

# **BIG PAW PAW LAKE**

## **WATERVLIET AND**

## **COLOMA TOWNSHIPS**

## **BERRIEN COUNTY**

### **2004-2010 WATER QUALITY STUDIES**

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#### **BIG PAW PAW LAKE DATA**

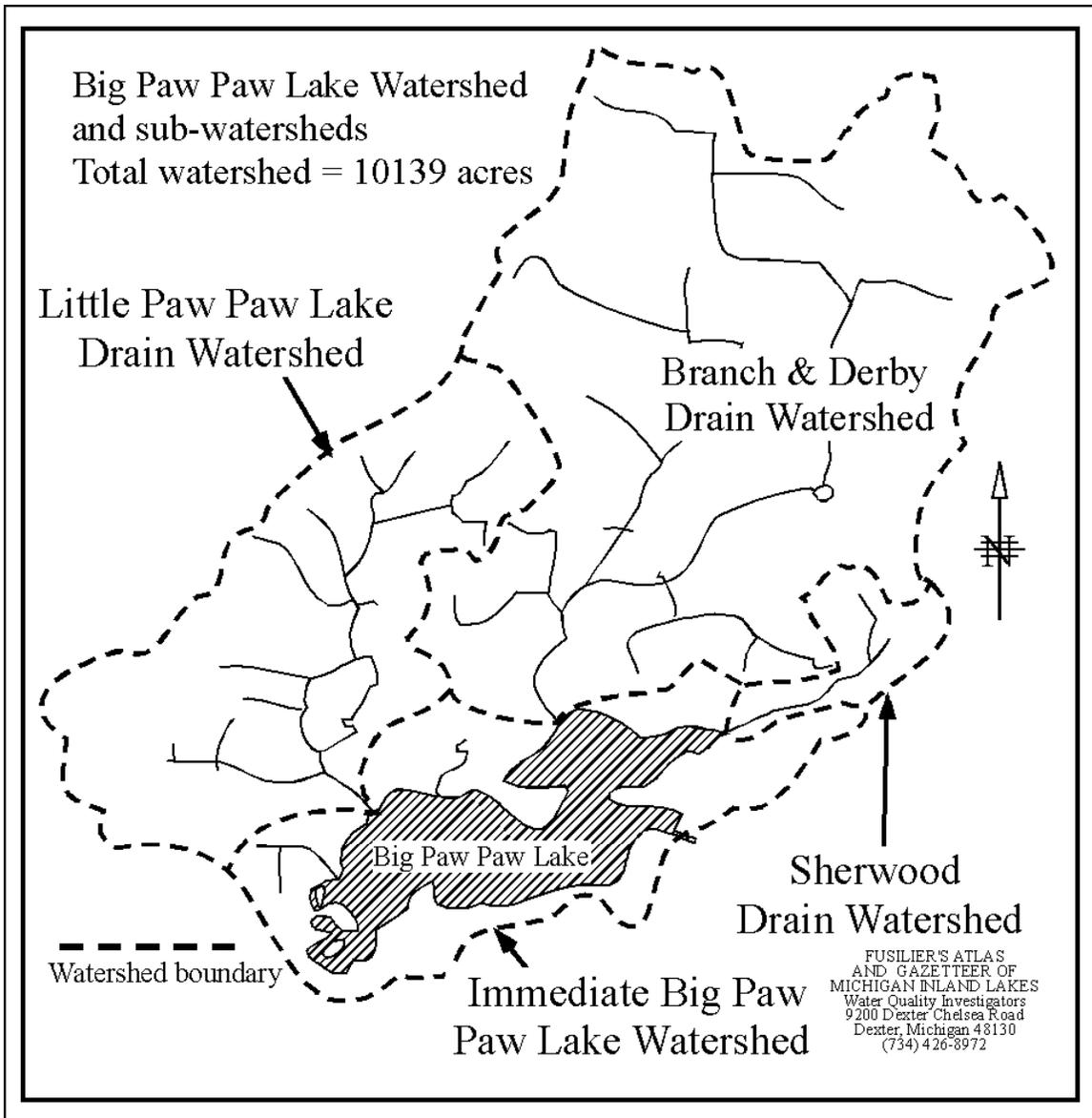
Big Paw Paw Lake is a 891acre natural soft water (in spring 2004) to moderately hard-water (the rest of the time) lake located in Sections 10, 11, 14, 15 and 16, Watervliet and Coloma townships (T3S R17W), Berrien County, Michigan. The lake consists of two basins, a 50-foot-deep, 217-acre north basin and a 90-foot-deep, 674-acre south basin separated by a shelf about 30 feet deep.

The lake has a water volume of 26130 acre-feet, and a mean depth of 29.3 feet. It has 46090 feet of shoreline. The elevation of the lake is 621 feet above sea level.

The outlet is on the east end of the south basin. The lake is in the Paw Paw River basin. The Paw Paw River joins the St. Joseph River just before it flows into Lake Michigan at St. Joseph, Michigan. The outlet discharges 36.06 billion pounds of water per year.

The size of the watershed, which is the land area that contributes water to the lake, but does not include the lake is 9248 acres. The drainage area, which includes the lake and the watershed, is 10139 acres. The watershed to lake ratio is 10.4 to 1, which is on the high side of normal for a Michigan inland lake. The lake flushes about once every 1.97 years, on an average.

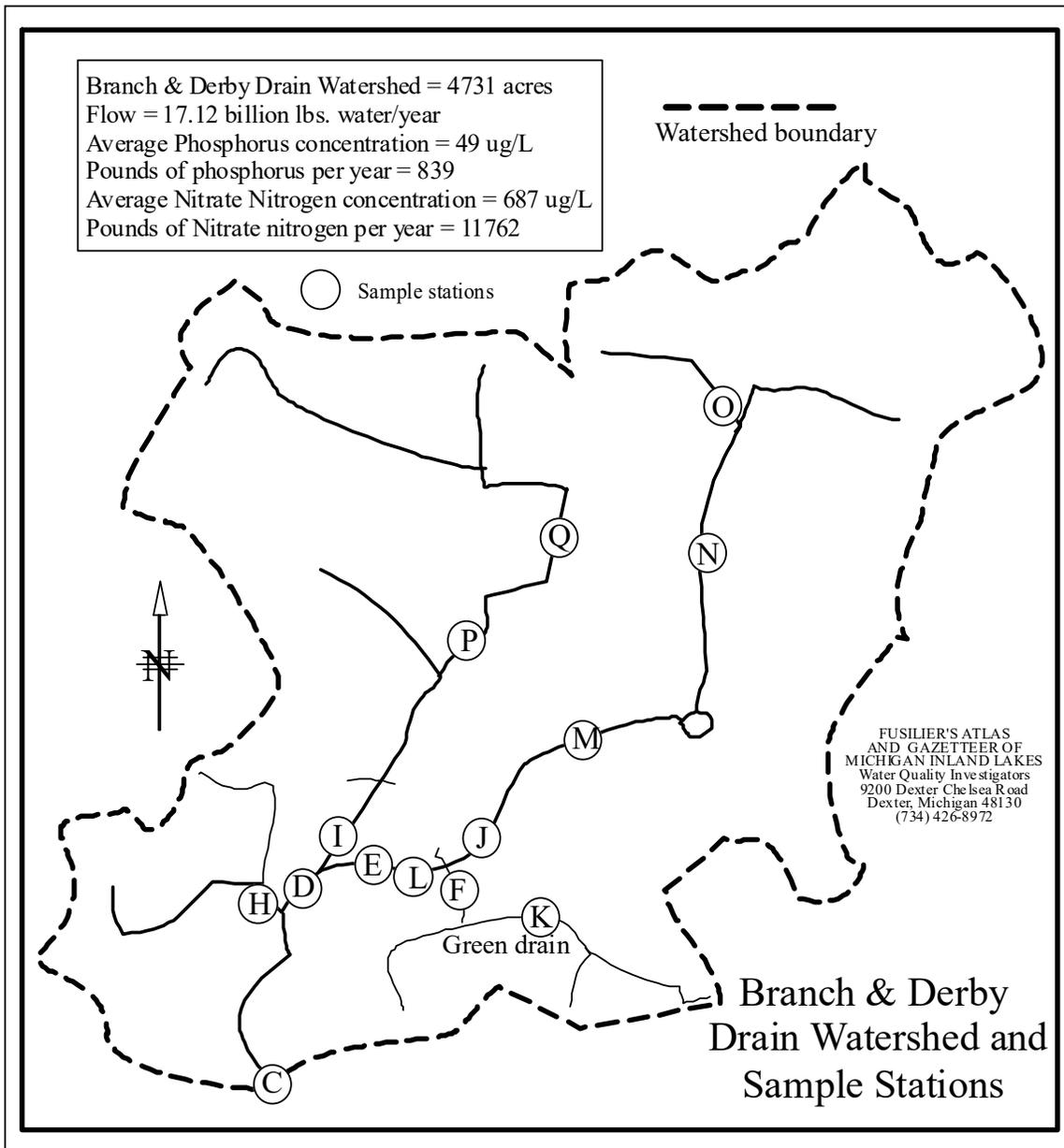
There are several inlets. The Branch & Derby Drain, the largest inlet, flows



into the lake on the north side of the north basin. It drains 4731 acres, and discharges 17.12 billion pounds of water a year into Paw Paw Lake.

The Little Paw Paw Lake Drain flows into the north side of the south basin near the west end. It drains 2654 acres and discharges 9.60 billion pounds of water a year into the lake.

The Smith and Strong Drain, the Kelly Drain and the Forest Beach Drain are small drains near the lake and were not sampled although they are included in the immediate Big Paw Paw Lake 1414-acre watershed. This area contributes 5.12 billion pounds of water to Big Paw Paw Lake each year.

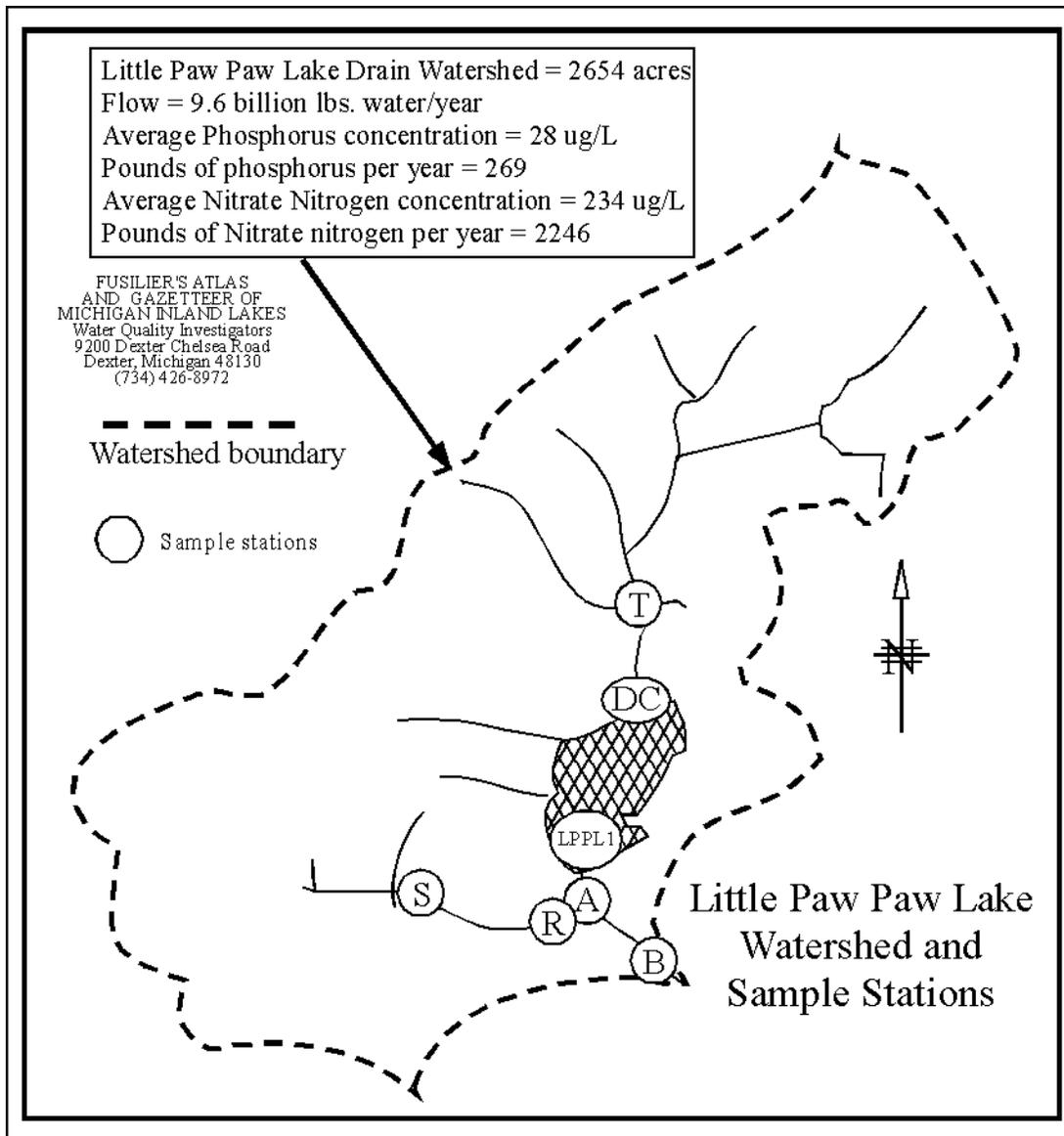


The Sherwood Drain flows into the north basin on the east end. It drains 364 acres and discharges 1.32 billion pounds of water a year into the lake.

The longitude and latitude of the 90-foot deep hole at Station 4 is 86° 16.350W and 42° 11.986N.

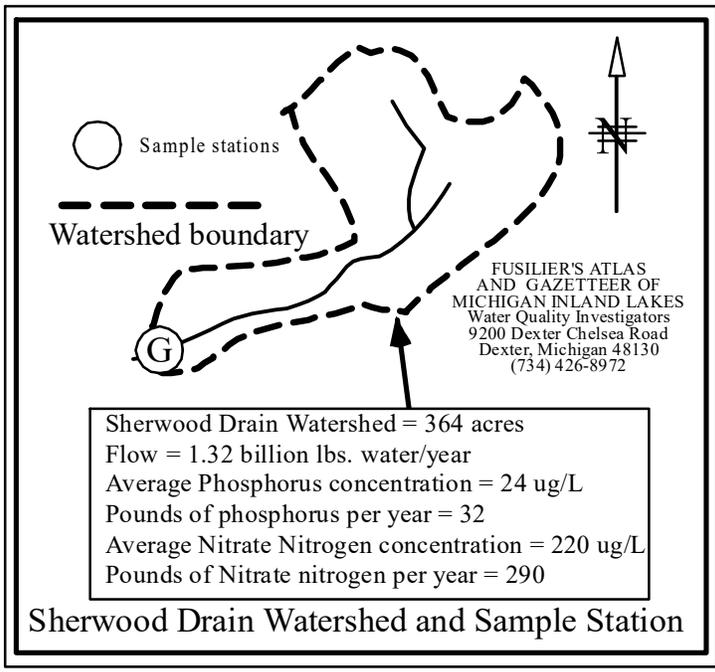
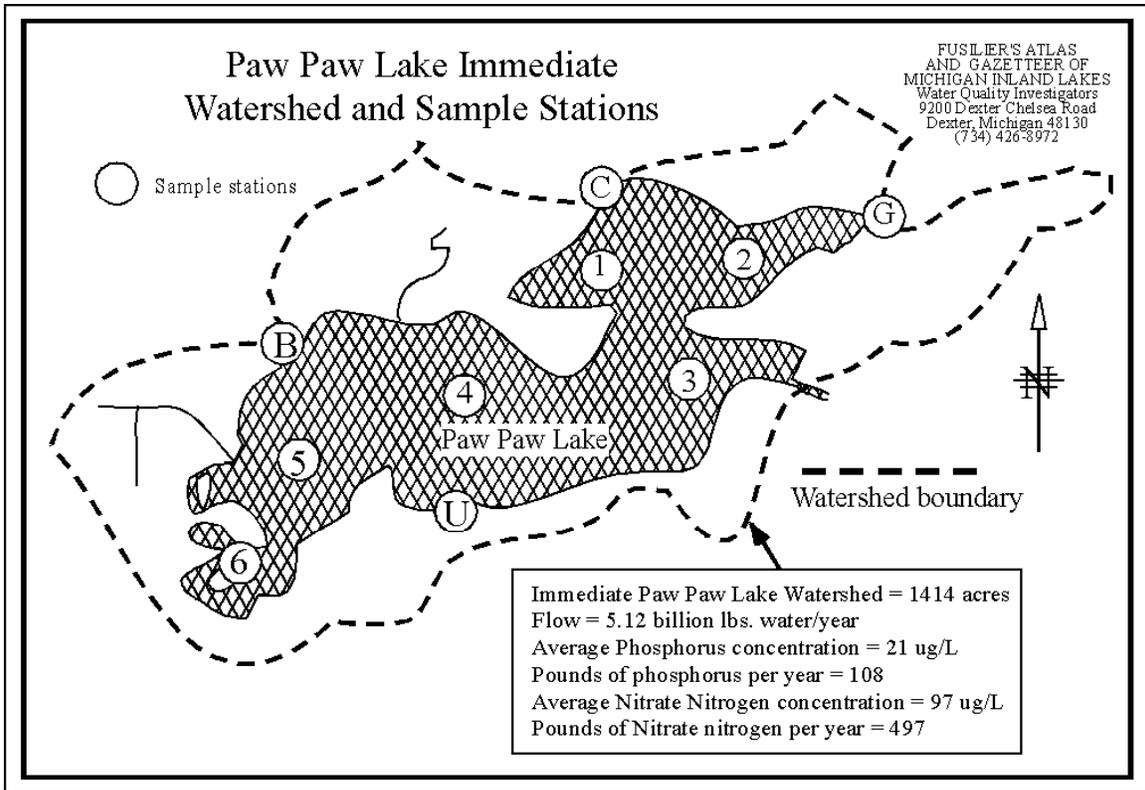
### THE SAMPLE DATES

Rick Rasmussen and Joe Engle took five Paw Paw Lake surface samples for water quality testing April 5, 2004, plus Secchi disk readings at the



sample sites shown on the surface sample map. Rasmussen also collected a number of samples on various drains that discharge into the lake December 2003 through August 2004. In 2005 Frank Jurenka collected four spring surface samples April 20, and four fall surface samples September 21 from Paw Paw Lake. He also collected a number of samples of various drains during the warm months.

Jurenka collected four spring surface samples from the lake March 23, 2006. He also collected samples from various sites on the drains through the summer months.



Jurenka collected six surface samples from the lake March 30, 2007 and July 6, 2009. In 2007 he collected samples from various sites on the drains during the warm months.

He collected five samples from the lake April 18, 2008 and March 8 and July 6, 2009 and one sample from Little Paw Paw Lake April 21, 2008 and May 5, 2009.

He collected 5 surface samples April 7, 2010. He sampled the Little Paw Paw Lake drain (Station B) once and the Branch & Derby Drain (Station C) 12 times during the warm months.

Jurenka collected Secchi disk data at five stations on the Paw Paw Lake during the warm months 2004 through 2010 along with numerous Secchi disk readings on Little Paw Paw Lake in 2007, 2008, 2009 and 2010.

In late summer 2004 WQI limnologists, accompanied by Rasmussen, collected five lake surface samples for water quality testing plus Secchi disk readings at the sites shown on the map August 31st. The various drains were also sampled on that date. Bottom sediments were collected at Stations 2, 4 & 5. Top to bottom temperature and dissolved oxygen profile data were collected at Station 4, the deepest part of the lake.

In late summer 2005 WQI limnologists collected three surface samples for water quality testing at Stations 1, 4 and 5. Top to bottom temperature and dissolved oxygen profile data were again collected at that time in the 90-foot deep hole.

Rasmussen and Engle did a good job collecting Secchi disk data on Big Paw Paw Lake through the warm months in 2004. Jurenka did the same in 2005, 2006, 2007, 2008, 2009 and 2010.

