Mount Hope Bay Buoy Data Report:
2017 and 2018 Fixed-Site Continuous Monitoring

Massachusetts Department of Environmental Protection

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
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List of Acronyms

AU	Assessment Unit
AWQC	Ambient Water Quality Criteria
CMR	Code of Massachusetts Regulations
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
GHCN	Global Historical Climatology Network
IR	Massachusetts' 2016 Integrated List of Waters Report
MassDEP	Massachusetts Department of Environmental Protection
NBFSMN	Narragansett Bay Fixed-Site Monitoring Network
RFU	Relative Fluorescence Units
RIDEM	Rhode Island Department of Environmental Management
SNEP	Southeast New England Program
SUNA	Submersible Ultraviolet Nitrate Analyzer
SWQS	Massachusetts Surface Water Quality Standards (314 CMR 4.00)
TMDL	Total Maximum Daily Load
URI-GSO	University of Rhode Island – Graduate School of Oceanography

1.0 Introduction

In 2016, the Massachusetts Department of Environmental Protection (MassDEP) partnered with the Rhode Island Department of Environmental Management (RIDEM) and the University of Rhode Island Graduate School of Oceanography (URI-GSO) on a successful grant proposal to the Environmental Protection Agency's (EPA's) Southeast New England Program (SNEP) for Coastal Watershed Restoration. The proposal, "Expanding Monitoring in Narragansett Bay Through Bi-State Partnership," supported expansion of the existing Narragansett Bay Fixed-Site Monitoring Network (NBFSMN) into the Massachusetts portion of Mount Hope Bay, a tidal sub-embayment of upper Narragansett Bay (Figure 1). The scope of the proposal was an initial four-year expansion, beginning in 2017, that could evolve into a long-term bi-state collaborative effort to continuously monitor water quality conditions in Mount Hope Bay.

2.0 Purpose of the Buoy Data

Continuous (unattended) water quality monitoring in Mount Hope Bay helps to address coastal monitoring data gaps and facilitates a more comprehensive assessment of water quality in the Massachusetts portion of the bay. These data support multiple MassDEP water quality management objectives, including: evaluation of potential revisions to coastal and marine criteria in the Massachusetts Surface Water Quality Standards (SWQS) at 314 Code of Massachusetts Regulations (CMR) 4.00 (MassDEP, 2013); calculation of effluent discharge limits to protect against pollutants that may cause or contribute to impairments in the bay; and application of water quality assessment procedures to support Clean Water Act (CWA) Section 305b and 303d decisions.

There are two water quality assessment units (AUs) in Mount Hope Bay: MA61-06 (Class SB in the SWQS) and MA61-07 (Class SA) (Figure 1). In Massachusetts' 2016 Integrated List of Waters Report (IR), both Mount Hope Bay AUs are listed as impaired for their designated uses due to multiple water quality stressors. Designated uses include aquatic life, primary and secondary contact recreation, and shellfish harvesting. Listed aquatic life impairments for MA61-06 in the 2016 IR are temperature, chlorophyll *a*, and total nitrogen. Dissolved oxygen (DO), chlorophyll *a*, temperature, and total nitrogen are listed aquatic life impairments for MA61-07.

3.0 Methods

One monitoring buoy was deployed in each Mount Hope Bay AU from May to November in approximately the same locations in 2017 and 2018. One buoy was deployed near the mouth of Taunton River ("Taunton buoy") within MA61-06 (41.70112 N, 71.187607W). The second buoy was deployed near the mouth of the Cole River ("Cole buoy") within MA61-07 (41.702001 N, 71.215952 W). Figure 1 shows the location of both buoys in Mount Hope Bay.

Under the direction of MassDEP, URI-GSO staff deploy, maintain, and retrieve the monitoring buoys in accordance with NBFSMN protocols. Each buoy (YSI EMM 770 water-quality monitoring module)

contains two YSI EXO2 water quality monitoring sondes and one Sea-Bird Scientific Submersible Ultraviolet Nitrate Analyzer (SUNA). One YSI sonde and the SUNA are deployed at approximately 1.0 meter below the surface ("Surface"), and the other YSI sonde is deployed approximately 0.5 meters above the sea floor ("Bottom") (Figure 2).

The saltwater-calibrated SUNA is outfitted with a 10mm optical pathlength and has no real-time temperature-salinity correction. The SUNA measures parameter data every hour, and the YSI sondes measure parameter data every 15 minutes. Water quality parameters measured by each device are listed in Table 1. Data are stored internally and telemetered via cellular communications to computers at URI-GSO and MassDEP.

Table 1. Parameters recorded by each data logger.

YSI EXO 2	Sea-Bird SUNA V2
Depth (meters)	Nitrate-Nitrogen (NO_3-N) (mg N/L)
Temperature (°C)	
Dissolved Oxygen (mg/L)	
Dissolved Oxygen Saturation (%)	
Specific Conductance (µS/cm)	
Salinity (Practical Salinity Units)	
pH (Standard Units)	
Chlorophyll (Relative Fluorescence Units (RFU))	
Phycoerythrin (Blue-Green Algae [Marine]; RFU)	

4.0 Quality Assurance and Quality Control

URI-GSO staff follow field and laboratory quality assurance and control procedures in accordance with NBFSMN protocols and the EPA-approved NBFSMN program QAPP (RIDEM, 2016), revised as needed for MassDEP's buoys. Discrete, co-located water samples were collected monthly for URI-GSO analysis for NO_3-N and chlorophyll *a* (and other nutrients) to compare to probe readings.

Summary raw data files were provided to MassDEP by URI-GSO, along with quality control information and metadata. Data validation and finalization were conducted by MassDEP staff using internal procedures for continuous (unattended) water quality data validation (MassDEP, 2015). If necessary, data were censored (do not use) or qualified (usable with caveat(s)).

5.0 Results

Data from the 2017 and 2018 monitoring seasons were modified prior to analyses: (1) data entries that had no reported values (due to being censored or missing) were excluded, (2) data entries marked qualified were included, and (3) non-detects were set to half of the detection limit. The total number of data points available per site and year are listed in

Table ***2***.

Estimated chlorophyll data using the probes were finalized as “chlorophyll” and in units of Relative Fluorescence Units (RFU). Fluorescence sensors on the sondes were not calibrated using a certified primary standard; thus, reported values are a relative change in measured fluorescence over time and not directly related to chlorophyll *a* concentration in units of mass per volume (i.e., µg/L). Phycoerythrin data were also reported in RFUs, but were largely censored due to poor quality control. Therefore, phycoerythrin data are not reported here.

Throughout this section, summary data are presented in both tables and boxplots. Sampling abbreviations used in the summary tables are listed in Table 3. Figure 3 is an example boxplot with labels to guide interpretation of other boxplots. Finally, a day (for purposes of calculating daily minima, for example) is defined as all data collected on the same calendar date between 0000 and 2345 buoy time.

Figure 1. Buoy deployment locations in Mount Hope Bay.

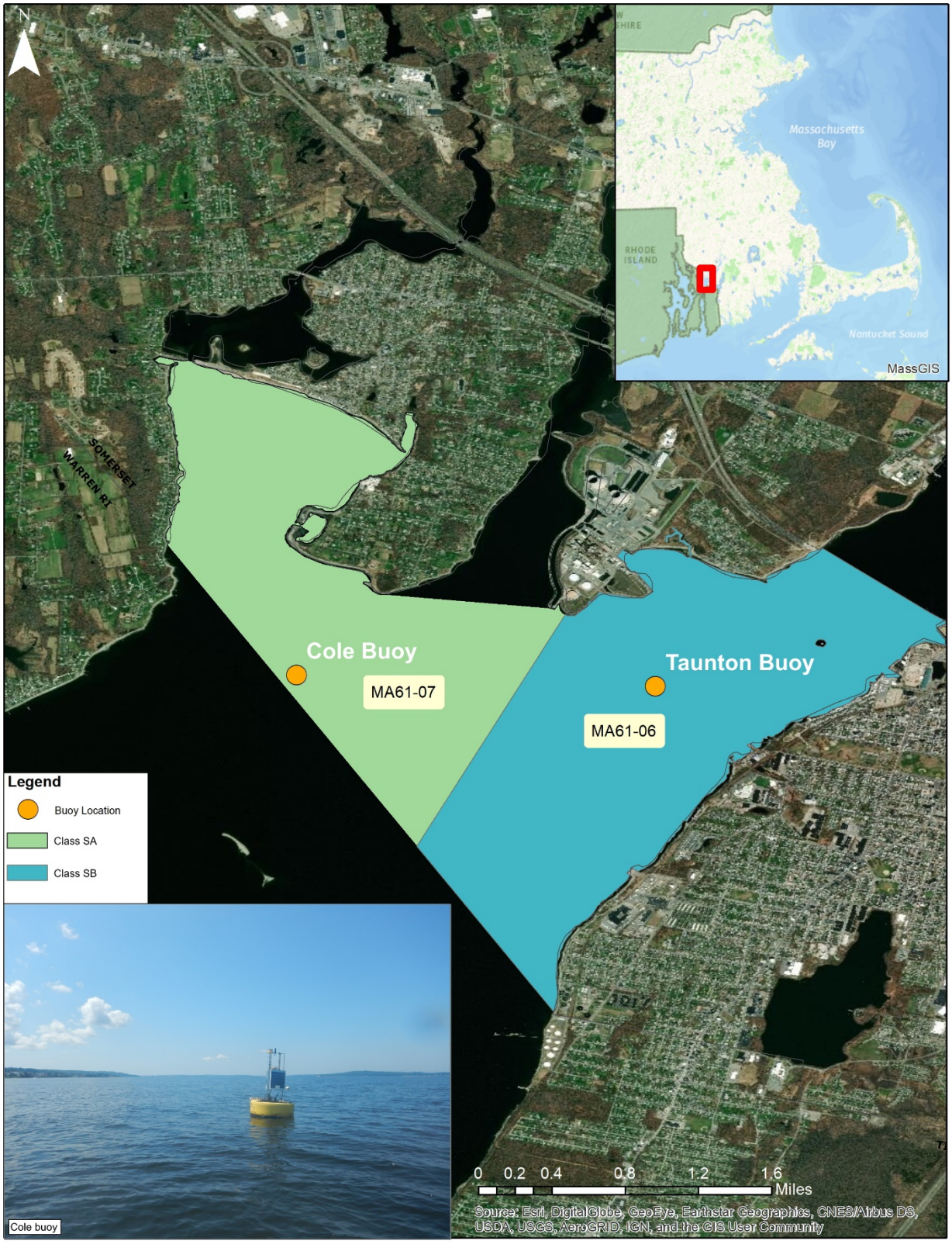


Figure 2. Buoy schematic *in-situ*.

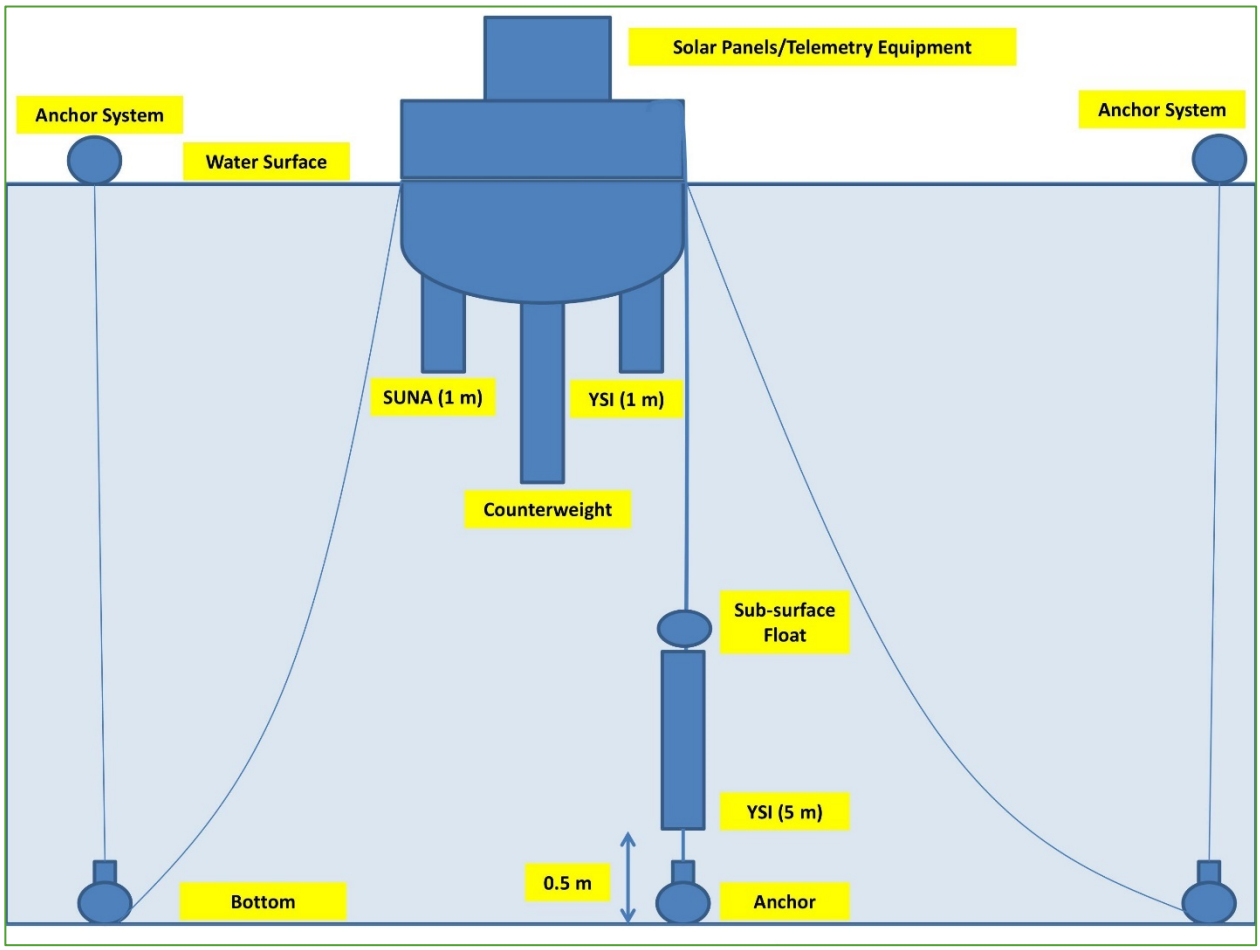


Table 2. Number of data points available for analysis (censored or missing data are excluded, but qualified data are included).

