



Deploying Continuous Sensor Arrays: A Pilot of the Regional Lake Monitoring Network Protocols

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27 March 2019, National Water Quality Monitoring Conference, Denver, CO



Step by Step ppt

Thanks Jen Stamp at Tetra Tech & Brita Bierwagen at EPA!!

RMNIlake_Sensors_20180607_v2 - Saved to Y: Drive

Merrell, Kellie



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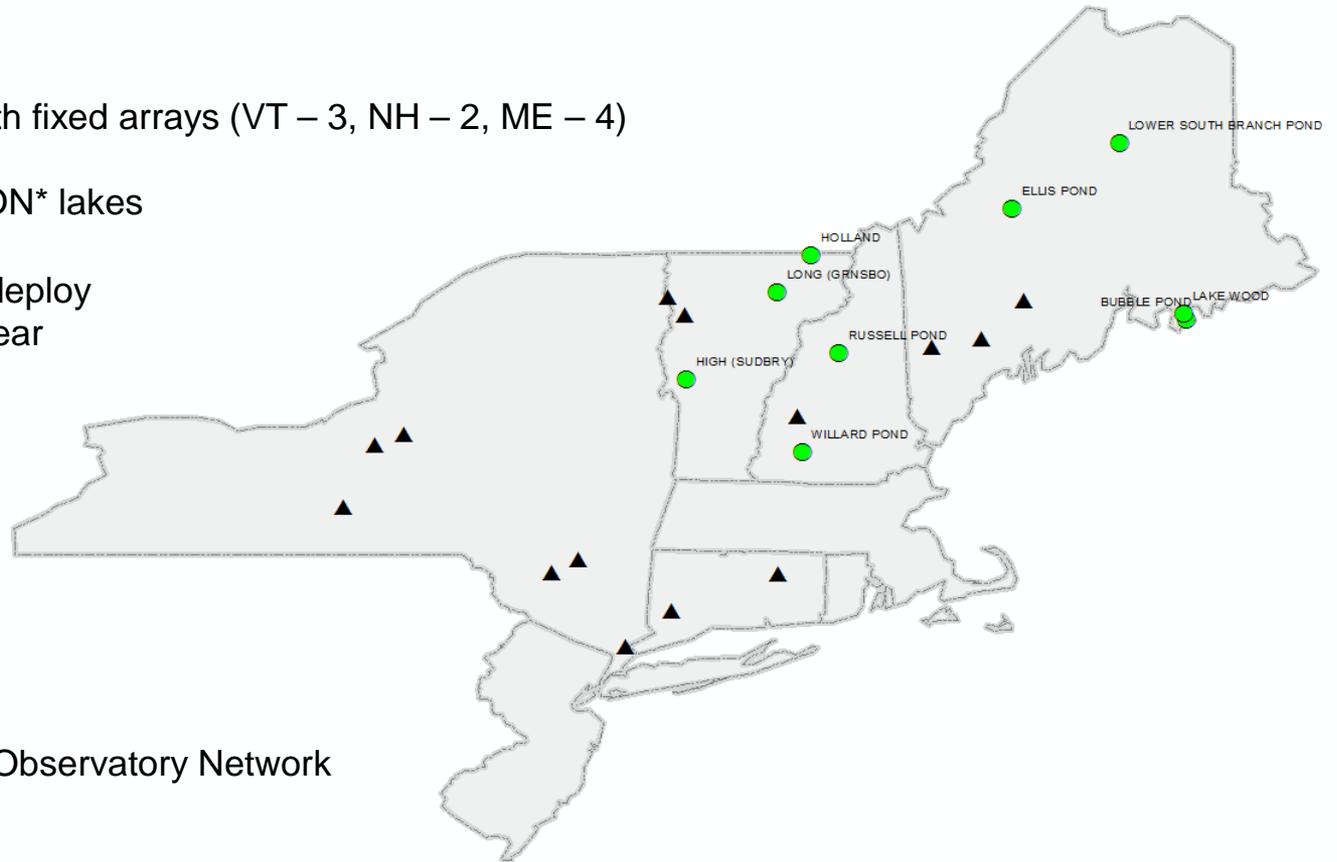
61 62 63 64 65 66

Lakes in the Northeast with continuous sensor arrays (that I'm aware of...)

Green dots = states with fixed arrays (VT – 3, NH – 2, ME – 4)

Black triangles = GLEON* lakes

CT & NJ each plan to deploy arrays at 2 lakes this year



*Global Lake Ecological Observatory Network

Sensors Provisioned by EPA Region 1, Thanks Diane Switzer!



