2019 POST-CONSTRUCTION OYSTER MONITORING REPORT

The Governor Mario M. Cuomo/New NY Bridge Project at Tappan Zee
Oyster Substrate and Water Quality Monitoring

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Introduction

The mitigation requirement (New York State Department of Environmental Conservation (DEC) Permit ID 3-9903-00043/00012) to establish shell/hard bottom oyster habitat in the Hudson River was implemented during the summer of 2018. Eight hundred and eighty one reef balls and 422 gabions were deployed over an area of approximately six acres at three locations in the vicinity of the Governor Mario M. Cuomo Bridge. As part of the substrate placement phase of the project, water quality monitoring was conducted between June and November 2018 to characterize environmental conditions during the first oyster spat settlement event. A post-construction monitoring effort was also developed to help determine the effectiveness of the oyster habitat restoration program and consisted of two major components, namely: monitoring oyster settling, survival, and growth on artificial substrates at the three locations, and monitoring water quality at those locations. The oyster habitat restoration post-construction monitoring plan which outlined the methodology to be employed for the two year post-construction monitoring program (2019 and 2020) was prepared on June 19, 2017, amended on March 25, 2019, and was approved by DEC. The substrate and water quality monitoring represents the final element of the oyster habitat restoration effort that falls under the responsibility of the Thruway Authority (The Authority).

This consolidated report presents both elements of the monitoring program completed in 2019. Attachment A is the substrate monitoring report, which focused on obtaining density and size distribution data from oysters collected in October 2019, and represents two years of spat settling. Attachment A was prepared through a collaboration of the Hudson River Foundation, the Billion Oyster Project and the University of New Hampshire. Attachment B is the water quality monitoring report, which presents water quality data collected from April-November, 2019, and was prepared by AKRF, Inc. A second more comprehensive final report will be prepared after the second monitoring season is completed in the fall, 2020.

ATTACHMENT A: 2019 OYSTER SUBSTRATE MONITORING REPORT

The Governor Mario M. Cuomo/New NY Bridge Project at Tappan Zee

Oyster Habitat Restoration Study – Oyster Monitoring

February 5, 2020

Submitted to: Fred Jacobs, AKRF, Inc.
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Introduction and Background

The Hudson River Foundation (HRF), the University of New Hampshire (UNH), and Billion Oyster Project (BOP) have partnered to conduct monitoring of the oyster mitigation project resulting from construction of the new Governor Mario M. Cuomo Bridge. The monitoring project is being conducted under the direction of AKRF, Inc., and the New York State Thruway Authority (NYSTA). Mitigation was accomplished by constructing new oyster reef habitat at three sites (Fig. 2) and involving two treatment types (=substrate types): 1) metal gabion cages containing recycled oyster shells, and 2) Reef Balls ("mini-bay ball" style). Site 0 "The Glove" restoration site encompasses an area of 0.07 acre and consists of 54 reef balls and 36 gabions. Site 1 encompasses an area of 3.35 acres and consists of 414 Reef Balls and 193 gabions. Site 8 encompasses an area of 2.57 acres and consists of 413 reef balls in 15 clusters and 193 gabions in 11 clusters. Installation of the substrates, which represent potential "new oyster reef habitat," occurred in July 2018 (Fig. 1). Therefore, it was expected that two year classes of oysters (recruitment in 2018 and 2019) would be represented in the data from the initial sampling in the fall of 2019.

Fig. 1. Deployment of Reef Balls and gabions in July 2018.

The three sites were chosen based on previous studies that characterized the occurrence at all three sites of live oysters at densities comparable to other areas in the northeastern US and were among the sites recommended for further study (AKRF 2016a, b). As described in the NYSDEC approved Oyster Habitat Restoration Post-Construction Monitoring Plan, Revised 3-25-19, the primary objective of the monitoring project is to quantify oyster recruitment, density, growth, and survival at the three study sites by annual sampling in the fall of 2019 and 2020. The present report describes the results of the fall 2019 monitoring. *It should be noted that only descriptive statistics are presented herein.*

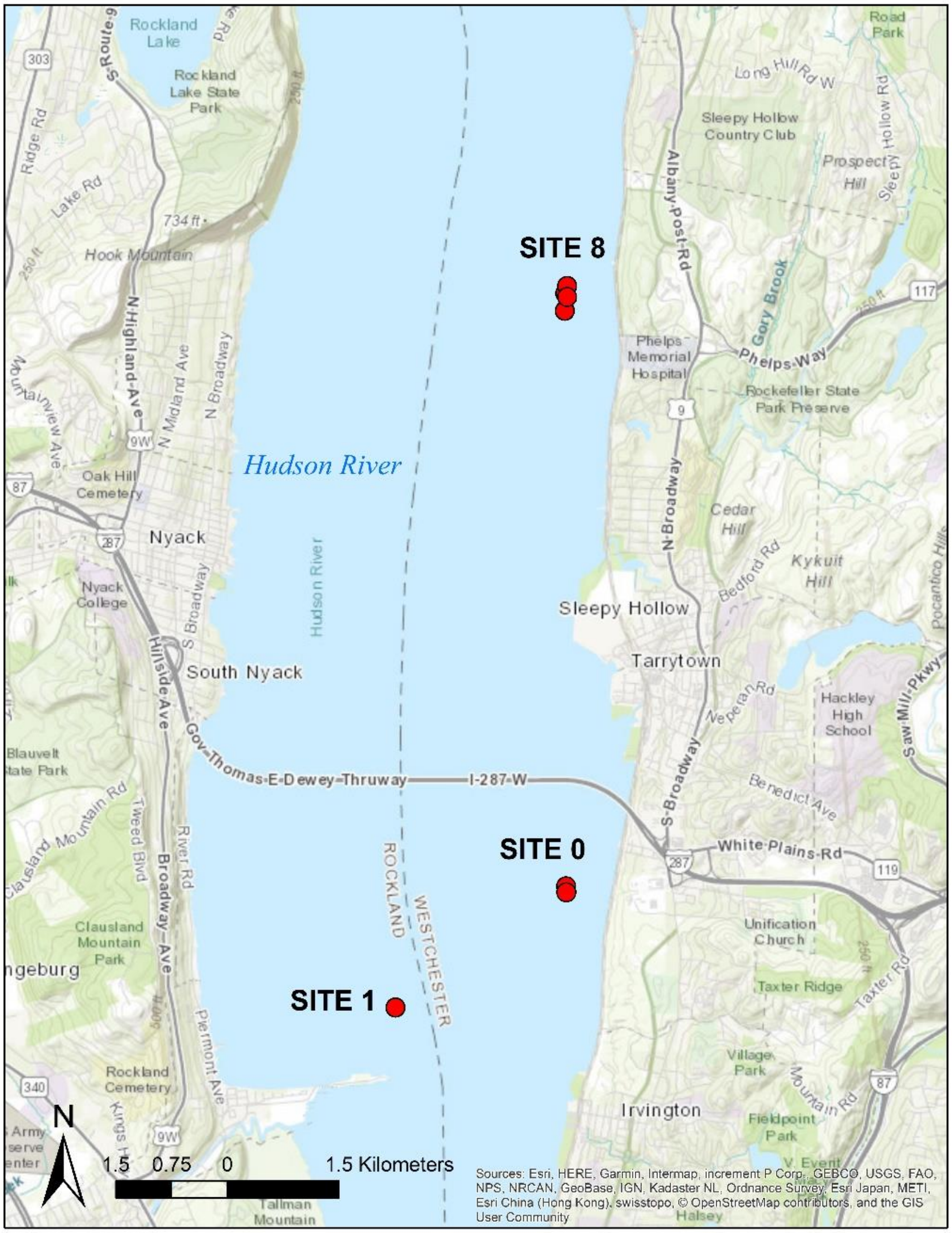


Fig. 2. Locations of the three oyster reef mitigation sites.

Monitoring Methods

The primary objective of the monitoring study is to quantify oyster recruitment, density, growth, and survival at the three study sites by annual sampling in the fall of 2019 and 2020. The present report describes the results of the fall 2019 monitoring. Monitoring was conducted in conformance with the Oyster Habitat Restoration Post Construction Monitoring Plan, dated 3-25-19.

Sampling occurred on six days over two periods (September 30, 2019 - October 2, 2019 and October 29 – October 30). Side-Scan Sonar and GPS were used to locate the substrates selected for monitoring. After locating the substrates SCUBA divers attached harnesses and lines to the reef balls and gabions enabling the substrates to be removed from the water using the vessel's A-frame and winch. In total 37 reef balls and 20 gabions were monitored from the three sites (16 reef balls and 8 gabions from Site 1, 17 reef balls and 8 gabions from Site 8 and 4 reef balls and 4 gabions from Site 0. After monitoring, the reef balls and gabions were placed at a new location within the restoration site.

Oyster Size and Density:

Standard sampling methods for oysters were used following the general recommendations in Baggett et al. (2014), and as used in previous studies in the region (Grizzle et al. 2013; Lodge et al. 2015). After the test substrates were removed from the water, the number and size (shell height measured with calipers or ruler to nearest 1 mm) of individual, live oysters were determined following the detailed methods below for each substrate type. It should be noted that only descriptive statistics are presented herein.

Reef Balls: If the number of oysters and oyster spat for the entire reef ball was <50, all oysters and oyster spat were counted and measured. If the number of oysters and oyster spat for the entire reef ball was >50, individual live oysters in four replicate 0.04 m^2 (20 cm x 20 cm) quadrats placed randomly at multiple locations on the reef ball were measured. Two quadrat samples from one side and two samples from the opposite side of the reef balls were sampled. A random number generator was used to determine the positions of the quadrats.

Gabions: A section of the wire mesh from the tops of the gabion cages in two areas was opened using wire cutters and two 0.04 m^2 (20 cm x 20 cm) quadrats were placed haphazardly. A photograph was taken of the quadrat, and after photographing shell/cultch was excavated from the upper 2 cm (approximately 2 shells depth). All oysters were counted on the excavated cultch material and shell height (to nearest 1 mm) from all live oysters was measured.

Non-oyster Epibenthos: Although oysters are the focus of the project, other species will colonize the restoration substrates. Thus, it is expected that diverse epibenthic communities (including oysters) will develop over time. The non-oyster taxa were characterized using quantitative "photographic quadrat sampling" using the photos taken of each 0.04 m^2 quadrat sample on both types of substrates, as described above. The methods described in Berman et al. (1992), Stachowitsch et al. (2002) and Grizzle et al. (2016) were followed. The photos were processed in the laboratory, identifying each taxon to the lowest level practical (species where possible) and measuring the percent cover in the overall quadrat. This process provides data on the number of taxa present (taxonomic richness) and relative abundance (percent cover). In order to ensure correct identification in the photo quadrats, representative specimens of each taxon were removed in the field, placed in isopropyl alcohol and returned to the laboratory for identification using standard taxonomic keys (Weiss 1995; Pollack 1998). At the time of this report, the photos are still being analyzed and will be described in the 2020 final report.

Results

Both substrate types were heavily colonized by oysters and other epibenthic fauna at all three sites, but there also were substantial differences in the communities. Visual inspection of the photographs of substrates typical of each site clearly show a range of oyster sizes and densities, with Site 0 having the largest oysters and highest densities on both substrates (Fig. 3). Sites 1 and 8 had communities that were spatially (i.e. areal coverage) dominated by barnacles and mussels but both also had substantial densities of oysters, though of smaller size classes than at Site 0.

There were marked differences in oyster density and mean size among the sites and substrate types. When substrate types were combined, mean oyster density and size were both greater at Site 0 compared to Sites 1 and 8 (Fig. 4). Although these data likely reflect differences in environmental conditions among the three sites, water quality data were not available for review at the time of the preparation of this section of the report (the relationship of the observed differences among sites to water quality, are briefly discussed in Attachment B). The site differences in these two metrics also reflect differences in recruitment and perhaps growth, and are discussed further below.

Fig. 3. Photos of typical substrates retrieved from the three mitigation sites during October 2019 sampling.

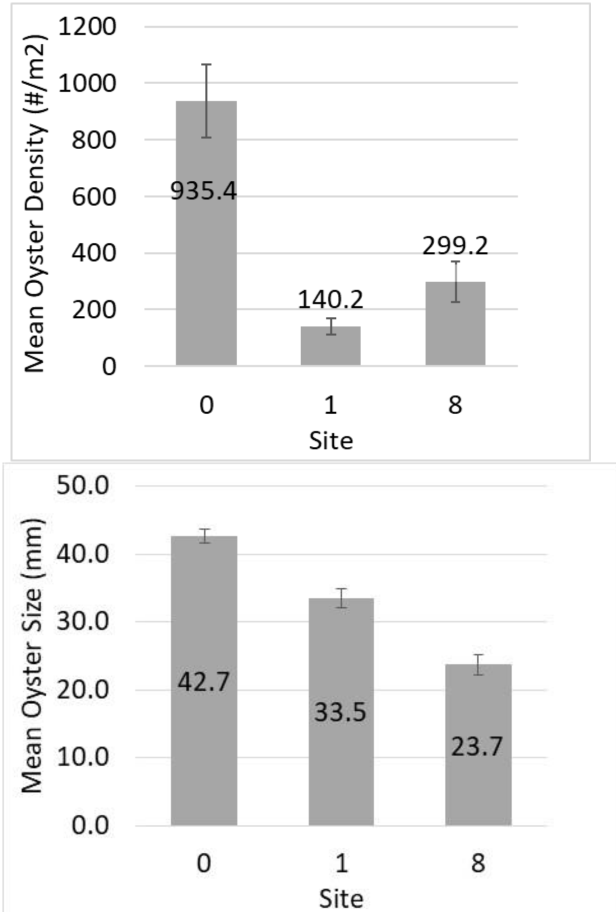


Fig. 4. Mean (±1SE) oyster densities (left) and live oyster shell height (right) by site when data from both substrate types (gabions and Reef Balls) were combined.

