# Water Quality Assessment Report
# 2017

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Indian Township Tribal Government

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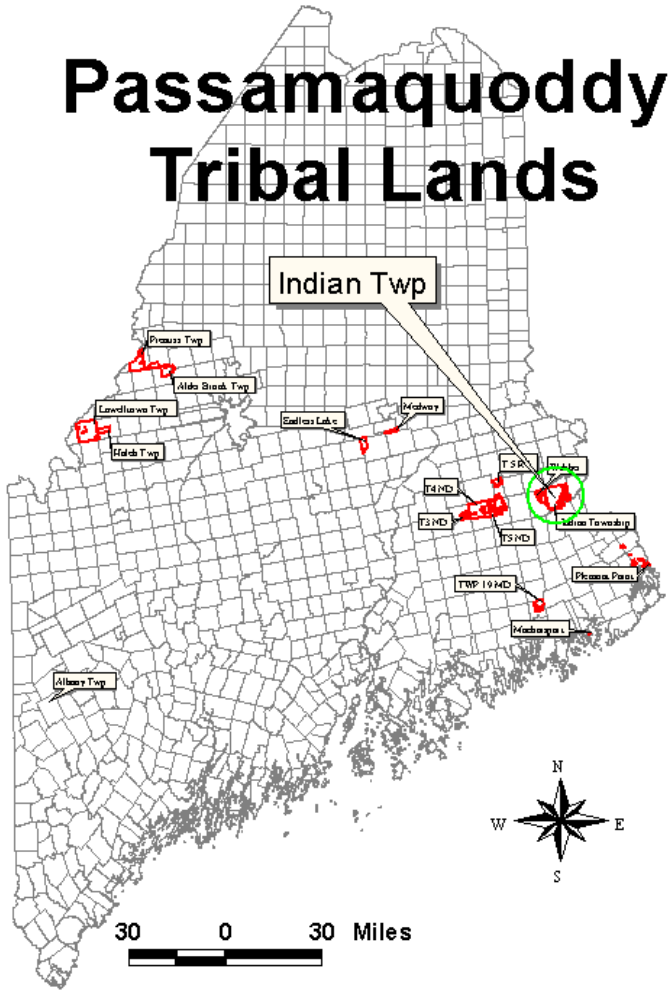



**Figure 1: Location of Indian Township, Maine.**

# Introduction

## Background

The Passamaquoddy Tribe at Indian Township began its Water Resources Planning and Inventory Program in April 1993 with funding from a Multi-Media grant from the U.S. Environmental Protection Agency (US EPA), and a Bureau of Indian Affairs (BIA) Water Resources contract. The US EPA requires a Quality Assurance Project Plan (QAPP) as a prerequisite for funding of monitoring programs. This plan details the program's procedures for field work, transportation, data use, laboratory and field protocols, and safety. For data to be useful, procedures must be consistent and reliable. This plan is submitted to, reviewed, and approved by the US EPA for each year of monitoring.

Indian Township has a wealth of water resources. Bordering the southern edge of the Reservation is part of a long series of reservoirs controlled by Woodland Pulp LLC as part of the St. Croix River drainage. The Reservation waters include Big Lake, Long Lake, Lewey Lake, Grand Falls Flowage and its tributary Tomah Stream. These water bodies make up a significant section of the 647 $mi^2$ West Branch of the St. Croix River basin. Reservoir water levels are controlled and used for power generation, mill effluent dilution, fisheries, and flood control. Indian Township's lake levels are controlled at the Grand Falls Dam in Woodland. In addition to Tribal land inside Indian Township, Passamaquoddy Tribe has in Trust over 115,000 acres distributed over 7 counties in the State of Maine. Water bodies adjacent to these trust lands have been subject to very little water quality testing in the past, but we have increased monitoring efforts there in the past ten years.

## Purpose

The Indian Township Water Quality Monitoring Program was undertaken to compile baseline data for reservation water bodies. Water quality is the biological, chemical, and physical composition of the water in its natural state, taking into account any human inputs and alterations. In order to protect water quality in the future, one must have an idea of the current water quality, the sources of pollution currently entering the system, and the trends of the system. Determining trophic state and water quality trends are nearly impossible without data to back up those determinations. A reliable, long term monitoring program can help identify problems before the degradation of water quality is irreversible. To further complicate the water quality issue, watersheds cross municipal, state, tribal and national boundaries. Reliable data can also provide the necessary scientific backing to elicit the political will to address pollution sources.

## General Program Summary

We restarted the Water Quality Sampling Program in 2008 with sampling the original four Township lakes: Big Lake, Long Lake, Lewey Lake, and Grand Falls Flowage. The 2009 season built on this foundation by continuing sampling of the Township lakes, as well as adding in monthly sampling of 13 other lakes and ponds, most of which had been regularly sampled in the past. The 2010 Water Quality Sampling Season continued on our 2009 season with sampling of the same 17 lakes and ponds. In 2011 we continued to build on 2010 by adding in 4 more lakes: East and West Musquash Lake, Pleasant Lake, and West Grand Lake. We also added in sampling of a small pond known locally as Bassett Pond, which is evidently fishless, in the summer of 2013.

All of those additions combined with slowly eroding budgets and of course inflation, have caught up to us this year. We were forced to cut back sampling in order to reduce costs and man hours. Bassett Pond, while interesting and unique, was given the axe for now. It would be best focused on with a special project. Shaw and Mill Privilege were also cut after just one visit in 2017, as the access is poor and causes damage to equipment. The three ponds in the Jackman area were also cut for now, as they require the most resources to get to for the amount of data gained.

An updated look at our sampling lakes are as follows: **Big Lake**, **Long Lake**, **Lewey Lake**, and **Grand Falls Flowage** (the original four lakes to be sampled) **Junior Lake**, **Pocumcus Lake**, **Scraggly Lake**, **Sysladobsis Lake, West Grand Lake** (5 major lakes upstream of the Township lakes), **Pleasant Lake** (large tributary to Scraggly Lake), **Upper Chain Lake**, **Middle Chain Lake** (2 tributaries to Sysladobsis Lake), **East and West Musquash Lakes** (eventually drain into Big Lake) **Side Pistol Lake** (drains into the Passadumkeag River, and eventually the Penobscot River), and **Killman Pond** (drains into Upper Chain Lake). If looked at the watershed level, fifteen of our lakes and ponds sampled are part of the St. Croix River watershed, while only one remains (Side Pistol) included of the extensive Penobscot River watershed.

Starting in 2011, we increased our sampling schedule to do a full sampling regiment of each lake every two weeks (up from at that time, once per month). A full sampling regiment includes the following: **Dissolved Oxygen** (DO), **Temperature**, **pH**, **Conductivity**, **Transparency** (Secchi depth), **Chlorophyll-a** (Chla), **Total Phosphorus** (TP), **Alkalinity**, and **True Color** analysis. Each one of those parameters will be explained in greater detail later on in the report. We'll also include our data collected for each parameter from the 2017 season in a broad, comparative sense as well as on a per lake basis.

## Monthly Program Summary

- **May 2017** Our weather station on the reservation recorded about 4.75in of rain for May 2017, compared to about 2.75in 2016, 2.35in for 2015 and 3.25in for 2014, so quite an increase over the last few years. This past winter was a pretty long winter, with quite varying stretches in above and below average in both temperature and snow fall amounts. December was quite cold helping lakes ice up quickly and most held on through a warmer than usual January with pretty low snowfall. February was back with a stretch of heavy snows and some above average temperatures before dropping back into some strong cold into March, keeping ice around well into April on some lakes. The first half of May was quite windy or raining, with muddy roads, as per usual, the second half seemed a bit less windy overall, and drier with some warm stretches. Eight lakes were lost to weather in the first half of the month and only one lost in the second half (due to truck issues), an overall sampling success rate of 27/36 (78%). After a couple strange readings early, our pH meter has worked well since, losing very little data.

- **June 2017** Our weather station on the reservation recorded about 1.90in of rain for June 2017, compared to about 2.80in for 2016, 6.80in for 2015 and 5.30in for 2014. The first half of June had a fair bit of sampling weather, mostly with some windy days to deal with, the second half was similar. Six lakes were missed in the first half of the month, with a mix of bad weather and truck issues. No lakes were lost in the second half of June, for an overall success rate of 81% (26/32). The truck's rear brakes locked up repeatedly while towing on gravel roads, the issue was finally diagnosed and fixed (leaking rear axle seal). Our pH probe and meter is currently working great (for once!). Maine's VLMP director Scott Williams met with us on June 22$^{nd}$ to recertify the program in Secchi disk readings and that the ProDO Meter was working correctly. It was good to speak with Scott, everything was working well.

- **July 2017** Our weather station on the reservation recorded about 1.4in of rain for July 2017, compared to 3.80in of rain for July 2016, about 2.15in for 2015 and 7.30in for 2014. It's a dry start to the summer with 2 rain events in the first half of the month near .5in. The first half of July was perfect in the sense of samples taken, with all 16 sites getting sampled. The second half of the month was also perfect. (100%, 32/32) The only issues were dealing with a flat trailer tire and the back again pH saga. Our pH probe and meter is currently out of commission, it worked flawlessly until about mid month then just stopped calibrating correctly.

- **August 2017** Our weather station on the reservation recorded only 1.0in of rain for August 2017, compared to about 3.25in of rain for 2016, 4.95in for 2015 and 2.05in for 2014. August is usually a pretty dry month but it was extremely so in 2017, especially with the second half of July being quite dry. Water levels by the end of August were down to winter draw down levels. The first half of August was perfect with no sites missed, as was the second half. (100% sampling success at 32/32)

The dry and calm weather, in combination with the reduced sampling schedule made keeping up with sampling much easier than in past seasons. Our pH probe and meter is still out of commission and we will have to figure pH out for 2018.

- **September 2017** Our weather station on the reservation recorded only 1.4in of rain for September 2017, compared to about 2.0in of rain for September 2016, 9.20in for 2015 (a 7in storm), and 1.75in for 2014. September is usually a pretty dry month, and it was about on par, but considering both July and August had under 1.5in of rain as well, it's been a significant drought here this summer. The first half of September was ok, with 4 sites missed, the second half was perfect, although we had to sample two sites in early October. Some rain finally started to come in September, combined with wind and our Health Faire public outreach contributed to the missed lakes. (88%, 28/32)

The last sample of the season was taken from the West Grand Lake on October 3rd, 2017. This ended the field portion of another successful season. We were able to sample 145/164 (88%) sites this year. Hopefully next season we are able to produce results around what we did this season, or better. It is much easier to keep up with samples with this reduced schedule so long as equipment stays functioning.

## Parameter Summary

In order to further measure our sampling success, the following shows each parameter sampled and its associated success rate (measured by valid samples taken/possible samples taken) not including quality control duplicate samples.

- **Dissolved Oxygen/Temperature Profiles:** 145/145 (100%) We had no issues what so ever with DO/Temp profile collection in 2017. The only missed data was when a lake site was missed. Scott Williams of VLMP met with us to successfully recertify our YSI ProDO meter on June 22nd, 2017. This meter has shown to be extremely accurate in DO and Temp readings and having a 40m cable allows us to take readings to the bottom of even the deepest lakes in the area.
- **Chlorophyll-a:** 143/145 (99%) We only lost two Chl-a readings in 2017, both were due to running out of filters and not being able to get more within the unfiltered holding time (2 days). A mix up with new staff caused this and will be remedied for next season. There were no outliers to deal with this year either, all the readings were within the general expected range from past experience. Chl-a readings ranged from a low of 1.0 ppb (Side Pistol) to a high of 6.5ppb (Side Pistol). Having both the high and low values be in the same lake is a bit unusual, maybe its small size has something to do with it.
- **Transparency/Secchi:** 145/145 (100%) No additional Secchi readings were missed in 2017. Numerous times the Secchi disk hit the bottom on some lakes (Grand Falls Flowage 2x, Side Pistol Lake 2x, and Lewey 1x) Secchi depth ranged from 3.4m (Middle Chain) in the shallowest to 12.65m (West Grand) at the deepest. This was the first time as far as I know that we hit bottom at Lewey Lake and the second season in a row on Grand Falls Flowage. Scott Williams of VLMP met with us to successfully recertify our Secchi readings on June 22nd, 2017.
- **Total Phosphorus:** 144/145 (99%) No additional Total Phosphorus samples were missed in 2017, but one value was an extreme outlier (84ppb) and was left out of calculations. Our TP range for 2017 was a low of 3ppb (Pleasant, Pocumcus, Sysladobsis, West Musquash, and West Grand Lakes) with an accepted high (still quite the outlier) of 24ppb (East Musquash Lake). We used the TP dupe value for Long Lake 6.8.17 (9) instead of the original (16) as it felt like an outlier when compared to the duplicate reading and past readings.
- **pH:** 52/145 (36%) pH continues to be a sticking point in the program. The probe/meter will calibrate perfectly one day and then not at all later in the afternoon. We were able to get a third of the season done before it was just too unreliable. The values were a bit more variable than we'd like to see, but everything checked out in the calibrations and post sampling tests to not rule them out. Our pH low for the season was 6.23 (West Grand Lake) and a high of 7.81 (Junior Lake).
- **Alkalinity:** 145/145 (100%) No additional samples were lost. No problems to report. Our low alkalinity reading for the season was 4.0 mg/l of CaCO3 (Upper Chain) with a high of 8.0 mg/l of CaCO3 (Half the sites). These readings are very stable from year to year it seems.

- **Conductivity:** 145/145 (100%) Our conductivity meter has always been very reliable, no issues to report as nothing was missed or lost in 2017. Our low conductivity reading was 16.6 UMHOS/cm (West Musquash Lake) with a high of 24.5 UMHOS/cm (Lewey Lake). Our usual high and low readings come from lakes that weren't sampled in 2017.
- **Color:** 143/145 (99%) We only lost two true color readings in 2017, both were due to running out of filters and not being able to get more within the unfiltered holding time (2 days). A mix up with new staff caused this and will be remedied for next season. Our lowest true color reading for 2017 was 4 PCU at Side Pistol Lake, with a high reading of 71 PCU (Upper Chain). When you look at the scatter plots of color readings down below, you'll notice the effects of the drought on true color values. As the influx of water from the watershed is reduced, the lakes get much clearer. The tannins from the surrounding bogs and fens are reduced, lightening the water clarity. This trend shows up in the Secchi graph as well.

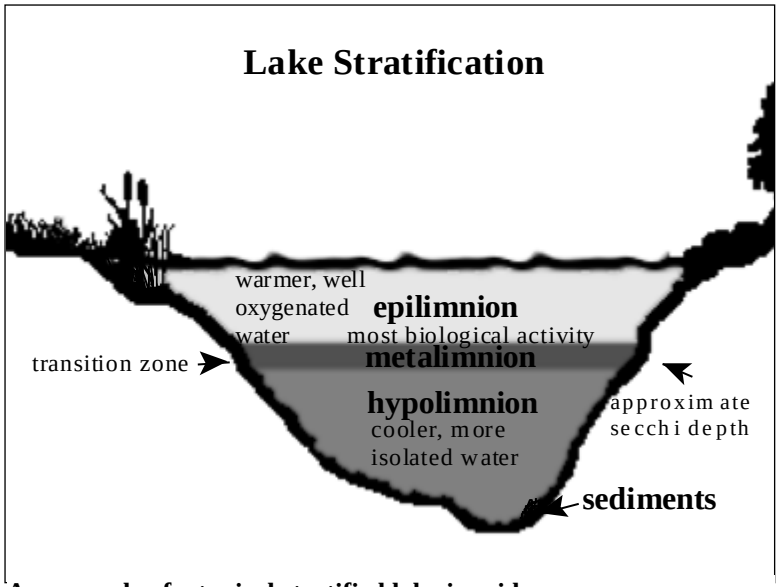
## General Information

### Stratification

Holdren et al (2001) defines stratification as a process in which several horizontal water layers of different density form in some lakes. These layers are classified as follows:

Epilimnion – the well-mixed and uniformly warm surface waters
Hypolimnion – the uniformly unmixed bottom waters
Metaliminion - zone of rapidly changing temperature and density separating the epilimnion and the hypolimnion

The lake is stratified when warm water, the epilimnion, floats on the significantly colder water, the hypolimnion. The metalimnion is formed in the region where the temperature gradient decreases markedly. This separation also allows little mixing of the upper layer with the bottom waters. After stratification, the hypolimnion has a finite quantity of oxygen until fall turnover.




**An example of a typical stratified lake in midsummer.**

### Dissolved Oxygen

Dissolved Oxygen (D.O.) is the measure of the amount of oxygen dissolved in the water. All living organisms, except for certain types of bacteria, need oxygen to survive. Organisms living in the water have the ability to use the oxygen dissolved in the water to breathe. Too little oxygen severely reduces the diversity and population of aquatic communities. Therefore the amount of D.O.in the water is very important to aquatic life. Low oxygen can directly kill or stress organisms such that they will not be able to successfully reproduce or grow. Water with less than 1 part per million (ppm) of oxygen is considered anoxic (no oxygen present); less than 5 ppm of oxygen is generally considered so stressful that most coldwater fish will avoid these areas. Anoxic conditions can also promote TP release from sediments (VLMP, 2008 Maine Lakes Report).

