NEON STANDARD OPERATING PROCEDURE: SUBSURFACE MOORED SENSOR ARRAY

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See configuration management system for approval history.

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	04/28/2022	ECO-06803	Initial release
B	05/19/2025	ECO-07143	• Hoboware Pro purchase link • Added D03 site information and instructions • Adjusted recordable Fulcrum information • Grafana LC installation tool instructions • Added sensor measurement step to deployment instructions • Removed quick reference steps • Split data management procedures into separate document NEON.DOC.005401 • Updated NEON logo

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LIST OF TABLES AND FIGURES

1 DESCRIPTION

The subsurface moored sensor array preventive maintenance document guides NEON Field Science staff on maintaining the sensor array and assembly, including assembly deployment, assembly retrieval, and manual data collection and submission.

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.004257	NEON Standard Operating Procedure (SOP): Decontamination of Sensors, Field Equipment and Field Vehicles
AD [02]	NEON.DOC.005218	NEON Sensor Command, Control and Configuration (C3) Document: Subsurface Moored Sensor Chain

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.004361	NEON Preventive Maintenance Procedure: AIS Surface Water Level
RD [04]	NEON.DOC.005401	NEON Standard Operating Procedure: Subsurface moored Sensor Array Data Management Procedure

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*
ER [07]	HOBOware Pro License Key https://www.onsetcomp.com/products/software/hoboware

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
GRAPE	Grouped Remote Analog Peripheral Equipment
GPS	Global Positioning System
LC	Location Controller
kPa	kilopascal
UTC	Coordinated Universal Time
µS/cm	microSiemens per centimeter
S/N	Serial Number

2.5 Terminology

The use of common names for NEON instrumentation and subsystems varies across departments and domains. This section aims to clarify and associate the common names with the technical names herein. The aim of this section is to marry up terms under one name so technicians are aware of the component referenced in the procedures herein, but also aware they may be called another term in a group discussion with headquarters or training staff. For more details on exact parts, refer to AD [02].

SYNONYMOUS COMMON NAME(S)	NEON TECHNICAL REFERENCE NAME
Pressure Transducer, Water Level, Troll *Note: Ground Water Wells (GWW) use the Aqua Troll.*	**Surface Water Level Sensor, Level TROLL 400** (*0317730400, Sensor In-Situ Level TROLL 400 15 psig (gauged) Surface Water Level Sensor*)
HOBO data logger, conductivity/temperature logger, conductivity/temperature sensors	HOBO Freshwater Conductivity Logger 0378610000
Wire Rope Clip	 1/8” Wire rope clip type 304, Miami Cordage item #WRCS18SUN
Thimble	 3/16” S/S Heavy duty wire rope thimble, Miami Cordage Item #THSHW316SUN
Shackle	 ¼” S/S Wide D, Miami Cordage Item #S01140006
Main line	The *taut* stainless steel cable/line between the float and anchor to which loggers are mounted at multiple positions (depths). 1/8” 7x19 S/S Aircraft cable, T304

SYNONYMOUS COMMON NAME(S)	NEON TECHNICAL REFERENCE NAME
Retrieval line	The slack, not taut line connecting from the top of float to the anchor. This is used for retrieving the assembly without putting stress on the main line with sensors (not at D09 shallow lakes). 1/8” 7x19 S/S Aircraft cable, T304
Level TROLL twist-lock backshell hanger (***stays at domain***)	
Miniature Buoy/Float	13 inch Mooring Buoy with Stainless Steel hardware. 35 lb submerged buoyancy. SKU W1300MAWSS; Walsh Marine Products.

3 SENSOR & ASSEMBLY OVERVIEW

3.1 Description

The subsurface-moored sensor array's design enables continuous, year-round collection of data relevant for monitoring lake stratification, even below ice. Lake stratification arises from variation in temperature and conductivity throughout the water column, resulting in layers of water of varying density. In cold (<4°C) temperatures, freshwater densities may become more sensitive to changes in conductivity than in temperature (Cortés et al., 2017). A taut line from the anchor to the float creates an assembly to which we connect a single non-vented pressure transducer, and multiple conductivity/temperature data loggers positioned at specifically designated depths (**Figure 1**). This design also works well for shallow lakes that change depth frequently, even if they don't have seasonal ice conditions. The surface mounted and subsurface mounted temperature chains can overlap or not depending on depth and maintain at least 60 % coverage of the entire water column.

To collect data relevant to lake stratification, loggers are mounted at specific locations such that accurate depth readings from the pressure transducer may be tied to conductivity/temperature logger depths. NEON's nearby barometric pressure data will be used to account for the non-vented pressure transducer readings. A retrieval line is a feature at D18 and D05 sites using a heavy, 50 lb. anchor.

