend (Table 4). Trend analyses were not possible at 22 sites because less than 10 years of continuous data existed.

pH – Eleven sites (28%) had no trend (stable), six sites (15%) had a decreasing (worsening) trend and one site (3%) had an increasing (improving) trend (Table 4). Trend analyses were not possible at 22 sites because less than 10 years of continuous data existed.

Total phosphorus – Seven sites (18%) had no trend (stable), zero sites had and increasing (worsening) trend and 6 sites (15%) had a decreasing (improving) trend (Table 4). Trend analyses were not possible at 27 sites because less than 10 years of continuous data existed.

Total nitrogen – Eight sites (20%) had no trend, zero sites had an increasing trend, and three (8%) had a decreasing (improving) (Table 4). Trend analyses were not possible at 29 sites because less than 10 years of continuous data existed.

Table 4. Outcome of trend analysis for RMN sites.

Water Quality Parameter	Outcome of Trend Analysis			Number Sites with 10 or more years of data for trend analysis
	No Trend (Stable)	Increasing Trend	Decreasing Trend	
Specific Conductance	12	5	1	18
pH	11	1	6	18
Total Phosphorus	7	0	6	13
Total Nitrogen	8	0	3	11

3.3 Short-term condition changes

The analysis of changes in conditions over a period of approximately 10 years documents abrupt shifts in water quality conditions which may be tied to dramatic changes in environmental conditions or human stressors. Results from the 2012 through 2016 were compared to results from 2005 through 2011 where data were available for specific conductance, nutrients (total phosphorus and total nitrogen), and pH.

MEASURE(S) OF CONDITION: For each indicator, the number of sites that did not change, decreased, or increased when the data from period of 2005-2011 was compared to data from the period of 2012-2016.

OUTCOME: Changes did not occur at 13 to 16 sites for each indicator. Decreases occurred in six instances; one for specific conductance, one for pH, and four for total phosphorus. Six increases occurred; two for pH and four for specific conductance. Of the 160 analyses, 91 had no or only a small amount of data prior to 2012 and could not be analyzed.

Table 5. Number of RMN sites with and without short-term changes in water quality condition indicators. Periods of comparison = 2012-2016 vs. 2005-2011.

Parameter	Not enough data	No change	Decrease	Increase
Specific Conductance	21	14	1	4
pH	21	16	1	2
Total Phosphorus	22	14	4	0
Total Nitrogen	27	13	0	0

3.4Individual RMN site reports

As a compendium to this report, data summaries for each of the RMN sites have been prepared. These individual reports include a variety of graphics and tables that summarize the specific conditions at each site. The reports provide various site characteristics, indicator trend plots, comparisons of current to past data, statewide distribution and site median plots, biological condition graphics, and water temperature summaries (Appendix C). The reports are organized by the five major river basins in New Hampshire.

4.0 SUMMARY OF CONDITIONS

- Fourteen RMN sites had specific conductance levels above the 75th percentile of all rivers sampled in the state and an increasing trend was detected at five sites.
- Six RMN sites had improving phosphorus trends but 11 sites had concentrations above the 75th percentile of all rivers sampled in the state.
- Nitrogen data were less abundant but seven RMN sites had concentrations above the 75th percentile of all rivers sampled in the state and trends were improving at three sites.
- Median pH values for the reporting period were below state water quality criteria for 16 RMN sites and six sites had worsening trends.
- Aquatic life, based on macroinvertebrates, was considered “healthy” at 22 wadeable RMN sites and in poor condition at six wadeable RMN sites. For non-wadeable streams, none of the sites had daily average dissolved oxygen concentrations below water quality criteria.
- The 7-day maximum daily water temperature was within the expected range for coldwater, transitional water, and warmwater streams within the RMN. The number of days the average daily water temperature exceeded expected benchmarks was 3.8%.
- Supplementary observations noted that RMN sites with elevated percentages of developed lands tended to have high specific conductance levels, high nutrient concentrations, and biological communities near or below “healthy” conditions.

Appendix A. RMN sites.

