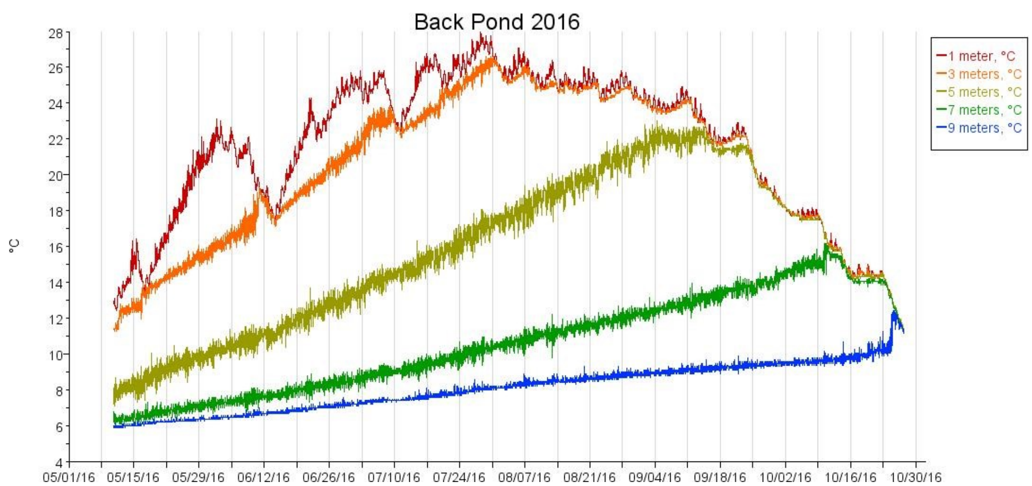
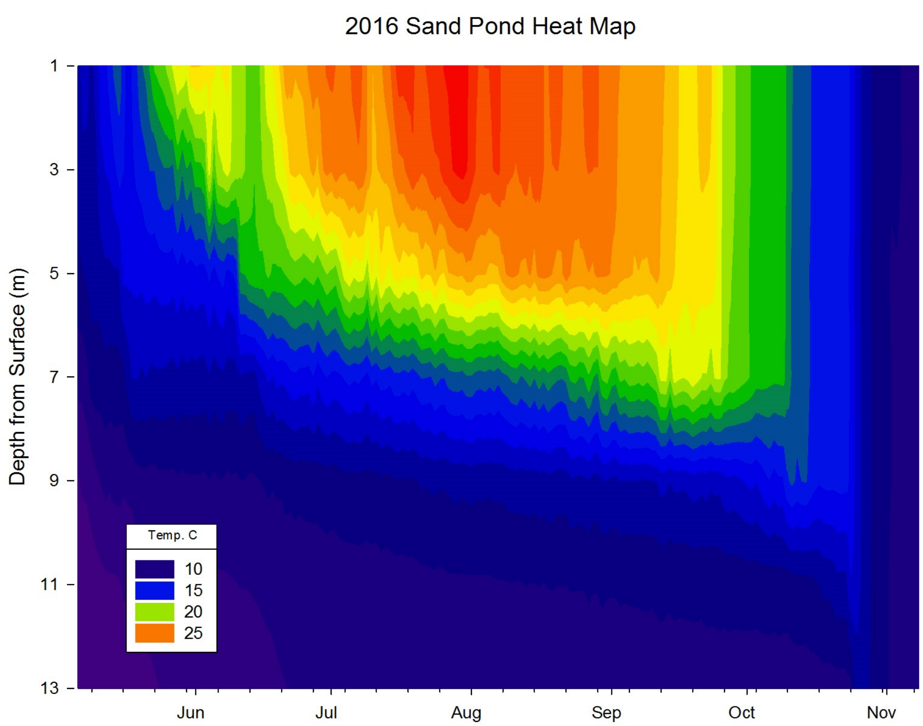
2016 Temperature Monitoring Project Report

February 17, 2017





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Project Summary

LEA began using in-lake data loggers to acquire high resolution temperature measurements in 2013. The effort was expanded in 2014 to include 15 basins on 12 lakes and ponds in the Lakes Region of Western Maine and since then three more deep-water strings have been added, two in 2015 and one in 2016. The loggers, which are also interchangeably referred to as HOBO sensors, temperature sensors, or thermistors, provide both a more detailed and longer record of temperature fluctuations over time. The goal is to capture the entire stratified period within the temperature record, from when stratification begins to form in the spring to when the lake mixes in the fall. This information allows for a better understanding of the structure, water quality, and extent and impact of climate change on the waterbody tested.

In 2016, the sensors recorded temperature readings from April/May to October/November in most lakes. Most of the lakes tested reached their maximum temperature between July 28th and 30th. Surface temperature patterns were similar across all basins. Weather patterns greatly influenced lake temperatures through heavy winds in May and June, changes in air temperature affecting surface water temperatures, and drought conditions altering stratification depth. The date of complete lake mixing varied considerably, with shallower lakes destratifying in September and others not fully mixed until November. While weather effects were similar between lakes due to their geographical proximity, the magnitude of response to weather drivers varied considerably. This is largely due to differences in lake characteristics such as size, shape, and depth. A comparison with routine water testing data confirmed the accuracy of the HOBO sensors throughout the season.

In addition to summer deep-water stratification monitoring, a complete temperature record from May 2015 to November 2016 was collected from Highland Lake using data from a remote sensing buoy and HOBO sensors. Shallow (littoral zone) temperature sensor data from the last four years has also been collected from Peabody Pond.

Deployment of temperature sensors on Trickey Pond

Introduction and Background

Temperature is critical to the biological function of lakes as well as the regulation of chemical processes. Lake stratification is especially important to assessing lake water quality. Temperature sensors can be used to study the impacts of lake morphology on temperature patterns and with data over several years, the effects of climate change can be monitored. In order to get a better idea of temperature patterns in and between lakes, LEA began monitoring lake temperature using in-lake digital data loggers in 2013. These loggers, also known as HOBO sensors, are programmed to record temperature readings every 15 minutes. The sensors are deployed in the spring and the data is stored on the sensors until they are retrieved in the mid to late fall.

LEA serves six towns in western Maine, providing comprehensive lake monitoring for 40 lakes and ponds. This comprehensive testing includes measurements of temperature profiles using a handheld YSI meter. However, this method is time consuming, resulting in at best 8 temperature profiles per year. While temperature sensors require an initial time investment, once deployed, the sensors record over 15,000 profiles before they are removed in the fall.

The data collected by these temperature sensors provides much greater detail and clarity than the traditional method ever could.

This wealth of data provides much greater detail and clarity than the traditional method ever could. Daily temperature fluctuations, brief mixing events caused by storms, the date and time of stratification set up and breakdown, and the timing of seasonal high temperatures are all valuable and informative events that traditional sampling can't accurately measure.

During the first season of testing in 2013, four basins on three lakes (Highland Lake, Moose Pond, and 2 sites on Long Lake) contained sensors at 2 meter intervals from near the surface of each lake to its deepest point. Nine additional lakes contained one sensor in a shallow area. For the second season of testing in 2014, thirteen basins at ten lakes and ponds contained sensors measuring the entire water column. Three additional sensors measured shallow temperature on two ponds. The locations of deep water sensors were clearly marked by regulatory-style buoys starting in 2014. The 2015 setup was similar to 2014, with two strings of sensors added—one in Keyes Pond and another in the south basin of Long Lake, and a few changes to shallow temperature sensor placement. In 2016, a deep sensor chain was added on Peabody Pond, which was also home to the only shallow sensor deployed that year (see figure 1 and table 1).

Lake Stratification

Most of the lakes LEA tests become stratified in the summer. This means that the lake separates into distinct layers – the epilimnion, metalimnion and hypolimnion – based on temperature and water density. The top layer, the epilimnion, is the warmest. Somewhere in the middle is a region where the temperature and density change rapidly. This is known as the metalimnion and it defines the location of the thermocline. The hypolimnion contains the coldest water and reaches from the bottom of the metalimnion to the bottom of the lake.

