

Wells (WEL) National Estuarine Research Reserve Meteorological Metadata
January-December 2006

Latest Update: **October 25, 2023**

I. Data Set & Research Descriptors

1) Principal investigator & contact persons:

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2) Entry verification:

a) Data Input Procedures

The meteorological information is sampled every 5 seconds from each instrument on the weather station and stored on a Campbell Scientific CR10X data logger and SM4 storage module until 7/11/2006 when a new Campbell CR1000 data logger was installed and the SM4 storage module removed. The CR1000 has two 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. Data are output to a file in three arrays: array 15 stores 15 minute average, max and min data; array 60 stores hourly average, max and min data (CR10X); and array 144 stores daily average, max and min data (CR10X). The CDMO Data Logger Program (NERR_4_1.CSI) was loaded into the CR10X and controls the sensors. Installation of a new CR1000 datalogger to replace the CR10X began on 7/11/2006 and was completed on 7/14/2006. On 7/11/2006 a new version 2 program was uploaded to the CR1000 datalogger. On 12/13/06 a new version 3 program was uploaded to the station which excluded minimum and maximum values for Relative Humidity and Barometric Pressure as well as the time of each min and max reading. The minimum wind speed and associated time was also removed from the file. The CR10X then interfaces with the PC208W (CR1000 with loggernet) software supplied by Campbell Scientific.

Data are uploaded from the CR10X-1000 data logger or storage module to a Personal Computer (IBM compatible). The data was saved as a monthly raw data file (LF050101.dat, indicating year/month/day as yymmdd). Files are exported from PC208W (loggernet) in a comma-delimited format (.DAT) and opened in Microsoft Excel for pre-processing with the EQWin format macro (EQWinFormat.xls) that was developed by the CDMO to reformat the header columns, insert station codes, insert a date column (mm/dd/yyyy), correct the time column format and reformat the data to the appropriate number of decimal places. The pre-processed file is then ready to be copied into the EQWin weather.eqi file where

the data are QA/QC checked and archived in a database. Viewing data in Excel and EQWin queries, reports and graphs are used to discover data set outliers (values which fall outside the range that the instrument is designed to measure) and large changes in the data. EQWin is also used to generate statistics, view graphs, create customized queries and reports of the data, cross query the water, weather and nutrient data and finally export the data to the CDMO. Any anomalous data are investigated and noted below in the Anomalous Data/Suspect Data section. Any data corrections that were performed are noted in the Deleted Data section below. Jeremy Miller is responsible for data management.

The most common reported errors/anomalies in 2006 were:

- 1) Slightly negative LiCor (Photosynthetically Active Radiation, or PAR).
- 2) Relative Humidity slightly over 100%.
- 3) 15 minute sample rainfall over 5mm.

All errors of these types were checked. The first two, slightly negative PAR and relative humidity slightly over 100% can both be explained by sensor drift (for PAR) or a combination of limits of accuracy and sensor drift (for Relative Humidity). Most of the slightly negative PAR readings happened during the winter months as well. Most data was kept and considered suspect. See sections 11, 12 and 13 for additional details. Any data corrections that were performed are noted in the Data Correction section below. Raw data files (.dat format), Excel pre-processed files and EQWin database files were saved to the SWMP laptop computer (Panasonic Toughbook CF-28), and backed up to the Wells NERR on campus server and a Maxtor One-Touch external hard drive.

B1) Data Collection Schedule for CR10x datalogger

Data is collected in the following formats and at the following intervals:

1) 15 minute averages are calculated from 5 second samples sorted by date and time except for PAR and precipitation data that are summed from 5 second samples sorted by date and time.

2) Hourly averages are calculated from 5 second samples sorted by date and time except for PAR and precipitation data that are hourly totals calculated from 5 second samples.

3) Daily average, maximum with time, and minimum with time are calculated from 5 second samples sorted by date and time except for PAR and precipitation data which are 24 hour totals calculated from 5 second samples.

ii) 15 minute sample point parameters: Date, Time, Air Temperature (°C), Relative Humidity (%), LiCor (PAR), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction; Rainfall (mm).

iii) Hourly average parameters: Date, Time, Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb); Wind Speed (m/s), Wind Direction, Wind Speed Maximum.

iv) Hourly total parameters: LiCor (PAR); Rainfall (mm)

v) Daily Average parameters: Date, Time, Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb); Wind Speed (m/s), Wind Direction, Wind Direction Standard Deviation (using Yamartino's Algorithm).

vi) Daily Total parameter: LiCor (PAR); Rainfall (mm).

vii) Daily Maximum parameters: Date, Time, Air Temperature (°C), Time, Relative Humidity (%), Time, Barometric Pressure (mb), Time, Wind Speed (m/s), Time,

viii) Daily Minimum parameters: Date, Time, Air Temperature (°C), Time, Relative Humidity (%), Time, Barometric Pressure (mb), Time, Wind Speed (m/s), Time,

B2) Data Collection Schedule for CR1000 datalogger

Data is collected in the following formats and at the following intervals:

i) 15 minute averages are calculated from 5 second samples sorted by date and time except for PAR and precipitation data that are summed from 5 second samples sorted by date and time.

ii) 15 minute sample point parameters: Date, Time, Air Temperature (°C), Relative Humidity (%), LiCor (PAR), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction; Rainfall (mm).

c) Error/Anomalous Data Criteria

Air Temperature:

ATempOutliers.eqr or ATempOutlierReport.eqw

- Sample not greater than 50 degrees Celsius (C)
- Sample not less than -40 degrees Celsius (C)
- 15 minute averages not greater than the max for the day, 15_144MaxTemp.eqg
- 15 minute averages not less than the min for the day, 15_144MinTemp.eqg

Relative Humidity:

RHOutliers.eqr or RHOutlierReport.eqw

- Sample not greater than 100 percent humidity (%)
- NOTE: Sensor accuracy limitations and sensor drift can be responsible for percent humidity reading slightly higher than 100 percent.
- Sample not less than 0 percent humidity (%)
 - 15 min, 15_144MaxRH.eqg
 - 15 minute averages not less than the min for the day, 15_144MinRH.eqg

Barometric Pressure:

BPOutliers.eqr or BP OutlierReport.eqw

- Sample not greater than 1060 millibars (mb)
- Sample not less than 900 millibars (mb)
- 15 minute averages not greater than the max for the day, 15_144MaxBP.eqg
- 15 minute averages not less than the min for the day, 15_144MinBP.eqg

Wind Speed:

WSpdOutliers.eqr or WspdOutlierReport.eqw

- Sample not greater than 30 meters per second (m/s)
- Sample not less than 0.5 meters per second (m/s) for 12 hours consecutively, WspdOutlier.eqg

Wind Direction:

WdirOutliers.eqr or WdirOutlierReport.eqw

- Sample not greater than 360 degrees
- Sample not less than 0 degrees

Precipitation:

TotPrpcOutliers.eqr or TotalPrpcOutliersReport.eqw

- 15 minute total not greater than 5 millimeters (mm)

NOTE: A few outliers were noted in this dataset and are addressed in sections 11, 12 or 13 below.

Solar Radiation (LiCor):

TotPAROutliers.eqr or TotPAROutlierReport.eqw

- 15 minute total not greater than 5000 millimoles per meter squared (mmol/m^2)
- 15 minute total not less than 0 millimoles per meter squared (mmol/m^2)

NOTE: slightly negative values can be due to sensor drift and have not been removed from the dataset.

Time:

checked in the EQWinformat.xls macro

- 15-minute interval recorded

For all data:

checked in EQWin during data validation

- Duplicate interval data

3) Research Objectives

The principal objective is to record long-term meteorological data for Wells, in order to supplement SWMP water quality YSI data and research data, and to observe any environmental changes or trends over time.

4) Research Methods

The Campbell Scientific weather station samples every 5 seconds continuously throughout the year. These data are used by the CR10X (CR1000) to produce 15 minute averages, maximum and minimums (array 15), hourly averages, maximums and minimums (array 60) and daily averages, maximums and minimums (array 144) of air temperature, relative humidity, barometric pressure, rainfall, wind speed, and wind direction. As of 7/11/2006, a new Campbell CR1000 data logger was installed and the SM4 storage module removed. The CR1000 has two 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. On 12/13/06, a version 3 program was uploaded to the station which removed the following data from the data set: Min and max (and times) of relative humidity, min and max (and times) of barometric pressure, and minimum wind speed and its associated time. (see section 2 on Entry verification for more detailed info on data format and intervals).

Sensors on the weather station are inspected monthly for damage or debris. Sensors are removed and replaced with recently calibrated sensors approximately every two years, with the exception of the rain gauge, which is calibrated approximately every year. Also, once a month on download day, we use a handheld Kestrel 4000, to run a comparative set of observations as a general check on the Campbell station sensors and hardware.

5) Site location and character

The Wells National Estuarine Research Reserve (and Laudholm Farm Meteorological station) is located in York County, within the Town of Wells, on the coast of southern Maine and faces the Atlantic Ocean at an elevation of

18.62 meters above sea level. The Wells NERR is approximately 31 km (20 miles) south of Portland, Maine and 110 km (70 miles) north of Boston, Massachusetts. The Reserve encompasses 1,690 acres along the Gulf of Maine coastline of tidally flushed wetlands, riparian and transitional upland fields and forests within the Little River Estuary and the larger Webhannet River Estuary. Both estuaries arise in the sandy glacial outwash plain about eight miles inland. Both rivers empty into Wells Bay, a sandy basin stretching for approximately ten miles along the Atlantic coast. Bordering each river's inlet are double spit barrier beaches attached to the mainland. The backbarrier system is approximately 5 sq. km and is composed of large intertidal marshes (predominantly *S. patens* and *S. alterniflora*), intertidal sand and mud flats, and tidal channels. The watershed for the Webhannet River estuary covers an area of 35 sq. km and has a total of 6 streams, brooks or creeks, which enter the estuary. These tributaries flow across sand and gravel deposits near the headwaters and the impermeable sandy mud of the Presumpscot Formation in the lower reaches. The Webhannet River is connected to the ocean via Wells Inlet, which has a spring tidal prism of 28,200,000 cub. m (Ward 1993). The force and volume of tidal action affect the salinity level of both rivers. In the Wells region, the annual mean wave height is almost 20 inches. The estuarine system is dominated by semi-diurnal tides having a range of 8.5 to 9.8 feet. The volume of freshwater influx into both estuaries is moderate to low (on the order of 0.5 cubic meters/second), especially in the summer, because of the rivers' relatively small drainage areas and the presence of deep glacial deposits. The relatively low flows from these two rivers taken in with the 20 inch per year average runoff of the area surrounding the estuaries combine to form a freshwater flow that is dwarfed by tidal flushing. Twelve-foot tides dwarf the freshwater flow into the Webhannet estuary, which has a drainage area of 14.1 square miles. The Webhannet estuary, fed by both Blacksmith and Depot Brooks, is adjacent to the harbor and greatly developed land. It offers a valuable opportunity for comparison with the relatively pristine Little River estuary. The land use of the Webhannet estuary include a total of 15% for wetland, fresh water, and tidal marsh; a total of 63.7 % for woodland; and a total of 18.6% for developed land (compared to a total of 5.7% development in the Little River estuary) (WNERR RMA 1996; Holden 1997).