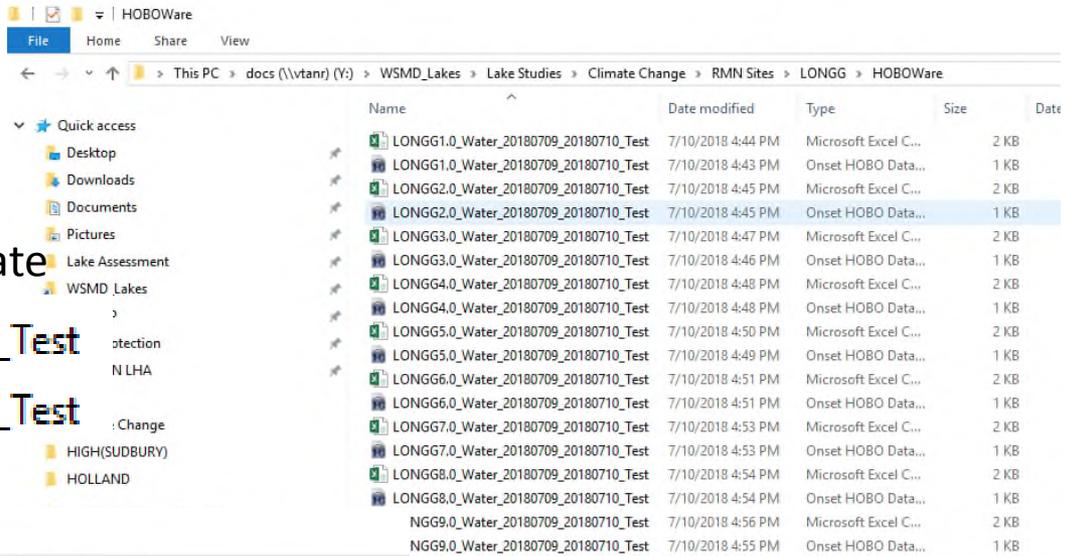
Labeling the temperature sensors



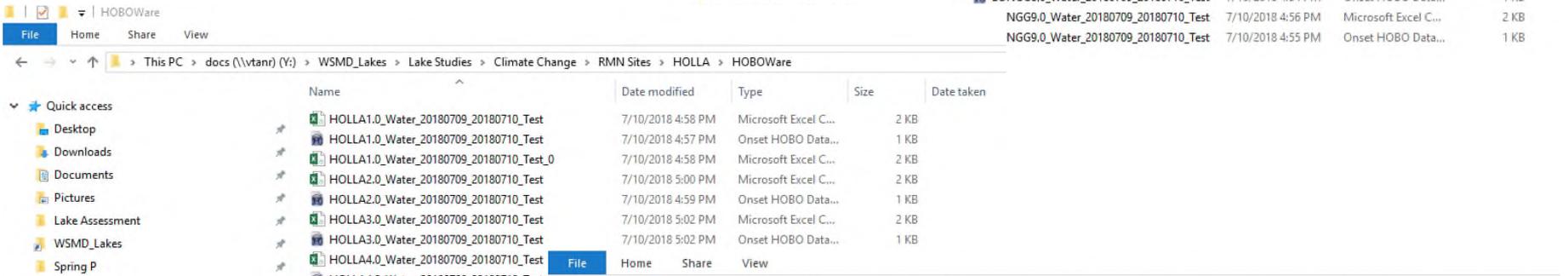
LakeDepth_Water_StartDate_EndDate

 **HIGHS4.0_Water_20180709_20180710_Test**

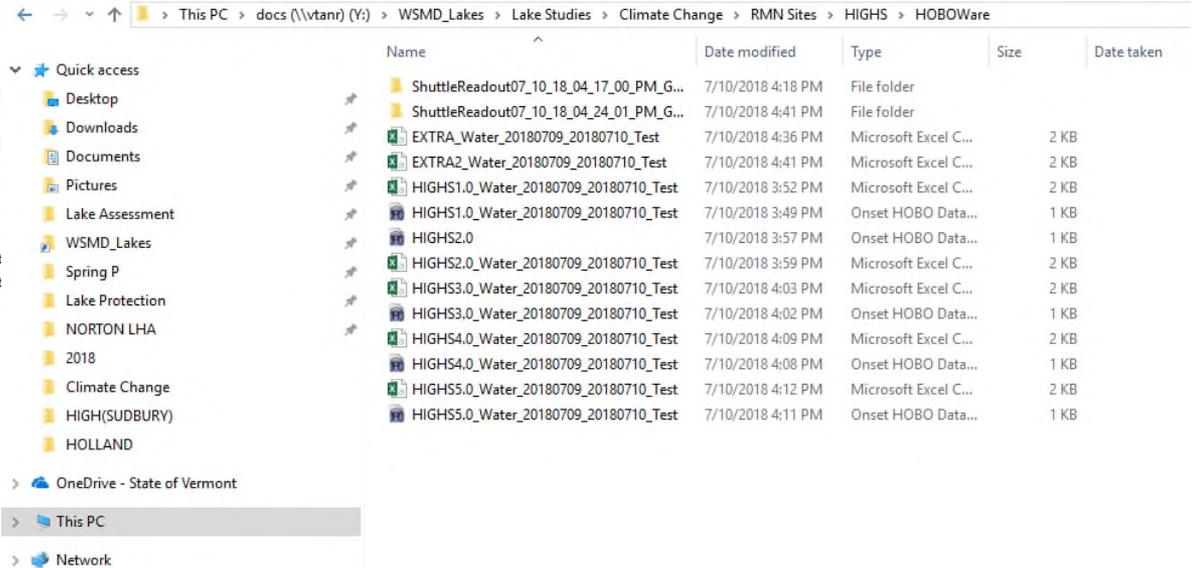
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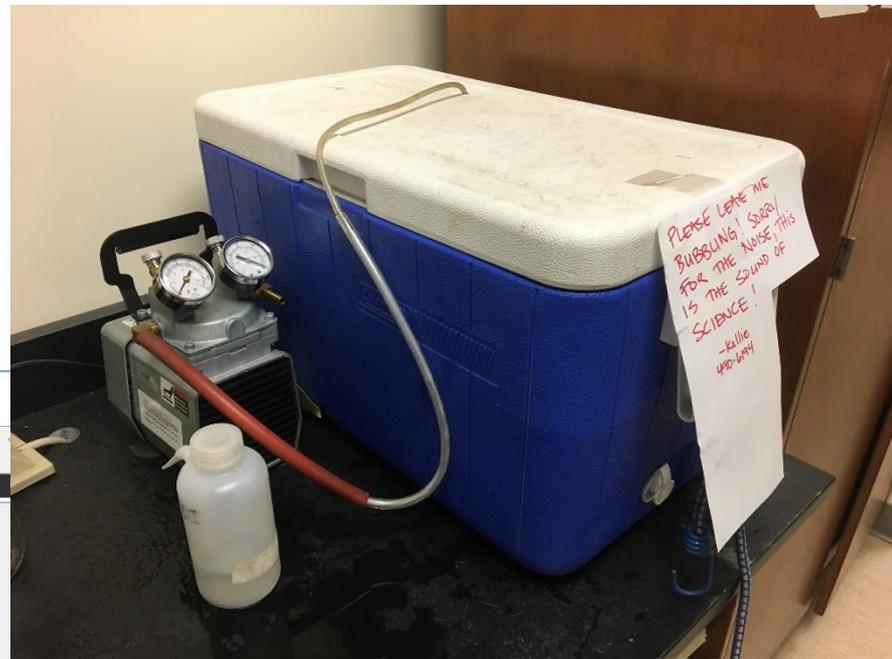


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File Management System BEFORE you deploy

(\\vtanr) (Y:) > WSMD_Lakes > Lake Studies > Climate Change > RMN Sites > LONGG

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 Data2_QC	7/10/2018 3:30 PM	File folder
 Data3_Aggregated	7/10/2018 3:31 PM	File folder
 Data4_Stats	7/10/2018 3:31 PM	File folder
 FieldForms	7/10/2018 3:31 PM	File folder
 HOBOWare	7/10/2018 4:56 PM	File folder
 Photos	7/10/2018 3:32 PM	File folder



HOBOWare Pro

File Device Edit View Tools Window Help

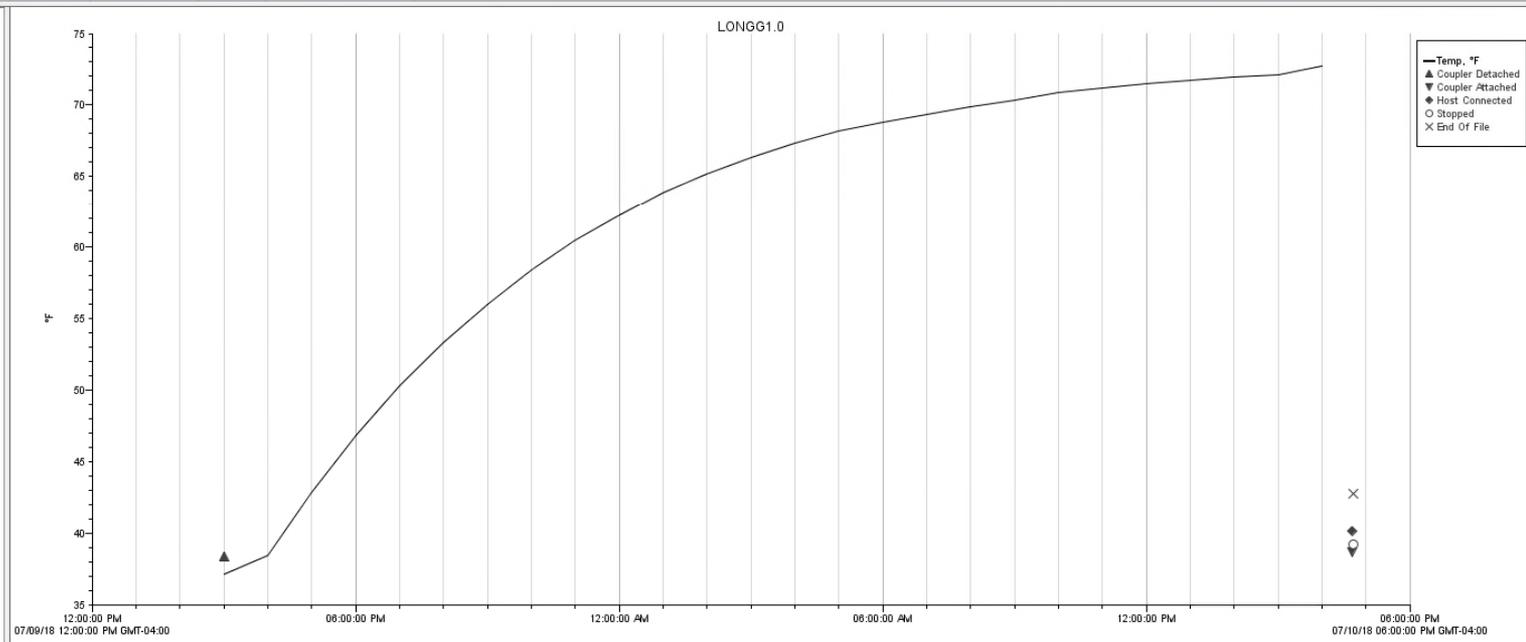
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#	Time, GMT-04:00	Temp, °F	Coupler Detached	Coupler Attached	Host Connected	Stopped	End Of File
1	07/09/18 03:00:00 PM	37.081		Logged			
2	07/09/18 04:00:00 PM	38.464					
3	07/09/18 05:00:00 PM	42.847					
4	07/09/18 06:00:00 PM	46.796					
5	07/09/18 07:00:00 PM	50.268					
6	07/09/18 08:00:00 PM	53.341					
7	07/09/18 09:00:00 PM	56.035					
8	07/09/18 10:00:00 PM	58.411					