Each lake's stratification is unique and is affected by weather, as well as the lake's size, depth, and shape. Stratification sets up in the spring and breaks down in the fall. "Lake turnover" refers to the destratification of a lake, when the water completely mixes and the temperature becomes uniform from top to bottom.

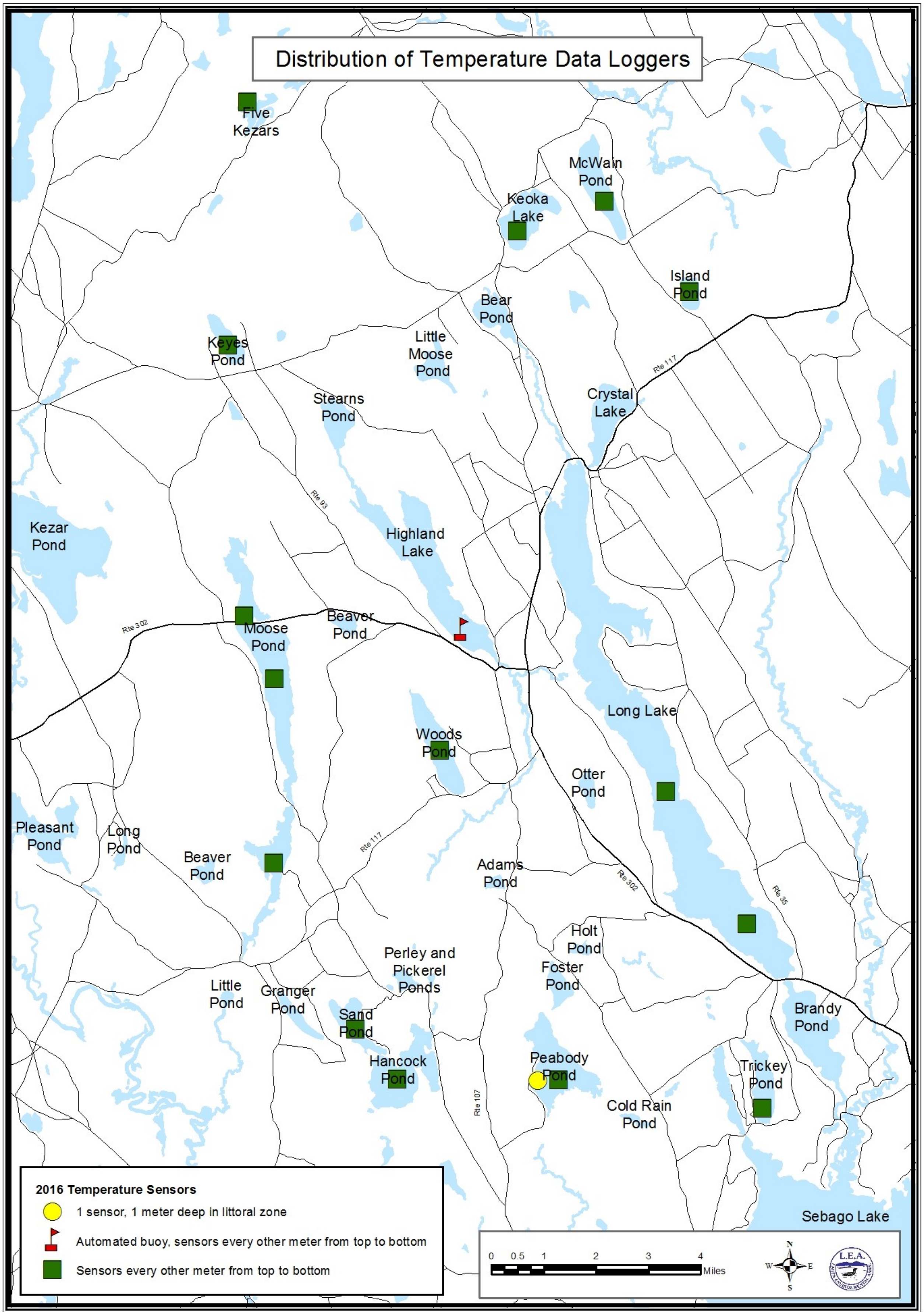


Figure 1. Map of temperature sensor sites within the Lakes Region of Western Maine. Yellow circles indicate shallow sensor placement; green squares show the location of multi-sensor temperature buoys. The red icon shows the location of our automated testing buoy on Highland Lake.

Sampling Methods

Sixteen sites on twelve lakes and ponds were outfitted with a regulatory-style buoy attached by rope to an anchor (figure 2). The HOBO sensors (figure 3) were attached to the line at 2 meter intervals, beginning 1 meter from the bottom and ending approximately 1 meter from the top. Each buoy apparatus was deployed at the deepest point of the basin it monitored. The setup results in the sensors being located at odd numbered depths throughout the water column (the shallowest sensor is approximately 1 meter deep, the next is 3 meters, etc.).

Peabody Pond also contained a temperature sensor located in a shallow area of the lake.

Temperature sensors were deployed between April 25th and June 30, 2016 and collected between October 26th and November 8, 2016.

Additionally, Highland Lake, which has a remote-sensing buoy that measures temperature similarly to the HOBO sensors, contained a string of temperature sensors marked by a small mooring buoy over the winter of 2015-2016 while the remote-sensing buoy was in winter storage. This allows for nearly uninterrupted temperature readings on Highland Lake.

Each sensor was configured to take temperature readings at 15 minute intervals. This results in 96 readings from each sensor every day, and thousands of readings during the course of deployment.

Table 1. Details of HOBO temperature data logger deployment, including lake/pond name, location of sensor string, type of deployment, and number of sensors per string.

Name	Midas #	Location	Type	# sensors
Back Pond	3199	Main basin	Deep	5
Hancock Pond	3132	Main basin	Deep	9
Island Pond	3448	Main basin	Deep	6
Keoka Lake	3416	Main basin	Deep	6
Keyes Pond	3232	Main basin	Deep	6
Long Lake	5780	North basin	Deep	8
Long Lake	5780	Middle basin	Deep	8
Long Lake	5780	South basin	Deep	8
McWain Pond	3418	Main basin	Deep	6
Moose Pond	3134	North basin	Deep	3
Moose Pond	3134	Main basin	Deep	11
Moose Pond	3134	South basin	Deep	5
Peabody Pond	3374	Main Basin/ West Shore	Deep/Shallow	9 / 1
Sand Pond	3130	Main basin	Deep	7
Trickey Pond	3382	Main basin	Deep	9
Woods Pond	3456	Main basin	Deep	4

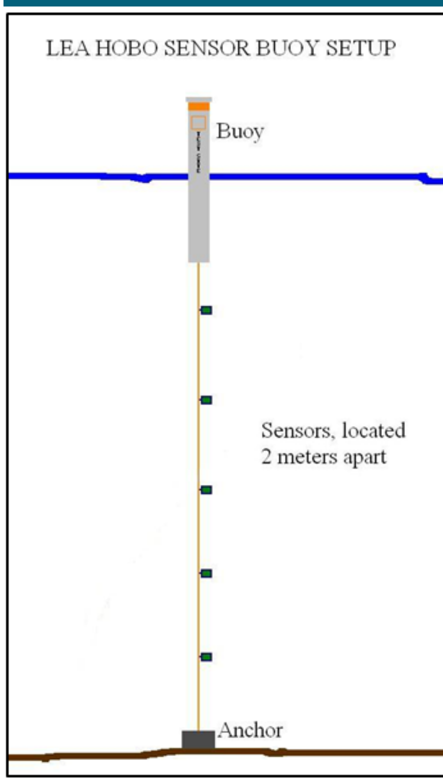


Figure 2. (Left) Diagram showing the buoy apparatus with temperature sensors attached.