The following information regarding annual weather patterns in the area was supplied by Maine State Climatologist Professor Gregory A. Zielinski extracted from "Monthly Station Normals of Temperature, Precipitation, Heating and Cooling Degree Days 1971-2000", Climatology of the United States No. 81, National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC. and "Daily Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971-2000", Climatology of the United States No. 84: "Average monthly temperatures range from 21.6F in January to 66.7F in July with daily highs averaging just below freezing in January and lows around 11F. Daily highs in July average around 76F and daily lows around 57F. The sea breeze often keeps daily highs lower during the summer than areas inland. Annual average temperature is 44.6F. Annual precipitation is 47.07 inches, including the water equivalent of snowfall, with monthly averages ranging from 3.01 inches in July to 4.77 inches in October. August receives just 3.02 inches on average. Annual snowfall is around 66 inches." According to Zielinski, "cool ocean temperatures keep down the number of afternoon showers and especially thunderstorms resulting in low summer precipitation amounts."

The weather station is located (43 deg 20.244 Latitude, 70 deg 33.000 Longitude) on a 32' telephone pole surrounded by mowed grass. The temperature and humidity probes are located on the north side of the pole at a height of 10'. The PAR sensor is located on the South side of the pole at a height of

aprox. 15'. The Barometric pressure sensor is located within the Campbell Scientific enclosure at a height of aprox. 5' and vented to the outside by a small length of aquarium tubing. The wind sensor is located atop the pole at approximately 33 feet above the ground. To the NW of the pole is the Coastal Ecology Center, a 20' high, 111' long building, at a distance of 37', running NE/SW. Further to the NW (153' from the pole) is the library, in a 25' high wing of the barn. The barn itself is 223' from the station and runs NE/SW. It is 38' high and is the largest obstruction in the area. The rain gauge is located 9' southeast of the weather station pole and is situated on a post with the top of the funnel is 10' from the ground.

There are two SWMP water quality sampling sites in the Webhannet River estuary. These are located at the Webhannet River Head of Tide, at the Webhannet Inlet, at Skinner Mill on the Merriland River and near the . The tidal range at each of these sites is 2.6-2.9 meters.

6) Data collection period

Weather data has been collected at the Wells NERR since December 1996. Data was collected for the entire year in 2006 from 1/1/2006 00:15 to 12/31/2006 23:45, with the exception of occasional gaps in the data which are due to weather station maintenance (addition of CR1000 and telemetry equipment) or malfunction.

7) Distribution

According to the Ocean and Coastal Resource Management Data Dissemination Policy for the NERRS System-wide Monitoring Program:

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 the 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/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 Section 1 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>. Data are available in text format and Access data tables. As of 7/11/2006, data is also available from the CDMO webpage in Near Real Time thanks to the installation of a Campbell Scientific Telemetry station.

8) Associated researchers and projects

WELLS NATIONAL ESTUARINE RESEARCH RESERVE RESEARCH AT THE RESERVE for 2006
(Please visit our website: www.wellsreserve.org/research.htm for further information on the Wells NERR research program):

The Research Program at the Wells NERR conducts and supports research, monitoring, workshops, and research/resource management planning of relevance at local, regional and national levels. The overall aim of our work is to produce science-based information needed to sustain or restore Gulf of Maine coastal habitats and resources, especially those found in salt marsh estuaries and watersheds. During 2004-2005 many different studies involving scores of scientists, students, staff and volunteers focused on several related themes: 1) the quality of water resources in salt marsh estuaries and watersheds 2) land conservation strategies to protect coastal watersheds 3) factors controlling salt marsh accretion, erosion and plant community vigor 4) the value of salt marsh as habitat for fish, shellfish and birds, 5) restoration of salt marsh habitat degraded through human actions, and 6) understanding the ecology and functions of salt marsh habitat.

Estuarine Water Resource Quality

Water quality is monitored continuously at several stations with automated instruments as part of a NERRS systemwide monitoring program, as well as bimonthly at 15-20 stations through our WET volunteer monitoring program. The WET program also monitors two important biological parameters: fecal coliform bacterial contamination (an indicator of human health risk) and phytoplankton productivity (an indicator of estuarine health). These data have 1) allowed us to identify several bacterial "hot spots" that we will be working to eliminate, 2) are used to identify and open areas safe for shellfishing, and 3) have uncovered a relation between tides and low dissolved oxygen (a stressful condition for marine life) that needs further study. Our water quality work has contributed to the designation of several Priority Watersheds in coastal Southern Maine by the Maine Department of Environmental Protection.

Seacoast Watershed Information Manager (Project S.W.I.M.)