## Trophic State Index

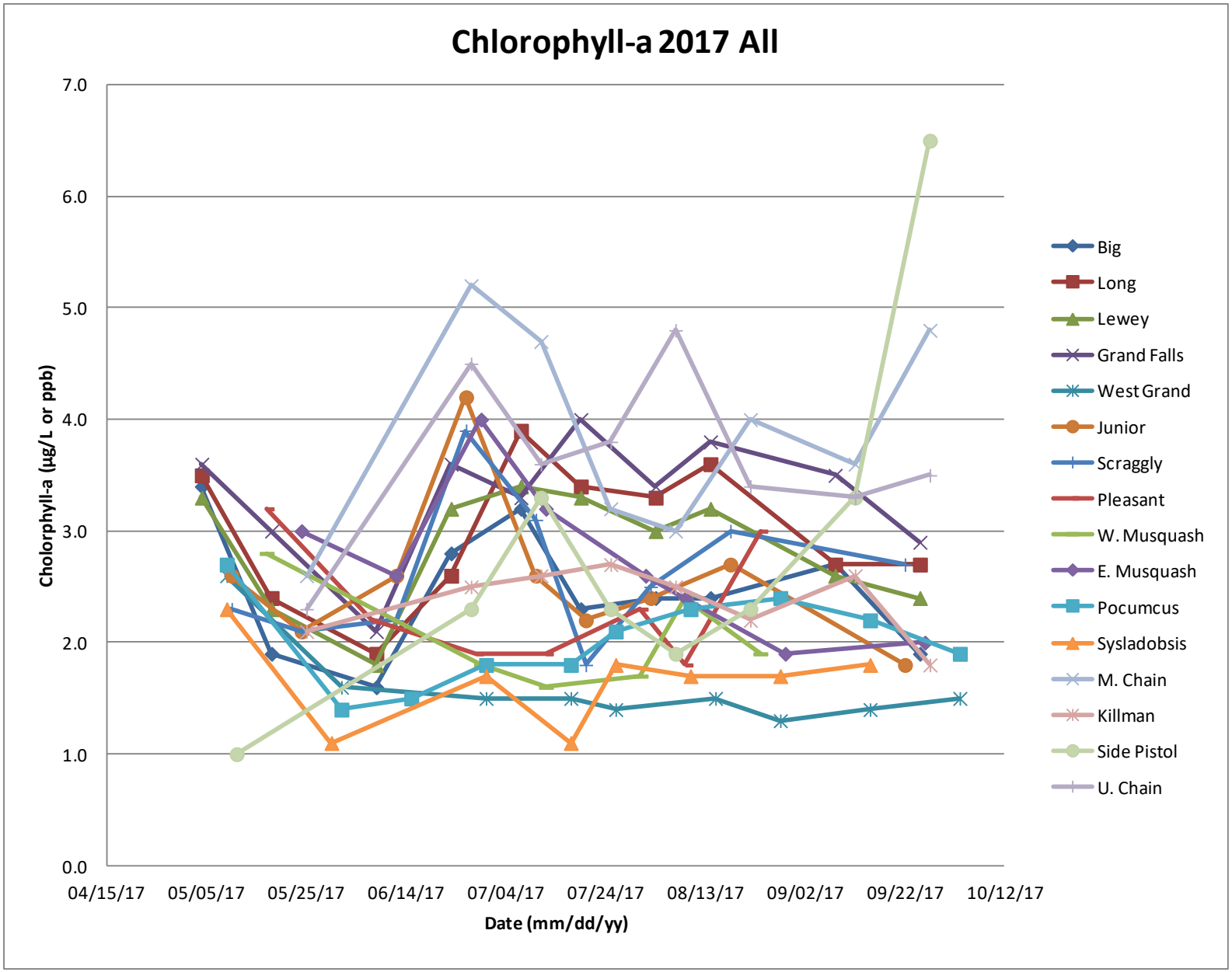
A simplified index of biological productivity in lakes, the Trophic State Index (TSI) was developed in 1977 by Robert Carlson as a means to be used for establishing a simple numerical scale for each of the three indicators of lake water quality that are commonly used to measure (directly or indirectly) lake productivity. Because the units of measurement and scale for Secchi disk transparency, total phosphorus and chlorophyll-a differ, the TSI provides a convenient means by which the three indicators can be compared. The TSI converts raw data from each of the three indicators to standard numerical scales that range from 0 to over 100, with higher numbers representing increasing productivity, and typically poorer water quality. The TSI models developed by Carlson have been modified for Maine lakes, based on historical data for each indicator (VLMP, 2008 Maine Lakes Report).

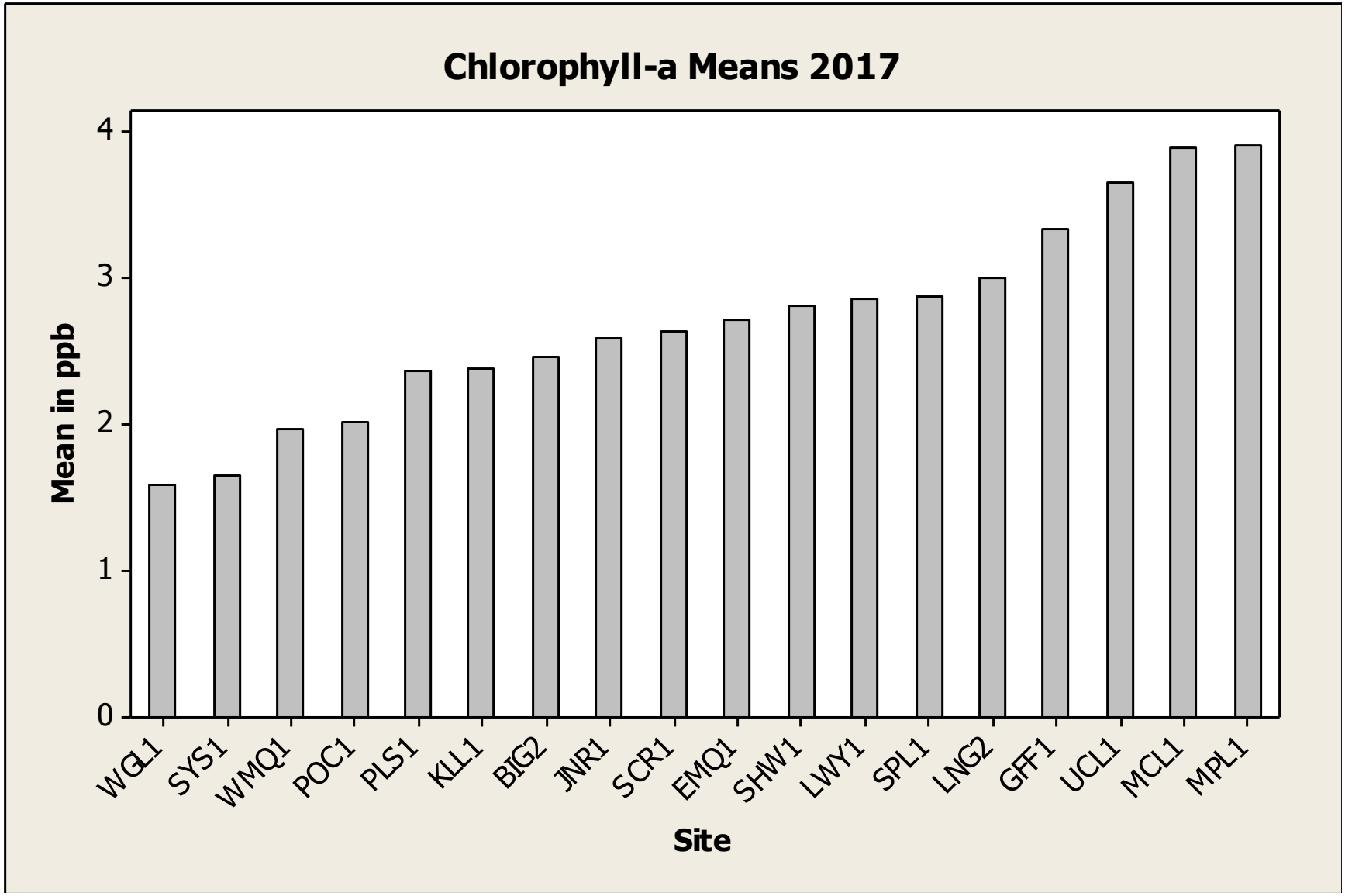
**Chlorophyll is what makes plants green, whether they be on land or water. It's how they convert sunlight into a more useable form of energy. Photo courtesy of Haleigh White.**

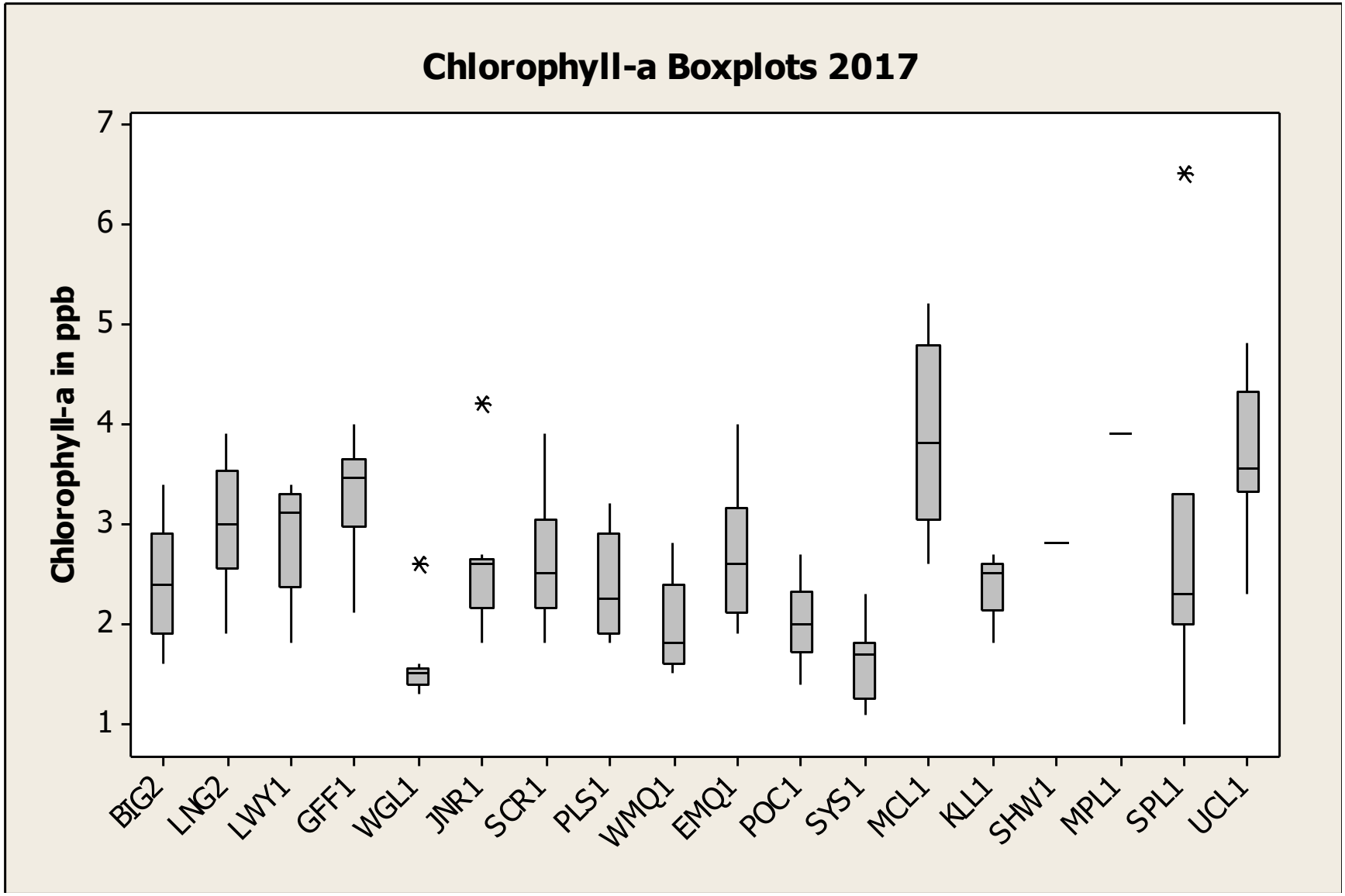
## Chlorophyll-a

A pigment found in algae and other plants used to estimate biological productivity of lake ecosystems. By measuring the concentration of Chl-a in lake water, the algae population can be estimated. Chl-a is measured in parts per billion (ppb). Chlorophyll-a samples are generally obtained from an integrated water column sample because the greatest concentration of algal growth typically occurs from the surface of the lake to the bottom of the epilimnion or the top of the thermocline (VLMP, 2008 Maine Lakes Report).

Below are three graphics displaying Chlorophyll-concentrations found for our sample sites for 2017. The Chl-a results have been broken down into three different graphs. The first is a scatter plot showing the change in values over the sampling season. The second graph is a simple bar chart showing the mean, or average, of each lake. The third is a chart of box plots for the lakes, adding in a bit more information like range, median, etc which helps show a visual of the range of values we see on Tribal waters. *SHW1 and MPL1 only have 1 value.


Chlorophyll-a 2017 All
Cholorphyll-a (µg/L or ppb)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
Date (mm/dd/yy)
Big
Long
Lewey
Grand Falls
West Grand
Junior
Scraggly
Pleasant
W. Musquash
E. Musquash
Pocumcus
Sysladobsis
M. Chain
Killman
Side Pistol
U. Chain


Chlorophyll-a Means 2017
Mean in ppb
0
1
2
3
4
WGL1
SYS1
WMQ1
POC1
PLS1
KLL1
BIG2
JNR1
SCR1
EMQ1
SHW1
LWY1
SPL1
LNG2
GFF1
UCL1
MCL1
MPL1
Site

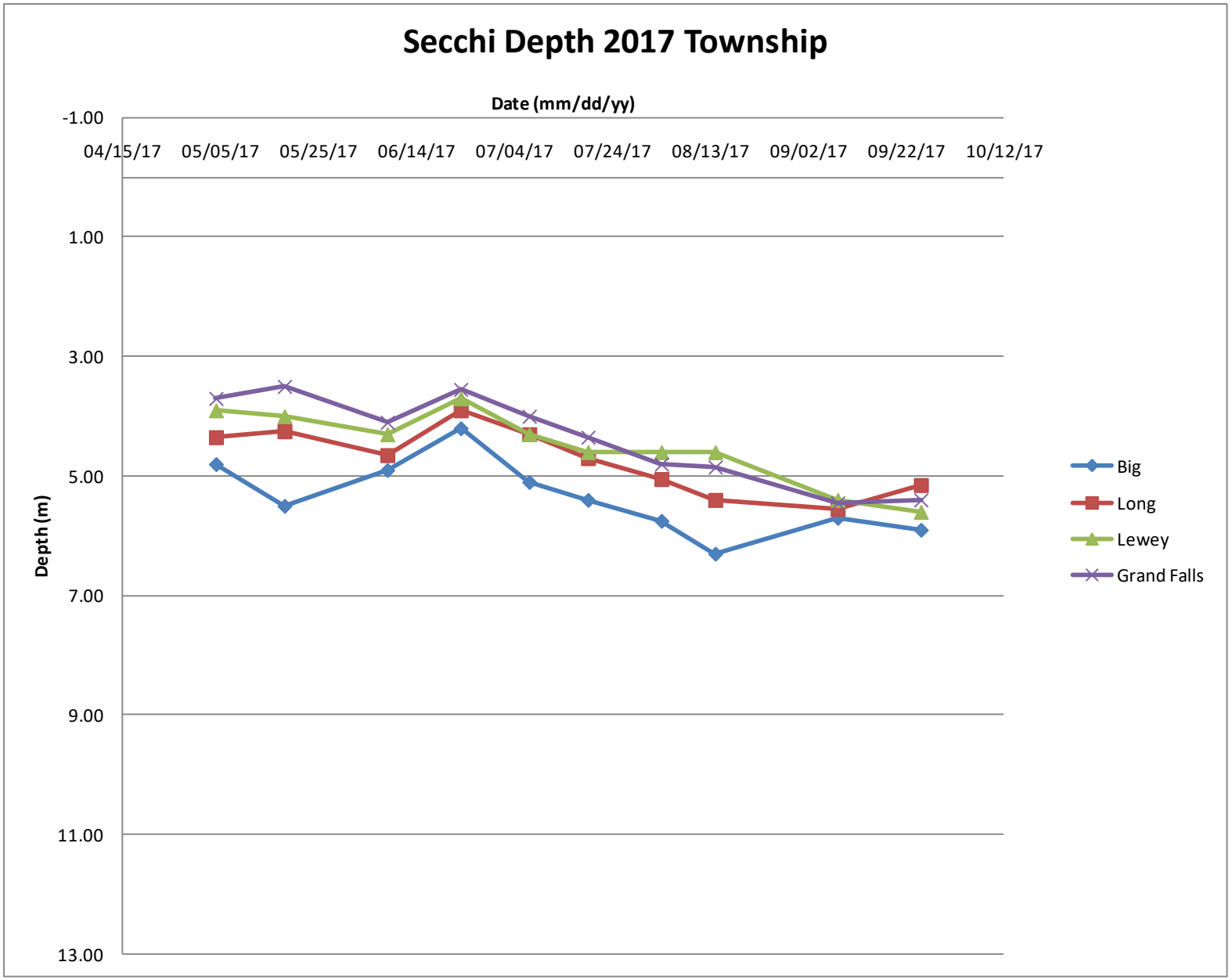

Chlorophyll-a Boxplots 2017
Chlorophyll-a in ppb
7
6
5
4
3
2
1
BIG2
LNG2
LWY1
GFF1
WGL1
JNR1
SCR1
PLS1
WMQ1
EMQ1
POC1
SYS1
MCL1
KLL1
SHW1
MPL1
SPL1
UCL1

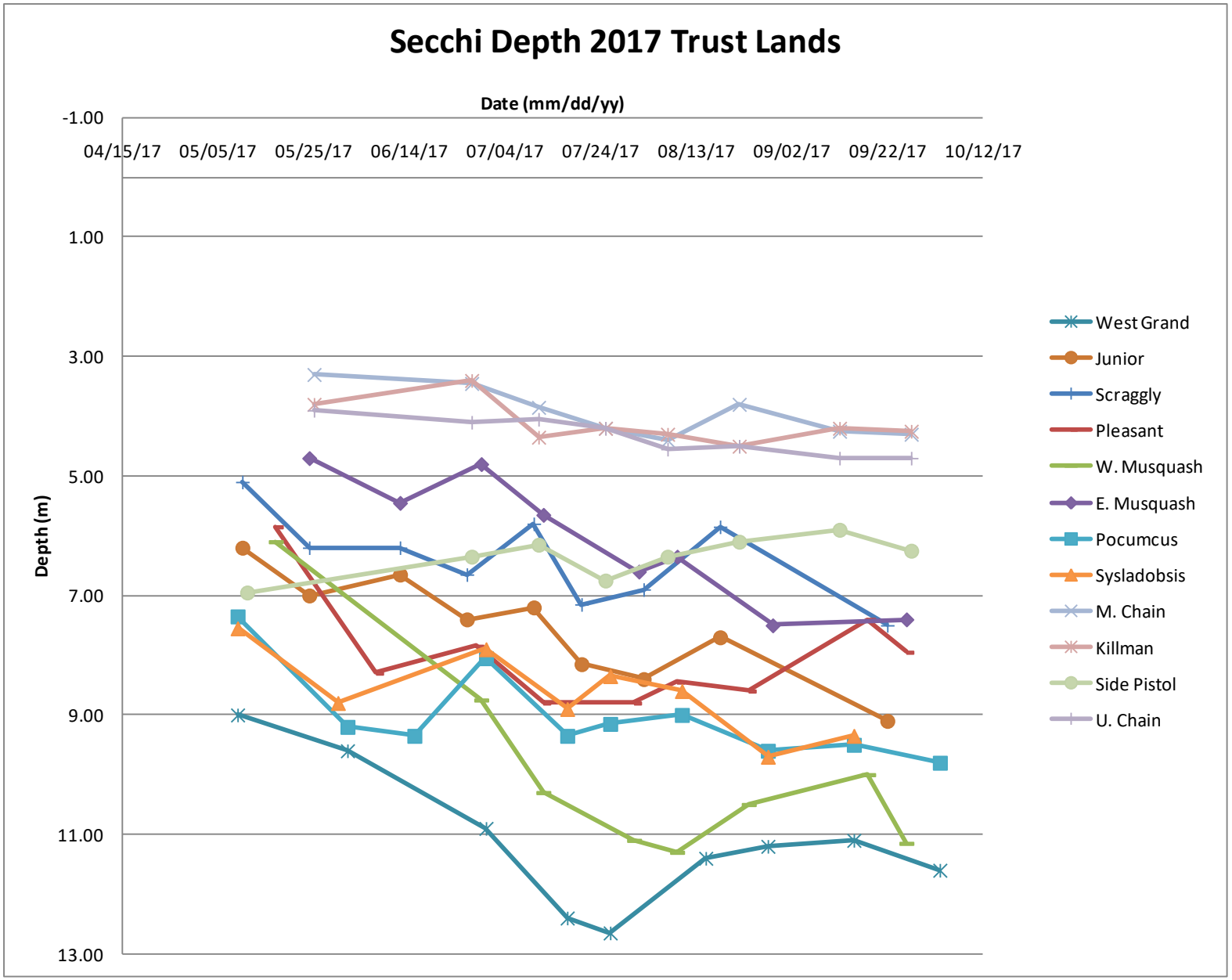
## Transparency

A measure of water clarity; the distance one can see down into the water column. Factors that affect transparency include algal growth, zooplankton, natural water color, and suspended silt particles. Because algae are the most abundant particles in most lakes, transparency indirectly measures algal growth. Transparency values vary widely in Maine lakes. Unless a lake is highly colored or turbid from suspended sediment, transparency readings of 2 meters or less generally indicates a severe algal bloom (VLMP, 2008 Maine Lakes Report).

