**Reserve Name** **Lake Superior (LKS) NERR Meteorological Metadata**

**August through December, 2013**

**Latest Update:** January 13, 2015

**I. Data Set and Research Descriptors**

1. **Principal investigator(s) and contact persons –** Staff members responsible for the design, implementation and continuation of the data set.

**Shon Schooler, Research Coordinator**

**14 Marina Drive, Superior, WI 54880**

**715-392-3141**

[**Sschoole@uwsuper.edu**](mailto:Sschoole@uwsuper.edu)

**Tracey Ledder, Monitoring Coordinator (SWMP)**

**14 Marina Drive, Superior, WI 54880**

**715-392-3141**

[**Tracey.ledder@ces.uwex.edu**](mailto:Tracey.ledder@ces.uwex.edu)

**SWMP Technicians – Joseph Ripley (UW-Superior student)**

1. **Entry verification**

Data are uploaded from the CR1000 data logger to a Trimble ruggedized tablet (IBM compatible) that runs the LoggerNet program. Data files are transferred to a PC (IBM compatible) via flash drive. 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.

Tracey Ledder, Monitoring Coordinator, is responsible for data management.

**3)Research objectives**

The LKSNERR is situated on the freshwater estuary at the confluence of the St. Louis River and Lake Superior, the largest and most pristine of the Great Lakes. The Reserve is a diverse, 16,697-acre complex that contains a variety of representative terrestrial and aquatic habitats allowing for the extensive research and educational opportunities. The Reserve will provide opportunities for research and monitoring, experiential learning, and training while continuing to contribute to the protection of the ecological health of the St. Louis River Freshwater Estuary and Lake Superior coastal habitats.

The Lake Superior NERR will implement the NERR System-Wide Monitoring Program (SWMP). This will include four continuous water quality monitoring stations with monthly nutrient and chlorophyll sampling, a meteorological station, and monthly sampling at one site consisting of 12 nutrient and chlorophyll samples collected over a 24-hour period. Data will be archived at the Centralized Data Management Office (CDMO) as per established protocols. During the 2013 open water season, three continuous stations were operational by May while the fourth was added in September. Partners in the St. Louis River added LSNERR SWMP sites to a St. Louis River nutrient sampling regime beginning in June.

In addition we have sought funding to become a NOAA Sentinel Site. This will include installing surface elevation tables, establishing permanent vegetation transects, installing water level monitoring wells, and establishing a geodetic framework for all instruments.

To promote information access by the public in a timely manner the Lake Superior NERR will seek to provide real-time water quality and meteorological information using telemetry systems (satellite and cellular). This information will be used in the Coastal Training Program (CTP) and Education programs and made available to the public online and in the Lake Superior NERR Science and Interpretive Center. During the third quarter of 2013, two SWMP sites were transmitting sonde data by telemetry to a LSNERR website and to the CDMO Real-Time data application.

**4) Research methods**

The CR1000 datalogger samples every 5 seconds continuously and 15 minute averages are produced and recorded as 15 minute data. This data is stored within the CR1000 until it is manually downloaded through Loggernet and uploaded to the CDMO for initial QA\QC procedures.

Campbell Scientific data telemetry equipment was installed at the Pokegama Bay Meteorological Station (*PO*) in July, 2013, and transmits data to the NOAA GOES satellite, NESDIS ID #3B048454. 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/).

Sensors on the weather station are inspected monthly for damage or debris. If any is found, it is repaired and/or cleaned. Sensors are removed and sent back to Campbell Scientific for calibration either annually or every two years, depending on sensor specifications.

Recommended calibration frequency for the MET station sensors:

- Temperature/Humidity- annual recalibration

- Rain Gauge- annual recalibration

- Wind Speed/Direction- annual or bi-annual inspection (depending on the sensor)

- Barometric Pressure- bi-annual recalibration

- PAR- bi-annual recalibration

- CR1000-every 5 years (required beginning 2014, one year initial grace period)

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 (°C) and their times from 5-second data (these data are available from the Reserve)

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

Wind Direction Standard Deviation (degrees)

Totals:

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

Total Solar Radiation (W/m2) was collected by the Reserve but is not available in the dataset. Contact LKS NERR for more information.