Expand All Collapse All

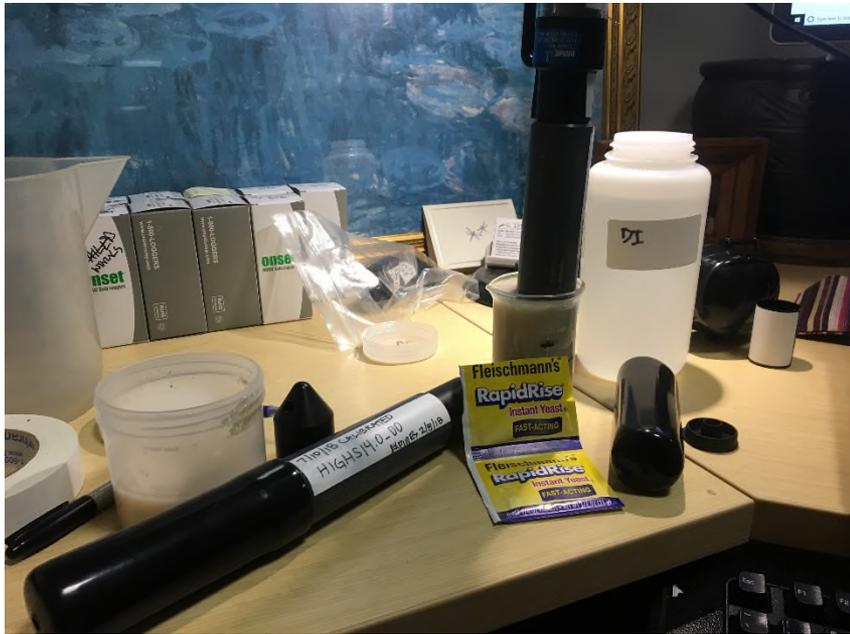
Details

- Series: Temp, °F
- Event Type: Coupler Detached
- Event Type: Coupler Attached
- Event Type: Host Connected
- Event Type: Stopped
- Event Type: End Of File



24 hour test run

The dissolved oxygen sensor





Hamilton Marine Inc
 Hamilton Marine Inc
 JUN 2015



Item No.	Qty.	Unit	Vendor	Description (include catalog & pg. # or webpage)	Vendor Item #	Est Amount	Total Amount
1	1		755615	HMP-DYSTL38&1 DYNA-STEEL FLOATING POT WARP 3/8" 12 THREAD GREEN (36 LBS COIL) https://shop.hamiltonmarine.com/products/dyna-steel-floating-pot-war-green-42725.html		\$73.80	\$73.80
2	8		174534	HML-BUOYS-6X14 LOBSTER BUOY 6X14 SEAMASTER (BY/EA) HML-BUOYS-6X14 https://shop.hamiltonmarine.com/products/lobster-buoy-seamaster-ea-case-42622.html		\$5.85	\$46.80
3	40		730169	HML-TOG-B NET TOGGLE FLOAT BROWN 3 1/4" X 4" X 5/8" HOLE (BY/EA) https://shop.hamiltonmarine.com/products/net-toggle-float-brown-3-1-4-x-4-x-5-8-hole-by-ea-44145.html		\$1.65	\$66.00
4	2		768978	ACT-CT8400 CABLE TIE NYLON 8" BLACK 100 PKG https://shop.hamiltonmarine.com/products/nylon-cable-ties-48596.html		\$6.49	\$12.98
5	4		143612	SD-314175 ANCHOR MUSHROOM BLACK VINYL COATED 15 POUND (BY/EACH) https://shop.hamiltonmarine.com/products/anchor-mushroom-vinyl-coated-black-by-each-43561.html		\$29.99	\$119.96
6	4		107154	DAN-S-0600 ANCHOR STD 9 LB \$600 600LBS HOLDING POWER		\$29.99	\$119.96

Setting up the Sensor Array

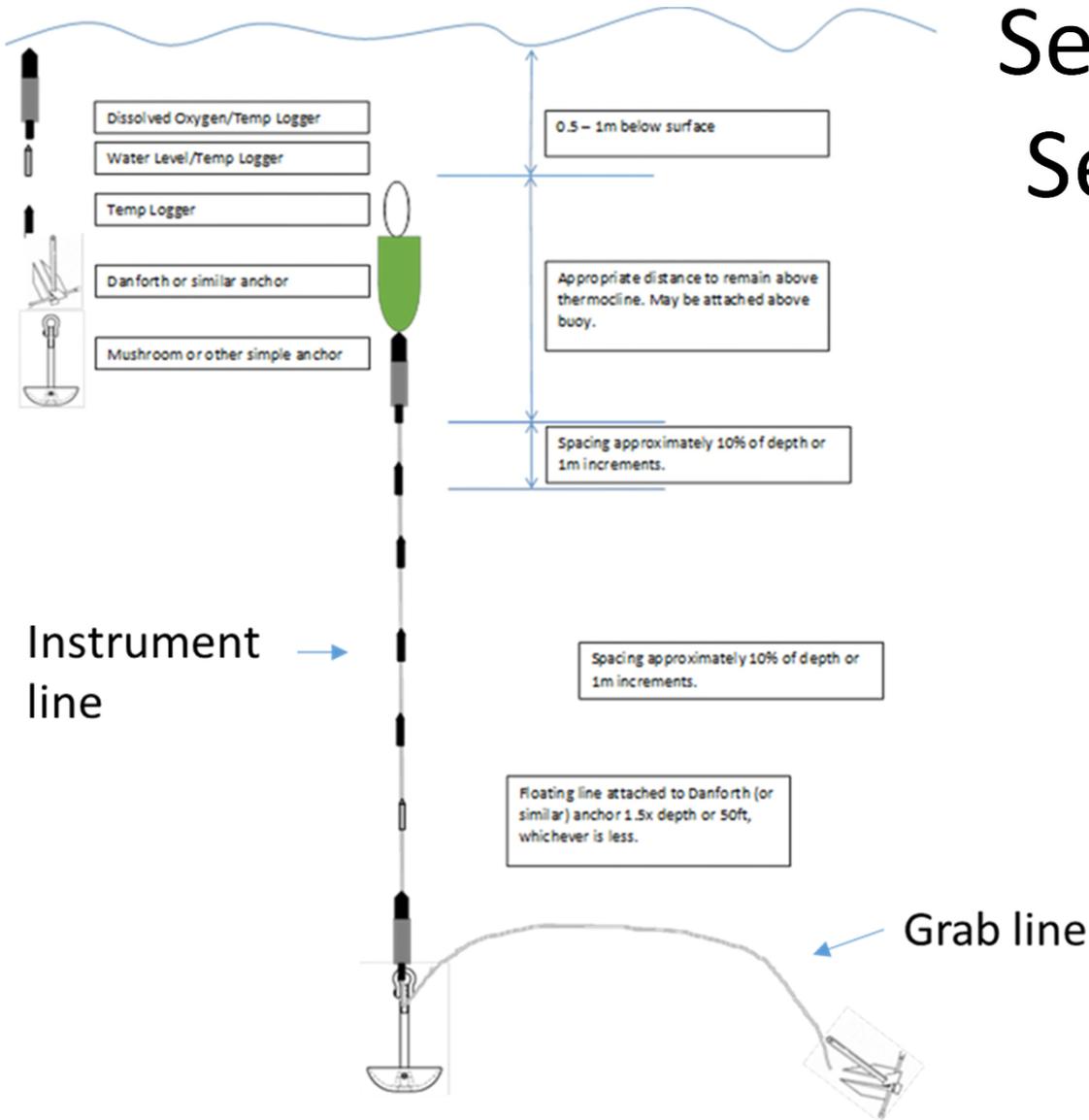


Diagram courtesy of Shane Bowe, Red Lake DNR

Setting up the line





2018 Sensor Deployment & Index Sampling Equipment Checklist

General Field Gear

Canoe or motorboat	Quat bucket with spray
2 Canoe Paddles or 2 Oars	Camera
Labels	2 GPS units with Index Locations loaded
Road Atlas	
6 Extra AA batteries for depth sounder	Clipboard
Cigarette to AC outlet plug for charging Surveyor on route	Tire inflator, emergency tire canister, ratchet set (under driver seat)
2 Life jackets	Boat hook
Depth map and coordinates of deep sites	Pencils
Index site data sheets (Thermocline worksheet, Index Site data sheet)	Sharpies
2 orange tool boxes	Anchor for boat
Come a long, tow rope, shovel, orange saw	Deployment set up with line, buoys, calibrated and programmed sensors, and two anchors
Cooler and ice into ice jug	Dremel tool
Carboy of DI water	2 backpacks if hiking in

Fishing buddy depth sounder	Hand held depth sounder and 4 extra 9V batteries
Integrated sampler with two plugs	Calibrated hydroLab sonde (preferably DSS), tap water, Empty 500ml bottle for DSS DO calibration, cable
Sampling Bottles for index site 4 TP, 4 TN, 1 Alk, 1 Metals, 2 CL, 1 Turb bottles, 1 color, 2 DOC, 2 DOM, 2 Phytoplankton, 4 bacteria Bottles enough to do dup and blank every 10 th sample per parameter for QC	Filter kit for taking extracted chl a check sample (swinex, 60cc syringe, plastic beaker, DI squirt bottle, GFF filters for chl a, 2 forceps)
Integrated sampler and bag	Surveyor to drive hydroLab (download and recharge ea day)