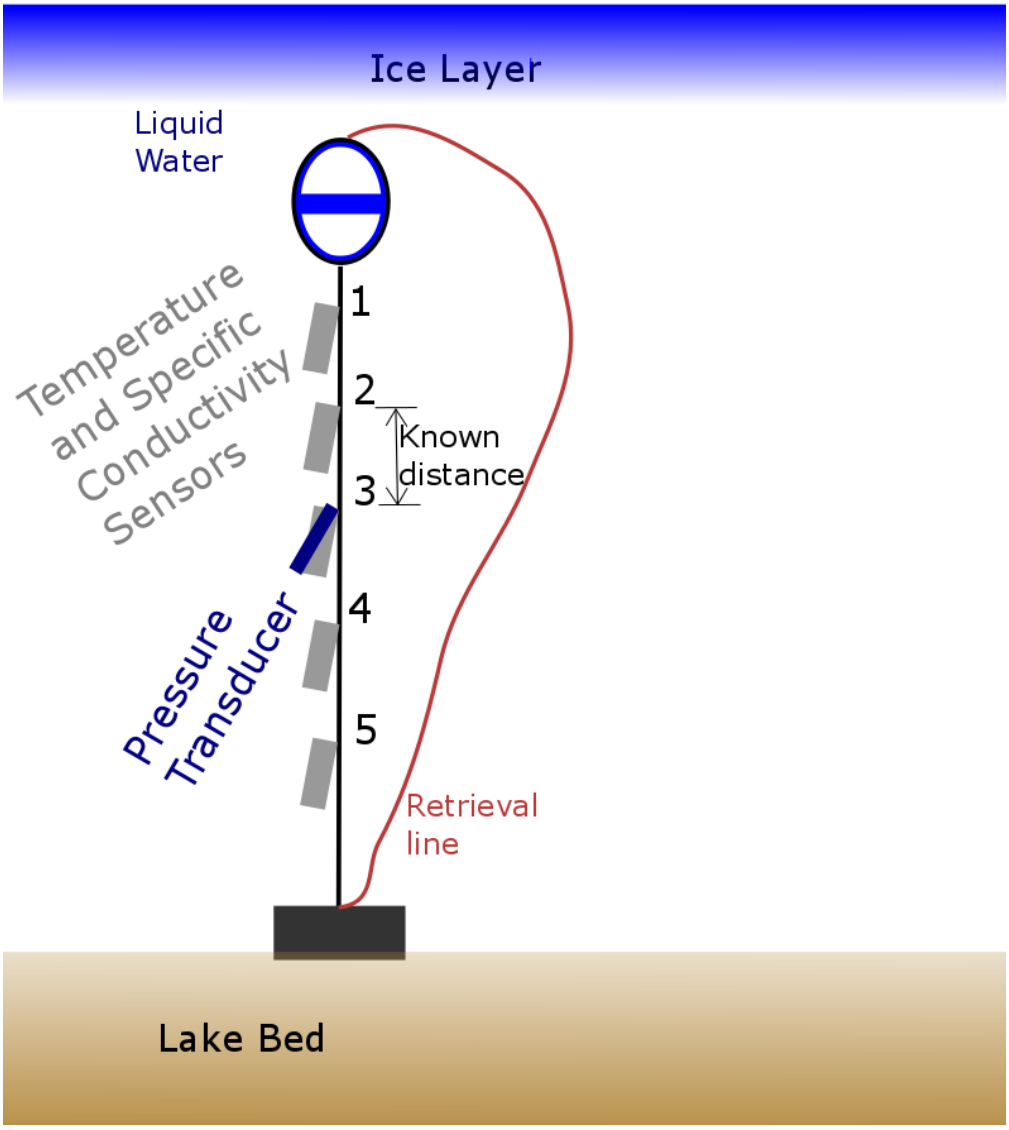

Figure 1. Simplified depiction of the float-anchor assembly with data loggers.

3.2 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

3.3 Sensor-Specific and Subsystem Assembly Handling Precautions

Aquatic Field Ecologists must employ special care to avoid dropping solutions, hardware, or tools into the water while working to prevent contaminating an aquatic environment. In addition, per NEON.AIS.4.1735, all vehicles, trailers, boats, tools, protective outerwear, and any other items that encounter an aquatic or riparian environment, require decontamination prior to site access (AD [01]).

3.3.1 Conductivity/temperature Data Logger Precautions

The internal clocks in the Onset HOBO U24-001 and corresponding HOBO waterproof shuttle are susceptible to time drift, as much as +/- 1 minute per month. Therefore, it is essential that time is diligently recorded in the Fulcrum App when launching sensors into logging mode and when retrieving data from the loggers using the HOBO shuttle. Accurate time recording is necessary for time drift corrections.

Ensure HOBOware **Pro** is installed on the field laptop. The free version can be downloaded from the IT-managed Software Center present on all laptops, but it must be upgraded to Hoboware Pro using a license key within the downloaded HOBOware software. The free version will not allow time synchronization with the logger. All Domains should already have a Pro license key, but it can be purchased from Onset if it is lost (ER[07]).

Prior to site visit (1-2 days prior), synchronize the field laptop and HOBO waterproof shuttle clock to UTC time using https://time.gov to the accuracy of +/- 2 seconds.