Sample Station ID	River Name	Town	Type	Latitude	Longitude	Assessment Unit ID (AUID)	Waterbody classification
01-AND	Androscoggin River	Gildead, ME	nonwadeable	44.3981	-70.9716	MERIV400020103-06	B
01-CNT	Connecticut River	Northfield, MA	nonwadeable	42.6836	-72.4714	MARIV802010501-05	B
01-MER	Merrimack River	Tyngsborough, MA	nonwadeable	42.6760	-71.4213	MARIV700061206-24	B
01-SAC	Saco River	Fryeburg, ME	nonwadeable	44.0169	-70.9899	MERIV600020305-02	B
02-CTC	Contoocook River	Boscawen	nonwadeable	43.2849	-71.5966	NHIMP700030507-07	B
02-ISG	Isinglass River	Rochester	nonwadeable	43.2334	-70.9554	NHRIV600030607-10	B
02-SHG	Souhegan River	Merrimack	nonwadeable	42.8606	-71.4930	NHRIV700060906-18	B
08-MER	Merrimack River	Manchester	nonwadeable	42.9360	-71.4565	NHRIV700060803-14-02	B
18-CCH	Cocheco River	Rochester	nonwadeable	43.2743	-70.9772	NHIMP600030607-02	B
23-PMI	Pemigewasset River	Woodstock	nonwadeable	44.0221	-71.6820	NHRIV700010203-01	B
27-MER	Merrimack River	Concord	nonwadeable	43.2710	-71.5645	NHRIV700060302-24	B
58-CNT	Connecticut River	Lancaster	nonwadeable	44.4961	-71.5944	NHRIV801010902-03	B
01-JWT	Jewett Brook	Laconia	wadeable	43.5325	-71.4654	NHRIV700020201-16	B
01K-HOB	Hodgson Brook	Portsmouth	wadeable	43.0693	-70.7785	NHRIV600031001-04	B
01-MSC	Mascoma River	Lebanon	wadeable	43.6338	-72.3174	NHRIV801060106-20	B
01-SGR	Sugar River	Claremont	wadeable	43.3983	-72.3939	NHRIV801060407-16	B
01T-MKB	Mink Brook	Hanover	wadeable	43.6920	-72.2710	NHRIV801040401-05	B
01T-SOP	South Branch Piscataquog River	New Boston	wadeable	42.9823	-71.6826	NHRIV700060606-05	B
01-TYB	Tully Brook	Richmond	wadeable	42.7365	-72.2322	NHRIV802020203-05	B
01X-OTB	Otter Brook	Roxbury	wadeable	42.9713	-72.2162	NHRIV802010201-19	B
02-ASH	Ashuelot River	Hinsdale	wadeable	42.7861	-72.4865	NHRIV802010403-19	B
02-BBO	Bear Brook	Allenstown	wadeable	43.1452	-71.3552	NHRIV700060503-16	B
02-CLD	Cold River	Walpole	wadeable	43.1321	-72.3904	NHRIV801070203-09	B
02E-NSR	North Branch Sugar River	Croydon	wadeable	43.4154	-72.1804	NHRIV801060404-11	B

Sample Station ID	River Name	Town	Type	Latitude	Longitude	Assessment Unit ID (AUID)	Waterbody classification
02-GNB	Grant Brook	Lyme	wadeable	43.8075	-72.1636	NHRIV801040204-02	B
02-ISR	Israel River	Lancaster	wadeable	44.4879	-71.5696	NHRIV801010806-09	B
03-AMM	Ammonoosuc River	Bath	wadeable	44.1548	-71.9819	NHRIV801030506-10	B
04-SBB	Stratford Bog Brook	Stratford	wadeable	44.6835	-71.5348	NHRIV801010602-03	B
05-NWL	Newell Brook	Dummer	wadeable	44.6863	-71.2254	NHRIV400010602-10	B
05-SMS	Simms Stream	Columbia	wadeable	44.8492	-71.4931	NHRIV801010403-02	B
06-EBS	East Branch Saco River	Bartlett	wadeable	44.1219	-71.1303	NHRIV600020301-03	B
06-SBR	South Branch Baker River	Wentworth	wadeable	43.8187	-71.9305	NHRIV700010304-12	B
07-BLM	Bellamy River	Madbury	wadeable	43.1744	-70.9178	NHRIV600030903-08	A
07-FLT	Flints Brook	Hollis	wadeable	42.7266	-71.5562	NHRIV700040402-03	B
07T-ISG	Isinglass River	Barrington	wadeable	43.2388	-71.0766	NHRIV600030607-01	B
09-OYS	Oyster River	Lee	wadeable	43.1483	-70.9657	NHRIV600030902-04	A
10-WNR	Warner River	Bradford	wadeable	43.2675	-71.9188	NHRIV700030302-12	B
14-ISR	Israel River	Jefferson	wadeable	44.4119	-71.4978	NHRIV801010806-06	B
15-EXT	Exeter River	Brentwood	wadeable	42.9847	-71.0384	NHRIV600030803-05	B
22-AMM	Ammonoosuc River	Bethlehem	wadeable	44.2716	-71.6316	NHRIV801030403-01	B

Appendix B. RMN site characteristics.