Although both substrates supported substantial oyster populations at all three sites, the by-substrate comparisons of oyster metrics indicated similar means for oyster size but much greater densities on the gabions than the Reef Balls (Fig. 5). It should be noted, however, that the two substrates, differ substantially in the potential surface area available for larval settlement, and the present study represents one of the only studies involving shell-filled gabions. Further assessment of differences in physical characteristics of the two substrates and their effectiveness for reef development will be provided in the 2020 final report.

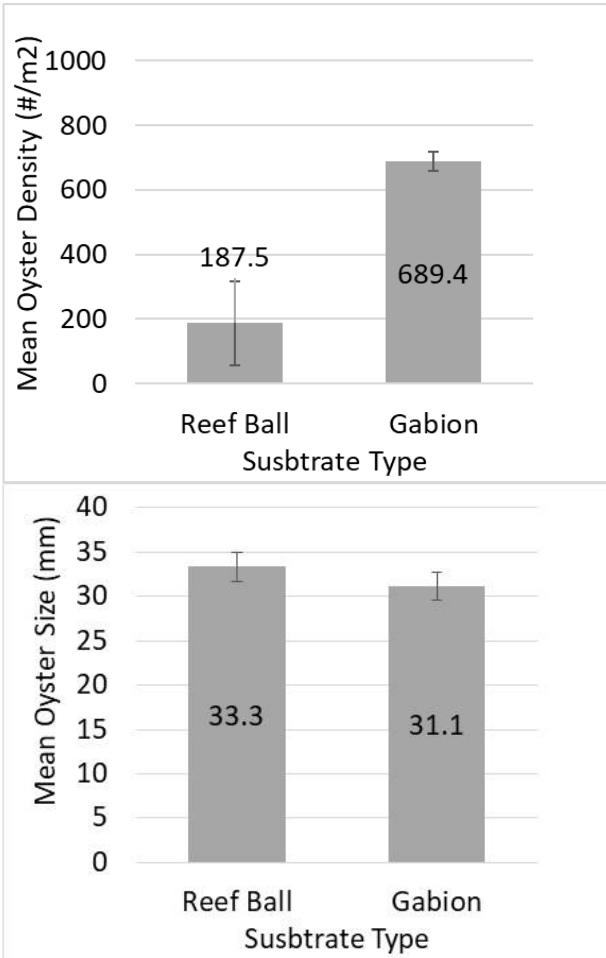


Fig. 5. Mean (±1SE) oyster densities (left) and oyster shell height (right) by substrate type when data from all three sites were combined.

When the oyster metrics were examined in more detail, differences in how the two substrates performed at the three sites also were indicated. Gabions at all three sites had much higher densities of oysters than Reef Balls (Fig. 6; see above brief discussion). Mean oyster size, however, had no consistent trend. The error bars suggest that the Reef Balls may have resulted in larger oysters at Site 0, but not at Sites 1 and 8.

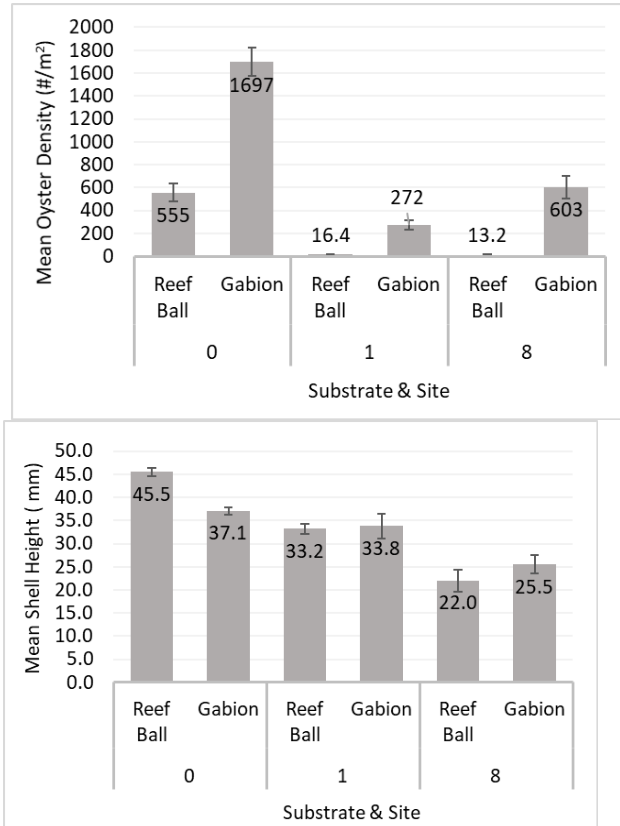
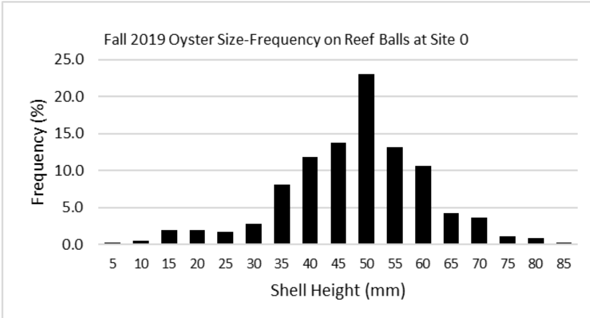
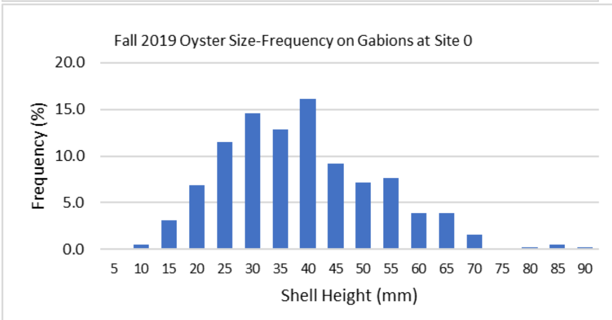
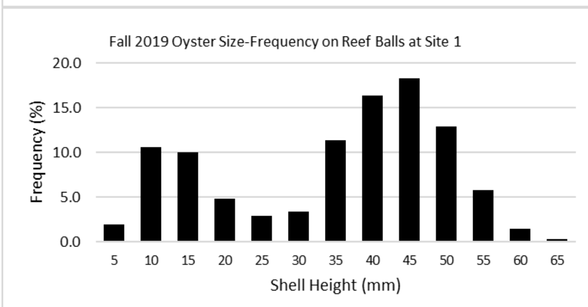


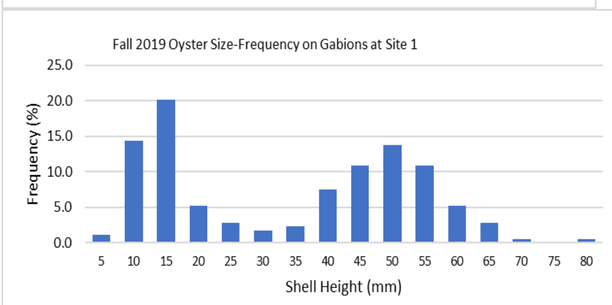
Fig. 6. Mean (±1SE) oyster densities (left) and oyster shell height (right) by site and by substrate.

Finally, assessment of live oyster size distributions at the three sites provided insight into the causes for differences evident in the photographs (Fig. 3) and metrics for density and size (Figs. 4-6).


Fall 2019 Oyster Size-Frequency on Reef Balls at Site 0
Frequency (%)
Shell Height (mm)


Fall 2019 Oyster Size-Frequency on Gabions at Site 0
Frequency (%)
Shell Height (mm)


Fall 2019 Oyster Size-Frequency on Reef Balls at Site 1
Frequency (%)
Shell Height (mm)


Fall 2019 Oyster Size-Frequency on Gabions at Site 1
Frequency (%)
Shell Height (mm)

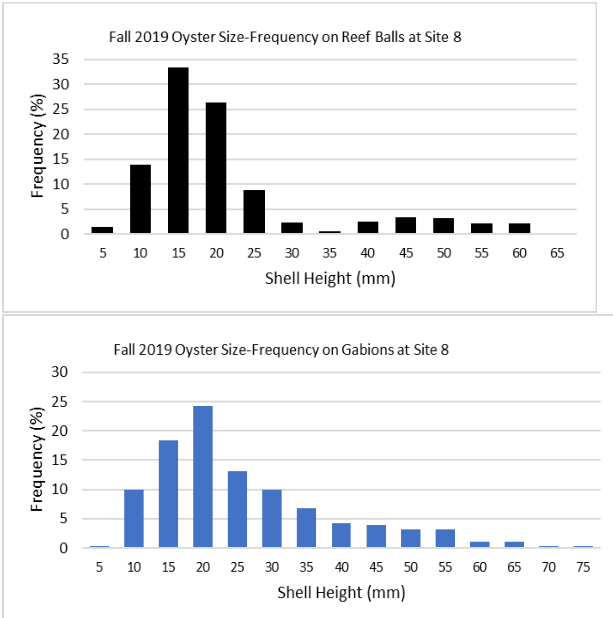


Fig. 7. Size-frequency distributions by site and substrate type for fall 2019 oyster data.

The overall size-frequency patterns were quite similar when comparing the two substrates on a site-by-site basis (Fig. 7), suggesting that the Reef Balls and gabions provide similar potential for oyster recruitment and early reef development. In contrast, there were substantial differences in the oyster population size structure among the three sites. Site 0 was dominated by large (probably in their 2nd year; size peaks at 50 mm on Reef Balls and 40 mm on gabions) oysters, with very few oysters in smaller size classes. This indicates poor recruitment in 2019, or at least poor survival of recruits through October when the samples were taken. Site 1 showed strong peaks at 10 to 15 mm and 40 to 50 mm on both substrates indicating strong recruitment in both 2018 and 2019. Data from Site 8 indicated strong 2019 recruitment, but poor 2018 recruitment or high mortality for the 2018 recruits. This was almost the reverse of the pattern at Site 0. As already noted, there may be differences among the three sites in water quality parameters that could explain these differences in oyster metrics, but no water quality data were available at the time of the preparation of this section of the report. However, Attachment B (see next section of report) discusses the relationship of these site differences to water quality and concludes that there were no substantial site differences in salinity or DO in 2018 or 2019 that would explain any of the observed patterns in oyster recruitment and survival. Furthermore, the temperature patterns recorded are also not believed to be responsible for the differences observed in this area of the Hudson River.

In sum, the oyster metrics overall indicate substantial oyster reef development at all three mitigation sites but also strong among-site differences. Such differences, however, should not be surprising because oyster reefs typically show wide variability from year to year in most population metrics. Differences between the two substrate types---with much denser oyster population on gabions compared to Reef Balls---had the same trend as the pilot study (Lodge et al. 2017). This trend will be assessed further in the 2020 final report.

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ATTACHMENT B: 2019 WATER QUALITY MONITORING REPORT

The Governor Mario M. Cuomo/New NY Bridge Project at Tappan Zee

Oyster Habitat Restoration Study – Oyster Monitoring

January 29, 2020

This section of the 2019 Monitoring Report presents the results of measurements of conductivity (converted to salinity), dissolved oxygen (DO), and temperature associated with Tier 4 of the four-tiered oyster research and restoration plan that was developed by the New York State Thruway Authority (the Authority), New York State Department of Environmental Conservation (NYSDEC) and other members of the Oyster Work Group (OWG) for the Governor Mario M. Cuomo Bridge Project. The 2019 water quality monitoring effort was performed as described in the Post Construction Monitoring Plan (originally prepared on 6-19-17 and revised on 3-25-2019) and collected temperature, salinity, and dissolved oxygen (DO) monitoring data following deployment of oyster shell gabions and reef balls at the three sites that were selected for restoration by the OWG and NYSDEC under Tier 4. The primary objective for the collection of salinity, DO, and temperature data collected at these three sites (Sites 0 [i.e., the Glove], 1, and 8; **Figure 1**) is to provide some additional context in which to interpret the results of the Tier 4 oyster density and growth rate monitoring that is being conducted by the Hudson River Foundation because salinity and DO are potential factors limiting oysters in this section of the Hudson River.

STUDY DESIGN AND SAMPLING FREQUENCY

The study design and sampling frequency during 2019 was similar to the previous year with the exception that the monitoring period began much earlier than in 2018 (April 2 vs. June 28). Two conductivity loggers and two DO loggers were deployed at each of the three study sites, in the same approximate locations as in 2018. The DO loggers also record temperature. These locations were originally selected to be as close to the restoration areas as possible to be representative of the conditions experienced by colonizing oysters without directly interfering with the reef balls and gabions.

