NEON STANDARD OPERATING PROCEDURE: SUBSURFACE MOORED SENSOR ARRAY DATA MANAGMENET PROCEDURE

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The National Ecological Observatory Network is a project solely funded by the National Science Foundation and managed under cooperative agreement by Battelle. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	05/19/2025	ECO-07143	• Initial Release • Moved data management procedures from NEON.DOC.005332 into this document • Expanded upon Log Stop Time instructions • Logjam upload instructions • Updated NEON logo

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1 Description

1.1 Purpose

The purpose of this document is to provide standard instructional guidance on how to download, store, and transfer data for the Subsurface Moored Sensory Array assembly. This document applies to Field Science, Manufacturing (Repair Lab), and the Calibration, Validation, and Audit Laboratory (CVAL).

1.2 Scope

The operating procedures herein apply to managing data for the Subsurface Moored Sensor Array at instrumented NEON lake sites. Data management procedures include data transmission and storage (downloading the log files and transferring them to Google cloud) using Onset Hoboware Pro and In-Situ Win-Situ 5 software.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD [01]	NEON.DOC.005332	NEON Standard Operating Procedure: Subsurface Moored Sensor Array

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms
RD [03]	NEON.DOC.005218	NEON Sensor Command, Control, and Configuration (C3) Document: Subsurface Moored Sensor Chain
RD [04]	NEON.DOC.004361	NEON Preventative Maintenance Procedure: AIS Surface Water Level
RD [05]	NEON.DOC.005222	NEON Standard Operating Procedure: Aqua & Level TROLL Data Management Procedure
RD [06]	NEON.DOC.005332	NEON Standard Operating Procedure: Subsurface Moored Sensor Array
RD [07]	NEON.DOC.000693	AOS Protocol and Procedure: Reaeration in Streams

2.3 External References

External references contain information pertinent to this document but are not NEON configuration controlled. Examples include manuals, brochures, technical notes, and external websites.

ER [01]	In-Situ, Inc. Win-Situ 5 Software. *https://in-situ.com/support/documents/win-situ-5-software/*
ER [02]	In-Situ, Inc. YouTube Channel, Win-Situ5 Software Training Instructions. *https://www.youtube.com/watch?v=umfmSOWohf4*
ER [03]	In-Situ, Inc. TROLL Com Communication Device *https://in-situ.com/us/troll-communication-device*
ER [04]	HOBO Waterproof Shuttle (U-DTW-1) Manual (2020), ver 10264-O MAN-U-DTW-1 https://www.onsetcomp.com/sites/default/files/resources-documents/10264-O%20MAN-U-DTW-1.pdf
ER [05]	HOBO U24 Conductivity Logger (U24-001) Manual (2019), ver 15070-J https://www.onsetcomp.com/sites/default/files/resources-documents/15070-J%20U24-001%20Manual.pdf
ER [06]	HOBO Waterproof Shuttle Battery Replacement *https://www.onsetcomp.com/resources/hobo-waterproof-shuttle-battery-replacement*

2.4 Acronyms

Acronym	Definition
AIS	Aquatic Instrument Systems
C	Celsius
CFGLOC	Configured Location
CVAL	Calibration and Validation Laboratory
DSF	Domain Support Facility
GMT	Greenwich Mean Time
GPS	Global Positioning System
LC	Location Controller
kPa	kilopascal
UTC	Coordinated Universal Time
µS/cm	microSiemens per centimeter
S/N	Serial Number

3 OVERVIEW

3.1 Components

- A000000015 Assembly, Under-Ice Temperature Chain, Crampton Lake
- A000000016 Assembly, Under-Ice Temperature Chain, Little Rock Lake
- A000000017 Assembly, Under-Ice Temperature Chain, Prairie Lake
- A000000018 Assembly, Under-Ice Temperature Chain, Prairie Pothole
- A000000019 Assembly, Under-Ice Temperature Chain, Toolik Lake
- A000000039 Assembly, Under-Ice Temperature Chain, Lake Suggs
- A000000040 Assembly, Under-Ice Temperature Chain, Lake Barco

3.2 Subsystem Location and Access

Subsurface Moored Sensor Arrays reside at both core and gradient AIS Lake sites. Access to AIS sites require aquatic PPE and may require a boat. At Lake sites, the sensor array is co-located with the floating buoy infrastructure and its temperature chain.

4 FIELD DATA MANAGEMENT PROCEDURE

Ensure that all precautions in RD [06] Section 3.3 have been observed to maintain accurate time keeping for both logged data and maintenance records.

Ensure HOBOware **Pro** is installed on the field laptop. The free version will not allow time synchronization with the logger. The free version can be downloaded from the IT-managed Software Center present on all laptops. All domains should already have a Pro license key, but it can be purchased from Onset if it is lost (https://www.onsetcomp.com/products/software/hoboware).

4.1 Equipment

Table 1. Equipment List for facilitating connection to TROLL and HOBO sensors.

