

Sapelo Island (SAP) NERR Meteorological Metadata
Months and year the documentation covers: January – December 2023
Latest Update: 01/27/2025

I. Data Set and Research Descriptors

1) Principal investigator(s) and contact persons –

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2) Entry verification –

Data are uploaded from the CR1000X data logger to a personal computer with a Windows 7 or newer operating system. Files are exported from LoggerNet in a comma-delimited format and uploaded to the CDMO where they undergo automated primary QAQC and become part of the CDMO's online provisional database. During primary QAQC, data are flagged if they are missing or out of sensor range. The edited file is then returned to the reserve where it is opened in Microsoft Excel and processed using the CDMO's NERRQAQC Excel macro. The macro inserts station codes, creates metadata worksheets for flagged data and summary statistics, and graphs the data for review. It allows the user to apply QAQC flags and codes to the data, append files, and export the resulting data file to the CDMO for tertiary QAQC and assimilation into the CDMO's authoritative online database. For more information on QAQC flags and QAQC codes, see Sections 11 and 12. Ivanna Knox was responsible for all data collection and management through May 2023. Dylan Bedortha was responsible for all data collection and management from June 2023 to the present. Dylan reviewed all data prior to 6/2023 before 2023 annual submission.

3) Research objectives –

The principal objectives are to record meteorological information for the Sapelo Island NERR's site that can be used 1) as a reference for meteorological data for research projects on the reserve, 2) to give meteorological context for our 15-minute SWMP water quality data, and other long term environmental monitoring projects at the Reserve, 3) to observe and characterize important events such as storms, heat and cold waves, droughts, and heavy rainfalls, and 4) to detect trends and characterize climate variability over the long-term.

4) Research methods –

Campbell Scientific data telemetry equipment was installed at the Marsh Landing station on 02/15/2007 and transmits data to the NOAA GOES satellite, NESDIS ID #3B036592. The transmissions are scheduled hourly at

4m40s after the hour and contain four (4) data sets reflecting fifteen minute data sampling intervals. These data sets are always reported in Eastern Standard Time. Upon receipt by the CDMO, the data undergoes the same automated primary QAQC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QAQC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at <http://cdmo.baruch.sc.edu>.

The 15-minute data are collected in the following formats for the **CR1000X**:

Averages from 5-second data:

Temperature (°C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction (degrees), Battery Voltage (volts)

Maximum and Minimum Temperature (°C) and their times from 5-second data (these data are available from the reserve)

Maximum Wind Speed (m/s) and time from 5-second data

Wind Direction Standard Deviation (degrees)

Totals:

Precipitation (mm), PAR (millimoles/m²), and Cumulative Precipitation (mm) (Cumulative precipitation is no longer available via export from the CDMO. Please contact the reserve or the CDMO for more information or to obtain these data.)

Recommended calibration frequency for the MET station sensors:

- Temperature/Humidity- yearly recalibration
- Precipitation Gauge- yearly recalibration
- Wind Speed/Direction- yearly or every 2 years (depending on the sensor)
- Barometric Pressure- every 2 years recalibration
- PAR- every 2 years recalibration
- CR1000/CR1000X - every 5 years