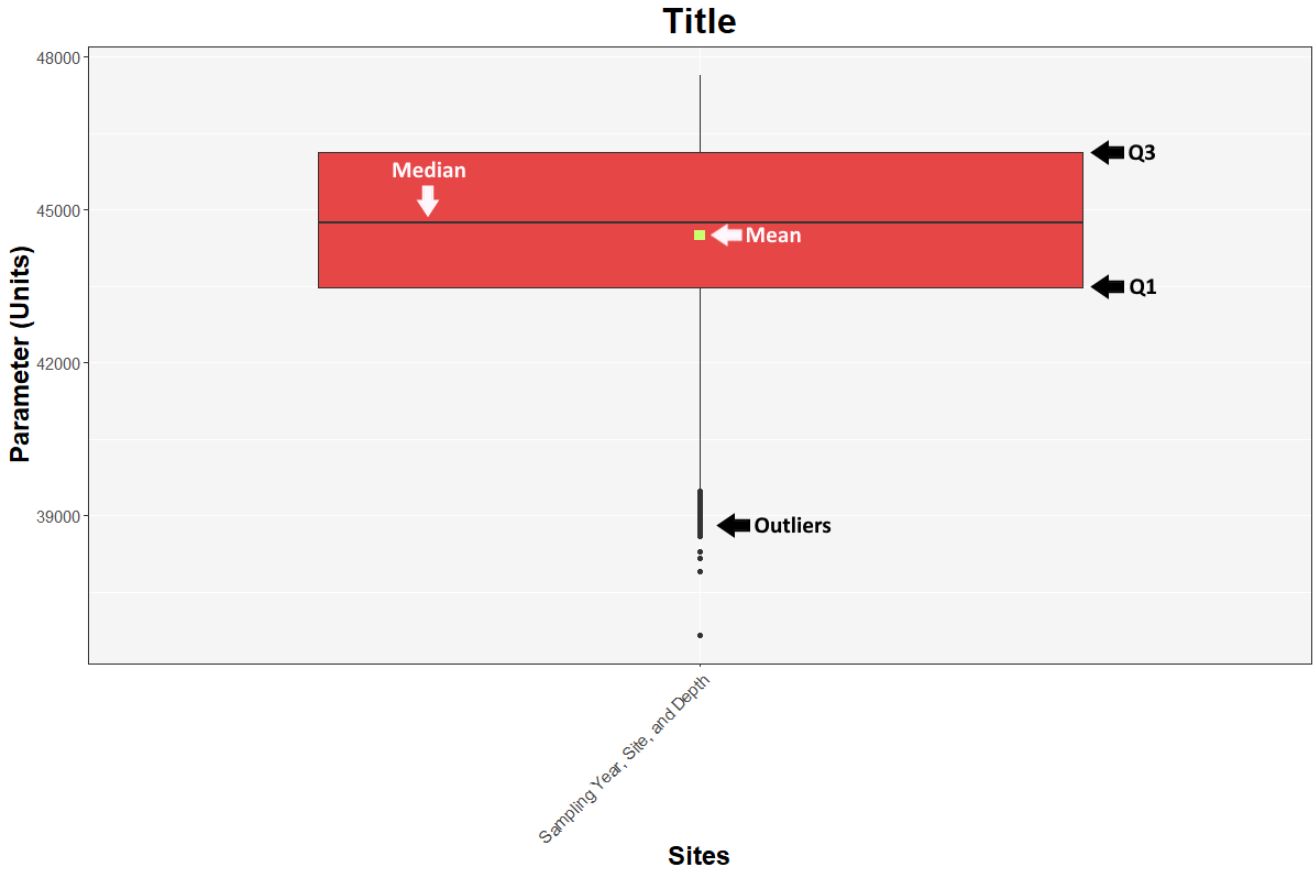
		Number of Data Points													
		D.O.		Temp.		pH		Sp. Cond.		CHL.		NO_3-N		Depth	
Site	Depth	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Cole	Surface	13170	15495	16614	15495	16459	15495	16611	15495	16606	15493	3480	3014	N/A[1]	N/A[1]
Cole	Bottom	15867	15639	16348	15639	16348	15637	16341	15639	12757	15639	N/A[2]	N/A[2]	16348	15639
Taunton	Surface	13749	15642	15950	15643	15950	15643	15949	15643	15876	15642	3875	3664	N/A[1]	N/A[1]
Taunton	Bottom	16523	15191	16607	15191	16516	14102	16447	15184	16461	10909	N/A[2]	N/A[2]	16607	15190

Table 3. Site and sampling abbreviations used in Section 5.0.

Abbreviation	Description
CRS17	Data collected from the surface waters at the Cole buoy in 2017.
CRB17	Data collected from the bottom waters at the Cole buoy in 2017.
CRS18	Data collected from the surface waters at the Cole buoy in 2018.
CRB18	Data collected from the bottom waters at the Cole buoy in 2018.
TRS17	Data collected from the surface waters at the Taunton buoy in 2017.
TRB17	Data collected from the bottom waters at the Taunton buoy in 2017.
TRS18	Data collected from the surface waters at the Taunton buoy in 2018.
TRB18	Data collected from the bottom waters at the Taunton buoy in 2018.

[1] Surface sondes were set approximately 1.0 meter below the water surface. Note that any recorded deviations from this value could be attributed to atmospheric and water column pressure differences over the deployment period, and surface depth data were not explored/evaluated in this data report.
[2] SUNAs were only deployed at the surface depth.

Figure 3. Example boxplot schematic.



5.1 Dissolved Oxygen

Summary statistics for dissolved oxygen concentrations (minimum, 25th percentile (Q1), 50th percentile (median), mean, 75th percentile (Q3), and maximum) are in Table 4 and Figure 4 for both buoys. Overall, the average dissolved oxygen concentration was lower in the bottom waters of the bay compared to the surface regardless of site or year, with the bottom waters experiencing dissolved oxygen concentrations of <3 mg/L for parts of the year.

Table 4. Summary statistics for dissolved oxygen concentrations in milligrams per liter (mg/L) for the Cole and Taunton buoys deployed in Mount Hope Bay.

DO Statistics	CRS17	CRB17	CRS18	CRB18	TRS17	TRB17	TRS18	TRB18
				(mg/L)				
Minimum	5.27	0.84	4.61	2.43	4.95	2.01	4.38	2.96
Q1	7.31	4.46	6.85	4.41	6.89	5.28	6.43	4.97
Median	7.73	5.95	7.43	5.40	7.33	6.11	7.15	5.80
Mean	7.96	5.56	7.54	5.45	7.42	6.02	7.12	5.86
Q3	8.37	6.96	8.16	6.63	7.70	7.08	7.89	6.73
Max	14.05	10.30	10.60	8.20	13.47	9.37	9.41	9.17

Figure 4. Summary statistics for dissolved oxygen concentrations in milligrams per liter (mg/L) for the Cole and Taunton buoys deployed in Mount Hope Bay.

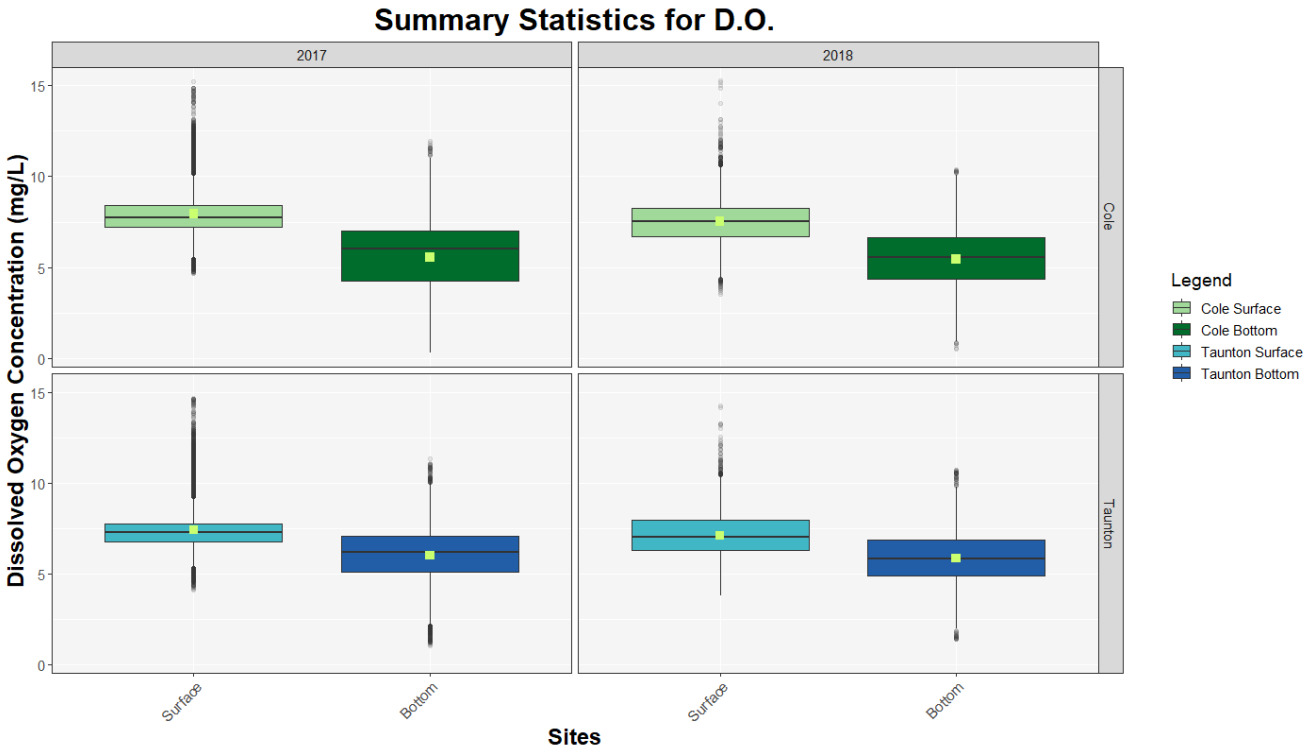


Figure 5 shows all dissolved oxygen concentrations for surface and bottom buoy measurements at both sites in 2017 and 2018. The dashed line represents the current numeric dissolved oxygen criterion for each location as defined in the SWQS. The Cole buoy is located in Class SA waters, and the Taunton buoy is located in Class SB waters. For Class SA waters, DO concentrations shall not be less than 6.0 mg/L unless naturally occurring. For Class SB waters, DO concentrations shall not be less than 5.0 mg/L unless naturally occurring (MassDEP, 2013).

Figure 6 shows daily minima dissolved oxygen concentrations for each buoy and differences in daily minima between surface and bottom waters by site and year, as well as in comparison to the site's dissolved oxygen criteria (for Class SA or Class SB). Figure 7 depicts the diel range of dissolved oxygen concentrations by year and depth for each buoy.

Dissolved oxygen concentrations varied between May and November each year, with higher diel ranges during the summer months. Data trends were relatively consistent between Cole and Taunton buoy sites each year; however, 2018 maintained a higher diel fluctuation later in the year compared to 2017. Daily minima concentrations followed a similar pattern, typically increasing after September. Overall, bottom dissolved oxygen concentrations were significantly lower than surface dissolved oxygen concentrations, dropping below respective criterion values more often during the summer months.

Figure 5. Dissolved oxygen concentrations in milligrams per liter (mg/L) for the Cole and Taunton buoys deployed in Mount Hope Bay.

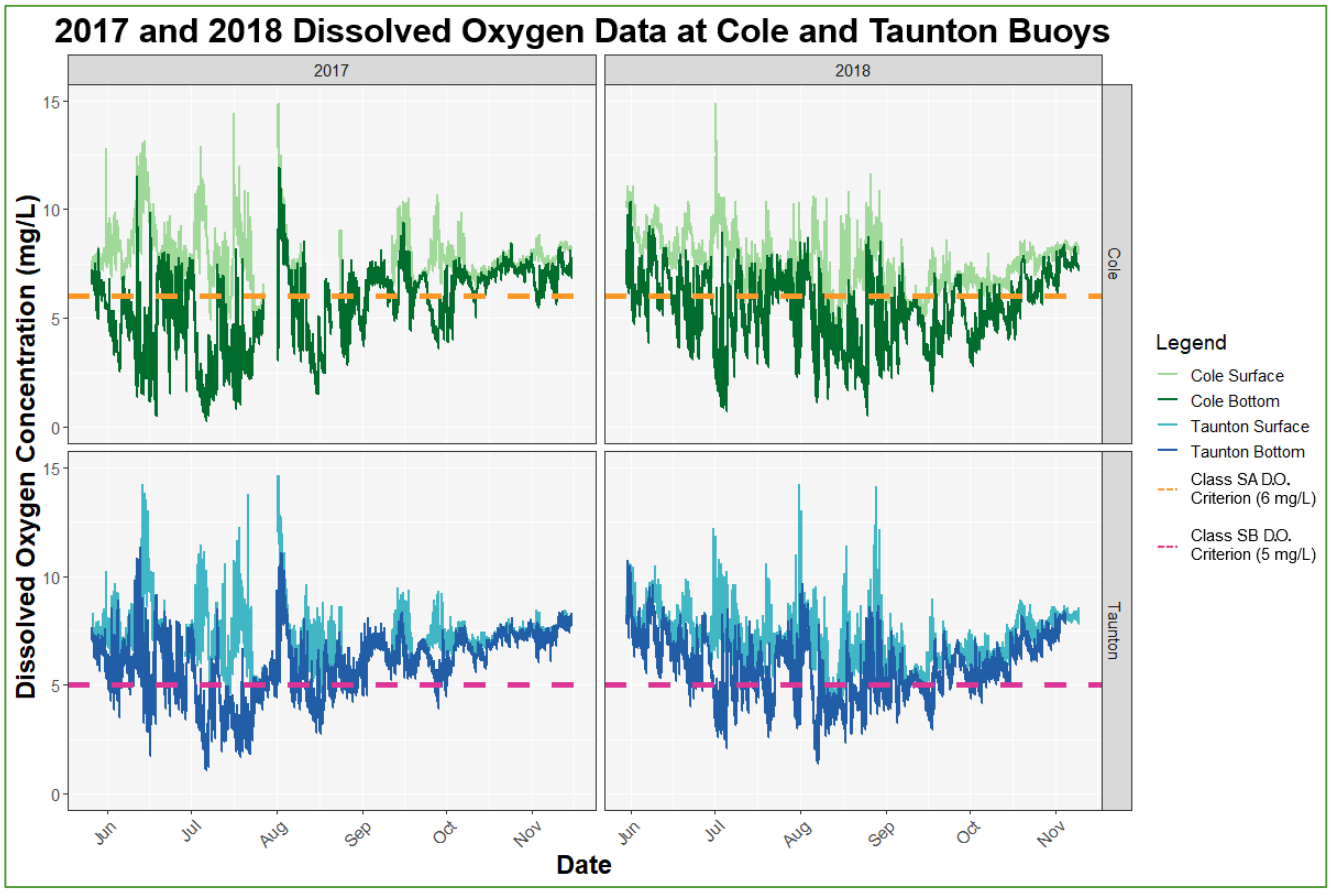


Figure 6. Daily minimum dissolved oxygen concentrations (daily minima) in milligrams per liter (mg/L) for the Cole and Taunton buoys deployed in Mount Hope Bay.