The same model of Onset HOBO conductivity loggers and PME DO loggers used from 2016-2018 were used in 2019, but some older units that were not functioning properly were refurbished or replaced by the manufacturers prior to the start of the season. All of the conductivity and DO loggers used in 2019 were factory calibrated prior to deployment. As in all past years, the loggers were suspended by buoys approximately 2 feet off of the river bottom and programmed to record at 10-minute intervals. They were deployed on April 2, 2019 and subsequently retrieved on a monthly basis to downloaded data until their removal from the river at the end of the season on November 19, 2019. Upon each retrieval event, the sensors and the main body of the loggers were cleaned to remove fouling. The conductivity loggers were also calibrated by taking a reading while submerged in a standard solution (5,000 µs/cm at 25° C). These readings were then used in the HOBOware Pro software to adjust the raw conductivity measurements from each sampling period.

RESULTS AND DISCUSSION

Following deployment on April 2, the conductivity and DO loggers were retrieved and downloaded on April 30, May 28, June 27, July 30, August 27, September 24, October 22, and November 19. During some download events, one or more loggers could not be found, but were later retrieved during a subsequent download event. Some units had memory capacities that filled downloads, or otherwise failed due to launch properly after a download, had batteries that died between downloads, or otherwise failed due to excessive fouling or other factors during the season, resulting in incomplete time series of data at some logger locations. However, such occurrences were less frequent than in past seasons and most locations had complete or nearly complete time series of data. The most complete time series for salinity, DO, and temperature for each plot within each site are shown in **Appendices A, B, and C** respectively. Outliers were omitted from the figures in the appendices and the summary statistics tables below.

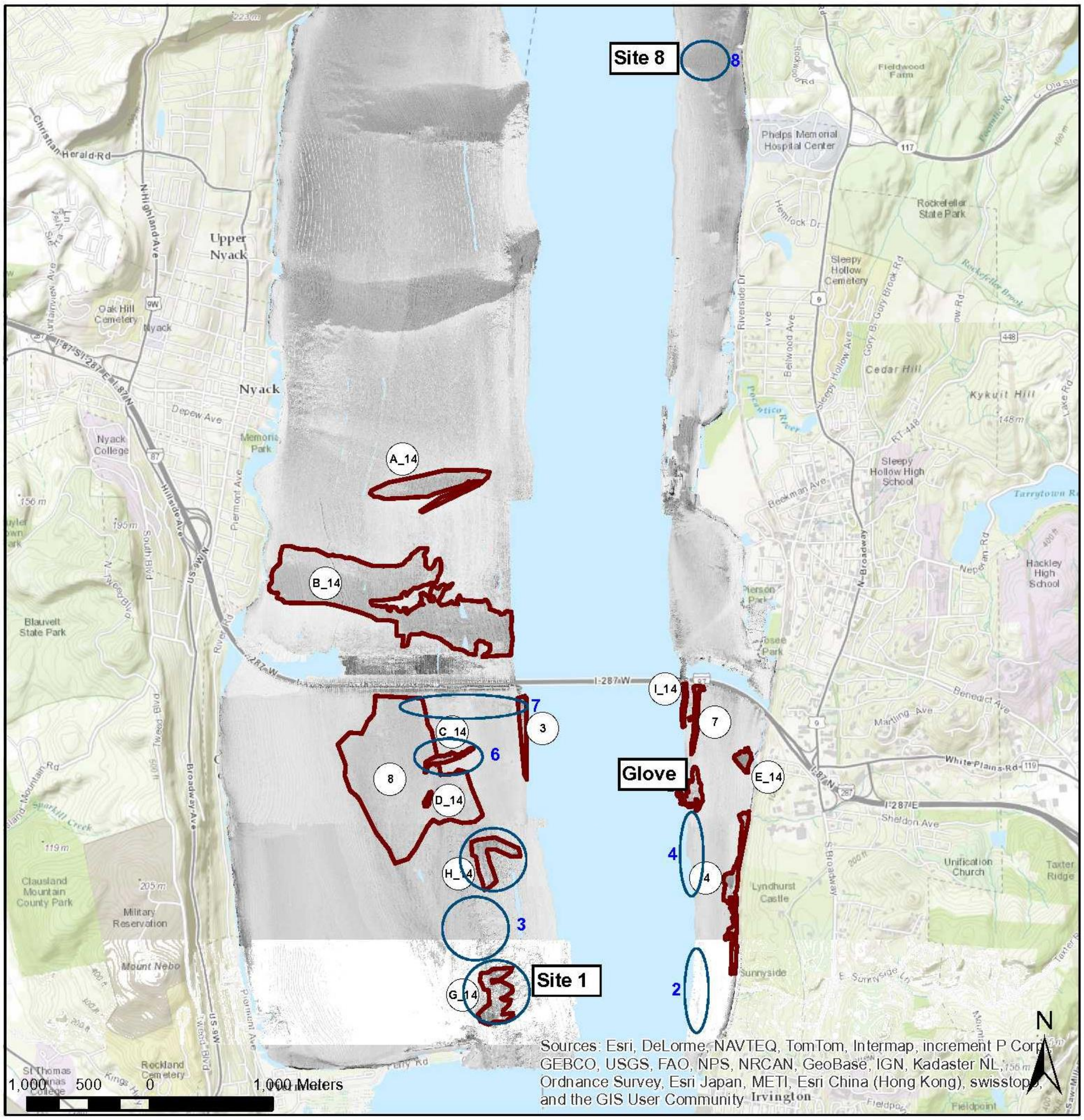


Figure 1. Locations of Sites 0 (Glove), 1, and 8 for Tier 4 water quality monitoring.

SALINITY

Overall, salinities observed across the three sites ranged from a minimum of 0.1 to a maximum of 20.2 PSU (**Table 1**). Mean salinity was comparable among sites, with the highest and lowest means differing by only 1.1 PSU. As in 2018, salinity averaged the highest at Site 1, but unlike that year, Site 0 averaged higher salinity levels than Site 8. Frequency distributions also show salinity to be high on the most occasions at Site 1 followed by Site 0 and then Site 8. For example, salinity was below 5 PSU 76% of the time at Site 8, 70% of the time at Site 0, and only 59% of the time at Site 1. Salinity was 10 PSU or greater only 0.1% of the time at Site 8, 0.4% of the time at Site 0, and 1.9% of the time at Site 1.

All three sites had lower mean salinity levels in 2019 than 2018. Mean salinity was 26% lower at Site 0, 36% lower at Site 1, and 37% lower at Site 8 in 2019 than in the previous year. This is likely due to the different date ranges sampled during the two years. Sampling in 2019 began in the early spring, 3 months earlier than in 2018 (April 2, 2019 vs. June 28, 2018), when salinity levels in the river tend to be lower than they are later into the spring and summer. All other factors remained largely constant between 2018 and 2019, including the sampling locations and associated water depth, the equipment used, and the download and maintenance frequency.

Table 1
Summary Statistics of Salinity Levels (PSU) at Sites 0, 1, and 8, April 2 – November 19, 2019

Site	Minimum	Maximum	Mean	10th Percentile	90th Percentile
0	0.1	15.7	3.7	0.2	7.9
1	0.1	20.2	4.4	0.2	8.5
8	0.1	15.4	3.3	0.2	6.7

Temporal trends in salinity were comparable among sites. Salinity declined sharply following deployment in early April and remained low until early May. Salinity levels were again low from mid- to late-May, and then steadily rose and remained relatively high for most of the remainder of the season. A brief decline occurred at all three sites in early November, but then salinity rose again until the end of the monitoring period on November 19. There was a strong degree of correlation between the replicate locations within each site, with both locations showing highly similar temporal trends for each site. All locations within all three sites showed a prolonged period of near-zero salinity from the middle to the end of April, and again during the second half of May and the first half of November. These events do not appear to be due to fouling of the instruments because the subsequent increases in salinity do not correspond with monthly retrieval and downloads, when the sensors on the instruments are scrubbed of any fouling. The simultaneous observance of these low salinity periods at each location within each site indicates that the data are accurate and not an artifact of fouling or other equipment malfunction. Frequency distributions show that salinity was between 0 and 1 PSU 22%, 18%, and 24% of the time at Sites 0, 1, and 8, respectively.

DISSOLVED OXYGEN

The time series of DO from each location is illustrated in **Appendix B** and the mean, minimum, and maximum values are reported in **Table 2.** DO levels measured across the three sites ranged from a minimum of 0.01 mg/L to a maximum of 13.76 mg/L. Site 8 had the highest mean followed by Site 1 and then Site 0, but the highest and lowest means differed by only 0.6 mg/L. Compared to 2018, DO averaged 21% higher at Site 0, 28% higher at Site 8, and 7% lower at Site 1. The start of the sampling period in early spring in 2019 versus the mid-summer beginning of the 2018 sampling period would be expected to result in higher mean DO levels among all sites in 2019 because of the negative relationship between DO and water temperature, so it is not clear why DO averaged higher at Sites 0 and 8 which would be expected, but not at Site 1.

DO generally followed similar temporal trends at each site, fluctuating from near-zero to approximately 10 mg/L over the course of the season. Overall, DO declined from the start of the season in early April until the end of July, rose sharply for the first half of August, declined again before increasing into September, and then gradually continued to increase until the end of the sampling period in late November (**Appendix B**). However, the sharp increases in DO at each site at the end of July and end of August (see scatter plots in **Appendix B**) coincide with the July 30 and August 27 download events, when the instruments were cleaned to remove fouling. The low DO levels measured in the weeks that preceded these two download events were clearly caused by fouling of the instruments' sensors, and were likely far lower than true DO levels at the time. For example, the final DO measurement at Site 1, Location 1 before retrieval of the instrument on July 30 was 0.3 mg/L, and the first measurement of that instrument after being cleaned and returned to the river less than an hour later was 7.3 mg/L. A similar issue occurred in 2018, clearly affecting the DO measurements between mid-August and the end of September of that year. Notwithstanding artificially low DO readings caused by fouling during these two time periods in 2019, DO infrequently fell below 3 mg/L, and not for prolonged periods of time. Frequency distributions show that over the course of the sampling period, DO was measured at < 3 mg/L 24% of the time at Site 0, 22% of the time at Site 1, and 18% of the time at Site 8 (**Appendix B**). This is considerably less frequent than what was observed in the previous year when DO was measured at < 3 mg/L 37% of the time at Site 0, 34% of the time at Site 1, and 27% of the time at Site 8. The difference, however, is likely to be largely due to the earlier start of the sampling period in 2019, which covered the months of early spring when colder water temperatures favor higher levels of DO.

Table 2
Summary Statistics of Dissolved Oxygen Levels (mg/L) at Sites 0, 1, and 8, April 2 – November 19, 2019

Site	Minimum	Maximum	Mean	10th Percentile	90th Percentile
0	0.1	12.2	6.0	1.3	9.4
1	0.1	13.8	6.4	0.6	10.3
8	0.0	13.7	6.6	1.1	10.2

TEMPERATURE

The time series of temperature readings from each location are illustrated in **Appendix C** and summary statistics are reported in **Table 3.** Temperatures across the three sites during the monitoring period ranged from a low of 2.0 ºC to a high of 29.6 ºC. The three sites had highly similar mean temperatures over the course of the monitoring period, differing by only 1.2 ºC. The three sites also had highly similar maximum temperatures between 29.3 and 29.6 ºC. Minimum temperatures, however, we considerably lower at Sites 1 and 8 than at Site 0 (**Table 3**). This is likely due to the deeper depth of Site 0, where the bottom of the water column is less influenced by winter air temperatures than it is at the shallower sites. All sites showed the same temporal pattern with temperatures increasing from between 5 and 10 ºC at the start of the monitoring period in early April, peaking between 25 and 30 ºC in late July/early August, and then steadily decreasing towards single digits at the end of the monitoring period in late November (**Appendix C**).

Table 3
Summary Statistics of Temperature (ºC) at Sites 0, 1, and 8, April 2 – November 19, 2019

Site	Minimum	Maximum	Mean	10th Percentile	90th Percentile
0	6.1	29.3	21.2	13.5	27.0
1	2.2	29.3	20.4	11.2	27.1
8	2.0	29.6	20.0	11.7	27.3

ASSOCIATIONS WITH SUBSTRATE MONITORING RESULTS

Post-restoration monitoring of oyster recruitment and survival on the reef balls and gabions that was conducted in the fall of 2019 by the Hudson River Foundation found marked differences among sites. Briefly, Site 0 had mostly second-year oysters, with few oysters of smaller size classes, indicating strong survival of oysters from 2018 to 2019, but low recruitment in 2019. Site 8 showed the opposite pattern, with low recruitment in 2018 or low survival of 2018 recruits into 2019, and low recruitment in 2019. Site 1 had strong recruitment in both years and high survivability of 2018 recruits into 2019.