1. In Windows, Navigate to Control Panel > Date and Time > Change Time Zone. Select *(UTC) Coordinated Universal Time.*
2. Ensure field laptop's time is within +/- 2 seconds of UTC at https://time.gov. Notice the feature on the right side of browser stating your computer's clock discrepancy (**Figure 2**).
    a. If the laptop time is off by any amount, sync the laptop clock by navigating to Control Panel > Date and Time > Change the date and time manually
3. Optionally use the Laptop clock from the website or check the box in Date and Time settings for "Show seconds in system tray clock" to show the laptop time in seconds on the system tray.

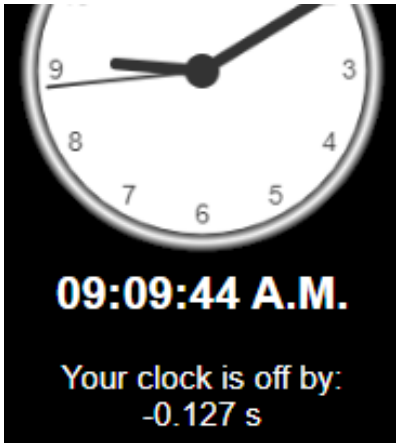

Figure 2. The time.gov PC clock time discrepancy feature on right hand side of screen.

4. Open HOBOware **Pro** software on field laptop once you're certain the clock is synced to UTC.
5. Connect HOBO waterproof shuttle to field laptop:
    a. Install AA batteries in shuttle.
    b. Plug large end of USB cable into field laptop's USB port.

c. Unscrew center cap on shuttle and plug small end of USB interface cable into shuttle.

d. Ensure that a logger is not plugged into the shuttle, as this will prevent sync of time.

e. Navigate to **Device > Manage Shuttle** dialog.

i) Ensure battery level is good. If low, replace shuttle with fresh AA batteries following procedure in ER [06].

6. Synchronize the shuttle's clock to the host computer clock:

a. Press the **Set Shuttle Clock** button.

b. Ensure all data files have already been offloaded from shuttle.

c. Click **Launch Shuttle**, which resets clock and deletes all data files.

PRO TIP: If difference between shuttle clock time and computer clock time is > 5 seconds, the shuttle clock label and icon will flash red.

PRO TIP: The shuttle's clock sets the Onset U24-001 logger clock when relaunching the logger.

3.3.2 Pressure Transducer Data Logger Precautions

The pressure transducer membrane is prone to damage by pressure and scratching. Never apply pressure on the transducer's membrane with any sort of object. Follow preventive maintenance guidelines in RD [04]. If the pressure transducer is ever suspected to have become exposed to ice, the transducer membrane should be inspected for damage (**Figure 3**).

Figure 3. Photo of a Level Troll 500 with dashed red line indicating the location of the sensing mechanism under the nose cone.

The 15 psig Level TROLL 400 must be deployed at a position in the upper 11m of the water to prevent damage. Placing the TROLL in deeper water levels will exceed its pressure rating.

3.4 Subsystem Assembly

The system design is depicted in **Figure 1**. A main line connects from the upper float(s) to the anchor, which may be a kettlebell or anchor depending on site. Sensors connect to shackles looped around thimbles. The thimbles are precisely spaced along the main line to ensure a known distance relative to the pressure transducer. At deep lake sites, a retrieval line also connects from the anchor to the float and is used to easily retrieve the anchor using a winch, without rolling up the main line containing all the sensors and thimble connections. Kettle bell anchors use a stainless-steel chain wrapped around the handle to connect to the main line and retrieval line with a shackle. Note that the anchor may sink a little into lake sediment when deploying the assembly depending on lake substrate.

AIS science has precisely designed the distances between sensor mounting locations (cable loops connected to the main line using wire rope clips). Adjustment is possible, but changes in mounting locations should only happen after consulting AIS science. Knowing relative distances between the pressure transducer mounting positions and conductivity/temperature logger mounting positions along the main line is critical and allows the algorithm to estimate conductivity/temperature at specific depths, an essential data point when determining lake stratification behavior. It is therefore also critical that no knots or tangles in the line occur during deployment.

3.4.1 Assembly Depth Adjustment

Adjusting the main line's total length between the anchor and float is permissible and encouraged if ice damage/float freezing may arise without adjustment. Please ensure no data logger mounting positions change in the process of adjusting the main line. If a change to any of the sensors is required, submit a SN INC to AIS field science support.

Adjusting the total length of the assembly from anchor to float on the 'main line' may be necessary if lake levels have fluctuated considerably prior to ice-on. Ensure the miniature buoys/floats suspending the cable assembly maintain a depth that is entirely beneath the expected maximum ice depth at your lake for the upcoming winter. D03 lake assemblies may need adjustment based on fluctuating water levels unrelated to ice formation.