**5) Site location and character**

The Lake Superior NERR is located within the estuary of the St. Louis River. The St. Louis River Watershed covers approximately 3,634 square miles in northeast Minnesota and 263 square miles in northwest Wisconsin. In the upper watershed the river flows through lake clays and glacial deposits for approximately 100 miles. Near the city of Thomson the channel narrows and the river flows through a rocky rapid-filled gorge. Approximately 23 river miles upstream from Lake Superior is the Fond du Lac dam, the lowest of several dams. Below the gorge and dams the river begins to take on the characteristics of a fresh water estuary. At the mouth of the river is the largest working harbor on the Great Lakes.

The MET three-meter instrument tower is mounted on a nine-foot metal platform embedded at the bank (helical anchors in the river bed) of the Pokegama River, within the Superior Municipal Forest, such that there is no shading and minimal wind block. Sensors are placed on the tower according to CDMO MET manual, with the exception of the rain sensor which sits at the western corner of the platform. The immediate surrounding area is riverine wetland, rising gently in elevation to forest. The Pokegama River is a tributary to the St. Louis River, entering the estuary on the Wisconsin side of Clough Island. The Pokegama River watershed measures approximately 20,144 acres, 51% of which is wetland, 37% forested, 4% developed and 6% agricultural use (the remainder is bare land or open water).

A SWMP water quality monitoring sonde was added to this station in September, 2013..

MET Geographical Location: 46.672360 -92.135614

Platform Base installed at shoreline at Altitude approx. 189 meters above sea level

The 1.9m2 metal platform sits 2.54 m above the adjacent land surface (river berm). The three-meter instrument tower sits on the platform such that the sensors are at the following heights;

Sensor Heights in meters (m) from Platform (from ground)

Temperature and Humidity: 1.75 m (4.3 m)

PAR and TotSoRad: 3m (5.5 m)

Wind: 3.5 m (6 m)

Rain: 1.1 m (3.7 m)

Distance to Oliver Bridge SWMP: 5,350.0 meters

Blatnick Bridge SWMP: 8,925.7 meters

Barkers Island SWMP: 7,796.6 meters

**6) Data collection period**

MET data were collected for 2013 at LKS from 8/27/2013 through 12/31/2013. The table below details the deployment dates for 2013.

MET Deployment Table

|  |  |  |
| --- | --- | --- |
| DEPLOYED | RETRIEVED | NOTES |
| 8/16/2013 9:15 | 8/22/2013 9:45 | Data removed – incorrect timestamp unable to correct |
| 8/22/2013 10:00 | 8/27/2013 12:14 | Data removed – incorrect timestamp unable to correct |
| 8/27/2013 16:00 | 8/30/2013 12:30 | During QC corrected timestamp and BP uploaded as Q3temp |
| 8/30/2013 12:48 | 9/16/2013 12:15 |  |
| 9/16/2013 12:15 | 9/26/2013 9:30 |  |
| 9/26/2013 9:30 | 10/10/2013 10:00 |  |
| 10/10/2013 10:10 | 10/24/2013 9:16 |  |
| 10/24/2013 9:30 | 11/14/2013 9:15 | Moved wind sensor junction box to S, corrected previous data |
| 11/14/2013 9:25 | 12/16/2013 14:15 | Cleaned and covered rain sensor with a bucket |
| 12/16/2013 14:20 | 1/13/2014 10:15 | New program 120613 with BP offset for altitude |

**7) Distribution**

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

Requested citation format:

National Estuarine Research Reserve System (NERRS). 2012.  System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: <http://cdmo.baruch.sc.edu/>; *accessed* 12 October 2012.

NERR meteorological data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal Investigators and Contact Persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page [http://cdmo.baruch.sc.edu/](http://cfcdmo.baruch.sc.edu/).  Data are available in comma delimited format.

**8) Associated researchers and projects**

Four water quality SWMP stations are operated in a river to lake gradient in the St. Louis River. Samples were taken monthly at these four sites for the SWMP required nutrient and chlorophyll *a* analyses (as well as parameters of local interest). These samples were taken and analyzed by staff at the EPA Mid-Continent Ecology Lab as part of a larger St. Louis River Estuary current conditions study in 2013. Chlorophyll *a* laboratory analyses results will be compared to sonde readings at the same site and time in order to better understand the limitations and use of the sonde Chlorophyll *a* fluorescence data.