In late summer 2006, WQI limnologists collected in-lake samples at the six stations shown on the map. They also collected top to bottom temperature and dissolved oxygen data at the deepest part of the lake.

In late summer 2007, WQI limnologists collected in-lake samples at Stations 1 through 5. They also collected top to bottom temperature and dissolved oxygen data plus samples for water quality testing every ten feet at the deepest part of the lake. As requested, they collected three surface samples, plus top to bottom samples for water quality testing at Little Paw Paw Lake August 28 of that year. Top to bottom temperature and dissolved oxygen data were also collected at that time.

In late summer 2008 and 2009, WQI limnologists again collected in-lake samples at Stations 1 through 5. They also collected top to bottom temperature and dissolved oxygen data plus samples for water quality testing every ten feet at the deepest part of the lake. They also sampled Little Paw Paw Lake at three surface sample stations, plus top to bottom temperature and dissolved oxygen August 13, 2009 as requested by the Paw Paw Lake Association.

Jurenka sampled the Branch and Derby drain at the lake August 5, 7, 12 and 17 and Station E August 7, 2007 for suspended solids analyses.

In 2010 WQI sampled six stations (1, 2, 3, 4, 5 & 7) every 10 feet from the surface to the bottom for water quality testing August 27, 2010. Temperature and dissolved oxygen profile data were also collected at the six stations on that date as well.

## **THE LOCATIONS OF THE DRAIN SAMPLE STATIONS**

Drain sample stations are labeled A through U on the various maps. With the help of Jurenka, the following locations were identified. Jurenka also added the numbers 1 through 7 to the stations and requested the data from these sites be analyzed in numerical order, which explains the unusual order of the drain data. Sample Stations B, C and G are important because they are where the various drains discharge into Paw Paw Lake. Nutrient concentrations at other sites in the watershed, even if they are high, are not a problem if they don't reach the lake.

A is located near the outlet of Little Paw Paw Lake on the Little Paw Paw Lake drain.

B is located on the Little Paw Paw Lake drain at Paw Paw Lake.

C (1) is located where the Branch & Derby Drain discharges into Paw Paw Lake.

D is located on the Branch & Derby Drain between the Beck/Peck/Grove Drain inlet and the McConnell and Olcott Drain inlet.

DC is located on the Dedrick Drain at Little Paw Paw Lake.

E (4) is located on the Branch & Derby Drain just downstream of the Green Drain inlet just after the Modified Green Drain.

F is located on the Green Drain just before the Branch & Derby Drain at entrance at wetland output at Branch & Derby drain.

G is located on the Sherwood Drain where it flows into Paw Paw Lake.

H (2) is located on the Beck/Peck/Grove Drain inlet before it discharges into the Branch & Derby Drain.

I (3) is located on the McConnell and Olcott Drain at the point where it discharges into the Branch & Derby Drain.

J (5) is located on the Branch & Derby Drain above the Green Drain inlet just before the modified Green Drain.

K (6) is located on the Green Drain at M-140.

L is located at the “modified Green Drain at Wetland Output at Branch & Derby Drain.”

M is located on the Branch & Derby Drain at North Watervliet Road.

N is located on the Branch & Derby Drain at 48<sup>th</sup> Avenue.

O is located on the Branch & Derby Drain at County Road 376.

P is located on the McConnell & Olcott Drain at M-140.

Q is located on the McConnell & Olcott Drain at 48<sup>th</sup> Avenue.

R is located on the Delfield & Crumb Drain at Interlocken Road.

S is located on the Delfield & Crumb Drain at Coloma North Road.

T is located on the Dedrick Drain at Hagar Shore Road.

U is located on the Forest Beach Drain at Forest Beach Road

## **THE ANALYSES**

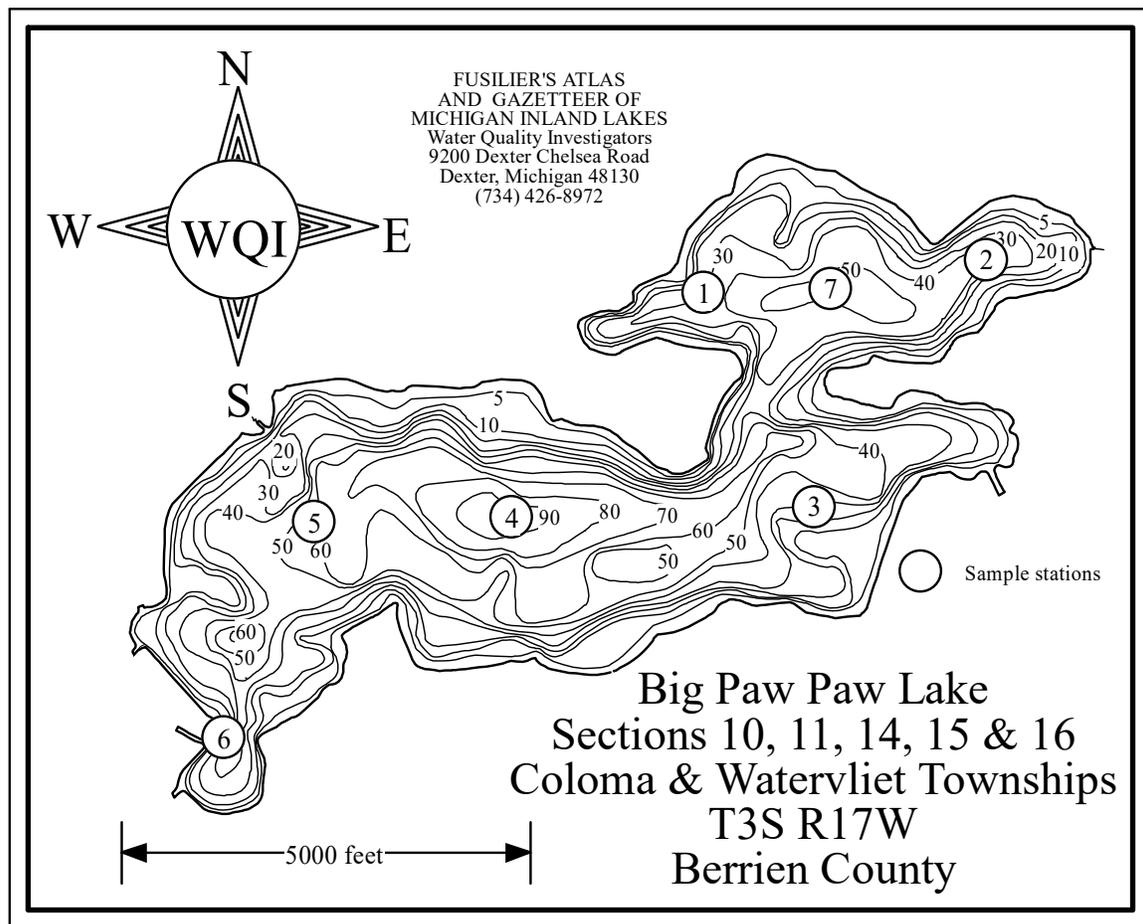
The tests performed on the lake samples included total phosphorus, total nitrate nitrogen, total alkalinity, pH, conductivity, chlorophyll a, Secchi disk depth, temperature, and dissolved oxygen. Tests performed on the drain samples included total phosphorus, total nitrate nitrogen, total alkalinity, pH and conductivity.

Temperature, dissolved oxygen and Secchi disk depths were measured in the field. Chlorophyll a, phosphorus, nitrate nitrogen, alkalinity, pH and conductivity tests were performed at the Water Quality Investigators laboratory in Dexter, Michigan. All test procedures followed those outlined in APHA's *Standard Methods for the Examination of Water and Wastewater* (1985).

## THE TEST RESULTS

The results of the tests are found in the text and graphs, in the tables at the end of this report, and on the enclosed atlas pages.

## THE SAMPLE STATIONS

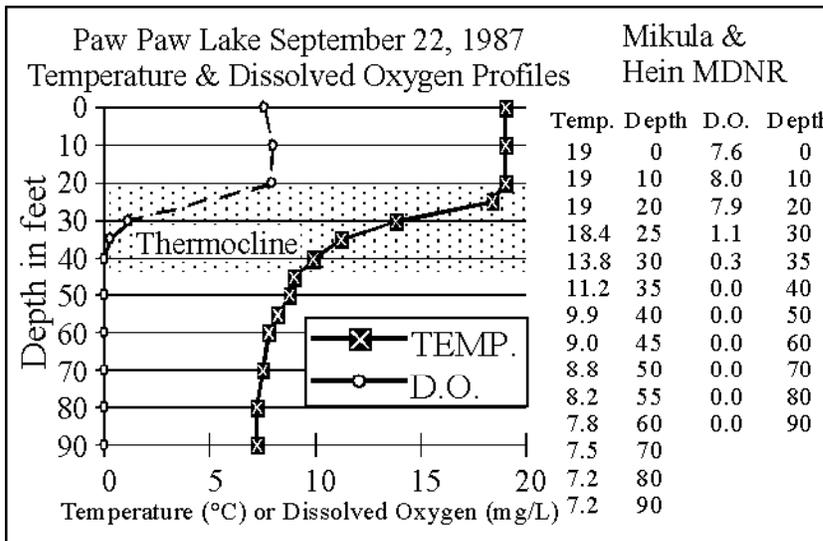


The locations of the in-lake sample stations are shown as circles on the hydrographic map of the lake. The location of the drain sample stations are shown as circles with alphabetic characters on the various watershed maps.

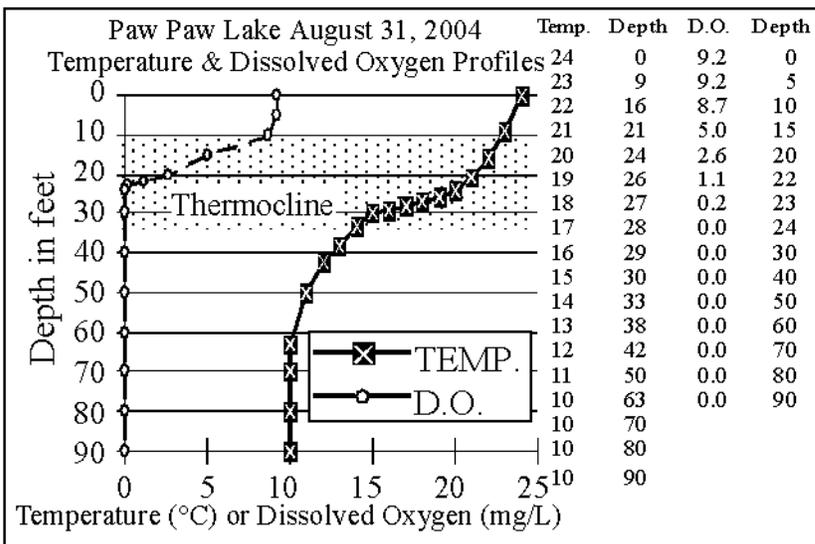
## TEMPERATURE AND DISSOLVED OXYGEN

Temperature exerts a wide variety of influences on most lakes, such as the separation of layers of water (stratification), solubility of gases and biological activity. In spring temperature (and dissolved oxygen) generally don't need to be measured because temperatures are low and dissolved oxygen is near saturation at that time.

Dissolved oxygen is the test most often selected by lake scientists as being important. Besides its importance in providing oxygen for aquatic organisms, in natural lakes oxygen is involved the capture and release of various chemicals, such as iron and phosphorus.



Because spring temperatures are cold, and dissolved oxygen is at saturated levels, it is unnecessary to collect these data. Each summer, we measured temperature and dissolved oxygen top to bottom at the 90-foot deep hole in Big Paw Paw Lake.

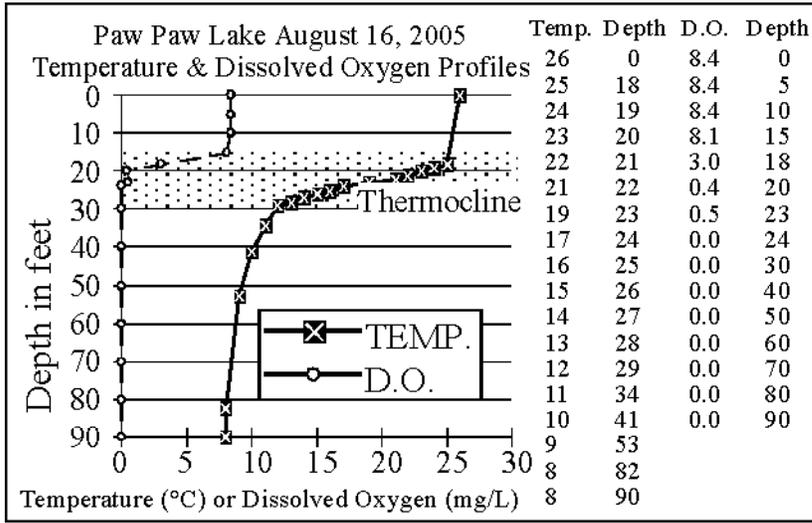


We also found 1987 temperature and dissolved oxygen profile data collected by MDNR limnologists Dick Mikula and Maureen Hein.

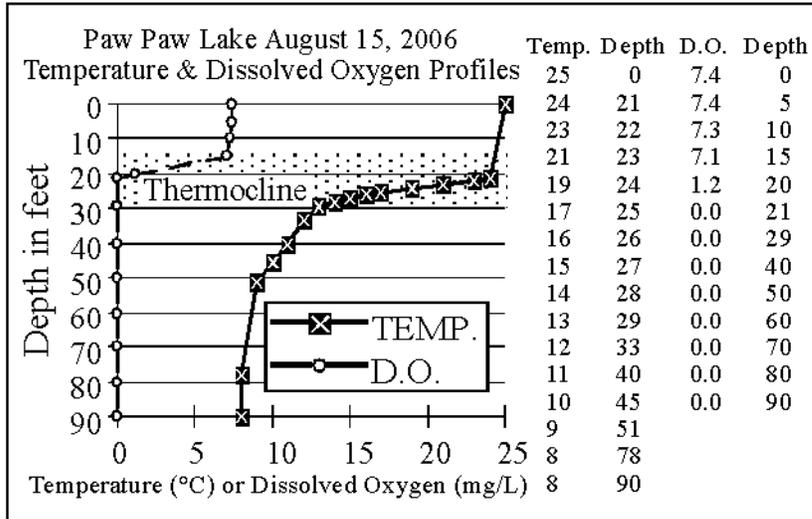
The graph shows

the temperature and dissolved oxygen profiles in Big Paw Paw Lake at the

deep hole in late summer (September) 1987.

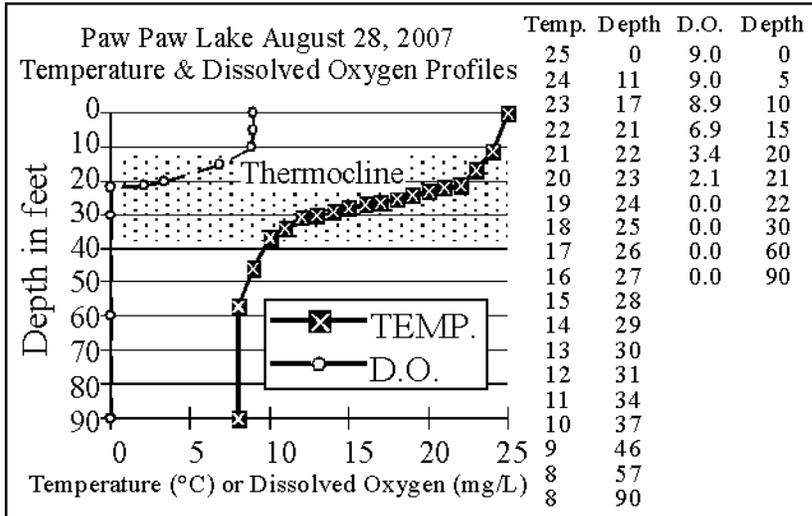


The graph shows in late summer 1987 Big Paw Paw Lake formed a 22-foot-thick thermocline (defined as a layer of water where the temperature



changes more than one degree C per meter of depth, and shown shaded on the graphs) from 20 to 42 feet.

Dissolved oxygen was plentiful above the thermocline. It started to decrease at the top of the thermocline (20 feet), and at 40 feet it was zero. That condition remained to the bottom at 90 feet.



The hypsographic (depth-area graph) shows about 39 percent of the lake is deeper than 40 feet.

## **2004**

The graph shows the temperature and dissolved oxygen profiles in Big Paw Paw Lake in late summer 2004.

It shows Big Paw Paw Lake formed a 23-foot-thick thermocline from 10 to 33 feet. Dissolved oxygen was again plentiful above the thermocline. It started to decrease at the top of the thermocline (10 feet), and by 24 feet, it was zero. That condition remained to the bottom at 90 feet.

About 58 percent of the lake is deeper than 24 feet.

## **2005**

The graph shows in late summer 2005 Big Paw Paw Lake formed a 15-foot-thick thermocline from 15 to 30 feet. Dissolved oxygen was plentiful above 15 feet, and started to decrease below that depth. The lake ran out of dissolved oxygen at 24 feet, which was the same as in 2004.

## **2006**

In late summer 2006 the lake formed a 15-foot thick thermocline from 15 to 30 feet. Dissolved oxygen concentrations were lower than normal, but adequate to support fish life above 15 feet. Dissolved oxygen started to decrease below 15 feet, and was zero at 21 feet. That condition remained to the bottom. About 63 percent of the lake is deeper than 21 feet.

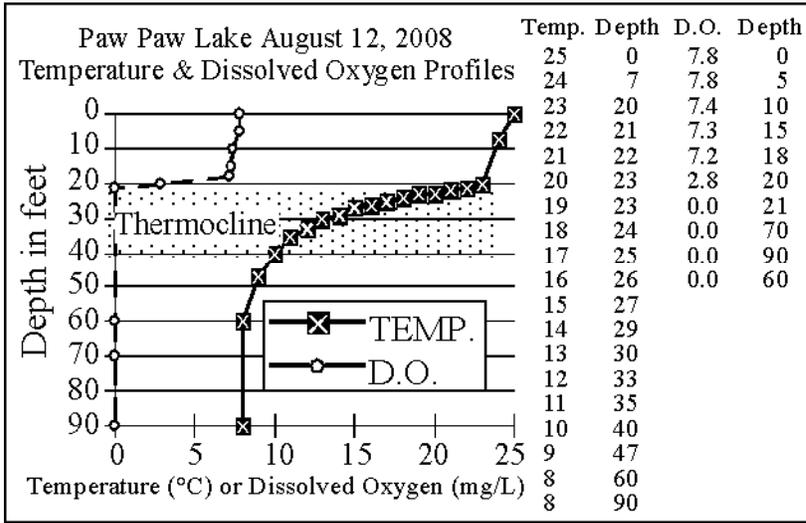
## **2007**

In late summer 2007 the lake formed a 28-foot thick thermocline from 10 to 38 feet. Dissolved oxygen supplies were plentiful above the thermocline and started to decrease at the top of the thermocline. The dissolved oxygen concentration was zero at 22 feet, and that condition remained to the bottom. About 61 percent of the lake is deeper than 22 feet.

## **2008**

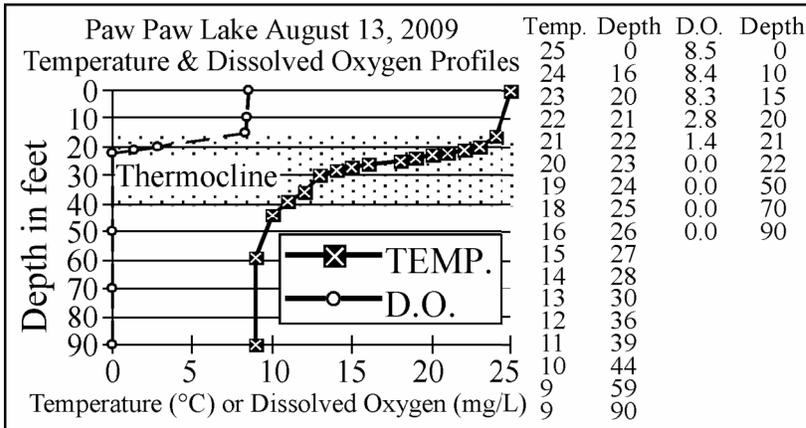
In late summer 2008, the lake formed a 17-foot thick thermocline from 18 to 35 feet. Dissolved oxygen concentrations were adequate above the thermocline and dropped to zero at 21 feet, which was one foot below the

top of the thermocline. This loss of dissolved oxygen so near the top of the thermocline



thermocline indicates the lake is receiving way too many nutrients, mainly from lawn fertilizers (see below). Residents need to realize this and quit using all fertilizers on lawns around the lake.