Figure 3. (Below) A HOBO temperature sensor.

Results and Discussion

General Patterns in 2016

Ice-out, the date when a lake becomes ice-free, occurred on most lakes around the end of March, which is much earlier in the spring than the historical average. However, cold temperatures in April and May delayed the onset of stratification, so that it was only beginning to set up when most sensors were deployed in late April and early May. In many ponds, high winds in mid-May disrupted stratification set up. After that, warmer air temperatures fueled the thermal separation of lake water, causing the water closest to the surface to warm more quickly than the deeper waters.

Individual reports for each lake can be found in LEA's 2016 Water Testing Report on our website, www.mainelakes.org

Sustained high winds coupled with cooler temperatures in mid-June again disrupted stratification, in some lakes completely mixing the water and "resetting" stratification completely. Bottom temperatures rose at least slightly in most lakes due to this mixing, which may have led to earlier fall turnover in some basins. Each lake quickly stratified again after the heavy winds subsided.

The peak in temperature occurred between July 27th and 30th in almost all of the lakes (Table 2 on page 8). This timing was slightly later than in 2013 and 2014, but much earlier than in 2015. The timing of this peak is determined by air temperature patterns. Most lakes began to mix in mid- to late August as air temperatures cooled. The date of lake turnover (complete mixing) occurred between September and November depending on the basin (Table 3 on page 14).

Figure 4 on the next page points out the general patterns seen on most lakes in 2016. The same overall pattern in surface water temperatures is seen on each basin because of the strong influence of regional weather on this parameter (see figure 5). For example, each of the basins shows a dip in surface temperature around July 10th, which corresponds to a few days of cooler air temperatures on and preceding that date. While air temperature is the main driver of water temperature, the features of the basin itself—its size, depth, and shape—will impact the extent to which lakes are affected by events such as the wind storms in May and June and the timing of lake turnover.

For detailed reports on individual lakes' temperature data, please refer to LEA's 2016 Water Testing Report, which can be found at our website, www.mainelakes.org.

Results and Discussion

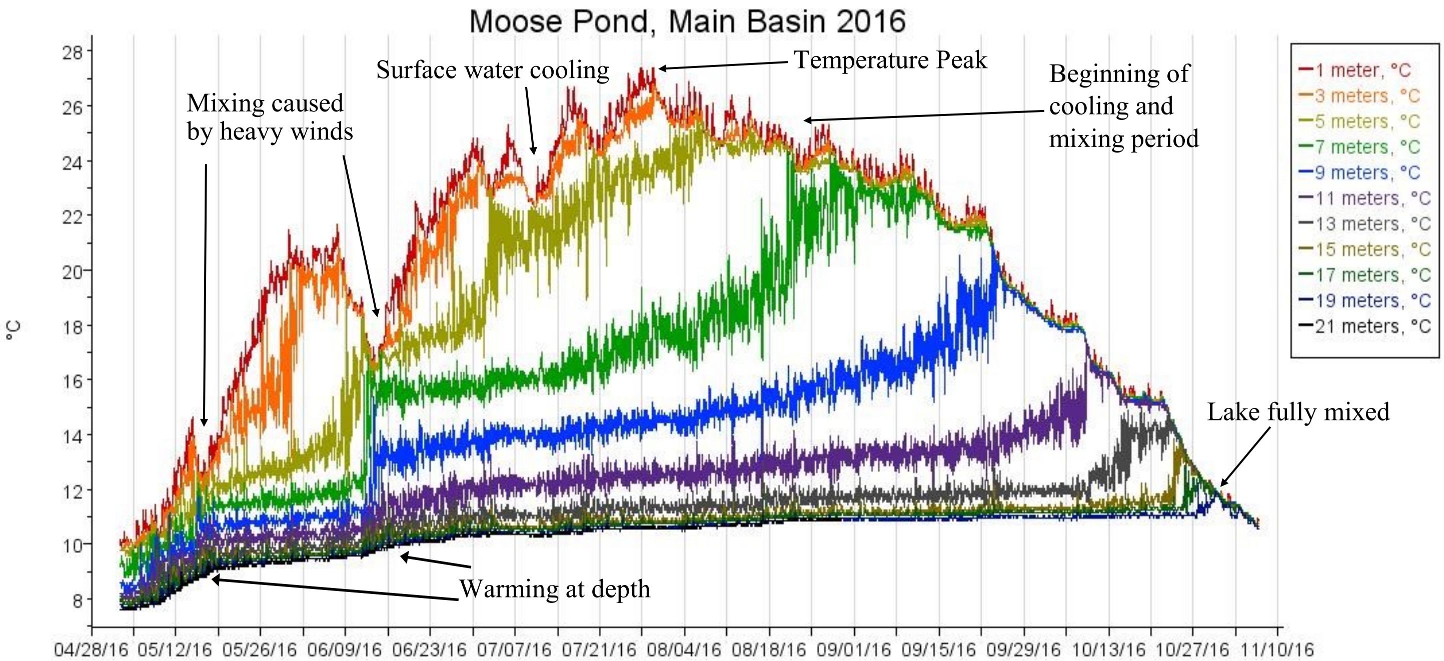


Figure 4. Graph of 2016 temperature data from Moose Pond, recorded between 5/3/16 and 11/7/16. Each line represents a different sensor's data; the topmost line (red) is data from the sensor at 1 meter below the water surface, the orange line represents 3 meters below the surface, and so on.

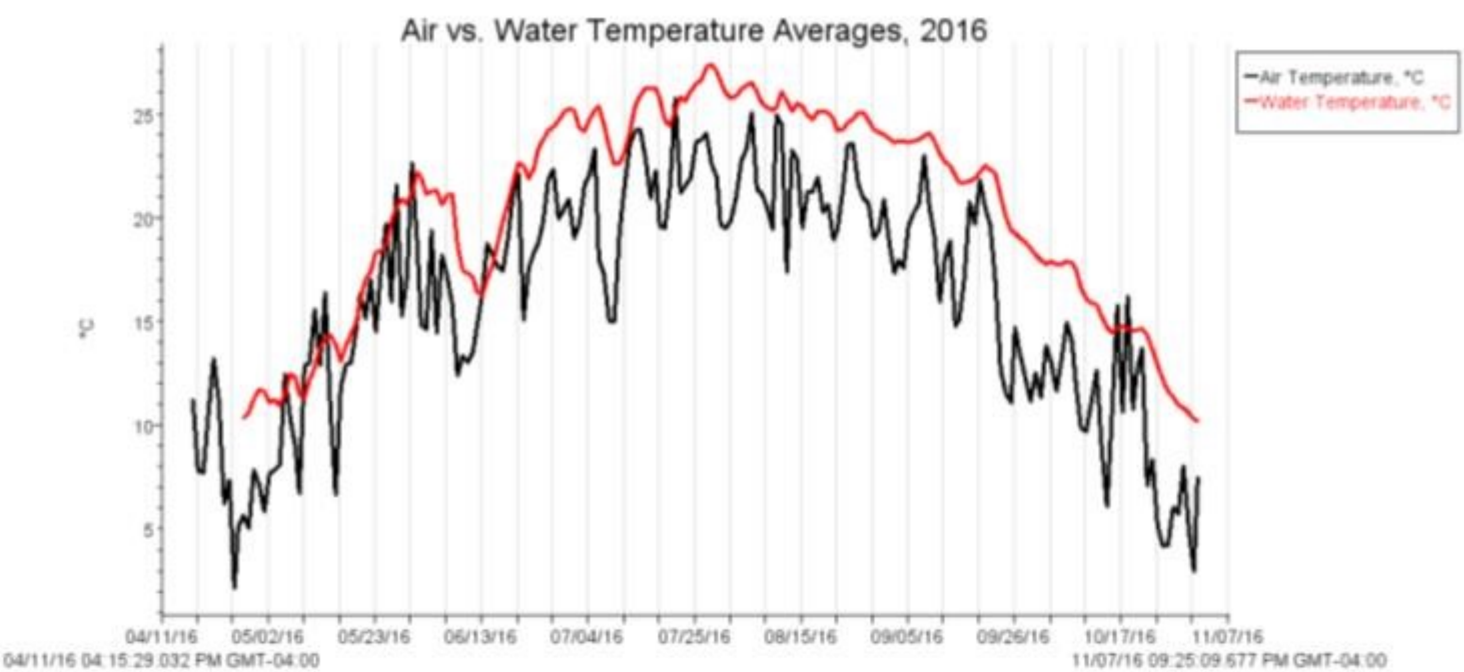


Figure 5. Comparison of average daily water temperature at one meters' depth (from Keoka Lake) and average daily air temperature (data from Highland Lake remote sensing buoy weather station). Water temperature fluctuates less than air temperature and is generally warmer due to the heat-retaining properties of water. Air temperatures clearly and directly influence water temperatures.