Part Number (P/N)	NEON P/N	Description	Quantity
CFG-LT400DL	0317730400	In-Situ non-vented Level TROLL 400, 15psig	1 per site, if refreshing sensors
CFG-TC		TROLL COM Cable (See ER [03]) (Either the 9-pin RS232 serial or USB port variant). Male connector mates with the Twist-Lock connector on the instrument cable.	1 per domain
U24-001	0378610000	Onset HOBO U24-001 freshwater temperature and conductivity data logger	Ranges from 4 to 10 depending on site, if refreshing sensors
U-DTW-1	N/A	Onset HOBO Waterproof Shuttle (U-DTW-1)	1 per domain

PRO TIP: Recommend downloading WinSitu 5 software on a loaner laptop to use in the field to prevent damaging the laptop you use daily for the program or to have the ability to download data or set up logging on Trolls simultaneously. ***Install USB TROLL Com drivers when installing Win-Situ****.*

4.2 Logger Data Download – Level TROLL 400 Pressure Transducer

1. Ensure Fulcrum app has record of mounting position of Level TROLL 400 logger along the assembly.
2. Connect to the TROLL by following steps in RD [05], Section 4.2
3. Record metadata on Fulcrum app during In-Situ 5 connection to Level TROLL 400 logger.
    a. Logger position on the assembly counting from the float (e.g., 01, 02, 03…)
    b. Serial Number
    c. Record discrepancy between TROLL time and laptop time offset from upper right corner of Win-Situ 5. Record the time of the logger as “Pre-sync Data Logger Time” and the laptop time as “Actual Laptop Time (UTC)” in Fulcrum.

d. Record internal logger battery voltage by navigating to the settings tab and selecting Diagnostics. Reference RD [05], Section 4.3 if necessary.

4. Download Level TROLL data to laptop. Follow RD [05] Section 4.6.

   a. Use the following file naming convention: SITE_Depth##_YYYYMMDD_SM_TROLL.csv, where:

      - SITE is the 4-letter NEON site code (e.g., PRLA)
      - Depth## is the mounting position of the TROLL along the assembly, counting as you move towards the anchor (e.g., Depth01 if the TROLL is at mounting location closest to the float). Refer to RD [06] Figure 1 for numbering convention.
      - YYYYMMDD is the date the data was downloaded
      - SM stands for subsurface moored

5. Open the downloaded file and confirm that start and end dates are as expected for the deployment.

6. Delete Log File. Follow RD [05] Section 4.7. Deleting log files will prevent data download times from increasing.

4.3 Logger Launch – Level TROLL 400 Pressure Transducer

1. Follow steps in RD [05] Section 4.4: Enable Logging Procedure, while noting that the logging interval will differ.

   a. If you do not find your site name from the dropdown option when initiating the Logging Setup Wizard, follow RD [05] Section 4.9 Add Site Name Procedure.

   b. Take and store a measurement every **30 minutes** using the **Linear** logging method**.**

   c. In the Logging Setup Wizard, the Scheduled Start - Start Condition **must begin on an even 30 minute interval** to align timestamps with the HOBO temp/cond loggers.

   d. Stop Condition should be None.

   REMINDER: Sync TROLL time to the computer's UTC time!

2. In Fulcrum, record the launched TROLL S/N, Scheduled Logger Launch time (UTC), internal battery voltage, and mounting position along the assembly. Refer to Figure 1 for numbering convention of mounting positions.

3. If swapping sensors, Follow RD [06] Section 5.5: Sensor Refresh

   a. Reuse the Level TROLL's twist-lock backshell hanger for the replacement TROLL!

4. Return the TROLL to previous position on the assembly.

4.4 Logger Data Download – Onset HOBO U24-001 Temperature/Conductivity

1. Connect the shuttle to the laptop using mini-USB cable.
   a. Unscrew the shuttle end cap and connect cable.
   b. If battery power is low, replace with fresh AA batteries.
2. Remove end cap from HOBO logger and connect shuttle.
   a. (Optional) Temporarily remove/replace HOBO from assembly location.
   b. Line up arrows between shuttle attachment and logger (**Figure 1**).

Figure 1. Plug a HOBO U24 logger into the shuttle with the coupler attached. Ensure proper alignment. This is ideally performed while the shuttle is connected to a laptop with HOBOware Pro installed so that you can re-sync the logger's time in UTC (GMT).

   c. Depress the lever on the side of shuttle until green status light illuminates (**Figure 2**). This might take multiple attempts. If you are unable to establish connection, try the following troubleshooting steps:
      i. Shade the HOBO – shuttle connection from direct sunlight.
      ii. Clean optical windows on shuttle and HOBO with soft cloth.
      iii. Inspect for scratches. Too many scratches could block signal paths.
      iv. The shuttle's green light must be on for shuttle to be connected to a HOBO, the shuttle will turn off after disconnecting a device. (**Figure 2**).