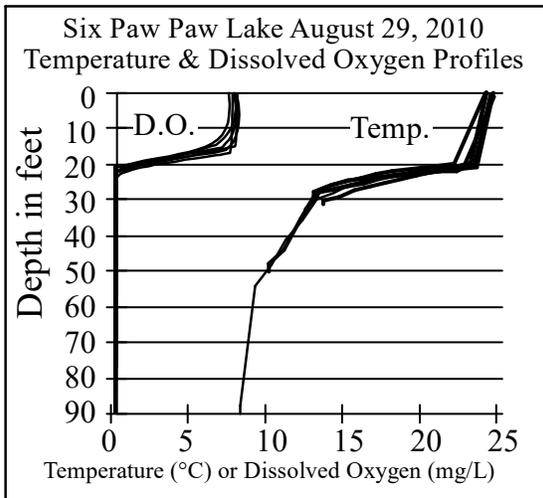
**2009**



In late summer 2009, the lake formed a 24-foot thick thermocline from 15 to 39 feet. Dissolved oxygen concentrations were adequate above the thermocline and dropped to zero at

22 feet.

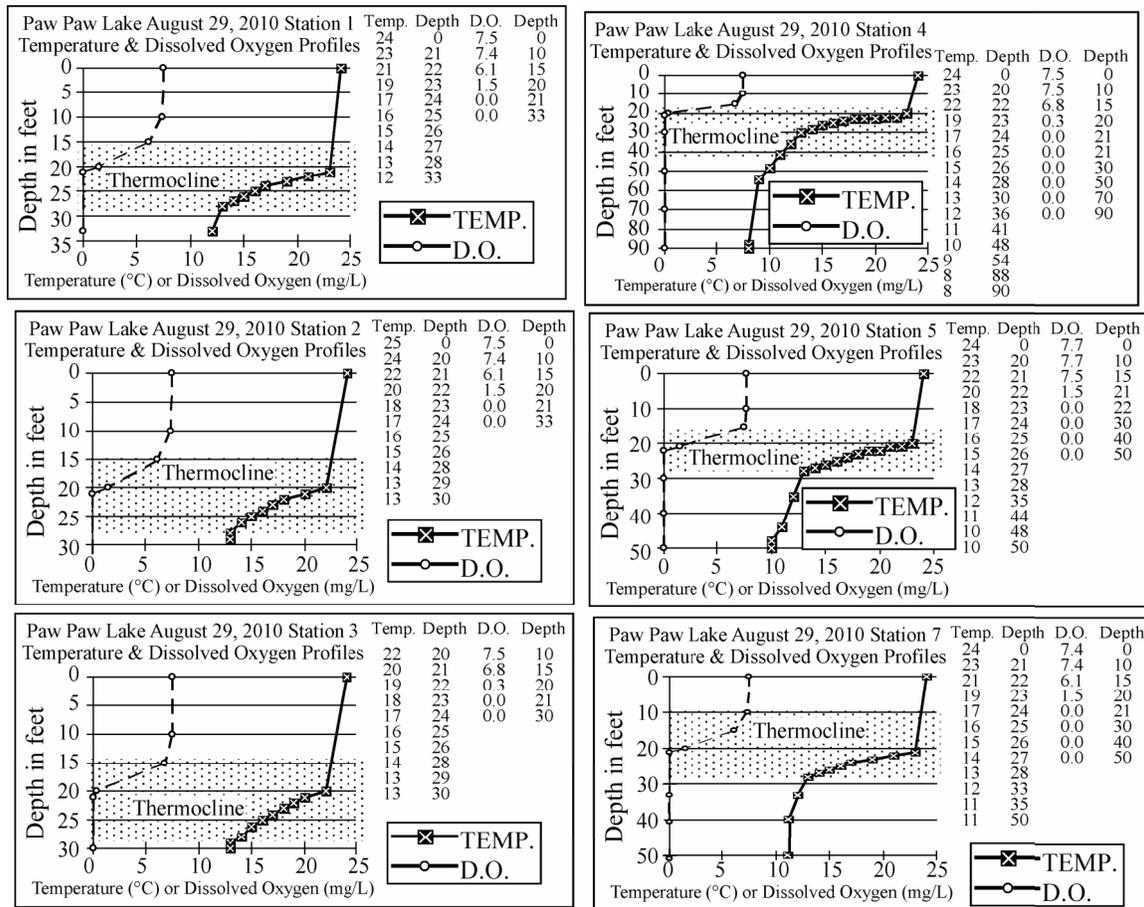
**2010**



In late summer 2010 WQI collected temperature and dissolved oxygen at six stations with depths ranging from 30 to 90 feet. The graph shows the data from all six stations superimposed. It shows there was little difference in the dissolved oxygen and temperature profiles at the

six stations regardless of where the data were collected. It appears a single profile is representative of conditions for the entire lake.

The data for the six stations are shown below.



The graphs show the lake generally formed a 10 to 15 foot thick thermocline starting at 15 to 20 feet and ending at about 30 feet. And the lake ran out of dissolved oxygen at 20 or 21 feet at all six stations.

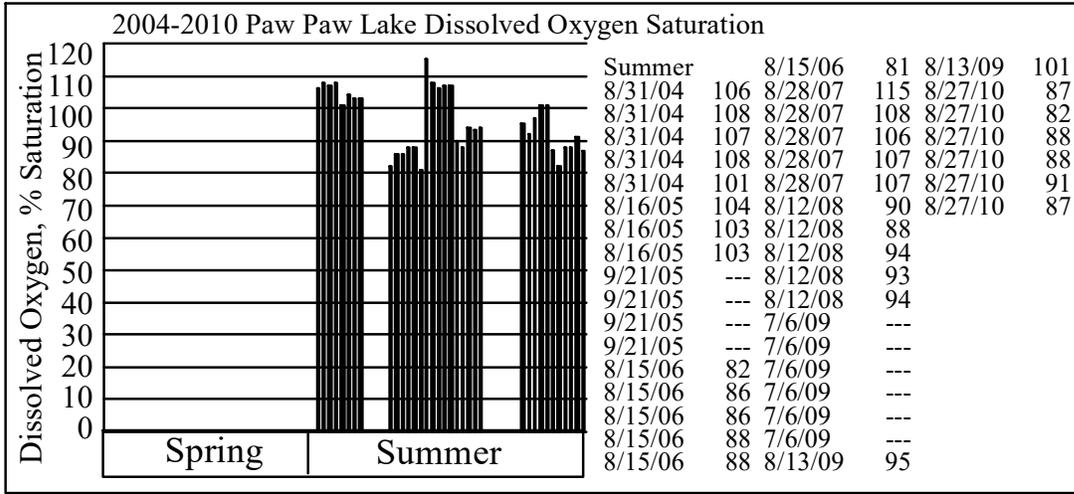
### A NOTE ABOUT THE FOLLOWING GRAPHS

The data on the Paw Paw Lake graphs below are sorted first by spring and summer, then by date. The purpose of this was to see if there were differences between the spring and summer data. The graphs show more summer data, but that's because the September 2005 and July 2009 samples were considered summer samples. Top to bottom graphs are vertical, sorted by year then by depth.

Drain graphs are sorted in specific order requested by Paw Paw Lake Association.

## DISSOLVED OXYGEN SATURATION

Because the amount of dissolved oxygen a water can hold is temperature dependent, with cold water holding more dissolved oxygen than warm water, dissolved oxygen saturation is often a better way to determine if dissolved oxygen supplies in the surface water are adequate. Best is between 90 and 110 percent.



The graph shows that is the case with the late summer samples in 2004 and 2005. It shows in 2006, dissolved oxygen saturation values were lower, ranging from 81 to 88 percent. The cause of these lower values is unknown. 2007 values were on the high side, while 2008 values were on the low side.

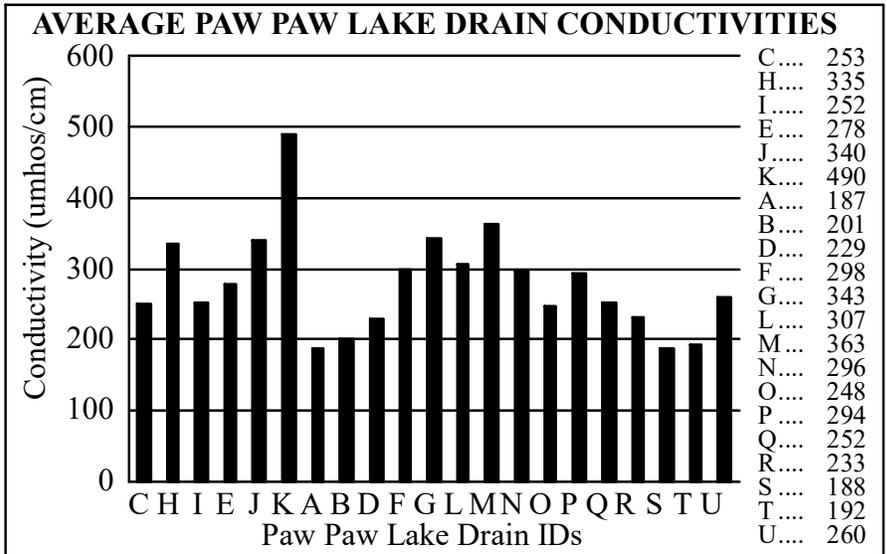
2009 oxygen saturation ranged from 92 to 101 percent, which is good. In 2010 dissolved oxygen saturation values ranged from 82 to 92 percent, which is low.

## CONDUCTIVITY

Conductivity, measured with a meter, detects the capacity of a water to conduct an electric current. More importantly however, it measures the amount of materials dissolved in the water (salts), since only dissolved materials will permit an electric current to flow. Theoretically, pure water will not conduct an electric current. It is the perception of the experts that poor quality water has more dissolved materials than good quality water. I agree. Lower is usually better.



The drain data show conductivities in some cases are higher than the lake. Not a surprise there.



The graph shows the average conductivity data for the various drains.

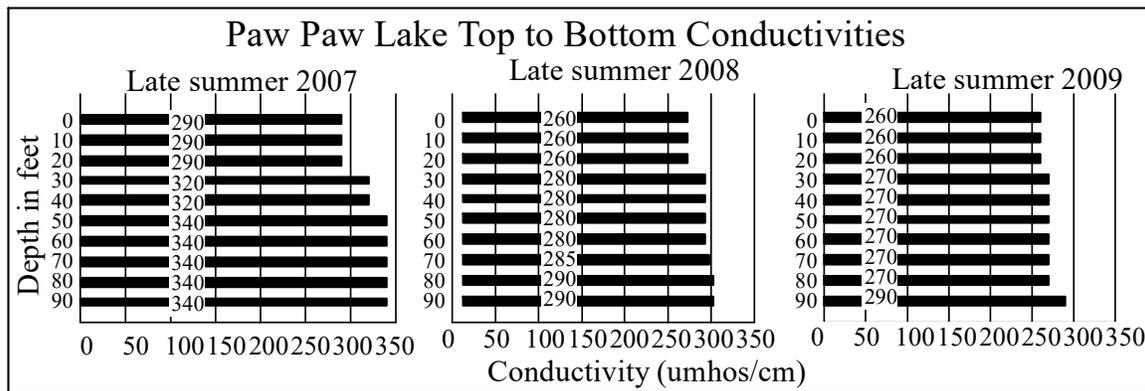
The average conductivity for the lake is 245 umhos/cm. The highest average conductivity is at sample station

K in the Green Drain, 490 umhos/cm, but that's based on only three samples.

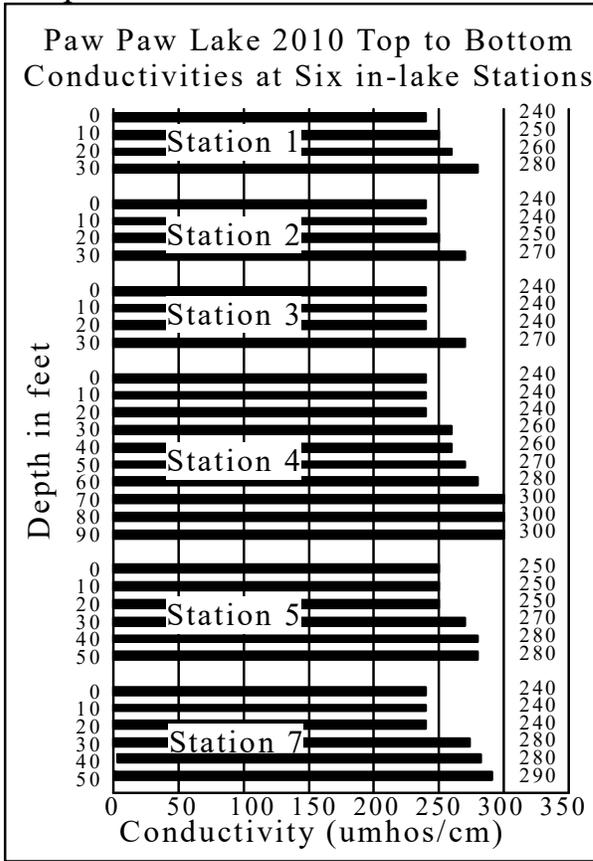
Little Paw Paw Lake Drain (B) average conductivities (201 umhos/cm) were lower than the lake. Branch & Derby Drain (C) average conductivities were slightly higher than the lake (253 umhos/cm) as were the average conductivities of Sherwood drain (G) (343 umhos/cm). The remainder of the average conductivity data really doesn't indicate any real problems.

### TOP TO BOTTOM CONDUCTIVITIES

Top to bottom data are shown as two different graphs, the first showing the 2007, 2008 and 2009 data and, a second showing the data for the six stations



sampled in 2010.

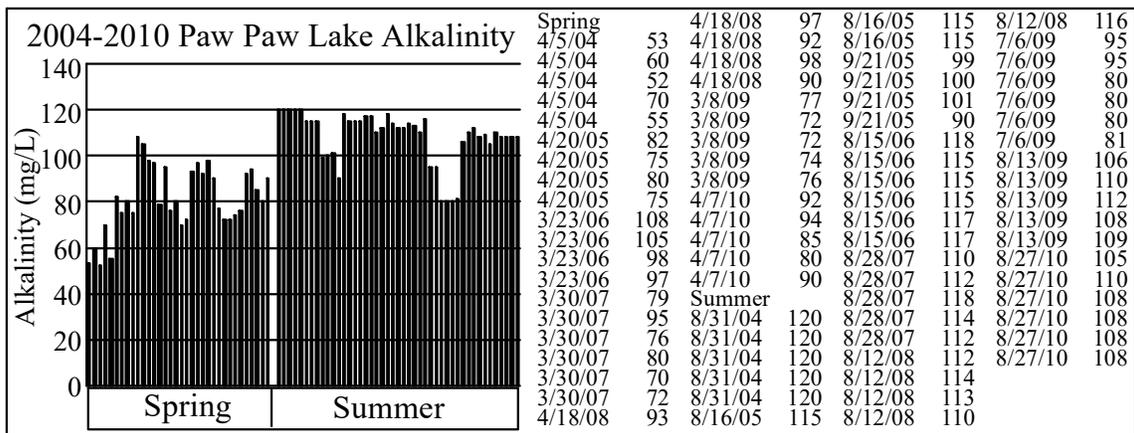


Top to bottom samples at Station 4, (the deep hole) were collected in Paw Paw Lake in late summer 2007, 2008 and 2009. In 2010 conductivity data were collected top to bottom at six stations. The graphs show each year conductivities, and hence salts increased with depth. This is normal, and what we usually see.

The graphs also show conductivities usually range from 240 to 300 umhos/cm.

### TOTAL ALKALINITY

Alkalinity measures carbonates and bicarbonates in water. Soft water lakes have alkalinities below 75 milligrams per liter. Moderately hard water lakes have alkalinities between 75 and 150 milligrams per liter. Hard water lakes have alkalinities above 150 milligrams per liter.



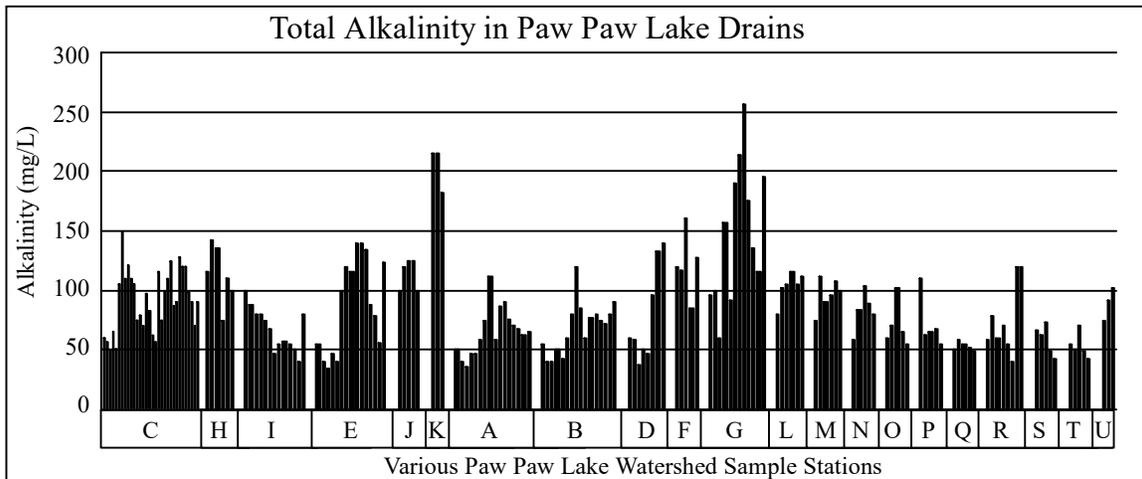
The graph shows the spring and summer alkalinity data for the lake. It shows in spring alkalinity concentrations ranged from 52 to 108 mg/L, which indicates in spring the lake was a soft water to moderately hard water

lake. In summer and fall, alkalinities ranged from 80 to 120 mg/L. This indicates in summer and fall the lake was a moderately hard water lake. The graph shows summer alkalinities are higher than spring alkalinities.

The reason for the lower July 2009 alkalinities, especially at Stations 3, 4, 5 and 6 is unknown, especially since the five August alkalinities were higher and much more in line with prior years.

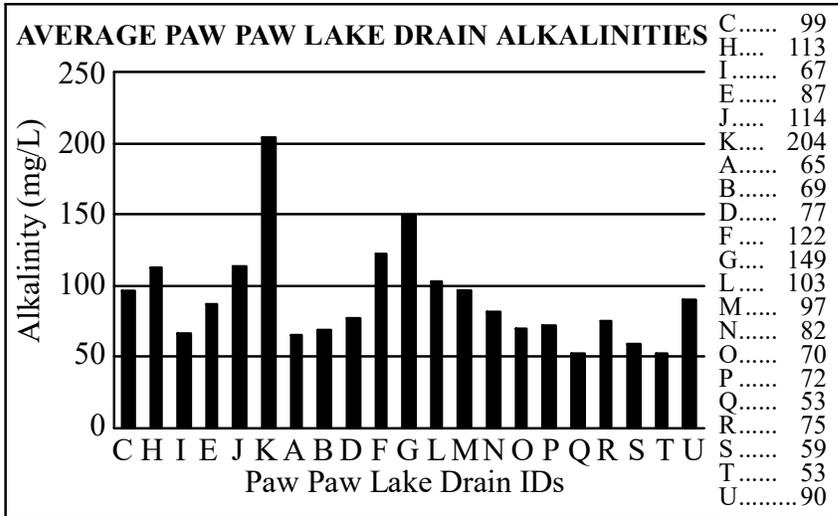
Hard water lakes are tougher than soft water lakes because they have the ability to precipitate some phosphorus to the bottom sediments as calcium phosphate. Soft water lakes lack that ability.

