

Padilla Bay (PDB) NERR Meteorological Metadata
January – December 2004
Latest Update: **October 15, 2023**

I. Data Set & Research Descriptors

1) Principal investigator & contact persons:

Contact Persons:

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2) Entry verification

a) Data Input Procedures:

The instruments on the weather station sample meteorological conditions every 5 seconds and store it on a Campbell Scientific CR10X datalogger. Data are logged to a file in three arrays of 15 minute (15), hourly (60) and daily (144) averages with maximums and minimums except for PAR and precipitation, which are totaled for each time period.

From January 1, 2004 through March 1, 2004 the CDMO Data Logger Program NERR_4.CSI was loaded into the CR10X and controlled the sensors and data collection schedule. On March 1, 2004 a new program was uploaded (NERR_4_1.CSI) to the CR10X that changed the midnight recorded time from 2400 to 0000. Due to an error in this program that logged “seconds” in addition to “hours” and “minutes” a corrected program was uploaded on July 15, 2004 and “seconds” were deleted from all files. The data are downloaded once a month in the field to a Toshiba Windows OS laptop computer connected to the SM4M storage module using Campbell Scientific software PC208W. Files are exported from PC208W in a comma-delimited format (.DAT) and opened in Microsoft Excel for pre-processing with the EQWin format macro 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. 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. Edited and raw files are archived on a PC hard drive, an external hard drive and on compact disk at Padilla Bay NERR. Robin Cottrell completed this process of entry verification for the 2004 data. Robin Cottrell and Doug Bulthuis completed final verification and this metadata documentation.

Any anomalous data are investigated and noted in the Anomalous Data/Suspect Data section. Any missing data are noted in the Missing Data section.

The most common errors/anomalies noted in 2004 are:

1. Small negative (< 1) PAR values are within the one year stability range for the probe.
2. Precipitation $> 5\text{mm}$ in 15 minutes.
3. Relative Humidity > 100 but ≤ 102 .

All errors/anomalies were double checked with other data that could support such "anomalous" weather changes and noted in Section 11.

c) Error/Anomalous Data Criteria

Air Temp: Sample not greater than 50 C or less than -30 C

Relative Humidity: Sample not greater than 100% or less than 0%

Pressure: Sample not greater than 1060 mb or less than 900 mb

Wind Speed: Wind speed not greater than 30 m/s

Wind Direction: Wind direction not greater than 360 degrees or less than 0 degrees

Rainfall: Precipitation not greater than 5 mm in 15 min

Photosynthetically Active Radiation (PAR): Sample not greater than 5000 mmol/m^2 or less than -0.5 mmol/m^2

For all data: No duplicate data

3) Research objectives:

The principal objective is to record meteorological data at Padilla Bay for use in studies investigating correlations between meteorological data and water quality data, biological data, or other phenomenon in Padilla Bay and its watershed.

4) Research methods:

From January 1 through December 31, 2004 data were downloaded at least once a month from the weather station. The sensors are visually inspected at this time for debris or damage except for the PAR sensor that cannot be seen from the ground so is inspected less often. Due to the location of the weather station in the middle of flat farm fields the sensors require very little cleaning. The most common problem occurs seasonally from air borne seeds partially blocking the rain gauge funnel. To mitigate this problem weeds near the site are cut before they set seed. While at the station downloading data a Kestrel 4000 Pocket Weather Tracker is used to make a general, comparative check of the Campbell station sensors.

Sensors are sent in to Campbell Scientific to be calibrated according to their maintenance schedule recommendations. On occasion very high or very low barometric pressures were checked against weather data posted on a NOAA weather website for this area.

5) Site location and character:

Padilla Bay (48° 30' N; 122° 30' W) is a shallow embayment in northern Puget Sound located in the greater Puget Sound-Georgia Basin estuary. It is an "orphaned" estuary in that the Skagit River, which formed the delta mud flats of Padilla Bay, no longer enters the bay directly. The tide flats are dominated by the eelgrass *Zostera marina*, which covers approximately 3,000 ha. *Zostera japonica*, a recent invader to the region, now covers about 350 ha of the bay. Tides are mixed semi-diurnal with a mean range of 1.55m. Salinity varies from about 15 to 30 PSU. Most of the land in the 9300 ha Padilla Bay watershed is agricultural, and is drained by four sloughs which empty into the bay. Some freshwater from the Skagit now enters Padilla Bay from the south through the Swinomish Channel which connects Padilla Bay to Skagit Bay. Other major freshwater flows into this area of the Puget Sound-Georgia Basin estuary from the Fraser and Nooksack Rivers to the north. Padilla Bay is bordered on the east and south by flat, diked farmland; farther to the east are foothills of the Cascade Range. March Point, on the western edge of the reserve, is the site of two large oil refineries. To the north and west are the San Juan Islands of northern Puget Sound.

The weather station is located near the southeast corner (122° 28' 4.81" W; 48° 27' 50.58" N) of Padilla Bay on a 40 hectare demonstration farm that is owned by the Reserve. Flat fields that are farmed for seasonal crops surround the site. Access is off of Bayview-Edison road about 150 m down a gravel driveway.

The sensors are mounted on a 3 m tower that is secured to a concrete pad as specified by the manufacturer, Campbell Scientific. The relative humidity/temperature sensor is mounted 2 m high and the wind and PAR sensors are at the top of the tower 3 m above ground level. The tipping-bucket rain gauge is bolted to a slab of wood that is attached to the top of a 55 gallon metal drum filled with water for stability, the top of the rain gauge is 1.2 m above ground level. Surrounding the site is a six foot high chain link fence for security. The weather station is about 300 m from the diked edge of the bay and approximately 4 km SE of the Bayview Channel YSI deployment site and about 4 km south of the Padilla Bay Research Reserve laboratory.