The SWMP weather station was established in Pokegama Bay and is the central location of a developing Sentinel Site at LKSNERR as well. Precipitation data is important to water quality data and an understanding of flow regimes during flooding events.

The LKSNERR cooperates with researchers at University of Wisconsin and University of Minnesota studying the biogeochemical processes in the estuary. Researchers are looking at the spatial and seasonal patterns of nutrient and organic matter processing. One outcome will be the identification of the role of anthropogenic stressors. The results will enhance our ability to interpret data from water quality monitoring in the estuary to inform management strategies. This project added cDOM and nitrate instrumentation to the Oliver and Blatnick SWMP sites for several months during the summer.

Other research in which LKSNERR participated in 2013 included the biological control of purple loosestrife, a study of the microbial communities related to mercury methylation in sediment, geospatial analyses of stressor gradients, habitat restoration for wildrice (planning) and stakeholder participation patterns in the estuary.

Other agencies working in the St. Louis River estuary include the Wisconsin and Minnesota Departments of Natural Resources, the United States Environmental Protection Agency Mid-Continent Ecological Lab, United States Fish and Wildlife Service and the United States Geological Survey. The LSNERR participates with partnerships in the area with these agencies as well as with the City of Superior, Douglas County and several non-profits.

**II. Physical Structure Descriptors**

**9) Sensor specifications**

Parameter: Temperature

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

Serial Number: ***F4540095***

Date of Last Calibration: ***11/20/10***

Dates of Sensor Use: 08/15/2013 – 12/31/2013

Parameter: Relative Humidity

Units: Percent

Sensor type: Vaisala HUMICAP© 180 capacitive relative humidity sensor

Model #: HMP45C Temperature and Relative Humidity Probe

Range: 0-100% non-condensing

Accuracy at 20°C: +/- 2% RH (0-90%) and +/- 3% (90-100%)

Temperature dependence of RH measurement: +/- 0.05% RH/°C

Serial Number: ***F4540095***

Date of Last Calibration: ***11/20/10***

Dates of Sensor Use: 08/15/2013 – 12/31/2013

Parameter: Barometric Pressure

Units: millibars (mb)

Sensor type: Vaisala Barocap © silicon capacitive pressure sensor

Model #: CS-106 (Vaisala PTB110)

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

Serial Number: ***G3260032***

Date of Last Calibration: **8/16/11**

Dates of Sensor Use: 08/15/2013 – 12/31/2013

Parameter: Wind speed

Units: meter per second (m/s)

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

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

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

Accuracy: +/- 0.3 m/s

Parameter: Wind direction

Units: degrees

Sensor type: balanced vane, 38 cm turning radius

Serial Number: ***WM110138***

Date of Last Calibration: **4/20/2011**

Dates of Sensor Use: 08/15/2013 – 12/31/2013

Parameter: Photosynthetically Active Radiation

Units: mmoles 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: <±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

**Multiplier: *1.25617, August 15, 2013***

Serial Number: ***Q45936***

Date of Last Calibration: **8/24/11**

Dates of Sensor Use: 08/15/2013 – 12/31/2013

Parameter: Total Solar Radiation

Units: W m-2

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

Model #: LI200S

Light spectrum waveband: 400 to 1100 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 90 uA per 1000 W m-2

**Multiplier: *108.2368, August 15, 2013***

Serial Number: ***PY74880***

Date of Last Calibration: **6/3/11**

Dates of Sensor Use: 08/15/2013 – 12/31/2013

Parameter: Precipitation (unheated rain gauge)

Units: millimeters (mm)

Sensor type: Tipping Bucket Rain Gauge (Texas Instruments)

Model #: TR-525I

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

Serial Number: ***48686-711***

Date of Last Calibration: **8/1/11 (calibration confirmed on deployment)**

Dates of Sensor Use: 08/15/2013 – 12/31/2013

The CR1000 has 2 MB of 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 (4 MB optional upgrade) 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.