5) Site location and character –

Sapelo Island is a fairly remote barrier island located in the middle of the Georgia coast. The island is only accessible boat, either private or by state run ferry. There is a small population of people who live on the island full time, less than 50. In addition to the reserve, the University of Georgia Marine Institute is located on the island as well as a Wildlife Management Area managed by the state. The meteorological station site is located at 31°25'04.3" N, 81°17'43.4" W, about 15 feet above sea level. All sensors are mounted on a 10m-aluminum tower located in the northern corner of the Marsh Landing parking lot on the southwest corner of the island. This lot is used for parking for the ferry, which docks here. The tower is located off of the pavement in the grass, mounted to a cement slab. The parking lot surface is approximately one meter above the surrounding marsh. The site is bordered with salt marsh to the north and south with transition into pine forest occurring 1/2 mi to the east. To the immediate west lies the Duplin River and the ferry dock, which is also the location of our Lower Duplin Water Quality sampling site. The meteorological station is well exposed to all winds and weather with little blockage and no shading. This region is subject to multiple severe weather events partially due to its proximity to the ocean. These events include severe summer thunderstorms, which can cause drastic, localized drops in pressure, temperature, and heavy rains; powerful fall and winter frontal systems carrying prolonged strong winds (usually NNE), drastic and sudden drops in temperature and pressure, and long, steady rains; and finally, the late summer and early fall hurricanes. It must be noted that due to the remote location and proximity to the ocean our weather patterns can vary greatly from those on the mainland, particularly temperatures which tend to moderate due to our being surrounded by water. The nearest sites for comparison are the Grays Reef NOAA weather Buoy located about 20nm east of Sapelo Island and Glynco airport located approximately 30 miles to the SSE.

Station measurements

All sensor heights are measured from the bottom of the aluminum tower they are mounted on. The tower sits on a cement slab that is approximately 1 foot off the ground.

Tower and sensor heights	Height (<i>meters</i>)	Notes
Tower	10	
Platform (<i>if applicable</i>)	N/A	
Temperature/Relative Humidity	2	
Barometric Pressure	1.5 (<i>inside enclosure</i>)	
Wind	10	
PAR	3	
Precipitation gauge	2.5	

SWMP station timeline

Station code	SWMP status	Station name	Location	Active dates	Reason decommissioned	Notes
ML	P	Marsh Landing	31°25'04.3" N, 81°17'43.4" W	02/15/2007 - present	NA	NA

6) Data collection period –

This is the 2023 annual file which covers the entire year of 2023 from 01/01/2023 00:00 – 12/31/2023 23:45.

Raw Files Start Date and Time	Raw Files End Date and Time
12/16/2022 15:45	01/19/2023 13:00
01/19/2023 13:15	04/14/2023 08:00
04/14/2023 08:15	05/22/2023 13:45
05/22/2023 14:00*	06/23/2023 06:00*
06/26/2023 13:15	06/29/2023 10:30
06/29/2023 10:45	07/05/2023 11:45
07/05/2023 12:00*	07/10/2023 09:00*
07/11/2023 09:00	07/21/2023 10:30
07/21/2023 10:45	08/09/2023 09:00
08/09/2023 09:15	08/17/2023 09:00
08/17/2023 09:15	10/02/2023 09:15
10/02/2023 09:30	11/14/2023 11:30
11/14/2023 11:45	12/08/2023 11:00
12/08/2023 11:15	01/11/2024 11:30

All data are reported in Eastern Standard Time (EST). The raw files marked with * reflect recovered telemetry data (flagged in data set) due to recording errors. There are gaps in data from 06/23/23 06:15 – 06/26/23 13:00 and 07/10/23 09:15 – 07/11/23 08:45 where telemetry data was unable to be recovered due to telemetry issues. See Other remarks/notes section 13 in this document for more details.

7) Distribution –

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS retains the right to be fully credited for having collected and processed the

data. Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

Requested citation format:

NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: <http://www.nerrsdata.org/>; accessed 12 October 2023.

NERR meteorological data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal Investigators and Contact Persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page www.nerrsdata.org. Data are available in comma delimited format.

8) Associated researchers and projects –

Sapelo Island has a long history of maintaining research. In 1953, the University of Georgia Marine Institute (UGAMI) was formed on Sapelo and the island became a working laboratory for many. The research continues today with SAP NERR and UGAMI creating a unique partnership with much of the current research being done facilitated by SAP NERR and UGAMI together. Given UGAMI's long history on Sapelo, a bibliographic list of over 800 articles of current and previous research can be found on the UGAMI website: <http://www.uga.edu/ugami> and on the Sapelo Island NERR site: <http://www.sapelonerr.org>.

As part of the SWMP long-term monitoring program, SAP NERR also collects 15-minute water quality data and monthly grab and diel samples for nutrient/pigment data which may be correlated with this meteorological dataset. These data are available at www.nerrsdata.org.