6) Data collection period:
January 1 at 00:00 to December 31 at 24:00.

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.

8) Associated researchers and projects:

None

II. Physical Structure Descriptors

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

Parameter: Temperature and Relative Humidity

Units: Celsius

Sensor type: Platinum resistance temperature detector (PRT)

Model #: HMP45C Temperature and Relative Humidity Probe

Operating Temperature: -40°C to +60°C
Range: -40°C to +60°C
Accuracy: ± 0.2 °C @ 20°C
Date of Last calibration: New sensor November 2003

Parameter: Barometric Sensor
Units: millibars (mb)
Sensor type: Vaisala Barocap © silicon capacitive pressure sensor
Model #: CS-105
Operating Range: Pressure: 600 to 1060 mb; Temperature: -40°C to +60°C;
Humidity: non-condensing
Accuracy: ± 0.5 mb @ 20°C; ± 2 mb @ 0°C to 40°C; ± 4 mb @ -20°C to 45°C; ± 6 mb @ -40°C to 60°C
Stability: ± 0.1 mb per year
Date of Last calibration: New sensor November 2003

Parameter: Wind speed
Units: meter per second (m/s)
Sensor type: 12 cm diameter cup wheel assembly, 40 mm diameter hemispherical cups
Model #: R.M. Young 03001-5 Wind Sentry
Range: 0-50 m/s (112 mph); gust survival 60 m/s (134 mph)
Accuracy: $\pm 2\%$
Date of last calibration: December 2000

Parameter: Wind direction
Units: degrees
Sensor type: balanced vane, 16 cm turning radius
Model #: R.M. Young 03001-5 Wind Sentry
Range: 360° mechanical, 355° electrical (5° open)
Accuracy: $\pm 5\%$
Date of last calibration: December 2000

Parameter: LI-COR Quantum Sensor
Units: mmol m⁻² (total flux)
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: $<\pm 2\%$ change over 1 yr
Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%
Sensitivity: typically 5 μ A per 1000 μ mol s⁻¹ m⁻²
Date of last calibration: December 2000

Parameter: Precipitation (unheated)
Units: millimeters (mm)
Sensor type: Tipping Bucket Rain Gauge

Model #: RG-2000-C
Rainfall per tip: 0.01 inch
Operating range: Not specified
Accuracy: +/- 1.0% at 14 inches per hour
Date of Last calibration: November 2003

Storage Module

Model #: SM4M
Storage capacity: 2 million low-resolution data values
Program storage: stores up to 8 programs with a total capacity of 128 KB
Processor: Hitachi H8S
Operating system: 64 KB, flash memory based, user downloadable
Operating range: Temperature: -35° to +65°C
Baud rates: 9600, 76800
Memory type: user selectable for either ring style (default) or fill and drop.
Power requirements: 5 +/-0.3 VDC @ 100 mA

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.

10) Coded variable indicator and variable code definitions:

Sampling station: Sampling site code: Station code:

Padilla Farm PF pdbpfmet

11) Anomalous Data/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.

The following PAR values are within the stability range of the sensor:

SMPLDATE	SMPLTIME	ARRAY	Total PAR
01/04/2004	18:15	15	-0000.7
03/09/2004	19:45	15	-0000.6
04/18/2004	20:00	15	-0000.6
04/21/2004	20:30	15	-0000.6
04/26/2004	20:15	15	-0000.6
05/05/2004	21:00	15	-0000.6
05/18/2004	21:15	15	-0000.6
06/28/2004	21:30	15	-0000.6

The following rainfall data is consistent with data on a NOAA weather website for this area and correspond to heavy rain events:

SMPLDATE	SMPLTIME	ARRAY	Total Precp
08/24/2004	16:15	15	05.1
08/24/2004	16:30	15	07.9
08/24/2004	16:45	15	05.1
09/11/2004	08:00	15	06.6

Relative humidity values >100 but ≤ 102 % were common during the fall and winter months of 2004. These are within the accuracy range of this sensor.

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.

On March 1 at 1400 a new program was uploaded to the CR10X to change the midnight time stamp from 2400 to 0000. Daily totals for March 1st, array 144 were deleted.

On July 15 a new program with a correction for the time (previous program erroneously logged seconds) was uploaded to the CR10X so data were deleted for 1130 (array 15), 1200 (array 60) and July 16 at 0000 (array 144).

On November 28 data was not logged until 1745 due to technical problems with real-time transmission hardware so data were deleted for 1800 (array 60) and at 2400 (array 144).

On December 12 data was not logged until 1600 due to technical problems with real-time transmission hardware so data were deleted for 1600 (array 60) and at 2400 (array 144).

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 is needed, contact the research Coordinator at the reserve submitting the data.

Missing Data Comment 1: On March 1, 2004 data is missing due to a program upload at 1400, data was not logged at 1400 for arrays 15 and 60.

Missing Data Comment 2: Real-time data transmission hardware was installed at the weather station on November 17, 2004. Due to technical problems with this hardware data is missing from 11/17 at 1615 through 11/28 at 1730 and in December from 12/1 at 1445 through 12/12 at 1600. Technical assistance from the company failed to resolve the problem.

14) Other Remarks/notes

On 10/15/2023 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:

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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.

It was anticipated that the Wind Sentry set and Quantum Sensor would be replaced in 2004, this did not happen which resulted in these sensors being overdue for calibration. Comparative checks of the wind speed with the handheld Kestral 4000 show good correlation with the Wind Sentry.