Below are two graphics displaying Secchi Depth (SD) values measuring transparency for our sample sites this year. The SD results have been broken down into two general groups of lakes: the 4 Township lakes and the 15 Springfield area Trust Land lakes and ponds. These graphs are simple scatter plots of SD depth values found for each sampling event from May through September 2017. These graphics are useful to see the corresponding seasonal variations between water bodies, and also gives a visual of the range of values we see on Tribal waters. The effects of the drought are very easy to see as the readings go from May – September.

**Being able to see down into water really makes lakes and ponds more aesthetically pleasing, and makes for some beautiful scenery. Photo courtesy of Haleigh White.**


Secchi Depth 2017 Township
Date (mm/dd/yy)
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
13.00
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
Depth (m)
Big
Long
Lewey
Grand Falls


Secchi Depth 2017 Trust Lands
Date (mm/dd/yy)
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
13.00
Depth (m)
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
West Grand
Junior
Scraggly
Pleasant
W. Musquash
E. Musquash
Pocumcus
Sysladobsis
M. Chain
Killman
Side Pistol
U. Chain

**Total Phosphorous**

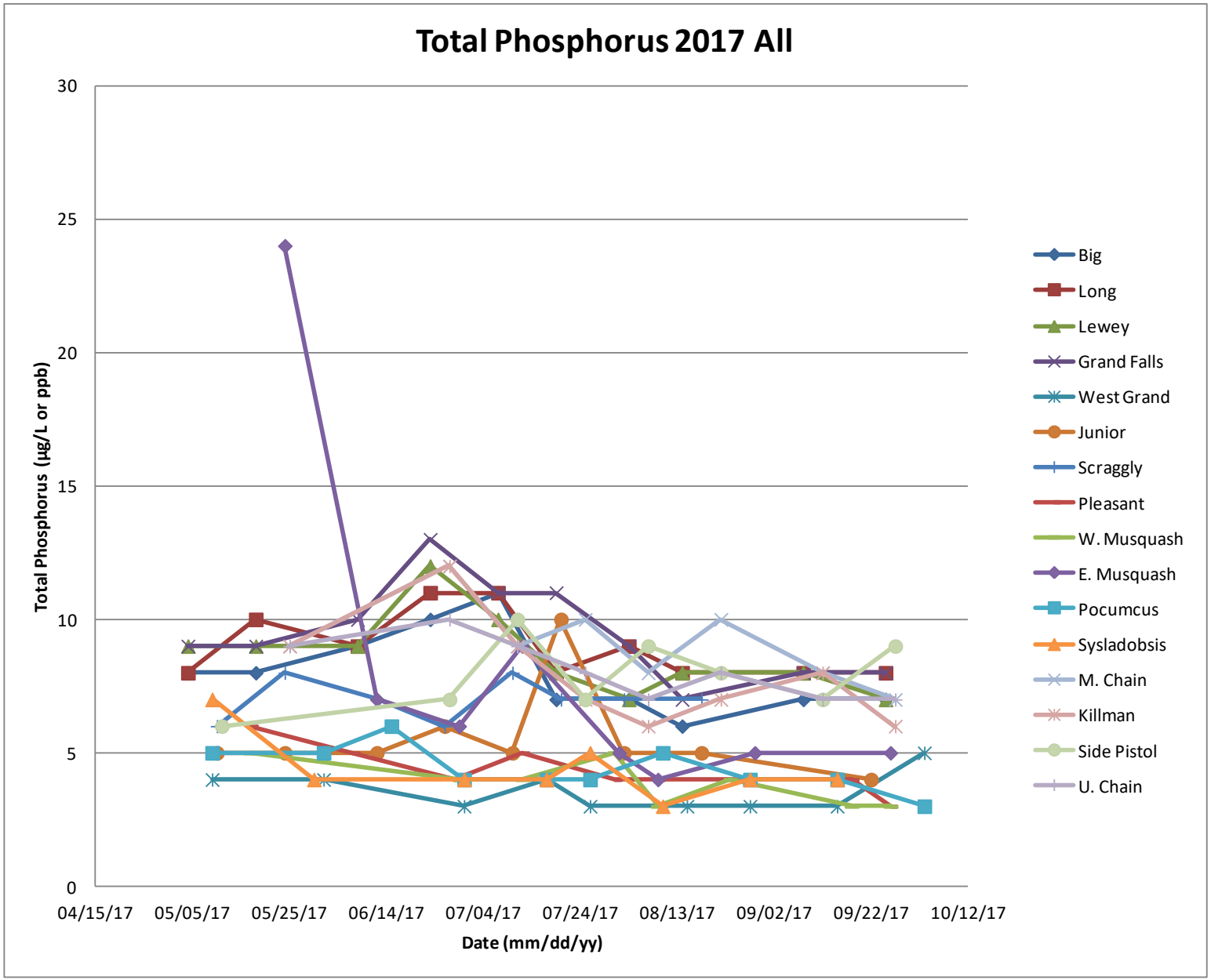
A measure of all forms of phosphorus (organic and inorganic) in the water. Phosphorus is one of the major nutrients needed for plant growth. Because its natural occurrence in lakes is very small, phosphorus "limits" the growth of algae in lake ecosystems. Small increases in phosphorus in lake water can cause substantial increases in algal growth. Phosphorus is measured in parts per billion (ppb). Phosphorus concentrations may be based on samples taken from the surface of the lake or from discrete samples taken at specific depths, or from an integrated water column (epilimnetic core) sample (VLMP, 2008 Maine Lakes Report).

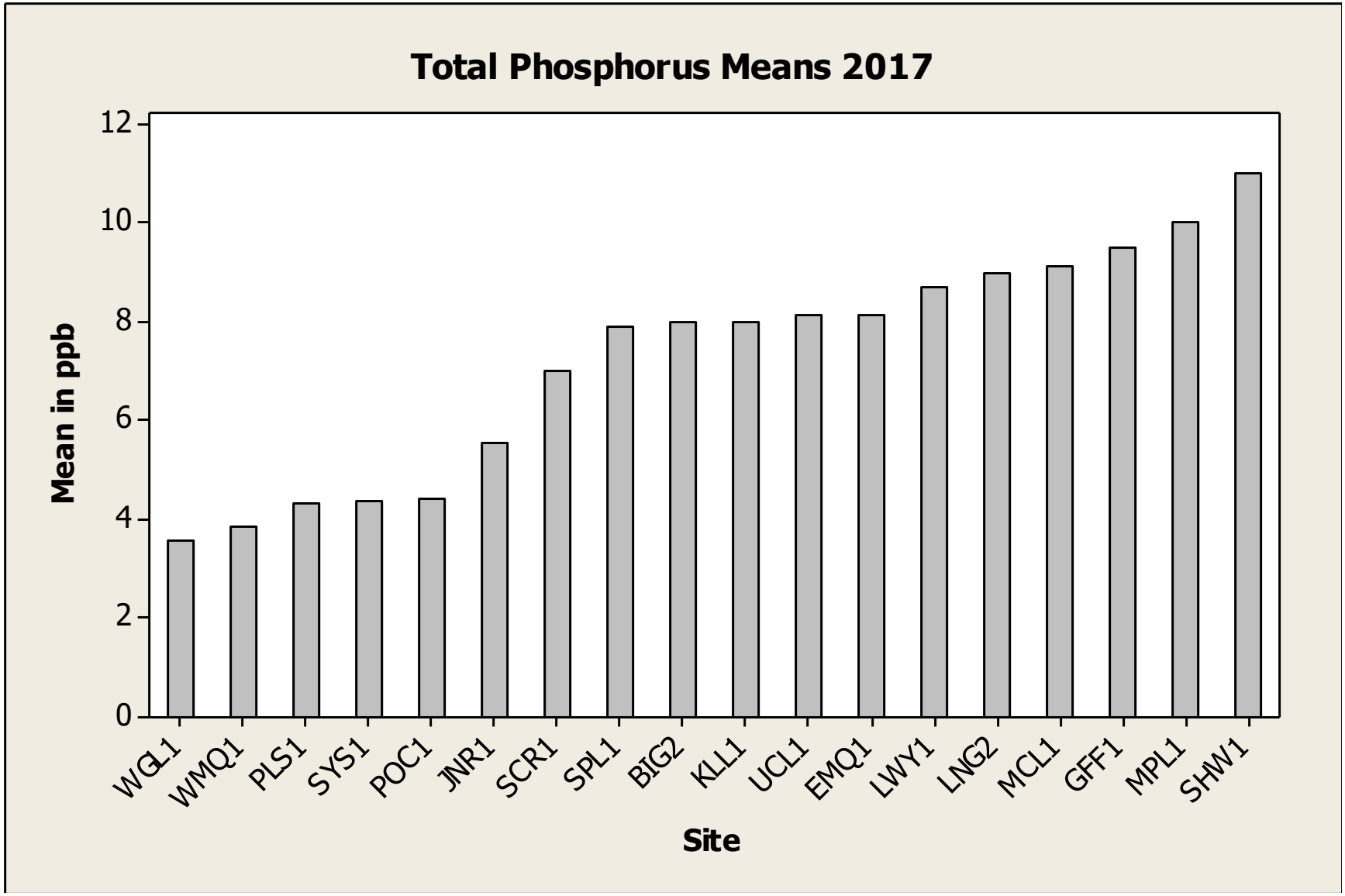
Below are three graphics displaying TP concentrations found for our sample sites for 2017. The TP results have been broken down into three different graphs. The first is a scatter plot showing the change in values over the sampling season. The second graph is a simple bar chart showing the mean, or average, of each lake. The third is a chart of box plots for the lakes, adding in a bit more information like range, median, etc which helps show a visual of the range of values we see on Tribal waters.

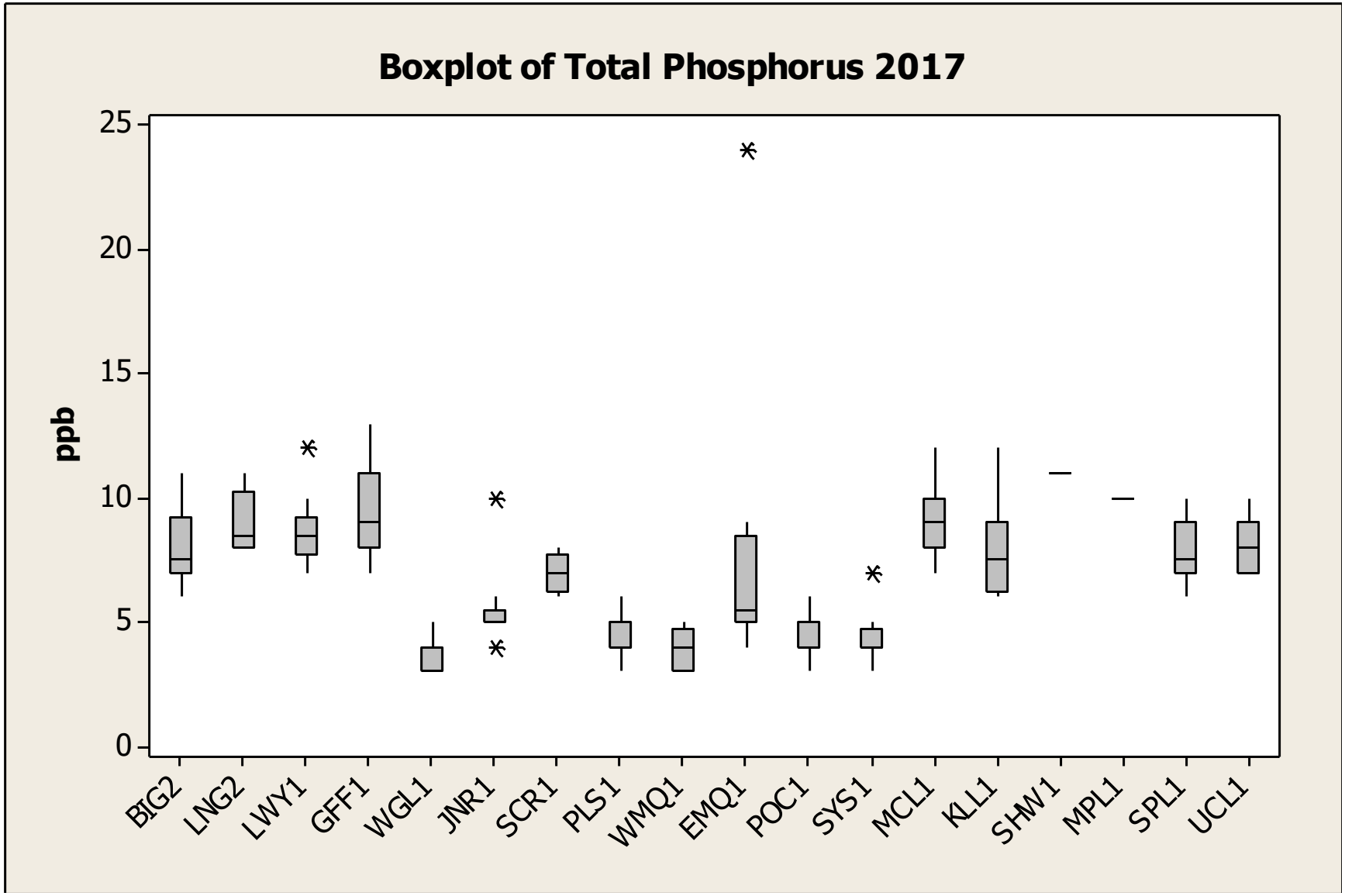
The best use of the first graph is to show the effects of the drought. The TP values have a strong correlation to drop as the amount of precipitation drops. Precipitation events carry sediment into the watershed, which adds Phosphorus and other nutrients.

*SHW1 and MPL1 only have 1 value.