II. Physical Structure Descriptors

9) Sensor specifications –

Parameter: Temperature

Units: Celsius

Sensor type: PT100 RTD, IEC 751 1/3 Class B, with calibrated signal conditioning

Model #: HC2-S3 Temperature and Relative Humidity Probe

Operating Temperature: -40°C to +60°C

Range: -40°C to +60°C

Accuracy: ± 0.1 °C @ 23°C

Serial number, dates of calibration and use:

SN: 61115039

Last calibration: 10/10/2019

In service: 11/08/2021 – 02/21/2023 (previous metadata has 09/26/2022 as removal date but more than likely this is the correct date)

SN: 60780595

Last calibration: 8/18/2022

In service: 2/21/2023 - 8/17/2023 (previous metadata has 09/26/2022 as install date but than more likely this is the correct data)

SN: 20072700
Last calibration: 2/16/2023
In service: 8/17/2023 – 2/15/2024

Parameter: Relative Humidity
Units: Percent
Sensor type: ROTRONIC® Hygromer IN-1
Model #: HC2-S3 Temperature and Relative Humidity Probe
Range: 0-100% non-condensing
Accuracy at 23°C: +/- 0.8% RH with standard configuration settings
Temperature dependence of RH measurement +/- 3% (-40 to 60C)

Serial number, dates of calibration and use:

SN: 60115039
Last calibration: 10/10/2019
In service: 11/08/2021 – 02/21/2023 (previous metadata has 09/26/2022 as removal date but more than likely this is the correct date)

SN: 60780595
Last calibration: 8/18/2022
In service: 2/21/2023 - 8/17/2023 (previous metadata has 09/26/2022 as install date but than more likely this is the correct data)

SN: 20072700
Last calibration: 2/16/2023
In service: 8/17/2023 – 2/15/2024

Parameter: Barometric Pressure
Units: millibars (mb)
Sensor type: Vaisala Barocap © silicon capacitive pressure sensor
Model #: CS-106 (PTB110)
Operating Range: Pressure: 500 to 1100 mb; Temperature: -40°C to +60°C
Humidity: non-condensing
Accuracy: ± 0.3 mb at +20°C, ± 0.6 mb at 0°C to 40°C, ± 1 mb at -20°C to +45°C, ± 1.5 mb at -40°C to +60°C
Stability: ± 0.1 mb per year

Serial number, dates of calibration and use:

SN: H0870031
Last calibrated: 8/18/2022
In service: 9/26/2022 – current as of 12/31/2023

Parameter: Wind speed
Units: meter per second (m/s)
Sensor type: 18 cm diameter 4-blade helicoids propeller molded of polypropylene
Model #: R.M. Young 05103 Wind Monitor
Range: 0-60 m/s (134 mph); gust survival 100 m/s (220 mph)
Accuracy: +/- 0.3 m/s

Serial number, dates of calibration and use:

SN: WM171991
Last calibrated: 9/22/2022
In service: 12/16/2022 – current as of 12/31/2023

Parameter: Wind direction

Units: degrees

Sensor type: balanced vane, 38 cm turning radius

Serial number, dates of calibration and use:

SN: WM171991

Last calibrated: 9/22/2022

In service: 12/16/2022 – current as of 12/31/2023

Parameter: Photosynthetically Active Radiation (PAR)

Units: mmol m⁻² (total flux)

Sensor type: Quantum Sensor; high stability silicon photodiode (blue enhanced) in anodized aluminum case with acrylic diffuser

Model: CS310 (SQ-500)

Light spectrum waveband: 389 to 692 nm

Temperature dependence: $-0.11 \pm 0.04\%/^{\circ}\text{C}$

Stability: $< \pm 2\%$ change over a 1-year period

Operating temperature: -40 to 70°C

Cosine Response: $\pm 5\%$ at 75° zenith angle

Sensitivity: 0.01 mV per $\mu\text{mol}/\text{m}^2/\text{s}$

Multiplier: 0.5 (this does not change)