Figure 2. A green light indicates a successful data transfer from the logger to the shuttle after pressing the lever to start the transfer.

<u>WARNING:</u> do not leave logger attached to coupler for extended periods of time, as this consumes considerable logger battery power.

3. Once connected, offload and save HOBO temperature/conductivity data. Refer to RD[08] SOP D for more detail as needed.

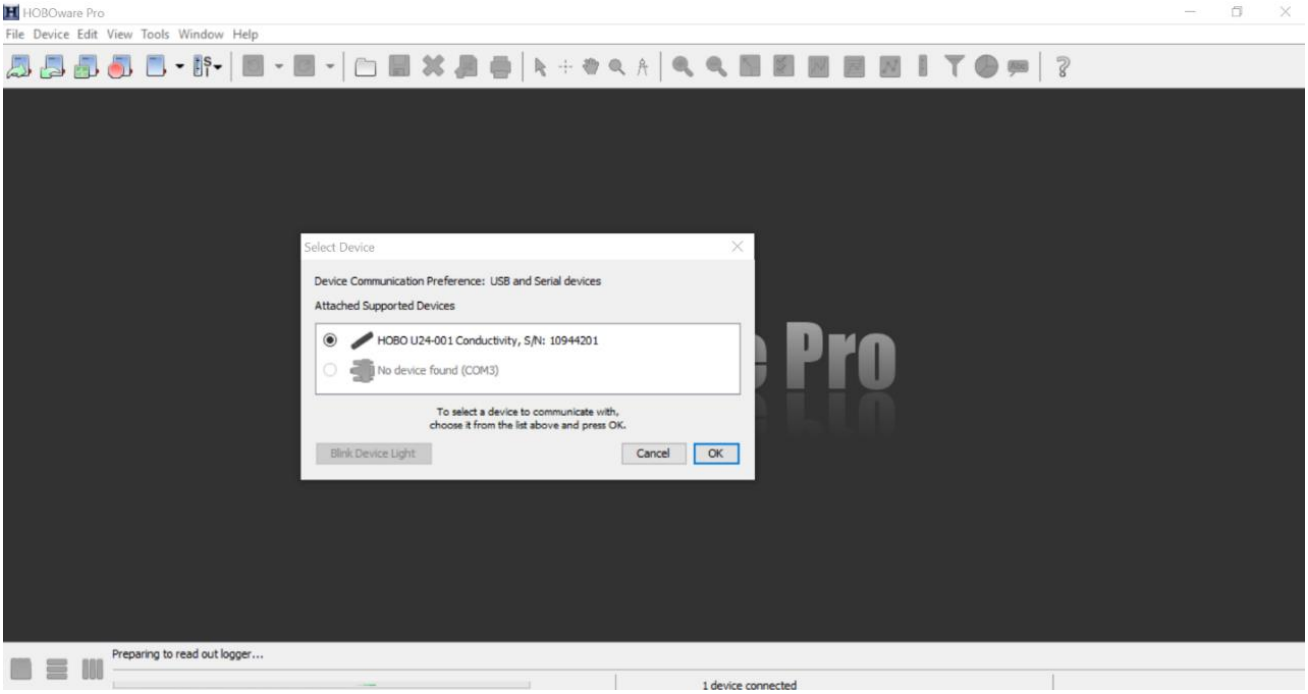

Figure 3. Connect to a device via USB and shuttle with coupler.

4. Record the following metadata in Fulcrum app during connection to HOBO U24-001 logger:
    a. Logger position on the assembly counting from the float (e.g., 01, 02, 03…)
    b. Serial Number
    c. HOBOware data download interface, summarized from RD [08] SOP D:
        i. Click the Readout icon on the toolbar 
            1) Stop sensor logging and reference time.gov to obtain an accurate time reading for your laptop in UTC in HH:MM:SS and record in Fulcrum as “Actual Laptop Time (UTC)” and “Actual Laptop Seconds” Obtain this measurement when the Stop button is clicked.