Results and Discussion

Deep Sensor Data

Table 2. Date when the maximum temperature was reached at 1 meters' depth on each lake, 2013—2016. *Highland Lake data from 2014-2016 are from LEA's Automated Testing Buoy.

Date of Peak Temperature by Year				
LAKE	2013	2014	2015	2016
Back Pond	N/A	7/23	8/20	7/28
Hancock Pond	N/A	7/24	8/29	7/30
Highland Lake	7/18	7/23*	8/18*	7/27*
Island Pond	N/A	7/23	8/21	7/30
Keoka Lake	N/A	7/17	8/19	7/29
Keyes Pond	N/A	N/A	8/19	7/28 & 7/30
Long Lake North	7/18 & 7/20	7/23	N/A	N/A
Long Lake Middle	7/17 & 7/18	7/18	8/19	7/28
Long Lake South	N/A	N/A	8/17	7/27
McWain Pond	N/A	7/23	8/19	7/28
Moose Pond Main	7/19	7/23	8/17	7/28 & 7/30
Moose Pond North	N/A	7/3	8/20	7/26 & 7/28
Moose Pond South	N/A	7/3	8/17	7/28
Peabody Pond	N/A	N/A	N/A	7/29 & 7/30
Sand Pond	N/A	7/24	8/20	7/29
Trickey Pond	N/A	7/24	8/20	8/12
Woods Pond	N/A	7/23	8/18	7/28

Each lake reached its peak temperature between July 27th and 30th, with the exception of Trickey Pond. The reason for this is that the Trickey Pond sensor string was closer to the surface of the water than is aimed for at deployment (see page 15 for more details). August 11th was the date of the peak in air temperature in the region for 2016, and the peak temperature on Trickey Pond was on August 12th. Because the Trickey Pond "1 meter deep" sensor was actually less than one meter from the surface, it was more affected by air temperature than the other lakes and ponds in the area. This is evident in figure 6b, where the red "1 meter deep" line shows more variability than those in figure 7a and 7b. July 29th was the second warmest date on Trickey Pond.

Results and Discussion

Lake temperature and stratification are greatly influenced by air temperature and strong winds, as already discussed. Precipitation, or a lack of precipitation, has important impacts on stratification as well. Rainfall was very low in the summer of 2016, leading to abnormally dry conditions in the lakes region. This in turn lowered lake levels through evaporation and increased water clarity by reducing runoff into the lakes. Greater light penetration generally means deeper stratification, i.e., the transition zone between the upper and lower lake layers is deeper. This makes stratification stronger by making the water more resistant to mixing. It also has important ecological ramifications.

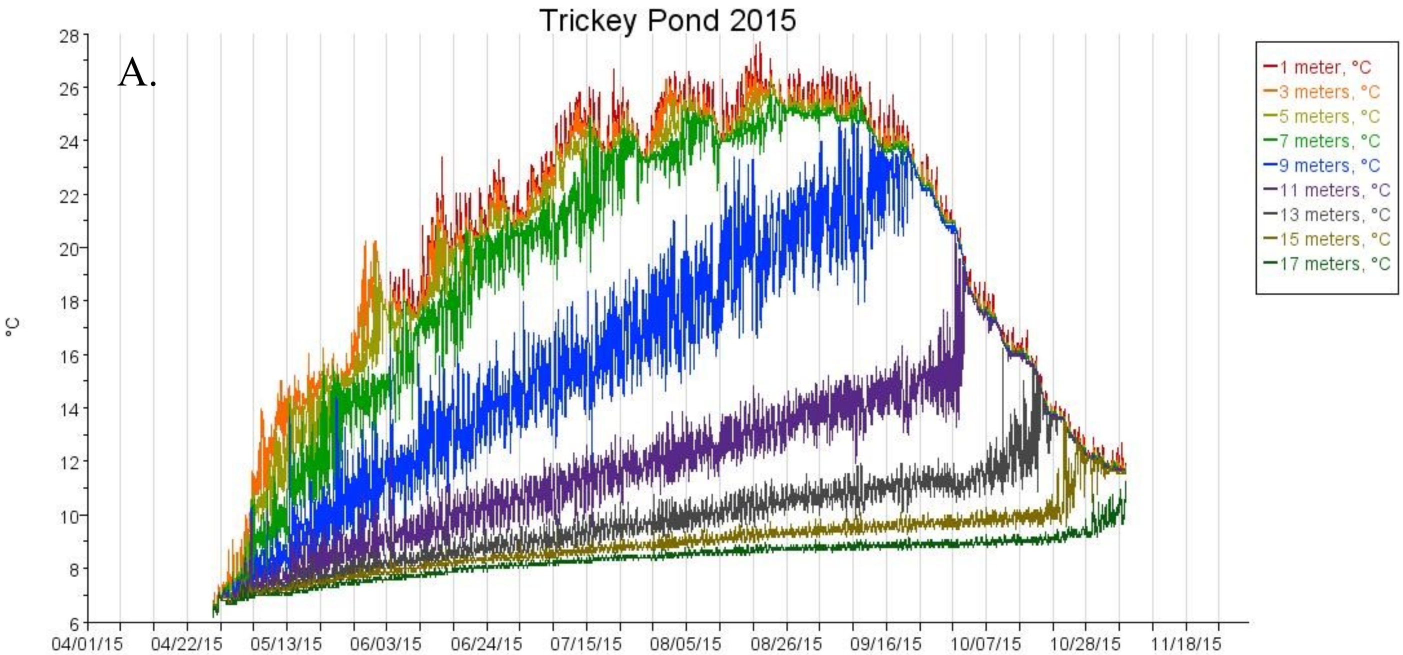
However, water temperature also plays an important role in stratification strength. The larger the difference in temperature between the top and bottom layers of the lake, the stronger the stratification is. Because of the May and June wind mixing events, deeper waters in some lakes increased in temperature. The effect of the wind events may have offset the stratification-strengthening effects of the drought conditions. Only about three lakes and ponds appeared to have deeper stratification in 2016 than in 2015, and these were all lakes that saw the least amount of disturbance from the wind mixing events: Back Pond (see graph on the cover of this report), Hancock Pond, and Sand Pond.

The graphs on the next page show temperature patterns in Trickey Pond in 2015 and 2016 (Figure 6a and 6b). Differences in surface water temperature patterns are the product of each year's unique air temperature patterns. Each line represents the temperature at a discrete depth, and the gaps between these lines show where stratification is occurring. This can be difficult to discern because the thermocline is often located somewhere in between the sensors. However, by comparing placement from year to year, we can see changes in stratification patterns. In the case of the Trickey Pond data, the line placement is similar in both years. However, the temperature at the sensor closest to the bottom of the lake was consistently over 1 ^{o}C warmer in 2016 than in 2015. This could be due to minor differences in sensor placement from year to year (discussed further on page 14), although this would only account for about 0.3 ^{o}C of the difference in temperature. More likely, the warmer 2016 temperature is due to a combination of warmer overall water temperatures prior to stratification (due to the near-record early ice out in late March) and the effect of the mixing in May and June causing a slight increase in bottom-water temperature.