If adjustments are necessary, proceed with the following steps:

1. Total depth may be adjusted by changing the length of line between the anchor and float:
    a. Loosen wire rope clips at the anchor end of the main cable using 5.5 mm wrench.
    b. Mark current thimble location on main cable. Electrical tape may work.
    c. Slide main cable along the thimble to a desired new length.

d. Once the thimble is at a new location along the cable, place the wire rope clips snug against the thimble and re-tighten using a 5.5 mm hex wrench.

e. Repeat step 1 until float is at a safe depth below expected ice, considering Table 1.

2. Total depth adjustments should avoid moving data logger mounting positions, also connected via wire rope clips. Data logger mounting positions have been precisely measured and should never slide or change position unless absolutely necessary, as determined by conversation with an AIS science team member.

3. Any changes to wire rope clip data logger mounting positions must be accurately measured and documented for the viability of data quality.

4. Ensure main line between anchor and float is taut, and that there are no knots or tangles.

Table 1. Sites with approximate lake water depths and ice depths.

SITE	CRAM	LIRO	PRLA	PRPO	TOOK	BARC	SUGG
Approx water depth [m]	18	11	2-4	1-2	22	6	2.6
Ice depth [m]	1	1	0.8	0.8	2	NA	NA

4 INSPECTION AND PREVENTATIVE MAINTENANCE EQUIPMENT

Table 2. Preventative Maintenance Equipment.

P/N	NEON P/N	Description	Quantity
Tools			
	MX115145	Field laptop *with the system clock that is set to UTC*	1
NEON IT		Onset HOBOWare **Pro** version software	1
NEON IT		In-Situ's Win-Situ 5 software and USB drivers	1
U-DTW-1		HOBO waterproof shuttle (with clock synced to UTC)	1
COUPLER2-C		HOBO shuttle COUPLER2-C (blue) for mating with the U24 logger	1
CFG-TC		In-situ male adapter to USB	1
	0317730400	In-Situ Level TROLL 400	1
	0378610000	Onset HOBO-U24-001	4-10
	0378610000	Spare Onset HOBO-U24-001 sensors for replacement	2
GENERIC		Boat hook to snag below-water buoy	1
	HJ15270000	Retrieval winch (D05)	1
GENERIC		Global Positioning System (GPS)	1
GENERIC		5.5mm socket for wire rope clips in case cable length adjustments are needed	1
GENERIC		A watch/clock reference while on boat synced precisely to UTC	1
GENERIC		Long rod or boat hook to measure depth of the deployed float with measuring tape	1
GENERIC		Heavy duty gloves for deploying and retrieving steel cable	2
OTR-30M		2mm Graduation Field Measuring Tape	1
	N/A	AIS Maintenance Fulcrum App	1
GENERIC		5-gallon bucket for safely containing the assembly cable during maintenance	1
Consumables			
GENERIC		Spare AA alkaline batteries for shuttle	2
GENERIC		Powder-free nitrile gloves for sensor cleaning	A/R
GENERIC		Distilled water or distilled water & mild detergent mix	A/R
GENERIC		Non-scratch scouring pad or soft brush for biofouling removal	A/R
GENERIC		Cotton swabs	A/R
GENERIC		Microfiber or lint-free cloth	A/R
GENERIC		Wash bottle	A/R
GENERIC		Electrical tape for marking points on the line or covering up poky wire strands	A/R
GENERIC		18 gauge stainless steel wire or zip ties to secure D-shackle pins	4-10

5 REMOVAL AND REPLACEMENT PROCEDURE

5.1 Scheduling

Subsurface-moored assemblies with loggers should be deployed year-round. At sites which freeze during winter, a minimum of two data-download visits during ice-off period should occur following the procedure in RD [04]. At a minimum, these should occur after ice-off, and before ice-on. At sites that do not freeze during winter, a quarterly (i.e. every 3 months) data download schedule should be implemented.

At sites which freeze during winter, TROLL and HOBO loggers should be refreshed prior to ice-on due to memory storage limitations in the Onset HOBO data loggers. Preferably, sensor refresh happens at least three days before the platform buoy is removed just before ice-on, enabling temperature data quality assurance and quality control comparison to temperature profiles between the platform buoy's temperature chain and the subsurface-moored temperature loggers.

Following ice-off, prioritize deploying the platform buoy as soon as possible, and allow at least three days of buoy temperature chain data to collect before retrieving data from the subsurface-moored loggers. A temporal overlap between the two temperature data systems could enable HOBO logger drift assessments of the internal clocks and sensor measurements.

5.2 Pre-site Visit Preparations

Normal AIS system time synchronization via the GRAPE/Portal is not possible with standalone sensors. *Accurate time recording is essential.* Synchronizing the Level TROLL 400, HOBO waterproof shuttle, and HOBO conductivity/temperature logger internal clocks with UTC is very important on the day of scheduled maintenance/data download when data connections/downloads/launches occur. Time synchronization reduces time drift effects and allows for more accurate comparisons between the subsurface moored temp chain and the buoy temp chain.