Serial number, dates of calibration and use:

SN: SQ-500-SS_3904

Last calibration: May 2022 (new)

In service: 12/16/2022 – 4/29/2024

Parameter: Precipitation

Units: millimeters (mm)

Sensor type: Tipping Bucket Rain Gauge

Model #: TE525

Rainfall per tip: 0.01 inch

Operating range: Temperature: 0° to 50°C ; Humidity: 0 to 100%

Accuracy: $\pm 1.0\%$ up to 1 in./hr; $\pm 0, -3\%$ from 1 to 2 in./hr; $\pm 0, -5\%$ from 2 to 3 in./hr

Serial number, dates of calibration and use:

SN: 50994-412

Last calibration: 9/27/2022

In service: 03/01/2017 – 9/12/2023

SN: 91816-0822

Last calibration: 9/5/2023

In service: 9/12/2023 – current as of 12/31/2023

Datalogger:

CR1000X:

The CR1000X has a total onboard memory of 128 MB of flash and 4MB of battery backed SRAM. There is 8 MB of flash memory reserved for loading the operating system and 1MB of flash reserved for configuration settings. SRAM is used for the CRBasic program operating memory, communication memory, and data storage, with 72 MB of flash for extended data storage. Additional data storage expansion is available with a removable microSD flash memory card of up to 16 GB.

Serial number: 13925

Date CR1000X installed: 3/4/2022 – current as of 12/31/2022

Date CR1000X calibrated: 11/21/2019

CR1000X firmware version (s):
OS Version: CR1000X.Std.05.01; date unknown

CR1000X program version(s):
(reservecodesitecodemet_loggertype_programver#_lastdatemodified
ex. delsjmet_CR1000_5.5_031023.CR1 or delsjmet_CR1000X_5.5_031023.CR1X)
SAPMLMET_CR1000x_6.0.0_010522.CR1X
- Used up until 4/14/2023

SAPMLMET_CR1000x_6.0.0_041423.CR1X
- Used from 4/14/2023 until present

GOES transmitter:

Model number: TX312
Serial number: 1339
Date installed: unknown

Model number: TX321-G
Serial number: 2363
Date installed: 8/22/2023

10) Coded variable definitions -

Sampling station:	Sampling site code:	Station code:
Marsh Landing	ML	sapmlmet

11) QAQC flag definitions –

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter's associated flag column (header preceded by an F_). During primary automated QAQC (performed by the CDMO), -5, -4, and -2 flags are applied automatically to indicate data that is above or below sensor range, or missing. All remaining data are then flagged 0, as passing initial QAQC checks. During secondary and tertiary QAQC 1, -3, and 5 flags may be used to note data as suspect, rejected due to QAQC, or corrected.

- 5 Outside High Sensor Range
- 4 Outside Low Sensor Range
- 3 Data Rejected due to QAQC
- 2 Missing Data
- 1 Optional SWMP supported Parameter
- 0 Passed Initial QAQC Checks
- 1 Suspect Data
- 2 *Open - reserved for later flag*
- 3 *Open - reserved for later flag*
- 4 Historical Data: Pre-Auto QAQC
- 5 Corrected Data

12) QAQC code definitions –

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the CR1000X, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point, but some comment codes (marked with an * below) can be applied to the entire record in the F_Record column.

General Errors

GIM	Instrument malfunction
GIT	Instrument recording error, recovered telemetry data
GMC	No instrument deployed due to maintenance/calibration
GMT	Instrument maintenance
GPD	Power down
GPF	Power failure / low battery
GPR	Program reload
GQR	Data rejected due to QA/QC checks
GSM	See metadata

Sensor Errors

SDG	Suspect due to sensor diagnostics
SIC	Incorrect calibration constant, multiplier or offset
SIW	Incorrect wiring
SMT	Sensor maintenance
SNV	Negative value
SOC	Out of calibration
SQR	Data rejected due to QAQC checks
SSD	Sensor drift
SSN	Not a number / unknown value
SSM	Sensor malfunction
SSR	Sensor removed