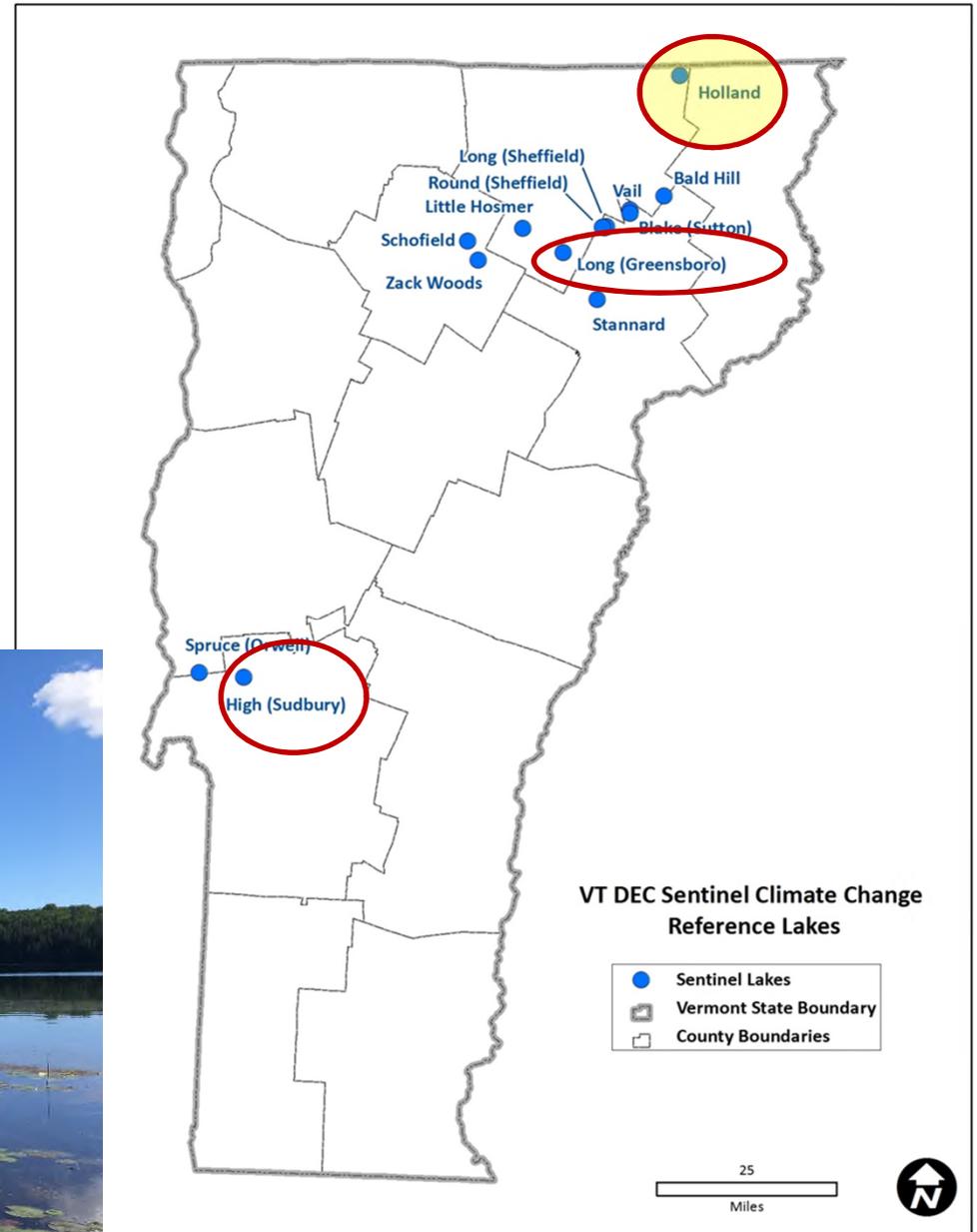
Secchi disk	Barometer on Surveyor and iPhone 6
Bucket to do chl a check in	Kemmerer (unless lake is too shallow)
Aluminum foil	DI water for blanks
Swinex, filters, forceps, syringe	GPS unit with index site and inlets on it and 2 extra AA batteries
DI squirt bottle, plastic beaker	DI in TSS bottle
	Lugols & 2ml pipette for phytoplankton sample

CHECKLIST

1st Deployment

Holland Pond Holland, VT

329 acres, 11.9m deep

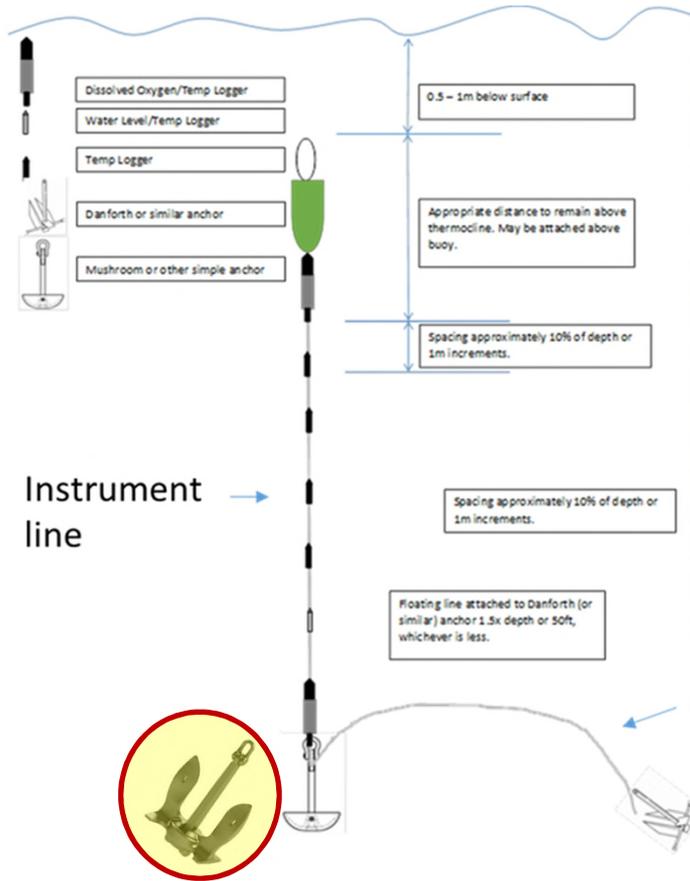




Setting up the line



More weight



Grab line



Hydrolab Profile & Discrete Sampling



Reference Water Level Check

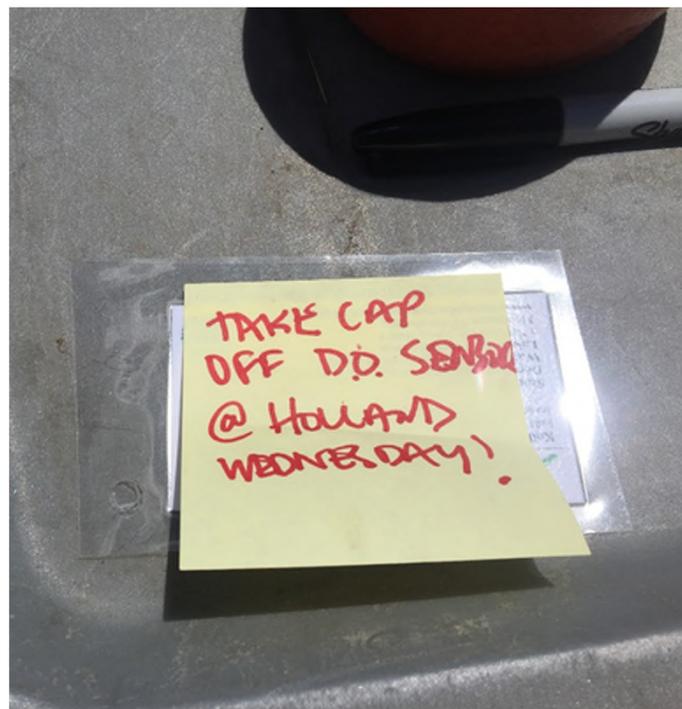
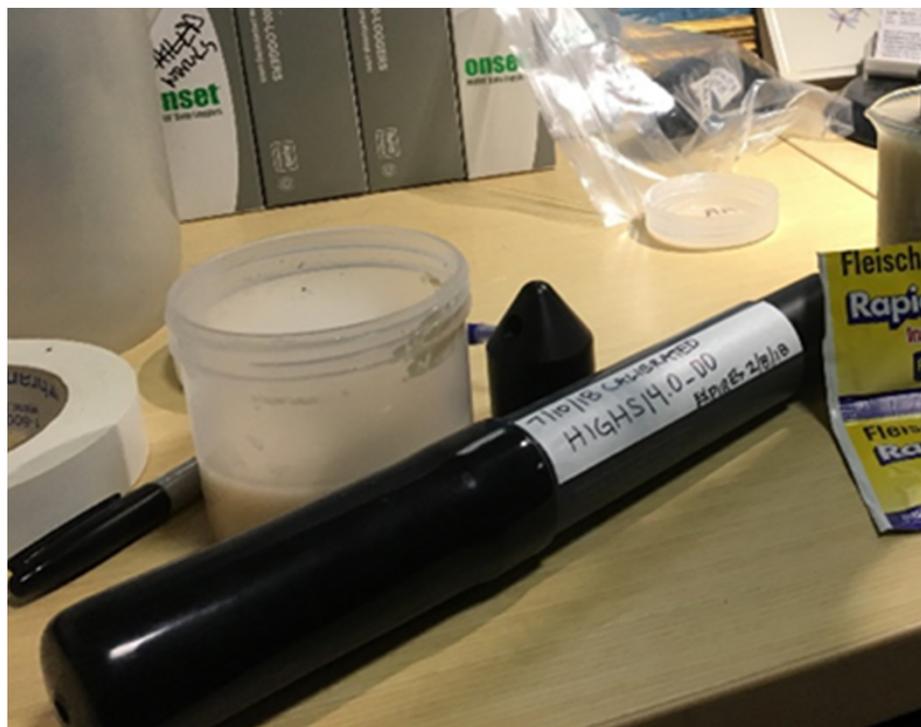