**A pair of eggs in a loon nest on Pocumcus Lake on a floating bog mat island, Spring 2010. Joe Musante**


Total Phosphorus 2017 All
Total Phosphorus (µg/L or ppb)
30
25
20
15
10
5
0
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
Date (mm/dd/yy)
Big
Long
Lewey
Grand Falls
West Grand
Junior
Scraggly
Pleasant
W. Musquash
E. Musquash
Pocumcus
Sysladobsis
M. Chain
Killman
Side Pistol
U. Chain


Total Phosphorus Means 2017
Mean in ppb
0
2
4
6
8
10
12
WGL1
WMQ1
PLS1
SYS1
POC1
JNR1
SCR1
SPL1
BIG2
KLL1
UCL1
EMQ1
LWY1
LNG2
MCL1
GFF1
MPL1
SHW1
Site


Boxplot of Total Phosphorus 2017
ppb
25
20
15
10
5
0
BIG2
LNG2
LWY1
GFF1
WGL1
JNR1
SCR1
PLS1
WMQ1
EMQ1
POC1
SYS1
MCL1
KLL1
SHW1
MPL1
SPL1
UCL1

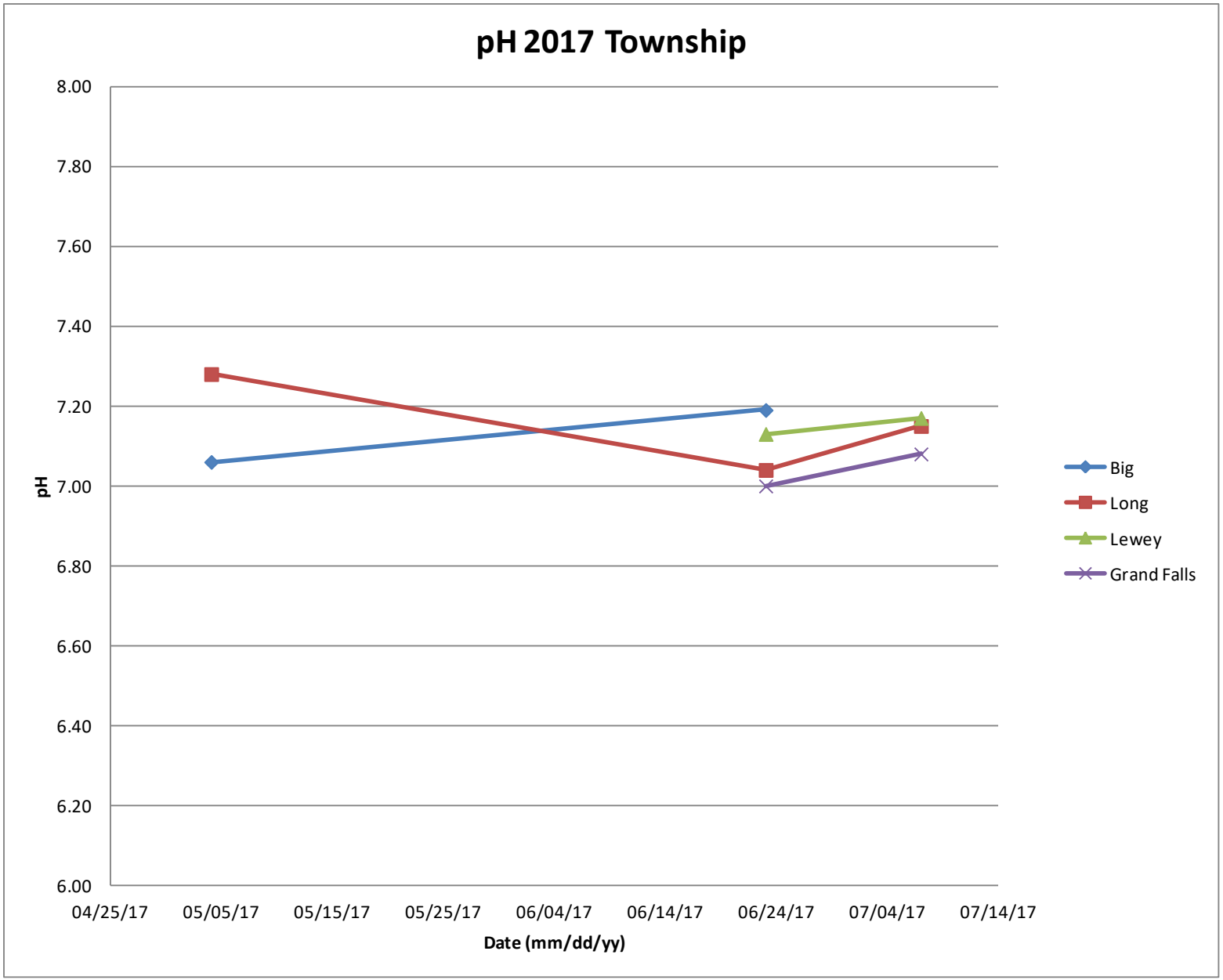
**pH**

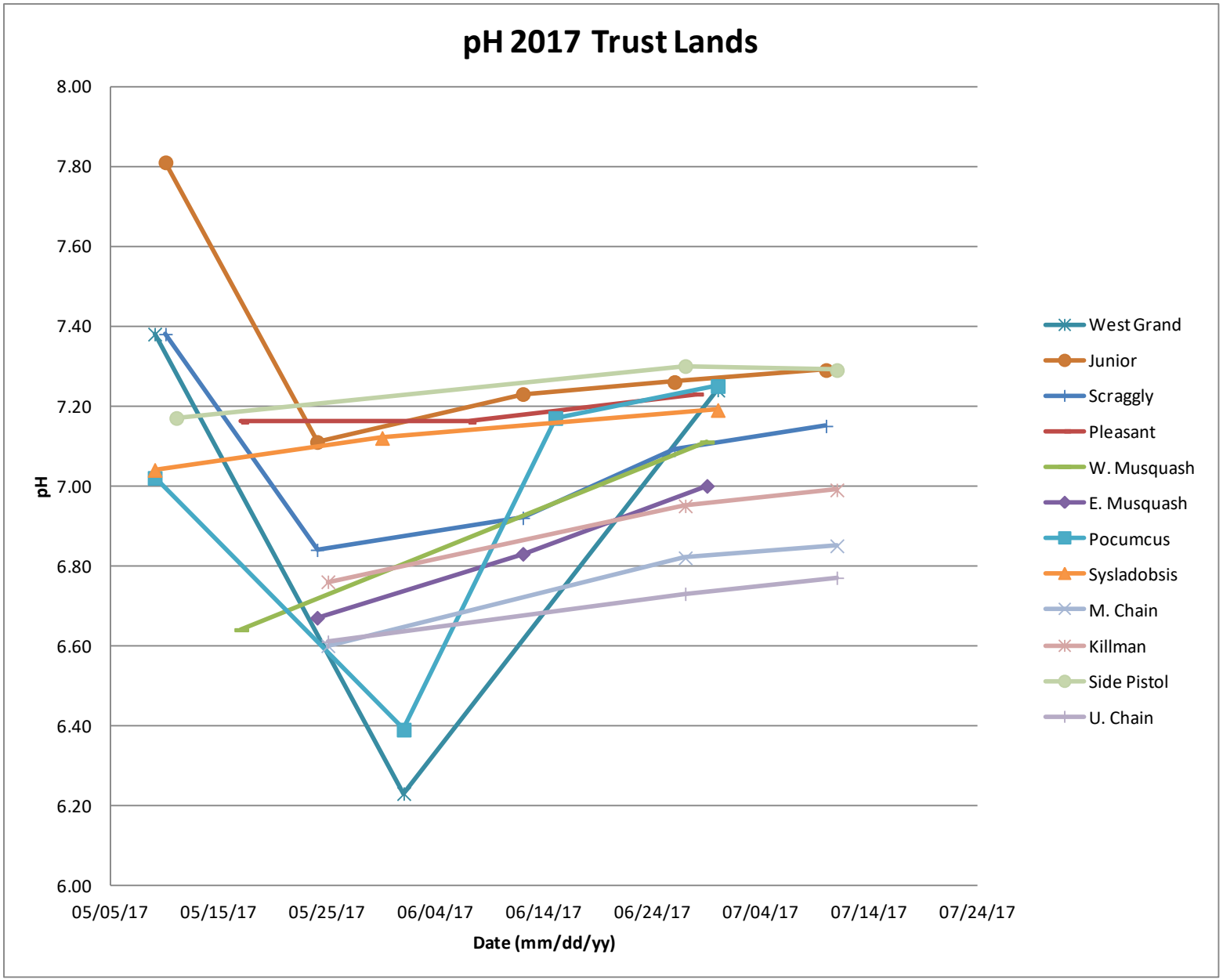
A measure of the relative acid-base status of lake water, pH helps determine which plant and animal species can live in the lake, and it governs biochemical processes that take place. The pH scale ranges from 0-14, with 7 being neutral. Water is increasingly acidic below 7, and increasingly alkaline above 7. A one unit change in pH represents a tenfold change in acidity or alkalinity. The pH scale is the inverse log of the hydrogen ion concentration (VLMP, 2008 Maine Lakes Report).

Below are two graphics displaying pH values for our sample sites this year. The pH results have been broken down into two general groups of lakes: the 4 Township lakes and the 15 Springfield area Trust Land lakes and ponds. These graphs are simple scatter plots of pH values found for each sampling event from May through July 2017.

Due to the smaller amount of data here, these graphs aren't as useful as we would hope. They at least give you a range of values we see here.

**Round-leaved sundews have adapted to low pH, low nutrient environments by capturing insects. Joe Musante**


pH 2017 Township
8.00
7.80
7.60
7.40
7.20
7.00
6.80
6.60
6.40
6.20
6.00
pH
04/25/17
05/05/17
05/15/17
05/25/17
06/04/17
06/14/17
06/24/17
07/04/17
07/14/17
Date (mm/dd/yy)
Big
Long
Lewey
Grand Falls

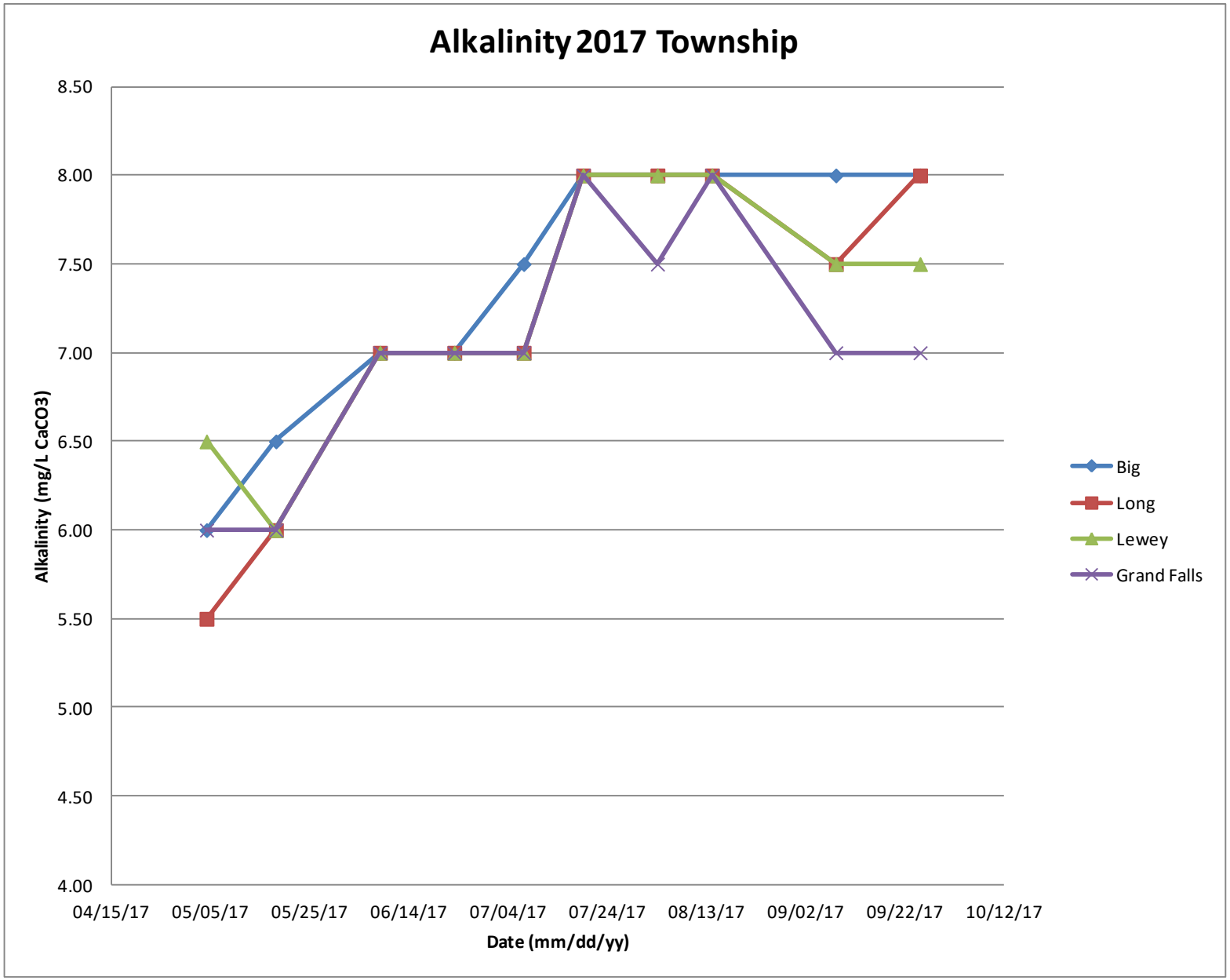

pH 2017 Trust Lands
8.00
7.80
7.60
7.40
7.20
7.00
6.80
6.60
6.40
6.20
6.00
pH
05/05/17
05/15/17
05/25/17
06/04/17
06/14/17
06/24/17
07/04/17
07/14/17
07/24/17
Date (mm/dd/yy)
West Grand
Junior
Scraggly
Pleasant
W. Musquash
E. Musquash
Pocumcus
Sysladobsis
M. Chain
Killman
Side Pistol
U. Chain

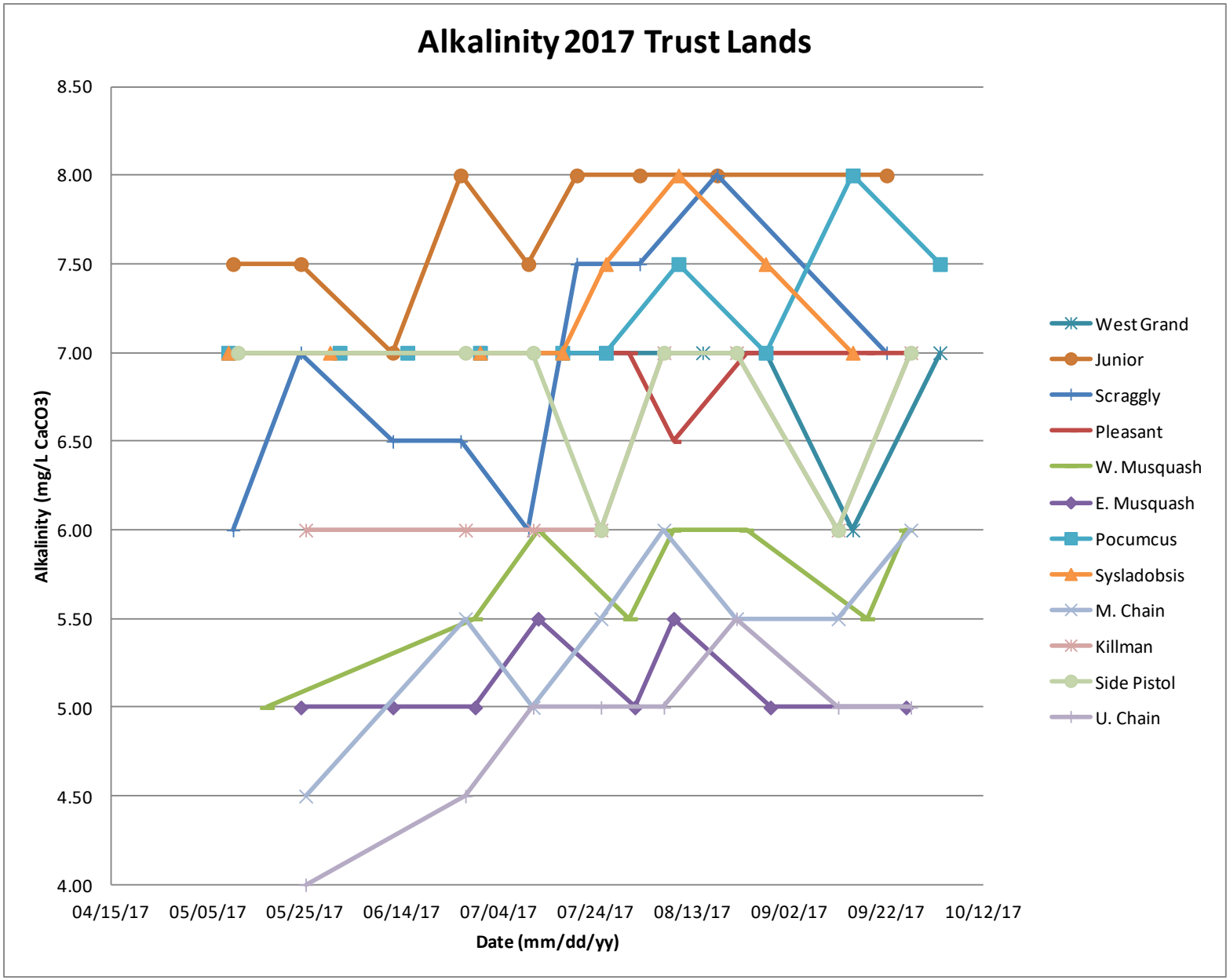
**Jack taking an integrated Core sample, May 2016.**

## Alkalinity

A measure of the capacity of water to neutralize acids, or buffer against changes in pH, alkalinity is also referred to as "buffering capacity." It is a measure primarily of naturally available bicarbonate, carbonate, and hydroxide ions in the water. Alkalinity is measured in milligrams per liter (mg/l) (VLMP, 2008 Maine Lakes Report).

Below are two graphics displaying Alkalinity values found for our sample sites this year. The Alkalinity results have been broken down into two general groups of lakes: the 4 Township lakes and the 15 Springfield area Trust Land lakes and ponds. These graphs are simple scatter plots of Alkalinity values found for each sampling event from May through September 2017. These graphics are useful to see the corresponding seasonal variations between water bodies, and also gives a visual of the range of values we see on Tribal waters.