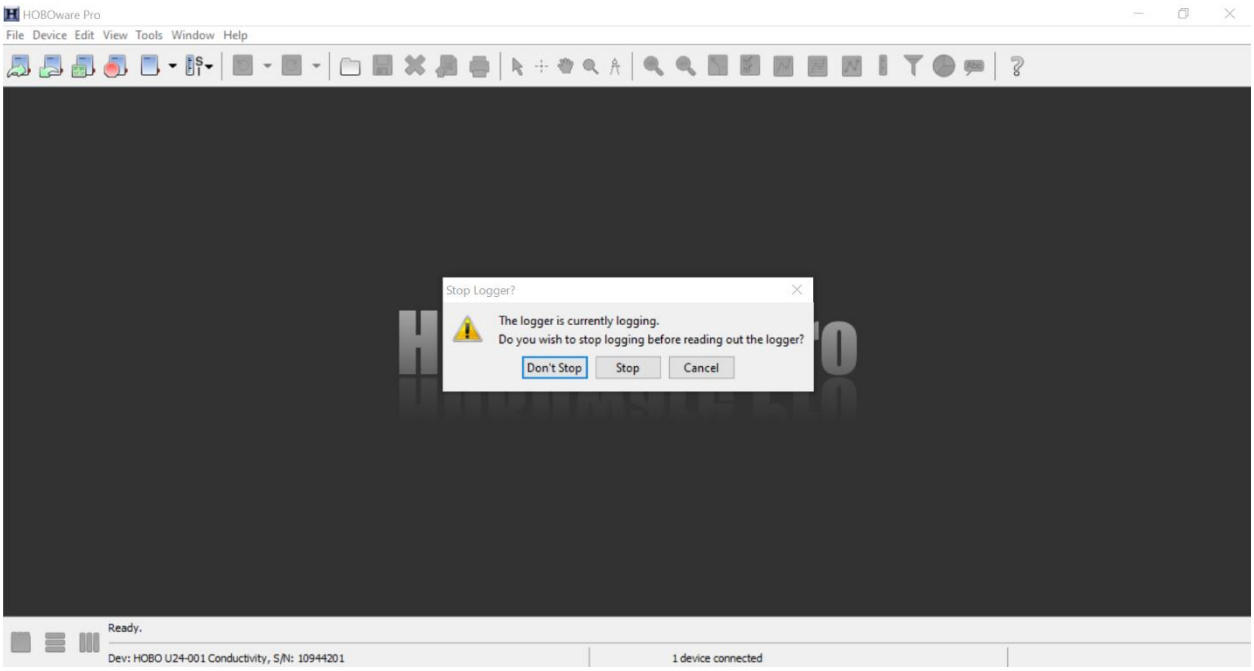

Figure 4. Stop logging before you read out the logger.

ii. Save the .hobo file (**Figure 5**) as SITE_Depth##_YYYYMMDD.hobo, where:

- SITE is the NEON 4-letter site code, e.g. ,'PRLA'
- Depth## represents the HOBO position, where 'Depth01' is the position closest to the float, and 'Depth02' is the second position down and so on depending on the number of loggers deployed at a particular site.
- YYYYMMDD is the year month date that the data was downloaded e.g., '20191006.'

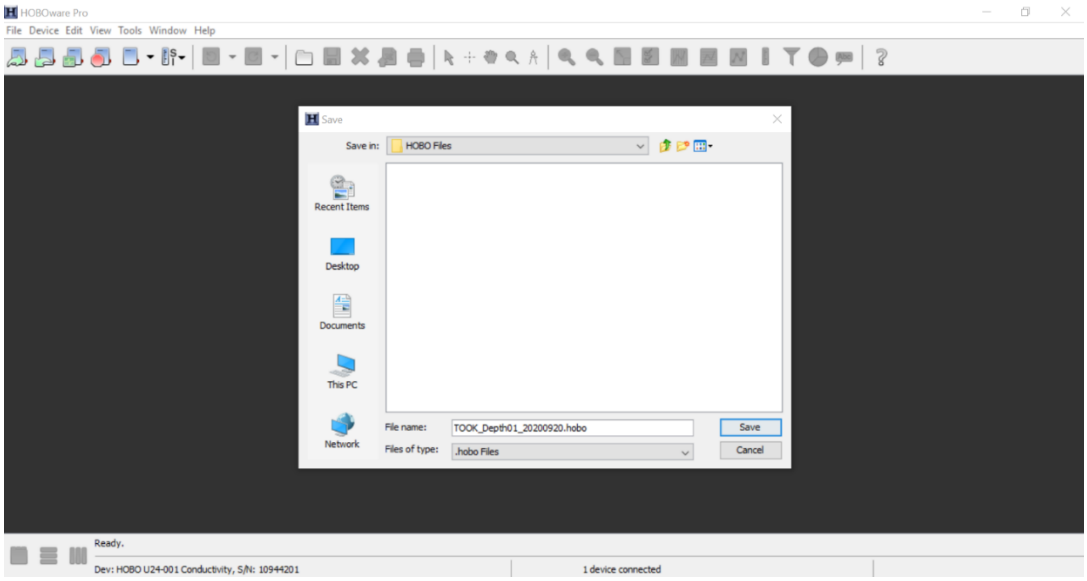

Figure 5. Saving a .hobo file offloaded from a HOBO U24 logger.

iii. **Description.** Ensure description in the Plot Setup window follows the same format SITE_Depth##_YYYYMMDD (**Figure 6**).

iv. **Select Series to Plot** – check the following (**Figure 6**):

- Low Range [µS/cm]
- Full Range [µS/cm] (Only if Conductivity > 1000 µS/cm at your site, i.e., D09)
- Temp [°C]

v. **Select Internal Logger Events to Plot** – check 'All'

vi. **Offset from GMT** – should be '0' when laptop and logger appropriately set to UTC