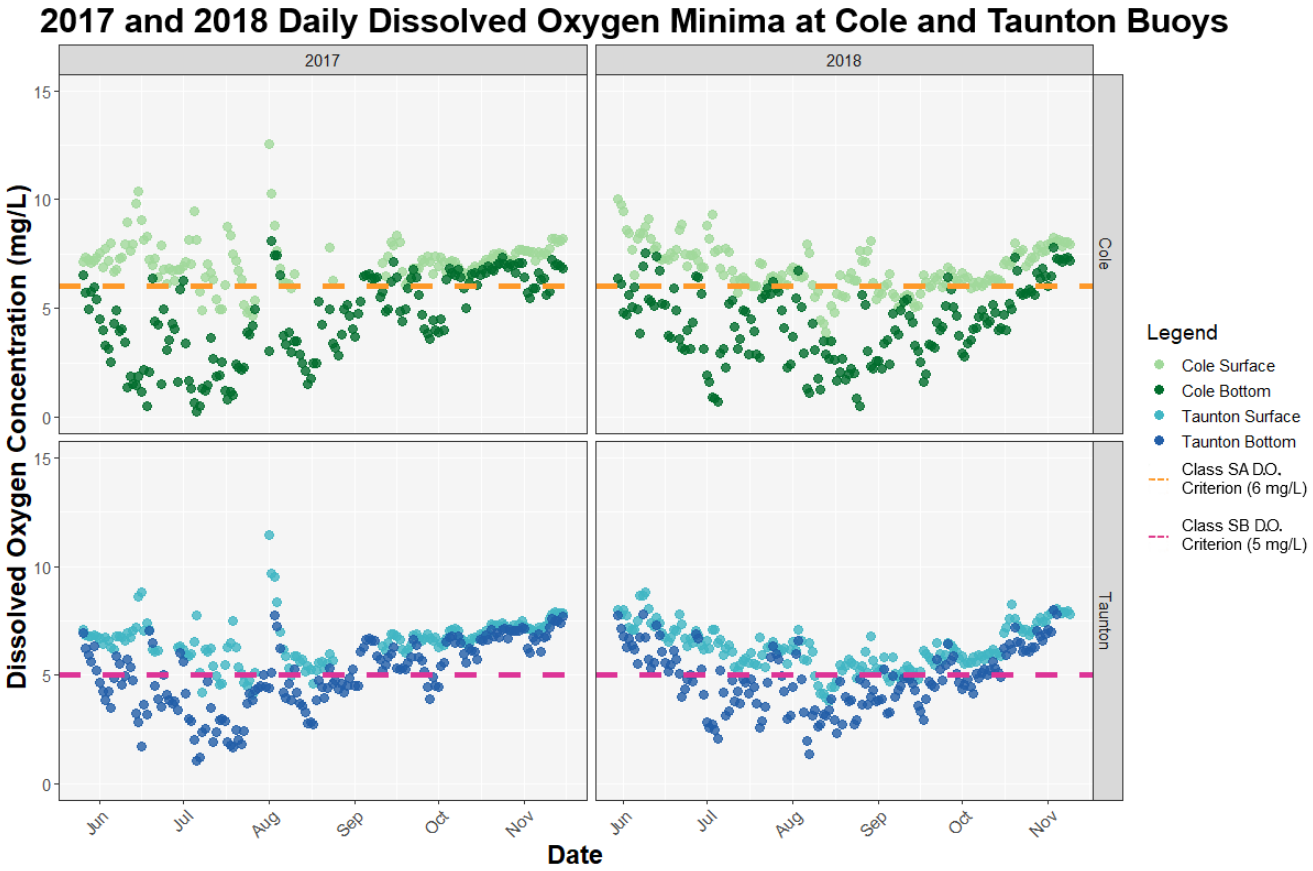
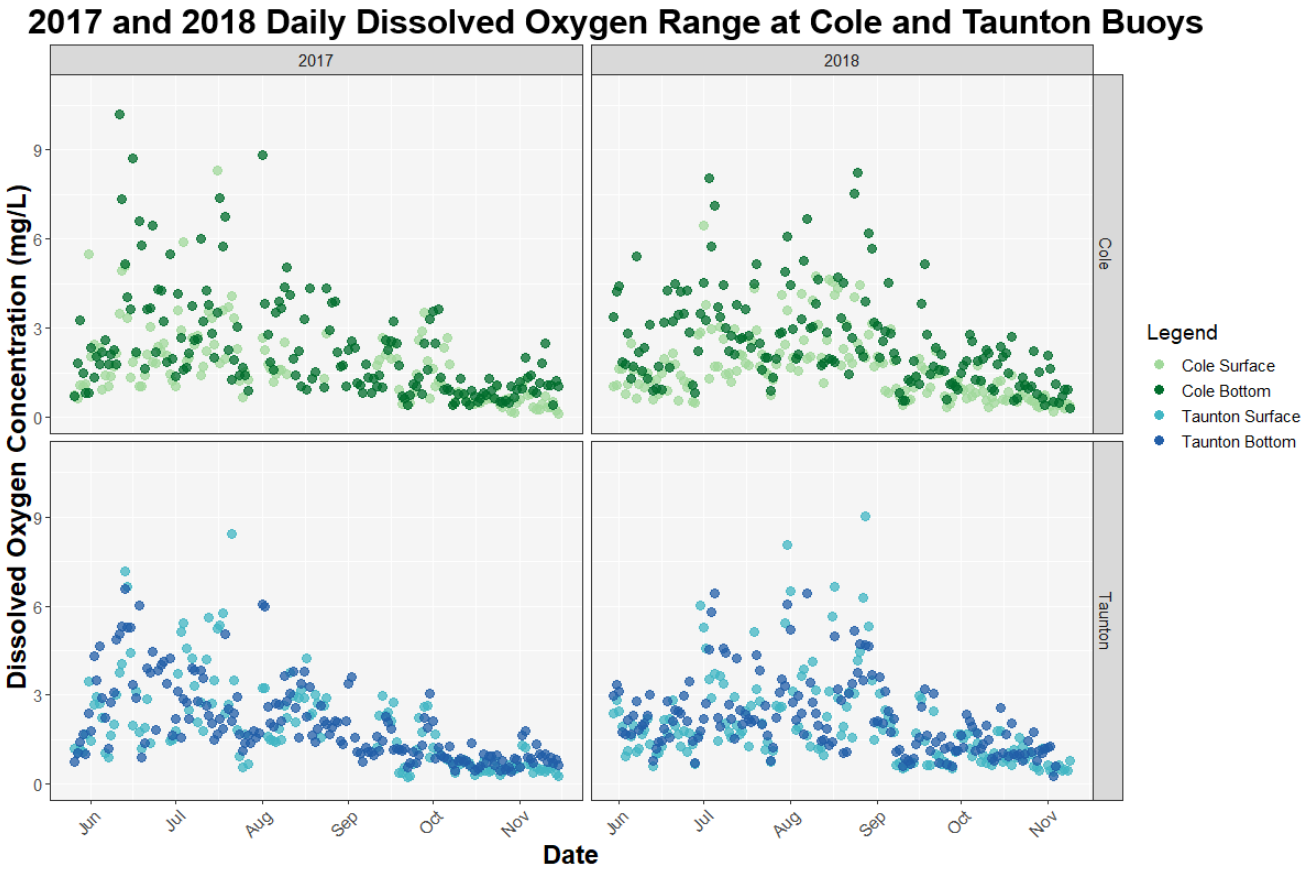


Figure 7. Daily differences between maximum and minimum dissolved oxygen concentrations (daily range) in milligrams per liter (mg/L) for the Cole and Taunton buoys deployed in Mount Hope Bay.



5.2 Temperature

Summary statistics for temperature data for the Cole and Taunton buoys are presented in Table 5 and displayed in

Figure ***8***. Average temperature was consistently lower in the bottom waters compared to the surface regardless of site or year. The 2018 deployment was also warmer than 2017, with average temperatures around 1 °C higher between years at each sampling location.

Table 5. Summary statistics for temperature data in degrees Celsius (°C) for the Cole and Taunton buoys deployed in Mount Hope Bay.

Temperature Statistics	CRS17	CRB17	CRS18	CRB18	TRS17	TRB17	TRS18	TRB18
				(°C)				
Minimum	10.2	10.6	10.0	12.3	10.4	11.3	11.2	12.2
Q1	18.2	17.3	18.7	18.2	17.9	17.7	18.5	19.1
Median	21.1	20.7	21.9	21.4	21.0	20.8	22.0	21.6
Mean	20.5	19.7	21.4	21.0	20.3	19.8	21.3	21.1
Q3	23.1	22.1	25.0	24.4	22.9	22.0	24.9	24.1
Max	28.4	24.7	29.7	28.1	27.7	24.5	29.4	28.0

Figure 8. Summary statistics for temperature data in degrees Celsius (°C) for the Cole and Taunton buoys deployed in Mount Hope Bay.

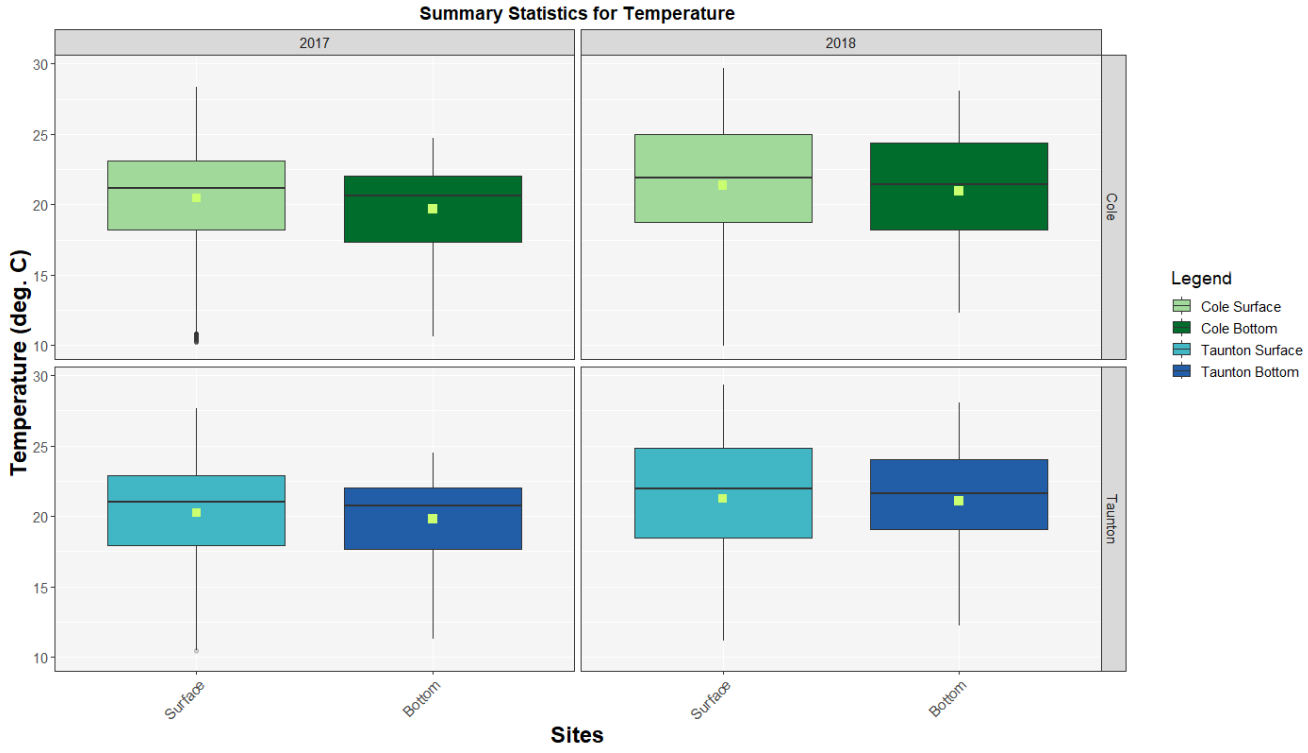


Figure 9 displays all temperature data for surface and bottom buoy measurements at both sites in 2017 and 2018. The dashed line represents the maximum temperature criterion of 29.4 °C, applicable to both Class SA and Class SB waters (MassDEP, 2013).

Figure 10 displays the daily mean temperature. The dashed line represents the maximum daily mean criterion of 26.7 °C for both Class SA and Class SB waters (MassDEP, 2013).

Figure 11 is the rolling 24-hour mean temperature. The dashed line represents the maximum daily mean criterion of 26.7 °C for both Class SA and Class SB waters (MassDEP, 2013).

Temperature in surface waters were typically greater than the bottom waters, with overall temperatures peaking during the summer months of July and August regardless of site or year (approaching 30 °C). During the late fall, Mount Hope Bay experienced temperatures close to 10 °C, with a significant drop in October. In general, temperatures were higher at both depths and sites during 2018 compared to 2017. The daily mean and rolling mean temperature followed a similar pattern to the continuous temperature data, with peaks around August of 2018.

Figure 9. Temperature data in degrees Celsius (°C) for the Cole and Taunton buoys deployed in Mount Hope Bay.

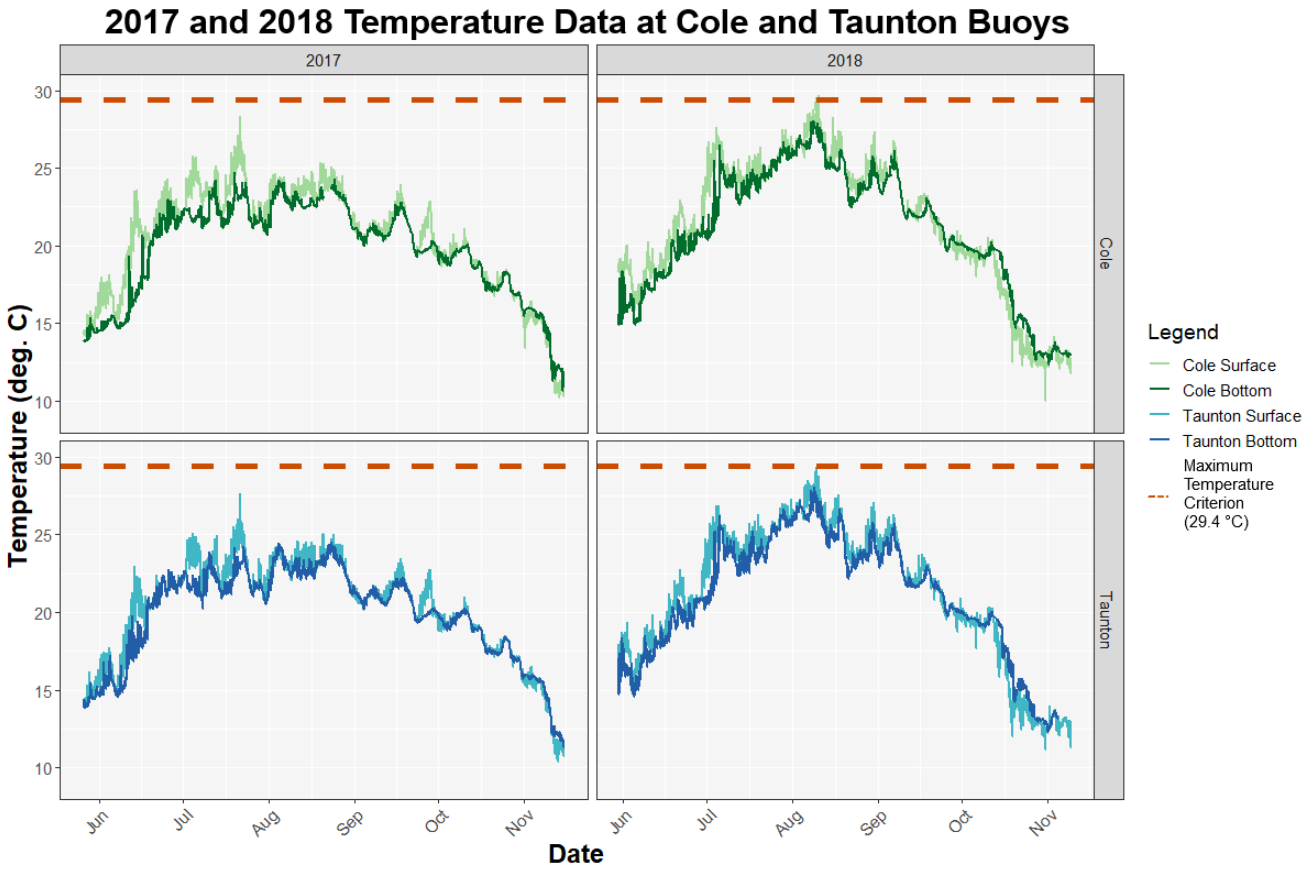


Figure 10. Daily mean temperature data in degrees Celsius (°C) for the Cole and Taunton buoys deployed in Mount Hope Bay.