Figures 7a and 7b, on page 11, illustrate the difference in lake response to wind mixing events. Despite being geographically very close to one another, Keoka Lake (Figure 7a) and McWain Pond (Figure 7b) were affected to different degrees by both the May and June mixing events. Both lakes are also similar in depth and surface area. The reason for the difference in response is related to the wind direction, lake shape and buoy location. McWain Pond is oriented roughly NW to SE, with its buoy placed in the middle of the pond. Keoka Lake, in contrast, is roughly bean shaped and its buoy was placed near the southwestern end of the lake. This means that the wind-induced wave/current action responsible for mixing the lake was stronger over the buoy on McWain Pond because there was a longer distance for the wind to travel over the lake before hitting the buoy, causing the currents to be stronger.

Another interesting difference between these two graphs is the temperature variability at individual depths. The greatest amount of variability in readings occurs around the thermocline (yellow line in both graphs), but Keoka Lake clearly has less variability than McWain Pond. The reason for this is that the line attached to the Keoka buoy was more taut and therefore the sensors bobbed less in response to surface waves. On McWain Pond, slack in the line caused more movement in the sensors, causing them to record subtle differences in temperature as their relative depths within the water changed.

Results and Discussion



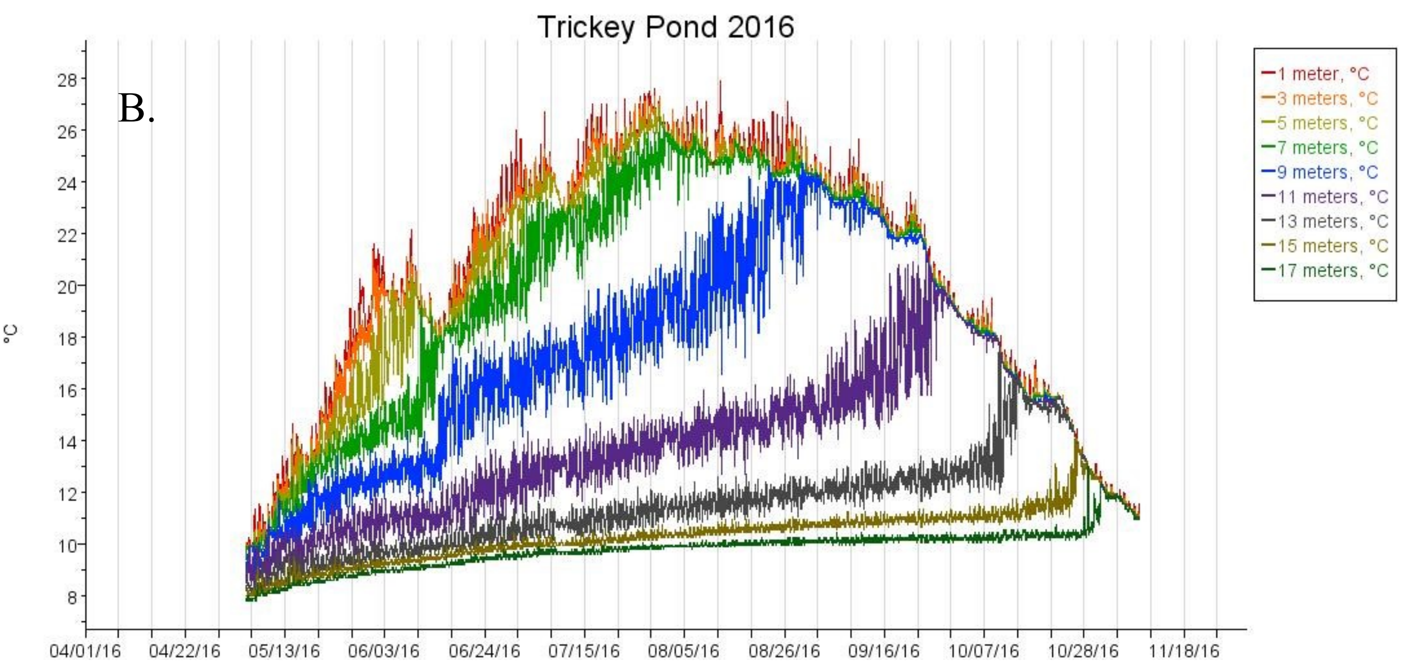


Figure 6a and 6b. Graphs showing Trickey Pond temperature records from 2015 (a) and 2016 (b). Surface patterns differ, and the effect of mixing in mid-June can be seen in the 2016 graph. Bottom temperatures are also consistently 1 ^{o}C warmer in 2016. Deep water mixing begins earlier and stratification ends sooner in 2016 than 2015. However, the overall stratification depth and pattern appears to be very similar from year to year.

