# Narragansett Bay (NAR) NERR Meteorological Metadata

January – December 2011

Latest Update: Wednesday, December 4, 2024

# I. Data Set and Research Descriptors

## 1) Principal Investigator(s) and Contact Persons

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SWMP Coordinator and Data Manager

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## 2) Entry Verification

Data are uploaded from the CR1000 data logger to a Personal Computer (IBM compatible). 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.

Daisy Durant (Marine Research Specialist II) was responsible for compiling and error checking the January through December 2011 weather data.

## 3) Research Objectives

The principal objective is to record long-term meteorological data for Narragansett Bay in order to observe any environmental changes or trends over time. These data are also used to support ongoing water quality and biological monitoring as well as scientific research.

## 4) Research Methods

Campbell Scientific data telemetry equipment was installed at the Potter Cove weather station on July 31, 2006 and transmits data to the NOAA GOES satellite, NESDIS ID 3B0211F8. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen minute data sampling intervals. 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](http://cdmo.baruch.sc.edu/).

Weather station sensors are inspected for damage or debris on a monthly basis. If any is found, it is repaired and/or cleaned. Sensors are swapped with newly recalibrated ones at the following recommended intervals.

* Temperature/Humidity: annual recalibration
* Rain Gauge: annual recalibration
* Wind Speed/Direction: bi-annual service and check
* Barometric Pressure: bi-annual recalibration
* PAR: bi-annual recalibration

All sensors are sent to Campbell Scientific for recalibration and service with the exception of the rain gauge which is recalibrated at the Reserve (in-house recalibration).

The 15 minute data are collected in the following formats for the **CR1000**:

Averages from 5-second data:

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

Maximum and Minimum Air Temperature (oC) and their times from 5-second data (these data are available from the Reserve)

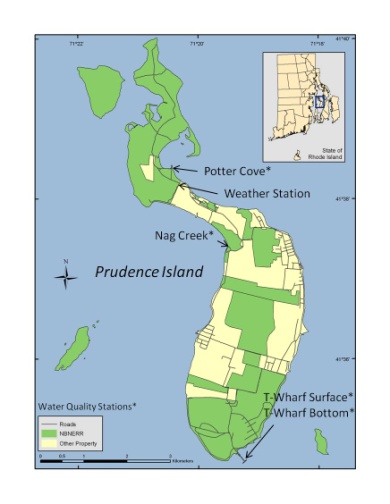
Maximum Wind Speed (m/s) and time from 5-second data

Wind Direction Standard Deviation (degrees)

Totals:

Precipitation (mm), PAR (millimoles/m2), and Cumulative Precipitation (mm).

## 5) Site Location and Character

The NBNERR consists of approximately 4349 acres (obtained from a digitized outline from Prudence Island and bathymetry data) of diverse estuarine and terrestrial habitats ranging from open estuarine water to salt marshes to forested uplands. The land holdings include approximately 60% of Prudence Island, most of nearby Patience Island, all of Hope Island off the west shore of Prudence Island, and Dyer Island located in the East Passage of Narragansett Bay. The Reserve is located close to the geographic center of Narragansett Bay in Rhode Island. The Bay has a drainage basin of 1,800 square miles.

The weather station is located on Prudence Island, approximately 389 m south of Potter Cove (41o 38’ 13.703” N, 71o 20’ 21.790” W, Trimble Geo XT, GeoExplorer 2008 Series). The weather station elevation is at 7.1m above sea level (NAVD 88). The Wind Monitor is located at the top of a 10 m high aluminum tower, the temperature and humidity sensor are located at approximately 2.0 m off the ground on the same aluminum tower. A large wooden platform approximately 2.4 m W x 1.8 m D x 2.1 m H has been situated at the weather station for about the past 16 years*.* It was originally constructed by the U.S. Environmental Protection Agency (EPA) to hold atmospheric deposition equipment which is no longer in use. We secured permission from the EPA to use this platform for weather station equipment. The Campbell housing unit is situated under the platform and contains the CR1000 data logger and all associated hardware (and telemetry equipment) as well as the barometric pressure unit (approximately 1.8 m off the ground). On top of the platform railing we placed the GPS antenna, solar panel, and Yagi antenna. The PAR meter was also relocated here to make it more accessible for cleaning than the previous location. It is approximately at 3.68 m off the ground. The rain gauge is also on the platform railing at approximately 3.46 m off the ground. All sensors were located in accordance with manufacturer recommendations to avoid the possible influence of shading, wind blocks, etc.