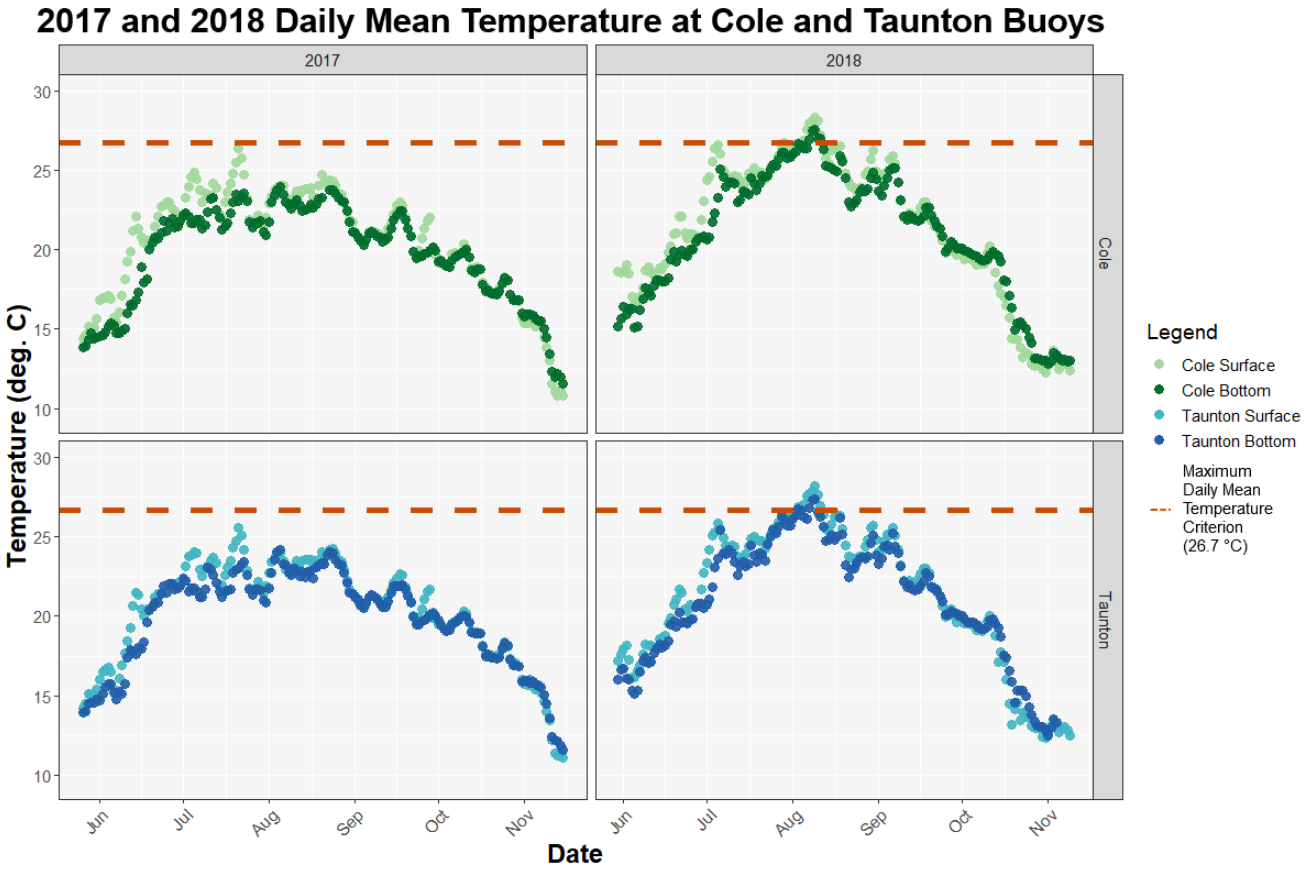
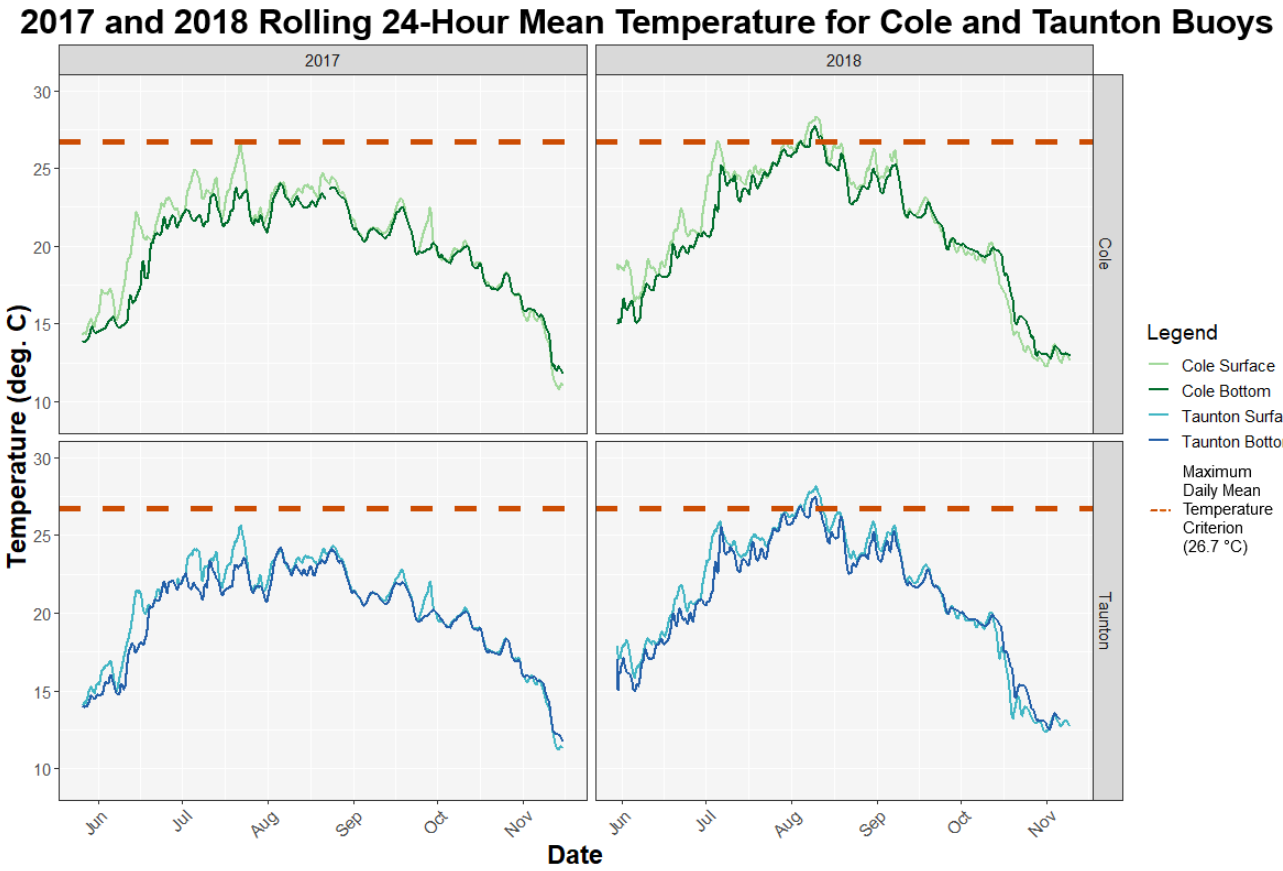


Figure 11. Rolling 24-hour mean temperature data in degrees Celsius (°C) for the Cole and Taunton buoys deployed in Mount Hope Bay.



5.3 pH

Summary statistics[3] for pH are in Table 6, Figure 12, and Figure 13. Average pH was consistently lower (more acidic) in the bottom waters compared to the surface regardless of site or year. The Cole buoy in 2017 had both the lowest and highest recorded pH out of all years, sites, and depths.

Table 6. Summary statistics for pH data in standard units (SU) for the Cole and Taunton buoys deployed in Mount Hope Bay.

pH Statistics	CRS17	CRB17	CRS18	CRB18	TRS17	TRB17	TRS18	TRB18
				(SU)				
Minimum	7.5	7.0	7.5	7.1	7.4	7.2	7.4	7.4
Q1	7.8	7.5	7.7	7.6	7.7	7.6	7.7	7.6
Median	7.9	7.7	7.9	7.7	7.8	7.7	7.8	7.7
Q3	8.1	7.8	8.0	7.8	8.0	7.8	7.9	7.8
Max	9.3	8.2	8.4	8.2	8.4	8.3	8.4	8.2

[3] As pH is the logarithm of the reciprocal of the [H+] ion activity in a solution, mean values are not reported.

Figure 12. Summary statistics for pH data in standard units (SU), with outliers included, for the Cole and Taunton buoys deployed in Mount Hope Bay.

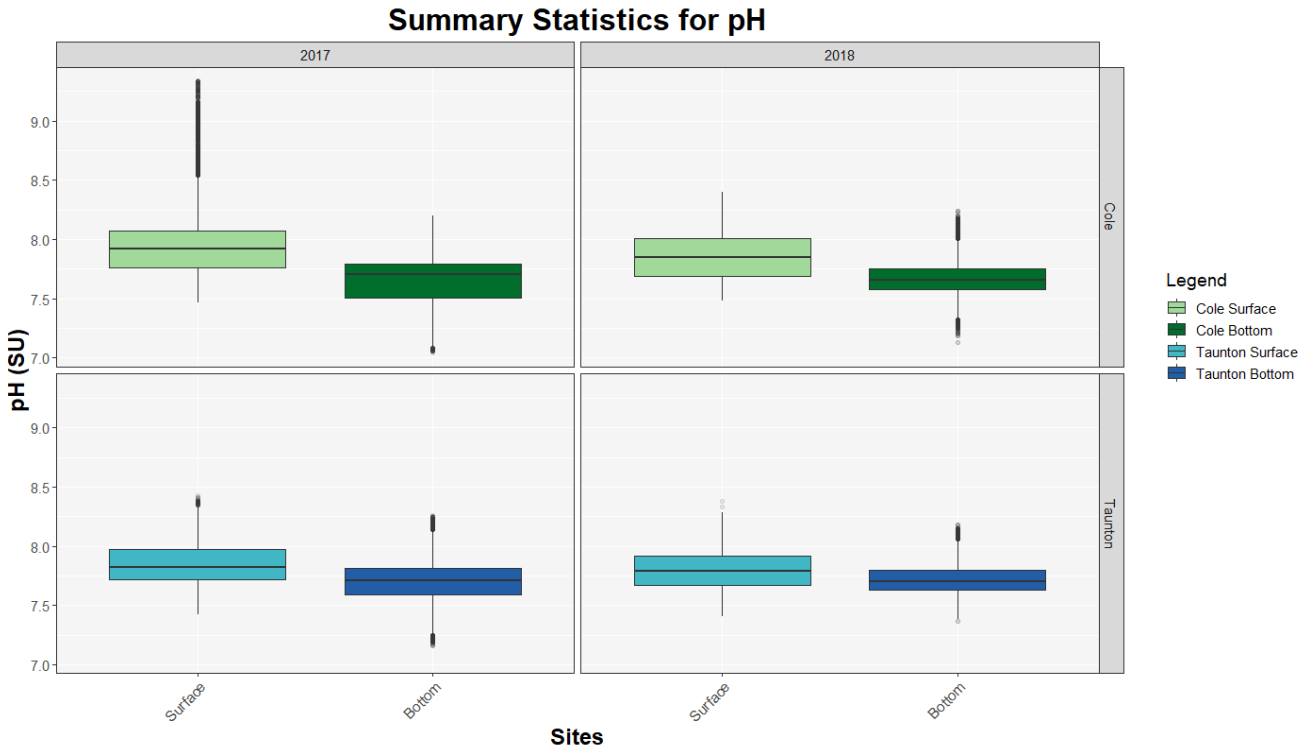


Figure 13. Summary statistics for pH data in standard units (SU), with outliers excluded, for the Cole and Taunton buoys deployed in Mount Hope Bay.

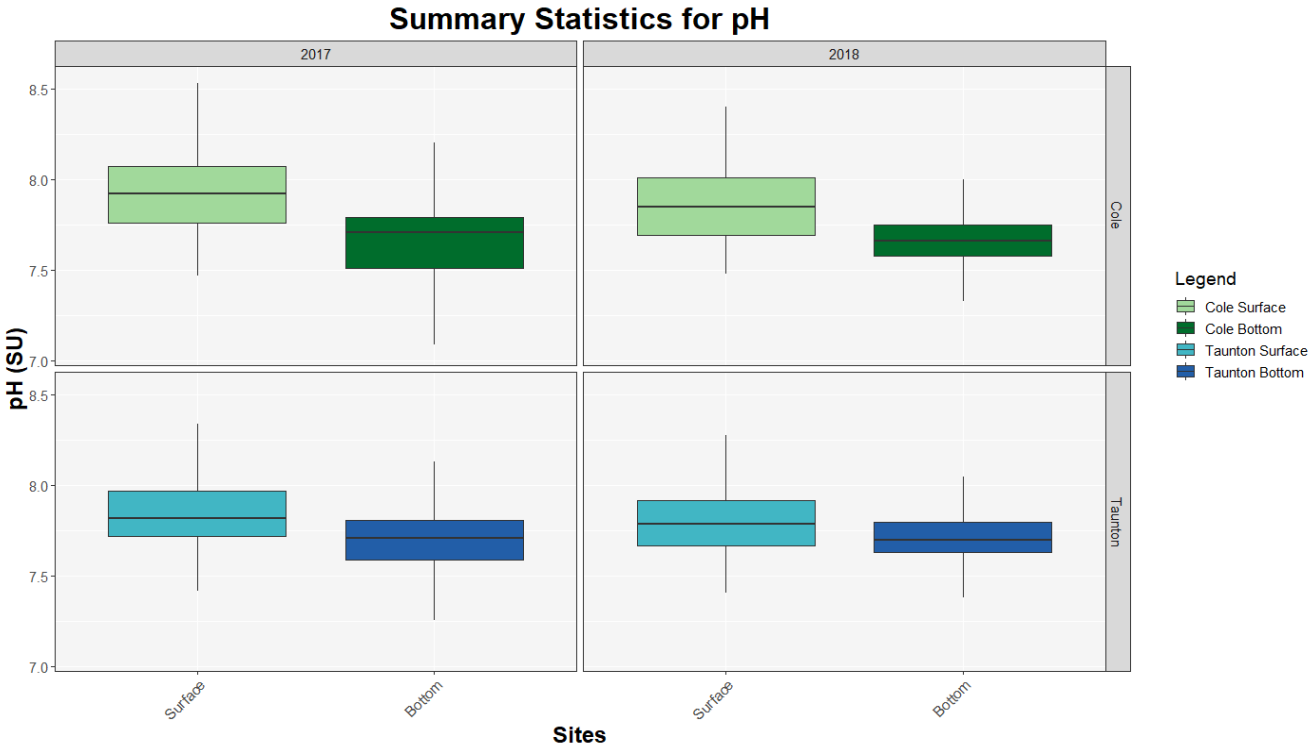


Figure 14 plots all pH data for surface and bottom buoy measurements at both sites in 2017 and 2018. The dashed line represents the pH criterion range of no less than 6.5 SU and no more than 8.5 SU for both Class SA and Class SB waters (MassDEP, 2013). Figure 15 is the diel range for each year and depth for the buoys.

Bottom waters typically had lower pH values than surface waters, with the largest differences between depths occurring during the early summer months. In addition, 2017 saw higher variability in recorded pH values compared to 2018, with local peaks in June and August.

Figure 14. pH data in standard units (SU) for the Cole and Taunton buoys deployed in Mount Hope Bay.