There were no substantial site differences in salinity or DO in 2018 or 2019 that would explain any of the observed patterns in oyster recruitment and survival, and temperature is not believed to be a factor limiting oysters in this area of the Hudson River. Site 0 had the lowest salinity of the three sites in 2018, and yet had strong recruitment and survival of those oysters into 2019. Site 0 had the lowest average DO of the three sites in 2019 and the most frequent occurrences of DO < 3 mg/L, coinciding with low recruitment that year. However, it did not appear that DO was ever chronically low for extended periods of time relative to the other sites to explain the poor recruitment in 2019. Site 8 had the lowest salinity levels but highest DO levels of any site in 2019, coinciding with moderate recruitment that year but poor survival of the 2018 recruits. There were no unique patterns in salinity or DO at Site 8 in 2018 to differentiate it from the other sites. Site 1 has thus far performed the best of the three sites, with strong recruitment in 2018, high survivability of those oysters into 2019, and strong recruitment of new oysters in 2019. Site 1 had the highest mean salinity of the three sites in 2018 and 2019, the lowest frequency of low salinity events (< 5 PSU), and the greatest frequency of high salinity events (> 10 PSU). However, these figures are relative and at no site did it ever appear that salinity was chronically low to an extent that would be expected to affect recruitment or survival. DO levels were moderate at Site 1 in both years relative to the other sites, which also does not explain the strong recruitment and survival of oysters there. In sum, variation in salinity and DO among sites was minimal in 2018 and 2019, and is therefore unlikely to explain any of the inter-site differences in oyster recruitment and survival that have been observed thus far.

NEXT STEPS

Salinity, DO, and temperature levels will continue to be monitored at the Tier 4 restoration sites in 2020, from April through November. The Tier 4 restoration substrates (reef balls and gabions) at each site are scheduled to be monitored again for oyster settlement and growth by the Hudson River Foundation in October 2020. All DO and conductivity loggers that were used in 2019 will be sent to their respective manufacturers for calibration and servicing prior to deployment for the 2020 season to ensure data quality. A final report for the 2020 oyster post-construction water quality monitoring program is expected to be submitted in the first quarter of 2021.

APPENDIX A

SALINITY FIGURES

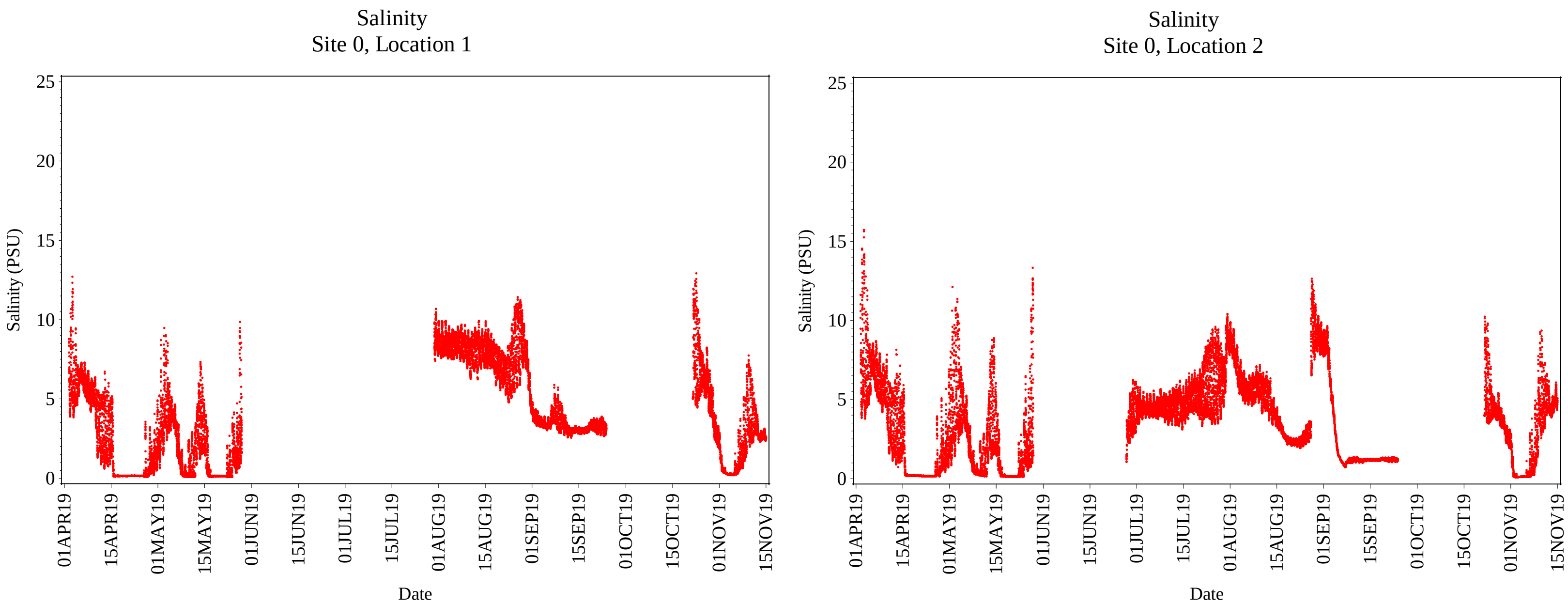


Figure A-1. Temporal trends in salinity at locations 1 (left) and 2 (right) at Site 0 (Glove).

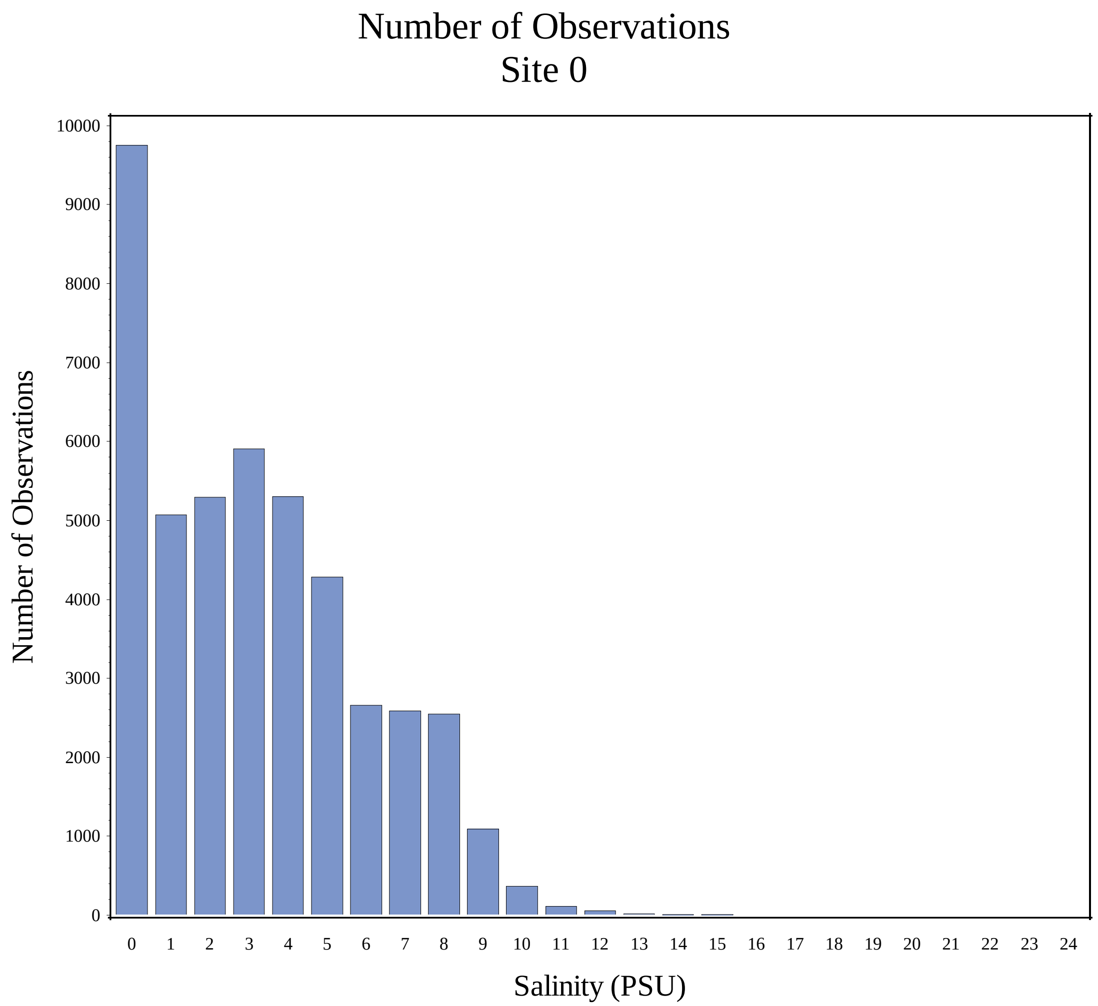


Figure A-2. Salinity frequency distribution at Site 0 (locations 1 and 2 combined)

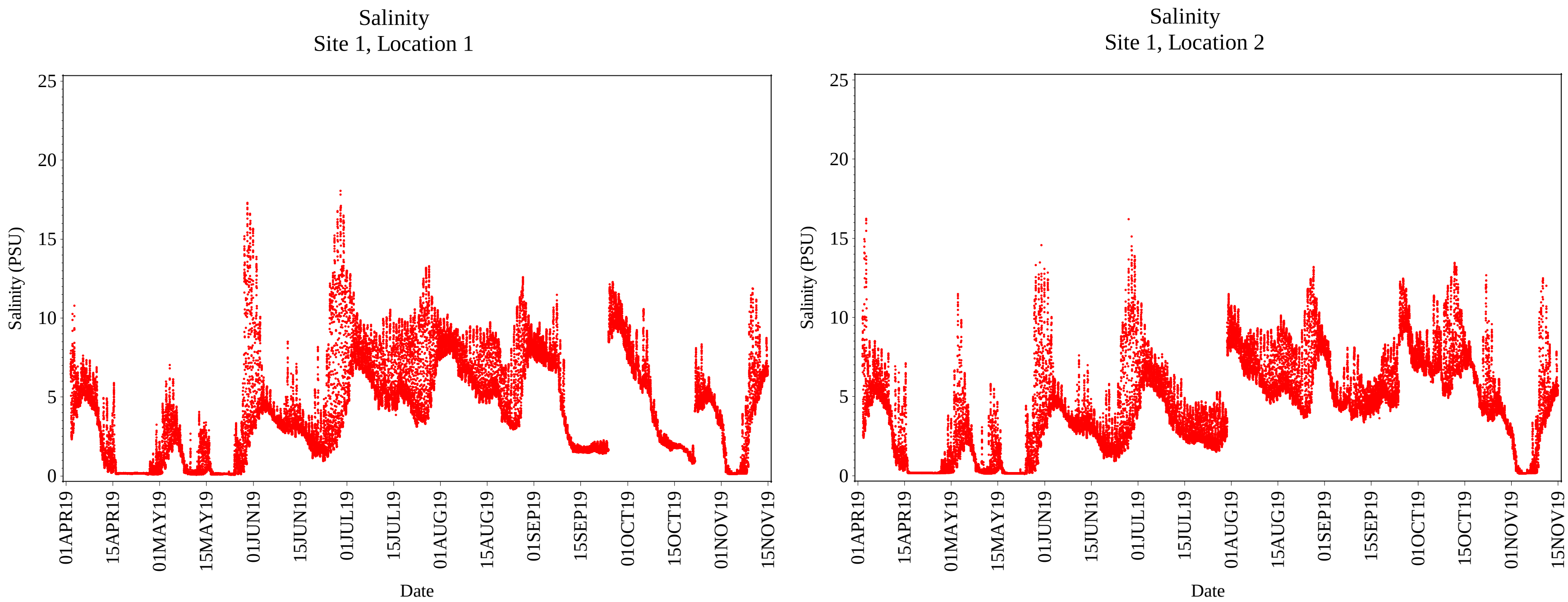


Figure A-3. Temporal trends in salinity at locations 1 (left) and 2 (right) at Site 1.