The Seacoast Watershed Information Manager (Project S.W.I.M.) will be an online resource to help local planners and the public evaluate, conserve, and restore coastal watershed resources along the Maine and New Hampshire seacoast by developing a website that describes the region and its resources, provides access to GIS data and other relevant information, and includes a decision-support tool that examines the impact of growth and development on water resources. It will include:

- A Narrative that informs local resource planners and the public by describing development impacts, water resources, and land use.
- Socioeconomic Analysis focused on water resource use as it relates to human activities.
- Land Use Change Assessments focusing on shoreland and permeability.
- A Data Clearinghouse providing users access to key data needed for local and regional-scale resource management.
- A GIS-based Decision Support Tool to help communities manage and protect water resources by considering how water supply, water quality and land use change are affected by land use planning decisions.

The Project focuses on the coastal watersheds from the Cocheco and Salmon Falls River in New Hampshire to the Kennebunk River in Maine. These 15 watersheds include 38 municipalities and cover 1,800 square miles. The Wells National Estuarine Research Reserve is the lead partner with support from NOAA's Coastal Services Center Landscape Characterization and Restoration Program and the Great Bay National Estuarine Research Reserve.

Salt Marsh Habitats and Communities

Factors that control the dynamics and vigor of salt marsh plant communities and marsh peat formation consequently determine the ability of a salt marsh to persist in the face of sea level rise. Through a combination of experimental manipulations and long term monitoring, a number of multi-year studies are currently producing data to answer questions concerning the sustainability of salt marsh habitats in this region. These studies are looking at nutrient-plant relations, plant community responses to physical and hydrologic disturbance, and the relative contribution of short-term natural events (e.g. storms) and human activities (dredging, tidal restriction) on patterns of sediment accretion and erosion. The Reserve's marshes and beaches are already among the best studied sites in the U.S. with regard to long term accretion and erosion (over thousands of years).

HABITAT VALUE FOR FISH, SHELLFISH AND BIRDS

The Reserve combines long-term monitoring with periodic surveys and short-term experiments to identify species and measure trends and changes in populations of fish, crustaceans, clams and birds. We have 10 years of data on upland and shore birds with which to assess the status of resident and migratory avian populations, and several years of wading bird data that we use as a gross level indicator of salt marsh health, which appears to be stable. Our periodic larval, juvenile and adult fish surveys have produced the best available data for fish utilization of salt marsh estuaries in the Gulf of Maine. Since 1994 we have been conducting surveys and field experiments to look at the survival and growth of hatchery seed, juvenile and adult softshell clam with regard to habitat characteristics and predation by the invasive green crab. Benthic invertebrates have been sampled from a number of marshes from Wells to Casco Bay in hopes of gaining a better understanding of invertebrate assemblage and their value to higher trophic levels.

Salt Marsh Degradation and Restoration

Salt marsh ecosystems in the Gulf of Maine have sustained themselves in the face of sea-level rise and other natural disturbances for nearly five thousand years. Since colonial times large areas of salt marsh (up to half of the total area) have been lost through diking, draining and filling. Today, the remaining marshland is fairly well protected from outright destruction, but during the past 100 years, and especially since the 1950's, salt marshes have been divided into fragments by roads, causeways, culverts and tide gates. Most of these fragments have severely restricted tidal flow, leading to chronic habitat degradation and greatly reduced access for fish and other marine species. Since 1991, the Wells Reserve has been studying the impact of these restrictions on salt marsh functions and values, and the response of salt marshes to tidal restoration. We have been working to promote an awareness of the damage being done and the benefits of salt marsh restoration throughout the Gulf of Maine.

Research Program Update: In addition to the Reserve-sponsored projects outlined above, numerous visiting investigators will be involved in on-site research.

Topics include: the effects of land use, sea level, and climate on estuarine productivity; the relationship between soil nutrients and plant community patterns; the influence of soil salinity on plant community interactions; the effect of tidal restriction on marsh peat accretion; the comparative ecology of fringe marshes and back barrier marshes; habitat use by upland birds, and the ecology of lyme disease.

"Ecological Functions of Fringing Salt Marshes Susceptible to Oil Spills in Casco Bay, Maine". We examined the ecological function of 9 different fringing marsh systems in Casco Bay that ranged from undisturbed to disturbed. Physical parameters measured included sedimentation rates, total suspended solids, and tidal range. Biological parameters included primary production, macroinvertebrate community composition and secondary production (4cm sediment cores), and resident and transient nekton community composition (fyke net). The project is still under way.

"BENTHIC HABITAT CORRELATES OF JUVENILE FISH DISTRIBUTION IN THE BIGELOW BIGHT AND ADJACENT ESTUARIES: LINKAGES BETWEEN FISH, HABITATS, SUBSTRATE AND HUMAN ACTIVITY". This recent project was a collaboration between the Wells N.E.R.R. and several members of the local fishing community. Through the use of beam trawls, gill nets, fish traps, van veen ponar, and a sediment profile imager (SPI camera), we are attempting to correlate benthic habitat type to juvenile groundfish and invertebrate assemblages in estuarine, near shore, and offshore habitat. Stations were also established near dredge spoil dump sites as well as sewage outflow to determine the impacts of human activity on the coast to benthic habitat.

The Wells NERR Research Department also worked on the following project: In partnership with the York Rivers Association and the Town of York, the Wells Reserve conducted a survey of the York River watershed. In this survey, volunteers looked for sources of pollution within a 250-foot buffer of the river and its tributaries (erosion, trash and debris and runoff from roads and lawns could have a negative impact on water quality). Most pollutants entering water bodies come from such undefined sources. Therefore, this type of survey is the best way to begin to address the problems of pollution in a water body. The idea of the project was to work with the community and landowners to help them understand the problems that come from these types of pollution and learn activities they might be able to do on their own land that would help prevent this pollution from entering the water. The results of the survey will become part of a Watershed Management Plan to improve and restore the water quality of the York River.