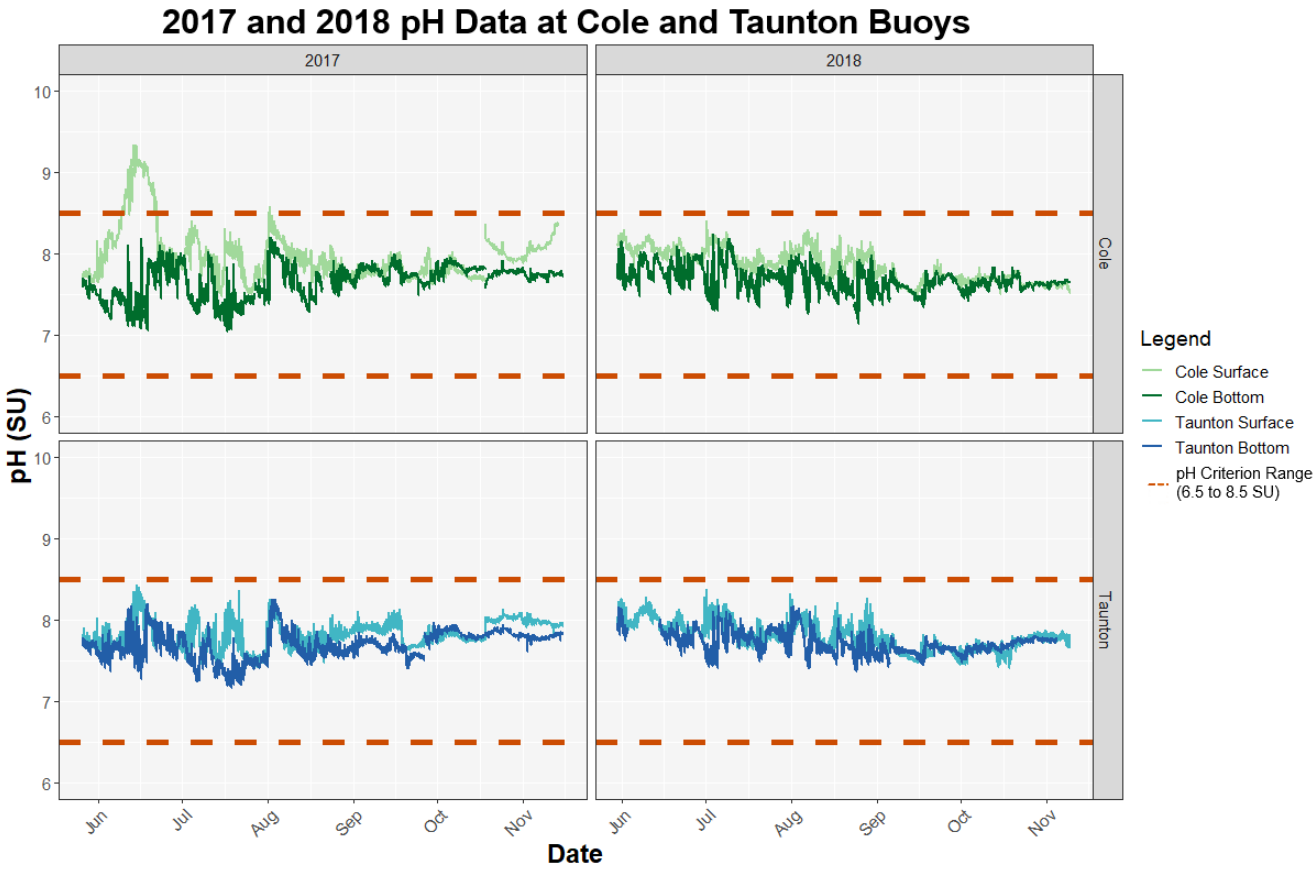
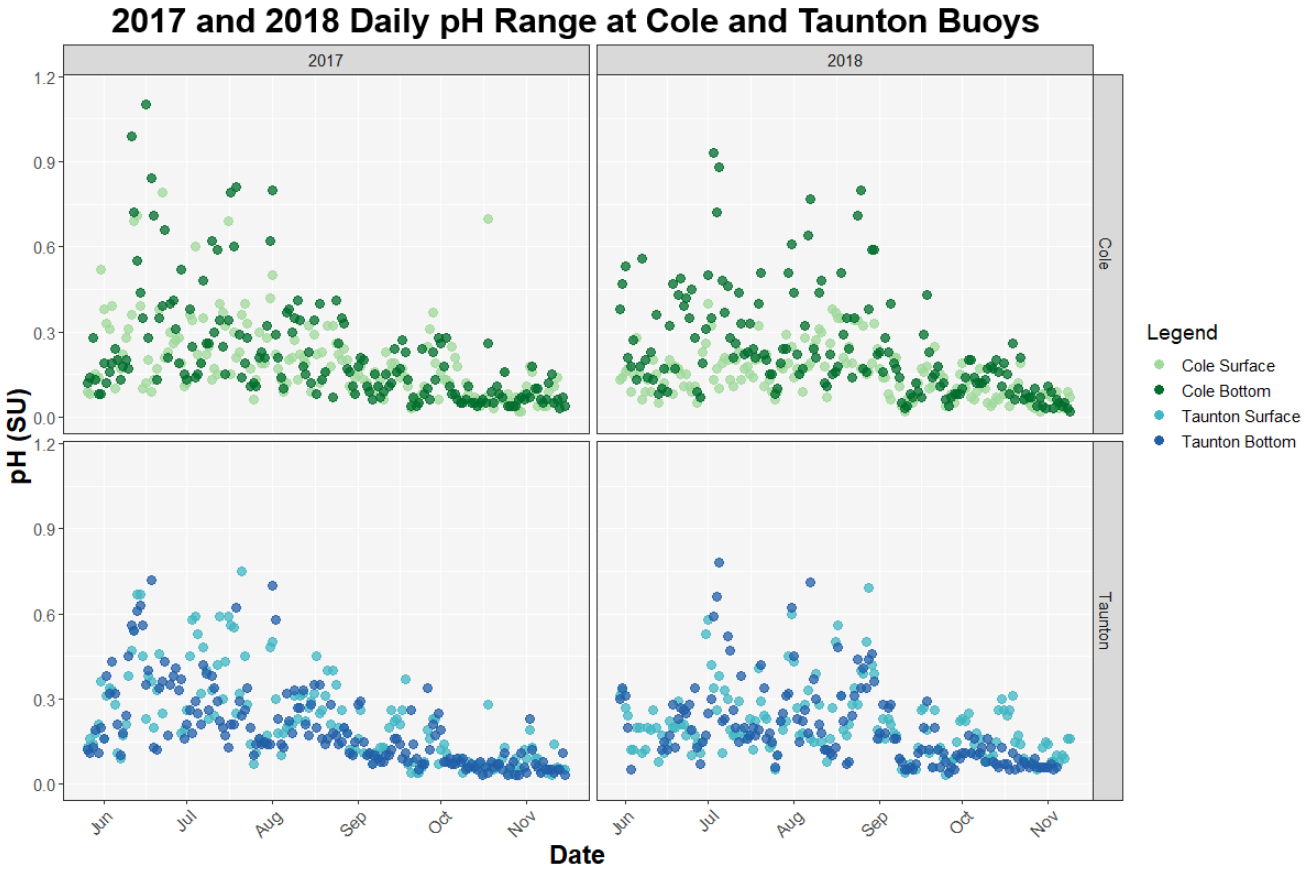


Figure 15. Daily differences between maximum and minimum pH (daily range) in standard units (SU) for the Cole and Taunton buoys deployed in Mount Hope Bay.



5.4 Specific Conductance

Summary statistics for specific conductance data collected at the Cole and Taunton buoys in 2017 and 2018 are in Table 7, Figure 16, and Figure 17. Average conductance was consistently higher on the bottom compared to the surface regardless of site or year, and mean conductivity decreased at each sampling location in 2018 compared to 2017.

Table 7. Summary statistics for specific conductance data in microsiemens per centimeter (µS/cm) for the Cole and Taunton buoys deployed in Mount Hope Bay.

Conductivity Statistics	CRS17	CRB17	CRS18	CRB18	TRS17	TRB17	TRS18	TRB18
				(µS/cm)				
Minimum	37504	41355	33906	39001	36887	39387	26845	37552
Q1	41101	43778	40790	43654	40674	43619	40307	43408
Median	43469	44778	43625	44997	43248	44690	43598	45116
Mean	43217	44689	42690	44496	42587	44509	42278	44474
Q3	45735	46029	44888	45740	45201	46074	44797	45709
Max	46633	47042	46698	46899	46263	47322	46790	47069

Figure 16. Summary statistics for specific conductance data in microsiemens per centimeter (µS/cm), with outliers included, for the Cole and Taunton buoys deployed in Mount Hope Bay.

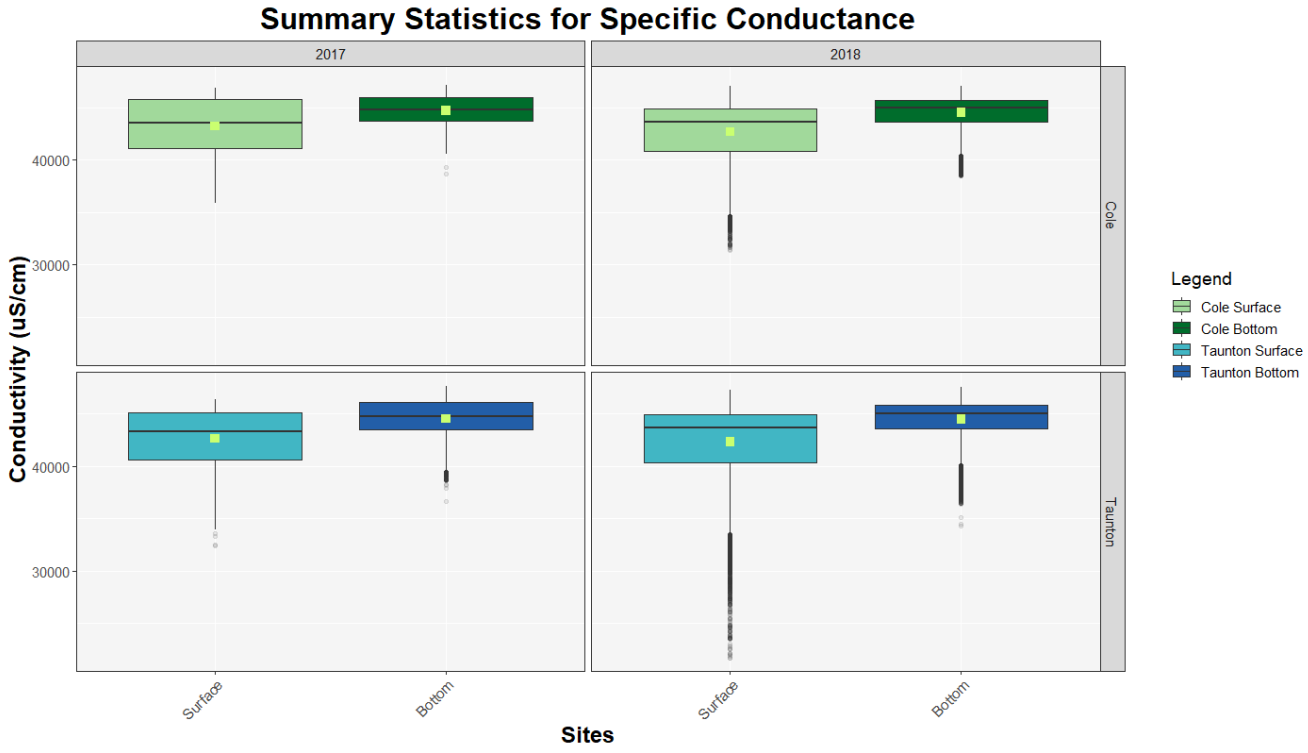


Figure 17. Summary statistics for specific conductance data in microsiemens per centimeter (µS/cm), with outliers excluded, for the Cole and Taunton buoys deployed in Mount Hope Bay.

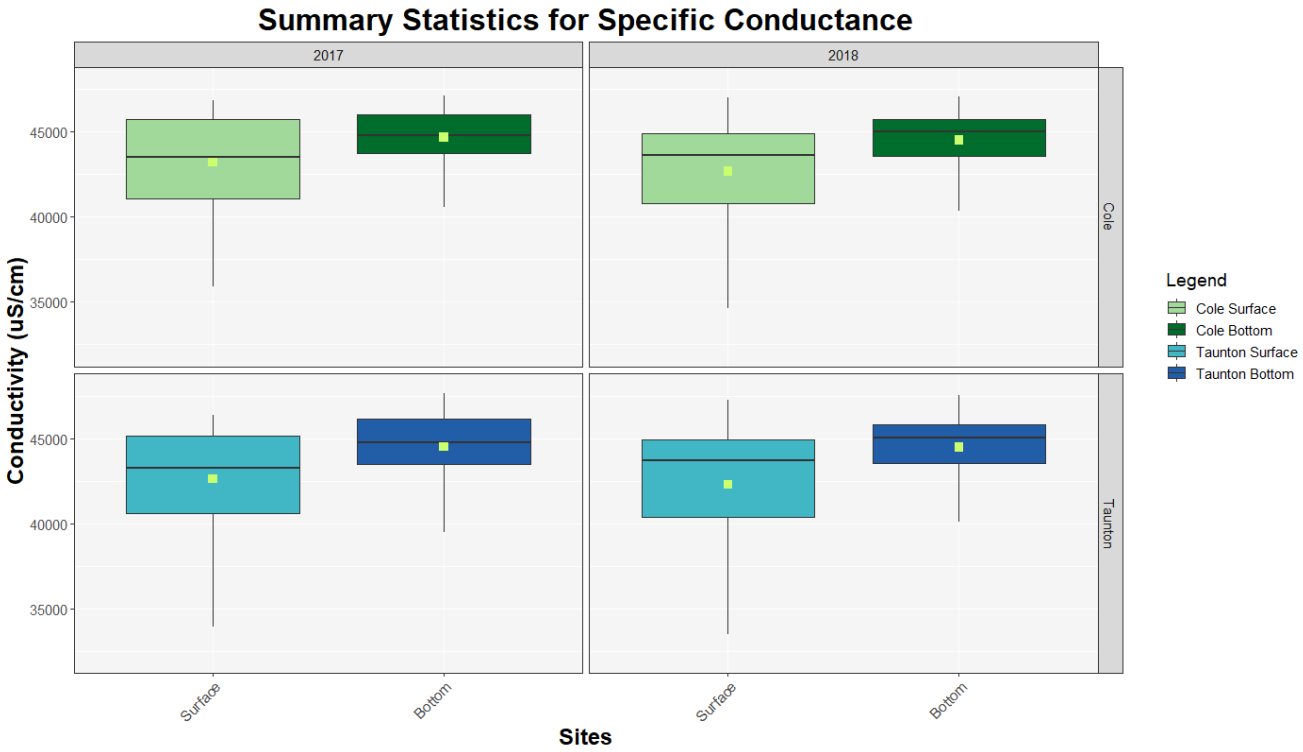


Figure 18 plots all specific conductivity data for surface and bottom buoy measurements at both sites in 2017 and 2018. Figure 19 plots the daily mean specific conductance.

In general, bottom waters had higher conductivity than surface waters. During the monitoring season, the early summer months typically had low conductivity, increasing into the late summer months of August through early October. Conductivity dropped significantly in the late fall months of October and November, with 2018 experiencing these conductivity drops earlier and in higher magnitude compared to 2017.

Figure 18. Specific conductance data in microsiemens per centimeter (µS/cm) for the Cole and Taunton buoys deployed in Mount Hope Bay.