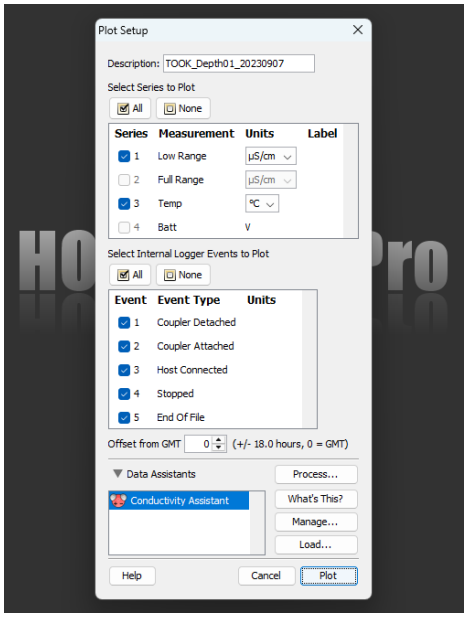

Figure 6. Plot setup for reviewing data.

vii. Click 'Plot' to view your data

1) Inspect 'Internal Logger Events' for a 'Bad Battery' event meaning the battery declined to 3.1V or lower. If present, substitute a replacement logger

viii. Export all available data by clicking on the export button  in the toolbar. ***Leave all series selected*** and click 'Export' (**Figure 7**). Then save your file as a .csv with the same name as the Description entered when launching the HOBO (ex. TOOK_Depth01_20200920).

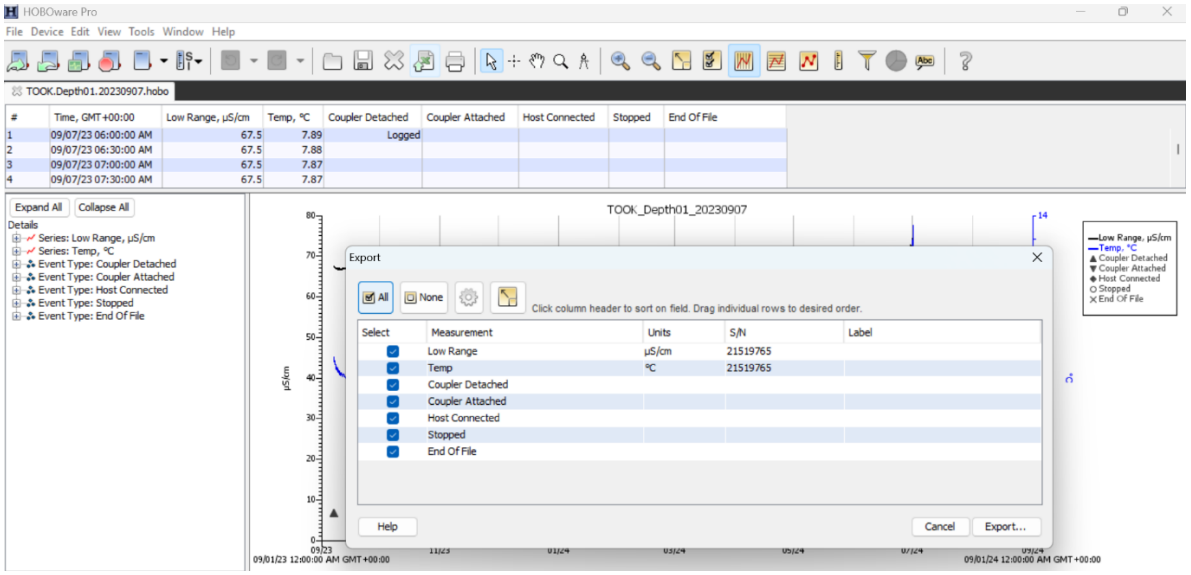

Figure 7. Export the readout of logger data. Ensure all available data are selected.

d. Once the log is downloaded from the HOBO, record, in Fulcrum, the time in GMT +0 (same as UTC) that the log was stopped. Collect this information from the measurement file and record in Fulcrum as "Pre-sync Data Logger Time" and "Pre-sync Data Logger Seconds". **Figure 8** shows the log stop time as 05:51:18 PM. This is used in conjunction with "Actual Laptop Time (UTC)" to obtain an offset for sensor drift.

TOOK.Depth01.20230907.hobo

#	Time, GMT+00:00	Low Range, µS/cm	Temp, °C	Coupler Detached	Coupler Attached	Host Connected	Stopped	End Of File
14318	07/01/24 12:30:00 PM	71.7	11.95					
14319	07/01/24 01:00:00 PM	70.4	11.40					
14320	07/01/24 01:30:00 PM	70.1	11.14					
14321	07/01/24 02:00:00 PM	70.4	11.20					
14322	07/01/24 02:30:00 PM	70.8	11.47					
14323	07/01/24 03:00:00 PM	70.4	11.40					
14324	07/01/24 03:30:00 PM	70.6	11.49					
14325	07/01/24 04:00:00 PM	70.9	11.66					
14326	07/01/24 04:30:00 PM	71.7	12.08					
14327	07/01/24 05:00:00 PM	72.1	12.26					
14328	07/01/24 05:30:00 PM	7.5	13.56					
14329	07/01/24 05:50:38 PM				Logged			
14330	07/01/24 05:50:48 PM					Logged		
14331	07/01/24 05:51:18 PM						Logged	Logged