Asset tags should not be attached to each sensor during deployment. Instead, store asset tags at the DSF looped together through a wire or zip tie. In-field record keeping will rely on sensor serial numbers. Asset tags should stay with the sensor when shipping back to logistics/warehouse during sensor refresh or replacement.

Ensure the following are ready prior to field deployment:

- Field laptop with HoboWare **Pro** and WinSitu installed
- Ensure field laptop time synced precisely to UTC using https://www.time.gov/
- Onset HOBO shuttle synced to UTC using HOBOware Pro

5.3 Assembly Retrieval

1. Use boat hook to snag the submerged assembly/floats. If submerged assembly is challenging to find, consider towing a sinking leaded line loop strung off the stern and slowly troll the area. If lake morphology permits (e.g. D09), a steel cable retrieval line can be attached to the sensor array and pulled to shore for subsequent retrieval.
2. Take note of approximate location (direction + distance) relative to the platform buoy for redeployment. Optionally collect GPS coordinates to assist in re-deploying at a similar location.
3. Retrieve the entire assembly, using a winch if necessary. If using a winch attached to the pontoon buoy platform (i.e., D05), refer to Section 5.3.1.
4. Spool the assembly cables in or around a bucket to safely store the cable while working on upcoming tasks and prevent a tripping hazard.
5. Record precise time to the minute in UTC that you retrieved the assembly. This is the start time that logger depths begin to change as caused by retrieval.
6. If desired, move boat and assembly with loggers to a secure location (e.g., shoreline, platform buoy) for downloading data and relaunching loggers via laptop.
7. Record each logger's serial number and corresponding mounting position along the assembly in the Fulcrum app. Mounting positions begin with #1 from the top-most mounting position near the float and count up as mounting positions approach the anchor (**Figure 1**).

5.3.1 Assembly Retrieval Using a Winch (D05 only)

If using an installed winch, retrieve the assembly with the following steps:

1. Disconnect the retrieval cable from the top of the float. The retrieval cable is the cable without sensors connected to it (**Figure 1**).
2. Attach the winch cable to the retrieval cable with the included small shackle.
3. Crank the winch to pull up the anchor, keeping in mind that the anchor gets 'heavier' once it exits the water.
    a. If loggers become visible on the same line you're spooling, that means you've connected the wrong line to the winch. Set the assembly back down and repeat the above steps using the retrieval line.
    b. Spool the assembly's main cable in or around a bucket to safely store the cable while working on upcoming tasks and prevent a tripping hazard.

Figure 4. Side profile of winch system with bow roller with the retrieval line routed through the bow roller and onto the hand crank winch.

Figure 5. Top-down view of winch system with retrieval line routed through the winch assembly.

5.4 Logger Download and Cleaning

Follow the procedures outlined in RD [04] to download data and redeploy sensor loggers. Data should be downloaded in the spring and fall at ice sites and quarterly at ice-free sites, according to the schedule described in Section 5.1.

As-needed, clean HOBO and TROLL loggers of biofouling following procedures outlined in RD [03]. Exercise caution, especially around TROLL pressure transducer membrane. Water with or without detergent may be used to cotton-swab the HOBO sensors.

If a subsurface moored logger appears faulty or non-communicative following assembly retrieval, staff should request a replacement logger. If the logged data is missing or corrupted, staff should verify logging capability and settings before re-deployment.

5.5 Sensor Refresh

1. Attach the corresponding asset tags to the loggers before returning them to NEON headquarters. These must be reattached prior to shipping since they are not deployed in the field with the sensor.
2. Prior to detaching HOBO loggers from the assembly, record each HOBO U24-001 logger's S/N and associated position, where position 1 is the mounting location closest to the float, position 2 is the second location below the float, etc. (**Figure 1**).
3. Prior to detaching TROLL from assembly, record the TROLL's mounting location, which should correspond to a HOBO logger mounting position number.
    a. Ensure the Level TROLL 400's twist-lock backshell hanger remains on assembly.
4. Record changes to each HOBO and TROLL logger positions in the asset management system (i.e., Maximo).
5. Complete Grafana LC installation via Brain Sensor Install Tool
    a. Since the sensor array is not connected to the site's LC, the Brain monitoring system cannot see these sensors. However, they should still be installed at their corresponding CFGLOC. Updates to CFGLOCs for sensors not visible to Brain can be accomplished by making a ServiceNow request to CI with the new and old asset information per each CFGLOC.
6. Ship previously deployed loggers back to headquarters for CVAL inspection.
7. HOBO logger low battery voltage
    a. If the battery voltage is below 3.3V, ship the logger directly to the Assembly and Repair Laboratory at NEON HQ. Create a Request in NEON's issue tracking system for CVAL to initiate the process for battery replacement with the manufacturer. Reference KB0012946 Mandatory Information Requirements for Returning Instrument System (IS) Items to HQ via ServiceNow for broken or non-communicative sensors.
8. After sensors have been refreshed, remove AA batteries inside the shuttle to prevent potential shuttle damage by battery leakage, especially when stored between uses.