We painted a line
on a rock



Reference sensor for the deployed water level sensor





NARS 2.0 Trial Team 1 week later

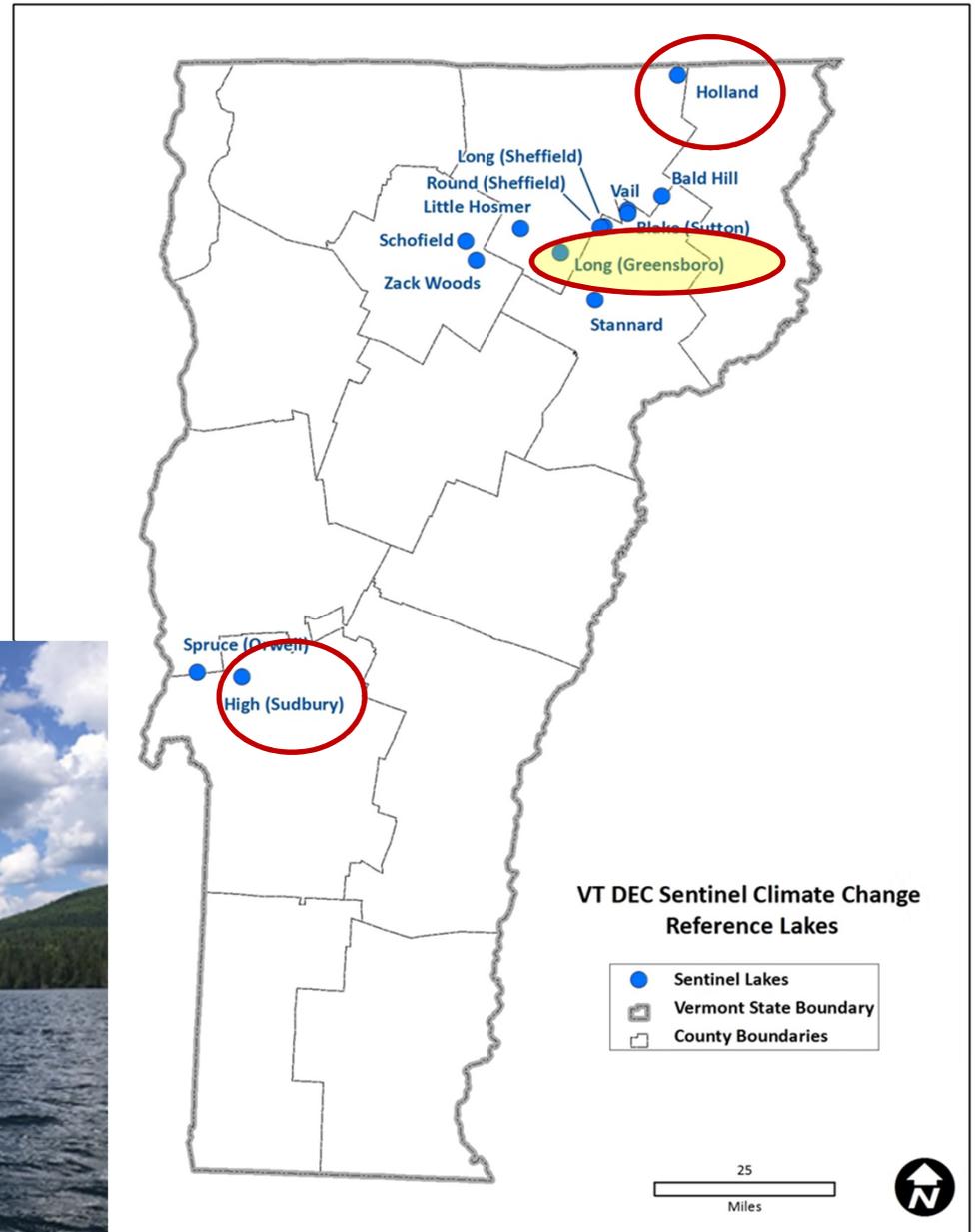


2nd Deployment

Long Pond

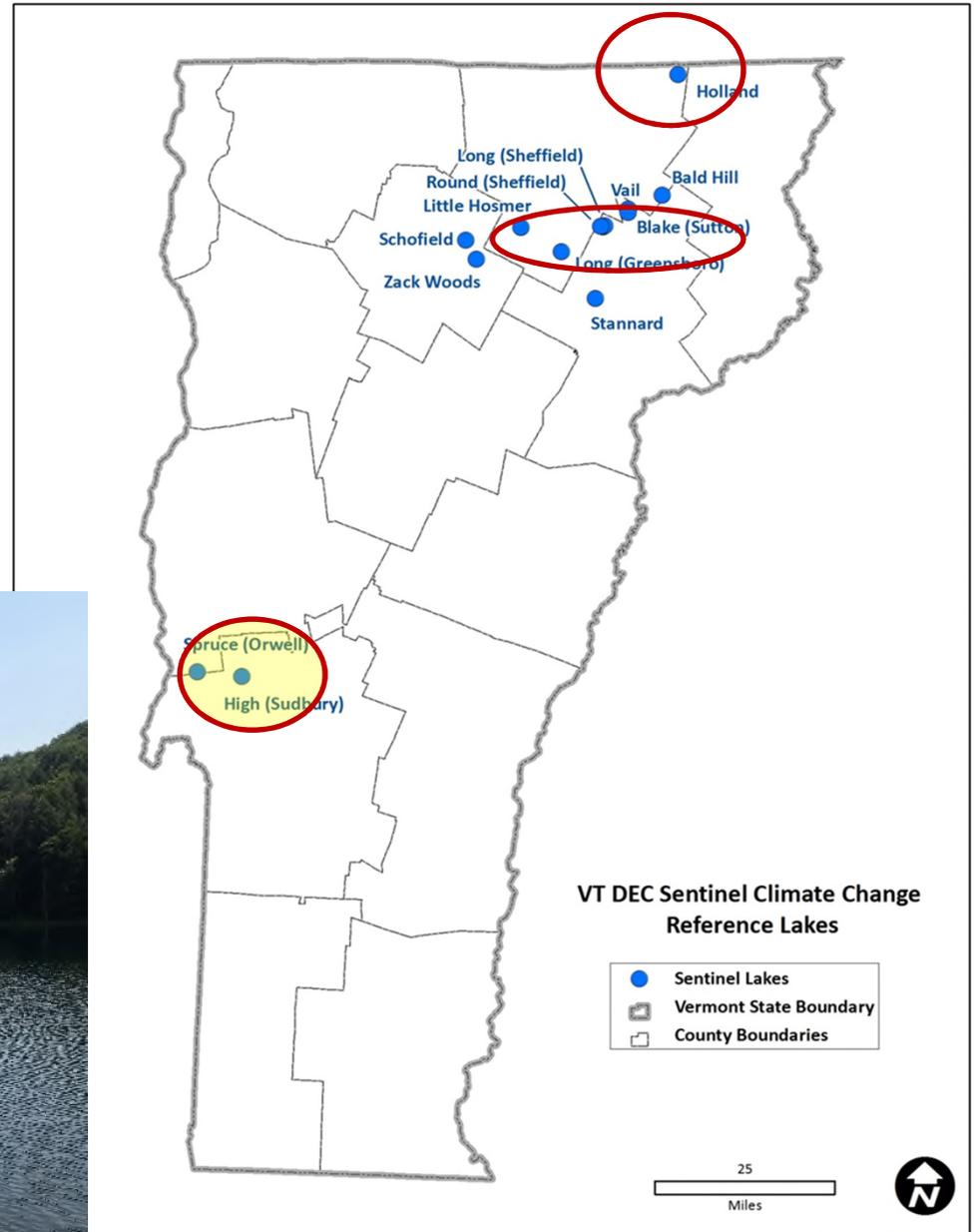
Greensboro, VT

99.4 acres, 10.1m deep

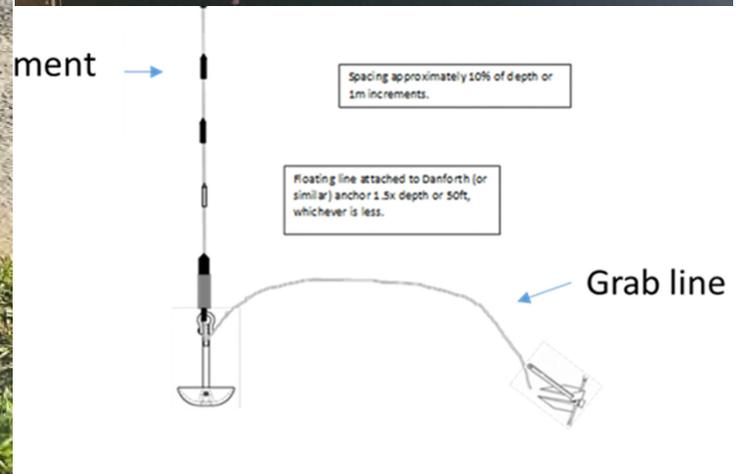
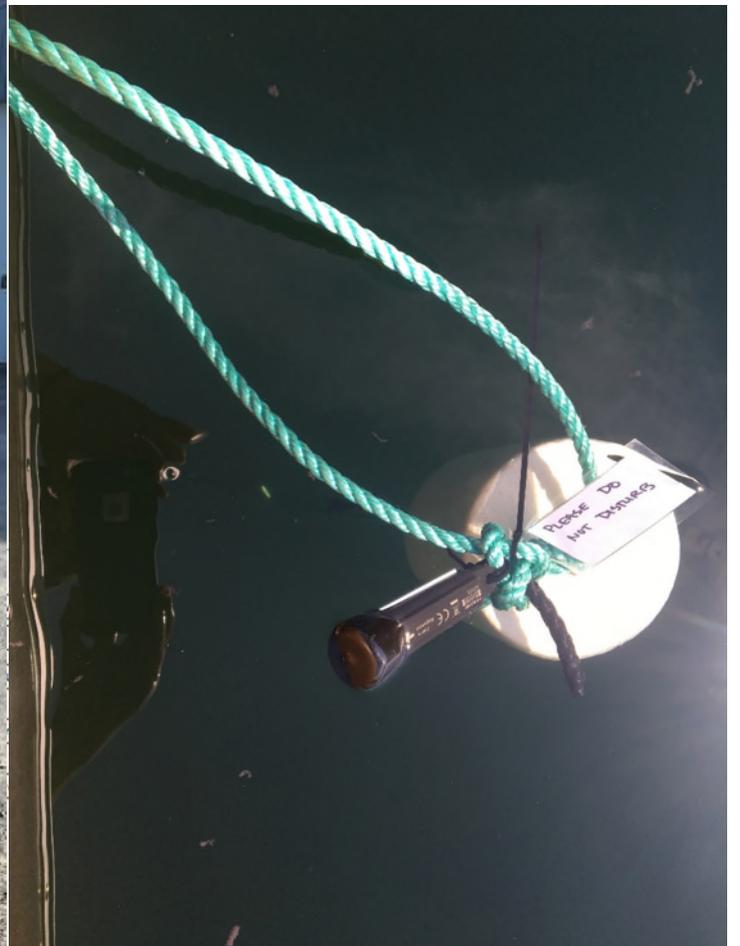




3rd Deployment High Pond, Sudbury, VT 17.5 acres, 17.1 m deep









Vermont winter 2018: Pre-Thanksgiving snowstorm

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 Fullscreen