It is unusual for the alkalinity of the lake to be higher in summer than in spring. Summer lake alkalinities are usually lower than spring alkalinities because the carbonates and bicarbonates, which are what the alkalinity test measures, precipitate to the bottom sediments as the water warms from spring to summer.



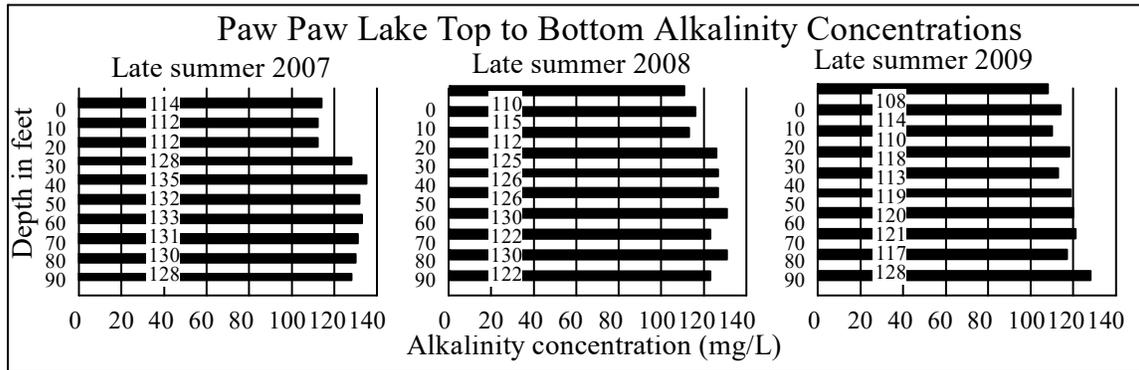
The graph shows the alkalinity of the various drains. It is unusual to find the alkalinities of the drains to be considerably lower than the lake, because most drains are fed by groundwater and the amounts of carbonates and bicarbonates in the groundwater is usually higher than that of lakes because those materials settle to the bottom of the lake when the water warms in summer.

The graph below shows the average alkalinities of the various drains.



It shows Green Drain (K) has the highest average alkalinity, followed by Sherwood Drain (G). The remainder are low. However higher alkalinities would be a benefit for Paw Paw Lake.

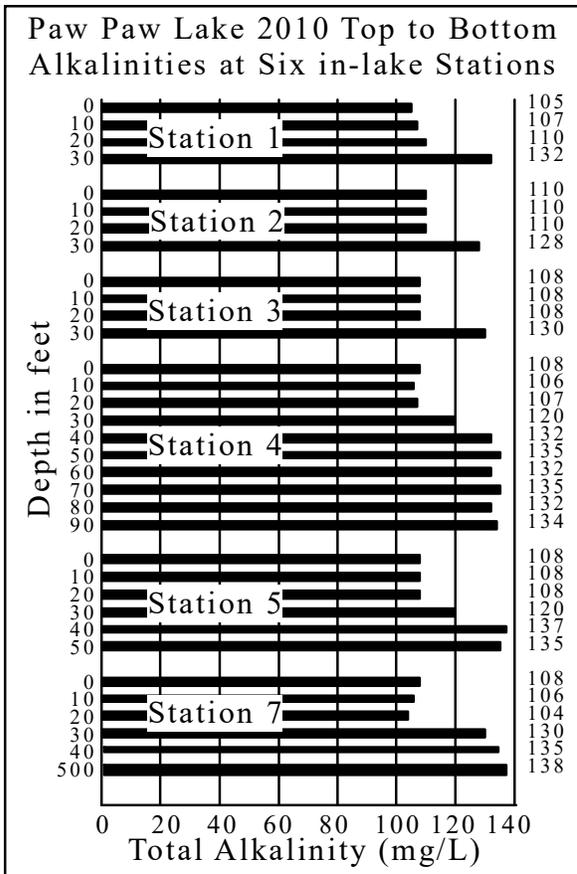
### TOP TO BOTTOM ALKALINITIES



Two graphs show the top to bottom alkalinities. The first shows the alkalinity of Paw Paw Lake at various depths in late summer 2007, 2008 and 2009.

The second shows the top to bottom alkalinities of the six stations sampled in 2010.

Both sets of graphs show the late summer alkalinities in the top 20 feet or so are less than the deeper water. This is because the carbonates and bicarbonates, which are what the alkalinity test measures, settle out (precipitate) to the bottom sediments as the water warms in summer. The reason they settle out is these materials are less soluble in warm water than they are in cold water. These materials make up a majority of the sediments in Paw Paw Lake.



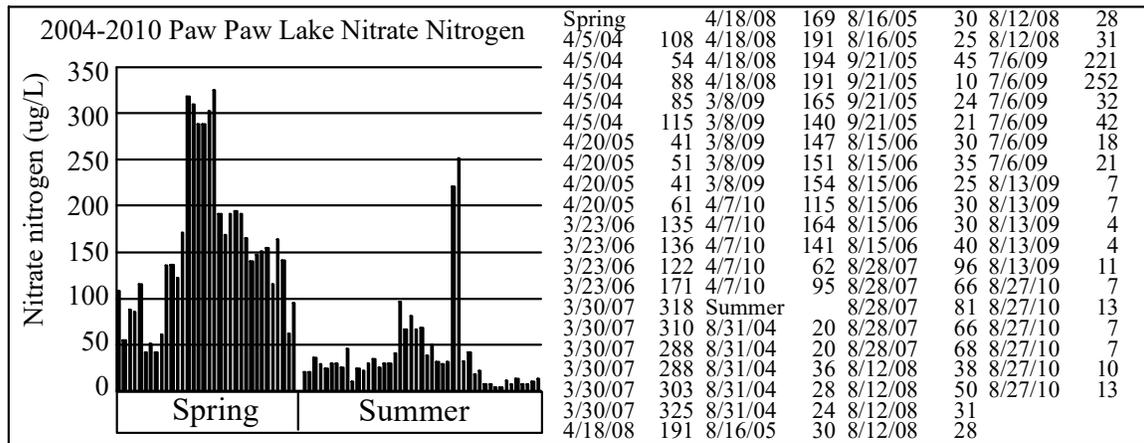
The late summer alkalinity concentration in the deeper water is similar to the spring alkalinity.

### NITRATE NITROGEN

Most Michigan inland lakes have spring nitrate nitrogen concentrations around 200 micrograms per liter (or parts per billion). Summer nitrate nitrogen concentrations are generally much lower, in the 10 to 40 micrograms per liter range.

The graph of 2004-2010 Paw Paw Lake surface nitrate nitrogen concentrations shows they were low or normal every time the lake was sampled in both spring and summer. Even the spring 2007

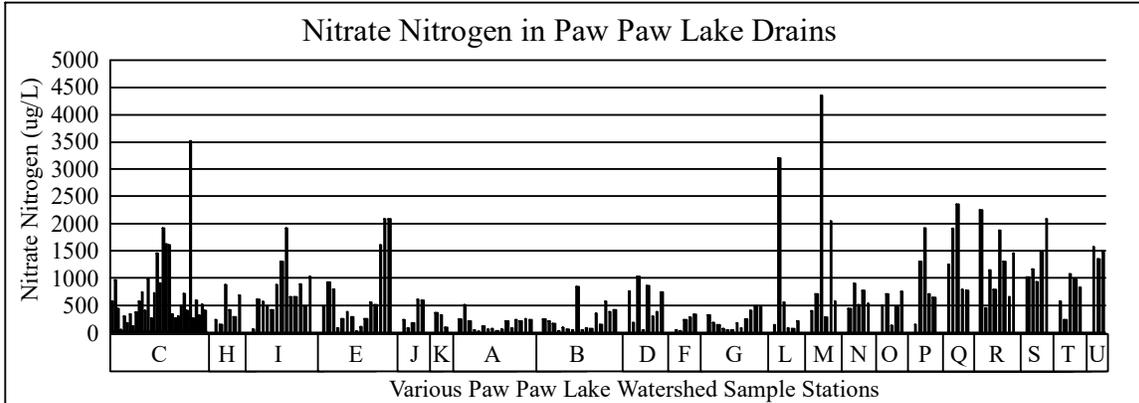
values which appear to be high on the graph are within the normal range.



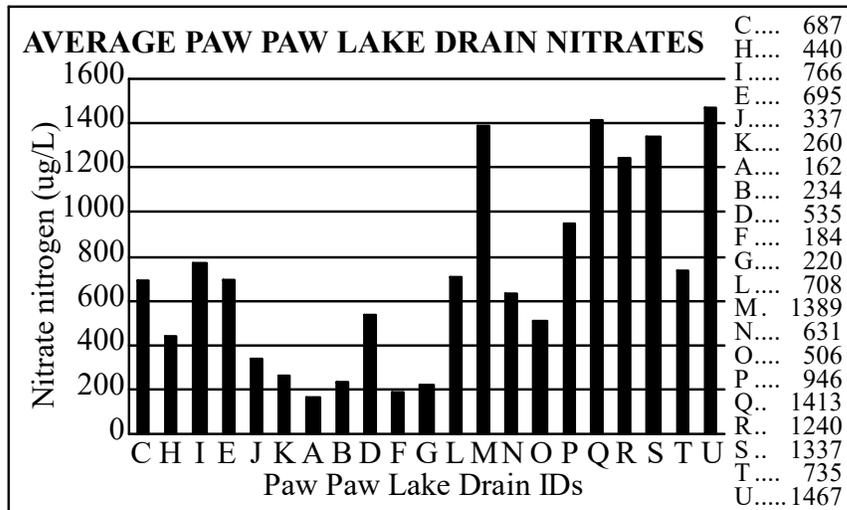
The reason for the high nitrates at Stations 1 and 2 in July 2009 is unknown, especially since the nitrates from Stations 3, 4 and 5 are low.

2010 spring nitrates ranged from 62 to 164 ug/L while summer nitrates ranged from 7 to 13 ug/L. These are normal nitrates for a Michigan inland lake.

These data indicate Big Paw Paw Lake may be nitrate rather than phosphorus limited in summer. It also means no fertilizers containing either nitrogen or phosphorus should be used on near lake areas.



The graph of drain nitrate nitrogen concentrations shows although the lake nitrates are low, drain nitrates can be high from time to time.



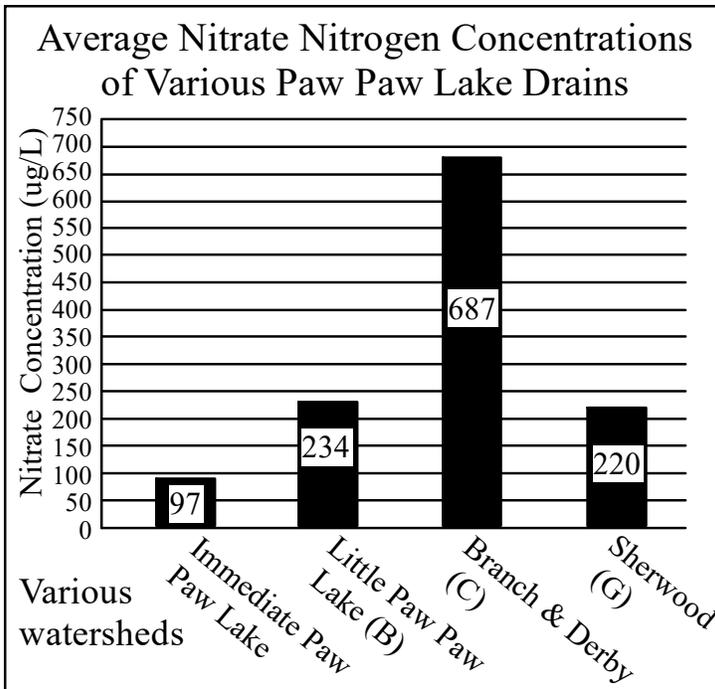
The graph shows the average nitrate nitrogen concentration of the various drains that were sampled during the past four years. Only Stations C, B and G are important because those

stations represent the outlets of the various drains that were sampled.

The graph below shows the average nitrate nitrogen concentrations of the drains as they flow into the lake. The average nitrate concentration of the lake is 89 ug/L.

The graph shows the average Branch & Derby Drain (C) nitrate is 687 ug/L, which is more than 7 times higher than the lake.

The average nitrate nitrogen concentration of Little Paw Paw Lake Drain (B) is 234 ug/L, or more than two times higher than the lake, while the average



nitrate nitrogen concentration of Sherwood Drain is 220 ug/L, again more than two times higher than the lake.

Some of the other average nitrates at upstream stations are much higher than the lake, but since the nitrate concentrations decrease before reaching the lake, they are not a problem.

Now we need to look at nitrate loading. Loading

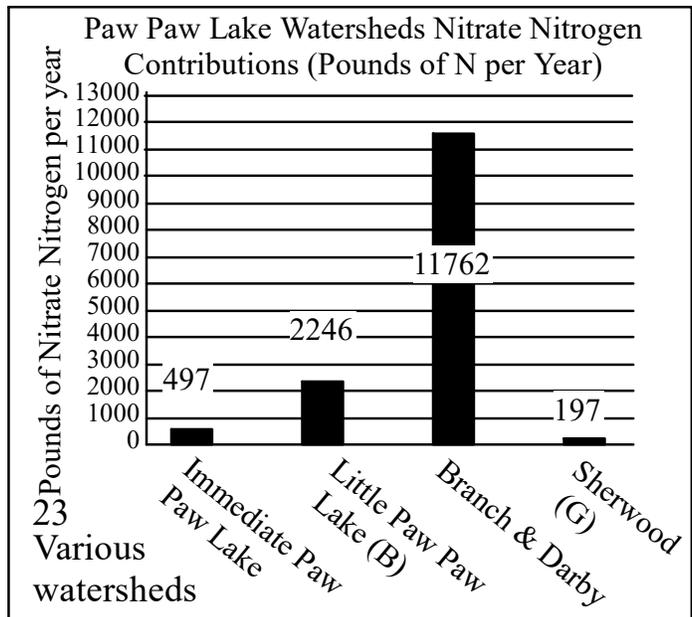
involves both concentration and water volume. The reason flow from the various drains is reported in billions of pounds is because both nitrate nitrogen and phosphorus are reported in parts per billion. To determine nutrient loading, all we need to do is multiply the concentration of the nitrate nitrogen or phosphorus for a particular drain times the flow in billions of pounds.

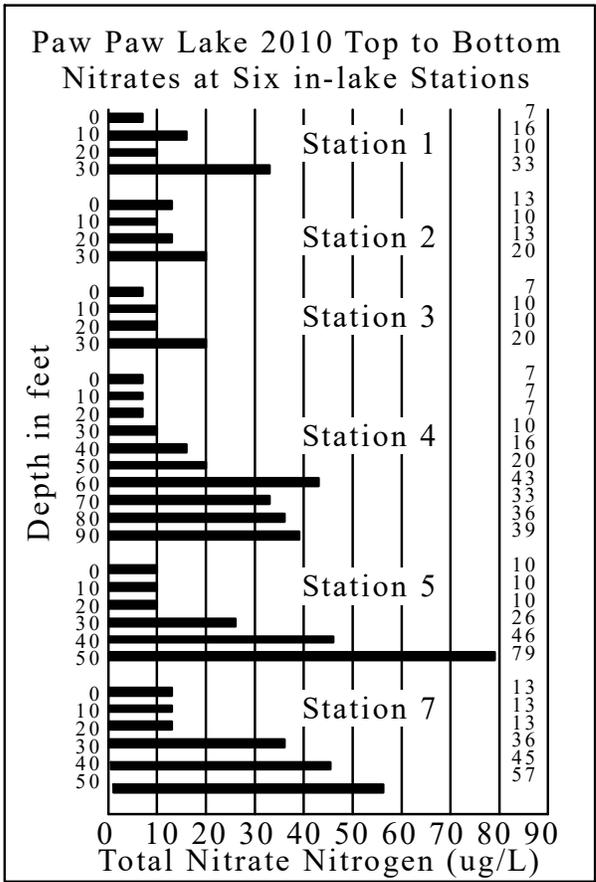
On the other hand, because water volume becomes a factor, loading calculations can sometimes lead to erroneous conclusions.

The graph shows the number of pounds of nitrate nitrogen contributed to Big Paw Paw Lake by the various drains.

In this case, the Branch & Derby Drain seems to contribute more than five times (11762 pounds) as much as the next highest contributor, Little Paw Paw Lake Drain (2246 pounds).

Among the drains, Sherwood Drain contributes the least, 197 pounds per year.



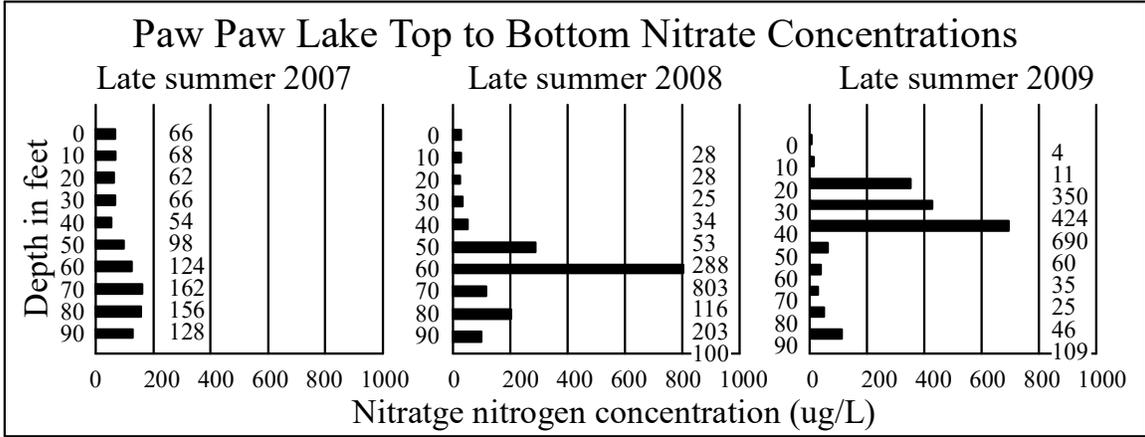


The immediate lake watershed contributed about 497 pounds of nitrate nitrogen to the lake. The lake itself had an average of 1492 pounds of nitrate nitrogen in it.

**TOP TO BOTTOM NITRATES**

Top to bottom nitrates are shown on two graphs, the first one shows the 2010 data collected from the six stations. The second shows the 2007, 2008 and 2009 top to bottom data from Station 4, the 90-foot deep hole.

In 2010 top to bottom nitrates were low at all stations. The graph shows nitrates increased in the deeper water, but they were still low



In 2007 top to bottom nitrates didn't vary a lot. In 2008, they did, especially at 50 and 60 feet. In 2009 they were higher at 20, 30 and 40 feet.

**CHLOROPHYLL A**



The graph shows the chlorophylls in the top 20 feet were high, ranging from 10.9 to 14.3 ug/L. Below that depth they ranged from 3.4 to 5.5 ug/L, which is lower than the surface chlorophylls, but still high.

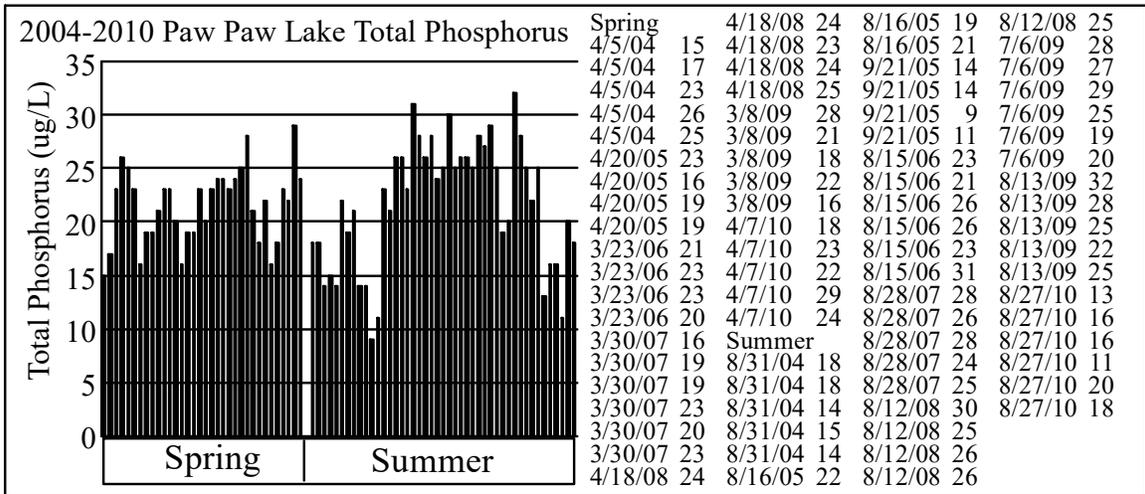
**pH (Hydrogen ion concentration) (no graph)**

2004-2010 in-lake surface pH values ranged from 7.7 to 9.1. These are normal pH values for a productive Michigan inland lake.