Figure 8. Record HOBO Log Stop Time from measurement file (05:51:18 PM in this example).

e. Check Battery State and Battery Voltage by navigating to Device > Status (**Figure 9**). If battery voltage falls below 3.3V, then the U24-001 logger is at risk of failure during re-deployment. Onset declares a battery 'bad' at 3.1V. If battery voltage is low, refer to RD [06] Section 5.5 Sensor Refresh.

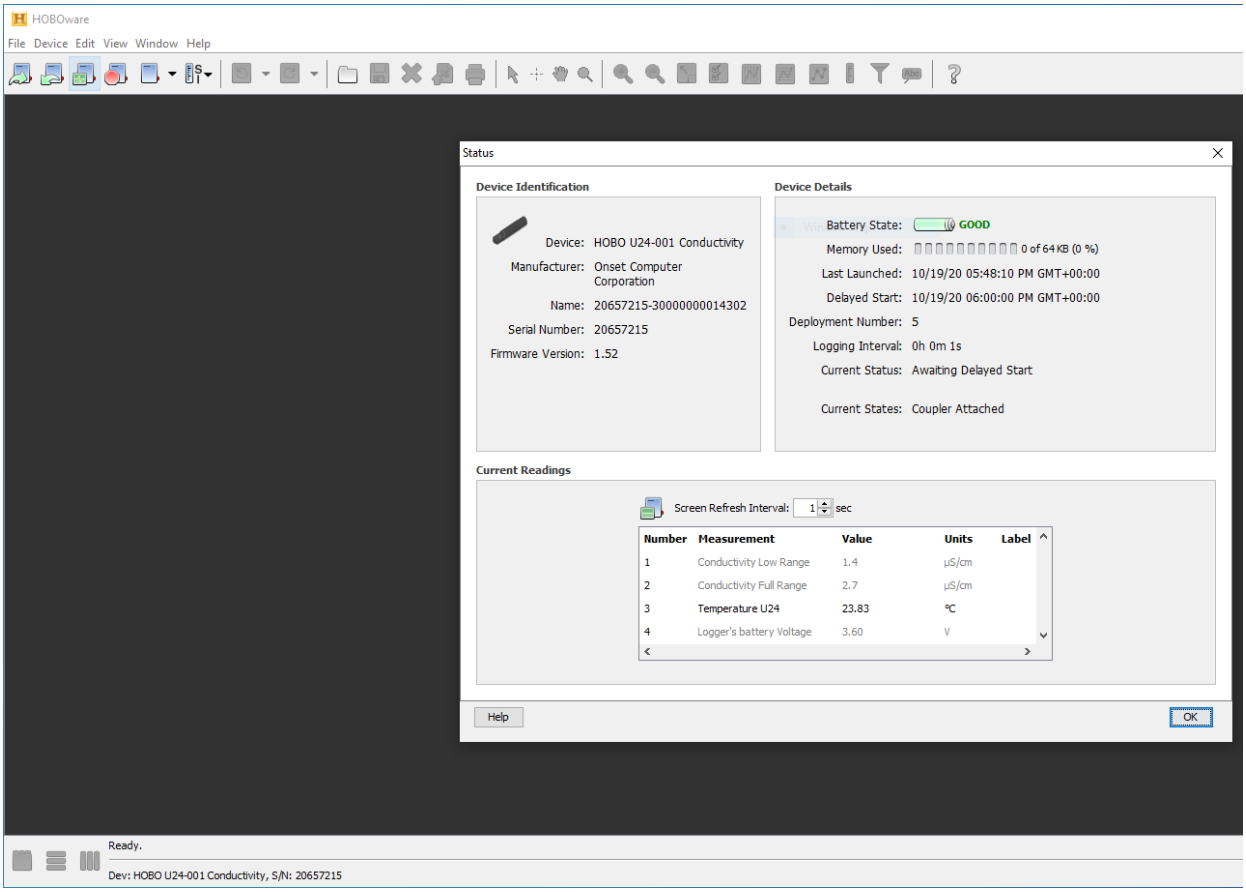

Figure 9. Checking logger status via Device > Status. Note Battery State and Logger's battery Voltage respectively appear in the Device Details and Current Readings sections.

5. Each logger should have data with a .csv export that is uploaded according to Section 5, but you should also save the .hobo file locally as a backup or in case a re-export is needed.

6. HOBO/shuttle disconnect procedure:

    a. If refreshing previously deployed sensors with replacements, disconnect HOBO from shuttle and attach the new HOBO and repeat the previous steps.

    b. Otherwise, proceed to Section 4.5 Logger Launch.