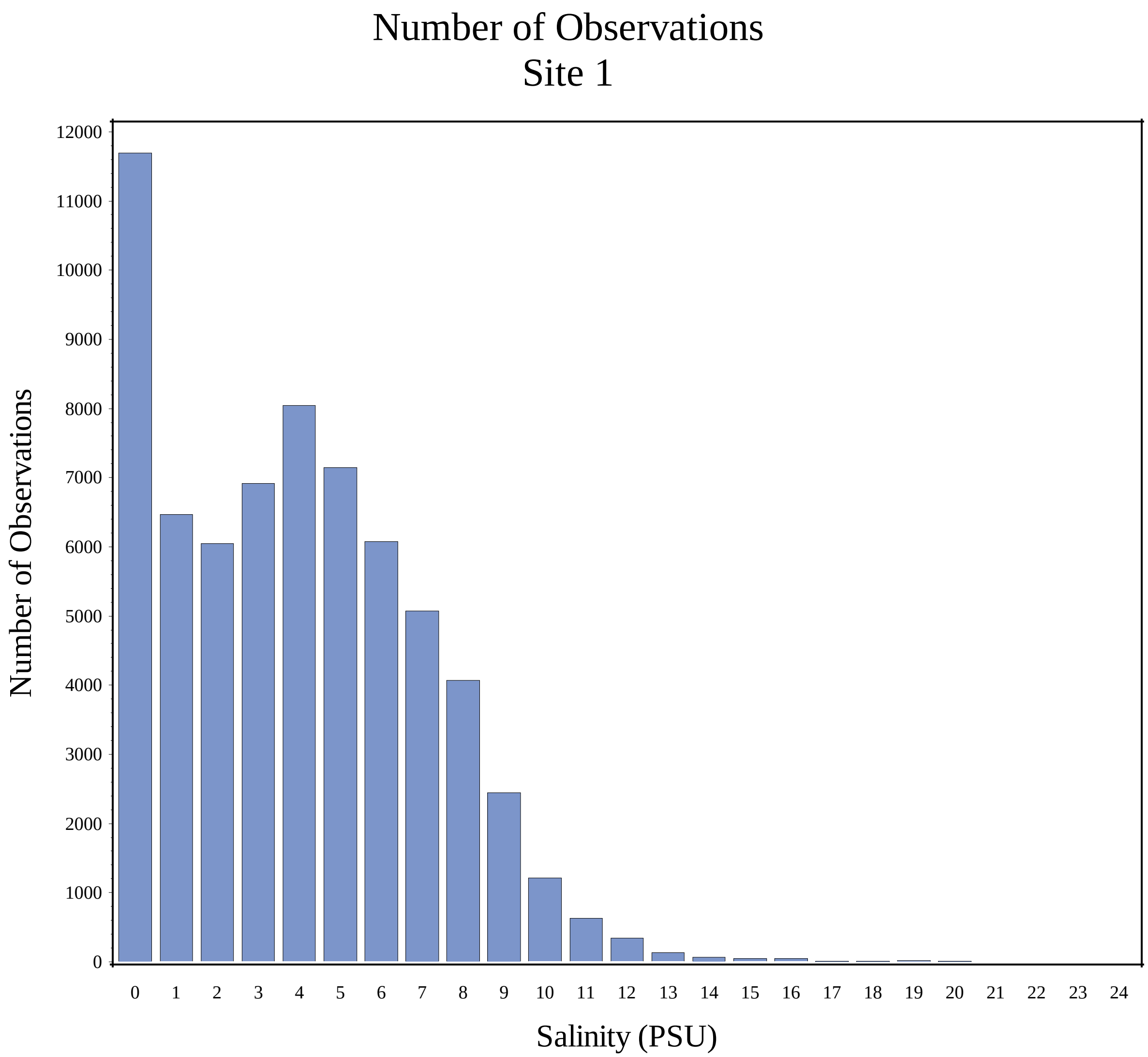
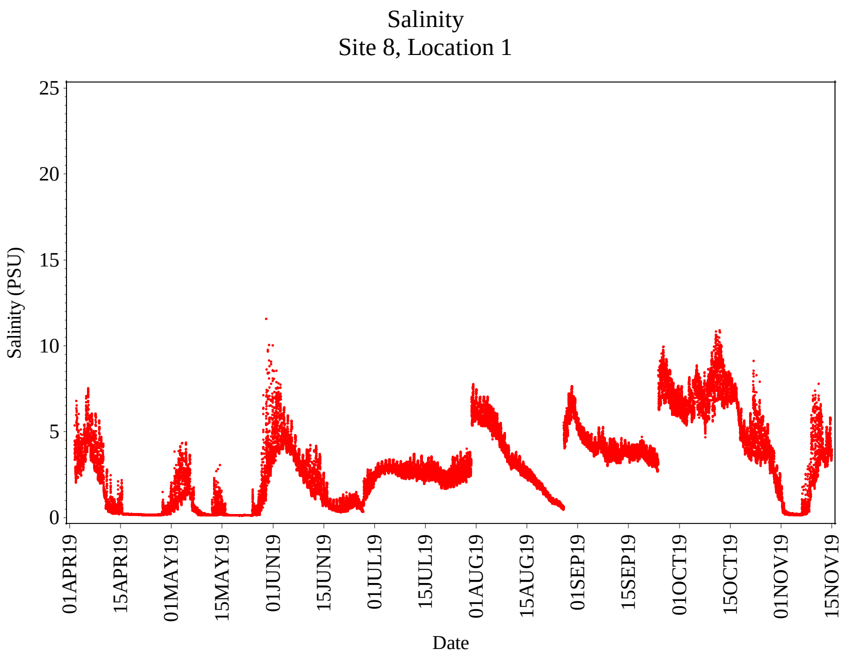


Figure A-4. Salinity frequency distribution at Site 1 (locations 1 and 2 combined).



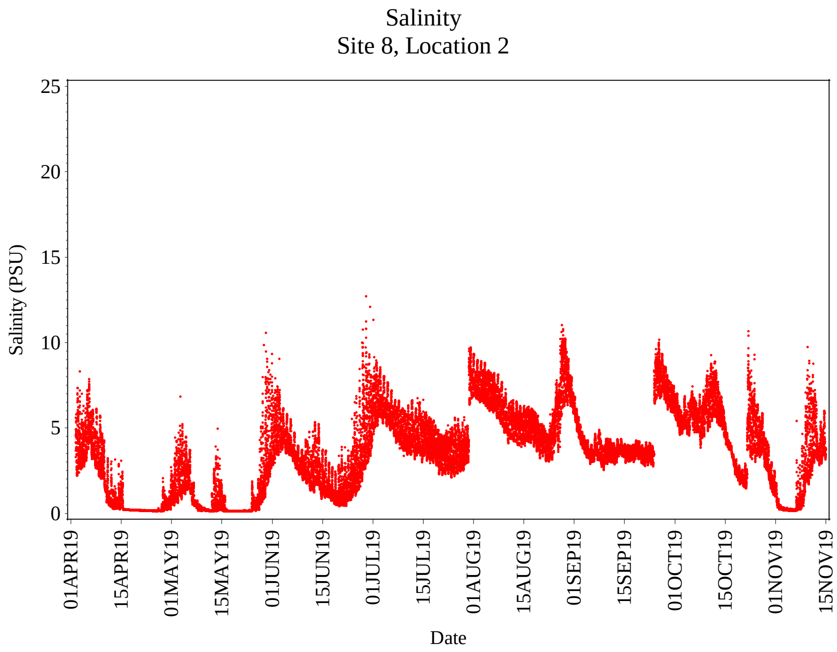


Figure A-5. Temporal trends in salinity at locations 1 (left) and 2 (right) at Site 8.

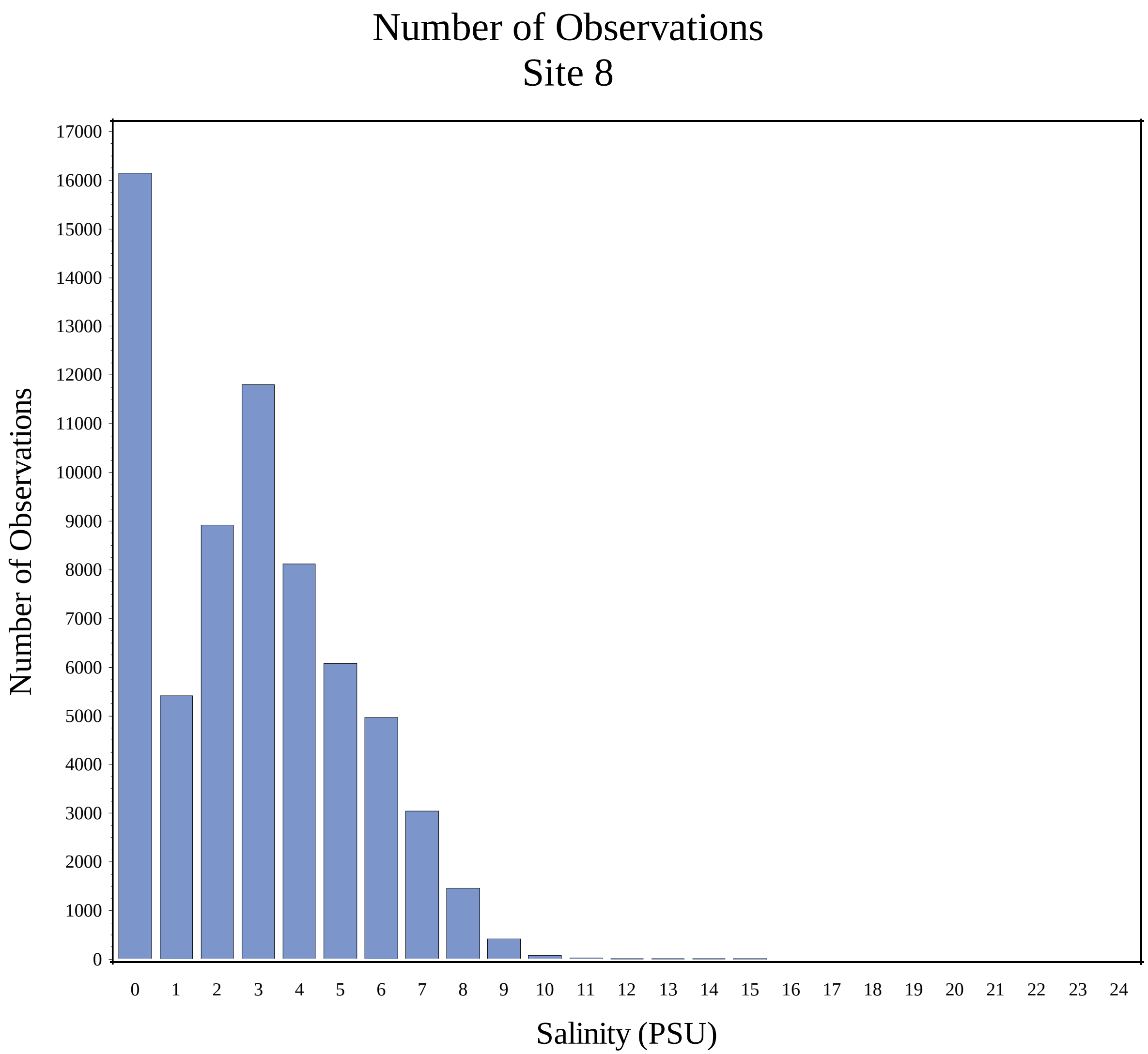
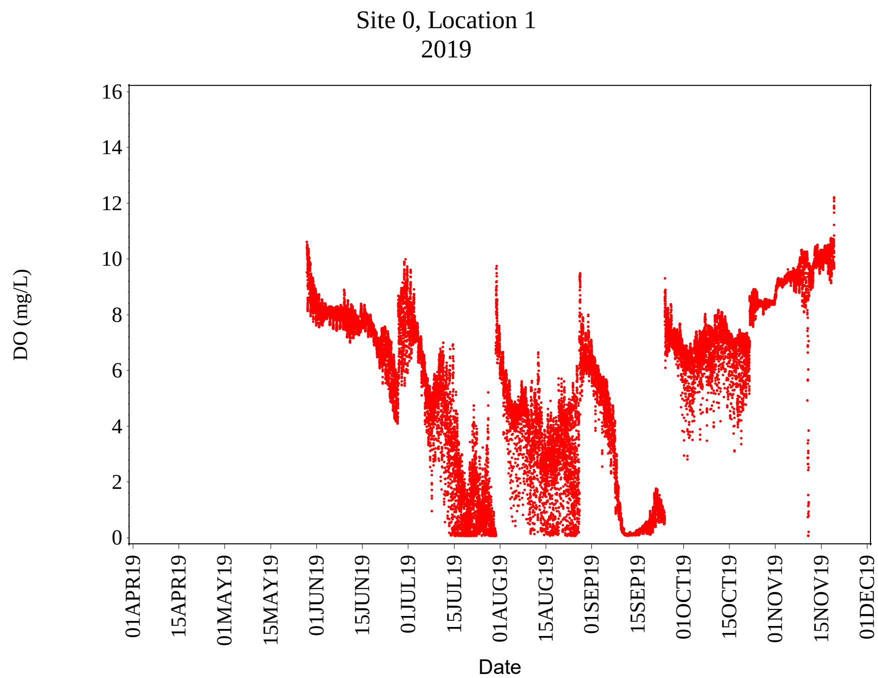


Figure A-6. Salinity frequency distribution at Site 8 (location 1 only).

APPENDIX B

DISSOLVED OXYGEN FIGURES



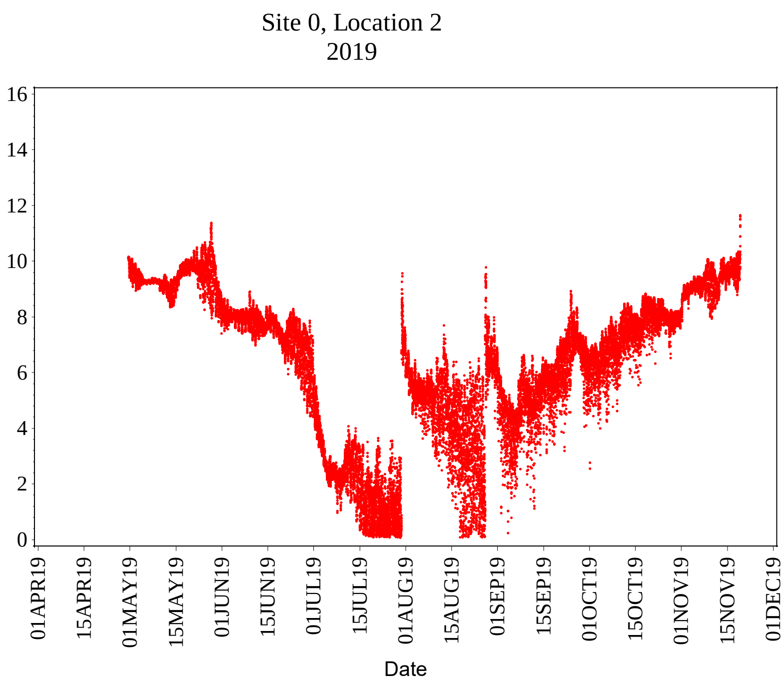


Figure B-1. Temporal trends in DO at locations 1 (left) and 2 (right) at Site 0 (Glove).