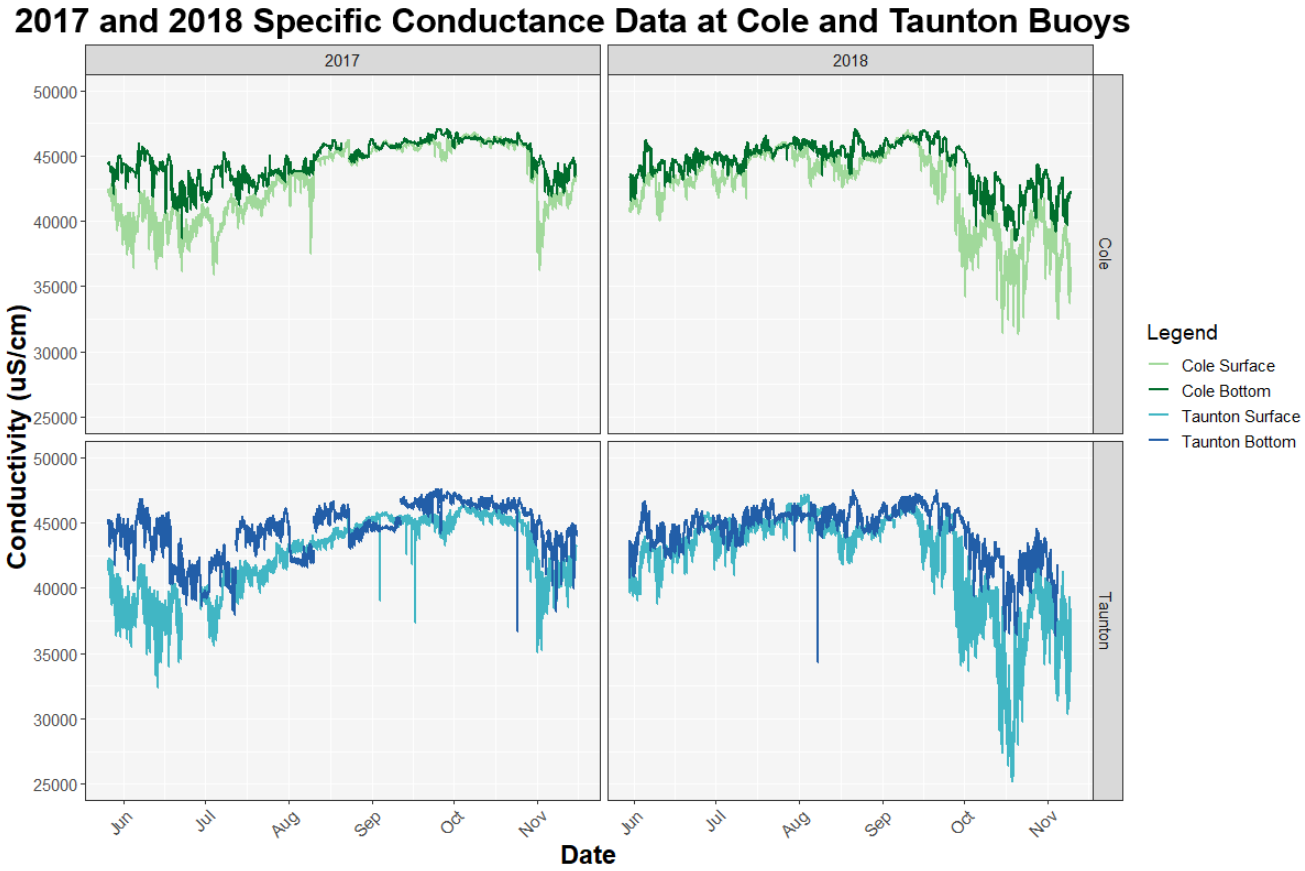
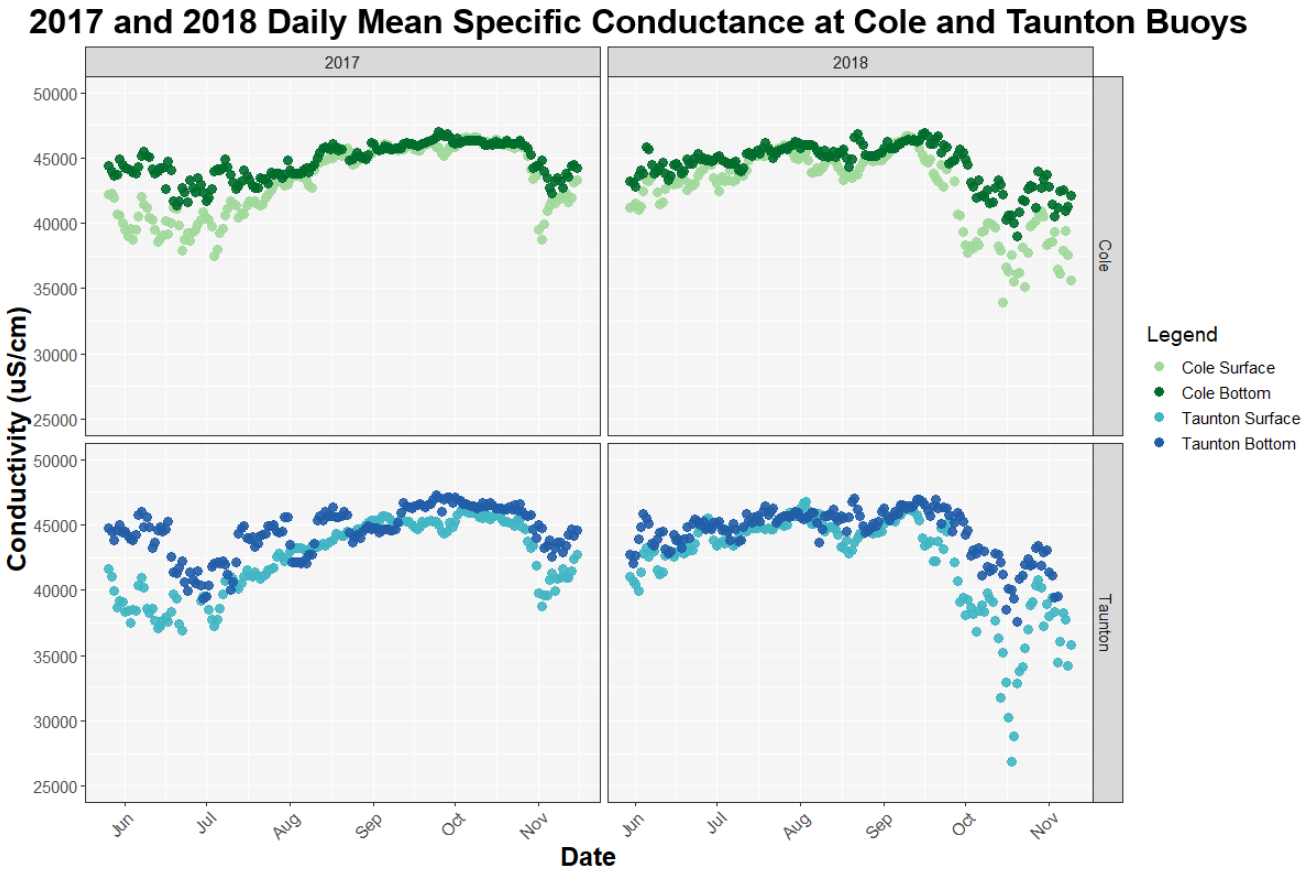


Figure 19. Daily mean specific conductance data in microsiemens per centimeter (µS/cm) for the Cole and Taunton buoys deployed in Mount Hope Bay.



5.5 Chlorophyll

Summary statistics for chlorophyll data for the Cole and Taunton buoys are in Table 8, Figure 20, and Figure 21. Bottom waters were characterized by higher maximums and lower means compared to the surface waters across all sites and years, excluding the mean chlorophyll measured at the Cole buoy in 2018.

Table 8. Summary statistics for chlorophyll data in relative fluorescence units (RFU) for the Cole and Taunton buoys deployed in Mount Hope Bay.

Chlorophyll Statistics	CRS17	CRB17	CRS18	CRB18	TRS17	TRB17	TRS18	TRB18
				(RFU)				
Minimum	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Q1	1.4	0.5	1.0	0.8	0.8	0.5	0.9	0.5
Median	3.5	1.0	2.4	1.9	1.6	0.9	2.3	1.1
Mean	4.3	1.7	2.7	3.1	2.4	1.5	2.7	1.7
Q3	6.0	1.9	3.7	3.9	3.4	1.7	3.8	2.4
Max	31.3	52.1	18.4	88.4	24.5	24.3	53.0	60.8

Figure 20. Summary statistics for chlorophyll data in relative fluorescence units (RFU), with outliers included, for the Cole and Taunton buoys deployed in Mount Hope Bay.

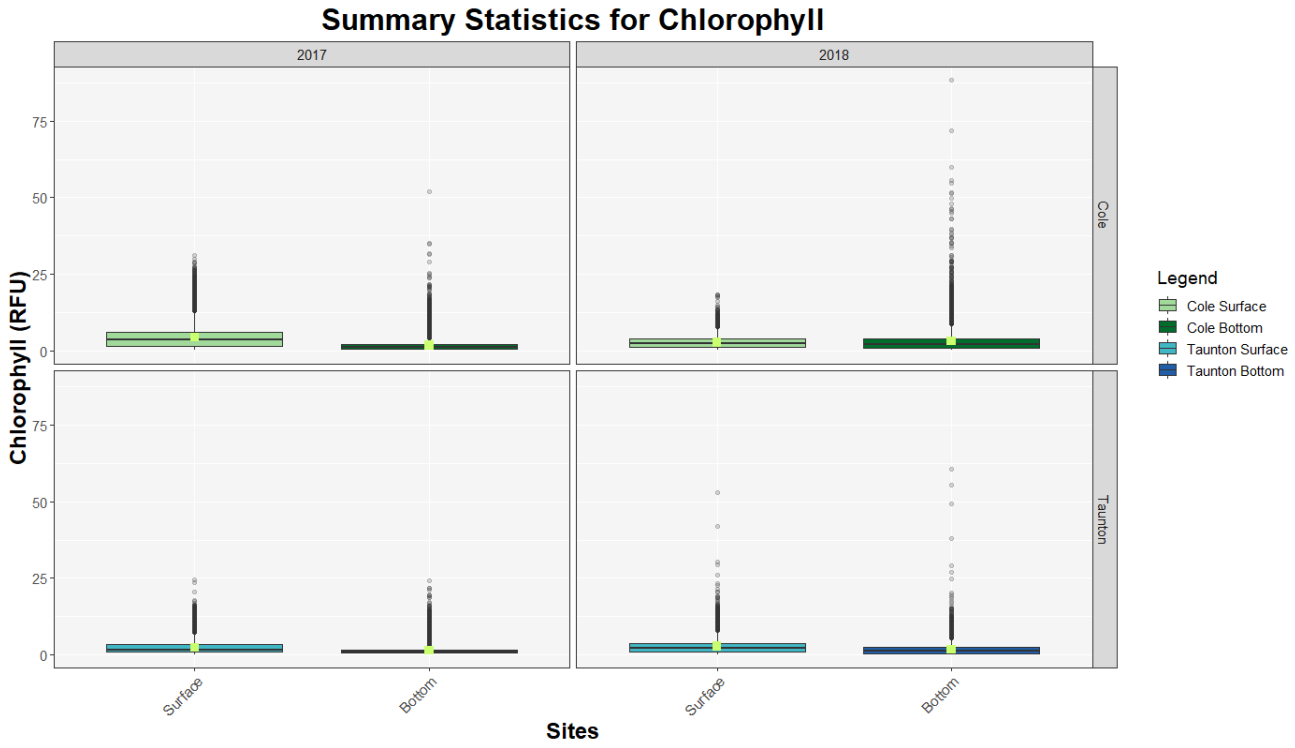


Figure 21. Summary statistics for chlorophyll data in relative fluorescence units (RFU), with outliers excluded, for the Cole and Taunton buoys deployed in Mount Hope Bay.

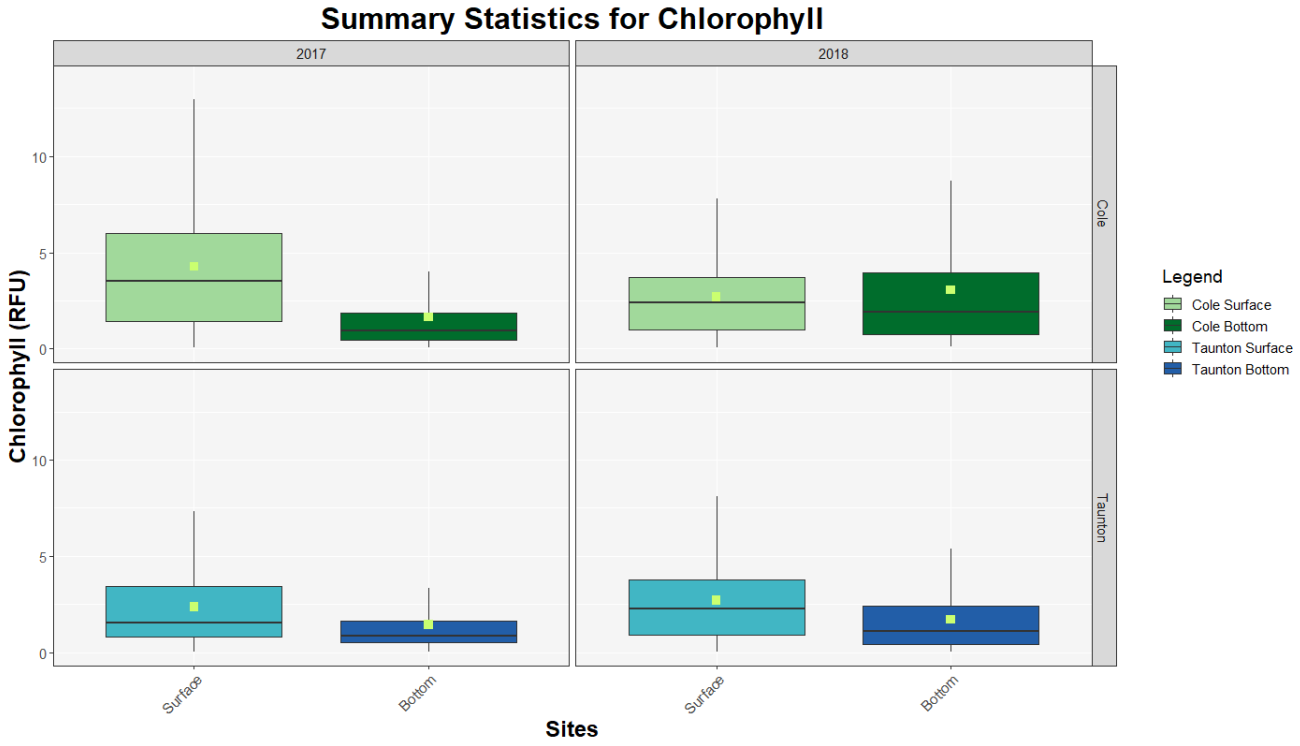


Figure 22 plots all chlorophyll data for surface and bottom buoy measurements at the Cole buoy in 2017 and 2018, and Figure 23 plots all chlorophyll data for surface and bottom buoy measurements at the Taunton buoy in 2017 and 2018.

Chlorophyll typically peaked in surface waters in late June and August, and peaked in bottom waters in June, July, August, and September. The average chlorophyll increased in bottom waters at both sites, increased in surface waters at the Taunton buoy, and decreased in surface waters at the Cole buoy between 2017 and 2018.

Figure 22. Chlorophyll data in relative fluorescence units (RFU) for the Cole buoy deployed in Mount Hope Bay.