## 6) Data Collection Period

During 2011 data was collected from 01/01/2011 at 00:00:00 AM to 12/31/2011 23:45:00 PM.

Meteorological data has been collected at the weather station on Potter Cove since 1992. However, it wasn’t until 2001 when the meteorological station was updated and became part of NERR-SWMP.

## 7) Distribution

NOAA/ERD retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The PI retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the PI and NERR site where the data were collected will be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. Manuscripts resulting from this NOAA/OCRM supported research that are produced for publication in open literature, including refereed scientific journals, will acknowledge that the research was conducted under an award from the Estuarine Reserves Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration. 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.

NERR weather 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 [http://cdmo.baruch.sc.edu/](http://cfcdmo.baruch.sc.edu/). Data are available in comma separated format.

## 8) Associated Researchers and Projects

sondeThe NBNERR System-Wide Monitoring Program (SWMP) has four water quality monitoring station around Prudence Island. The principal objective of the SWMP program is to record short-term variability and long-term changes in water quality data in order to observe trends or patterns in water quality over time. Water quality parameters have been collected since 1995 with the establishment of the first water quality monitoring station at Potter Cove. Other three water quality stations (Nag Creek, T-Wharf Surface and T-Wharf Bottom) were brought online in 2002. These stations were selected to represent a gradient in habitat types that range from salt marsh (Nag Creek station) to shallow cove (Potter Cove) to open Bay water (T-Wharf Surface and T-Wharf Bottom). Water temperature (oC), salinity (ppt), dissolved oxygen (% saturation, and mg L-1), pH, turbidity (NTU), and chlorophyll (μg L-1) data are collected at each station every 15 minutes using data loggers that are calibrated and swapped out at each station approximately every two weeks.

Complementary to the existing long-term water quality monitoring program, the NERRS implemented a new nutrient and chlorophyll monitoring program in 2002. The two sub-components of this program include monthly grab sampling at each of the four water quality stations, and diel sampling once a month at one site. Previously (from 2002 to 2010) the station was located at T-Wharf. However, after analyzing the historic data from the site, no significant trend or patterns were found over time. Therefore, the station was moved to Potter Cove on January of 2011 in order to characterize nutrients and chlorophyll from this site. All collected samples are analyzed for concentrations of phosphates (PO4), ammonia (NH4), nitrite (NO2), nitrate (NO3), NO2+NO3, dissolved inorganic nitrogen (DIN), silicates (SiO4) and chlorophyll *a*. The grab sampling program requires the collection of duplicate water samples every month from each of the four long-term water quality monitoring stations to quantify seasonal patterns of nutrient and chlorophyll concentrations in different estuarine habitats (marsh creek, cove, open water surface, open water bottom).. The diel sampling program required to collect a series of samples from one station over an approximately 24-hour period each month to examine how nutrient and chlorophyll concentrations change over diel and tidal cycles.

Meteorological data collected at the NBNERR since 2001 is continuously used to support the aforementioned water quality, nutrients, and also biological monitoring efforts at the Reserve, and to assist scientific research projects, and educational activities around Narragansett Bay.

A Physical Oceanographic Real-Time System (PORTS) meteorological station is housed in the NERRS weather station at Potter’s Cove and independently records air temperature, atmospheric pressure, wind speed, and wind direction. This is one of six PORTS meteorological stations in Narragansett Bay. The purpose of PORTS is to support safe and cost efficient navigation. Data are available real-time and the system is managed for quality control.

Bob Marshall of the Prudence Island Groundwater Task Force has been using the NBNERR precipitation data since 2006. These data are being used in conjunction with groundwater level and stream-flow monitoring efforts to evaluate the status of the groundwater resource on Prudence Island.