Lakes with extensive plant communities often have high summer pH values (greater than 9) because the plants use the carbonates in the water as a carbon source. This causes a decrease in the buffering capacity of the water, and allows the pH to increase.

**TOTAL PHOSPHORUS**

Phosphorus is a major nutrient in lakes. There are many forms, but they can all be converted to the other forms. Because of this, the experts selected total phosphorus as the most meaningful test. Best is below 10 micrograms per liter.

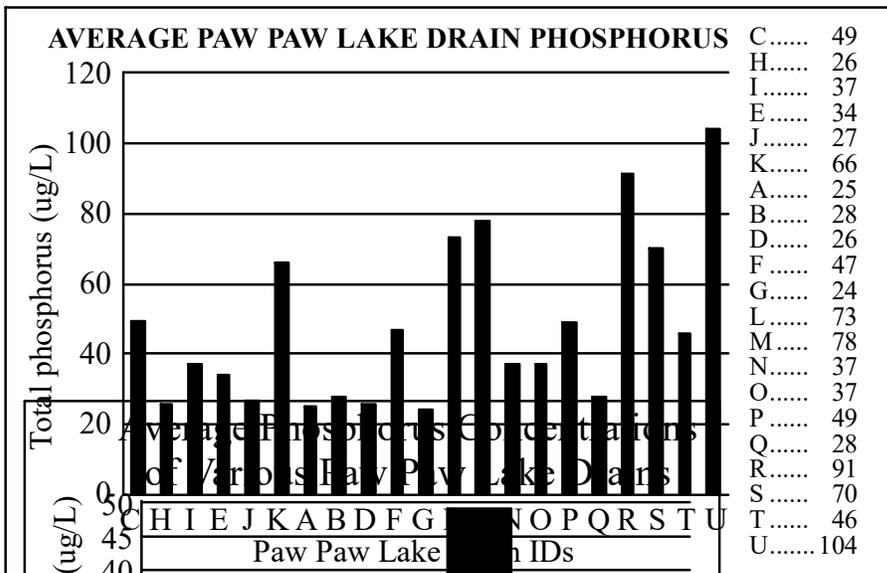
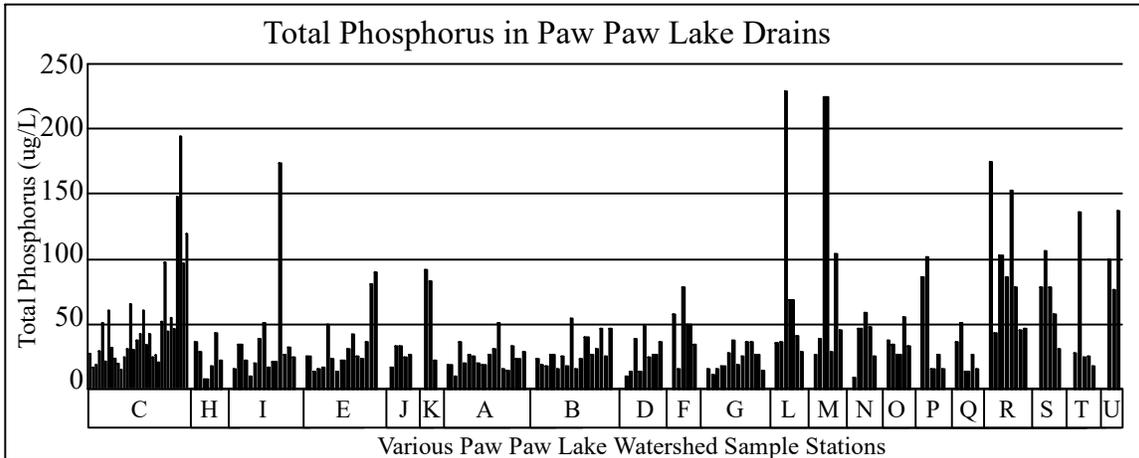


The graph shows surface phosphorus concentrations range from 9 to 32 ug/L. Spring Paw Paw Lake phosphorus concentrations ranged from 15 to 29 ug/L. Spring 2010 phosphorus concentrations ranged from 18 to 29 ug/L.

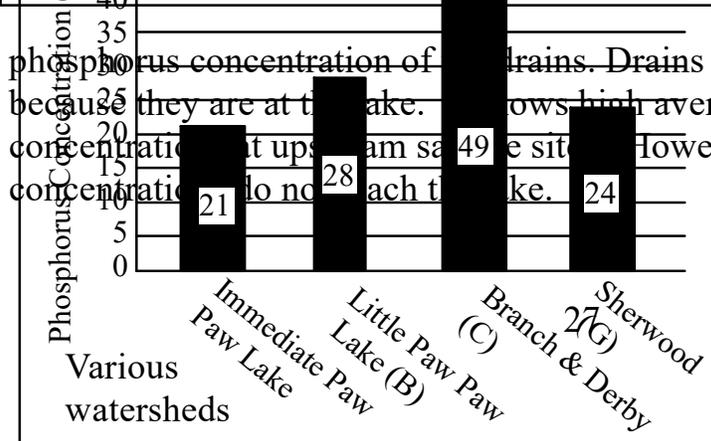
Fall 2005 phosphorus were among the lowest, ranging from 9 to 14 ug/L. 2006 and 2008 phosphorus concentrations in both spring and summer were

20 ug/L or more, as were summer 2007 values. Summer 2008 phosphorus concentrations ranged from 25 to 30 ug/L. In summer and late summer 2009 phosphorus concentrations ranged from 19 to 32 ug/L. In late summer 2010 phosphorus concentrations were better than most years, ranging from 11 to 20 ug/L.

As phosphorus concentrations approach 20 ug/L, if other nutrients are present in sufficient quantities, they will encourage plants and algae to grow.



The graph of drain phosphorus concentrations shows occasional high spikes, but most of the samples were below 30 ug/L.

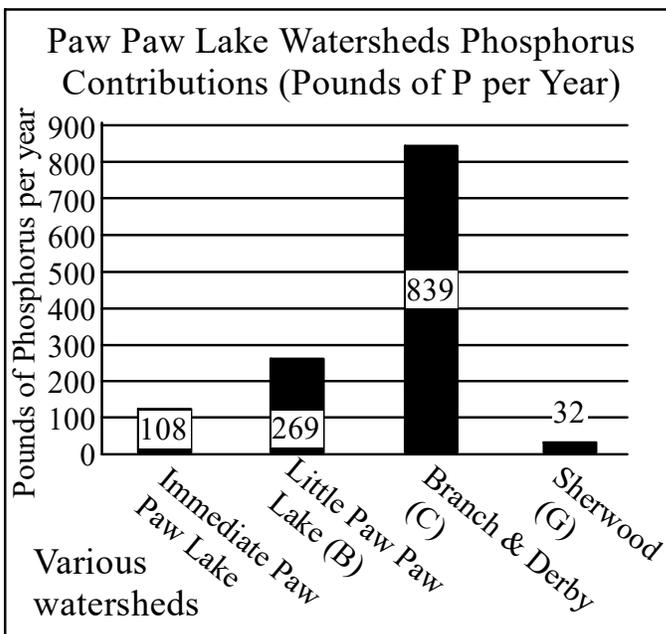


The graph at left compares the average phosphorus concentration of the drains.

Drains C, B and G are important because they are at the lake. The graph shows high average phosphorus concentration at upstream sampling sites. However those high phosphorus concentrations do not reach the lake.

The graph at left compares the average phosphorus concentration of the various drains at the point where they flow into the lake.

This is one of the most important graphs in this report, because it shows the average phosphorus concentrations of the three drains are not a lot different from the lake which averages 21 ug/L. It indicates the Branch & Derby Drain has the highest average phosphorus concentration (49 ug/L), which is up from prior years, but in 2010, 12 samples were collected from this drain, often during or just after rain storms, which may skew the data and make it less reliable as representing actual conditions in the drain water.

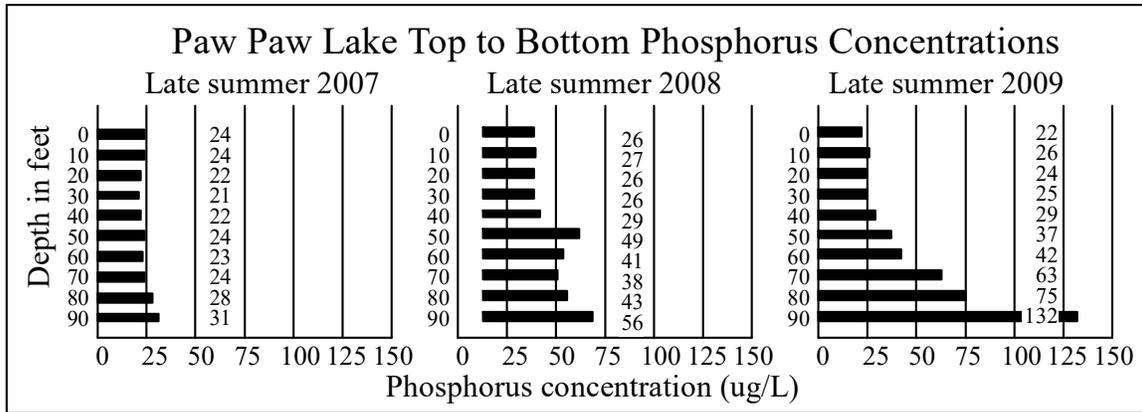


The phosphorus loading graph at left shows the Branch & Derby Drain contributes the most phosphorus to the lake (839 pounds per year, versus 565 pounds last year), but that's mainly because it has the largest flow. This is a good example of where loading calculations skew the data.

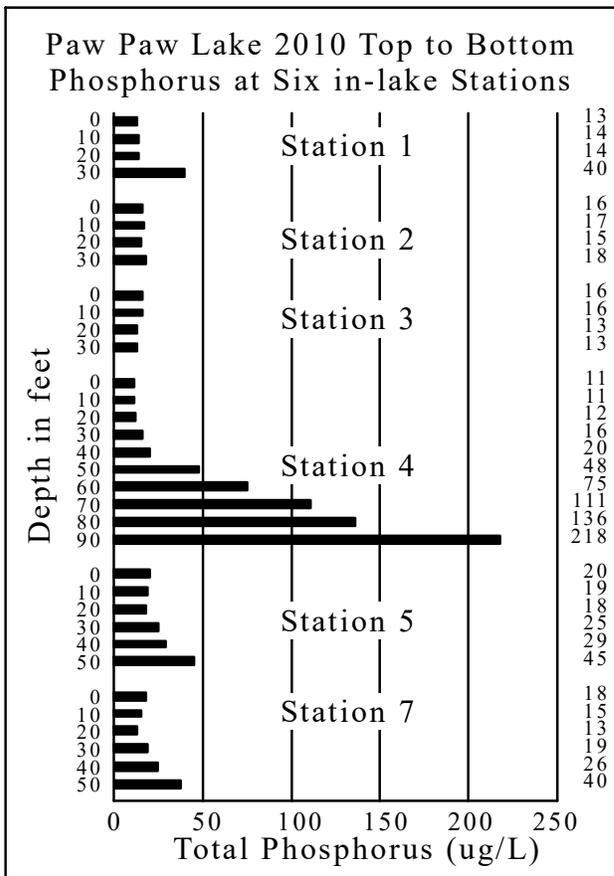
The higher 2010 B & D loading is the result of selective rather than random sampling of the stream. The

earlier 565-pound figure probably more accurately reflects the actual loading.

## TOP TO BOTTOM PHOSPHORUS



The top to bottom phosphorus concentrations are shown by two graphs. The first graph shows the phosphorus concentrations of the 2007, 2008 and 2009 late summer top to bottom samples.



It shows in 2007 phosphorus concentrations were fairly uniform top to bottom, with the bottom water having slightly more phosphorus than the surface water.

In 2008 the graph shows the bottom water phosphorus was about twice the surface water phosphorus. And in 2009, the bottom water phosphorus was 6 times higher than the surface water phosphorus. This high phosphorus concentration in the

bottom water is the result of the lake running out of dissolved oxygen in the deep water, and as a result, phosphorus which was carried to the bottom sediments is released back into the water column where it will cause additional algae to grow the following year.

The 2010 data shows only at Station 4, the 90-foot deep hole, is phosphorus being released from the bottom sediments in a significant amount. And

because the amount of water at that depth is small compared to the rest of the lake, it probably doesn't cause much of a problem.

## **ORTHOPHOSPHORUS**

Orthophosphorus data are found in the table in the atlas pages labeled Water Quality Data for Paw Paw Lake 2010.

## **SECCHI DISK TRANSPARENCY (originally Secchi's disk)**

In 1865, Angelo Secchi, the Pope's astronomer in Rome, Italy devised a 20 centimeter (8 inch) white disk for studying the transparency of the water in the Mediterranean Sea. Later an American limnologist (lake scientist) named Whipple divided the disk into black and white quadrants which many are familiar with today.

The Secchi disk transparency is a lake test widely used and accepted by limnologists. The experts generally felt the greater the Secchi disk depth, the better quality the water. However, one Canadian scientist pointed out acid lakes have very deep Secchi disk readings. Most lakes in southeast Michigan have Secchi disk transparencies of less than ten feet. On the other hand, Elizabeth Lake in Oakland County had 34 foot Secchi disk readings in summer 1996, evidently caused by a zebra mussel invasion a couple of years earlier.

Most limnology texts recommend the following: to take a Secchi disk transparency reading, lower the disk into the water on the shaded side of an anchored boat to a point where it disappears. Then raise it to a point where it's visible. The average of these two readings is the Secchi disk transparency depth.

We do it slightly differently. We lower the disk on the shaded side of an anchored boat until the disk disappears, and note the depth, then report the depth to the next deepest foot. For example if the disk disappears at six and a half feet, we report the Secchi disk depth as 7 feet. The reason we do this is that some suggest using a water telescope (a device that works like an underwater mask and eliminates water roughness) to view the disk as it disappears. Since we don't use this device, we compensate for it by noting the slightly deeper depth.

We feel it is only necessary to report Secchi disk measurements to the closest foot. Secchi disk measurements should be taken between 10 AM and 4 PM. Rough water will give slightly shallower readings than smooth water. Sunny days will give slightly deeper readings than cloudy days. However, roughness influences the visibility of the disk more than sunny or cloudy days. Furthermore, it's been reported that most adults can see the Secchi disk disappear at about the same depth, but grand-children see it disappear 3-4 feet deeper than grand-parents.

If there are sample sites where the lake is too shallow and the disk is visible when resting on the bottom, the reading should be taken at a nearby deeper site. Since the sampling procedure is designed to obtain "representative samples" moving the boat to an area where a Secchi disk transparency reading can be properly taken is appropriate. In the case of Secchi disk readings, this procedure is more valid than reporting the disk is visible on the lake bottom.

## **BIG PAW PAW LAKE SECCHI DISK DATA**

### **2004**

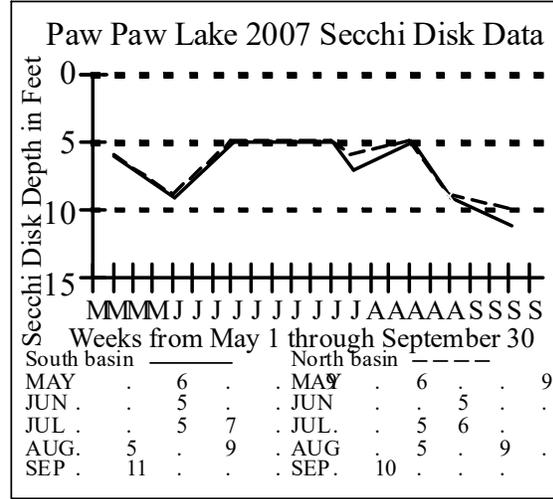
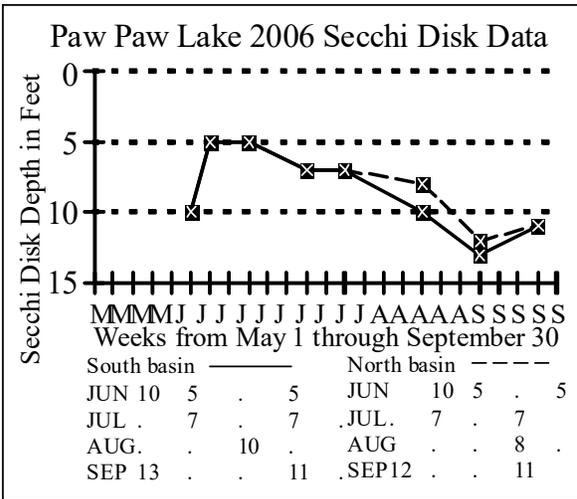
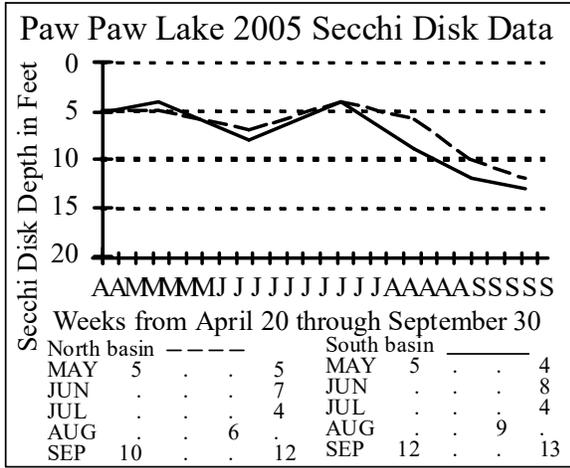
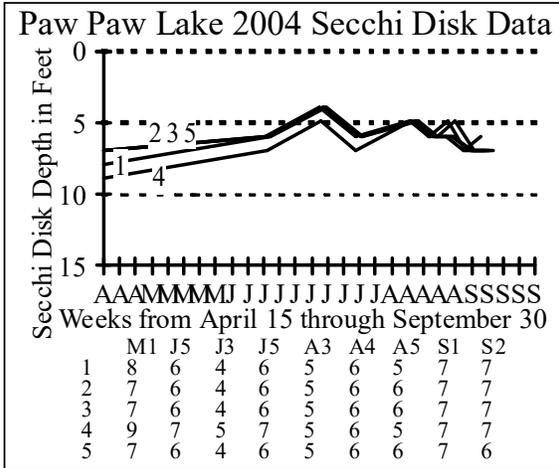
Rasmussen and Engle did a good job taking Secchi disk readings on Big Paw Paw Lake in 2004.

They took them at five stations on a regular basis through the warm months. The graph shows their 2004 data from the five stations, stacked.

The graph shows water clarity varies from 4 to 9 feet. Spring readings were deepest, especially at Station 4 in the middle of the south basin, 9 feet. As the water warmed, the clarity decreased to between 4 and 7 feet the rest of the year.

### **2005**

Frank Jurenka did a good job taking Secchi disk readings through the warm months in 2005. The graph shows his averaged data from the north and south basins. It shows just the opposite of the 2004 data.