5.6 Assembly Redeployment

1. Ensure that all D-shackle pins that screw in/out have been secured. Small 18-gauge wire or zip-ties must be used to secure the pin by snaking the wire/zip-tie through a hole in the pin's handle and then wrapping the wire/zip-tie around the inside of the D-shackle and closing with a couple twists.
2. Prior to redeployment, record the distance of each sensor along the main line in the Fulcrum application.
    a. Lay out the sensor assemblies on the floor (or on the ground outside for longer lines) and pull them taught from float to anchor. Sensors should be attached to the main line during measurement. Lay out a meter tape next to the main line to record sensor distances. Use a meter tape with a maximum of 2mm graduations.
    b. Use the top of the D-Shackle which connects the main line to the buoy as the zero-point for the meter tape. Note that the main line may be connected to the buoy float via a shackle attached to the buoy or via steel cabling wrapped around the buoy (as in **Figure 6**).

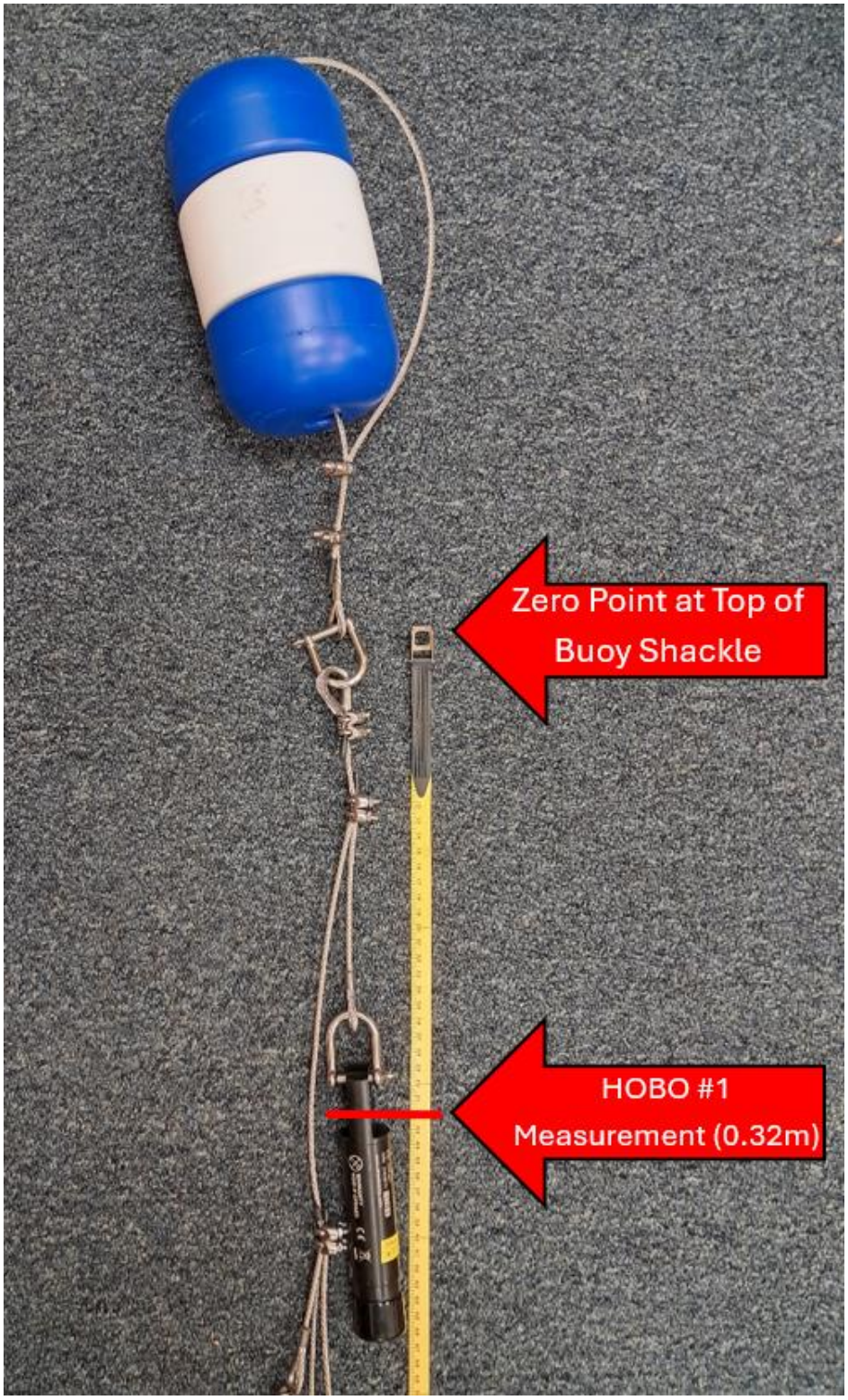

Figure 6. Close up view of Main Line measurements including the zero-point and HOBO #1.

c. Record each sensor position along the main line at the sensing end (**Figure 7**). On HOBOs, this point is a small depression on the opposite end of the optical connector. On Level Trolls, this point is at the end of the sensor covered by a cap. This measurement should be taken with the sensor draped parallel to the main line as if it were deployed in the water.