PRO TIPS: *Troubleshooting HOBO files:*

1. *If you can't find your data on the HOBO after retrieving, it may have downloaded to the shuttle. Connect the shuttle and readout the device.*

2. *If you are having trouble communicating with the loggers/shuttle you may have the free version of HOBOware, and you'll need to update HOBOware* ***Pro****.*

4.5 Logger Launch – Onset HOBO U24-001 Temperature/Conductivity

1. If refreshing sensors, substitute the replacement sensor from the sensor that was just downloaded
   a. Attach HOBO to shuttle and press the power bar so that the green light shows on the shuttle

      WARNING: do not leave logger attached to coupler for extended periods of time, as this consumes considerable logger battery power.

2. Record metadata in Fulcrum during HOBOware connection to HOBO U24-001 logger:
   a. Logger position on the assembly counting from the float.
   b. Scheduled Logger Launch time in UTC.
   c. Serial Number.
   d. Battery Voltage, by navigating to Device > Status (**Figure 9**) while U24 logger is connected.
      i. If battery voltage is low (<3.3V), refer to RD [06] Section 5.5 Sensor Refresh.
3. HOBOware: **Launch Logger** per RD [07] SOP D, ensuring that the shuttle is synced following instructions in Section 3.2.1. prior to launch (**Figure 10**).
   a. **Description.** Ensure description follows appropriate format SITE_Depth##_YYYYMMDD, where:
      i. SITE is the NEON 4-letter site code, e.g., 'PRLA'
      ii. Depth## represents the HOBO position, counting from the top, e.g., 'Depth01' at the position closest to the float
      iii. YYYYMMDD is the year month date the data was downloaded e.g., '20210418'
   b. **Sensors**. Ensure sensors configured with appropriate conductivity low/full range for your site by referring to **Table 2** and **Table 3** below.

Table 2. HOBO U24-001 configuration for D09 lake sites, with waters often > 1000 µS/cm.

Parameter	Configuration
Data Acquisition Rate	1 reading per 30 mins
Raw data acquired from HOBO U24-001 sensor	lowRangeConductivity fullRangeConductivity temperature
Measurement mode	Logging

Table 3. HOBO U24-001 configuration for D03, D05, and D18 lake sites, with waters < 1000 µS/cm.

Parameter	Configuration
Data Acquisition Rate	1 reading per 30 mins
Raw data acquired from HOBO U24-001 sensor	lowRangeConductivity temperature
Measurement mode	Logging

c. **Deployment**. Ensure appropriate logging interval **(30 minutes)**

4. In the Deployment section, choose "On Date/Time". The **start time must start on an even 30-minute interval** to align timestamps with the TROLL logger. Choose a time in the future when you are confident that the array will be returned to the site and settled in place.