The Wells NERR Research Dept. is involved with the following CICEET* Projects:

Project Title: Estuarine Responses to Dredging: Analysis of Sedimentary and Morphological Change in Back Barrier Marsh to Aid Local Management and Develop a Regional Management Tool Principal Investigator (s): Michele Dionne, Wells NERR, ME; Duncan Fitzgerald, Boston University; Joe Kelley, University of Maine; David Burdick and Larry Ward, University of New Hampshire

Management Issue: Coastal management tool for assessing the impacts of dredging in estuaries. Project Summary: An adequate supply of sediment is essential for maintaining salt marshes. Human activities, such as channel dredging and tidal restriction due to road construction, can alter water flows in estuaries and result in dramatic changes in salt marsh sediment supply, affecting the speed of salt marsh erosion. The objective of this project is to determine the impact of dredging and tidal restriction on salt marshes in the Wells NERR. A digital coastal management guide will be created on CD ROM, providing coastal managers

with useful conceptual models for predicting the impacts of dredging and other activities that affect water flow and sediment deposition in salt marshes.

June Ficker Project Title: Monitoring avian productivity and survivorship

Outside Researchers: Theresa Theodose, Ph.D., University of Southern Maine
Project Title: Relationships between soil nutrient availability and species composition of a high salt marsh in southern Maine.

David Burdick, Ph.D. and Roelof Boumans, Ph.D. University of New Hampshire,
University of Maryland Project Title: Sediment dynamics in salt marshes:
functional assessment of accretionary biofilters

Peter Rand, M.D., Chuck Lubelczyk, Robert Smith, M.D. Maine Medical Center
Project Title: Ecological determinants of the spread of the tick vector of Lyme disease and other pathogens.

II. Physical Structure Descriptors

9) Sensor specifications, operating range, accuracy, date of last calibration.

Parameter: Photosynthetically Active Radiation (PAR)
Sensor: CSI LI-COR Quantum Sensor
Units: mmol m⁻² (total flux)
Operating Temperature: -40 to 65°C
Sensor type: High stability silicon photovoltaic detector (blue enhanced)
Model #: LI190SB
Light spectrum waveband: 400 to 700 nm
Temperature dependence: 0.15% per °C maximum
Stability: < +/-2% change over 1 year
Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%
Sensitivity: typically 5 µA per 1000 µmol s⁻¹ m⁻²
Date of last calibration: 06-27-06

Parameter: Wind speed
Units: meter per second (m/s)
Sensor type: 3-cup anemometer, Integrated in CSI Wind Sentry module
Model #: 03001
Operating Temperature: -50° to +50°C assuming non-riming conditions
Range: 0 to 50 m/s
Accuracy: +/-0.5 m/s
Threshold: 0.5 m/s
Date of last calibration: 06-24-2004

Parameter: Wind direction
Units: degrees of a 360 degree circle
Sensor: Balanced vane, 16 cm turning radius, integrated in CSI Wind Sentry module
Model #: 03001
Operating Temperature: -50° to +50°C assuming non-riming conditions
Range: 360° mechanical, 355° electrical (5° open)
Accuracy: +/-5°
Threshold: 0.8 m s⁻¹ (1.8 mph) at 10° displacement, 1.8 m s⁻¹ (4 mph) at 5° displacement
Date of last calibration: 06-24-2004

Parameter: Wind speed and direction
Units: meter per second (m/s)- degrees of a 360 circle
Sensor type: RM Young 5103 wind speed and direction
Model #: 05103-5
Operating Temperature: -50° to +50°C assuming non-riming conditions
Range: 0 to 50 m/s
Accuracy: +/-0.5 m/s
Threshold: 0.5 m/s
Date of last calibration: New sensor installed on 07/11/06

Parameter: Temperature
Units: degrees Celsius
Sensor type: 1000 ohm PRT, part of CSI Temperature and Relative Humidity Probe
Model #: HMP45C
Operating Temperature: -40 to +60°C
Range: -39.2° to +60°C
Accuracy: +/- 0.2 °C @ 20°C
Date of Last calibration: 06-27-06

Parameter: Relative Humidity
Units: percent
Sensor type: CSI Temperature and Relative Humidity Probe
Model #: HMP45C
Operating Temperature: -40 to +60°C
Range: 0.8-100% non-condensing
Accuracy: +/-2% RH (0-90%) and +/-3% (90-100%)
Temperature Dependence: +/-0.05% RH/°C
Stability: Better than 1% RH per year
Date of Last calibration: 06-27-06

Parameter: Barometric Pressure
Units: millibar
Sensor type: CSI Barometric Sensor
Model#: CSI 105 (also known as Vaisala PTB101B)
Operating Range: Pressure: 600-1060 mb
Temperature: -40 to +60C
Humidity: non-condensing
Total Accuracy:
+/-0.5 mb @ +20 degrees C
+/-1.5 mb @ 0° to 40 degrees C
+/-2.0 mb @ -20 degrees to +45 degrees C
+/-3.0 mb @ -40 degrees to +60 degrees C
Stability: +/- 0.1 mb per year
Date of Last calibration: 06-27-06

Parameter: Precipitation
Units: mm
Sensor type: Electrically Heated Tipping Bucket Rain/Snow Gauge
Model #: 385/385M (also know as Met One 385)
Range: 0.1mm to unlimited
Resolution: 0.1 mm
Accuracy: +/-0.5%<0.5" (1.27 cm)/hr rate
 +/-2.0%<3.0" (7.62 cm)/hr rate
Operational Temperatures: -20° to 50°C; 0 to 100% RH
Date of Last calibration: 07-10-06

Campbell Scientific CR10X Wiring Panel has 128K of flash memory (EEPROM), in which it stores the operating system and its program (that it uses to run the weather station). Additionally, there is 128K of SRAM, which it uses to run the program and store its measurements and for final data storage.