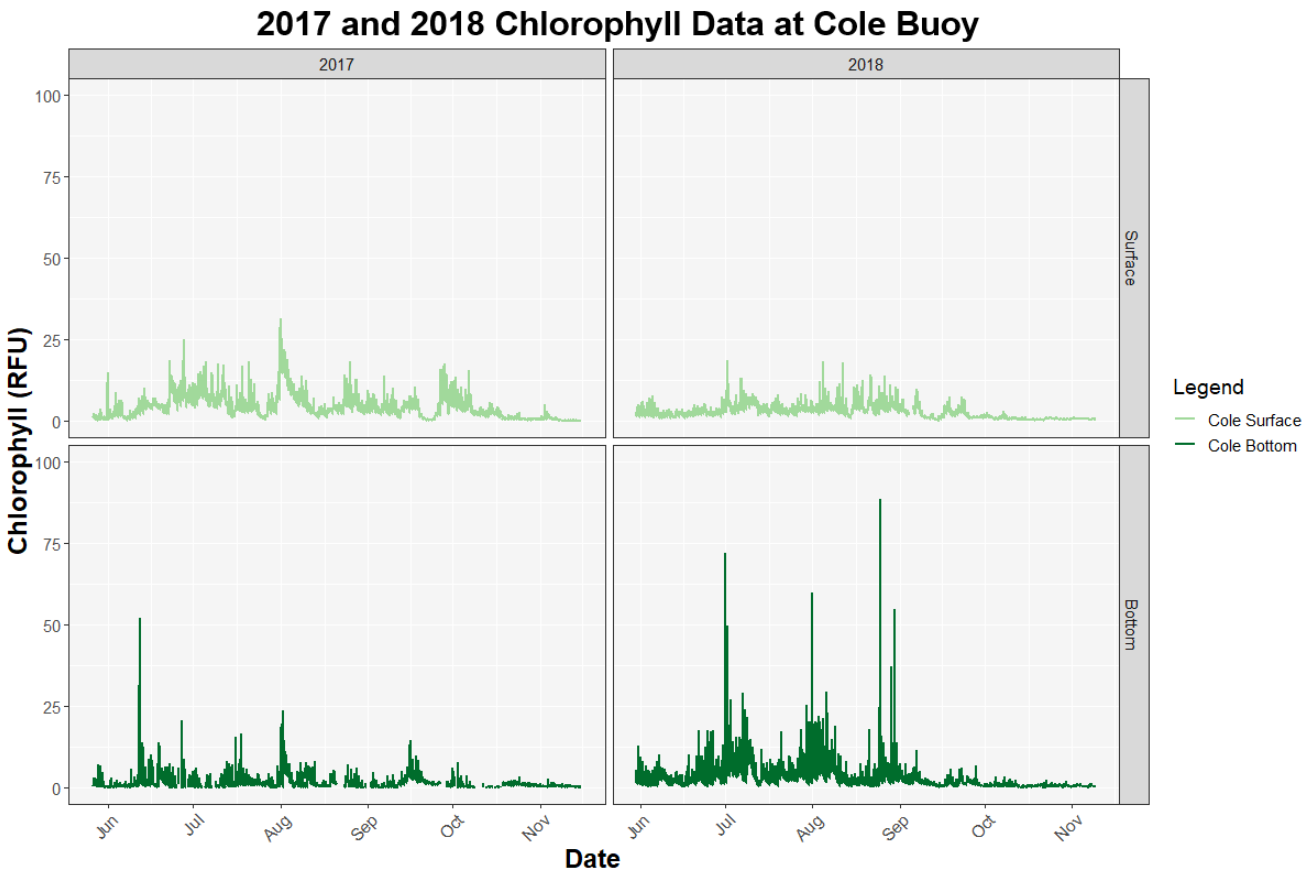
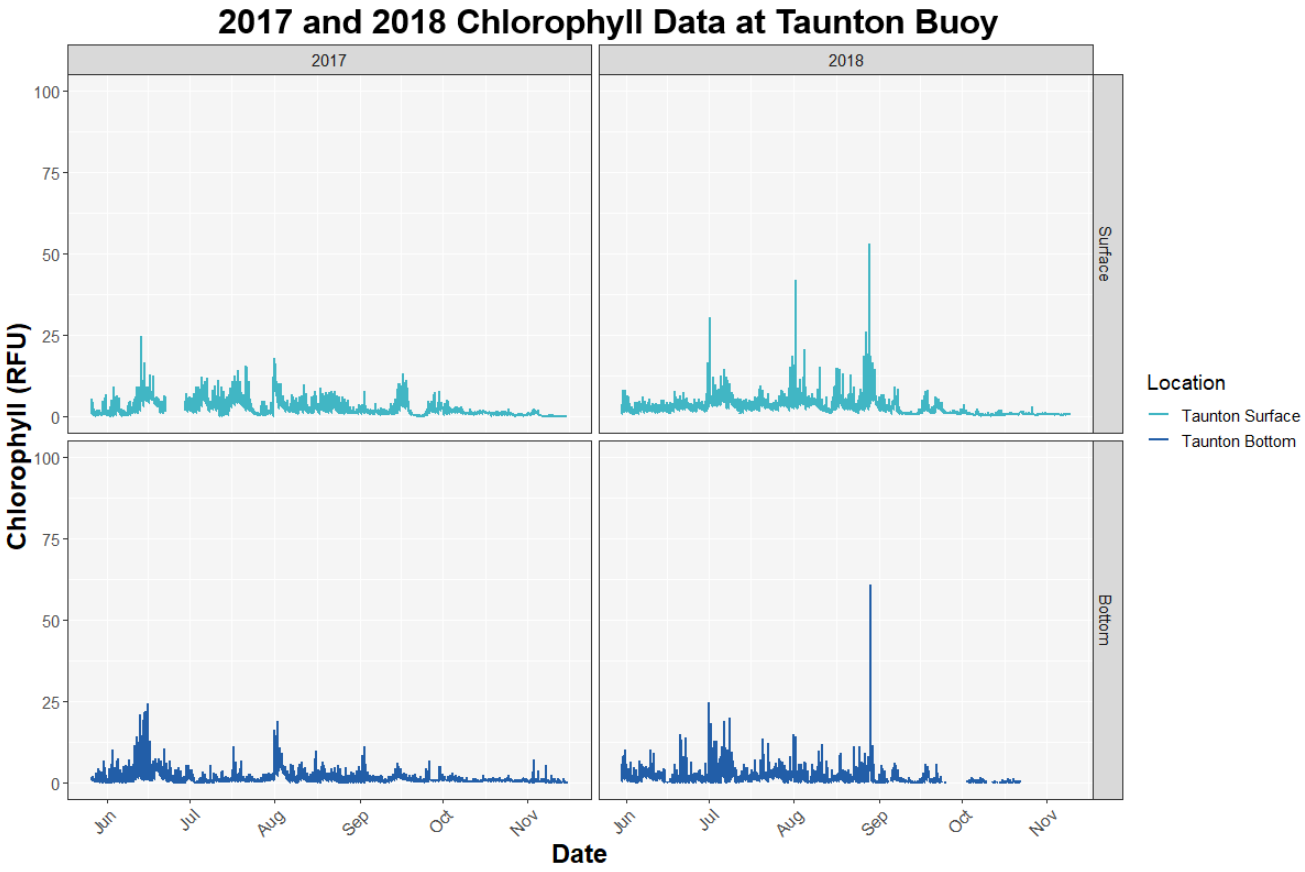


Figure 23. Chlorophyll data in relative fluorescence units (RFU) for the Taunton buoy deployed in Mount Hope Bay.



5.6 Nitrate-Nitrogen

Summary statistics for nitrate-nitrogen (NO_3-N) data for the Cole and Taunton buoys are in Table 9 and Figure 24. At the Cole buoy, average NO_3-N concentrations decreased from 2017 to 2018, while Taunton River surface waters saw an increase during the same time frame. Both sites had lower maximum NO_3-N concentrations in 2018.

Table 9. Summary statistics for nitrate-nitrogen data in milligrams per liter (mg/L) for the Cole and Taunton buoys deployed in Mount Hope Bay.

NO_3-N Statistics	CRS17	CRS18	TRS17	TRS18
		(mg/L)		
Minimum	0.03	0.03	0.03	0.03
Q1	0.03	0.03	0.03	0.03
Median	0.07	0.03	0.06	0.05
Mean	0.09	0.07	0.08	0.11
Q3	0.13	0.10	0.12	0.20
Max	0.44	0.33	0.43	0.39

Figure 24. Summary statistics for nitrate-nitrogen data in milligrams per liter (mg/L) for the Cole and Taunton buoys deployed in Mount Hope Bay.

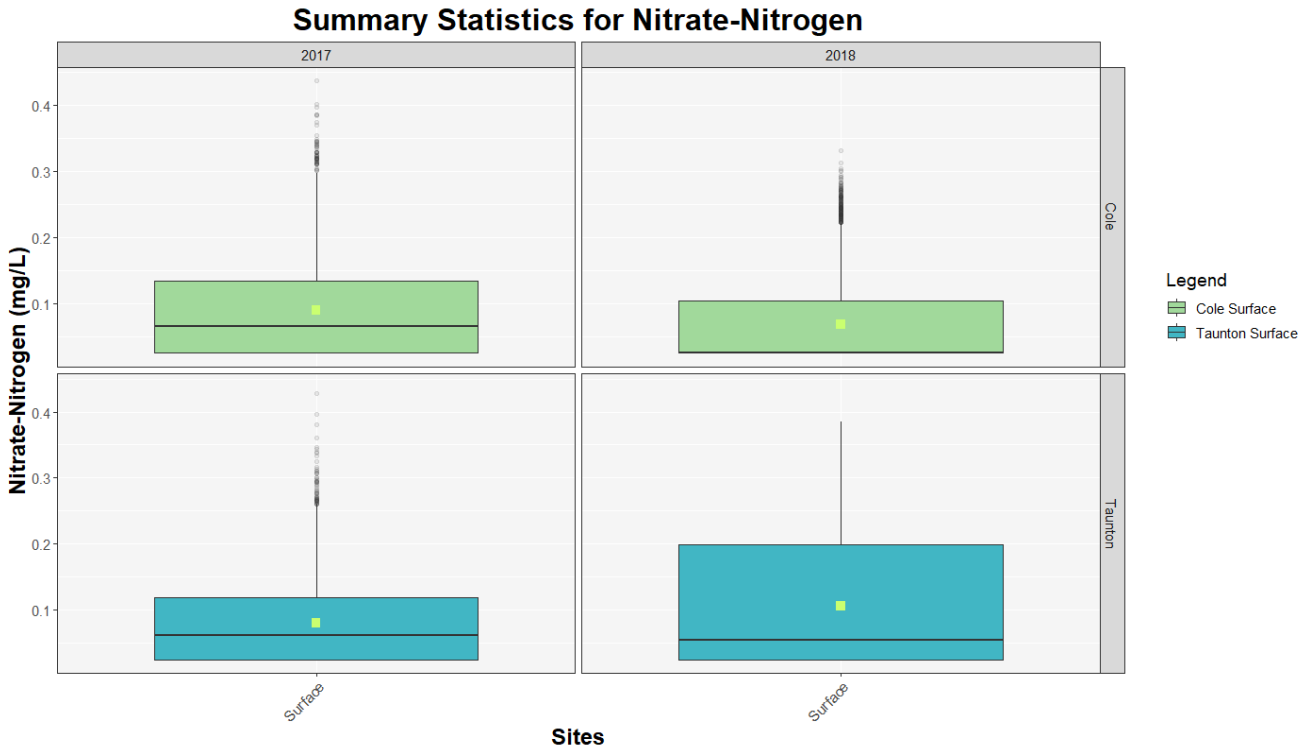
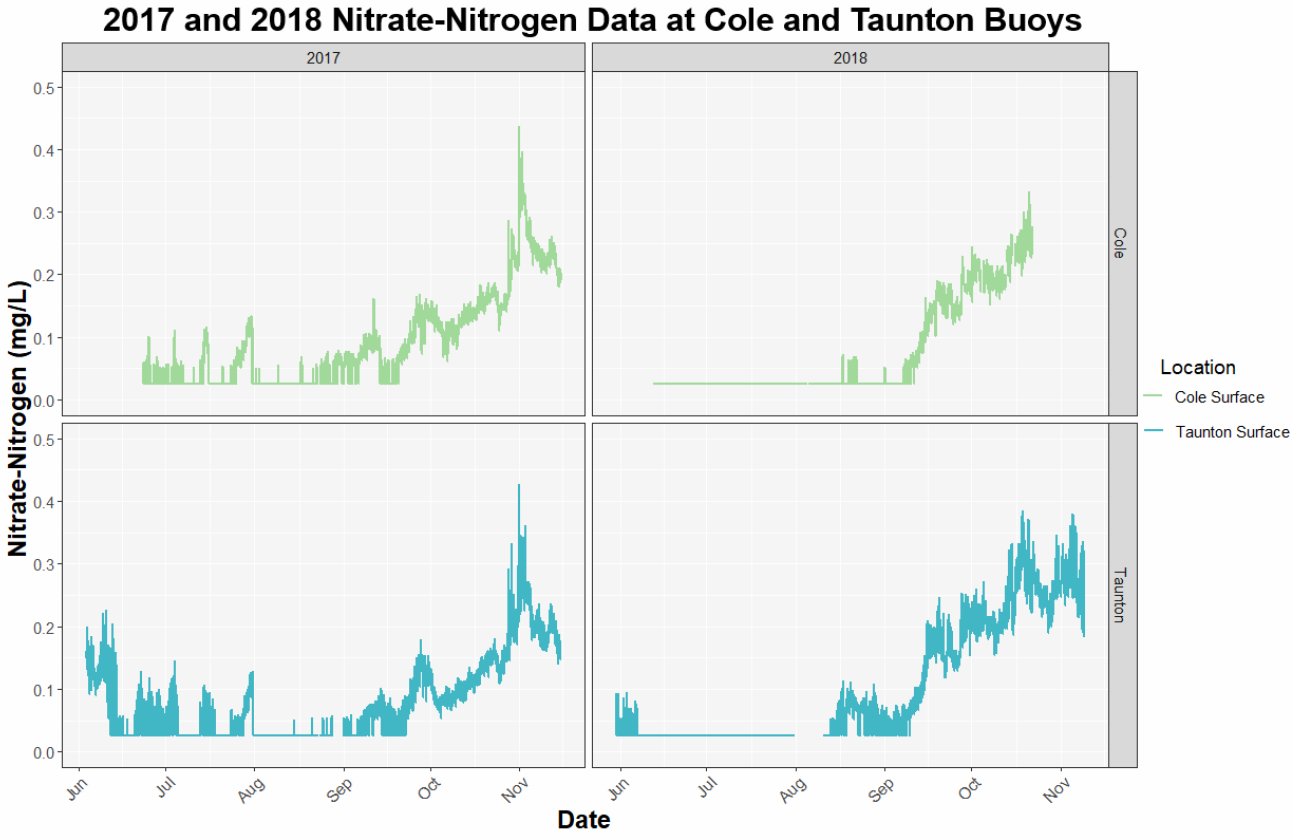


Figure 25 plots all NO_3-N data for surface buoy measurements at both sites in 2017 and 2018. Data points at y = 0.025 represent the non-detect data.

In general, measured concentrations of NO_3-N between June and September were the lowest, typically dropping below the detection limits of the SUNA (the minimum reporting limit used for the NO_3-N data was 0.05 mg/L). Concentrations would increase rapidly in October and November, typically peaking near the end of the monitoring season. The 2018 monitoring season saw lower maximum NO_3-N concentrations at both sites compared to 2017, as well as lower concentrations during the summer months.