Secchi disk readings were shallowest, (5 to 7 feet) in spring and early summer. In August, they started increasing, and in September they were deepest (10 to 13 feet)

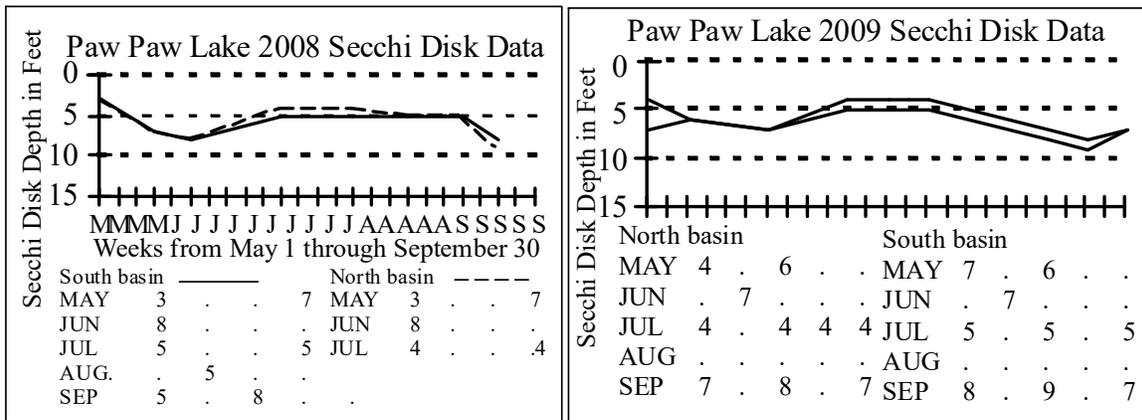
## 2006

Secchi disk readings were collected by Jurenka in both basins in 2006. In early June, they were 10 feet in both basins. They decreased to five feet in both basins in about a week. From that point they gradually increased to 12 and 13 feet in early September. The south basin had slightly deeper Secchi disk readings than the north basin, but not by much.

## 2007

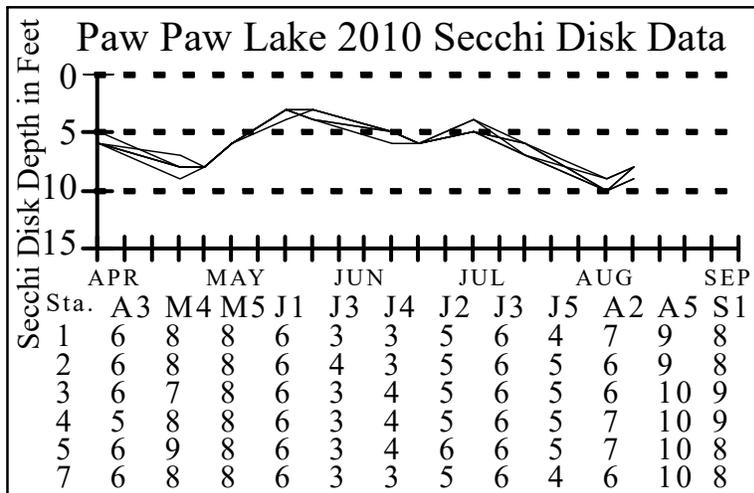
In 2007 Jurenka collected Secchi disk readings in both basins. The graph shows his data from the north and south basins were just about the same through the warm months, ranging from 5 to 9 feet until September when they were 10 and 11 feet.

### 2008 & 2009



The graphs of Jurenka's 2008 and 2009 Secchi disk data shows most of the time the readings were about 5 feet. In June and September they increased to 7, 8 and 9 feet. These data indicate the lake pretty much had an algal bloom all summer long, which not a good sign.

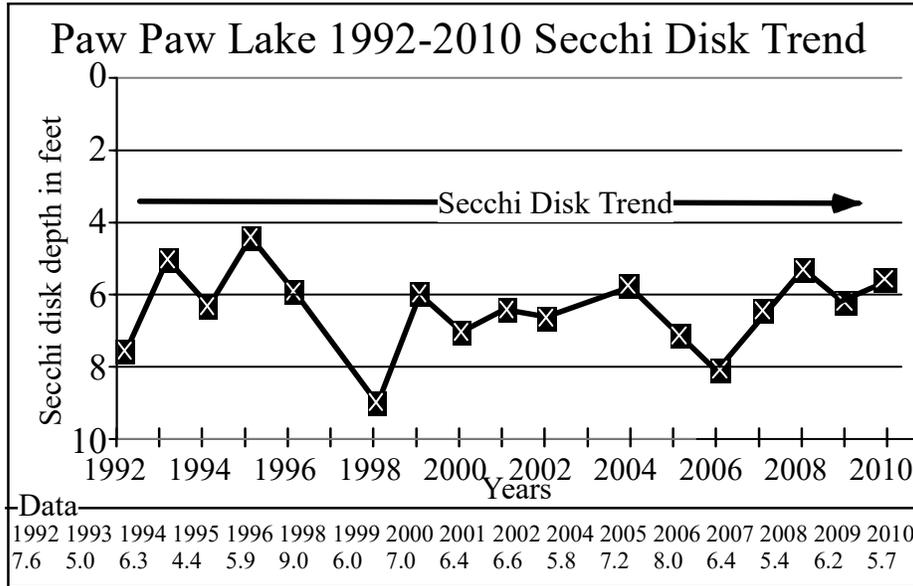
### 2010



In 2010 Jurenka took Secchi disk readings at the six stations during the warm months. The graph shows the data from the six stations superimposed. It shows little difference between the data. In other words, conditions were pretty similar throughout the lake.

April readings were 5 and 6 feet. Early May readings were 7 to 9 feet. Late May, June and July readings were 3 to 6 feet. In August readings increased to a maximum of 10 feet.

**THE SECCHI DISK TREND GRAPH**



Because Big Paw Paw Lake residents have been taking Secchi disk readings on a regular basis since 1992, we were able to construct a Secchi disk

Trend graph, which shows whether the lake is getting clearer or cloudier as years pass. (Missing data were supplied by Ralph Bednarz, MDEQ). (Apparently no one took Secchi disk readings in 1997 and 2003.) The graph shows the available data.

1998 average data were best, 9.0 feet. And 2006 average Secchi disk readings were the best since 1998.

However 2007, 2008, 2009 and 2010 average Secchi disk readings were worse than 2006, with the 2008 average the worse since 1995. 2009 average readings were slightly better. However, there doesn't seem to be a trend one way or the other.

**SECCHI DISK READINGS TAKEN WITH THE SAMPLES**

The graph shows the Secchi disk readings taken with the samples. It shows fall 2005 were the best of the seven years. 2006 and 2007 readings appear to be more uniform and not as deep as the fall 2005 readings. And in 2009, spring (4 and 7 feet) and summer (4 and 5 feet) readings were among the worse so far. In 2010 spring readings were 5 and 6 feet while summer



The first questionnaire asked the scientists to select tests which they felt should be used to define lake water quality. The tests most often selected by the panel became the index parameters (or tests). They were:

Dissolved oxygen (percent saturation)	
Total phosphorus	Total alkalinity
Chlorophyll a	Temperature
Secchi disk depth	Conductivity
Total nitrate nitrogen	pH

The second questionnaire, sent out after the first was returned, asked the scientists what the results of the tests they selected as good indicators of lake water quality meant.

After the responses to the second questionnaire were returned and tabulated, the nine parameters and the accompanying rating curves were combined into a Lake Water Quality Index.

The index ranges from 1 to 100 and rates lakes about the same way professors rate students: 90-100=A, 80-90=B, 70-80=C, 60-70=D, and below 60 = E. The lake with the highest LWQI was Long Lake in Grand Traverse County, with a spring LWQI of 100. The lowest was 16 at an Ottawa County lake.

## **THE LAKE WATER QUALITY INDEX CALCULATION SHEETS**

The Lake Water Quality Index calculation sheets which follow were developed to show graphically what the results of the nine different lake water quality tests mean in terms of lake water quality.

### **HOW TO READ THE LAKE WATER QUALITY INDEX CALCULATION SHEETS.**

Listed across the top of the calculation sheets are the tests selected by the panel of experts as being good indicators of lake water quality. The results of the tests are entered into the square boxes immediately under the names of the tests.

The figures which look like thermometers are actually graphs which convert the test results (the numbers found outside the thermometer) to a uniform 1-

100 lake water quality rating (found inside the thermometer).

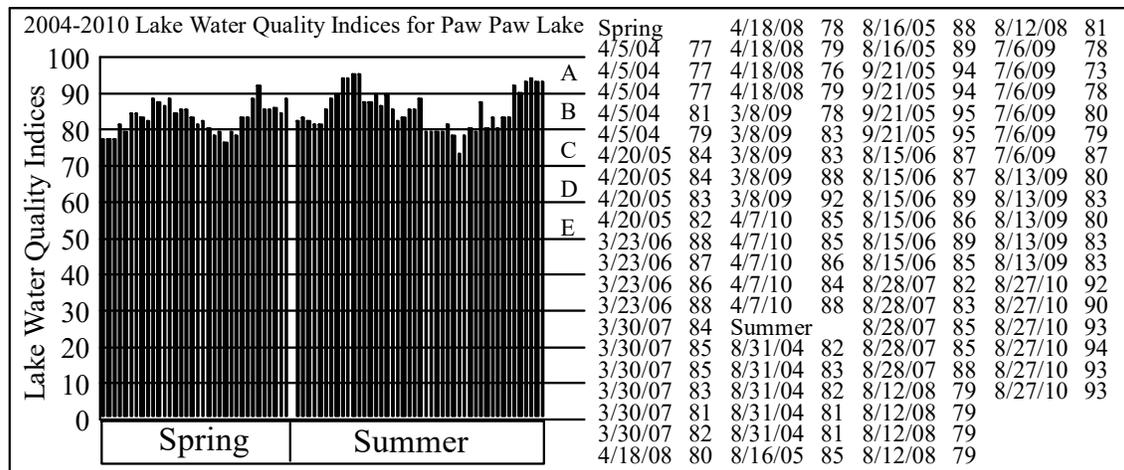
The calculation sheet permits calculation of the Lake Water Quality Index, using the results of all nine lake water quality tests.

The position of the red lines across the thermometer indicates how the results of each test compare in terms of lake water quality. Test results indicating excellent water quality are indicated by red lines near the top of the thermometer. Test results indicating poor water quality are indicated by red lines lower on the thermometer. And the lower the red line on the thermometer, the greater the water quality problem. A glance at the top of the calculation sheet indicates the test and the actual test results.

The thermometer rating scales also allow you to determine what test results would be considered excellent in terms of lake water quality. They are the numbers found outside the thermometer near the top.

The index is shown three different ways, as a number between 1 and 100 in the circle marked LWQI, and by a color and position on the sheet edge scale. The purpose of the sheet edge scale is to review quickly large numbers of lakes or test sites within a lake, and determine how the water quality of the various lakes, or test sites within a lake compare.

### THE 2004-2010 BIG PAW PAW LAKE WATER QUALITY INDICES



The graph shows the Lake Water Quality Indices for Big Paw Paw Lake ranged from 77 to 81 in spring 2004, or in the C to B range. In spring 2005 the LWQIs ranged from 82 to 84 (B). In spring 2006, they ranged from 86

to 88 (B). In spring 2007 they ranged from 81 to 85 (B), in spring 2008 they ranged from 76 to 80 (B to C), and in spring 2009 they varied the most, from 78 to 92 (C to A). In 2010 spring LWQIs ranged from 84 to 88 (B).

In summer 2004 the Lake Water Quality Indices ranged from 81 to 83, indicating the water quality in late summer is in the B range.

In summer 2005 they ranged from 85 to 89 or in the B range, while in fall 2005 they were 94 or 95, or in the A range.

In summer 2006 they ranged from 85 to 89, again in the B range.

In summer 2007 they ranged from 82 to 88, again in the B range.

In summer 2008 they ranged from 79 to 81, or in the C to B range.

In July 2009 they ranged from 73 to 80 or in the C to B range, while in August they ranged from 80 to 83 or in the B range.

In summer 2010 they ranged from 90 to 94 (A). The summer LWQIs were among the best since we started studying the lake.

## **THE LAKE WATER QUALITY INDEX CALCULATION SHEETS**

Because the 2010 Lake Water Quality Indices for Big Paw Paw Lake surface samples were similar in spring (85 85 86 84 88) and in August (92 90 93 94 93 93) only two Lake Water Quality Index calculation sheets are included in this report, one for the five spring surface lake samples, using averaged data, and a second for the six August surface samples, again using averaged data.

In the report marked MASTER, all 11 of the LWQI calculation sheets are included. That is the only difference between the MASTER and the rest of the reports.

## **NUTRIENT BUDGETS**

Calculating a theoretical nutrient budget can help lake residents understand the sources, sinks and pathways and amounts of nutrients that can cause unwanted plant or algal conditions in their lake. Nitrogen and phosphorus are both nutrients. Currently, most people involved in lake management feel

if the amount of nutrients in a lake could be reduced, water quality problems will be reduced in the lake. The following discussion addresses the sources and sinks of phosphorus, one of the nutrients that cause excess plants and algae to grow.

## **A PHOSPHORUS NUTRIENT BUDGET FOR PAW PAW LAKE**

The following is a theoretical phosphorus nutrient budget for Paw Paw Lake. The following data (and sources) were used in the nutrient budget calculations. The lake volume is in billions of pounds because in the nutrient budget, phosphorus is measured in pounds of phosphorus per one billion pounds of water (or parts per billion).

This makes it easy to determine the amount of phosphorus in Paw Paw Lake, if that needs to be done in the future. Just multiply the average phosphorus concentration in the lake (in parts per billion) times 71.03 billion pounds, the number of billions of pounds of water in Paw Paw Lake.

## **BIG PAW PAW LAKE DATA AND ASSUMPTIONS**

- Paw Paw Lake water volume..... 71.03 billion pounds
- Little Paw Paw Lake Drain flow/yr. ... 9.6 billion pounds
- Sherwood Drain flow/yr ..... 1.32 billion pounds
- Branch & Derby Drain flow/yr..... 17.12 billion pounds
- Paw Paw Lake watershed area..... 10139 acres
- Little Paw Paw Lake watershed area 2654 acres
- Sherwood Drain watershed area.... 364 acres
- Immediate Paw Paw Lake watershed area 1414 acres
- Branch & Derby Drain watershed area 4731 acres
- Water weighs 62.4 pounds per cubic foot, or 8.34 pounds per gallon
- Paw Paw Lake flushes once every 1.97 years, or 719 days
- Mean spring lawn fertilizer phosphorus concentration = 4% Sloan, 1984
- Mean fall lawn fertilizer phosphorus concentration = 20% Sloan, 1984
- Paw Paw Lake average discharge = 36.06 billion pounds of water per year
- All lake lots are one acre lots, and 50% of each lot is lawn
- Assumption: 20% of Paw Paw Lake residents fertilize their lawns
- The average Big Paw Paw Lake phosphorus concentration was 21 micrograms per liter

- The average phosphorus concentration of twenty-eight Branch & Derby Drain samples was 49 micrograms per liter.
- The average phosphorus concentration of sixteen Sherwood Drain samples was 24 micrograms per liter.
- The average phosphorus concentration of the sixteen Little Paw Paw Lake Drain samples was 28 micrograms per liter.
- All 712 homes on Paw Paw Lake are served by a public sewer.
- The laboratory test results were representative of the concentration of nutrients in Paw Paw Lake.
- The phosphorus concentration in the outlet water is the same as in the lake water. This is true because just a few minutes before, it was lake water.

### **PAW PAW LAKE PHOSPHORUS RETENTION**

The total amount of phosphorus in the water of Big Paw Paw Lake, based on surface data, is 1492 pounds.

### **PHOSPHORUS LOST THROUGH FLUSHING**

Paw Paw Lake loses about 36.06 billion pounds per year through flushing.

If we assume the phosphorus concentration of the water flowing out of Paw Paw Lake is the same as the lake (21 ug/L, since it was lake water just a few minutes earlier) and multiply that by the amount of water that leaves the lake in a year, we can determine how much phosphorus is lost through flushing each year. Here is the calculation:

$$(21 \text{ ppb} \times 36.06 \text{ billion}) = 757 \text{ pounds}$$

### **STORMWATER ADDITIONS FROM LAWN FERTILIZER**

As stated above, we assume 142 residences (20% of 712 homes) on Paw Paw Lake use lawn fertilizer at a commonly applied rate, 40 pounds of phosphorus per acre per year, that half the lot is lawn, and that a spring and fall fertilizer application is made each year (a local nurseryman reports he sells almost as much lawn fertilizer in the fall that he does in spring, but the fall fertilizer has a much higher phosphorus concentration).

The average spring phosphorus concentration in lawn fertilizer is 4%, while the average late summer phosphorus concentration is 20%. Most lawn fertilizers are sold in 40-pound bags that cover 10,000 square feet (or a quarter of an acre).

Thus, each person who fertilizes his/her lawn buys 80 pounds of fertilizer in spring containing 4% phosphorus and 80 pounds in late summer containing 20% phosphorus. Each person who fertilizes his/her lawn uses about 20 pounds of phosphorus each year. Here is the calculation:

$$80 \text{ pounds} \times 4\% \text{ plus } 80 \text{ pounds} \times 20\% = 19.2 \text{ pounds}$$

This amounts to 2726 pounds for the 142 homes that fertilize their lawns. Assuming half the phosphorus is taken up by the lawns, 1363 pounds of phosphorus from lawn fertilizers could be washed into Paw Paw Lake each year.

## **PHOSPHORUS ADDITIONS FROM INLET STREAMS**

### **BRANCH & DERBY DRAIN**

The Branch & Derby Drain drainage area is 4731 acres. That amount of land generates a flow of 17.12 billion pounds of water a year.

Based on sixteen Branch & Derby Drain samples the average phosphorus concentration is 49 parts per billion. That means the Branch & Derby Drain adds 839 pounds of phosphorus per year to the lake. Here is the calculation.

$$17.12 \text{ billion pounds of water} \times 49 \text{ ppb phosphorus concentration} = 839 \text{ pounds.}$$

### **LITTLE PAW PAW LAKE DRAIN**

The Little Paw Paw Lake Drain drainage area is 2654 acres. That amount of land generates a flow of 9.60 billion pounds of water a year.

Based on fifteen Little Paw Paw Lake Drain samples, the average phosphorus concentration is 28 parts per billion. That means the Little Paw Paw Lake Drain adds 269 pounds of phosphorus per year to the lake. Here is the calculation.

9.60 billion pounds of water X 28 ppb phosphorus concentration = 269 pounds.

### SHERWOOD DRAIN

Sherwood Drain drainage area is 364 acres. That amount of land generates a flow of 1.32 billion pounds of water a year.

Based on nine Sherwood Drain samples the average phosphorus concentration is 24 parts per billion. That means Sherwood Drain adds 32 pounds of phosphorus per year to the lake. Here is the calculation.

1.32 billion pounds of water X 24 ppb phosphorus concentration = 32 pounds.

### IMMEDIATE BIG PAW PAW LAKE WATERSHED

The immediate Big Paw Paw Lake drainage area is 1414 acres. That amount of land generates a flow of 5.12 billion pounds of water a year.

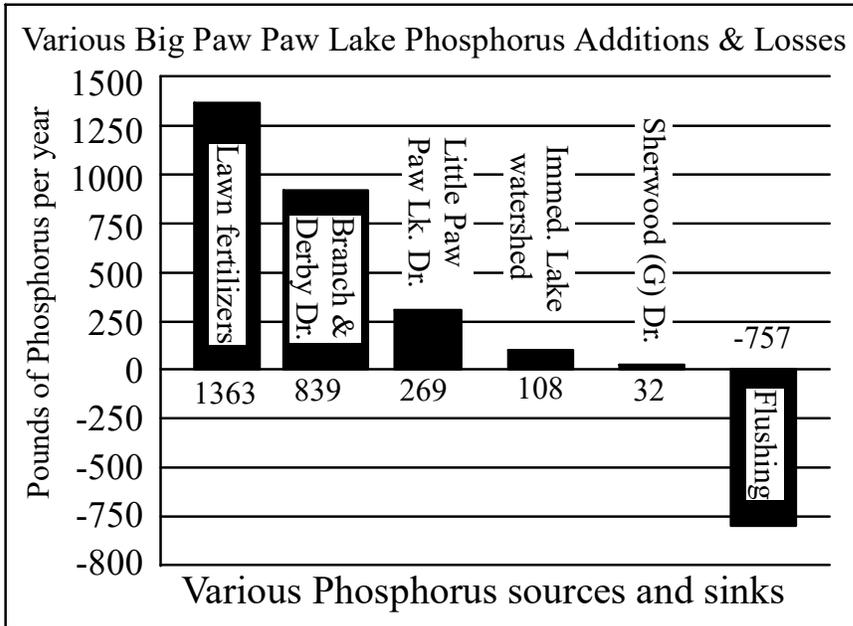
Based on 79 Big Paw Paw Lake surface samples, the average phosphorus concentration is 21 parts per billion. That means Big Paw Paw Lake immediate watershed adds 108 pounds of phosphorus per year to the lake. Here is the calculation.