The CR1000 has two 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. This station was installed on 07/11-12/06.

10) Coded variable code definitions

Sampling Station: Laudholm Farm
Sampling site code: LF
Station code: wellfmet

11) Anomalous/Suspect Data

Arrays:

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

NOTE: Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X/CR1000 Datalogger. The Maximum signal noise error for the Licor sensor is +/- 2.214 mmol/m² over a 15 minute interval. These data have been retained.

NOTE: Relative Humidity data sometimes show values slightly higher than 100% (usually less than 103%). The sensor's accuracy is listed at +/-3% in the range of 90-100%, and sensor drift is +/-1% over a year. Relative humidity data up to 104% are not deleted from the data. They are not noted below.

NOTE: dramatic changes in temperature and humidity are sometimes common and usually coincide with shifts in wind direction from land to water. Fog and cold ocean air can move into the uplands and our station rather quickly showing rapid changes in both parameters.

NOTE: On July 14th 2006 at 11:00, the PAR sensor was moved from the north side of the weather station at an elevation of 32 feet to the South side of the station at an elevation of 12 feet. This change in sensor position is visible in the data as PAR levels seem to be elevated as compared to the previous months readings.

January 2006

The following RH data is considered suspect/anomalous. Readings stayed near 100% humidity for almost two days after the last recorded rain event.

Wellfmet 1/30/06 00:15 through 02/01/06 01:15 (all data)

The following wind speed data is considered suspect. The data remains close to zero for extended periods of time. Ice on the sensor could be a cause for this suspect data. Most data points read 0.2 m/s.

Wellfmet 01/05/06 from 02:30 to 05:30

Wellfmet 01/13/06 from 03:15 to 07:45

Wellfmet 01/31/06 from 03:15 to 24:00

The following 15 minute RH data is considered suspect due to the instability of the readings.

Station_Code	ArrayId	Date	Time	ATemp	RH	TotPrcp
wellfmet	15	02/18/2006	09:00	-02.1	049	00.0
wellfmet	15	02/18/2006	09:15	-03.0	061	00.0
wellfmet	15	02/18/2006	09:30	-05.4	092	00.0
wellfmet	15	02/18/2006	09:45	-05.0	071	00.0
wellfmet	15	02/18/2006	10:00	-04.8	051	00.0

The following wind speed data is considered suspect. Values fall to near zero and remain that way for an extended period of time. Could be caused by icing of sensor.

Wellfmet 02/01/06 00:15 to 10:45

Wellfmet 02/23/06 20:30 through 02/24/06 10:00

March 2006

The following 15 minute air temperature data is anomalous due to its large jump in value in just 1 hours time.

Station_Code	ArrayId	Date	Time	ATemp	RH	WSpd	Wdir
wellfmet	15	03/10/2006	19:45	04.6	099	00.3	056
wellfmet	15	03/10/2006	20:00	04.8	099	01.6	256
wellfmet	15	03/10/2006	20:15	06.3	099	04.1	251
wellfmet	15	03/10/2006	20:30	11.2	079	03.8	246
wellfmet	15	03/10/2006	20:45	12.4	072	03.9	249

The following RH data is considered suspect/anomalous. Readings were either unstable or changed sharply without apparent cause. This change could be due to shifts in wind direction from land to ocean which is visible in the data.

Wellfmet 03/02/06 23:30 through 03/03/06 00:15

Wellfmet 03/10/06 from 20:15 to 21:15

Wellfmet 03/14/06 from 13:15 to 22:00

Wellfmet 03/15/06 from 07:30 to 08:00

Wellfmet 03/27/06 from 12:15 to 18:15

April 2006

The following RH data is suspect because of the large variations in the readings. This could be caused by changes in temperature or fog so the data has been retained.

Wellfmet 04/11/06 22:00 through 04/12/06 04:30

Wellfmet 04/15/06 06:45 through 04/16/06 02:45

The following RH data is considered suspect due to the extremely low readings seen.

Station_Code	ArrayId	Date	Time	ATemp	RH
wellfmet	15	04/02/2006	15:45	14.4	022
wellfmet	15	04/02/2006	16:00	14.6	021
wellfmet	60	04/02/2006	16:00	14.3	022
wellfmet	15	04/02/2006	16:15	14.8	017
wellfmet	15	04/02/2006	16:30	14.6	015
wellfmet	15	04/02/2006	16:45	14.5	014
wellfmet	15	04/02/2006	17:00	14.4	014
wellfmet	60	04/02/2006	17:00	14.6	015
wellfmet	15	04/02/2006	17:15	14.0	014
wellfmet	15	04/02/2006	17:30	13.6	015
wellfmet	15	04/02/2006	17:45	13.2	017
wellfmet	15	04/02/2006	18:00	12.5	023
wellfmet	60	04/02/2006	18:00	13.3	017
wellfmet	15	04/02/2006	18:15	11.8	025

The following wind speed data is considered suspect. The data remains close to zero for extended periods of time. Most data points read 0.2 m/s.