Figure 25. Nitrate-nitrogen data in milligrams per liter (mg/L) for the Cole and Taunton buoys deployed in Mount Hope Bay.



5.7 Station Depth

As noted in Figure 2, the surface sondes were deployed approximately 1.0 meter below the water surface. As any recorded deviations from this value could be attributed to atmospheric and water column pressure differences[4] over the deployment period, the surface depth data are not explored in this section. Bottom sondes were set to approximately 0.5 meters above the sea floor, which provides useful information about variations in station depth (i.e., water column depth) over time due to estuarine events, including large storms and tidal variations. The summary statistics for the station depth[5] are in

[4] The depth value is calculated by taking the pressure exerted by the water column on the sonde's strain gauge and subtracting the atmospheric pressure set during calibration of the sonde.

[5] Station depth is equal to depth recorded by the bottom sonde plus 0.5 meters (height of bottom sonde above sea floor).

Table ***10*** and Figure 26. On average, station depth was higher in 2017 for both sites.

Table 10. Summary statistics for station depth data in meters (m) for the Cole and Taunton buoys deployed in Mount Hope Bay.

Depth Statistics	CRB17	CRB18	TRB17	TRB18
		(m)		
Minimum	4.3	4.2	4.0	3.8
Q1	5.1	4.9	5.1	4.8
Median	5.4	5.3	5.5	5.2
Mean	5.5	5.3	5.5	5.2
Q3	5.9	5.7	5.9	5.6
Max	6.4	6.3	6.4	6.1

Figure 26. Summary statistics for station depth data in meters (m) for the Cole and Taunton buoys deployed in Mount Hope Bay.

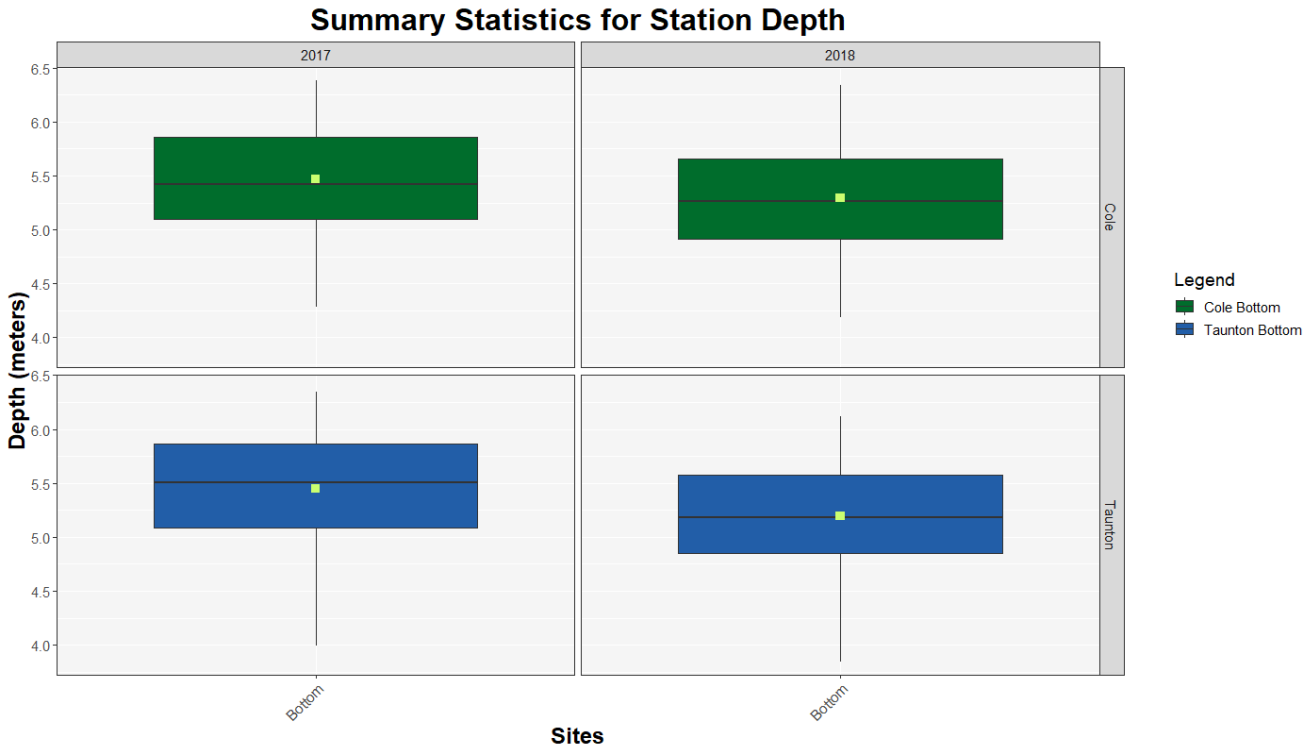
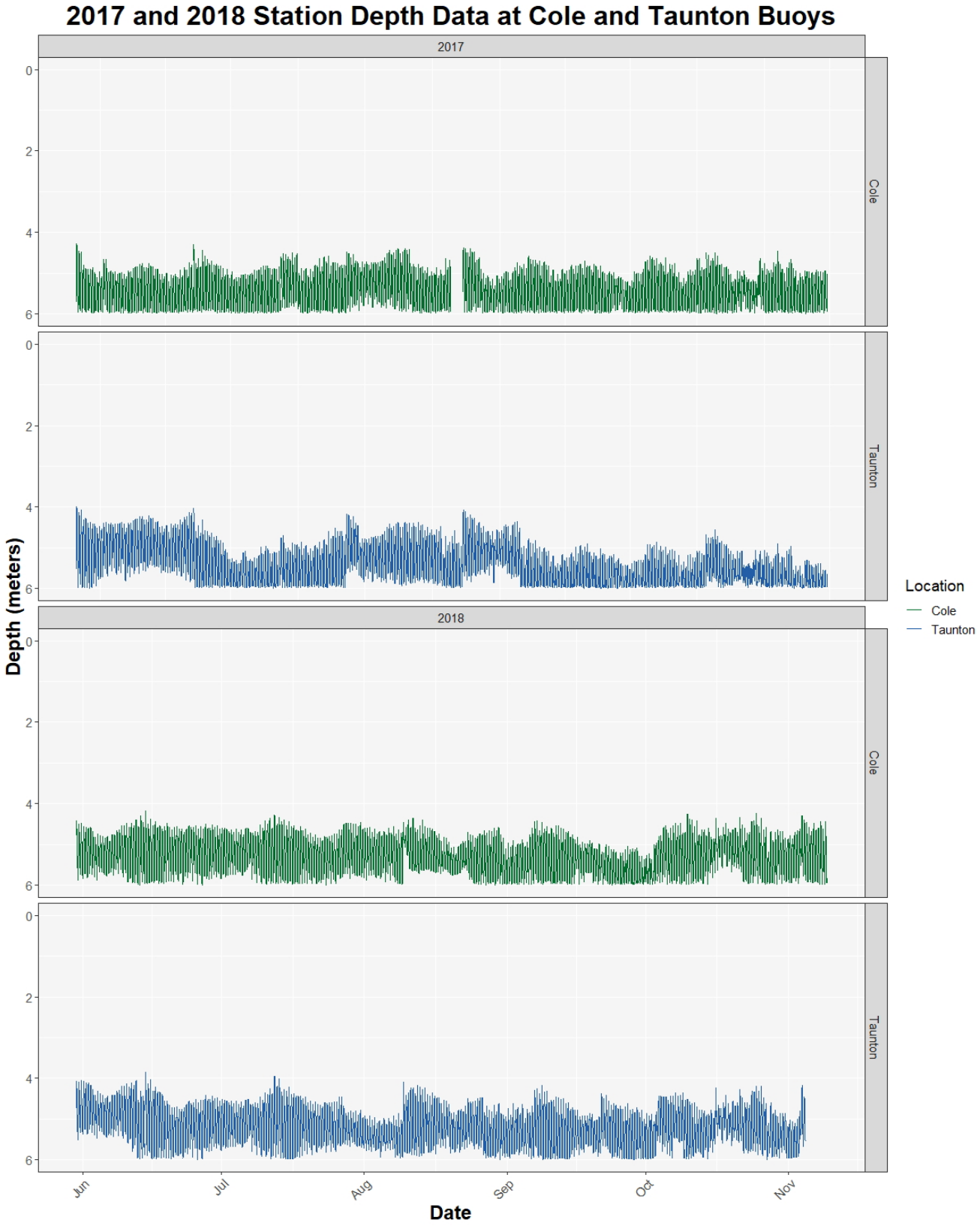


Figure 27 plots all station depth data for bottom buoy measurements at both sites in 2017 and 2018. Note that the y-axis has been inverted: values closer to the bottom of the graphs represent deeper station depths.

Overall, the cyclic nature of the station depths indicates clear tidal influences in Mount Hope Bay, with depths ranging by just over 2.0 meters between local peaks and troughs. The Cole buoy site was, on average, deeper than the Taunton buoy site. In addition, the Taunton buoy recorded a slightly larger range between minimum and maximum depths across both years. Due to the method by which depth is calculated[4], any sharp changes in recorded depth seen in Figure 27 are most likely due to probe swaps and not a sudden change in water column depth.

Figure 27. Station depth data in meters (m) for the Cole and Taunton buoys deployed in Mount Hope Bay.

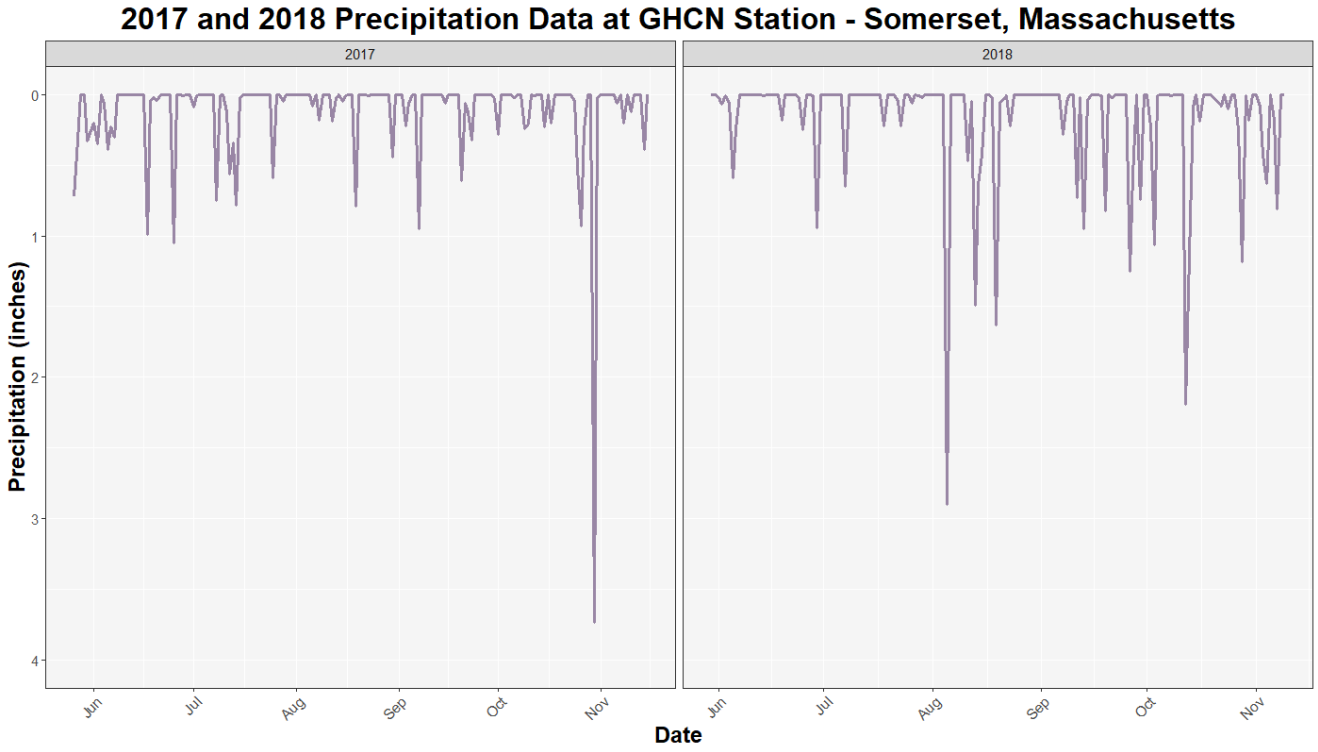


5.8 Precipitation

Precipitation data were sourced from the closest Global Historical Climatology Network (GHCN)[6] station, located in Somerset, Massachusetts (GHCND:US1MABR0016). Precipitation totals (measured in inches) represent daily collection intervals.

Figure 28 shows recorded rainfall in 2017 and 2018 at the Somerset site. The total rainfall during the buoy deployment for 2017 was 20.07 inches; 2018 total precipitation was 24.80 inches.

Figure 28. Precipitation data in inches for the Cole and Taunton buoys deployed in Mount Hope Bay.



5.9 Other Parameters

Data for other measured parameters (i.e., DO saturation (%), salinity (PSU), and phycoerythrin (RFU)), as well as the full 2017 and 2018 continuous monitoring datasets for the buoys, are available on MassDEP's online data page (available at https://www.mass.gov/guides/water-quality-monitoring-program-data), or by contacting MassDEP.

[6] The Global Historical Climatology Network is an integrated database of climate summaries from land stations and is part of the National Oceanic and Atmospheric Administration's National Centers for Environmental Information.

6.0 Discussion

The multi-year seasonal deployment of the buoys in Mount Hope Bay allowed MassDEP to establish two fixed, coastal water quality monitoring stations in Massachusetts. These stations provide critical data for the evaluation of potential SWQS revisions, permit limit calculations, and water quality assessments applicable to Mount Hope Bay and upstream waters. In addition, the buoys continue MassDEP's partnerships with regional stakeholders in the NBFSMN and can support analyses dependent on long-term data. Potential long-term future use of these data could include understanding climatic influences on Mount Hope Bay, decadal variability of water quality, long-term effects of the Brayton Point power station closure, TMDL development, and evaluation of TMDLs or alternative watershed management plans intended to restore impaired AUs in Mount Hope Bay and upstream waters. The 2020 monitoring season in Mount Hope Bay is underway, and data from the 2019 monitoring season are currently being prepared for validation and finalization in 2020.

This data report for the Cole and Taunton buoys presents the results of the 2017 and 2018 fixed-site continuous monitoring in Mount Hope Bay. The data present initial evidence indicating inter- and intra-annual variability of measured water quality parameters. In the summer, Mount Hope Bay experienced both low DO and NO_3-N concentrations. Bottom waters in particular experienced hypoxic periods, with DO concentrations dropping below 3 mg/L at both buoys. High water temperatures (approaching 30 °C) and high conductivity (approaching 48,000 µS/cm) also occurred. In the cooler months of the monitoring season, diel DO concentration flux was reduced, conductivity decreased, and NO_3-N increased to its annual maxima. Across the monitoring season, all sites recorded pH data greater than 7.0 SU for both years, with pH typically lower in the bottom waters.

7.0 References

MassDEP. (2013). *Massachusetts Surface Water Quality Standards (Revision of 314 CMR 4.00, effective December 6, 2013).* Massachusetts Department of Environmental Protection.

MassDEP. (2015). *Quality Assurance Program Plan - Surface Water Monitoring & Assessment.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Watershed Planning Program.

RIDEM. (2016). *Quality Assurance Project Plan - Narragansett Bay Fixed-Site Monitoring Network (NBFSMN).* Providence: Rhode Island Department of Environmental Management.