5.12 billion pounds of water X 21 ppb phosphorus concentration = 108 pounds.

### **SUMMARY OF BIG PAW PAW LAKE PHOSPHORUS ADDITIONS AND LOSSES**

Residential lawn fertilizer	1363 pounds per year
Branch & Derby drain	839 pounds per year
Little Paw Paw Lake Drain	269 pounds per year
Immediate Big Paw Paw Lake WS	108 pounds per year
Sherwood Drain	32 pounds per year
Flushing losses	-757 pounds per year
<b>TOTAL POUNDS OF PHOSPHORUS</b>	<b>1854 pounds per year</b>

The graph shows the data. It shows the largest potential source of phosphorus to Paw Paw Lake is lawn fertilizers, about 1363 pounds per year (assuming 20% of riparians fertilize their lawns).



A distant second is the Branch & Derby Drain, which adds 839 pounds per year. The Little Paw Paw Lake drain adds about 269 pounds per year, while the immediate Paw Paw Lake watershed adds 108 pounds per year. Sherwood

Drain adds the least, 32 pounds per year.

The lake loses about 757 pounds of phosphorus per year through flushing.

### WHERE DOES THE EXTRA PHOSPHORUS GO?

The table indicates the lake captures about 1854 pounds of phosphorus per year, yet the amount of phosphorus in the lake is 1492 pounds. This indicates the lake is accumulating phosphorus because the amount entering the lake is more than the lake contains. The amount of phosphorus in the lake doesn't change much from year to year, but the amount flowing into the lake every year is about 1854 pounds per year. To understand this, let's assume the amount of phosphorus introduced into the lake is the same every year, 1854 pounds. That means in ten years, 18,540 pounds of phosphorus would enter the lake, yet the lake has about 1492 pounds of phosphorus in it every year. So where does the extra phosphorus go.

As long as there is oxygen dissolved in the lake water, phosphorus will precipitate to the bottom sediments. And that's where most of it is probably

going. That's the reason the aquatic plants are increasing and growing well in the lake.

However, the phosphorus in the bottom sediments doesn't disappear. It remains, fueling plant and algal growth. And that may be happening in Paw Paw Lake.

## **BOTTOM SEDIMENTS**

Many times bottom sediments tell us more about what is happening in a lake than the water quality tests do. That's because bottom sediments provide sort of a history of what's been happening in a lake, while water testing just provides a snapshot.

Bottom sediments are collected with a Pederson dredge, transferred to pint freezer containers and allowed to air dry. Once they are dry, the (usually) shrunken block of material is measured to determine volume, then ground, placed in porcelain dishes, dried at 100 degrees C, weighed, burned at 550 degrees C, and weighed again. Color after air-drying and after burning is also noted.

Bottom sediments almost always come up from the lake bottom black, and many people consider these black sediments "muck". However that's not usually the case.

The bottom sediments are black because no oxygen penetrates them, so the decomposition processes which occur use sulfur rather than oxygen, and in this process, they produce iron sulfides, which are black. However once the sediments are exposed to air, they usually turn some other color.

If the sediments remain black after air drying it usually means they are less than about 65 percent mineral (or more than 35% organic material). Sediments also remain black if they are from soft water lakes, but there's a reason for that.

If the sediments turn gray after air drying it usually means they are made up primarily of carbonates. This is what we usually see in moderately hard water and hard water lakes.

If the sediments turn tan, it usually means they are made up primarily of clays. Further evidence of this occurs when we burn the sediments at 550 degrees C.

We determine how much bottom sediments shrink when they air dry because this information is useful when considering dredging a lake. Normal shrinkage after air-drying is in the range of 50 to 80 percent. However sands and gravels don't shrink at all. Excessive shrinkage is more than 95 percent. In other words, there is only five percent or less of the material remaining after air-drying.

If the gray bottom sediments remain gray after burning they are considered carbonates, and the loss of material during this process is considered organic material. The results are expressed in the percentage of minerals in the bottom sediments.

If the tan bottom sediments turn red after burning, it means the lake is filling with clay. Clay enters the lake from near-lake activities such as road building, home building or farming. Usually clay is not a material that makes up the bottom sediments of most inland lakes.

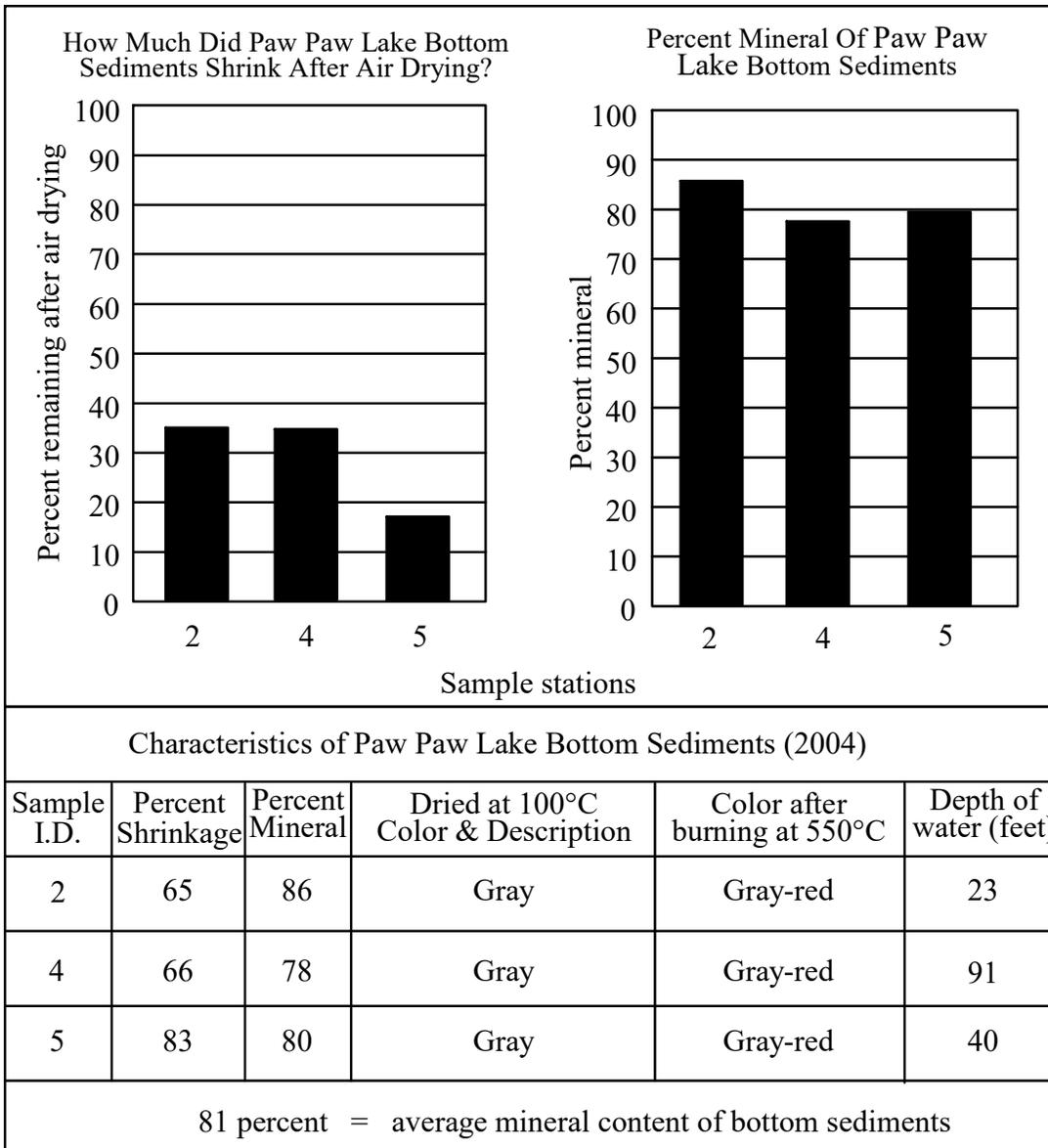
Highly organic sediments that remained black after air drying usually turn tan after burning, but the mineral content is usually quite low.

I consider high quality bottom sediments from natural lakes to be above 85 percent mineral. And I consider bottom sediments less than 50 percent mineral to be muck.

## **BIG PAW PAW LAKE BOTTOM SEDIMENTS**

Three bottom sediment samples were collected from Big Paw Paw Lake in summer 2004. The graph shows the data.

The sample from Station 2 in the north basin was collected in 23 feet of water. It shrunk 65 percent, was black when recovered and gray after air-drying. It turned red-gray after burning at 550 degrees C, and was 86 percent mineral.



The sample from Station 4, the deep hole in the south basin was collected in 91 feet of water. It shrunk 66 percent, was black when recovered and gray after air-drying. It turned red-gray after burning at 550 degrees C, and was 78 percent mineral.

The sample from Station 5 in the south basin was collected in 40 feet of water. It shrunk 83 percent, was black when recovered and gray after air drying. It turned red-gray after burning at 550 degrees C, and was 80 percent mineral.

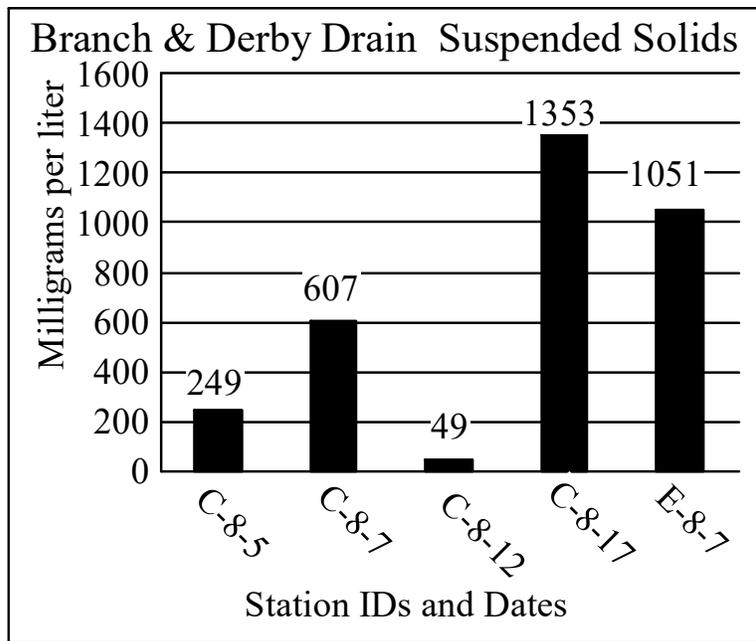
The red-gray color probably indicates the presence of clay in the bottom sediments. Clay is not a normal constituent of bottom sediments and is usually washed in from near-shore home or road building activities.

The amount of shrinkage is normal for a Michigan inland lake.

The mineral content (86, 78, & 80) indicates Big Paw Paw Lake is starting to build up organic material at a rate faster than the lake can decompose it, especially in the south basin.

Every effort should be made to prevent this from happening because it is by this process of accumulating organic material in the bottom sediments that lakes die.

### **BRANCH & DERBY DRAIN SUSPENDED SOLIDS**



Jurenka collected five samples from the Branch and Derby drain on various dates in August 2008 for suspended solids analyses. The graph shows the data.

However three of the samples had various amounts of sand, which is not a suspended solid, it's a solid that can settle. Because of that

problem these data should be used with caution.

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Water Quality Investigators  
Dexter, Michigan  
November 2010

Water Quality Data for Paw Paw Lake

Date	Sample Station Number	Temperature °C	Dissolved Oxygen		Chlorophyll a ug/L	Secchi Disk Depth (feet)	Total Nitrate Nitrogen ug/L	Alkalinity mg/L	pH	Conductivity umhos per cm at 25°C	Total Phosphorus ug/L	Lake Water Quality Index	Grade
			(mg/L)	Percent Saturation									
4/8/87	3 (DNR)	6	12.7	102	---	8	---	---	8.6	282	---	---	---
9/22/87	3 (DNR)	19	7.6	82	4	12	5	118	8.5	260	14	90	A
4/5/04	1	---	---	---	23.1	9	108	53	8.8	140	15	77	C
4/5/04	2	---	---	---	21.1	7	54	60	8.8	140	17	77	C
4/5/04	3	---	---	---	14.8	7	88	52	8.8	150	23	77	C
4/5/04	4	---	---	---	14.4	7	85	70	8.4	180	26	81	B
4/5/04	5	---	---	---	9.6	8	115	55	8.9	150	25	79	C
8/31/04	1	24	9.0	106	7.5	5	20	120	8.6	300	18	82	B
8/31/04	2	24	9.2	108	7.2	6	20	120	8.6	300	18	83	B
8/31/04	3	24	9.1	107	8.5	6	36	120	8.7	280	14	82	B
8/31/04	4	24	9.2	108	8.3	5	28	120	8.7	290	15	81	B
8/31/04	5	24	8.6	101	10.8	6	24	120	8.6	290	14	81	B
4/20/05	1	---	---	---	4.9	5	41	82	8.4	190	23	84	B
4/20/05	2	---	---	---	5.5	5	51	75	8.6	220	16	84	B
4/20/05	3	---	---	---	7.5	5	41	80	8.4	220	19	83	B
4/20/05	4	---	---	---	7.2	5	61	75	8.6	220	19	83	B
8/16/05	1	26	8.5	104	5.4	6	30	115	8.5	290	22	85	B
8/16/05	4	26	8.4	103	4.6	6	30	115	8.5	290	19	88	B
8/16/05	5	26	8.4	103	3.8	6	25	115	8.5	290	21	89	B
9/21/05	1	---	---	---	1.4	12	45	99	8.1	280	14	94	A
9/21/05	2	---	---	---	2.2	12	10	100	7.9	280	14	94	A
9/21/05	3	---	---	---	1.1	13	24	101	7.9	280	9	95	A
9/21/05	4	---	---	---	1.1	13	21	90	8.2	260	11	95	A
3/23/06	1	---	---	---	5.9	10	135	108	8.0	290	21	88	B
3/23/06	2	---	---	---	5.6	10	136	105	7.7	290	23	87	B
3/23/06	3	---	---	---	7.9	10	122	98	7.7	250	23	86	B
3/23/06	4	---	---	---	5.4	10	171	97	8.2	290	20	88	B
8/15/06	1	25	6.9	82	3.7	8	30	118	8.3	280	23	87	B
8/15/06	2	25	7.2	86	4.7	8	35	115	8.4	280	21	87	B
8/15/06	3	25	7.2	86	3.9	11	25	115	8.5	280	26	89	B
8/15/06	4	25	7.4	88	4.8	8	30	115	8.5	280	26	86	B
8/15/06	5	25	7.4	88	4.5	10	30	117	8.5	280	23	89	B
8/15/06	6	25	6.8	81	4.7	8	40	117	8.4	280	31	85	B
3/30/07	1	---	---	---	6.9	8 E	318	79	8.2	280	16	84	B
3/30/07	2	---	---	---	6.9	8 E	310	95	8.1	220	19	85	B
3/30/07	3	---	---	---	5.8	8 E	288	76	8.6	260	19	85	B
3/30/07	4	---	---	---	8.8	8 E	288	80	8.5	250	23	83	B
3/30/07	5	---	---	---	4.1	8 E	303	70	9.0	220	20	81	B
3/30/07	6	---	---	---	5.5	8 E	325	72	8.8	220	23	82	B
8/28/07	1	25	9.7	115	3.6	9	96	110	8.9	280	28	82	B
8/28/07	2	25	9.1	108	4.1	9	66	112	8.8	280	26	83	B
8/28/07	3	24	9.0	106	4.1	10	81	118	8.8	290	28	85	B
8/28/07	4-0	25	9.0	107	2.7	9	66	114	8.7	290	24	85	B
8/28/07	4-10	25	8.9	10	---	---	68	112	8.6	290	24	---	---
8/28/07	4-20	23	3.4	39	---	---	62	112	8.0	290	22	---	---
8/28/07	4-30	13	0.0	0	---	---	66	128	7.7	320	21	---	---
8/28/07	4-40	10	0.0	0	---	---	54	135	7.6	320	22	---	---
8/28/07	4-50	9	0.0	0	---	---	98	132	7.5	340	24	---	---
8/28/07	4-60	8	0.0	0	---	---	124	133	7.6	340	23	---	---
8/28/07	4-70	8	0.0	0	---	---	162	131	7.5	340	24	---	---
8/28/07	4-80	8	0.0	0	---	---	156	130	7.6	340	28	---	---
8/28/07	4-90	8	0.0	0	---	---	128	128	7.5	340	31	---	---
8/28/07	5	25	9.0	107	3.3	10	68	112	8.8	280	25	88	B
4/18/08	1	---	---	---	8.5	8	191	93	8.9	230	24	80	B
4/18/08	2	---	---	---	8.5	8	169	97	9.1	230	24	78	C
4/18/08	3	---	---	---	11.2	8	191	92	8.9	240	23	79	C
4/18/08	4	---	---	---	11.9	8	194	98	9.1	240	24	76	C
4/18/08	5	---	---	---	9.9	8	191	90	8.9	230	25	79	C
8/12/08	1	25	7.6	90	11.9	5	38	112	8.5	260	30	79	C
8/12/08	2	25	7.4	88	12.6	5	50	114	8.4	270	25	79	C
8/12/08	3	25	7.9	94	11.6	5	31	113	8.5	260	26	79	C