Robin Weber, GIS/Natural Resources Specialist from the NBNERR has been conducting biweekly monitoring of tick populations since 2008 during the warmer months which, over time, may inform management of the deer population and indicate the degree of public health risk for tick borne disease. Sampling success for ticks is influenced by environmental conditions (e.g., relative humidity, air temperature) so meteorological data available from NBNERR’s weather station for is being incorporated in the data analysis each sampling date and time to remove potential sources of variation in annual abundance levels.

Lauren Szathmary, a Ph.D. student at Brown University, is using the long-term meteorological data to study climate change and its impacts on salt marsh plant communities on Prudence Island.

Courtney Schmidt, a Ph.D. student (and former GRF of NBNERR) at the Graduate School of Oceanography, University of Rhode Island, is using weather data from our station to examine patterns in atmospheric deposition of nitrogen.

# II. Physical Structure Descriptors

## 9) Sensor Specifications, Operating Range, Accuracy, Date of Last Calibration

Parameter:  **Temperature**

Units: Celsius

Sensor type: Platinum resistance temperature detector (PRT)

Operating Temperature: -40°C to +60°C

Range: -40°C to +60°C

Accuracy: ± 0.2°C at 20°C

Model #: HMP45C Temperature and Relative Humidity Probe

Serial Number: X0410089

Date of last calibration: 02/19/10

Installed on: 04/08/10

Serial Number: X3410026

Date of last calibration: 11/10/11

Installed on: 11/28/11

Parameter: **Relative Humidity**

Units: Percent

Sensor type: Vaisala HUMICAP© 180 capacitive relative humidity sensor

Range: 0-100% non-condensing

Accuracy: ± 2% RH (0-90%) and ± 3% (90-100%), at 20oC

Temperature dependence: ± 0.05% RH/°C

Model #: HMP45C Temperature and Relative Humidity Probe

Serial Number: X0410089

Date of last calibration: 02/19/10

Installed on: 04/08/10

Serial Number: X3410026

Date of last calibration: 11/10/11

Installed on: 11/28/11

Parameter: **Barometric Pressure**

Units: millibars (mb)

Sensor type: Vaisala Barocap © silicon capacitive pressure sensor

Operating Range: Pressure: 600 to 1060 mb; Temperature: -40°C to +60°C

Humidity: non-condensing

Accuracy: ± 0.5 mb at 20°C; ± 2 mb at 0°C to 40°C; ± 4 mb at -20°C to 45°C;

± 6 mb at -40°C to 60°C

Stability: ± 0.1 mb per year

Model #: CS-105 Vaisala PTB101B

Serial Number: X13220022

Date of last calibration: 02/22/10

Installed on: 08/04/10

Parameter: **Wind Speed**

Units: meter per second (m s-1)

Model # R.M. Young 5305 L - AQ

Sensor type: 20 cm diameter 4-blade helicoid propeller carbon fiber thermoplastic

Range: 0-50 m/s (112 mph)

Accuracy: ±0.2 m/s (0.4 mph)

or

Model # R.M. Young 5103 - 5 Wind Monitor

Sensor type: 18 cm diameter 4-blade helicoids propeller molded of polypropylene

Range: 0-60 m s-1 (0-134 mph); gust survival 100 m s-1 (220 mph)

Accuracy: ± 0.3 m s-1 (± 0.6 mph)

Model #: Wind Monitor R.M. Young 05305 L-AQ

Serial Number: 75311

Date of last calibration: 02/22/10

Install on: 08/03/10

Model #: Wind Monitor R.M. Young 05103-5

Serial Number: 83868

Date of last calibration: 08/09/11

Install on: 10/17/11

Parameter: **Wind Direction**

Units: degrees

Model # R.M. Young 5305 L – AQ

Sensor type: balanced vane, 48.3 cm turning radius

Range: 0-360° mechanical, 355° electrical (5° open)

Accuracy: ±3°

or

Model # R.M. Young 5103 -5 Wind Monitor

Sensor type: balanced vane, 38 cm turning radius

Range: 0-360° mechanical, 355° electrical (5° open)