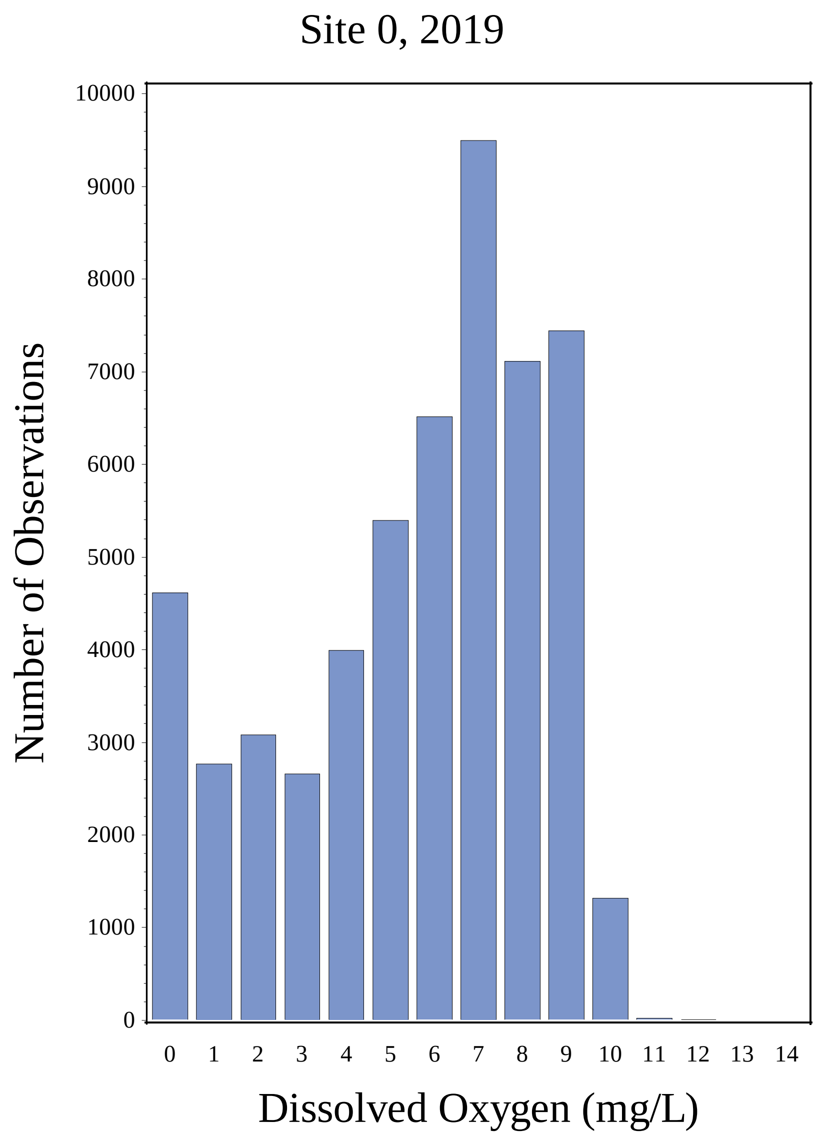


Figure B-2. DO frequency distribution at Site 0 (locations 1 and 2 combined).

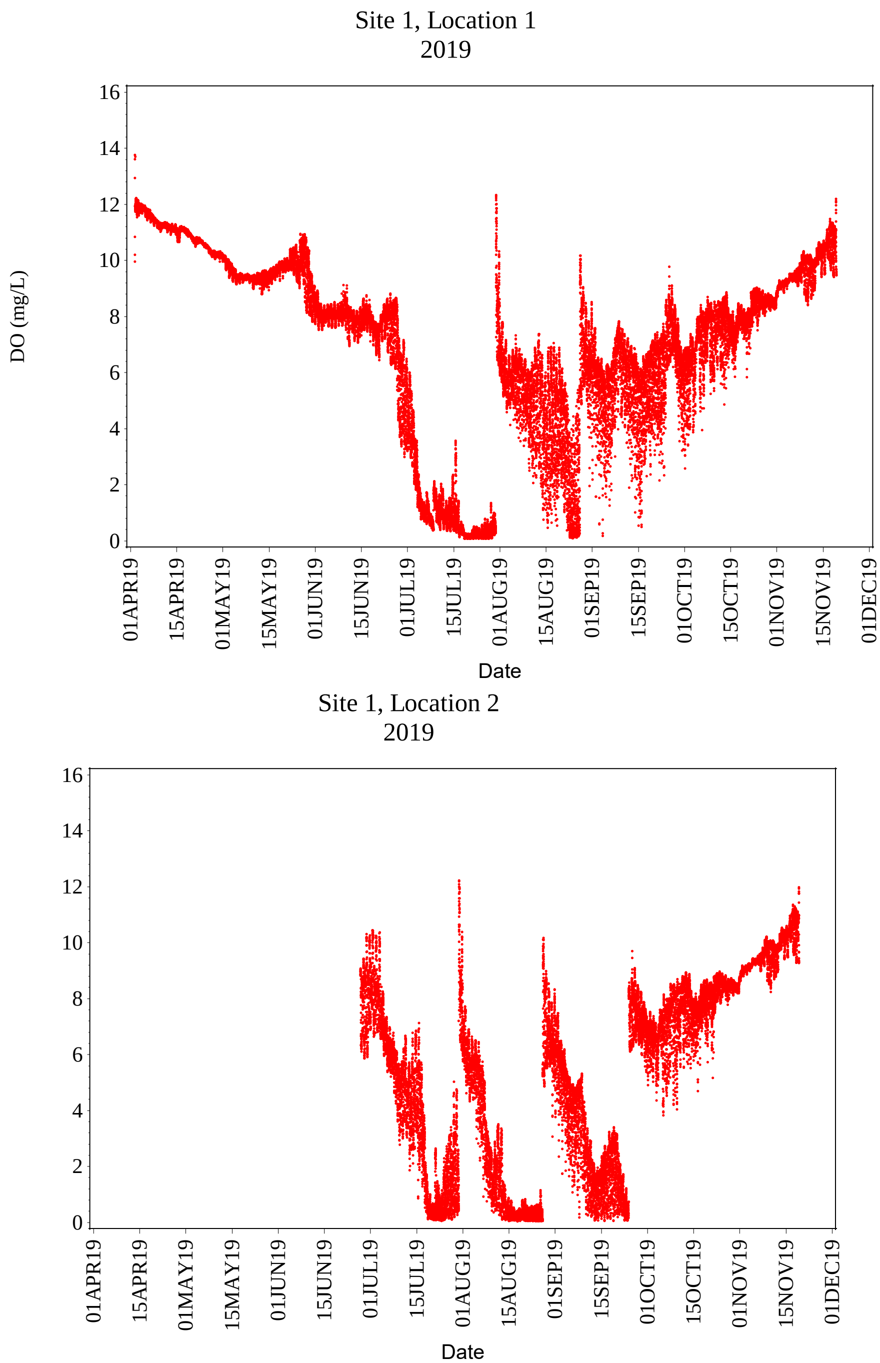


Figure B-3. Temporal trends in DO at locations 1 (left) and 2 (right) at Site 1.

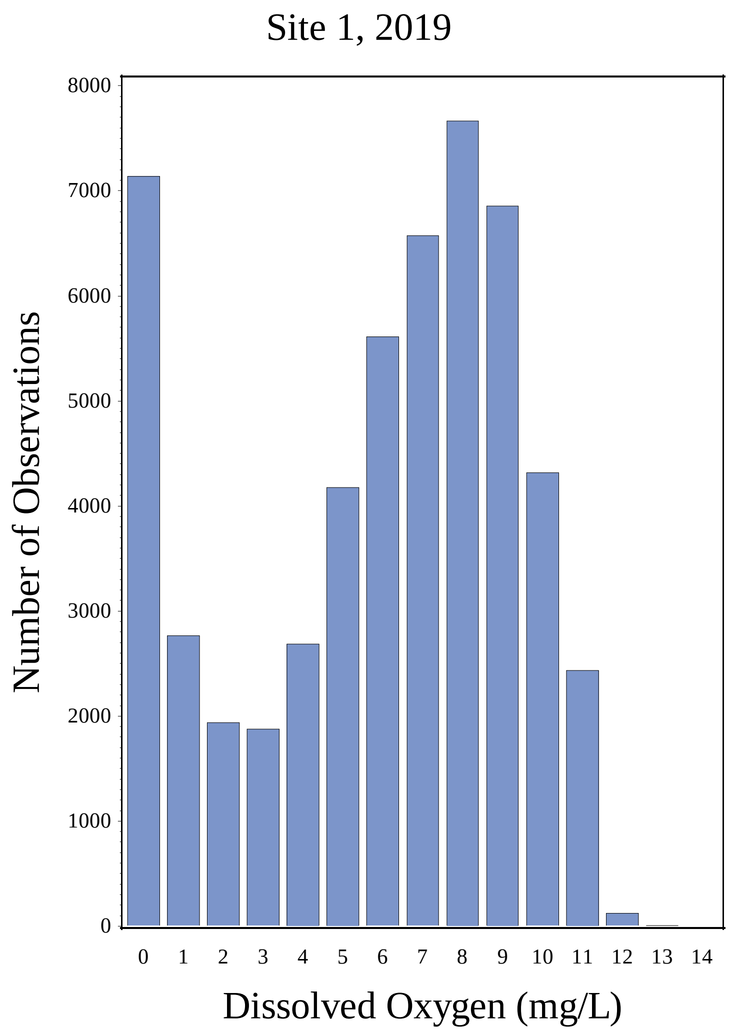
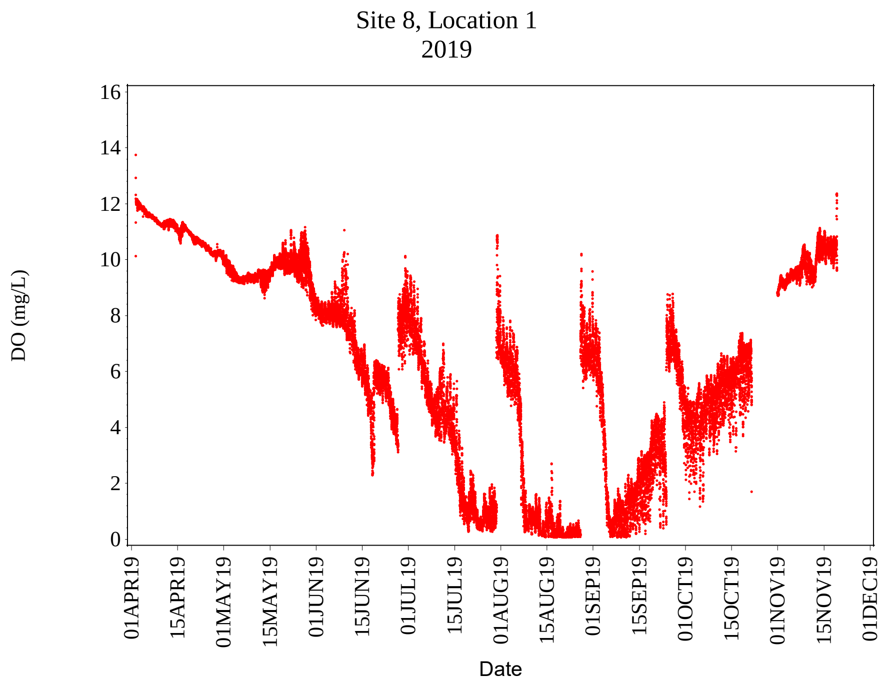


Figure B-4. DO frequency distribution at Site 1 (locations 1 and 2 combined).



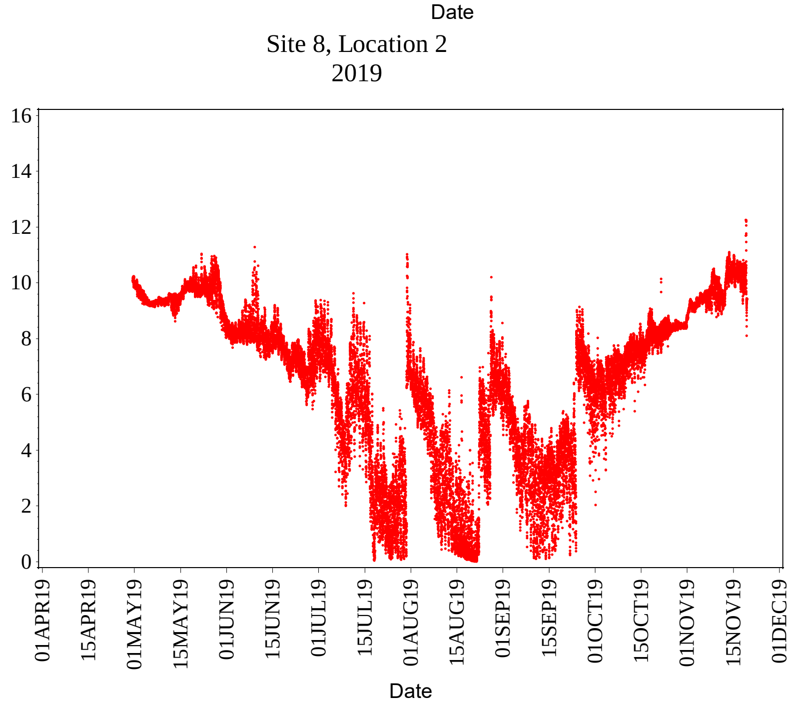


Figure B-5. Temporal trends in DO at locations 1 (left) and 2 (right) at Site 8.