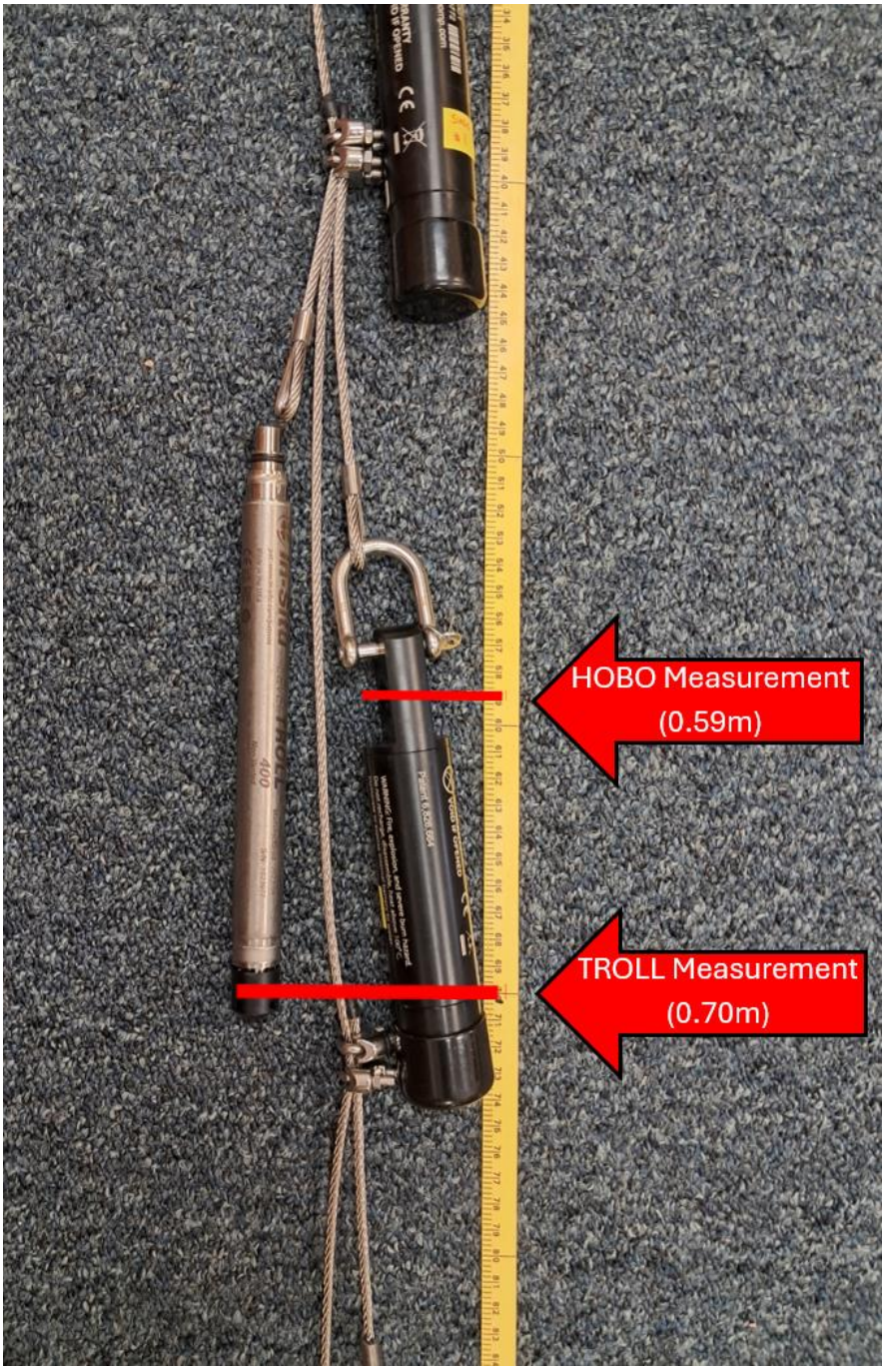

Figure 7. Measurement along meter tape for HOBO and Level TROLL (note that the backshell hanger for the TROLL is not attached in this picture but should be attached when deployed).

d. Take successive measurements of sensor positions along the main line while keeping the meter tape at zero at the buoy shackle (**Figure 8**). Sensor position measurements should be successively increasing as you work down the main line towards the anchor.