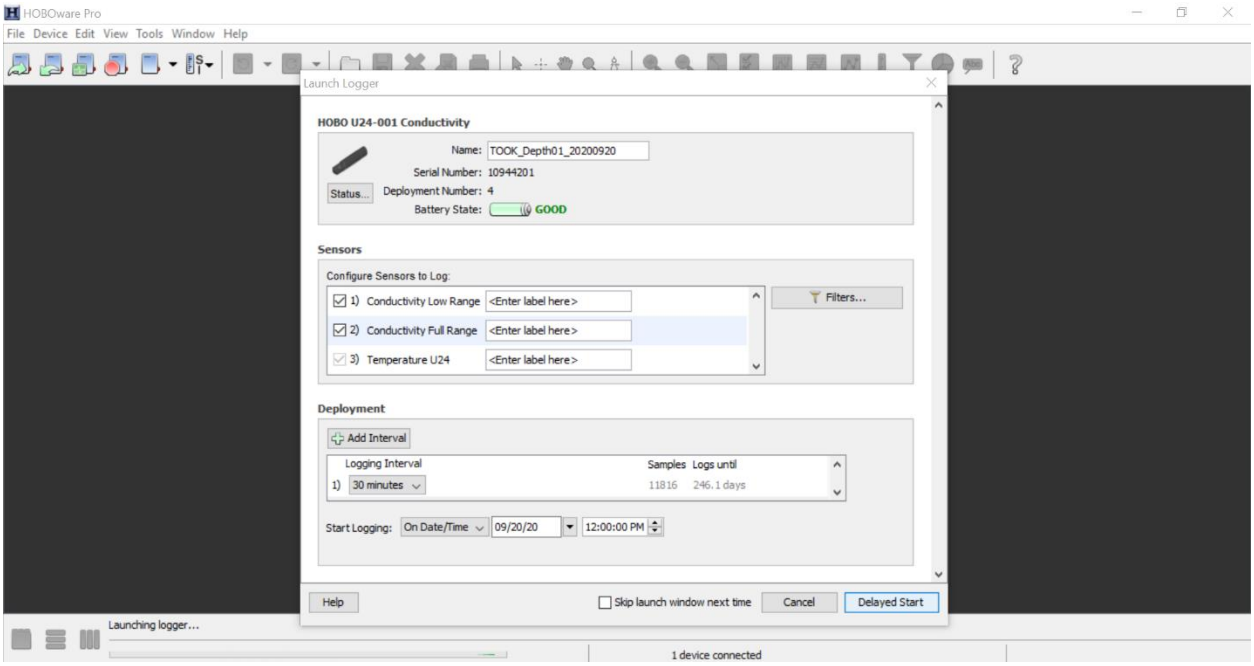

Figure 10. Configure Sensors to Log. Select the appropriate conductivity range for the site's water and the logging interval. Refer to Table 2 and Table 3 for site-specific configuration. This is important as it determines how many days of data will fit in the logger.

Figure 11. Launch Successful. Note in lower left the confirmation that you had a successful launch.

5. Select “Delayed Start” and confirm that the launch was successful in the lower left corner of Hoboware (**Figure 11**). If the “Launch successful” message does not appear, verify logging is active by navigating to Readout device. If the HOBO is logging, the readout can be cancelled as it is verified to be logging appropriately.
6. Cover the optical transmission end of the HOBO sensor with rubber protective end caps before deploying.
7. Repeat for each sensor along the assembly.

5 DATA UPLOAD

5.1 Uploading Logged Data with Logjam

All data must be uploaded using the Logjam Shiny application within 7 days of collection in the field. See the User Guide that accompanies Logjam for details on how to upload data to the app.

1. Upload/sync AIS Maintenance Fulcrum app with site visit metadata.
2. Navigate to Logjam for data file upload (https://logjam.gcp.neoninternal.org/)
   a. Enter technician email.
   b. Select HOBO sensor type (SM troll files can be added when HOBO is selected).
   c. Select all HOBO and TROLL data files for the day of download; this will automatically load the files into Logjam.
      i. HOBO files should have the following format: SITE_Depth##_YYYYMMDD_HOBO.csv.
      ii. TROLL files should have the following format: SITE_Depth##_YYYYMMDD_SM_TROLL.csv.
      iii. Depth## represents the mounting position and YYYYMMDD is the date the data was downloaded

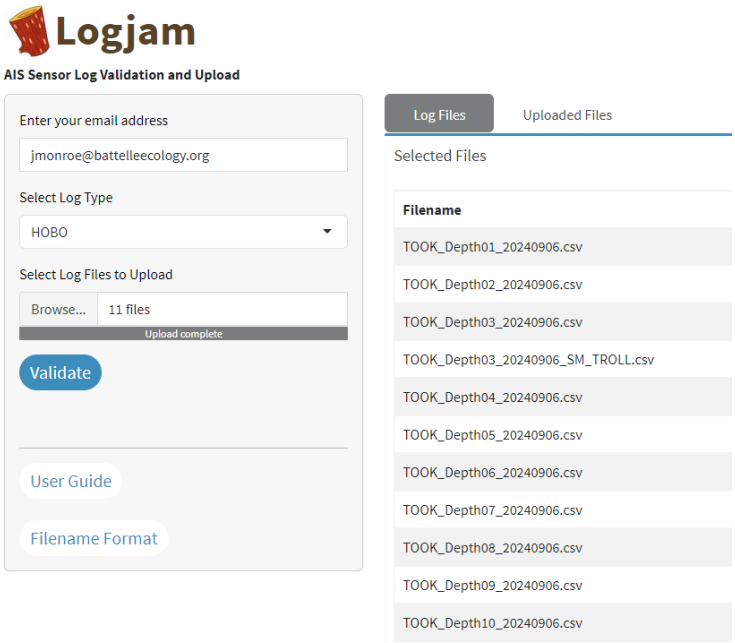

Figure 12. Logjam Upload Interface.

   d. Click “Validate” to perform verification on the uploaded files.
      i. If validation errors occur, open the User Guide to find a detailed list of validation errors and corrections. Correct and reupload files.

ii. If issues persist, contact the Logjam Shiny App author/maintainer via ServiceNow for assistance.

e. Examine the resulting graph to check that named files make sense in terms of depth and temperature.

f. Click “Submit” to finalize file upload to Google Cloud.

3. Maintain a local copy of the .csv and .hobo files for at least two (2) years to have backup files in the event of an emergency (if HQ requires files to be re-uploaded to another or same location).

5.2 Uploaded Log Data QA/QC

Beginning in May 2025, AIS Science will begin running automated checks of cloud-storage locations to verify continuous records of logged data are available for all active configured locations and explore the root cause of data gaps. Incident tickets will be created in ServiceNow if an expected log file is missing in the database *or* if a >7 day gap is present between the startDate of one log file and the endDate of the previous file.

To optimize logged data collection, reference preventative maintenance documentation to ensure sensors are configured correctly for logging and to confirm that logging settings are enabled for all relevant data streams (e.g. Low/Full Range Conductivity, Temperature, and Pressure).