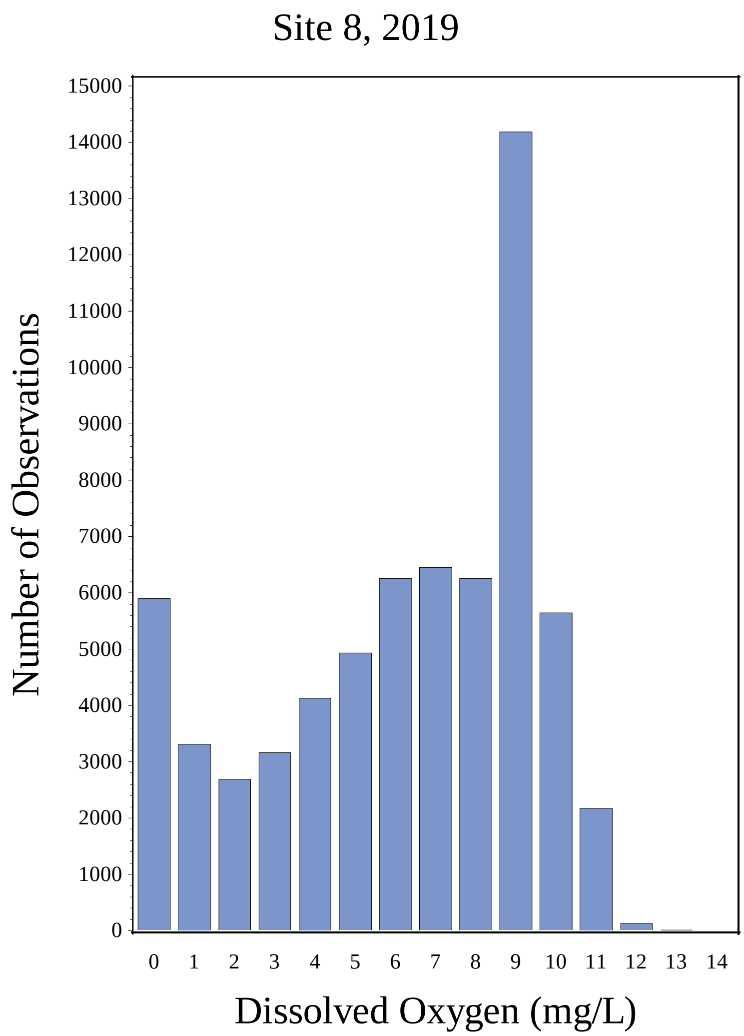
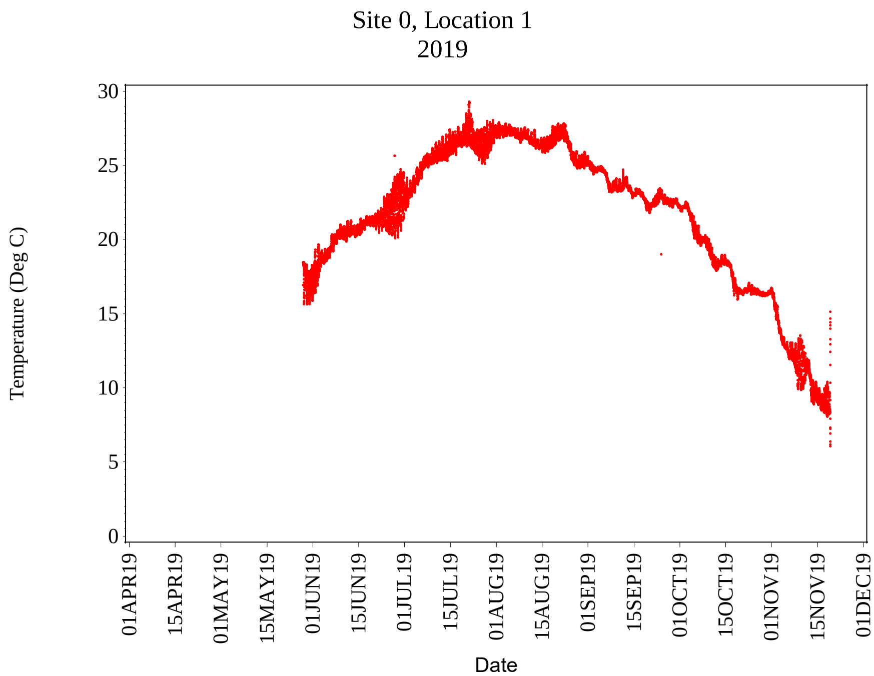


Figure B-6. DO frequency distribution at Site 8 (locations 1 and 2 combined).

APPENDIX C

TEMPERATURE FIGURES



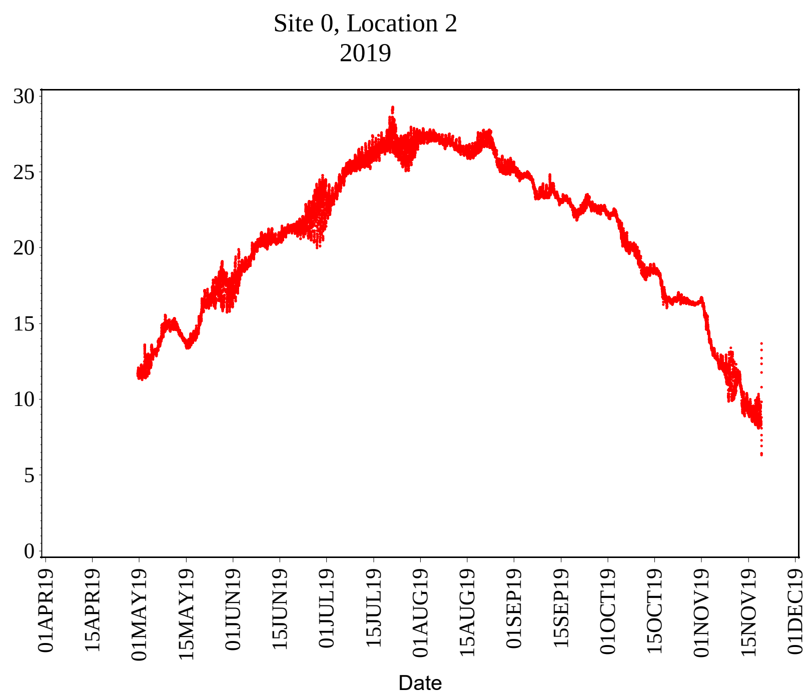


Figure C-1. Temporal trends in temperature (°C) at locations 1 (left) and 2 (right) at Site 0 (Glove).

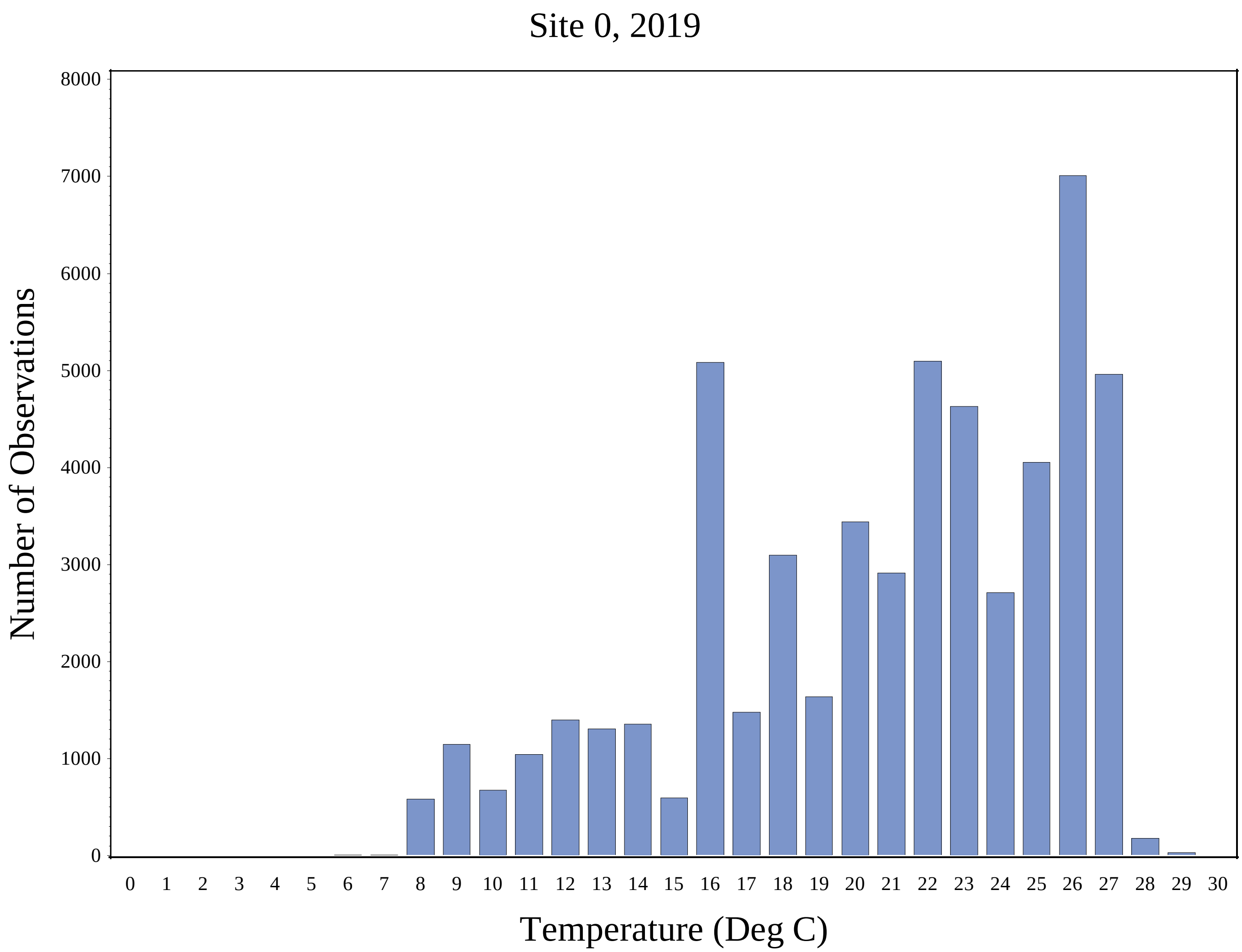


Figure C-2. Temperature frequency distribution at Site 0 (locations 1 and 2 combined).

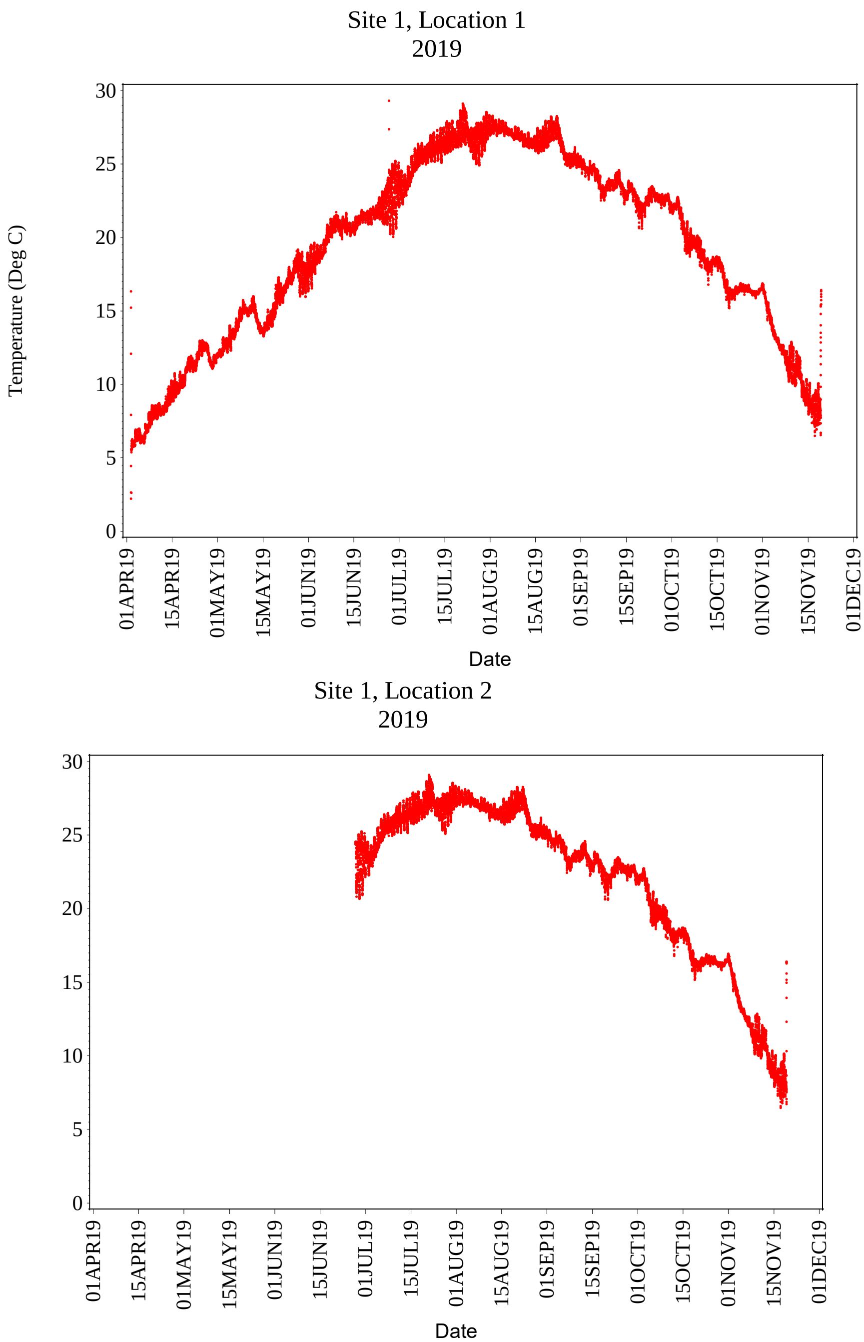


Figure C-3. Temporal trends in temperature (°C) at locations 1 (left) and 2 (right) at Site 1.