Justin Barrows of Burlington parked his motorcycle Thursday night, only to wake up Friday morning, Nov. 16, 2018, to find it covered in. "The season's over," he chuckled, as he warmed it up to move it to its winter storage space as a winter storm moved into Vermont, promising up to a foot of snow or more in some areas. RYAN MERCER/FREE PRESS





1m below
the surface



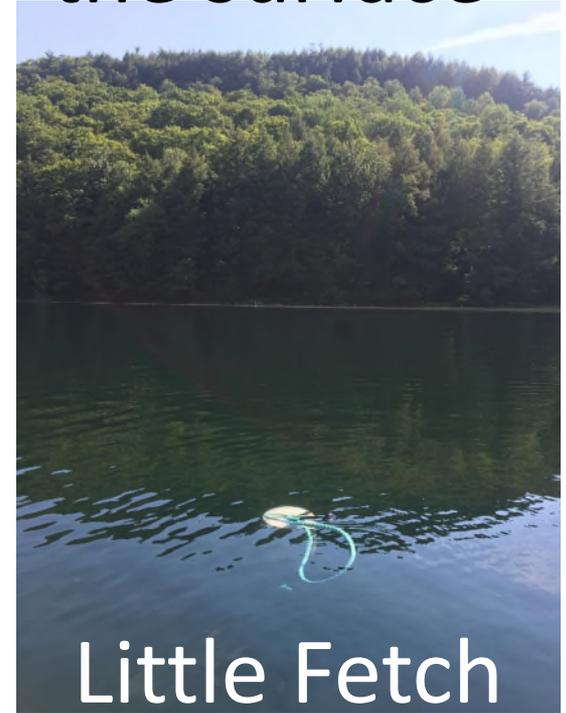
Big Fetch

Floating on
the surface



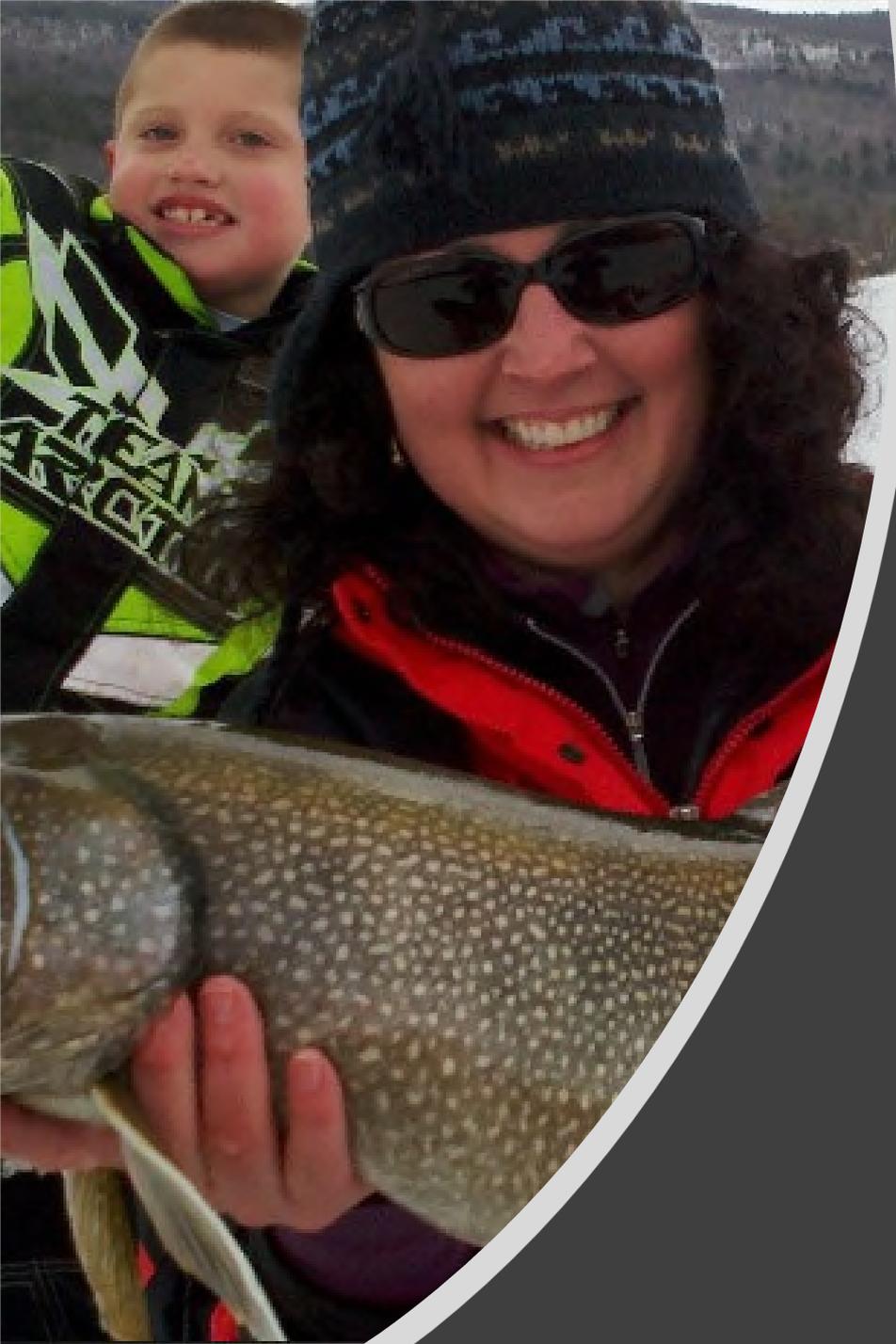
Big Fetch

Just below
the surface



Little Fetch

Which configuration will Survive
a Vermont Winter?