Alkalinity 2017 Township
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
Alkalinity (mg/L CaCO3)
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
Date (mm/dd/yy)
Big
Long
Lewey
Grand Falls

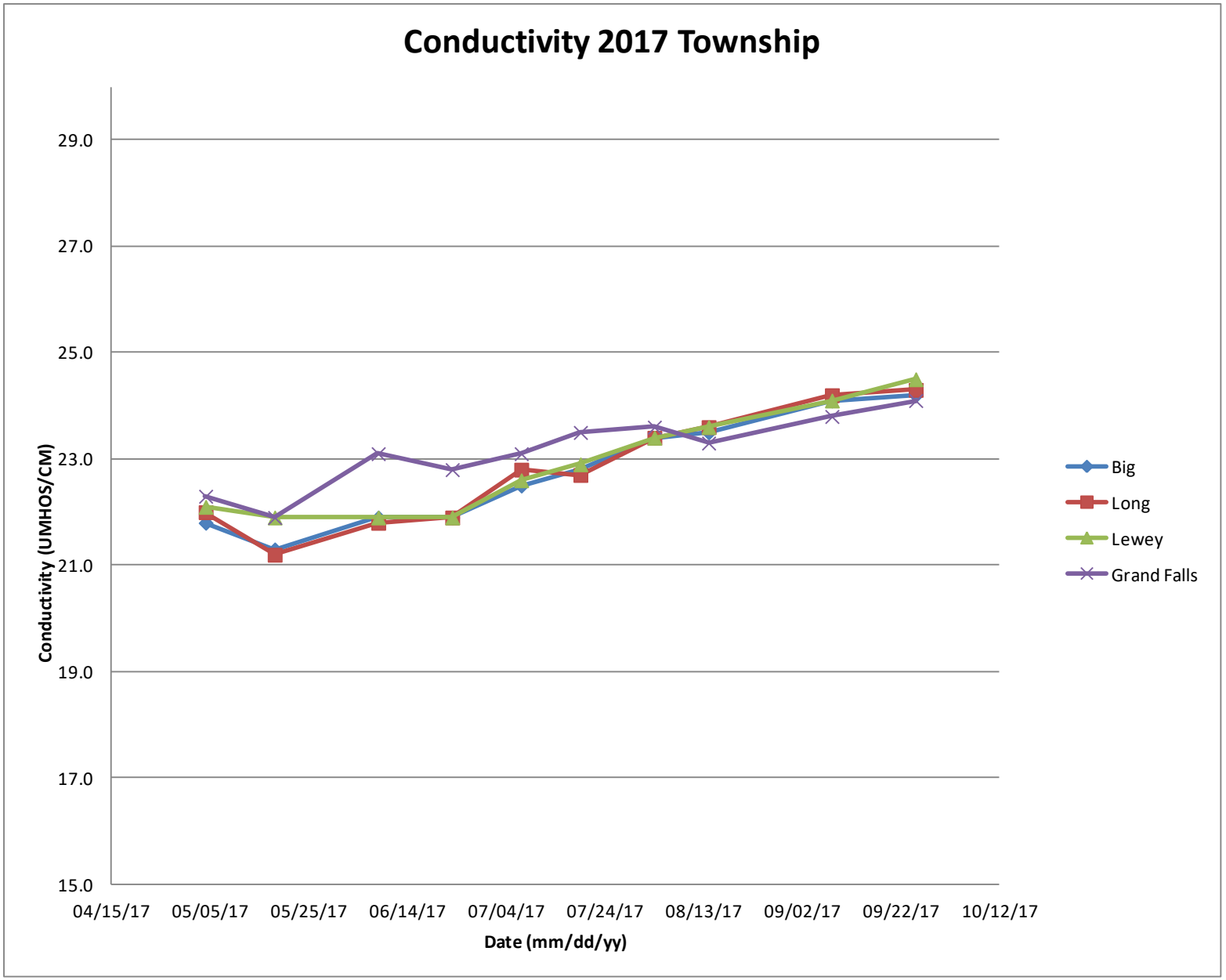

Alkalinity 2017 Trust Lands
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
Alkalinity (mg/L CaCO3)
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
Date (mm/dd/yy)
West Grand
Junior
Scraggly
Pleasant
W. Musquash
E. Musquash
Pocumcus
Sysladobsis
M. Chain
Killman
Side Pistol
U. Chain

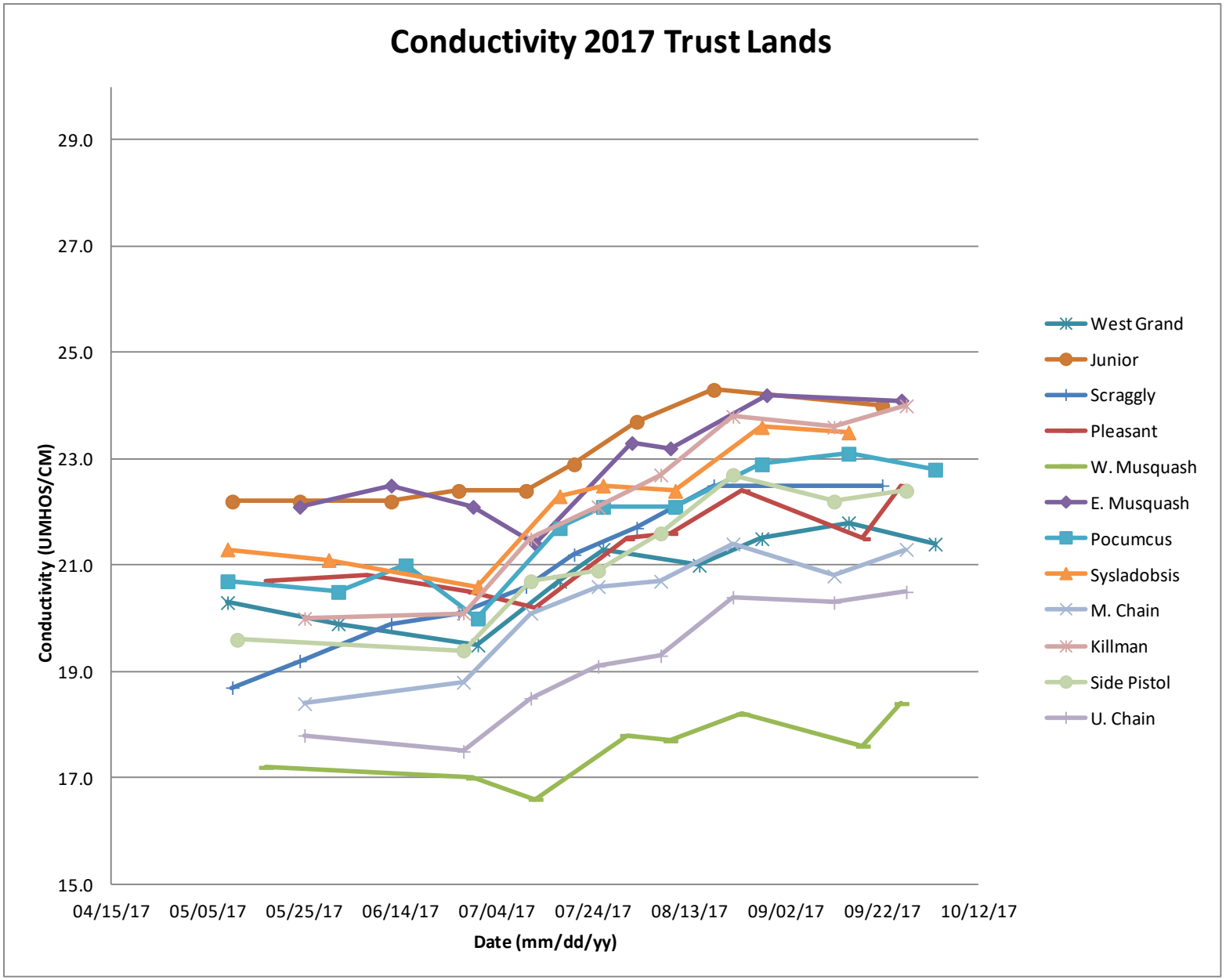
**Specific Conductance**

A measure of the ability of water to carry an electrical current, conductivity is directly related to the level of dissolved ions in the water. Conductivity levels will generally increase if there is an increase in the concentration of pollutants in the water. Conductivity is measured in micro-siemens per centimeter (µS/cm) or micro-mhos per centimeter (or µmhos/cm) (VLMP, 2008 Maine Lakes Report).

Below are two graphics displaying Specific Conductance values found for our sample sites this year. These results have been broken down into two general groups of lakes: the 4 Township lakes and the 15 Springfield area Trust Land lakes and ponds. These graphs are simple scatter plots of the conductivity values found for each sampling event from May through September 2017. These graphics are useful to see the corresponding seasonal variations between water bodies, and also gives a visual of the range of values we see on Tribal waters.

You can easily see the trend of increasing conductivity as the summer season progresses. This shows up yearly, typically because the Spring snow melt adds in the largest amount of lower conductivity water. As the summer goes on the amount of water from precipitation and run off decreases and the conductivity increases. This year being a drought year makes this trend even stronger.


Conductivity 2017 Township
29.0
27.0
25.0
23.0
21.0
19.0
17.0
15.0
Conductivity (UMHOS/CM)
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
Date (mm/dd/yy)
Big
Long
Lewey
Grand Falls

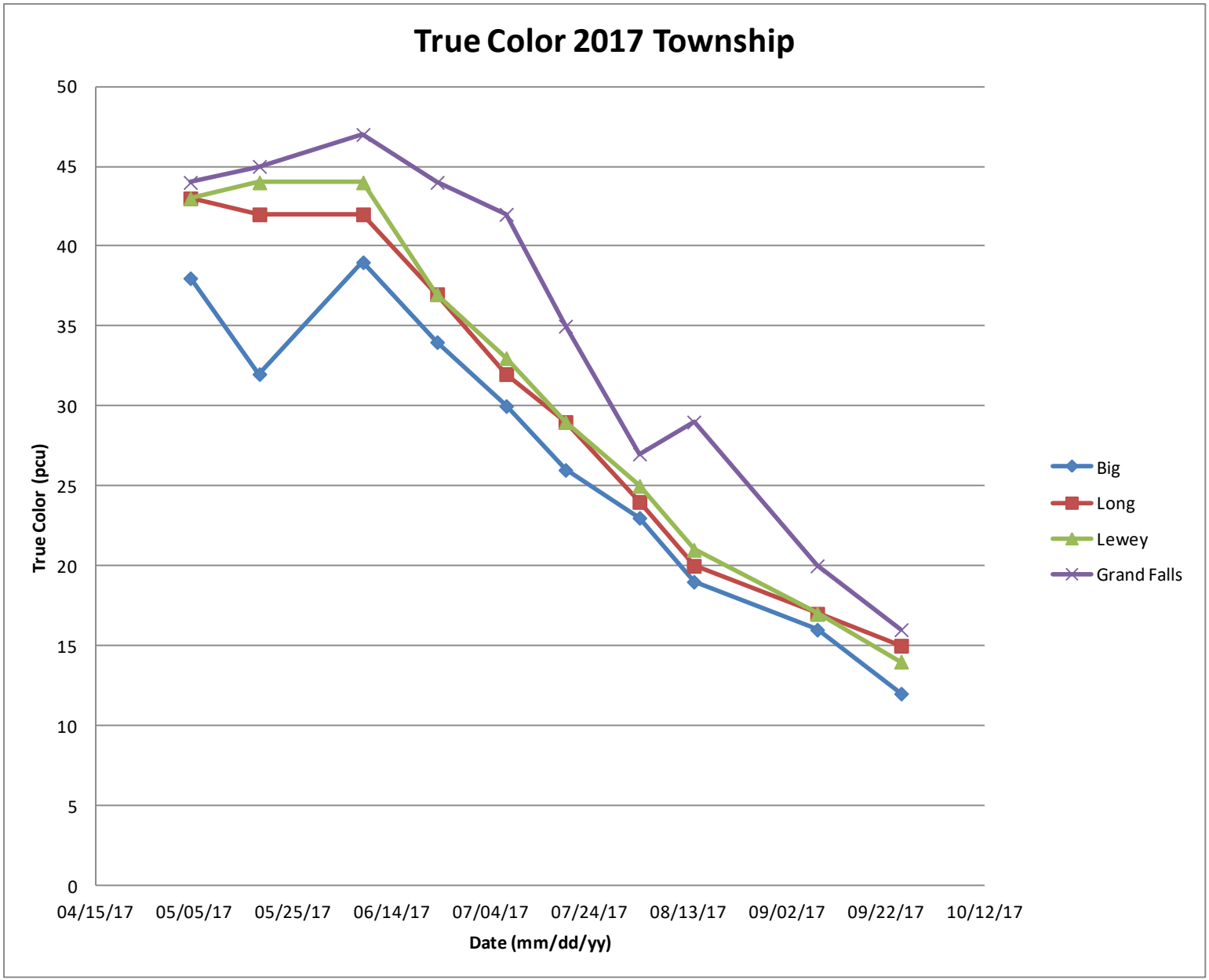

Conductivity 2017 Trust Lands
29.0
27.0
25.0
23.0
21.0
19.0
17.0
15.0
Conductivity (UMHOS/CM)
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
Date (mm/dd/yy)
West Grand
Junior
Scraggly
Pleasant
W. Musquash
E. Musquash
Pocumcus
Sysladobsis
M. Chain
Killman
Side Pistol
U. Chain

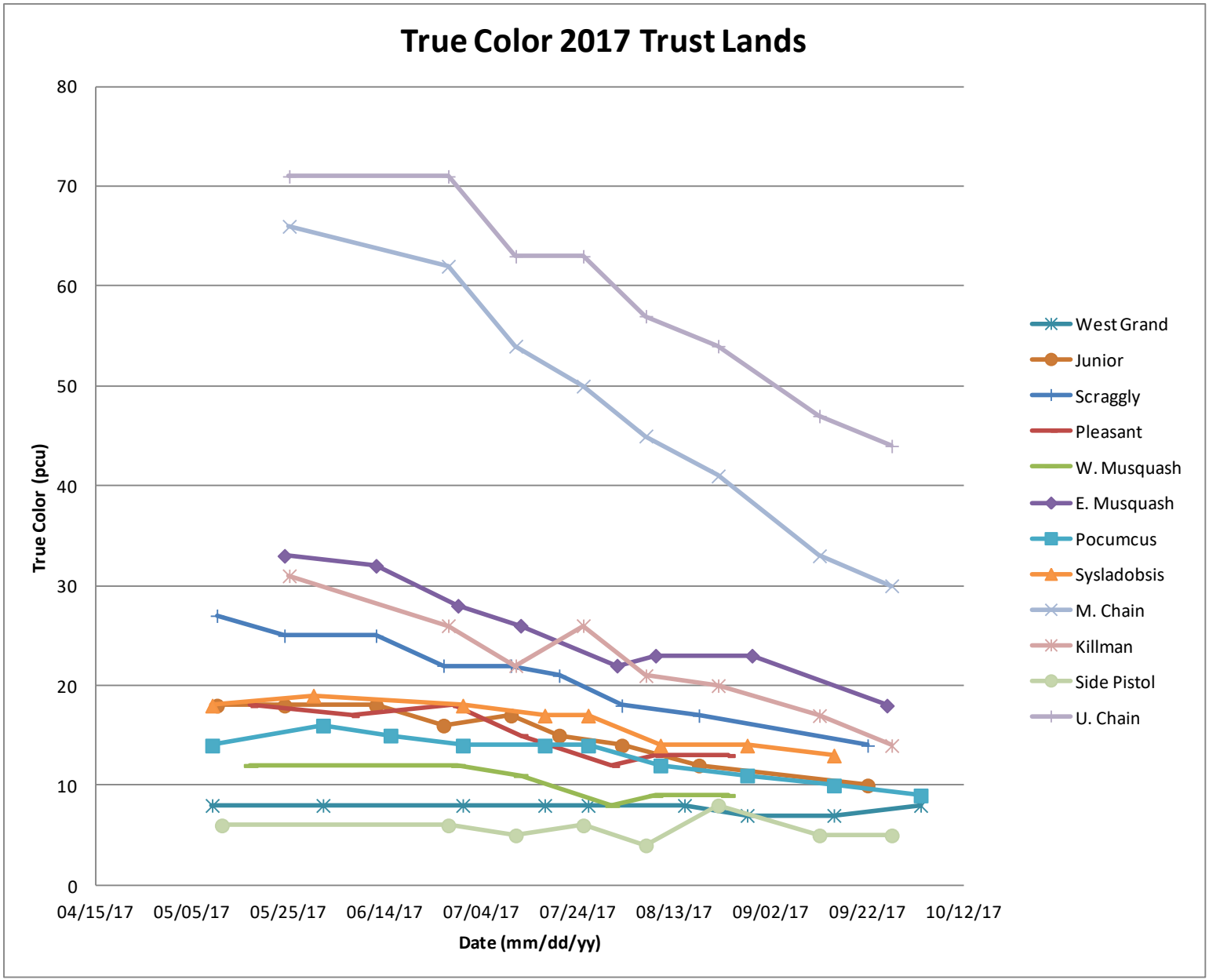
## Color

The concentration of natural, dissolved, humic acids in lake water, organic "Humic" acids leach from vegetation in the lake watershed. Color is measured in Standard Platinum Units (SPU). Lakes with color levels greater than 25 SPU are considered to be colored. This can cause transparency to be reduced, and phosphorus levels to be elevated. The water in highly colored lakes often has the appearance of tea. When lakes are highly colored, the best indicator of algal growth is chlorophyll-a (VLMP, 2008 Maine Lakes Report).

**Some striking colors in nature from a coastal salt marsh. Photo courtesy of Joe Musante.**

Below are two graphics displaying true (filtered) color values found for our sample sites this year. These results have been broken down into two general groups of lakes: the 4 Township lakes and the 15 Springfield area Trust Land lakes and ponds. These graphs are simple scatter plots of the color values found for each sampling event from May through September 2017. These graphics are useful to see the corresponding seasonal variations between water bodies, and also gives a visual of the range of values we see on Tribal waters.


True Color 2017 Township
50
45
40
35
30
25
20
15
10
5
0
True Color (pcu)
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
Date (mm/dd/yy)
Big
Long
Lewey
Grand Falls


True Color 2017 Trust Lands
True Color (pcu)
80
70
60
50
40
30
20
10
0
04/15/17
05/05/17
05/25/17
06/14/17
07/04/17
07/24/17
08/13/17
09/02/17
09/22/17
10/12/17
Date (mm/dd/yy)
West Grand
Junior
Scraggly
Pleasant
W. Musquash
E. Musquash
Pocumcus
Sysladobsis
M. Chain
Killman
Side Pistol
U. Chain

## Methods

### Site Selection

Lakes on or near tribal lands to be included in the monitoring program were selected according to accessibility by road. Bathymetric maps were obtained from the Maine Department of Inland Fisheries and Wildlife for the following water bodies: **Junior Lake, Killman Pond, Middle Chain Lake, Mill Privilege Lake, Pocumcus Lake, Scraggly Lake, Shaw Lake, Side Pistol Lake, Sysladobsis Lake, Upper Chain Lake**, **Pleasant Lake, West Musquash Lake, East Musquash Lake, and West Grand Lake.** These were all incorporated into the monitoring program along with the 4 lakes on Indian Township: **Big Lake, Long Lake, Lewey Lake, Grand Falls Flowage**. See Table 1 for summary of water bodies sampled each season. Site location maps are also included in appendix A.