Comments

CAF	Acceptable calibration/accuracy error of sensor
CCU	Cause unknown
CDF	Data appear to fit conditions
CML	Snow melt from previous snowfall event
CRE*	Significant rain event
CSM*	See metadata
CVT*	Possible vandalism/tampering
CWE*	Significant weather event

13) Other remarks/notes –

Data are missing due to equipment or associated specific sensors not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. Any NaNs in the dataset stand for “not a number” and are the result of low power, disconnected wires, or out of range readings. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

Relative Humidity data greater than 100 are within range of the sensor accuracy of $\pm 3\%$ and are flagged and coded as suspect, <1> (CAF), unless there are problems with the sensor. Values greater than 103 are rejected <-3>.

Data recorded for all parameters (with the exception of cumulative precipitation) at the midnight timestamp (00:00) are the 15 minute averages and totals for the 23:45-23:59 time period of the previous day. Cumulative precipitation data at the midnight timestamp (00:00) are the sum of raw (unrounded) precipitation data from 00:00 to 23:59 of the previous day. Summing each individual 15-minute total precipitation value from the same period will result in small differences from cumulative precipitation due to rounding. It is especially important to note how data at the midnight timestamp are recorded when using January 1st and December 31st data. **Note: Cumulative precipitation is no longer available via export from the CDMO. Please contact the reserve or the CDMO for more information or to obtain these data.**

Slightly negative and elevated nighttime PAR values are considered suspect, <1> (CSM).

The temp/relative humidity sensor (serial number 61115039) began drifting/malfunctioning in January 2023. When the sensor was returned to Campbell Scientific after removal it could not be repaired and was retired from service. Beginning January 8, 2023 02:30 and continuing through the sensor swap on 02/21/2023 both temperature and relative humidity are considered suspect due to the malfunctioning sensor, <1> [SSM] (CSM). In addition, all RH values of 104 or greater are flagged as rejected as are RH values recorded as "NAN". When erroneous maximum or minimum temperature values (not included in the data but available from the reserve) were recorded, temperature and RH were both rejected. Another temperature/RH sensor, serial number 60780595, was installed on 2/21/2023; however, the time of the swap was not recorded. Because no time is given for the sensor swap both temperature and relative humidity are marked as suspect due to sensor maintenance for the entire day.

PAR Sensor experienced a wiring issue after maintenance on 12/16/2022 so all data points from 12/16/2022 to 4/14/2023 08:30 are rejected. The sensor multiplier and wiring were fixed during a troubleshooting session on 4/14/2023 from 08:45 – 10:45. A new program for the data logger was also uploaded at this time.

On 05/25/2023, while checking precipitation gauge for obstructions, it was observed that the gold funnel was absent from the top of the gauge. It is believed to have blown off during a high wind event. A backup funnel was installed onto the gauge. This maintenance took place between 8:45 – 10:15 and all precipitation data at 08:45, 09:00, and 09:45 have been flagged as corrected due to maintenance (5 GIT CSM).

The meteorological site experienced telemetry issues beginning sometime in mid-June. The real time data would not post to the CDMO's RTA site, usually for multiple hours at a time. While trying to troubleshoot/fix this issue on 06/26/2023, Dylan inadvertently stopped the program running on the data logger. After getting the program back running, it was found that the data from 05/22/2023 14:00 – 06/26/2023 13:00 had been lost. Telemetry data was recovered from the CDMO and included in this quarter's report in place of lost data. The entirety of the telemetry data is flagged as suspect. Precipitation data flagged as corrected are also considered suspect. Due to our ongoing issue with the telemetry station, there are some gaps in this dataset that reflect when the telemetry was offline. Data missing due to telemetry issues from 6/23/2023 06:15 – 6/26/2023 13:00.