Wellfmet 04/06/06 from 04:15 to 06:30

May 2006

NOTE

There was a significant rain event which occurred mainly between 5/12 and 05/15 with the bulk of the rain (almost 6 inches) falling on the 13th alone and a total of 10+ inches in three days. Please see section 14 for more information

The following RH data is considered suspect due to its instability.

Wellfmet 05/05/06 from 08:00 to 14:30

June 2006

No suspect/anomalous data

Large amount of missing data from this month. See section 13 for more information.

July 2006

The following 15 minute PAR data is considered suspect due to its unusually high values over 2000.

Wellfmet 07/19/06 from 11:45 to 12:30

Wellfmet 07/28/06 at 12:15

August 2006

The following RH data is considered suspect. The readings jump sharply in value for no apparent reason. This change could be due to shifts in wind direction.

Station_Code	ArrayId	Date	Time	ATemp	RH
wellfmet	15	08/31/2006	12:00	22.1	049

wellfmet 15 08/31/2006 12:15 20.3 063

The following PAR data is considered suspect due to its unusually high values above 1800 mmoles/m².

Station_Code	Arrayld	Date	Time	TotPAR
wellfmet	15	08/04/2006	12:45	1803.9
wellfmet	15	08/04/2006	13:00	1810.9
wellfmet	15	08/04/2006	13:15	1825.7
wellfmet	15	08/05/2006	12:00	1857.1
wellfmet	15	08/05/2006	12:30	1864.1
wellfmet	15	08/06/2006	12:15	1801.1
wellfmet	15	08/06/2006	12:30	1801.4
wellfmet	15	08/08/2006	11:30	1811.9
wellfmet	15	08/08/2006	11:45	1807.7
wellfmet	15	08/08/2006	12:15	1828.1
wellfmet	15	08/08/2006	12:30	1816.5
wellfmet	15	08/09/2006	11:45	1804.2
wellfmet	15	08/09/2006	12:00	1808.6
wellfmet	15	08/09/2006	12:15	1811.8
wellfmet	15	08/09/2006	12:30	1815.6
wellfmet	15	08/09/2006	12:45	1803.8
wellfmet	15	08/10/2006	12:30	1871.9
wellfmet	15	08/11/2006	11:30	1828.0
wellfmet	15	08/11/2006	11:45	1857.2
wellfmet	15	08/11/2006	12:00	1884.7

September 2006

The following RH data are considered suspect. The readings are from shortly after a rain event and show unstable "shaky" readings.

Wellfmet 09/05/06 09:00 to 15:00

Wellfmet 09/06/06 07:00 to 16:45

The follwong 15 minute precipitation data is considered suspect due to the isolated occurrence.

Station_Code	Arrayld	Date	Time	ATemp	RH	BP	WSpd	Wdir	TotPrcp	TotPAR
wellfmet	15	09/24/2006	13:45	26.3	072	0993	06.8	235	00.0	1183.0
wellfmet	15	09/24/2006	14:00	26.1	072	0993	07.6	239	00.0	0622.4
wellfmet	15	09/24/2006	14:15	21.0	087	0994	05.6	277	05.6	0092.1
wellfmet	15	09/24/2006	14:30	19.5	093	0994	03.4	267	00.0	0501.8
wellfmet	15	09/24/2006	14:45	20.8	091	0994	03.2	250	00.0	0702.6
wellfmet	15	09/24/2006	15:00	21.5	085	0994	02.8	265	00.0	0903.2

The following wind speed data is considered suspect. The data remains close to zero for extended periods of time. Most data points read 0.1 m/s.

Station_Code	Arrayld	Date	Time	WSpd	Wdir	MaxWSpd	MinWSpd
wellfmet	15	09/06/2006	20:00	00.0	257	00.5	00.0
wellfmet	15	09/06/2006	20:15	00.1	262	00.5	00.0
wellfmet	15	09/06/2006	20:30	00.1	264	00.6	00.0
wellfmet	15	09/06/2006	20:45	00.0	278	00.3	00.0
wellfmet	15	09/06/2006	21:00	00.0	000	00.0	00.0

wellfmet	15	09/06/2006	21:15	00.0	000	00.0	00.0
wellfmet	15	09/06/2006	21:30	00.1	351	00.7	00.0
wellfmet	15	09/08/2006	20:15	00.0	175	00.5	00.0
wellfmet	15	09/08/2006	20:30	00.0	176	00.0	00.0
wellfmet	15	09/08/2006	20:45	00.0	264	00.4	00.0
wellfmet	15	09/08/2006	21:00	00.0	282	00.3	00.0
wellfmet	15	09/08/2006	21:15	00.0	282	00.3	00.0
wellfmet	15	09/08/2006	21:30	00.1	282	00.4	00.0

October 2006

The following RH data are considered suspect. Readings are generally unstable.

Wellfmet 10/03/06 09:30 to 15:00

Wellfmet 10/13/06 12:30 to 16:30

November 2006

No suspect/anomalous data

December 2006

No suspect/anomalous data

12) Deleted data:

Arrays:

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

All deleted data is denoted by blank spaces.