**Joe taking a Secchi disk reading, Upper Chain Lake May 2016.**

**Table 1. Waterbodies included in ITTG Monitoring Program**

| Waterbodies Sampled in the ITTG Water Quality Program by Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **93-'99** | **00-'02** | **2002** | **03-'04** | **2005** | **06-'07** | **2008** | **09-'10** | **11-'12** | **13-'16** | **2017** |
| Big | Big | Big | Big | Big (2) | No | Big | Big | Big | Big | Big |
| Long | Long | Long | Long | Long | sampling | Long | Long | Long | Long | Long |
| Lewey | Lewey | Lewey | Lewey | Lewey | done | Lewey | Lewey | Lewey | Lewey | Lewey |
| Grand Falls | Grand Falls | Grand Falls | Grand Falls | Grand Falls(2) | these | Grand Falls | Grand Falls | Grand Falls | Grand Falls | Grand Falls |
| | | | Tomah Str. | Tomah Str | two | Tomah Str | Tomah Str | | | |
| | *Side Pistol | Side Pistol | Side Pistol | Side Pistol | years. | | Side Pistol | Side Pistol | Side Pistol | Side Pistol |
| | *Upper Chain | Upper Chain | Upper Chain | Upper Chain | | *Upper Chain | Upper Chain | Upper Chain | Upper Chain | Upper Chain |
| | | Duncan | Duncan | Duncan | | *Duncan | Duncan | *Duncan | *Duncan | |
| | | Junior | Junior | Junior | | | Junior | Junior | Junior | Junior |
| | | Killman | Killman | Killman | | *Killman | Killman | Killman | Killman | Killman |
| | | Mill Privilege | Mill Privilege | Mill Privilege | | | Mill Privilege | Mill Privilege | Mill Privilege | *Mill Privilege |
| | | Pocumcus | Pocumcus | Pocumcus | | | Pocumcus | Pocumcus | Pocumcus | Pocumcus |
| | | Scraggly | Scraggly | Scraggly | | | Scraggly | Scraggly | Scraggly | Scraggly |
| | | Shaw | Shaw | Shaw | | | Shaw | Shaw | Shaw | *Shaw |
| | | Sysladobsis | Sysladobsis | Sysladobsis | | | Sysladobsis | Sysladobsis | Sysladobsis | Sysladobsis |
| | | | | Mary Petuche | | *Mary Petuche | Mary Petuche | *Mary Petuche | *Mary Petuche | |
| | | | | | | *Hall | Hall | *Hall | *Hall | |
| | | | | East Grand | | | Middle Chain | Middle Chain | Middle Chain | Middle Chain |
| | | | | | | | | West Grand | West Grand | West Grand |
| | | | | | | | | Pleasant | Pleasant | Pleasant |
| | | | | | | | | E. Musquash | E. Musquash | E. Musquash |
| | | | | | | | | W. Musquash | W. Musquash | W. Musquash |
| *Only sampled once or twice this year | | | | | | | | | Bassett | |

## Sample Collection and Field Measurements

Samples were collected and *in situ* measurements were taken according to procedures outlined in *Maine Department of Environmental Protection's 1993 Standard Field Methods for Lake Water Quality Monitoring by Judy Potvin and Linda Bacon.* Detailed Standard Operating Procedures for the monitoring program are included in Appendix B.

## Laboratory Analysis

Alkalinity samples were typically titrated within 48 hours of collection by staff in the office, some however are tested later, but well within the 14 day holding time. True color samples were processed by staff in the office within 48 hours of collection. Chl *a* samples were filtered within 24 hours using a hand held filter apparatus. The filter is then stored in the freezer waiting to be sent to the Health and Environmental Testing Lab in Augusta (HETL) to be processed. TP samples were immediately placed in the fridge. Within the appropriate time period (generally 1-2 weeks) Chl a and TP samples were mailed to HETL for analysis. The holding time for Chl-a and TP samples to be processed by the lab (assuming the Chl-a has been filtered and frozen) is 28 days. Sending samples every two weeks gives the lab an additional 2-3 weeks of time to process. See Appendix B for Standard Operating Procedures for all Lab analysis.

## Statistical Analysis

The formulas for calculating the Carlson Trophic State Index values for Secchi disk, chlorophyll *a*, and total phosphorus are presented below. Also presented is a table that lists the trophic state values and the corresponding measurements of the three parameters. Ranges of trophic state index values are often grouped into trophic state classifications. The range between 40 and 50 is usually associated with mesotrophy (moderate productivity). Index values greater than 50 are associated with eutrophy (high productivity). Values less than 40 are associated with oligotrophy (low productivity).

All 2017 samples were organized by water body and sampling site. For each parameter, mean, max, min, standard deviation, and TSI values were calculated. Historic data has not been included in this report, this data is only from the 2017 season. A historic comparison will be illustrated in a future report.

### Maine DEP Lake Assessment Criteria for Calculating Valid TSIs

1. Samples are to be taken from open water.
2. Five months of data are necessary; one reading per month is acceptable, but 2 readings per month are preferred.
3. Sampling period is May through November.
4. It is not permissible to be missing any 2 consecutive months of data.

5. The mean used in the equations shall be calculated as the mean of the monthly means in order that all months be equally weighted in the calculation.
6. Integrated cores should be taken to a depth equal to that of the late summer epilimnion or to the 2.0 mg/l D.O. level, whichever is less.
7. Secchi Transparency readings must not have hit the lake bottom.

**Formulas**

All lakes: TSIc = 70 log (mean Chlorophyll a in ppb + 0.71)

Lakes having color less than or equal to 25 Standard Platinum Units:

TSIp = 70 log (0.33 mean total phosphorus in ppb + 0.7)

TSIsd = 70 log [( 105 / mean Secchi transparency$^2$ ) + 0.7 ]

Note: Secchi transparency in meters

**TSI Table**

| TSI | Chlorophyll a (ppb) | Secchi Transparency (m) | Total Phosphorus (ppb) |
|---|---|---|---|
| 0 | 0.3 | 18.7 | 0.9 |
| 10 | 0.7 | 12.3 | 2.1 |
| 20 | 1.2 | 9.2 | 3.1 |
| 30 | 2.0 | 7.3 | 6.0 |
| 40 | 3.0 | 5.9 | 9.2 |
| 50 | 4.5 | 4.8 | 13.6 |
| 60 | 6.5 | 4.0 | 19.7 |
| 70 | 9.3 | 3.4 | 28.2 |
| 80 | 13.2 | 2.8 | 40 |
| 90 | 18.6 | 2.4 | 56.4 |
| 100 | 26.1 | 2.0 | 79.2 |

Note: Avoid making comparisons using raw data for the various parameters; the criteria assure that the TSIs are representative of the water quality for the open water season of May through November.

## Results: Reservation Waters

### Big Lake, Washington County, Maine

**Table 2, Big Lake 2017.**

| 2017 Big Lake | | | Site: BIG2 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/04/17 | 3.4 | 8 | 4.80 | 6.00 | 7.06 | 21.8 | 38 |
| 05/18/17 | 1.9 | 8 | 5.50 | 6.50 | NONE | 21.3 | 32 |
| **May Avg** | **2.7** | **8** | **5.15** | **6.25** | **7.06** | **21.6** | **35** |
| 06/08/17 | 1.6 | 9 | 4.90 | 7.00 | NONE | 21.9 | 39 |
| 06/23/17 | 2.8 | 10 | 4.20 | 7.00 | 7.19 | 21.9 | 34 |
| **June Avg** | **2.2** | **10** | **4.55** | **7.00** | **7.19** | **21.9** | **37** |
| 07/07/17 | 3.2 | 11 | 5.10 | 7.50 | 7.26 | 22.5 | 30 |
| 07/19/17 | 2.3 | 7 | 5.40 | 8.00 | NONE | 22.8 | 26 |
| **July Avg** | **2.8** | **9** | **5.25** | **7.75** | **7.26** | **22.7** | **28** |
| 08/03/17 | 2.4 | 7 | 5.75 | 8.00 | NONE | 23.4 | 23 |
| 08/14/17 | 2.4 | 6 | 6.30 | 8.00 | NONE | 23.5 | 19 |
| **Aug Avg** | **2.4** | **7** | **6.03** | **8.00** | **NONE** | **23.5** | **21** |
| 09/08/17 | 2.7 | 7 | 5.70 | 8.00 | NONE | 24.1 | 16 |
| 09/25/17 | 1.9 | 7 | 5.90 | 8.00 | NONE | 24.2 | 12 |
| **Sept Avg** | **2.3** | **7** | **5.80** | **8.00** | **NONE** | **24.2** | **14** |
| **Year Mean:** | **2.5** | **8** | **5.36** | **7.40** | **7.17** | **22.7** | **27** |
| **Maximum:** | **3.4** | **11** | **6.30** | **8.00** | **7.26** | **24.2** | **39** |
| **Minimum:** | **1.6** | **6** | **4.20** | **6.00** | **7.06** | **21.3** | **12** |
| **Stand Dev:** | **0.58** | **1.56** | **0.61** | **0.74** | **0.10** | **1.02** | **9.28** |
| **TSI:** | **35** | **37** | **45** | | | | |
| | | ***Only valid TSI is CHLA due to Color >25** | | | | | |

Table 2 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color mean, max, min, standard deviations, and TSI values for Big Lake in 2017. Big Lake is about 10,300 acres, with a max depth of 70 feet (21m) and is part of the St. Croix River watershed. Our sample site is in a shallower basin of 30 feet (9m). Sampling has been done on this lake since 1993.

## Long Lake, Washington County, Maine

**Table 3, Long Lake 2017.**

| 2017 Long Lake | | | Site: LNG2 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/04/17 | 3.5 | 8 | 4.35 | 5.50 | 7.28 | 22.0 | 43 |
| 05/18/17 | 2.4 | 10 | 4.25 | 6.00 | NONE | 21.2 | 42 |
| **May Avg** | **3.0** | **9** | **4.30** | **5.75** | **7.28** | **21.6** | **43** |
| 06/08/17 | 1.9 | 9 | 4.65 | 7.00 | NONE | 21.8 | 42 |
| 06/23/17 | 2.6 | 11 | 3.90 | 7.00 | 7.04 | 21.9 | 37 |
| **June Avg** | **2.3** | **10** | **4.28** | **7.00** | **7.04** | **21.9** | **40** |
| 07/07/17 | 3.9 | 11 | 4.30 | 7.00 | 7.15 | 22.8 | 32 |
| 07/19/17 | 3.4 | 8 | 4.70 | 8.00 | NONE | 22.7 | 29 |
| **July Avg** | **3.7** | **10** | **4.50** | **7.50** | **7.15** | **22.8** | **31** |
| 08/03/17 | 3.3 | 9 | 5.05 | 8.00 | NONE | 23.4 | 24 |
| 08/14/17 | 3.6 | 8 | 5.40 | 8.00 | NONE | 23.6 | 20 |
| **Aug Avg** | **3.5** | **9** | **5.23** | **8.00** | **NONE** | **23.5** | **22** |
| 09/08/17 | 2.7 | 8 | 5.55 | 7.50 | NONE | 24.2 | 17 |
| 09/25/17 | 2.7 | 8 | 5.15 | 8.00 | NONE | 24.3 | 15 |
| **Sept Avg** | **2.7** | **8** | **5.35** | **7.75** | **NONE** | **24.3** | **16** |
| **Year Mean:** | **3.0** | **9** | **4.73** | **7.20** | **7.16** | **22.8** | **30** |
| **Maximum:** | **3.9** | **11** | **5.55** | **8.00** | **7.28** | **24.3** | **43** |
| **Minimum:** | **1.9** | **8** | **3.90** | **5.50** | **7.04** | **21.2** | **15** |
| **Stand Dev:** | **0.63** | **1.25** | **0.54** | **0.89** | **0.12** | **1.07** | **10.75** |
| **TSI:** | **40** | **42** | **51** | | | | |
| ***Only valid TSI is CHLA due to Color >25** | | | | | | | |
| ****Used the Duplicate value for TP 6.8.17 as the original was an outlier. (16-9)** | | | | | | | |

Table 3 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Long Lake in 2017. Long Lake is about 595 acres, and is part of the St. Croix River watershed. It has been sampled since 1993. It also should be noted in Long Lake that from June to late August the hypoliminion becomes anoxic. This results in an increase of anaerobic bacteria and production of hydrogen sulfide. Water collected from the hypolimnion typically has a rotten egg odor when anoxic. Numerous seasonal and year round residences and camps occur on its western and southern shores.

## Lewey Lake, Washington County, Maine

**Table 4, Lewey Lake 2017.**

| 2017 Lewey Lake | | | Site: LWY1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/04/17 | 3.3 | 9 | 3.90 | 6.50 | NONE | 22.1 | 43 |
| 05/18/17 | 2.3 | 9 | 4.00 | 6.00 | NONE | 21.9 | 44 |
| **May Avg** | **2.8** | **9** | **3.95** | **6.25** | **NONE** | **22.0** | **44** |
| 06/08/17 | 1.8 | 9 | 4.30 | 7.00 | NONE | 21.9 | 44 |
| 06/23/17 | 3.2 | 12 | 3.70 | 7.00 | 7.13 | 21.9 | 37 |
| **June Avg** | **2.5** | **11** | **4.00** | **7.00** | **7.13** | **21.9** | **41** |
| 07/07/17 | 3.4 | 10 | 4.30 | 7.00 | 7.17 | 22.6 | 33 |
| 07/19/17 | 3.3 | 8 | 4.60 | 8.00 | NONE | 22.9 | 29 |
| **July Avg** | **3.4** | **9** | **4.45** | **7.50** | **7.17** | **22.8** | **31** |
| 08/03/17 | 3.0 | 7 | 4.60 | 8.00 | NONE | 23.4 | 25 |
| 08/14/17 | 3.2 | 8 | 4.60 | 8.00 | NONE | 23.6 | 21 |
| **Aug Avg** | **3.1** | **8** | **4.60** | **8.00** | **NONE** | **23.5** | **23** |
| 09/08/17 | 2.6 | 8 | 5.40 | 7.50 | NONE | 24.1 | 17 |
| 09/25/17 | 2.4 | 7 | 5.60 | 7.50 | NONE | 24.5 | 14 |
| **Sept Avg** | **2.5** | **8** | **5.50** | **7.50** | **NONE** | **24.3** | **16** |
| **Year Mean:** | **2.9** | **9** | **4.50** | **7.25** | **7.15** | **22.9** | **31** |
| **Maximum:** | **3.4** | **12** | **5.60** | **8.00** | **7.17** | **24.5** | **44** |
| **Minimum:** | **1.8** | **7** | **3.70** | **6.00** | **7.13** | **21.9** | **14** |
| **Stand Dev:** | **0.54** | **1.49** | **0.61** | **0.68** | **0.03** | **0.97** | **11.28** |
| **TSI:** | **39** | **40** | **54** | | | | |
| | | | ***Only valid TSI is CHLA due to Color >25** | | | | |

Table 4 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Lewey Lake in 2017. Lewey Lake is about 447 acres, and is part of the St. Croix River watershed. It has been sampled since 1993. It is very populated along its eastern and southern shores, Indian Township and Princeton respectively.

## Grand Falls Flowage, Washington County, Maine

**Table 5, Grand Falls Flowage 2017.**

| 2017 Grand Falls Flowage | | | Site: GFF1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/04/17 | 3.6 | 9 | 3.70 | 6.00 | NONE | 22.3 | 44 |
| 05/18/17 | 3.0 | 9 | 3.50 | 6.00 | NONE | 21.9 | 45 |
| **May Avg** | **3.3** | **9** | **3.60** | **6.00** | **NONE** | **22.1** | **45** |
| 06/08/17 | 2.1 | 10 | 4.10 | 7.00 | NONE | 23.1 | 47 |
| 06/23/17 | 3.6 | 13 | 3.55 | 7.00 | 7.00 | 22.8 | 44 |
| **June Avg** | **2.9** | **12** | **3.83** | **7.00** | **7.00** | **23.0** | **46** |
| 07/07/17 | 3.3 | 11 | 4.00 | 7.00 | 7.08 | 23.1 | 42 |
| 07/19/17 | 4.0 | 11 | 4.35 | 8.00 | NONE | 23.5 | 35 |
| **July Avg** | **3.7** | **11** | **4.18** | **7.50** | **7.08** | **23.3** | **39** |
| 08/03/17 | 3.4 | 9 | 4.80 | 7.50 | NONE | 23.6 | 27 |
| 08/14/17 | 3.8 | 7 | 4.85 | 8.00 | NONE | 23.3 | 29 |
| **Aug Avg** | **3.6** | **8** | **4.83** | **7.75** | **NONE** | **23.5** | **28** |
| 09/08/17 | 3.5 | 8 | 5.45 | 7.00 | NONE | 23.8 | 20 |
| 09/25/17 | 2.9 | 8 | 5.40 | 7.00 | NONE | 24.1 | 16 |
| **Sept Avg** | **3.2** | **8** | **5.43** | **7.00** | **NONE** | **24.0** | **18** |
| **Year Mean:** | **3.3** | **10** | **4.37** | **7.05** | **7.04** | **23.2** | **35** |
| **Maximum:** | **4.0** | **13** | **5.45** | **8.00** | **7.08** | **24.1** | **47** |
| **Minimum:** | **2.1** | **7** | **3.50** | **6.00** | **7.00** | **21.9** | **16** |
| **Stand Dev:** | **0.54** | **1.78** | **0.73** | **0.69** | **0.06** | **0.67** | **11.26** |
| **TSI:** | **42** | **42** | **55** | | | | |
| ***Only valid TSI is CHLA due to Color >25** | | | | | | | |

Table 5 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Grand Falls Flowage in 2017. Grand Falls Flowage expands to 6,691 acres of mostly shallow coves due to the impoundment of the dam. Not far below the dam does this watershed finally meet the St. Croix River. Maximum depth is listed at 29 feet (9 m), but our sampling site is located at 20 feet (6m). There are numerous seasonal and year-round residences along its shores, primarily to the south.