Data from 07/05/2023 12:00 – 07/10/2023 13:00 are recovered telemetry data due to data loss associated with system maintenance/troubleshooting. This maintenance/troubleshooting was being done to fix telemetry issues, so some data in this five-day period is missing due to intermittent telemetry failure. All

data is either flagged as suspect or missing and given the GIT CSM flag. There is also a gap in data from 07/10/23 09:15 – 07/10/13:00 due to telemetry issues.

Total and cumulative precipitation maintenance rain gauge tip on 07/10/2023 13:30 was corrected back to 0.0 and cumulative values were corrected to reflect precipitation that occurred later in the day.

On 07/17/2023 between 8:30 – 8:45sdt, the MET station battery was replaced in an effort to resolve telemetry issues. Both the temperature/relative humidity and barometric pressure sensors were affected during battery maintenance. At 08:45 both max and min temperatures values were inconsistent with the 15-minute temperature average and barometric pressure dropped. Only those data were rejected as no other sensors were affected.

Both the temperature/relative humidity and barometric pressure sensors were cleaned on 07/21/2023 10:45 – 11:00.

Precipitation recorded on 08/06/2023 21:45 is considered suspect due to exceeding the sensor limit for 15-minute rain fall totals. The suspect precipitation value at 21:45 is included in cumulative totals making those data suspect for the remainder of the day.

On 08/09/2023 between 09:00 – 09:30sdt, the leveling platform for the precipitation gauge was minorly adjusted to maintain level. No precipitation data was recorded during this time, so no flags or codes were applied to data.

On 08/17/2023, battery was again replaced to address intermittent telemetry failure, specifically outages at night. The temperature/relative humidity sensor was also replaced at this time. Sensor with SN: 20072700 was installed to replace sensor with SN: 60780595. Sensor replacement took place between 9:00 – 9:30sdt and all temperature, RH, and BP data from this time have been flagged as rejected. All other parameters were rejected at 09:15 due to the station battery voltage dropping to below the voltage required to avoid a station shutdown. The battery voltage drop to 2.5 was most likely related to the maintenance at the station.

Temperature/relative humidity and barometric pressure were rejected due low values recorded for both min temperature (-19.1°) and barometric pressure on 08/21/2023 at 11:15. The cause for the drop in values is unknown.

The new battery installed on 08/17/23 did not solve telemetry issues. A new GOES transmitter was installed on 08/22/2023 between 11:00 - 12:30sdt. A model TX321-G with SN: 2363 was installed to replace a model TX312 with SN: 1339. The transmitter was configured the following day on 08/23/2023 09:00 – 10:00 and telemetry was restored at 10:00sdt. Temperature/relative humidity (max temperature value jumped to 46.4°) and barometric pressure values were affected by the transmitter installation and were rejected on 08/22/2023 at 11:45. No flagging or coding was applied to the data for the maintenance on 08/23/2023.

Telemetry continued to fail intermittently, and after troubleshooting, a new regulator was installed on 08/25/2023. A model CH200 with SN: 9946 was installed to replace a model CH100 with SN: 2622. Since this switch, telemetry has not experienced any major issues. No flagging or coding was applied to the data for the new regulator installation.

Hurricane Idalia passed close to the reserve on 08/30/2023 12:00 – 22:00. The storm brought high winds (15 – 27 m/s) and low pressure (as low as 990 mb).

On 09/12/2023, the precipitation gauge was replaced. Precipitation gauge with SN: 91816-0822 was installed and gauge with SN: 50994-412 was taken out of service. This maintenance took place between 10:30 – 12:15sdt. Maintenance tips that occurred during the installation from 10:45 – 11:00 were corrected back to 0.0 for both total and cumulative precipitation. Cumulative precipitation was also corrected from 20:30 through the end of the day to so that the amounts recorded were actual rain fall and did not include the maintenance tips. During this change, the precipitation gauge was moved from 6m down to 2.5m in order to maintain the gauge more easily. This move should not affect rain data.

An intense storm system passed near the reserve on 12/17/23 04:00 – 15:00 bringing low BP values and heavy rainfall. Rainfall from this event had noticeable effect on Salinity and Specific Conductivity values at water quality sites.