Sample Station ID	River Name	Elevation (ft)	Upstream Drainage Area (sq. mi.)	Size Class	Development Category	Expected fish assemblage type	Year of trend sample initiation	Number of years of data	% developed lands
01-AND	Androscoggin River	674	1536	Large	Low	warmwater	1990	26	1.6
01-CNT	Connecticut River	173	6721	Large	Moderate	warmwater	1990	26	4.9
01-MER	Merrimack River	93	4060	Large	High	warmwater	1994	22	10.1
01-SAC	Saco River	391	425	Large	Moderate	warmwater	1990	26	4.2
02-CTC	Contoocook River	271	763	Large	Moderate	warmwater	1990	26	5.9
02-ISG	Isinglass River	114	74	Medium	High	warmwater	2012	5	7.7
02-SHG	Souhegan River	94	169	Large	High	warmwater	1995	21	12.1
08-MER	Merrimack River	110	3086	Large	High	warmwater	1990	26	7.0
18-CCH	Cocheco River	160	80	Large	High	warmwater	2012	5	14.0
23-PMI	Pemigewasset River	704	181	Large	Low	warmwater	1990	26	2.4
27-MER	Merrimack River	240	2359	Large	Moderate	warmwater	1990	26	5.3
58-CNT	Connecticut River	815	1243	Large	Low	warmwater	1990	26	2.3
01-JWT	Jewett Brook	512	5	Small	High	transitional water	2013	4	27.3
01K-HOB	Hodgson Brook	21	4	Small	High	warmwater	2013	4	81.5
01-MSC	Mascoma River	358	195	Large	Moderate	warmwater	2013	4	5.4
01-SGR	Sugar River	298	272	Large	High	warmwater	2012	5	7.1
01T-MKB	Mink Brook	502	16	Medium	High	transitional water	2013	4	6.4
01T-SOP	South Branch Piscataquog River	392	56	Medium	Moderate	warmwater	2013	4	6.0
01-TYB	Tully Brook	940	5	Small	Moderate	transitional water	2013	4	3.4
01X-OTB	Otter Brook	826	41	Medium	Moderate	warmwater	2013	4	4.7
02-ASH	Ashuelot River	235	421	Large	High	warmwater	1990	26	6.3
02-BBO	Bear Brook	369	10	Small	Moderate	warmwater	2013	4	4.3
02-CLD	Cold River	396	83	Large	Moderate	warmwater	2012	5	4.6
02E-NSR	North Branch Sugar River	826	68	Medium	High	warmwater	2013	4	6.1

Sample Station ID	River Name	Elevation (ft)	Upstream Drainage Area (sq. mi.)	Size Class	Development Category	Expected fish assemblage type	Year of trend sample initiation	Number of years of data	% developed lands
02-GNB	Grant Brook	489	13	Small	Low	coldwater	2013	4	2.1
02-ISR	Israel River	865	133	Large	Low	warmwater	2013	4	2.9
03-AMM	Ammonoosuc River	466	395	Large	Moderate	warmwater	2012	5	4.9
04-SBB	Stratford Bog Brook	1063	17	Medium	Low	transitional water	2013	4	1.7
05-NWL	Newell Brook	1276	7	Small	Low	coldwater	2013	4	0.0
05-SMS	Simms Stream	1263	28	Medium	Low	transitional water	2013	4	1.2
06-EBS	East Branch Saco River	801	34	Medium	Low	transitional water	2013	4	0.8
06-SBR	South Branch Baker River	793	31	Medium	Low	transitional water	2013	4	1.6
07-BLM	Bellamy River	93	23	Medium	High	warmwater	2012	5	9.5
07-FLT	Flints Brook	178	5	Small	High	warmwater	2013	4	15.2
07T-ISG	Isinglass River	235	58	Medium	Moderate	warmwater	2013	4	5.6
09-OYS	Oyster River	69	12	Small	High	warmwater	2013	4	11.1
10-WNR	Warner River	610	58	Medium	Moderate	warmwater	2013	4	4.4
14-ISR	Israel River	1052	71	Medium	Low	transitional water	2013	4	2.7
15-EXT	Exeter River	65	63	Medium	High	warmwater	2013	4	10.2
22-AMM	Ammonoosuc River	1183	88	Large	Moderate	warmwater	2012	5	4.0