## Results: Trust Lands

### Junior Lake, Penobscot County, Maine

**Table 6, Junior Lake 2017.**

| 2017 Junior Lake | | | Site: JNR1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/10/17 | 2.6 | 5 | 6.20 | 7.50 | 7.81 | 22.2 | 18 |
| 05/24/17 | 2.1 | 5 | 7.00 | 7.50 | 7.11 | 22.2 | 18 |
| **May Avg** | **2.4** | **5** | **6.60** | **7.50** | **7.46** | **22.2** | **18** |
| 06/12/17 | 2.6 | 5 | 6.65 | 7.00 | 7.23 | 22.2 | 18 |
| 06/26/17 | 4.2 | 6 | 7.40 | 8.00 | 7.26 | 22.4 | 16 |
| **June Avg** | **3.4** | **6** | **7.03** | **7.50** | **7.25** | **22.3** | **17** |
| 07/10/17 | 2.6 | 5 | 7.20 | 7.50 | 7.29 | 22.4 | 17 |
| 07/20/17 | 2.2 | 10 | 8.15 | 8.00 | NONE | 22.9 | 15 |
| **July Avg** | **2.4** | **8** | **7.68** | **7.75** | **7.29** | **22.7** | **16** |
| 08/02/17 | 2.4 | 5 | 8.40 | 8.00 | NONE | 23.7 | 14 |
| 08/18/17 | 2.7 | 5 | 7.70 | 8.00 | NONE | 24.3 | 12 |
| **Aug Avg** | **2.6** | **5** | **8.05** | **8.00** | **NONE** | **24.0** | **13** |
| 09/22/17 | 1.8 | 4 | 9.10 | 8.00 | NONE | 24.0 | 10 |
| **Sept Avg** | **1.8** | **4** | **9.10** | **8.00** | **NONE** | **24.0** | **10** |
| **Year Mean:** | **2.5** | **5** | **7.69** | **7.75** | **7.33** | **23.0** | **15** |
| **Maximum:** | **4.2** | **10** | **9.10** | **8.00** | **7.81** | **24.3** | **18** |
| **Minimum:** | **1.8** | **4** | **6.20** | **7.00** | **7.11** | **22.2** | **10** |
| **Stand Dev:** | **0.68** | **1.74** | **0.91** | **0.36** | **0.27** | **0.85** | **2.87** |
| **TSI:** | **35** | **26** | **28** | | | | |
| | | | **All TSI Values are Valid.** | | | | |

Table 8 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Junior Lake in 2017. Junior Lake is a large lake in the St. Croix River watershed at approximately 3866 acres. Junior has seasonal camps primarily dotting the north and western shores, and its deepest spot is about 64 feet (19.5m). Up lake from Junior is Scraggly Lake, and down lake via Junior Stream is Junior Bay and West Grand Lake. Junior has been sampled most years since 2002.

## Killman Pond, Hancock County, Maine

**Table 7, Killman Pond 2017**

| 2017 Killman Pond | | | Site: KLL1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/25/17 | 2.1 | 9 | 3.80 | 6.00 | 6.76 | 20.0 | 31 |
| **May Avg** | **2.1** | **9** | **3.80** | **6.00** | **6.76** | **20.0** | **31** |
| 06/27/17 | 2.5 | 12 | 3.40 | 6.00 | 6.95 | 20.1 | 26 |
| **June Avg** | **2.5** | **12** | **3.40** | **6.00** | **6.95** | **20.1** | **26** |
| 07/11/17 | 2.6 | 9 | 4.35 | 6.00 | 6.99 | 21.5 | 22 |
| 07/25/17 | 2.7 | 7 | 4.20 | 6.00 | NONE | 22.1 | 26 |
| **July Avg** | **2.7** | **8** | **4.28** | **6.00** | **6.99** | **21.8** | **24** |
| 08/07/17 | 2.5 | 6 | 4.30 | 7.00 | NONE | 22.7 | 21 |
| 08/22/17 | 2.2 | 7 | 4.50 | 7.00 | NONE | 23.8 | 20 |
| **Aug Avg** | **2.4** | **7** | **4.40** | **7.00** | **NONE** | **23.3** | **21** |
| 09/12/17 | 2.6 | 8 | 4.20 | 6.00 | NONE | 23.6 | 17 |
| 09/27/17 | 1.8 | 6 | 4.25 | 7.00 | NONE | 24.0 | 14 |
| **Sept Avg** | **2.2** | **7** | **4.23** | **6.50** | **NONE** | **23.8** | **16** |
| **Year Mean:** | **2.4** | **9** | **4.02** | **6.30** | **6.90** | **21.8** | **23** |
| **Maximum:** | **2.7** | **12** | **4.50** | **7.00** | **6.99** | **24.0** | **31** |
| **Minimum:** | **1.8** | **6** | **3.40** | **6.00** | **6.76** | **20.0** | **14** |
| **Stand Dev:** | **0.31** | **2.00** | **0.35** | **0.52** | **0.12** | **1.59** | **5.44** |
| **TSI:** | **34** | **40** | **60** | | | | |
| | | | **All TSI Values are Valid** | | | | |

Table 9 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Killman Pond in 2017. Killman Pond is a small pond of about 17 acres flowing into Upper Chain Lake via a small stream. It is part of the St. Croix River watershed. There are no camps or structures along its shores, but it does have a maintained dirt road within 100 feet along its north shore, which undoubtedly adds runoff and sediments. The boat launch is only accessible to canoes and the like. This pond is strongly stratified most of the field season, and is about 23 feet (7m) at its deepest. This pond has been sampled most years since 2002.

## Middle Chain Lake, Hancock County, Maine

**Table 8, Middle Chain Lake 2017**

| 2017 Middle Chain Lake | | | Site: MCL1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/25/17 | 2.6 | 9 | 3.30 | 4.50 | 6.60 | 18.4 | 66 |
| **May Avg** | **2.6** | **9** | **3.30** | **4.50** | **6.60** | **18.4** | **66** |
| 06/27/17 | 5.2 | 12 | 3.45 | 5.50 | 6.82 | 18.8 | 62 |
| **June Avg** | **5.2** | **12** | **3.45** | **5.50** | **6.82** | **18.8** | **62** |
| 07/11/17 | 4.7 | 9 | 3.85 | 5.00 | 6.85 | 20.1 | 54 |
| 07/25/17 | 3.2 | 10 | 4.20 | 5.50 | NONE | 20.6 | 50 |
| **July Avg** | **4.0** | **10** | **4.03** | **5.25** | **6.85** | **20.4** | **52** |
| 08/07/17 | 3.0 | 8 | 4.40 | 6.00 | NONE | 20.7 | 45 |
| 08/22/17 | 4.0 | 10 | 3.80 | 5.50 | NONE | 21.4 | 41 |
| **Aug Avg** | **3.5** | **9** | **4.10** | **5.75** | **NONE** | **21.1** | **43** |
| 09/12/17 | 3.6 | 8 | 4.25 | 5.50 | NONE | 20.8 | 33 |
| 09/27/17 | 4.8 | 7 | 4.30 | 6.00 | NONE | 21.3 | 30 |
| **Sept Avg** | **4.2** | **8** | **4.28** | **5.75** | **NONE** | **21.1** | **32** |
| **Year Mean:** | **3.9** | **9** | **3.83** | **5.35** | **6.76** | **19.9** | **51** |
| **Maximum:** | **5.2** | **12** | **4.40** | **6.00** | **6.85** | **21.4** | **66** |
| **Minimum:** | **2.6** | **7** | **3.30** | **4.50** | **6.60** | **18.4** | **30** |
| **Stand Dev:** | **0.94** | **1.55** | **0.41** | **0.50** | **0.14** | **1.11** | **12.91** |
| **TSI:** | **46** | **40** | **63** | | | | |
| ***Only valid TSI is CHLA due to Color >25** | | | | | | | |

Table 11 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Middle Chain Lake in 2017. Middle Chain Lake is about 220 acres, and flows downstream into Lower Chain Lake, and eventually into the large lake of Sysladobsis. These are all part of the St. Croix River watershed. Middle Chain had one camp along its shores that burned down recently, and also did have a small wood mill on the northern shore in the past, with remnant saw dust piles. Maximum depth found was 20 feet (6m). The lake strongly stratifies in the summer, and also is very colored. A new boat launch was constructed recently, allowing easy boat access. Middle Chain has been sampled regularly since 2009. It is recommended that in order to see a reliable trend in water quality data, ten years of sampling needs to occur.

## Mill Privilege Lake, Penobscot County, Maine

**Table 9, Mill Privilege Lake 2017**

| 2017 Mill Privilege Lake | | | Site: MPL1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/23/17 | 3.9 | 10 | 4.75 | 7.00 | 6.99 | 20.0 | 28 |
| **Year Mean:** | **3.9** | **10** | **4.75** | **7.0** | **6.99** | **20.0** | **28** |
| **Maximum:** | **3.9** | **10** | **4.75** | **7.0** | **6.99** | **20.0** | **28** |
| **Minimum:** | **3.9** | **10** | **4.75** | **7.0** | **6.99** | **20.0** | **28** |
| **Stand Dev:** | | | | | | | |
| **TSI:** | | | | | | | |

***Non-valid TSI value due to having less than 5 months of sample data, reference only.**

Table 12 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Mill Privilege Lake in 2017. Mill Privilege Lake is about 110 acres, with a maximum depth of 29 feet (9m). Mill Privilege's outlet stream goes directly into Junior Lake, making it part of the St. Croix River watershed. There are a few camps dotting the shores, as well as a maintained dirt road to the north. The only boat access is for canoes or from camps. This lake also stratifies during the summer months. Mill Privilege has been sampled now 2002 in some capacity. There has been significant tree harvesting in the watershed in the last couple year likely causing some sedimentation and nutrient enrichment.

## Pocumcus Lake, Washington County, Maine

**Table 10, Pocumcus Lake 2017**

| 2017 Pocumcus Lake | | | Site: POC1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/09/17 | 2.7 | 5 | 7.35 | 7.00 | 7.02 | 20.7 | 14 |
| 06/01/17 | 1.4 | 5 | 9.20 | 7.00 | 6.39 | 20.5 | 16 |
| **May Avg** | **2.1** | **5** | **8.28** | **7.00** | **6.71** | **20.6** | **15** |
| 06/15/17 | 1.5 | 6 | 9.35 | 7.00 | 7.17 | 21.0 | 15 |
| 06/30/17 | 1.8 | 4 | 8.05 | 7.00 | 7.25 | 20.0 | 14 |
| **June Avg** | **1.7** | **5** | **8.70** | **7.00** | **7.21** | **20.5** | **15** |
| 07/17/17 | 1.8 | 4 | 9.35 | 7.00 | NONE | 21.7 | 14 |
| 07/26/17 | 2.1 | 4 | 9.15 | 7.00 | NONE | 22.1 | 14 |
| **July Avg** | **2.0** | **4** | **9.25** | **7.00** | **NONE** | **21.9** | **14** |
| 08/10/17 | 2.3 | 5 | 9.00 | 7.50 | NONE | 22.1 | 12 |
| 08/28/17 | 2.4 | 4 | 9.60 | 7.00 | NONE | 22.9 | 11 |
| **Aug Avg** | **2.4** | **5** | **9.30** | **7.25** | **NONE** | **22.5** | **12** |
| 09/15/17 | 2.2 | 4 | 9.50 | 8.00 | NONE | 23.1 | 10 |
| 10/03/17 | 1.9 | 3 | 9.80 | 7.50 | NONE | 22.8 | 9 |
| **Sept Avg** | **2.1** | **4** | **9.65** | **7.75** | **NONE** | **23.0** | **10** |
| **Year Mean:** | **2.0** | **4** | **9.04** | **7.20** | **6.96** | **21.7** | **13** |
| **Maximum:** | **2.7** | **6** | **9.80** | **8.00** | **7.25** | **23.1** | **16** |
| **Minimum:** | **1.4** | **3** | **7.35** | **7.00** | **6.39** | **20.0** | **9** |
| **Stand Dev:** | **0.41** | **0.84** | **0.76** | **0.35** | **0.39** | **1.09** | **2.28** |
| **TSI:** | **30** | **21** | **21** | | | | |
| | | | **All TSI Values are Valid** | | | | |

Table 13 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Pocumcus Lake in 2017. Pocumcus Lake is a large lake of 2200 acres in the St. Croix River watershed. Upstream is Sysladobsis Lake, and downstream is West Grand Lake. Numerous camps, including a campground, dot its shores, particularly the southern shore. The campground has a good boat launch where you can launch any reasonably sized motor boat, the launch is shallow however. Maximum depth of this lake is 44 feet (13.5m) and it does not strongly stratify every year. The lake is cool and clear. Pocumcus Lake has been sampled now since 2002.

## Scraggly Lake, Penobscot County, Maine

**Table 11, Scraggly Lake 2017**

| 2017 Scraggly Lake | | | Site: SCR1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/10/17 | 2.3 | 6 | 5.10 | 6.00 | 7.38 | 18.7 | 27 |
| 05/24/17 | 2.1 | *84 | 6.20 | 7.00 | 6.84 | 19.2 | 25 |
| **May Avg** | **2.2** | **6** | **5.65** | **6.50** | **7.11** | **19.0** | **26** |
| 06/12/17 | 2.2 | 8 | 6.20 | 6.50 | 6.92 | 19.9 | 25 |
| 06/26/17 | 3.9 | 7 | 6.65 | 6.50 | 7.09 | 20.1 | 22 |
| **June Avg** | **3.1** | **8** | **6.43** | **6.50** | **7.01** | **20.0** | **24** |
| 07/10/17 | 3.1 | 6 | 5.80 | 6.00 | 7.15 | 20.6 | 22 |
| 07/20/17 | 1.8 | 8 | 7.15 | 7.50 | NONE | 21.2 | 21 |
| **July Avg** | **2.5** | **7** | **6.48** | **6.75** | **7.15** | **20.9** | **22** |
| 08/02/17 | 2.5 | 7 | 6.90 | 7.50 | NONE | 21.7 | 18 |
| 08/18/17 | 3.0 | 7 | 5.85 | 8.00 | NONE | 22.5 | 17 |
| **Aug Avg** | **2.8** | **7** | **6.38** | **7.75** | **NONE** | **22.1** | **18** |
| 09/22/17 | 2.7 | 7 | 7.50 | 7.00 | NONE | 22.5 | 14 |
| **Sept Avg** | **2.7** | **7** | **7.50** | **7.00** | **NONE** | **22.5** | **14** |
| **Year Mean:** | **2.6** | **7** | **6.49** | **6.90** | **7.09** | **20.9** | **21** |
| **Maximum:** | **3.9** | **84** | **7.50** | **8.00** | **7.38** | **22.5** | **27** |
| **Minimum:** | **1.8** | **6** | **5.10** | **6.00** | **6.84** | **18.7** | **14** |
| **Stand Dev:** | **0.64** | **0.76** | **0.75** | **0.70** | **0.21** | **1.37** | **4.24** |
| **TSI:** | **36** | **33** | **35** | | | | |
| | | | **All TSI Values are Valid** | | | | |
| ***Odd TP Outlier not included in calculations.** | | | | | | | |

Table 14 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Scraggly Lake in 2017. Scraggly Lake is the furthest lake upstream to be affected by the impoundment by the dam at Sysladobsis Lake, all part of the St. Croix River watershed. Measuring up at 2758 acres, this lake is sizeable, with a channel running through the center of it at about 42 feet (13m) at its deepest. Shallow coves line the north, south, and eastern shores. There are a few seasonal camps along its shores, and has a small boat launch at Hasty Cove where small trailered boats can be launched. This lake stratifies each summer as well. We have sampled this lake since 2002.

## Shaw Lake, Penobscot County, Maine

**Table 12, Shaw Lake 2017**

| 2017 Shaw Lake | | | Site: SHW1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/23/17 | 2.8 | 11 | 4.50 | 6.00 | 6.88 | 19.4 | 31 |
| **Year Mean:** | **2.8** | **11** | **4.50** | **6.0** | **6.88** | **19.4** | **31** |
| **Maximum:** | **2.8** | **11** | **4.50** | **6.0** | **6.88** | **19.4** | **31** |
| **Minimum:** | **2.8** | **11** | **4.50** | **6.0** | **6.88** | **19.4** | **31** |
| **Stand Dev:** | | | | | | | |
| **TSI:** | | | | | | | |

Table 15 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Shaw Lake in 2017. Shaw Lake is a small lake of about 211 acres, with a max depth of 31 feet (9.5m). Most of the lake however is only 10-20' deep. Neither camps, nor real boat launches occur on this lake. Canoe access can be found via the outlet that crosses the road to the south, or off an old woods road at the northwestern corner. This outlet dumps directly into Scraggly Lake, and is thus part of the St. Croix River watershed. Shaw stratifies every summer, and can become fairly warm, and is somewhat colored. Water quality data has been collected here since 2002.

## Side Pistol Lake, Hancock County, Maine

**Table 13, Side Pistol Lake 2017**

| 2017 Side Pistol Lake | | | Site: SPL1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/11/17 | 1.0 | 6 | 6.95 | 7.00 | 7.17 | 19.6 | 6 |
| **May Avg** | **1.0** | **6** | **6.95** | **7.00** | **7.17** | **19.6** | **6** |
| 06/27/17 | 2.3 | 7 | 6.35 | 7.00 | 7.30 | 19.4 | 6 |
| **June Avg** | **2.3** | **7** | **6.35** | **7.00** | **7.30** | **19.4** | **6** |
| 07/11/17 | 3.3 | 10 | 6.15 | 7.00 | 7.29 | 20.7 | 5 |
| 07/25/17 | 2.3 | 7 | 6.75 | 6.00 | NONE | 20.9 | 6 |
| **July Avg** | **2.8** | **9** | **6.45** | **6.50** | **7.29** | **20.8** | **6** |
| 08/07/17 | 1.9 | 9 | 6.35 | 7.00 | NONE | 21.6 | 4 |
| 08/22/17 | 2.3 | 8 | 6.10 | 7.00 | NONE | 22.7 | 8 |
| **Aug Avg** | **2.1** | **9** | **6.23** | **7.00** | **NONE** | **22.2** | **6** |
| 09/12/17 | 3.3 | 7 | 5.90 | 6.00 | NONE | 22.2 | 5 |
| 09/27/17 | 6.5 | 9 | 6.25 | 7.00 | NONE | 22.4 | 5 |
| **Sept Avg** | **4.9** | **8** | **6.08** | **6.50** | **NONE** | **22.3** | **5** |
| **Year Mean:** | **2.6** | **8** | **6.41** | **6.80** | **7.25** | **20.9** | **6** |
| **Maximum:** | **6.5** | **10** | **6.95** | **7.00** | **7.30** | **22.7** | **8** |
| **Minimum:** | **1.0** | **6** | **5.90** | **6.00** | **7.17** | **19.4** | **4** |
| **Stand Dev:** | **1.65** | **1.36** | **0.35** | **0.46** | **0.07** | **1.25** | **1.19** |
| **TSI:** | **36** | **37** | **36** | | | | |
| **All TSI Values are Valid, first secchi hit bottom, TSI should be a bit lower.** | | | | | | | |
| ***Secchi hit bottom 5/11/17** | | | | | | | |

Table 16 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Side Pistol Lake in 2017. Side Pistol Lake is a small lake of 147 acres in a series of small lakes known as the Pistol's. Maximum depth of the lake is 26 feet (8m). There are only a few seasonal camps on this lake, as well as a small boat launch able to handle small trailered boats. This lake is mostly sand bottomed near the launch (NE corner), and is very clear, almost blue-green colored. This lake chain is the only lake sampled in the Springfield or Township area that isn't part of the St. Croix River watershed; it flows into the Passadumkeag River, and finally the Penobscot River. There is some level of stratification here in the summer. Side Pistol Lake has been sampled in differing degrees since 2000.