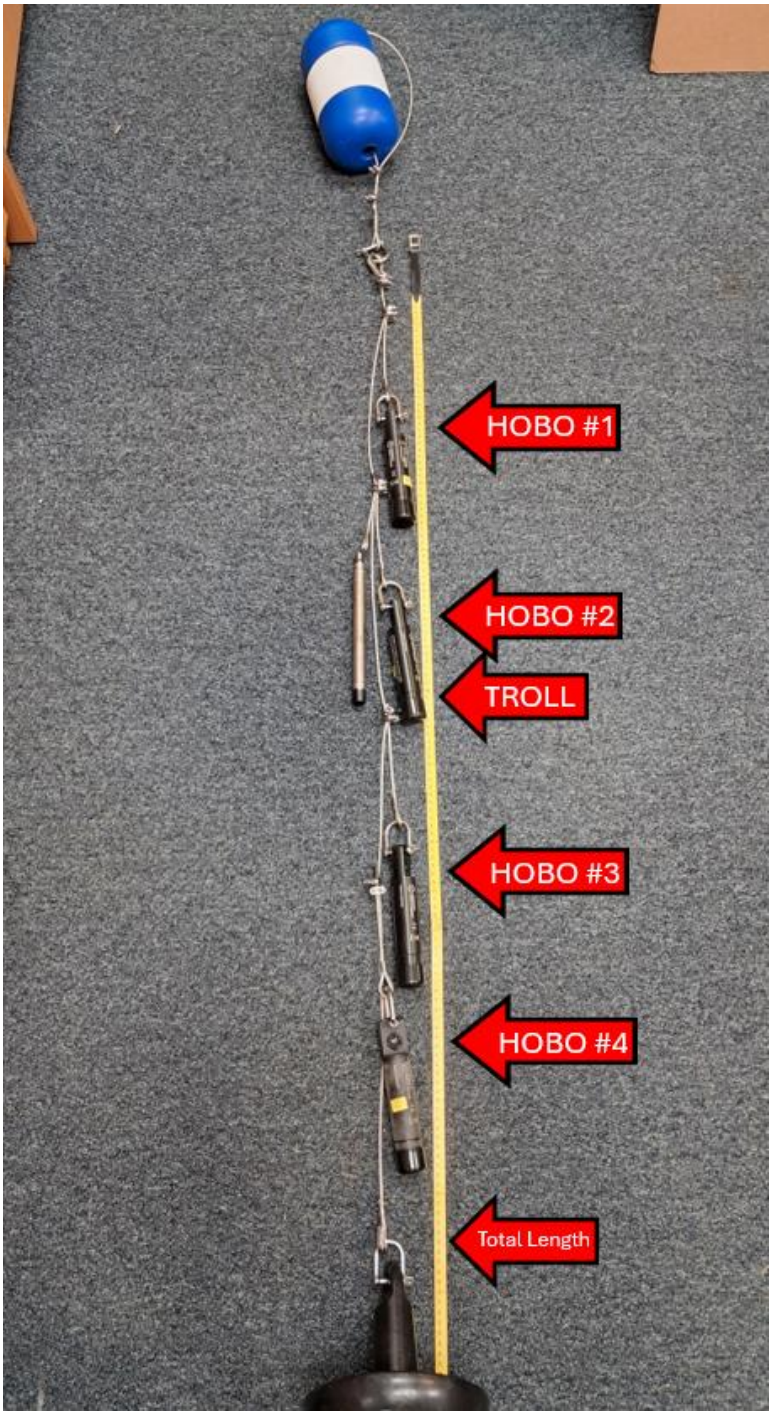

Figure 8. Successive measurements along the main line with Total Length recorded at the top of the shackle connecting to the anchor.

e. Record the total length of the line by measuring to the top of the anchor shackle. If the main line is connected to the anchor via a chain, measure to the top of the anchor. This measurement may be higher on the main line than some sensor position measurements if the site is relatively shallow with a short main line (e.g. D09).

3. Return as close as possible to the previously deployed location, using the platform buoy as a reference and/or GPS coordinates.

   a. The sensor array is usually deployed within 5-10m of the Buoy Temp Chain, but this depends on the site. Too close and the array may get tangled in mooring lines but too far and it will not be in a similar enough location to the buoy temp chain.

   b. Record GPS coordinates in Fulcrum app for future reference.

4. Slowly lower the assembly with logging sensors into location, anchor first, keeping the line taught and ensuring that there are no knots or twists in the line.

5. Record the time, in UTC, that the assembly returned to water and settled in place in Fulcrum application.

6. Verify the approximate depth from the water surface to the top of the float by using a measuring stick or long object such as a rod or boat hook plus measuring tape.

7. Ensure the uppermost part of the float is at a safe depth such that no part would freeze in ice or become unsubmerged with varying water level. Refer to Table 1 for estimated ice depths. D03 buoys should be positioned ~0.5m below the water surface. If adjustments are necessary, proceed with the steps in Section 3.4.1.

8. Sync tablet once all bout information has been completed and sensors returned to the lake.

6 SOURCES

Cortés, A., MacIntyre, S., & Sadro, S. (2017). Flowpath and retention of snowmelt in an ice-covered arctic lake. Limnology and Oceanography, 62(5), 2023-2044.