New Hampshire Lakes RMN Program

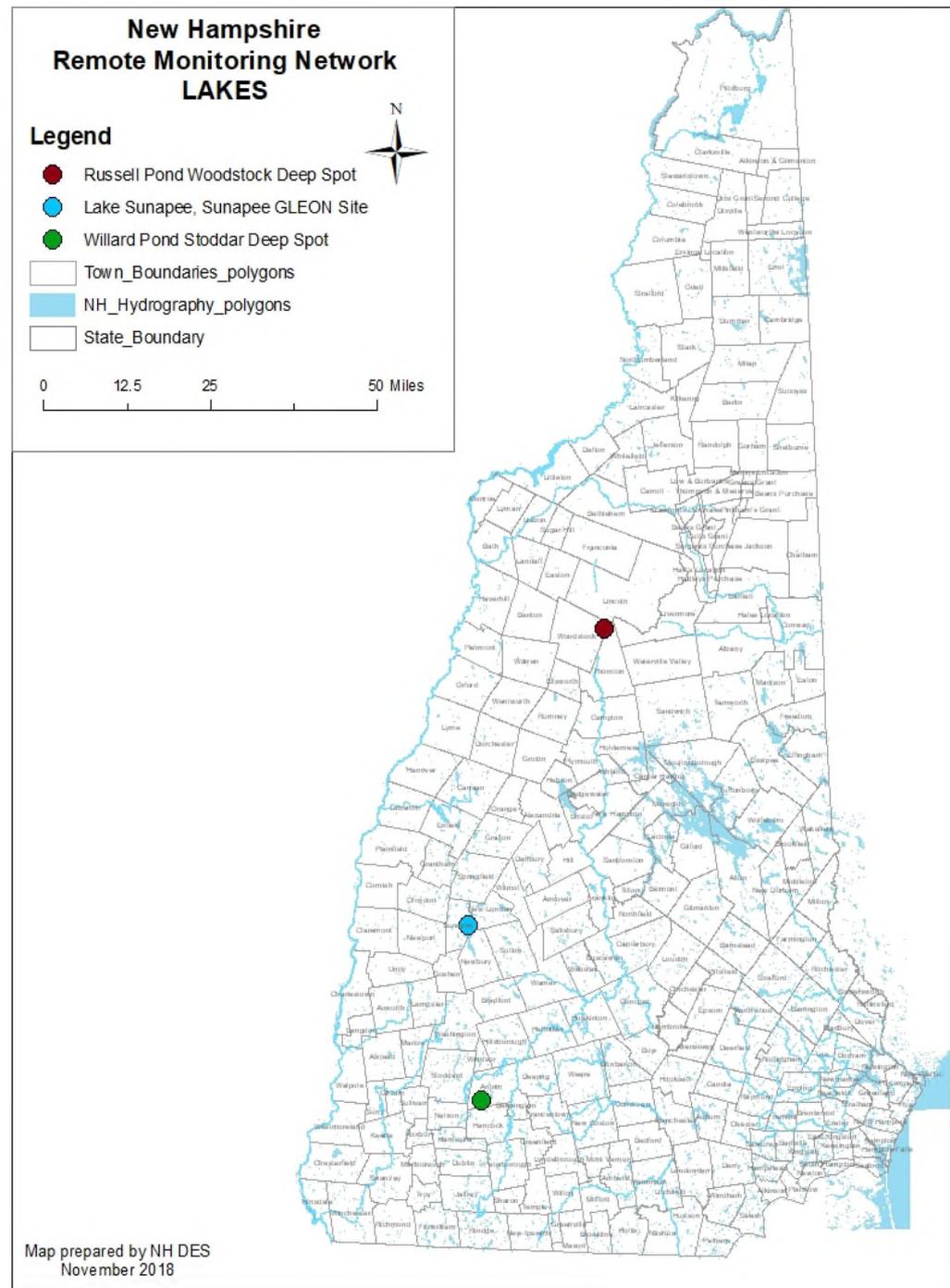
Contact:

Amy Smagula, Limnologist

NH Department of Environmental
Services

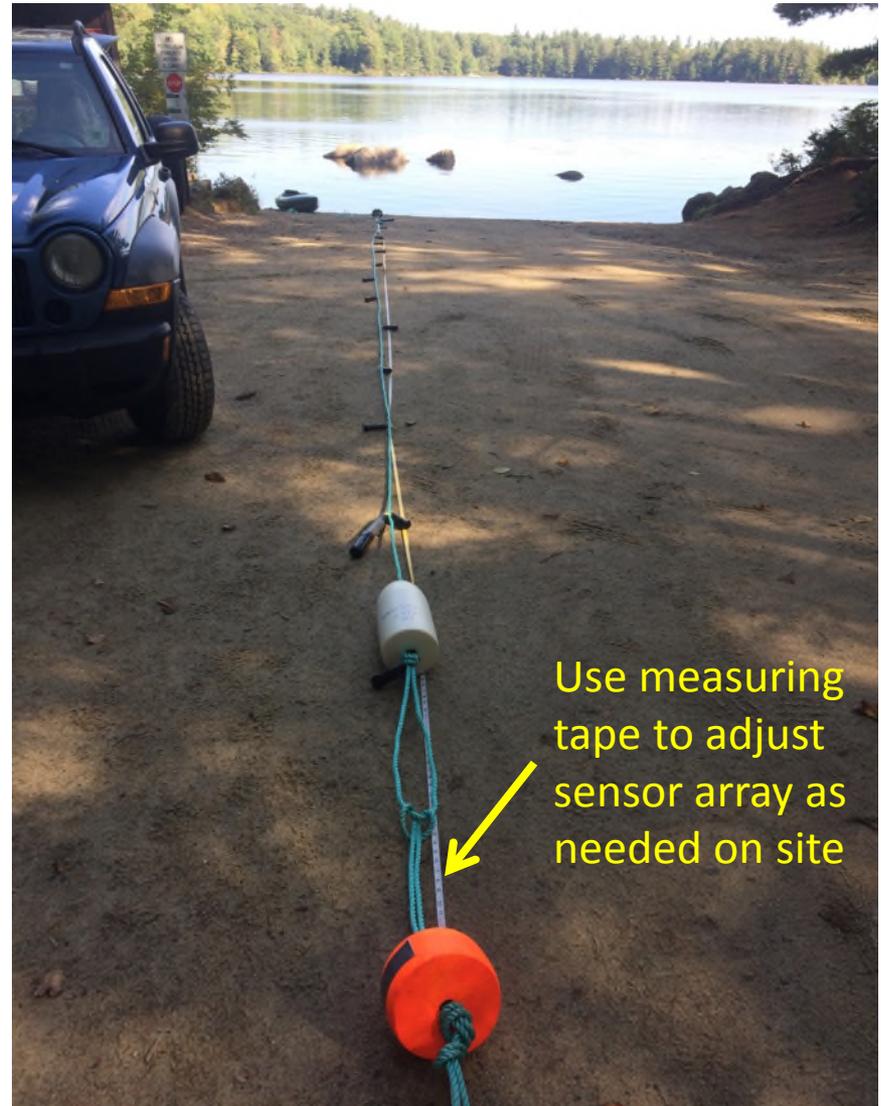
New Hampshire Lakes RMN Program

- Lakes RMN program initiated in 2018, like our neighboring states
- Three waterbodies selected
 - Willard Pond, Stoddard/Antrim
 - Deployed 9/18/18 during NLA reference lake survey
 - Russell Pond, Woodstock
 - Deployed 10/9/18, a few weeks after an NLA reference lake survey
 - Lake Sunapee, Sunapee
 - Established GLEON site (we are mooching data from here)



Array Set-Up Tips, cont.