## Sysladobsis Lake, Hancock County, Maine

**Table 14, Sysladobsis Lake 2017**

| 2017 Sysladobsis Lake | | | Site: SYS1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/09/17 | 2.3 | 7 | 7.55 | 7.00 | 7.04 | 21.3 | 18 |
| 05/30/17 | 1.1 | 4 | 8.80 | 7.00 | 7.12 | 21.1 | 19 |
| **May Avg** | **1.7** | **6** | **8.18** | **7.00** | **7.08** | **21.2** | **19** |
| 06/30/17 | 1.7 | 4 | 7.90 | 7.00 | 7.19 | 20.6 | 18 |
| **June Avg** | **1.7** | **4** | **7.90** | **7.00** | **7.19** | **20.6** | **18** |
| 07/17/17 | 1.1 | 4 | 8.90 | 7.00 | NONE | 22.3 | 17 |
| 07/26/17 | 1.8 | 5 | 8.35 | 7.50 | NONE | 22.5 | 17 |
| **July Avg** | **1.5** | **5** | **8.63** | **7.25** | **NONE** | **22.4** | **17** |
| 08/10/17 | 1.7 | 3 | 8.60 | 8.00 | NONE | 22.4 | 14 |
| 08/28/17 | 1.7 | 4 | 9.70 | 7.50 | NONE | 23.6 | 14 |
| **Aug Avg** | **1.7** | **4** | **9.15** | **7.75** | **NONE** | **23.0** | **14** |
| 09/15/17 | 1.8 | 4 | 9.35 | 7.00 | NONE | 23.5 | 13 |
| **Sept Avg** | **1.8** | **4** | **9.35** | **7.00** | **NONE** | **23.5** | **13** |
| **Year Mean:** | **1.7** | **4** | **8.64** | **7.20** | **7.14** | **22.1** | **16** |
| **Maximum:** | **2.3** | **7** | **9.70** | **8.00** | **7.19** | **23.6** | **19** |
| **Minimum:** | **1.1** | **3** | **7.55** | **7.00** | **7.04** | **20.6** | **13** |
| **Stand Dev:** | **0.35** | **1.19** | **0.71** | **0.38** | **0.08** | **1.09** | **2.25** |
| **TSI:** | **27** | **21** | **23** | | | | |
| | | | **All TSI Values are Valid** | | | | |

Table 17 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Sysladobsis Lake in 2017. Sysladobsis Lake is a large lake of 5376 acres in the St. Croix River watershed. Maximum lake depth found was 65 feet (20m). Numerous camps dot the shoreline and islands of this large lake. There is a small boat launch at the southern end, as well as a state run public launch on the northern end of the lake. This lake can get rough easily with just a little wind. Early morning sampling on the calmest of days is recommended. Sampling has occurred here since 2002.

## Upper Chain Lake, Hancock County, Maine

**Table 15, Upper Chain Lake 2017**

| 2017 Upper Chain Lake | | | Site: UCL1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/25/17 | 2.3 | 9 | 3.90 | 4.00 | 6.61 | 17.8 | 71 |
| **May Avg** | **2.3** | **9** | **3.90** | **4.00** | **6.61** | **17.8** | **71** |
| 06/27/17 | 4.5 | 10 | 4.10 | 4.50 | 6.73 | 17.5 | 71 |
| **June Avg** | **4.5** | **10** | **4.10** | **4.50** | **6.73** | **17.5** | **71** |
| 07/11/17 | 3.6 | 9 | 4.05 | 5.00 | 6.77 | 18.5 | 63 |
| 07/25/17 | 3.8 | 8 | 4.20 | 5.00 | NONE | 19.1 | 63 |
| **July Avg** | **3.7** | **9** | **4.13** | **5.00** | **6.77** | **18.8** | **63** |
| 08/07/17 | 4.8 | 7 | 4.55 | 5.00 | NONE | 19.3 | 57 |
| 08/22/17 | 3.4 | 8 | 4.50 | 5.50 | NONE | 20.4 | 54 |
| **Aug Avg** | **4.1** | **8** | **4.53** | **5.25** | **NONE** | **19.9** | **56** |
| 09/12/17 | 3.3 | 7 | 4.70 | 5.00 | NONE | 20.3 | 47 |
| 09/27/17 | 3.5 | 7 | 4.70 | 5.00 | NONE | 20.5 | 44 |
| **Sept Avg** | **3.4** | **7** | **4.70** | **5.00** | **NONE** | **20.4** | **46** |
| **Year Mean:** | **3.6** | **8** | **4.27** | **4.75** | **6.70** | **18.9** | **61** |
| **Maximum:** | **4.8** | **10** | **4.70** | **5.50** | **6.77** | **20.5** | **71** |
| **Minimum:** | **2.3** | **7** | **3.90** | **4.00** | **6.61** | **17.5** | **44** |
| **Stand Dev:** | **0.77** | **1.13** | **0.31** | **0.44** | **0.08** | **1.18** | **10.12** |
| **TSI:** | **44** | **37** | **57** | | | | |
| ***Only valid TSI is CHLA due to Color >25** | | | | | | | |

Table 18 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Upper Chain Lake in 2017. Upper Chain Lake is about 717 acres with a maximum depth of 30 feet (9m). This lake eventually flows into Sysladobsis Lake, and thus is part of the St. Croix River watershed. There are only a few camps along the north, east, and southern shores. There is a public boat launch able to take small boat trailers at the northern end of the lake. Also here is a group of tribally run tenting campsites and a year-round residence. The lake strongly stratifies in the summer, and also is very colored. Sampling here has occurred since 2000 in some form.

## West Grand Lake, Washington County, Maine

**Table 16, West Grand Lake 2017**

| 2017 West Grand Lake | | | Site: WGL1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/09/17 | 2.6 | 4 | 9.00 | 7.00 | 7.38 | 20.3 | 8 |
| **May Avg** | **2.6** | **4** | **9.00** | **7.00** | **7.38** | **20.3** | **8** |
| 06/01/17 | 1.6 | 4 | 9.60 | 7.00 | 6.23 | 19.9 | 8 |
| 06/30/17 | 1.5 | 3 | 10.90 | 7.00 | 7.24 | 19.5 | 8 |
| **June Avg** | **1.6** | **4** | **10.25** | **7.00** | **6.74** | **19.7** | **8** |
| 07/17/17 | 1.5 | 4 | 12.40 | 7.00 | NONE | 20.7 | 8 |
| 07/26/17 | 1.4 | 3 | 12.65 | 7.00 | NONE | 21.3 | 8 |
| **July Avg** | **1.5** | **4** | **12.53** | **7.00** | **NONE** | **21.0** | **8** |
| 08/15/17 | 1.5 | 3 | 11.40 | 7.00 | NONE | 21.0 | 8 |
| 08/28/17 | 1.3 | 3 | 11.20 | 7.00 | NONE | 21.5 | 7 |
| **Aug Avg** | **1.4** | **3** | **11.30** | **7.00** | **NONE** | **21.3** | **8** |
| 09/15/17 | 1.4 | 3 | 11.10 | 6.00 | NONE | 21.8 | 7 |
| 10/03/17 | 1.5 | 5 | 11.60 | 7.00 | NONE | 21.4 | 8 |
| **Sept Avg** | **1.5** | **4** | **11.35** | **6.50** | **NONE** | **21.6** | **8** |
| **Year Mean:** | **1.7** | **4** | **10.89** | **6.90** | **7.06** | **20.8** | **8** |
| **Maximum:** | **2.6** | **5** | **12.65** | **7.00** | **7.38** | **21.8** | **8** |
| **Minimum:** | **1.3** | **3** | **9.00** | **6.00** | **6.23** | **19.5** | **7** |
| **Stand Dev:** | **0.39** | **0.73** | **1.18** | **0.33** | **0.63** | **0.78** | **0.44** |
| **TSI:** | **27** | **21** | **14** | | | | |
| | | | **All TSI Values are Valid** | | | | |

Table 19 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for West Grand Lake in 2017. West Grand Lake is a large lake, at about 14,340 acres with numerous islands. Most of the shoreline is forested with few camps, the only built up area is along the dam in the Southeastern corner. Our sampling location of about 110ft near a supposed 127ft hole that could not be located. West Grand is part of the West Branch of the St. Croix Watershed and is considered one of the more premier fishing and recreation lakes in the area.

## Pleasant Lake, T6R1 Washington County, Maine

**Table 17, Pleasant Lake 2017**

| 2017 Pleasant Lake | | | Site: PLS1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/17/17 | 3.2 | 6 | 5.85 | 7.00 | 7.16 | 20.7 | 18 |
| **May Avg** | **3.2** | **6** | **5.85** | **7.00** | **7.16** | **20.7** | **18** |
| 06/07/17 | 2.2 | 5 | 8.30 | 7.00 | 7.16 | 20.8 | 17 |
| 06/28/17 | 1.9 | 4 | 7.85 | 7.00 | 7.23 | 20.5 | 18 |
| **June Avg** | **2.1** | **5** | **8.08** | **7.00** | **7.20** | **20.7** | **18** |
| 07/12/17 | 1.9 | 5 | 8.80 | 7.00 | NONE | 20.2 | 15 |
| 07/31/17 | 2.3 | 4 | 8.80 | 7.00 | NONE | 21.5 | 12 |
| **July Avg** | **2.1** | **5** | **8.80** | **7.00** | **NONE** | **20.9** | **14** |
| 08/09/17 | 1.8 | 4 | 8.45 | 6.50 | NONE | 21.6 | 13 |
| 08/24/17 | 3.0 | 4 | 8.60 | 7.00 | NONE | 22.4 | 13 |
| **Aug Avg** | **2.4** | **4** | **8.53** | **6.75** | **NONE** | **22.0** | **13** |
| 09/18/17 | NONE | 4 | 7.40 | 7.00 | NONE | 21.5 | NONE |
| 09/26/17 | 2.6 | 3 | 7.95 | 7.00 | NONE | 22.5 | 12 |
| **Sept Avg** | **2.6** | **4** | **7.68** | **7.00** | **NONE** | **22.0** | **12** |
| **Year Mean:** | **2.5** | **5** | **7.79** | **7.0** | **7.18** | **21.2** | **15** |
| **Maximum:** | **3.2** | **6** | **8.80** | **7.0** | **7.23** | **22.5** | **18** |
| **Minimum:** | **1.8** | **3** | **5.85** | **6.5** | **7.16** | **20.2** | **12** |
| **Stand Dev:** | **0.53** | **0.87** | **0.93** | **0.2** | **0.04** | **0.81** | **2.60** |
| **TSI:** | **35** | **26** | **27** | | | | |
| | | | **All TSI Values are Valid** | | | | |

Table 20 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for Pleasant Lake in 2017. Pleasant Lake is a moderately sized lake at 1,574 acres, with a max depth of 92ft. Two campgrounds are located on this lake, a public one with boat launch on the Southern shore, as well as a private business with a few rentable cabins and sites on the North shore. There are few, if any, other camps along its shores. Pleasant Lake outlet flows out of the Southwest part of the lake into Scraggly Lake, making it part of the St. Croix Watershed.

## East Musquash Lake, Washington County, Maine

**Table 18, East Musquash Lake 2017**

| 2017 East Musquash Lake | | | Site: EMQ1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/24/17 | 3.0 | 24 | 4.70 | 5.00 | 6.67 | 22.1 | 33 |
| **May Avg** | **3.0** | **24** | **4.70** | **5.00** | **6.67** | **22.1** | **33** |
| 06/12/17 | 2.6 | 7 | 5.45 | 5.00 | 6.83 | 22.5 | 32 |
| 06/29/17 | 4.0 | 6 | 4.80 | 5.00 | 7.00 | 22.1 | 28 |
| **June Avg** | **3.3** | **7** | **5.13** | **5.00** | **6.92** | **22.3** | **30** |
| 07/12/17 | 3.2 | 9 | 5.65 | 5.50 | NONE | 21.4 | 26 |
| 08/01/17 | 2.6 | 5 | 6.60 | 5.00 | NONE | 23.3 | 22 |
| **July Avg** | **2.9** | **7** | **6.13** | **5.25** | **NONE** | **22.4** | **24** |
| 08/09/17 | 2.4 | 4 | 6.35 | 5.50 | NONE | 23.2 | 23 |
| 08/29/17 | 1.9 | 5 | 7.50 | 5.00 | NONE | 24.2 | 23 |
| **Aug Avg** | **2.2** | **5** | **6.93** | **5.25** | **NONE** | **23.7** | **23** |
| 09/26/17 | 2.0 | 5 | 7.40 | 5.00 | NONE | 24.1 | 18 |
| **Sept Avg** | **2.0** | **5** | **7.40** | **5.00** | **NONE** | **24.1** | **18** |
| **Year Mean:** | **2.7** | **9** | **6.06** | **5.1** | **6.79** | **22.9** | **26** |
| **Maximum:** | **4.0** | **24** | **7.50** | **5.5** | **7.00** | **24.2** | **33** |
| **Minimum:** | **1.9** | **4** | **4.70** | **5.0** | **6.67** | **21.4** | **18** |
| **Stand Dev:** | **0.68** | **6.60** | **1.08** | **0.23** | **0.17** | **1.00** | **5.15** |
| **TSI:** | **37** | **40** | **39** | | | | |
| ***Kept the outlier TP from 5/24/17 in the calculations, pushed TP average from 6 to 9.** | | | | | | | |
| ****Only valid TSI is CHLA due to Color >25** | | | | | | | |

Table 21 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for East Musquash Lake in 2017. East Musquash, located right alongside of Rt 6, in Topsfield, is about 806 acres. Rt. 6 runs along most of the Southern shore of the lake with numerous camps and year round residences. There is also a public boat launch and rest area (with restrooms) here. The outlet is located on the southeastern corner of the lake and eventually flows into Big Lake, including it in the St. Croix Watershed.

## West Musquash Lake, Washington County, Maine

**Table 19, West Musquash Lake 2017**

| 2017 West Musquash Lake | | | Site: WMQ1 | | | | |
|---|---|---|---|---|---|---|---|
| Date | Chl-a(µg/L) | TP(µg/L) | Secchi(m) | Alka(mg/l CaCO3) | pH | Cond(UMHOS/CM) | Color (PCU) |
| 05/17/17 | 2.8 | 5 | 6.10 | 5.00 | 6.64 | 17.2 | 12 |
| **May Avg** | **2.8** | **5** | **6.10** | **5.00** | **6.64** | **17.2** | **12** |
| 06/29/17 | 1.8 | 4 | 8.75 | 5.50 | 7.11 | 17.0 | 12 |
| **June Avg** | **1.8** | **4** | **8.75** | **5.50** | **7.11** | **17.0** | **12** |
| 07/12/17 | 1.6 | 4 | 10.30 | 6.00 | NONE | 16.6 | 11 |
| 07/31/17 | 1.7 | 5 | 11.10 | 5.50 | NONE | 17.8 | 8 |
| **July Avg** | **1.7** | **5** | **10.70** | **5.75** | **NONE** | **17.2** | **10** |
| 08/09/17 | 2.4 | 3 | 11.30 | 6.00 | NONE | 17.7 | 9 |
| 08/24/17 | 1.9 | 4 | 10.50 | 6.00 | NONE | 18.2 | 9 |
| **Aug Avg** | **2.2** | **4** | **10.90** | **6.00** | **NONE** | **18.0** | **9** |
| 09/18/17 | NONE | 3 | 10.00 | 5.50 | NONE | 17.6 | NONE |
| 09/26/17 | 1.5 | 3 | 11.15 | 6.00 | NONE | 18.4 | 9 |
| **Sept Avg** | **1.5** | **3** | **10.58** | **5.75** | **NONE** | **18.0** | **9** |
| **Year Mean:** | **2.0** | **4** | **9.41** | **5.6** | **6.88** | **17.5** | **10** |
| **Maximum:** | **2.8** | **5** | **11.30** | **6.0** | **7.11** | **18.4** | **12** |
| **Minimum:** | **1.5** | **3** | **6.10** | **5.0** | **6.64** | **16.6** | **8** |
| **Stand Dev:** | **0.47** | **0.83** | **1.74** | **0.4** | **0.33** | **0.60** | **1.67** |
| **TSI:** | **30** | **21** | **19** | | | | |
| | | | **All TSI Values are Valid** | | | | |

Table 22 shows this year's Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, standard deviations, and TSI values for West Musquash Lake in 2017. This lake can be accessed off of the Pleasant Lake Road, south of Rt. 6. The shores of this lake are primarily undeveloped, except for a few camps on the Eastern shores. Numerous public boat access only campsites are available on the west end of the lake with great sand beaches. This lake has beautiful clear and cold water. The outlet is located on the eastern end of the lake and eventually flows into Big Lake, including it in the St. Croix Watershed.

## Literature Cited


Amnell, T., P. Anttila, A. Määttä, T. Ruoho-Airola and T. Salmi. 2002. Detecting Trends of Annual Values of Atmospheric Pollutants by the Mann-Kendall Test and Sen's Slope Estimates - The Excel Template Application MAKESENS, Finnish Meteorological Institute, Helsinki Finland

Bacon L. and J. Potvin. 1993 Standard Field Methods for Lake Water Quality Monitoring Maine Department of Environmental Protection, ME

Carlson, R.E., 1977. A Trophic State Index for Lakes. Limno. Oceangr. 22:361-368.

Holdren, C., W. Jones, and J. Taggart. 2001. Managing Lakes and Reservoirs. N. Am. Lake Manage. Soc. and Terrence Inst., in coop. With Off. Water Assess. Watershed Prot. Div. U.S. Environ. Prot. Agency, Madison, WI

Hill, R., Williams, S. 2008 Maine Lakes Report. Volunteer Lake Monitoring Program, US Environmental Protection Agency and Maine Department of Environmental Protection., ME