Accuracy: ±3°

Model #: Wind Monitor R.M. Young 05305 L-AQ

Serial Number: 75311

Date of last calibration: 02/22/10

Install on: 08/03/10

Model #: Wind Monitor R.M. Young 05103-5

Serial Number: 83868

Date of last calibration: 08/09/11

Install on: 10/17/11

Parameter: **Photosynthetically Active Radiation (PAR)**

Units: mmoles m-2 (total flux)

Sensor type: High stability silicon photovoltaic detector (blue enhanced)

Light spectrum waveband: 400 to 700 nm

Temperature dependence: 0.15% per °C maximum

Stability: ± 2% change over 1 yr

Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%

Sensitivity: typically 5 µA per 1000 µmoles s-1 m-2

Model #: LI-190SZ

Serial Number: Q22179

Date of last calibration: 03/01/10

Installed on: 08/04/10

Multiplier: 1.582819445

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: ± 1.0% up to 1 in/hr; +0, -3% from 1 to 2 in/hr; +0, -5% from 2 to 3 in/hr

Model #: TE525

Serial Number: 24701-899

Date of last calibration: 09/01/10

Installed on: 09/01/10 (collecting data @ 11:45)

Date of last calibration: 10/07/11

Installed on: 10/07/11 (collecting data @ 12:15)

The CR1000 has 2 MB Flash EEPROM that is used to store the Operating System. Another 128 K Flash is used to store configuration settings. A minimum of 2 MB SRAM is (4 MB optional) is available for program storage (16K), operating system use, and data storage. Additional storage is available by using a compact flash card in the optional CFM100 Compact Flash Module.

CR1000 was installed on July 31st, 2006.

## 10) Coded Variable Definitions

Sampling station: Sampling site code: Station code:

Potter’s Cove PC narpcmet

## 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 CR1000, 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

CDF Data Appear to Fit Conditions

CML Snow melt from previous snowfall event

CRE\* Significant Rain Event

CSM\* See Metadata

CCU Cause Unknown

CVT\* Possible Vandalism/Tampering

CWE\* Significant weather event

## 13) Other Remarks and 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.

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.

Relative Humidity data greater than 100 are within range of the sensor accuracy of ± 3%.Small negative PAR values are within range of the sensor and are due to normal errors in the sensor and the CR1000 data logger. The maximum signal noise error for the LiCOR sensor is ± 2.214 mmoles m-2 over a 15 minute interval.

Elevated nighttime PAR data

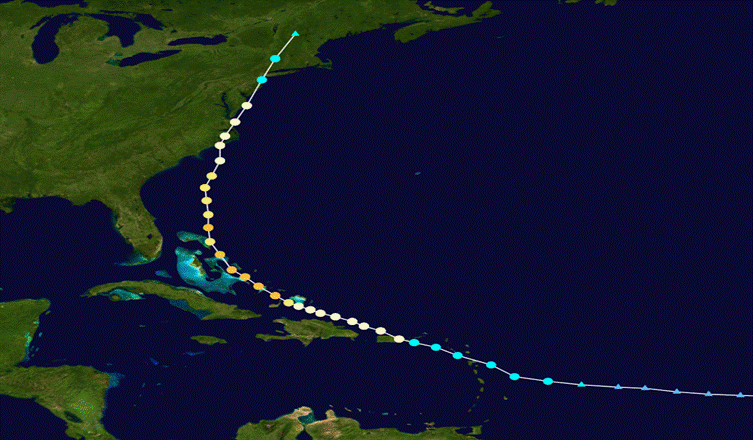
Slightly elevated nighttime PAR was observed throughout the year. However, visible light in the PAR range (400 - 700 nm) should not be recorded at night or should not be due to moonlight because of the sensor and data logger resolution. This elevated nighttime PAR might be related, among other things, to moisture trapped in the sensor, or electromagnetic noise such as ambient light pollution, electromagnetic radiation, etc.; thus, the data were flagged as suspect. To determine sunrise and sunset times for Prudence Island, the [www.sunrisesunset.com](http://www.sunrisesunset.com) website was used to flag and coded the data accordingly.