- At lake on day of deployment, sound bottom with a measured tape and the same anchor to be used for sensor array (to account for thick sediments/sinkage/etc)
- Use that sounded depth measurement to adjust fixed sensor array as needed based on actual depth of lake. Just line up the tape with your array and adjust as needed
- To adjust for depth while on shore at lake, use extra rope at bottom of array to adjust so top buoy/float is set at 1m from surface when deployed, based on sounding just done on waterbody





Temp sensors set at every meter, DO sensors affixed at 2m from surface and 2m from bottom, pressure sensor affixed towards bottom of array

This lobster float is set at 1m and serves to support the fixed sensor array in the water column

Buoy floats on surface of lake, temp sensor affixed at bottom of buoy at 0.1m depth

Fixed sensor array was fed into a bin for holding until deployment, fed in starting with top buoy and loosely piled so that deeper sensors at top of pile, connected outside to weight. This helped keep things tidy on the boat.



Extra anchor (wasn't needed)

Grapple line wrapped around bin of lid to keep it tidy with those small buoys

Weight for fixed sensor array, attached and ready.

Weight for grapple line



Sensor array line

Both connected to
sensor array weight

Grapple line

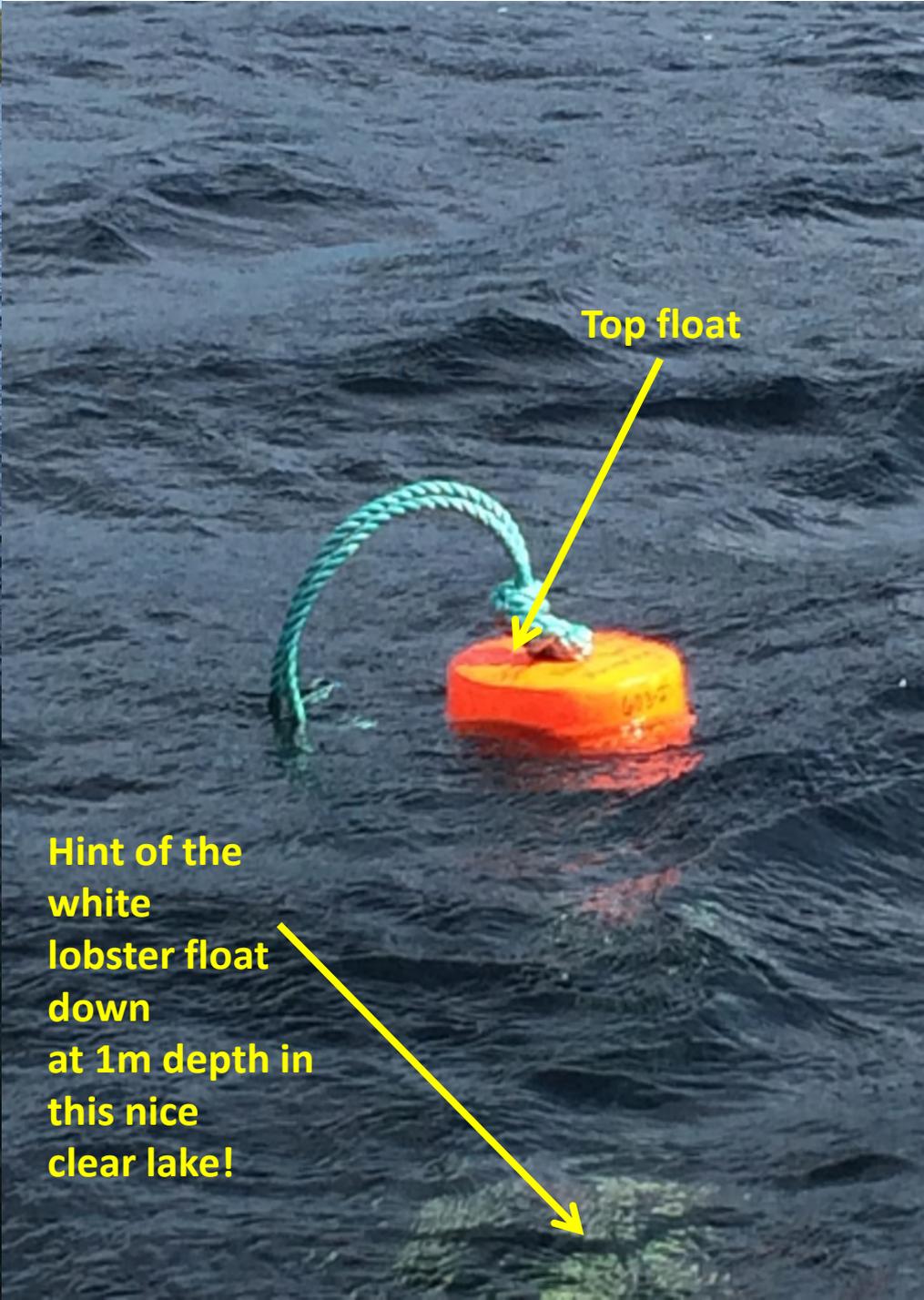


Deploying sensor array from bin where it was stored

Deploying grapple line as sensor array is fed into lake

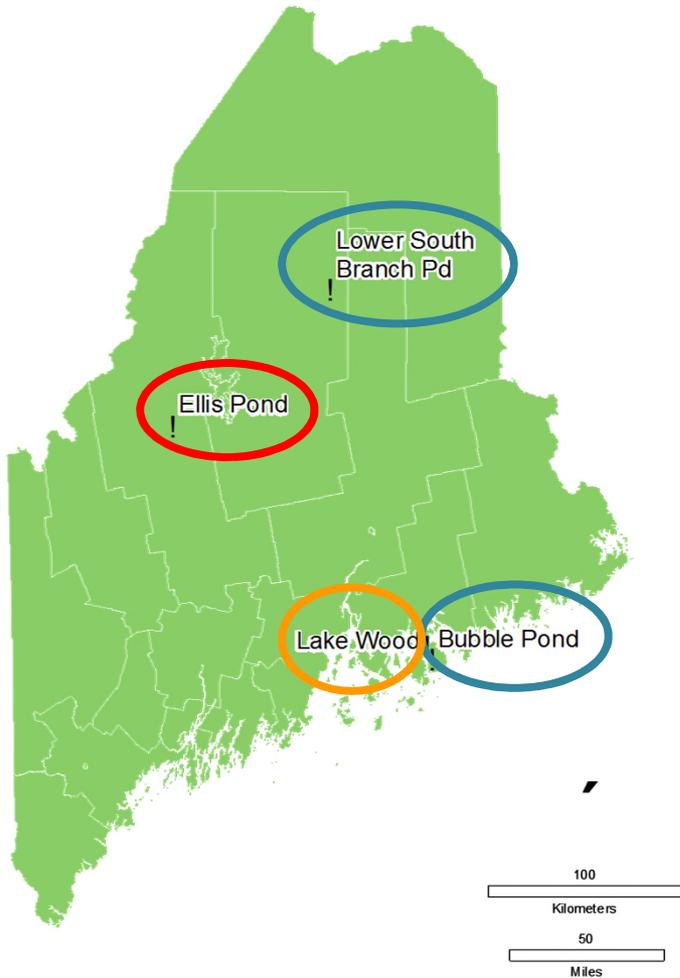


Last little bit!



Top float

Hint of the white lobster float down at 1m depth in this nice clear lake!



SDT ≥ 5 m, Depth 9-30 m,
● Reference

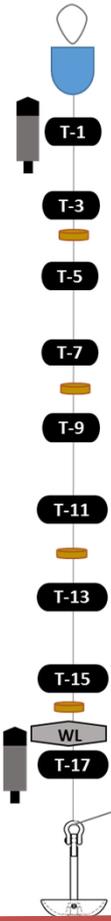
Depth 1-5m,
● Reference

Color ≥ 30 , Depth ≥ 5 ,
● Reference

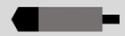
Lake Surface



DO Sensors
(2 zip ties
each – keep
vertical)



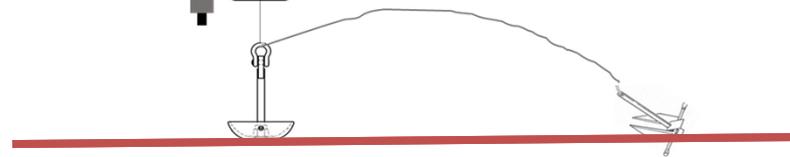
Top of loop:
minimum 0.5 m
below surface

 T-1	Temperature Logger – depth (m)
	Float
 WL	Water level Logger
	DO Logger

Lower South Branch Pond

Max depth: 18 m

Lake Bottom



June 2018







Nov. 2018







Lower South Branch Pond Water Temperature - 2018