Results and Discussion

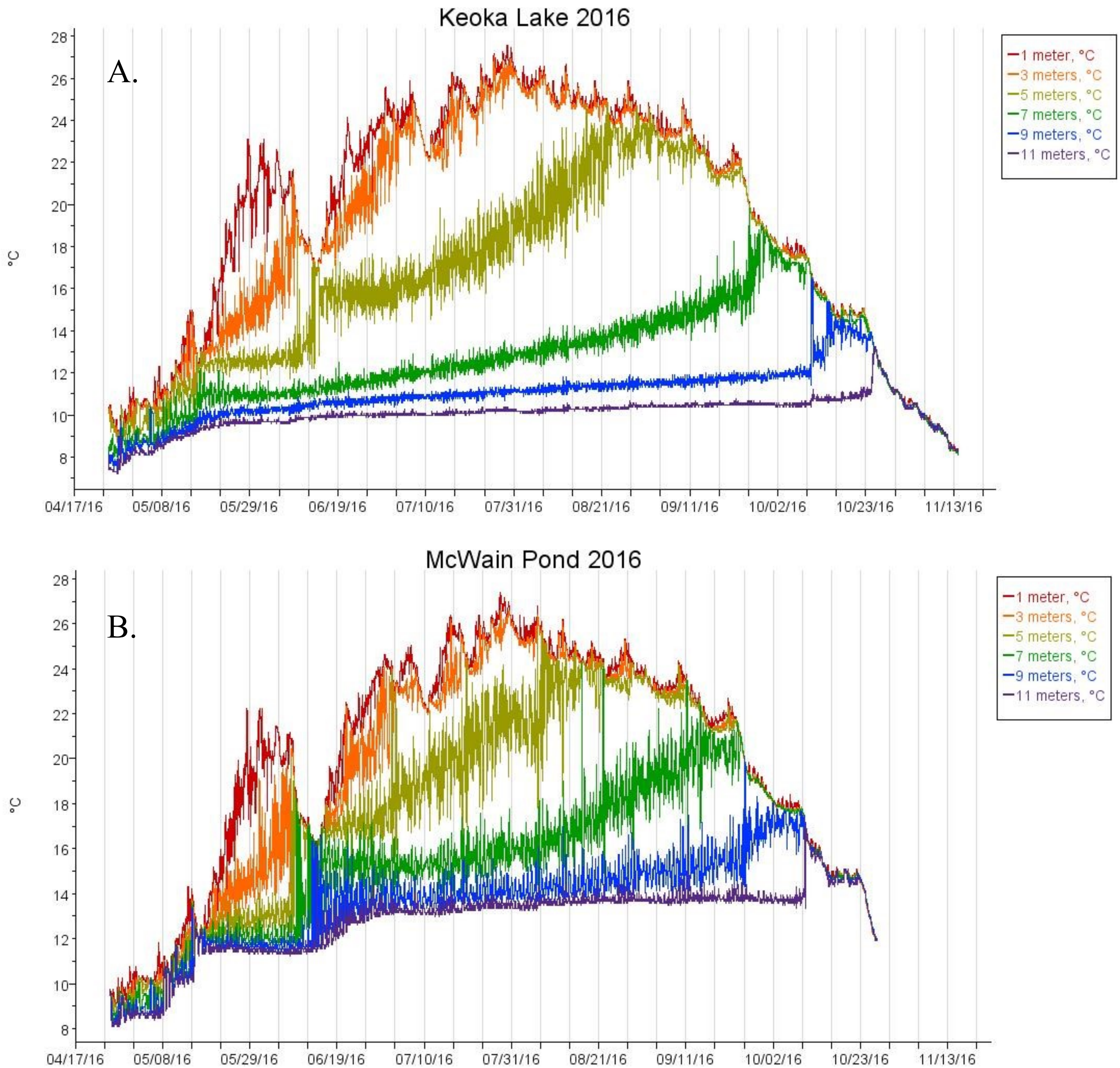


Figure 7a and 7b. Keoka Lake (top) and McWain Pond (bottom) show different resistance to mixing in May and June despite similar depth, area, and geographical location. This is due to the shape of the lake and location of the sensor string as well as prevailing wind direction. Additionally, McWain Pond's temperature data shows much more variability, particularly at 5, 7 and 9 meters. This is explained by the amount of slack in the sensor line which causes sensors to move around in the water more, and thus be exposed to more varied temperatures. Note that both graphs have the same x-axis scale, and that McWain Pond mixed earlier in the fall than Keoka, likely due to a warmer deep-water temperatures facilitating mixing.

Results and Discussion

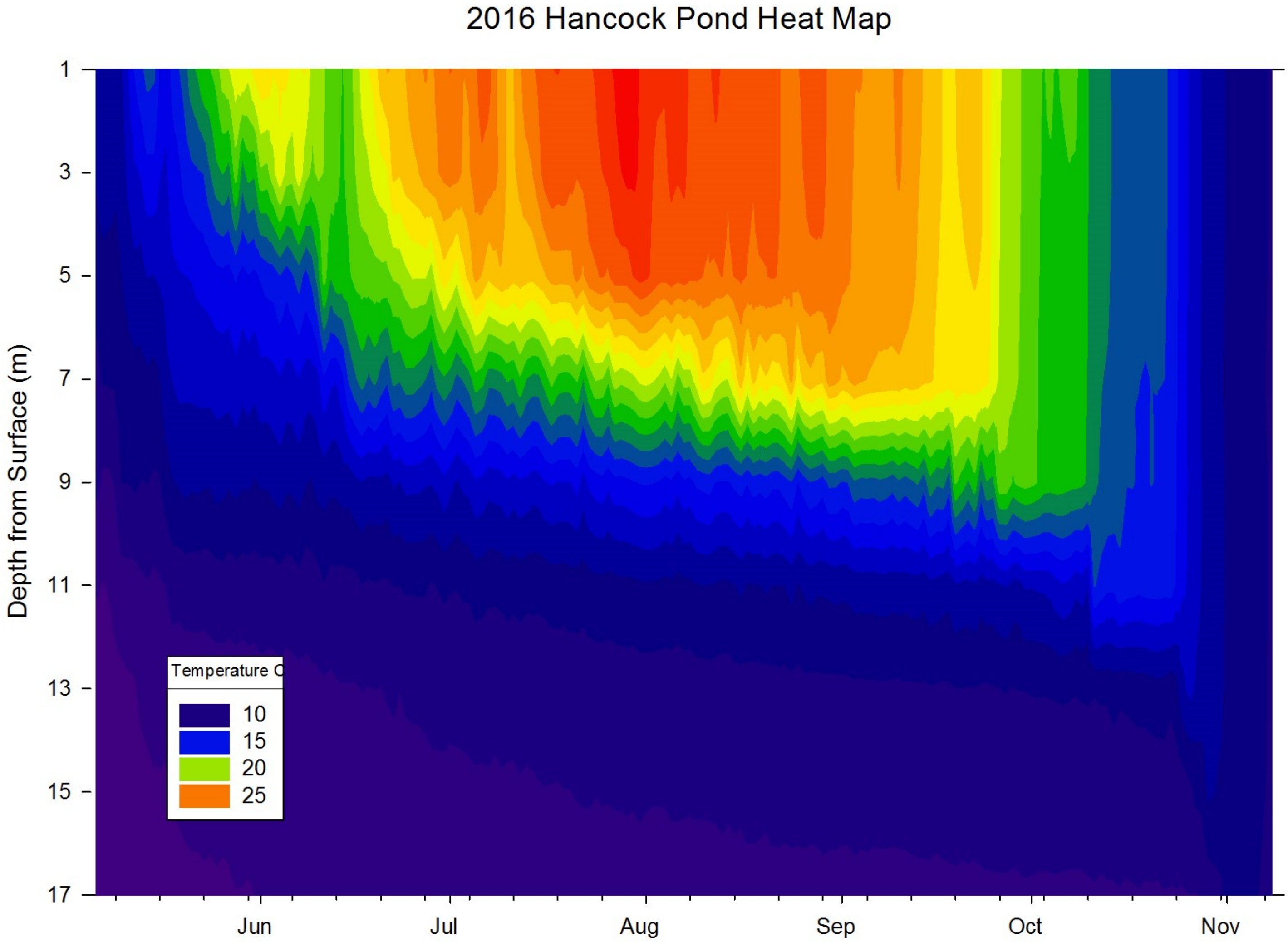


Figure 8. "Heat map" of Hancock Pond created using temperature sensor data. This graph displays vertical profiles of the lake (y axis, top to bottom) and demonstrates how temperature changes over time (x-axis, left to right).

Figure 8, above, shows a different way to display temperature data from the sensors. This graph visually shows the temperature at various depths over time and can be more intuitive to interpret than the line graphs. The far left and right areas of the graph are dark blue, indicating consistent temperatures from the top of the lake to the bottom (i.e., the lake is fully mixed). In between, the lake is stratified as there is a strong temperature gradient from the top to the bottom. The effect of the June wind mixing event can be seen toward the left of the graph; the deepening of stratification accompanied by oranges and reds denoting warmer temperatures do not appear until after mid-June. Peak temperatures in late July are shown by the dark red band of color. The graph also displays the deepening of stratification throughout the summer (block of color extends deeper over time) and the cooling and mixing of the water throughout the fall.