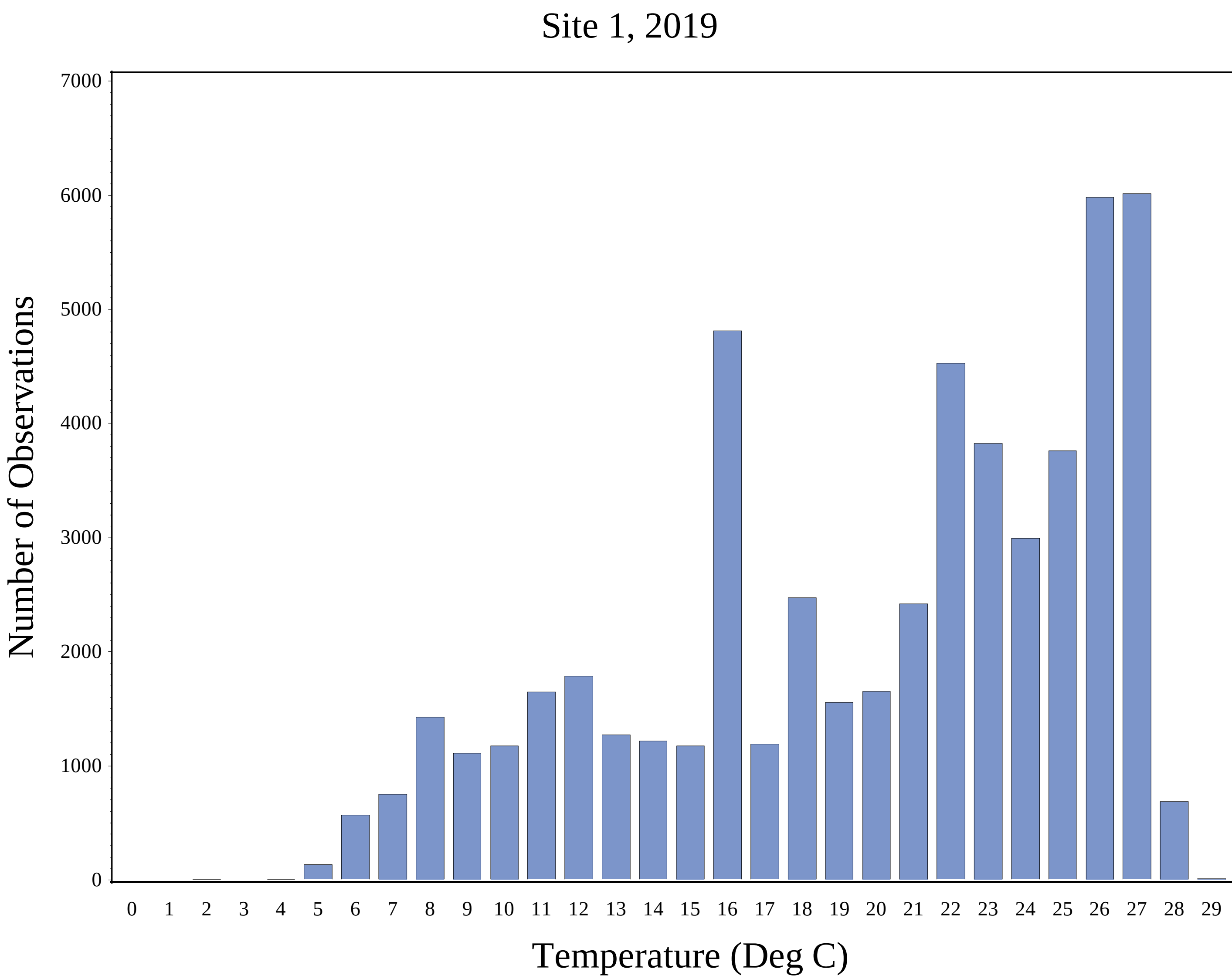
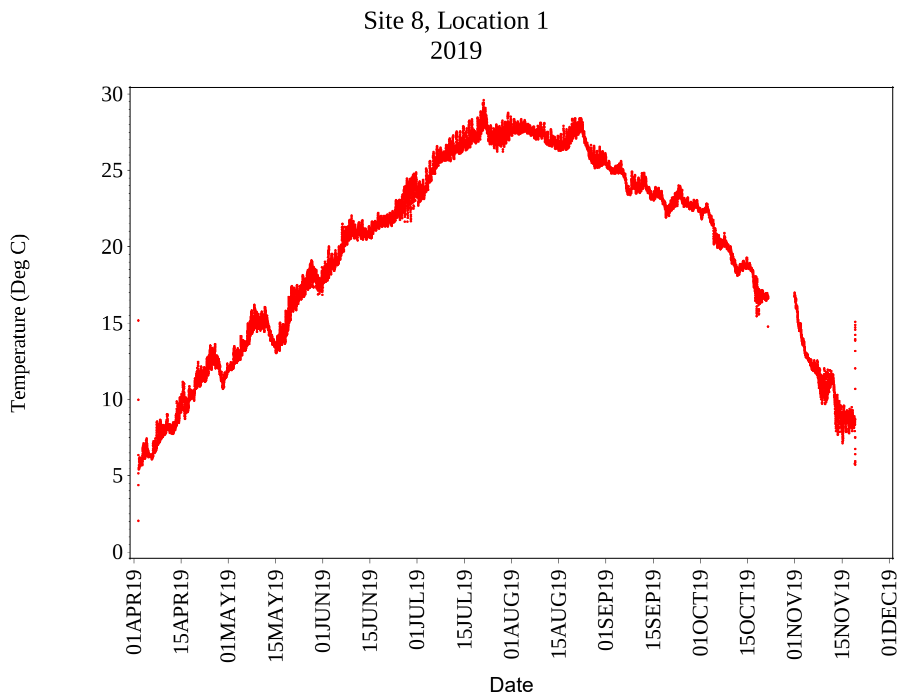


Figure C-4. Temperature frequency distribution at Site 1 (locations 1 and 2 combined).



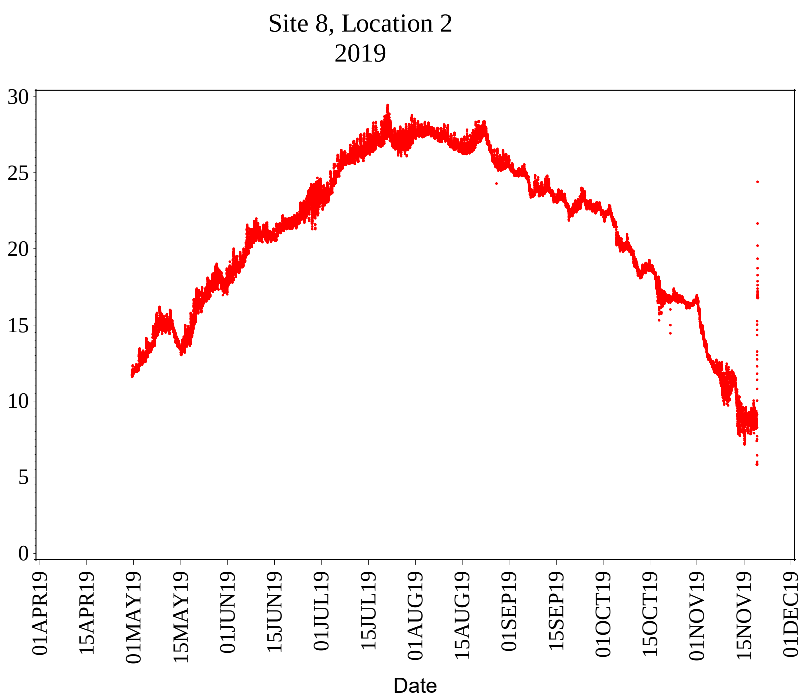


Figure C-5. Temporal trends in temperature (°C) at locations 1 (left) and 2 (right) at Site 8.

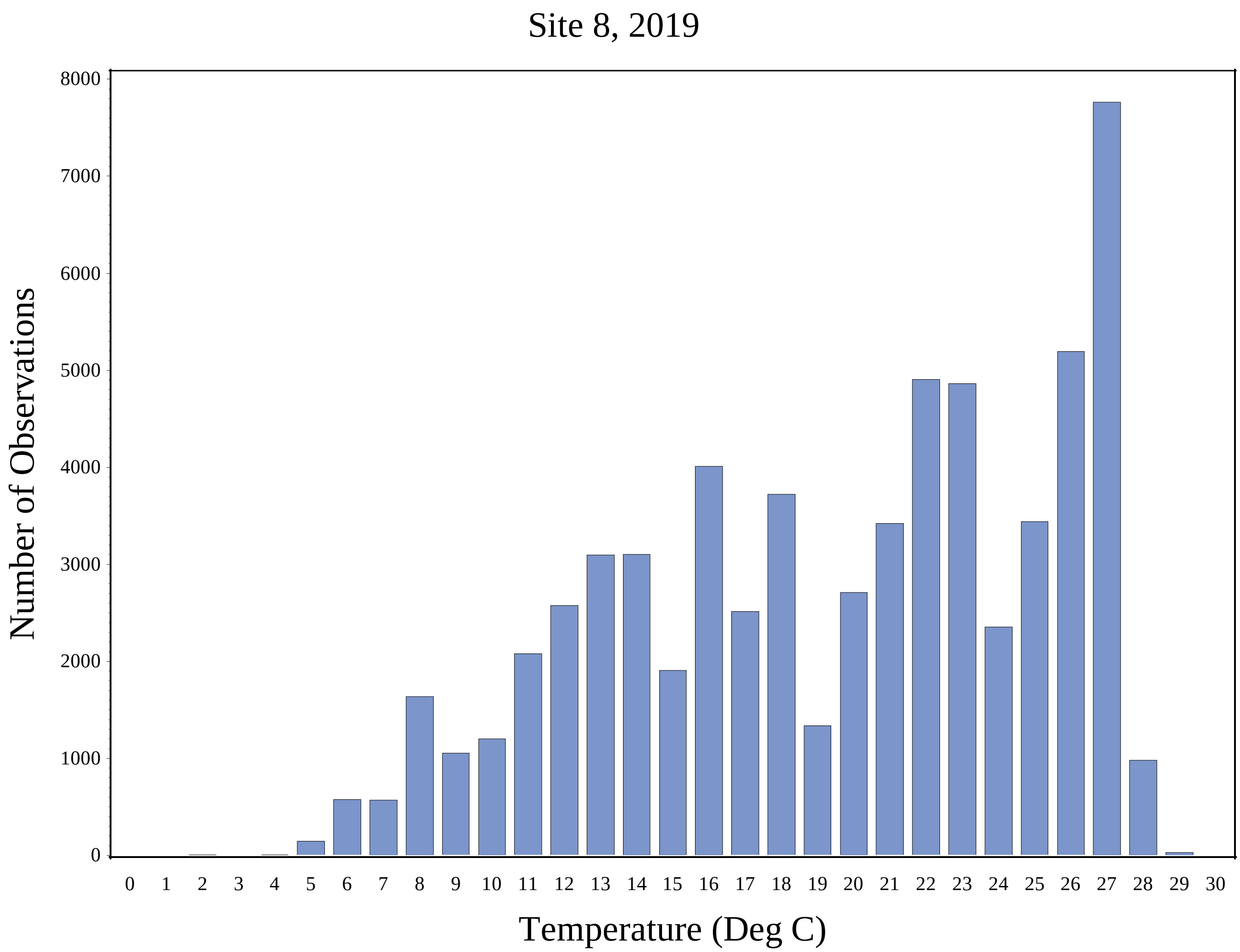


Figure C-6. Temperature frequency distribution at Site 8 (locations 1 and 2 combined).