Date CR1000 Installed: July, 2013

CR1000 Firmware Version (s): *LoggerNet Version 4.1*

CR1000 Program Version(s): *lkspomet\_VER5.5\_09052013.cri*

**10) Coded variable definitions**

Sampling station: Sampling site code: Station code:

Pokegama Bay PO lkspomet

**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/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.

Small negative PAR values are within range of the sensor and are due to normal errors in the sensor and the CR1000 Datalogger. The Maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval.

Relative Humidity data greater than 100 are within range of the sensor accuracy of +/-3%.

Data recorded for all parameters (with the exception of cumulative precipitation) at the midnight timestamp (00:00) are the 15 minute averages and totals for the 23:45-23:59 time period of the previous day. Cumulative precipitation data at the midnight timestamp (00:00) are the sum of raw (unrounded) precipitation data from 00:00 to 23:59 of the previous day. Summing each individual 15-minute total precipitation value from the same period will result in small differences from cumulative precipitation due to rounding. It is especially important to note how data at the midnight timestamp are recorded when using January 1st and December 31st data.

The late fall and winter of 2013 to 2014 has been colder than usual. Subzero temperatures began in early December with approximately 3 feet of snow.

First set of data transmitted through GOES beginning August 16, 2013. Due to programming and sensor setting difficulties, data was not included in the dataset sent to the CDMO until August 27. The following notes describe the issues.

* Time offset from GMT/UTC was entered into the CR1000 program as “-6” which caused the first short data sets to be collected with a TimeStamp that was off by 12 hours (PAR was highest at midnight). The TimeStamp was corrected during the QC process (8/16 through 8/27).
* The jumper inside the PTB110 (CS106) was not installed initially so BP was reading “500” until 8/22 when the jumper was installed.
* Total Solar Radiation (a non-standard parameter) initially read “0” as the CR1000 program had the incorrect channel noted for this sensor. The correct channel was added to the program August 30, 2013 and the sensor began readings at 13:00. Note that Total Solar Radiation is not included in the 2013 dataset, those data are available from the LKS Reserve.

Occasional slightly elevated nighttime PAR value (0.1-0.3) were recorded during 2013. These data were flagged and coded as <1> CSM.

Data are missing on 8/30/2013 12:45 because of a program upload. Data at 13:00 were rejected due to more than likely not being a full 15 minutes of 5-second data following the program upload.

Data are missing on 9/16/2013 12:30 because of a program upload. Data at 12:45 were rejected due to more than likely not being a full 15 minutes of 5-second data following the program upload.

From around 9/24/2013 through 10/3/2013 the wind direction flat lined around 180-198 degrees. Other weather stations in the area show a similar pattern of wind direction.

During a strong wind storm in mid-October, it was noted that the MET wind sensor direction was not at all in agreement with surrounding weather stations for wind direction. After checking with CDMO, it was determined that the sensor had been installed incorrectly. In order for the Young wind sensor to record directions related to True North the junction box should be set to the South. On installation the junction box had been set to True North instead of South. The junction box was corrected on 10/24/2013 between 09:16 and 09:26. All original wind direction data was corrected 180 degrees. Data on 10/24/2013 at 09:30 were rejected due following a program reload at 09:26.

Data are missing on 11/14/2013 at 09:30 due to sensor maintenance. Data at 09:45 were rejected due to more than likely not being a full 15 minutes of 5-second data following the powerdown.

Ice began forming on bays and river in November. The Rain sensor will not function below freezing, as we have no source of electricity nor heat. The Rain bucket was covered with a bucket for winter, therefore there is no rain data from 11/14/2013 09:45 to end of year.

Updated program (lkspomet\_Ver5.5\_120613) was sent to the datalogger on 12/16/2013 including a new offset for BP to account for the altitude above sea level at the MET station. Prior to new program BP data read 990.74, after new program BP read 1013.34 which is close in agreement with the local airport at 1013.55. MET now reading BP corrected to sea level from the local altitude. BP data from 8/27/2013 through the program upload on 12/16/2013 are flagged and coded as suspect <1> SIC CSM. Data are missing on 12/16/2013 14:15 and are rejected at 14:30 because of the program upload.