The telemetry station has not been transmitting data continuously due to problems with the rechargeable battery during the last quarter of 2011. The Reserve is working on solving this problem.

The following are explanations to the CSM (Comment-See Metadata) code found in the meteorology data file of 2011.

* **During the NAR 2023 MET review the CDMO discovered that the wind speed multiplier had not been updated in the logger program following sensor swaps. Wind speed and maximum wind speed values were corrected from 10/17/2011 10:30 through the end of 2011. The R.M. Young 5305 model (SN 75311) has a multiplier of 0.1024 while the R.M. Young 5103 (SN 83868) has a multiplier of 0.0980. To make the corrections, data were divided by the incorrect multiplier, 0.1024, and that value was multiplied by correct multiplier, 0.0980. The data were flagged and coded 5 SIC CSM, unless rejected or missing. Corrected data are considered suspect.**
* **During 2017 the CDMO discovered an incorrect line in the CR1000 programming.  If RHumidity>100 And RHumidity<108 Then RHumidity=100.  A decision was made by the DMC during 2006 to discontinue correcting >100 RH values to 100. This change was never made in our program and has remained in each updated version until it was removed during 2017.  By correcting all values >100 during data collection we may have missed erroneous values that could have indicated a problem with the RH sensor.  CSM coding was added to all RH data from 2007 until the programming change in 2017.**
* Aug 26 10:45 - Nov 28: The air temperature/relative humidity probe was not working correctly. After various attempts to fix the issue, the sensor was removed on Nov 04 (11:15-11:45, with a program upload resulting in all missing data at 11:30 and rejected at 11:45). The sensor was replaced on Nov 22 (with power down resulting in all missing and rejected data at 14:45 and 15:00). Problems with wiring kept the station from collecting air temperature and relative humidity until the problem was fixed on Nov 28 at 10:00 (power down to rewire at 09:30-09:45 resulted in all missing data); however, relative humidity did not begin working correctly until 15:30.
* All data from 9/26/11 8:45-20:30 are rejected and all data from 9/26/2011 20:45 to 9/27/2011 20:30 are missing. When the raw file was downloaded, datetimestamps were corrupted for the 9/26/2011 8:45-20:30 data and data were missing for the 9/26/2011 20:45-9/27/2011 20:30 data. Data were rejected at 9/27/2011 20:45. Datetimestamps were corrected for the data, however, since we do not know the reason for the corrupted file, those data were rejected.
* Oct 9 12:15 – Oct 10 12:15: Data flagged as suspect (air temperature and humidity rejected, see above). After obtaining the data from the weather station, we noticed duplicate date/time stamps from 10/09 12:15 to 10/10 12:15, but the data was not duplicated. We isolated the two subsets, plotted the data, and compared them with data obtained from the PORTS weather station on Prudence Island (8452951), located at the same site as our weather station. The data used was similar to the PORTS data, and the duplicate data was deleted.
* Nov 2-3 – The barometric pressure (11/2/2011 11:45 - 11/3/2011 17:30) and photosynthetic active radiation (11/2/2011 11:45- 11/3/2011 18:45) sensors malfunction almost coinciding with a spike in the battery voltage. We do not know the cause of this, but apparently it resolved on its own. The data were rejected.

Rain Gauge

* Feb 07 12:00 – rain gauge was tipped accidentally. The Total and Cumulative Precipitation data were corrected (CumPrcp Feb 07 12:00 –Feb 08 00:00).
* Sep 01 11:00 – Oct 07 11:00 – Rain gauge out of calibration. The Total and Cumulative Precipitation data were flagged as suspect; nevertheless, we strongly believe that this did not have any significant effect on the precipitation data.

Record Column

Aug 28 - Rhode Island felt the effects of Hurricane Irene, a powerful Atlantic hurricane that left extensive flood and wind damage along its path through the Caribbean, the United States East Coast and as far north as Canada (Figure 1) (NOAA NWS).

(Figure 1. Hurricane Irene’s path. From NOAA National Weather Service).