Results and Discussion

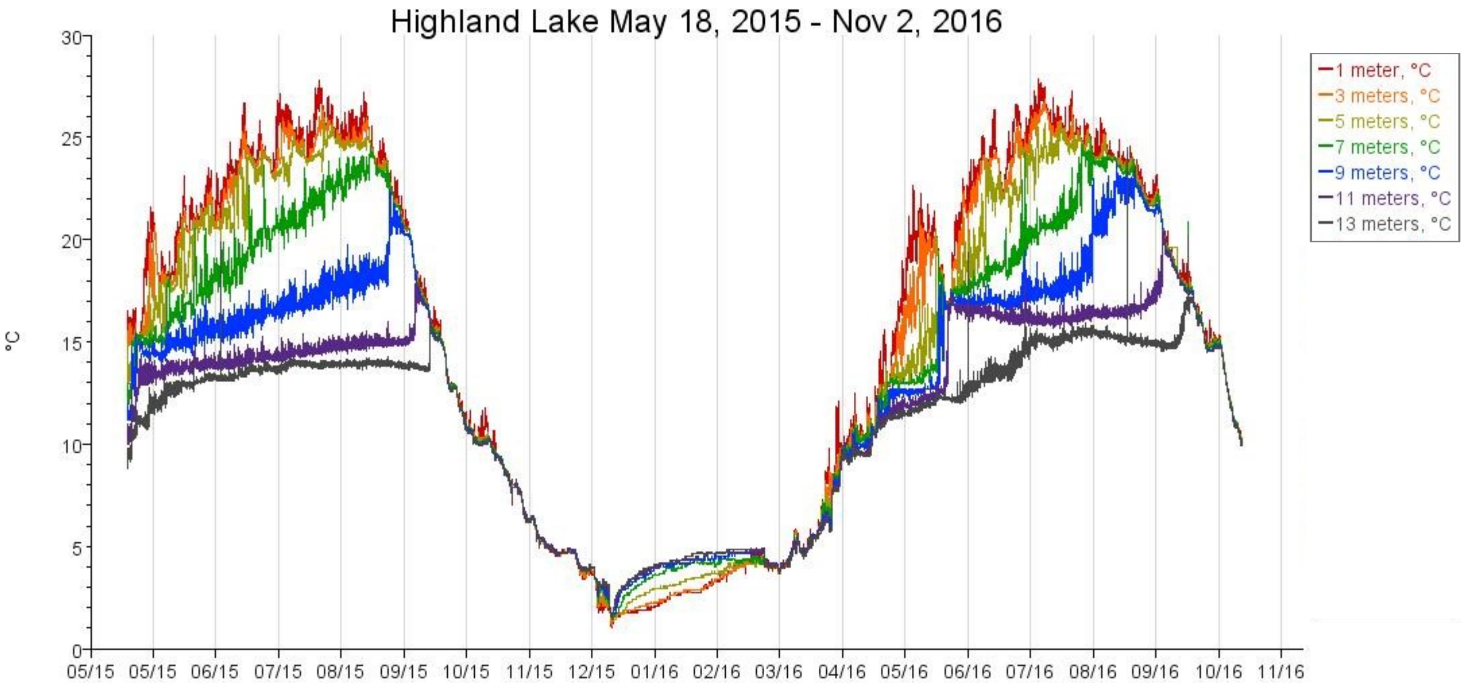


Figure 9. Full 18-month temperature record for Highland Lake, May 2015-November 2016. This graph shows summer 2015 stratification, fall mixing, winter "reverse" stratification, spring mixing, and summer 2016 stratification on Highland Lake.

Figure 9 shows a continuous temperature record from May 2015 through November 2016. May through November temperatures in 2015 and 2016 are from Highland Lake's automated water testing buoy, which measures temperature at two meter intervals in the same way as the HOBO sensors. November 2015—May 2016 data is from HOBO sensors that were deployed when the buoy was removed from the water and retrieved when the buoy was re-launched in the spring.

Continuous temperature data is important because it provides information about the lake after stratification breaks down in the fall and before sensors are able to be launched in the spring. The winter of 2015-2016 was interesting because the ice-covered period was so short that year. Many lakes did not freeze over until January, and the ice had melted on most lakes by April 1st.

The graph reveals the timing of ice-in and ice-out on Highland Lake, which corresponds to the stratified period from January 5th to March 18th. Ice cover prevents winds from mixing the water and allows the water to stratify. This weak stratification is sometimes referred to as "reverse stratification" because the upper depths are actually colder than the deeper water. This is because water is at its most dense at 4 ^{o}C and settles to the bottom. Water that is colder than 4 ^{o}C floats to the top and freezes at 0 ^{o}C. None of the sensors register 0 ^{o}C readings, which means that the ice was less than one meter deep in the middle of the lake.

Once ice-out occurred on March 18th, the waters began to warm gradually. However, the lake did not begin to stratify until May 10th, showing well mixed waters throughout March and April, with only slight temperature differences between the top and bottom of the lake. This fact that mixing began early in March and was able to continue through April allowed the temperatures at the bottom of the lake to be warmer than in past years, even before mixing events in May and June increased temperatures further.

Results and Discussion

Table 3. Date when lakes destratified, by year. When "after" a certain date is specified, this indicates that sensors were removed before full mixing occurred. The date stated is when the sensors were removed. *Data from Highland Lake in 2014 and 2015 are from LEA's Automated Testing Buoy.

Date of Fall Turnover (Complete Mixing) by Year				
LAKE	2013	2014	2015	2016
Back Pond	N/A	after 10/25	10/26	10/26
Hancock Pond	N/A	11/3	after 11/10	11/5
Highland Lake	after 10/11	10/12*	10/11*	10/10*
Island Pond	N/A	11/2	after 10/27	after 10/27
Keoka Lake	N/A	10/22	10/23	10/25
Keyes Pond	N/A	N/A	10/26	10/25
Long Lake North	10/25	10/23	N/A	N/A
Long Lake Middle	9/16	9/12	9/28	9/2
Long Lake South	N/A	N/A	10/11	10/2
McWain Pond	N/A	10/19	10/18	10/10
Moose Pond Main	11/3	11/2	11/2	10/31
Moose Pond North	N/A	9/12	9/22	8/22
Moose Pond South	N/A	10/22	10/3	9/25
Peabody Pond	N/A	N/A	N/A	11/5
Sand Pond	N/A	after 10/30	10/31	10/26
Trickey Pond	N/A	11/2	after 11/5	10/31
Woods Pond	N/A	9/13	9/30	9/12

Lake Turnover

The date of full lake mixing, also known as destratification or lake turnover (See "Lake Stratification" box, page 3) is dependent on the each lake's unique characteristics, including surface area, depth, shape, and morphology. Of the lakes studied, the earliest destratification occurred on August 22nd in the north basin of Moose Pond and the latest took place after November 5th on both Peabody and Hancock Pond. This range of dates is earlier than in 2015, however some lakes mixed on or about the same date in both years (Table 3).

The lakes that were most impacted by the wind events in May and June were the lakes that mixed the earliest in 2016. These lakes, which include both basins of Long Lake, Moose Pond's north and south basins, McWain Pond, and Woods Pond, experienced deep-water warming during the wind events that facilitated earlier whole-lake mixing in the fall. Stratification patterns showed that many lakes began to mix in August, which was much earlier than in 2015, a year that had an unusually warm August and September.

Results and Discussion

Comparison with Water Testing Data

In order to verify sensor depth and accuracy of temperature readings, temperature profiles collected by the HOBO sensors were compared with manual testing profiles collected with YSI handheld meters. LEA conducts routine lake monitoring bi-monthly in the summer, which includes taking temperature measurements at 1-meter intervals from the top of each lake to its deepest point. The resulting temperature profiles were graphed with HOBO sensor profiles from the same date and time of manual testing and compared.

The stated depth of the individual HOBO sensors is an estimate based on the depth of the lake. The actual depth of the sensors varies depending on the specific placement of the anchor, the lake level, and the amount of slack in the line. When setting up the HOBO sensor lines, sensor placement is measured relative to the bottom, with the first sensor being 1 meter from the bottom of the lake and each additional sensor being 2 meters above the last. However, when graphing the results, the sensors are labelled from the top of the line, near the water's surface, and we assume that the first sensor is at 1 meter deep. In a lake that is 14.5 meters deep, the sensors might be labeled 1, 3, 5, 7, 9, 11, and 13 meters, but in reality they may be closer to 1.5, 3.5, 5.5 meters, and so on.

These subtle differences in depth can be seen when comparing the manual and digital temperature profiles. Adjusting the HOBO sensor profiles to be 1 meter deeper or shallower, for example, can provide a much better data fit (Figure 10), indicating sensors are actually deeper or shallower than marked, for the reasons discussed above. Manually collected temperature profiles are collected from a boat, and depths are measured from the surface of the water down. The YSI meter used to collect the data has markings at each meter and effort is made to keep the line straight up and down in the water during sampling to ensure accuracy.