January

No Deleted Data

February

For the following date and time PAR data were deleted because they exceeded the maximum signal noise error for the Licor sensor is +/- 2.214 mmol/m² over a 15 minute interval and +/- 8.856 mmol/m² over a 60 minute interval. Hourly and daily totals that were affected were also deleted:

02/01/2006 23:45 and 24:00 (arrays 15, 60, and 144)

02/02/2006 00:15 thru 06:30 (arrays 15 and 60), 07:00 (array 60), 24:00 (array 144)

02/05/2006 02:00 (arrays 15 and 60), 24:00 (array 144)

02/06/2006 03:30, 03:45, 04:00 (array 60), 24:00 (array 144)

02/13/2006 17:30 thru 18:15 (arrays 15 and 60), 19:00 (array 60), 24:00 (array 144)

02/14/2006 02:15 thru 03:00 (array 60), 17:45 thru 24:00 (arrays 15, 60, and 144)
02/15/2006 00:15 thru 06:15 (arrays 15 and 60), 07:00 (array 60), 18:30 thru 19:45 (arrays 15 and 60), 20:00 (array 60), 22:45 thru 24:00 (arrays 15, 60, and 144)
02/16/2006 00:15 thru 01:00 (arrays 15 and 60), 24:00 (array 144)
02/20/2006 18:00 (arrays 15 and 60), 24:00 (array 144)

March

No Deleted Data

April

No deleted data

May

For the following date and time PAR data were deleted because they exceeded the maximum signal noise error for the Licor sensor is +/- 2.214 mmol/m² over a 15 minute interval and +/- 8.856 mmol/m² over a 60 minute interval. Hourly and daily totals that were affected were also deleted:

05/14/2006 19:15-24:00 (arrays 15, 60, and 144)
05/15/2006 00:15-04:15 (arrays 15 and 60), 05:00 (array 60), 19:15-24:00 (arrays 15, 60, and 144)
05/16/2006 00:15-01:30 (arrays 15 and 60), 02:00 (array 60), 24:00 (array 144)

June

There are unexplained missing data from 06/16/06 at 10:15 until 06/30/06 at 09:15. Due to missing 15 minute and hourly readings, the data on 6/30/06 at 10:00 (array 60) and 24:00 (array 144) were deleted.

July

The weather station was taken off line from 7/11/06 10:30 until 7/14/06 13:45 to replace the CR10X with the CR1000. Data on 7/14/06 at 14:00 were deleted due to missing data that resulted in inaccurate 15 minute averages and totals.

The following PAR data was deleted because it was NAN

07/21/06 10:45
07/23/06 13:15

August

The following PAR data was deleted because it was NAN

08/21/06 12:30

September

No deleted data

October

No deleted data

November

No Deleted Data

December

A new program (ver. 3) was uploaded to the CR1000 on 12/13 at 12:09. Data at 12:15 were deleted due to missing data that resulted in inaccurate 15 minute averages and totals.

13) Missing data:

Arrays:

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

Data are missing due to equipment or associated specific probes not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. For more details on deleted data, see the Deleted Data Section (12.). If additional information on missing data are needed, contact the Research Coordinator at the reserve submitting the data. Blank spaces within other data are not missing but deleted (see section 12). Missing data means ALL parameters are missing for a certain date and time.

*There is a chunk of unexplained missing data from 06/16/06 at 10:15 (just after a download) to 06/30/06 at 09:15 when the station began to log data again. There was no interaction with the station during this time period and the cause of the missing data is unknown and assumed to be an internal error in the CR10X datalogger.

14) Other Remarks:

On 10/25/2023 this dataset was updated to include embedded QAQC flags for anomalous/suspect data. System-wide monitoring data beginning in 2007 were processed to allow for QAQC flags and codes to be embedded in the data files rather than detailed in the metadata alone (as in the anomalous/suspect, deleted, and missing data sections above). Prior to 2007, rejected data were deleted from the dataset so they are unavailable to be used at all, but suspect data were only noted in the metadata document. Suspect data flags <1> were embedded retroactively in order to allow suspect data to be easily identified and filtered from the dataset if desired for analysis and reporting purposes. No other flags or codes were embedded in the dataset and users should still refer to the detailed explanations above for more information.

Arrays:

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through

the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

Precipitation:

During the initial years of NERRS SWMP weather data collection the CR10X programming was inconsistent in how precipitation values were recorded. For most reserves, zeros were not recorded when rainfall had not occurred between 2001-2003, instead no rainfall was represented by a blank cell. The CDMO verified which datasets were impacted by this issue for the 2001-2006 datasets and inserted zeros when the metadata indicated that no precipitation occurred and data were not missing for other reasons. In some cases, zero values for precipitation data were evaluated and removed where the metadata confirmed that no rainfall should have been in the dataset. The pre-2007 data did not go through a thorough QAQC process again at that time (in addition to previous QAQC); however, if discrepancies were noticed between what was documented in the metadata and what was in the dataset, additional updates may have been made. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout early 2023.

Station upgrades and the addition of a Campbell telemetry station caused some data gaps and changes in the data set structure throughout the year. Every effort was made to collect and deliver the data in a standardized format.

Notable storms:

May 12th-15th saw record setting rain events around Maine and much of Coastal New England. The Wells NERR weather station recorded 5.5 inches of rain on the 13th alone and a total of just over 10 inches from the 12th to the 15th.

There were also considerable rain events in the month of October as well on 10/12 and in July on 7/22.