Despite the potential sources of error, HOBO sensor temperature profiles from all the lakes tested matched closely with YSI meter profiles after adjusting for actual lake depth. Most readings were within 1 ^{o}C of the YSI data. Discrepancies were most often found around the thermocline, which is expected because of the rapidly changing temperatures that occur in this area of the lake.

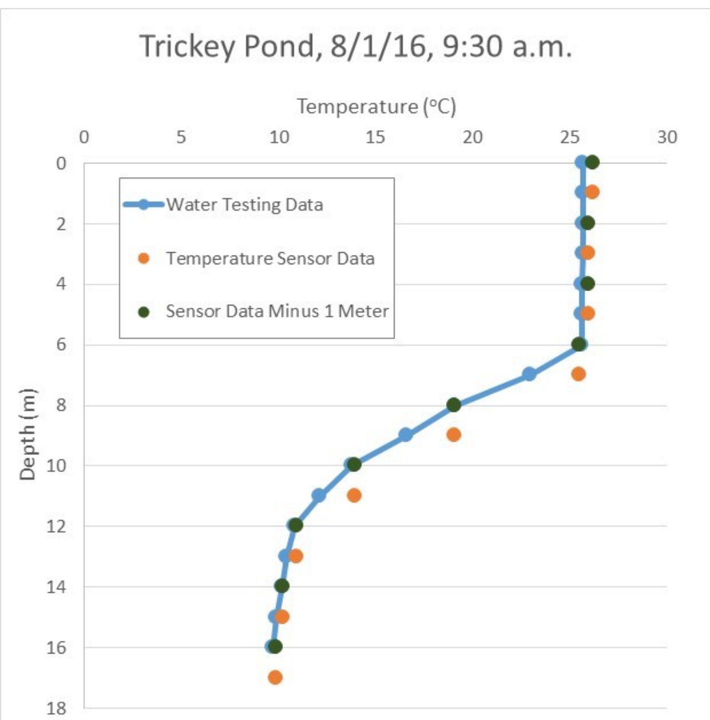


Figure 10. Graph of manually collected water testing data (blue line) versus HOBO sensor data (orange and green circles). The sensor data fits the water testing data much better if the assumed sensor depth is decreased by one meter (green circles). This indicates that the sensors were closer to the surface of the water than marked.

Results and Discussion

Shallow Sensor Data

One shallow temperature sensor was deployed in 2016, on the western shore of Peabody Pond. The sensor was located at about one meter below the surface and two meters from the bottom of the pond. 2016 was the fourth year the Peabody sensor was deployed. The placement and depth were similar each year, but did vary slightly as the sensor and anchor were removed each fall.

Figure 11 shows daily average shallow water temperature between June 17th and September 24th in each of the four years the sensor was deployed. This is the common time period over which sensor data was available in all four years. The average temperature at the sensor differed by less than one degree Celsius over this time period. Average temperatures ranged from 23.6 ^{o}C to 24.4 ^{o}C (74.5 ^{o}F to 75.9 ^{o}F). Maximum temperatures were between 28.1 ^{o}C and 30.3 ^{o}C (82.6 ^{o}F to 86.5 ^{o}F) and are not shown directly in figure 11 but are part of the daily averages.

The highest maximum temperature occurred in 2013, although 2015 had the highest average temperatures over the dates specified, thanks to a warmer than average August and September. In contrast, 2014 had the lowest average, maximum and minimum temperatures of all four years. The data shows seasonal variations but a similar overall temperature range. Late September temperatures were slightly warmer in 2015 and 2016 than in the previous two years, although it will take several more years of data before any conclusions can be made about this pattern.

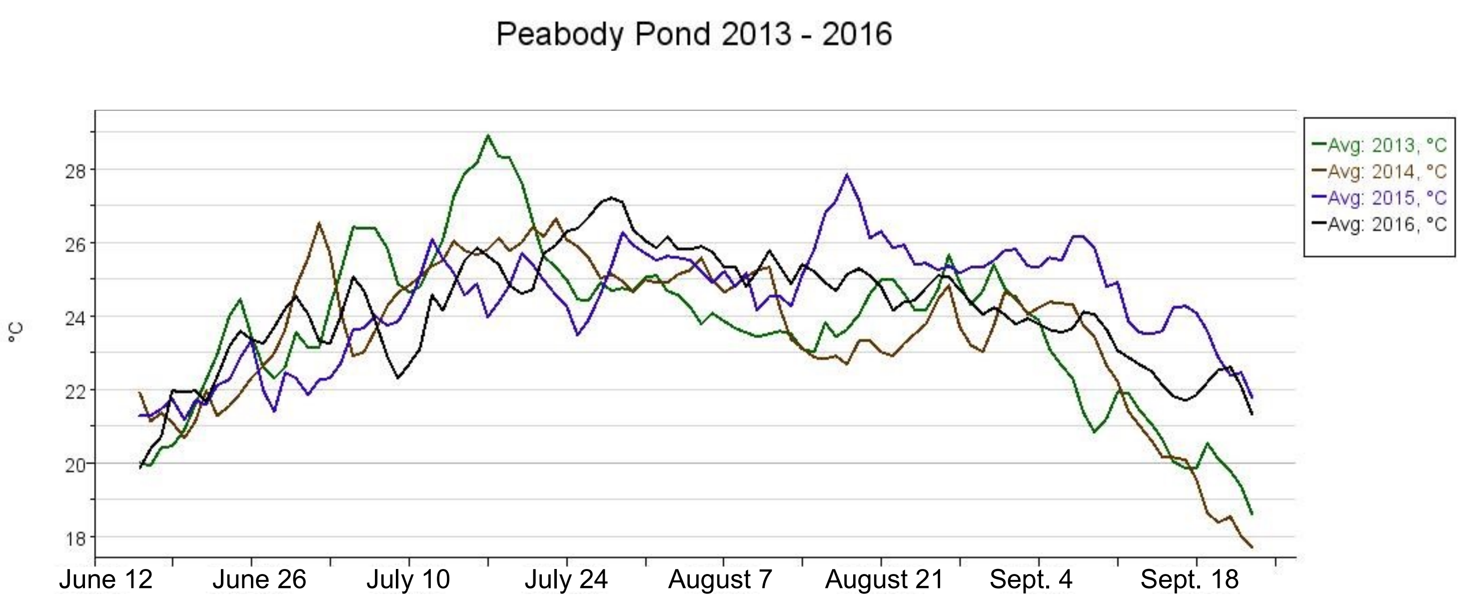


Figure 11. Comparison of Peabody Pond shallow data from each of the last 4 years. Graph shows daily averages over a common time period (June 17th to September 24th of each year).

Looking Ahead to 2017

No major changes in the temperature monitoring program are anticipated for 2017. As always, sensors will be deployed as soon as is practical in the spring. Deployment date depends on a number of factors including ice out date, weather, and boat availability on the lakes tested. It is important to launch the sensors as soon after ice-out as possible so that the entire temperature record for the season can be recorded.

Over-winter sensors have already been deployed in Highland Lake and Long Lake's north basin. These will be collected in the spring when large remote-sensing buoys are returned to these sites, thus allowing us to have full-year temperature records in these basins.

An ongoing goal for this project is to improve quality assurance and control. This includes both maintaining and testing the sensors themselves as well as updating and altering methods as necessary.

LEA gratefully acknowledges the help and expertise we have received from Dr. Dan Buckley at the University of Maine, Farmington over the course of this project.

LEA Would Like to Thank...

Five Kezar Ponds Watershed Association
Hancock and Sand Ponds Association
Island Pond Association
Keoka Lake Association
McWain Pond Association
Moose Pond Association
Peabody Pond Association
Friends of Woods Pond
Trickey Pond Association
Keyes Pond Environmental Protection Association

An anonymous foundation

and all of our members

…for making this project possible with their generous support!

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