Water Quality Data for Paw Paw Lake

Date	Sample Station Number	Temperature °C	Dissolved Oxygen		Chlorophyll a ug/L	Secchi Disk Depth (feet)	Total Nitrate Nitrogen ug/L	Alkalinity mg/L	pH	Conductivity umhos per cm at 25°C	Total Phosphorus ug/L	Lake Water Quality Index	Grade
			(mg/L)	Percent Saturation									
8/12/08	4-0	25	7.8	93	11.9	5	28	110	8.5	260	26	79	C
8/12/08	4-10	24	7.4	88	14.3	---	28	115	8.5	260	27	---	---
8/12/08	4-20	23	2.8	27	10.9	---	25	112	8.5	260	26	---	---
8/12/08	4-30	13	0.0	0	4.1	---	34	125	7.9	280	26	---	---
8/12/08	4-40	10	0.0	0	3.4	---	53	126	7.8	280	29	---	---
8/12/08	4-50	9	0.0	0	4.1	---	288	126	7.8	280	49	---	---
8/12/08	4-60	8	0.0	0	4.4	---	803	130	7.7	280	41	---	---
8/12/08	4-70	8	0.0	0	5.5	---	116	122	7.7	285	38	---	---
8/12/08	4-80	8	0.0	0	3.4	---	203	130	7.7	290	43	---	---
8/12/08	4-90	8	0.0	0	5.1	---	100	122	7.7	290	56	---	---
8/12/08	5	25	7.9	94	9.2	5	31	116	8.5	270	25	81	B
3/8/09	1	---	---	---	4.4	4	165	77	8.9	200	28	78	C
3/8/09	2	---	---	---	4.1	4	140	72	8.6	200	21	83	B
3/8/09	3	---	---	---	8.5	7	147	72	7.8	190	18	83	B
3/8/09	4	---	---	---	1.4	7	151	74	8.8	200	22	88	B
3/8/09	5	---	---	---	0.6	7	154	76	7.8	200	16	92	A
7/6/09	1	---	---	---	13.1	5	221	95	7.8	200	28	78	C
7/6/09	2	---	---	---	24.4	4	252	95	7.9	220	27	73	C
7/6/09	3	---	---	---	15.3	5	32	80	8	220	29	78	C
7/6/09	4	---	---	---	9.9	5	42	80	8	200	25	80	B
7/6/09	5	---	---	---	17.6	5	18	80	8.2	190	19	79	C
7/6/09	6	---	---	---	4.1	6	21	81	7.9	200	20	87	B
8/13/09	1	25	8.0	95	11.2	6	7	106	8.3	260	32	80	B
8/13/09	2	25	7.7	92	9.1	7	7	110	8.3	260	28	83	B
8/13/09	3	25	8.2	97	13.5	6	4	112	8.4	260	25	80	B
8/13/09	4-0	25	8.5	101	9.8	7	4	108	8.2	260	22	83	B
8/13/09	4-10	25	8.4	100	---	---	11	114	8.3	260	26	---	---
8/13/09	4-20	23	2.8	32	---	---	350	110	7.9	260	24	---	---
8/13/09	4-30	13	0.0	0.0	---	---	424	118	7.7	270	25	---	---
8/13/09	4-40	11	0.0	0.0	---	---	690	113	7.6	270	29	---	---
8/13/09	4-50	10	0.0	0.0	---	---	60	119	7.6	270	37	---	---
8/13/09	4-60	9	0.0	0.0	---	---	35	120	7.6	270	42	---	---
8/13/09	4-70	9	0.0	0.0	---	---	25	121	7.6	270	63	---	---
8/13/09	4-80	9	0.0	0.0	---	---	46	117	7.5	270	75	---	---
8/13/09	4-90	9	0.0	0.0	---	---	109	128	7.5	290	132	---	---
8/13/09	5	25	8.5	101	9.1	7	11	109	8.2	260	25	83	B
4/7/10	1	---	---	---	4.7	6	115	92	8.6	260	18	85	B
4/7/10	2	---	---	---	5.5	6	164	94	8.3	240	23	85	B
4/7/10	3	---	---	---	4.7	6	141	85	8.3	240	22	86	B
4/7/10	4	---	---	---	4.7	5	62	80	8.5	200	29	84	B
4/7/10	5	---	---	---	2.0	6	95	90	8.6	230	24	88	B
8/27/10	1	24	7.4	87	1.7	9	7	105	8.5	240	13	92	A
8/27/10	1-10	24	7.4	87	---	---	16	107	8.4	250	14	---	---
8/27/10	1-20	24	1.5	18	---	---	10	110	8.4	260	14	---	---
8/27/10	1-30	13	0.0	0	---	---	33	132	7.6	280	40	---	---
8/27/10	2	25	6.9	82	3.0	9	13	110	8.3	240	16	90	A
8/27/10	2-10	25	6.9	82	---	---	10	110	8.3	240	17	---	---
8/27/10	2-20	24	1.5	18	---	---	13	110	8.0	250	15	---	---
8/27/10	2-30	13	0.0	0	---	---	20	128	7.6	270	18	---	---
8/27/10	3	24	7.5	88	1.5	10	7	108	8.4	240	16	93	A
8/27/10	3-10	24	7.5	88	---	---	10	108	8.4	240	16	---	---
8/27/10	3-20	24	0.3	4	---	---	10	108	8.4	240	13	---	---
8/27/10	3-30	13	0.0	0	---	---	20	130	7.6	270	13	---	---
8/27/10	4	24	7.5	88	1.2	10	7	108	8.3	240	11	94	A
8/27/10	4-10	24	7.5	88	---	---	7	106	8.5	240	11	---	---
8/27/10	4-20	23	1.3	15	---	---	7	107	8.4	240	12	---	---
8/27/10	4-30	13	0.0	0	---	---	10	120	7.7	260	16	---	---
8/27/10	4-40	12	0.0	0	---	---	16	132	7.7	260	20	---	---
8/27/10	4-50	10	0.0	0	---	---	20	135	7.6	270	48	---	---
8/27/10	4-60	9	0.0	0	---	---	43	132	7.5	280	75	---	---
8/27/10	4-70	9	0.0	0	---	---	33	135	7.5	300	111	---	---
8/27/10	4-80	9	0.0	0	---	---	36	132	7.4	300	136	---	---
8/27/10	4-90	8	0.0	0	---	---	39	134	7.4	300	218	---	---
8/27/10	5	24	7.7	91	1.7	10	10	108	8.4	250	20	93	A
8/27/10	5-10	24	7.7	91	---	---	10	108	8.4	250	19	---	---
8/27/10	5-20	23	1.5	17	---	---	10	108	8.4	250	18	---	---
8/27/10	5-30	13	0.0	0	---	---	26	120	7.7	270	25	---	---
8/27/10	5-40	12	0.0	0	---	---	46	137	7.7	280	29	---	---
8/27/10	5-50	10	0.0	0	---	---	79	135	7.6	280	45	---	---
8/27/10	6	24	7.8	92	1.5	10	13	108	8.4	240	18	93	A
8/27/10	6-10	24	7.5	88	---	---	13	106	8.4	240	15	---	---
8/27/10	6-20	24	1.4	16	---	---	13	104	8.1	240	13	---	---
8/27/10	6-30	23	0.0	0	---	---	36	130	7.6	290	19	---	---
8/27/10	7	24	7.4	87	1.5	10	13	108	8.4	240	18	93	A
8/27/10	7-10	24	7.4	87	---	---	13	106	8.4	240	15	---	---
8/27/10	7-20	24	1.5	17	---	---	13	104	8.1	240	13	---	---
8/27/10	7-30	23	0.0	0	---	---	36	130	7.6	280	19	---	---
8/27/10	7-40	11	0.0	0	---	---	45	135	7.6	280	25	---	---
8/27/10	7-50	11	0.0	0	---	---	57	138	7.4	290	40	---	---

WATER QUALITY DATA FOR VARIOUS PAW PAW LAKE DRAINS

Date	Sample Station Number	Temperature °C	Dissolved Oxygen		Chlorophyll a ug/L	Secchi Disk Depth (feet)	Total Nitrate Nitrogen ug/L	Alkalinity mg/L	pH	Conductivity umhos per cm at 25°C	Total Phosphorus ug/L	Lake Water Quality Index	Grade
			(mg/L)	Percent Saturation									
12/6/03	C	---	---	---	---	---	552	59	8.3	260	26	---	---
1/2/04	C	---	---	---	---	---	944	56	8.3	260	15	---	---
3/20/04	C	---	---	---	---	---	410	49	8.7	140	17	---	---
4/26/04	C	---	---	---	---	---	30	65	9.0	150	28	---	---
5/14/04	C	---	---	---	---	---	271	50	8.1	140	50	---	---
7/14/04	C	---	---	---	---	---	160	105	8.1	260	20	---	---
8/31/04	C	---	---	---	---	---	316	150	7.8	360	59	---	---
4/20/05	C	---	---	---	---	---	91	110	8.4	300	31	---	---
5/28/05	C	---	---	---	---	---	350	121	7.8	320	22	---	---
7/6/05	C	---	---	---	---	---	556	110	8.0	370	18	---	---
12/25/05	C	---	---	---	---	---	725	105	7.7	360	13	---	---
2/20/06	C	---	---	---	---	---	387	75	8.6	310	23	---	---
5/13/06	C	---	---	---	---	---	965	79	9.0	360	30	---	---
8/3/06	C	---	---	---	---	---	250	70	7.8	190	64	---	---
8/31/06	C	---	---	---	---	---	708	97	8.8	310	29	---	---
10/2/06	C	---	---	---	---	---	1440	83	8.5	210	36	---	---
8/5/07	C	---	---	---	---	---	880	62	8.1	280	41	---	---
8/7/07	C	---	---	---	---	---	1887	56	7.7	220	59	---	---
8/12/07	C	---	---	---	---	---	1600	116	8.1	340	32	---	---
8/17/07	C	---	---	---	---	---	1593	75	7.9	240	41	---	---
5/16/10	C	---	---	---	---	---	327	100	8.3	220	23	---	---
5/25/10	C	---	---	---	---	---	239	110	8.1	220	25	---	---
5/30/10	C	---	---	---	---	---	281	125	8.4	270	19	---	---
6/13/10	C	---	---	---	---	---	475	87	8.2	180	51	---	---
6/19/10	C	---	---	---	---	---	694	90	7.9	200	96	---	---
6/20/10	C	---	---	---	---	---	386	128	7.9	260	43	---	---
6/23/10	C	---	---	---	---	---	3502	120	8.3	240	53	---	---
7/4/10	C	---	---	---	---	---	247	120	7.9	310	45	---	---
7/12/10	C	---	---	---	---	---	572	98	7.8	180	147	---	---
7/24/10	C	---	---	---	---	---	288	90	8.0	230	194	---	---
7/25/10	C	---	---	---	---	---	484	70	7.5	140	95	---	---
7/26/10	C	---	---	---	---	---	386	90	7.8	280	118	---	---
Average	C	---	---	---	---	---	687	91	8.2	253	49	---	---
4/20/05	H	---	---	---	---	---	228	115	8.2	280	36	---	---
5/28/05	H	---	---	---	---	---	152	142	7.5	360	29	---	---
7/6/05	H	---	---	---	---	---	877	135	7.9	470	8	---	---
2/20/06	H	---	---	---	---	---	410	75	8.7	320	18	---	---
5/13/06	H	---	---	---	---	---	290	110	8.8	380	43	---	---
12/2/06	H	---	---	---	---	---	680	100	7.5	200	22	---	---
Average	H	---	---	---	---	---	440	112	8.1	335	26	---	---
4/20/05	I	---	---	---	---	---	56	100	8.6	240	15	---	---
5/28/05	I	---	---	---	---	---	613	88	7.8	280	34	---	---
7/6/05	I	---	---	---	---	---	570	80	7.6	280	22	---	---
12/20/05	I	---	---	---	---	---	484	79	7.7	320	10	---	---
2/20/06	I	---	---	---	---	---	410	75	8.9	320	20	---	---
5/13/06	I	---	---	---	---	---	875	68	8.5	300	39	---	---
8/3/06	I	---	---	---	---	---	1300	47	7.7	200	51	---	---
8/31/06	I	---	---	---	---	---	1920	55	8.7	190	17	---	---
10/2/06	I	---	---	---	---	---	660	57	8.4	190	21	---	---
12/2/06	I	---	---	---	---	---	660	55	7.9	150	174	---	---
8/5/07	I	---	---	---	---	---	893	50	7.6	240	26	---	---
8/7/07	I	---	---	---	---	---	480	40	7.6	220	32	---	---
8/12/07	I	---	---	---	---	---	1033	80	8.1	340	24	---	---
Average	I	---	---	---	---	---	766	67	8	252	37	---	---

WATER QUALITY DATA FOR VARIOUS PAW PAW LAKE DRAINS

Date	Sample Station Number	Temperature °C	Dissolved Oxygen		Chlorophyll a ug/L	Secchi Disk Depth (feet)	Total Nitrate Nitrogen ug/L	Alkalinity mg/L	pH	Conductivity umhos per cm at 25°C	Total Phosphorus ug/L	Lake Water Quality Index	Grade
			(mg/L)	Percent Saturation									
12/6/03	E	---	---	---	---	---	468	54	8.2	240	25	---	---
1/2/04	E	---	---	---	---	---	927	40	8.6	260	13	---	---
3/20/04	E	---	---	---	---	---	799	35	8.9	110	15	---	---
4/26/04	E	---	---	---	---	---	81	46	9.0	120	17	---	---
5/14/04	E	---	---	---	---	---	257	40	7.6	140	50	---	---
6/15/04	E	---	---	---	---	---	376	99	9.1	280	23	---	---
7/14/04	E	---	---	---	---	---	288	120	8.0	320	13	---	---
8/31/04	E	---	---	---	---	---	28	115	8.5	300	22	---	---
4/20/05	E	---	---	---	---	---	101	140	8.6	320	31	---	---
5/28/05	E	---	---	---	---	---	253	140	7.9	330	42	---	---
7/6/05	E	---	---	---	---	---	560	134	7.5	500	25	---	---
12/2/06	E	---	---	---	---	---	512	88	8.1	220	23	---	---
8/5/07	E	---	---	---	---	---	1600	78	8.1	450	37	---	---
8/7/07	E	---	---	---	---	---	2093	56	7.9	210	81	---	---
8/12/07	E	---	---	---	---	---	2087	123	8.0	370	90	---	---
Average							695	87	8	278	34		
4/26/04	J	---	---	---	---	---	230	100	9.7	250	17	---	---
4/20/05	J	---	---	---	---	---	76	119	8.7	300	33	---	---
5/28/05	J	---	---	---	---	---	172	125	8.2	320	33	---	---
7/6/05	J	---	---	---	---	---	615	125	8.1	530	24	---	---
12/2/06	J	---	---	---	---	---	592	100	8.4	300	26	---	---
Average							337	114	8.6	340	27		
4/20/05	K	---	---	---	---	---	355	215	8.2	480	92	---	---
5/28/05	K	---	---	---	---	---	329	215	7.7	480	83	---	---
12/30/05	K	---	---	---	---	---	97	182	7.5	510	22	---	---
Average							260	204	8	490	66		
12/6/03	A	---	---	---	---	---	242	51	7.9	180	19	---	---
1/2/04	A	---	---	---	---	---	506	40	8.6	120	10	---	---
3/20/04	A	---	---	---	---	---	203	36	9.2	100	36	---	---
4/26/04	A	---	---	---	---	---	44	46	8.8	120	20	---	---
5/14/04	A	---	---	---	---	---	27	46	8.0	120	27	---	---
6/15/04	A	---	---	---	---	---	118	58	8.6	180	25	---	---
7/14/04	A	---	---	---	---	---	62	74	8.2	220	20	---	---
8/31/04	A	---	---	---	---	---	68	111	7.9	240	19	---	---
2/20/06	A	---	---	---	---	---	36	58	8.8	180	27	---	---
5/13/06	A	---	---	---	---	---	60	86	8.7	220	31	---	---
8/3/06	A	---	---	---	---	---	210	90	8.0	240	51	---	---
10/2/06	A	---	---	---	---	---	80	76	8.1	250	16	---	---
12/2/06	A	---	---	---	---	---	232	70	8.3	220	14	---	---
8/5/07	A	---	---	---	---	---	213	68	8.0	220	33	---	---
8/7/07	A	---	---	---	---	---	253	62	8.2	190	23	---	---
8/12/07	A	---	---	---	---	---	233	65	8.2	190	29	---	---
Average							162	65	8	187	25		
12/6/03	B	---	---	---	---	---	247	55	8.2	170	23	---	---
1/2/04	B	---	---	---	---	---	204	40	8.9	120	19	---	---
3/20/04	B	---	---	---	---	---	159	40	9.1	100	18	---	---
4/26/04	B	---	---	---	---	---	34	50	8.6	120	27	---	---
5/14/04	B	---	---	---	---	---	88	43	7.8	100	16	---	---
6/15/04	B	---	---	---	---	---	56	60	8.9	180	25	---	---
7/14/04	B	---	---	---	---	---	50	80	8.1	280	18	---	---
8/31/04	B	---	---	---	---	---	840	120	7.9	360	54	---	---
12/30/05	B	---	---	---	---	---	41	85	7.8	220	16	---	---
2/20/06	B	---	---	---	---	---	81	60	8.7	180	23	---	---
5/13/06	B	---	---	---	---	---	70	77	8.3	200	40	---	---
8/3/06	B	---	---	---	---	---	350	79	8.6	230	27	---	---
8/31/06	B	---	---	---	---	---	152	75	8.2	230	31	---	---
10/2/06	B	---	---	---	---	---	580	72	7.8	240	46	---	---
12/2/06	B	---	---	---	---	---	376	79	8.1	220	25	---	---
8/5/07	B	---	---	---	---	---	413	90	8.0	260	46	---	---
4/17/10	B	---	---	---	---	---	92	102	8.2	240	12	---	---
Average							234	69	8	201	28		

Water Quality Data for Paw Paw Lake 2010

Date	Sample Station Number	Temperature °C	Dissolved Oxygen		Chlorophyll a ug/L	Secchi Disk Depth (feet)	Total Nitrate Nitrogen ug/L	Alkalinity mg/L	pH	Conductivity umhos per cm at 25°C	Total Phosphorus ug/L	Lake Water Quality Index	Grade	Ortho-Phosphorus ug/L
			(mg/L)	Percent Saturation										
4/7/10	1	---	---	---	4.7	6	115	92	8.6	260	18	85	B	
4/7/10	2	---	---	---	5.5	6	164	94	8.3	240	23	85	B	
4/7/10	3	---	---	---	4.7	6	141	85	8.3	240	22	86	B	
4/7/10	4	---	---	---	4.7	5	62	80	8.5	200	29	84	B	
4/7/10	5	---	---	---	2.0	6	95	90	8.6	230	24	88	B	
8/27/10	1	24	7.4	87	1.7	9	7	105	8.5	240	13	92	A	1
8/27/10	1-10	24	7.4	87	---	---	16	107	8.4	250	14	---	---	1
8/27/10	1-20	24	1.5	18	---	---	10	110	8.4	260	14	---	---	3
8/27/10	1-30	13	0.0	0	---	---	33	132	7.6	20	40	---	---	1
8/27/10	2	25	6.9	82	3.0	9	13	110	8.3	250	16	90	A	1
8/27/10	2-10	25	6.9	82	---	---	10	110	8.3	240	17	---	---	1
8/27/10	2-20	24	1.5	18	---	---	13	110	8.0	250	15	---	---	1
8/27/10	2-30	13	0.0	0	---	---	20	128	7.6	270	18	---	---	6
8/27/10	3	24	7.5	88	1.5	10	7	108	8.4	240	16	93	A	1
8/27/10	3-10	24	7.5	88	---	---	10	108	8.4	240	16	---	---	1
8/27/10	3-20	24	0.3	4	---	---	10	108	8.4	240	13	---	---	1
8/27/10	3-30	13	0.0	0	---	---	20	130	7.6	270	13	---	---	1
8/27/10	4	24	7.5	88	1.2	10	7	108	8.3	240	11	94	A	1
8/27/10	4-10	24	7.5	88	---	---	7	106	8.5	240	11	---	---	1
8/27/10	4-20	23	1.3	15	---	---	7	107	8.4	240	12	---	---	1
8/27/10	4-30	13	0.0	0	---	---	10	120	7.7	260	16	---	---	1
8/27/10	4-40	12	0.0	0	---	---	16	132	7.7	260	20	---	---	1
8/27/10	4-50	10	0.0	0	---	---	20	135	7.6	270	48	---	---	2
8/27/10	4-60	9	0.0	0	---	---	43	132	7.5	280	75	---	---	20
8/27/10	4-70	9	0.0	0	---	---	33	135	7.5	300	111	---	---	38
8/27/10	4-80	9	0.0	0	---	---	36	132	7.4	300	136	---	---	43
8/27/10	4-90	8	0.0	0	---	---	39	134	7.4	300	218	---	---	37
8/27/10	5	24	7.7	91	1.7	10	10	108	8.4	250	20	93	A	1
8/27/10	5-10	24	7.7	91	---	---	10	108	8.4	250	19	---	---	1
8/27/10	5-20	23	1.5	17	---	---	10	108	8.4	250	18	---	---	1
8/27/10	5-30	13	0.0	0	---	---	26	120	7.7	270	25	---	---	1
8/27/10	5-40	12	0.0	0	---	---	46	137	7.7	280	29	---	---	1
8/27/10	5-50	10	0.0	0	---	---	79	135	7.6	280	45	---	---	4
8/27/10	7	24	7.4	87	1.5	10	13	108	8.4	240	18	93	A	1
8/27/10	7-10	24	7.4	87	---	---	13	106	8.4	240	15	---	---	5
8/27/10	7-20	24	1.5	17	---	---	13	104	8.1	240	13	---	---	2
8/27/10	7-30	12	0.0	0	---	---	36	130	7.6	280	19	---	---	1
8/27/10	7-40	11	0.0	0	---	---	45	135	7.6	280	25	---	---	1
8/27/10	7-50	11	0.0	0	---	---	57	138	7.4	290	40	---	---	1
4/17/10	B	---	---	---	---	---	92	102	8.2	240	12	---	---	1
5/16/10	C	---	---	---	---	---	327	100	8.3	220	23	---	---	2
5/25/10	C	---	---	---	---	---	239	110	8.1	220	25	---	---	1
5/30/10	C	---	---	---	---	---	281	125	8.4	270	19	---	---	1
6/13/10	C	---	---	---	---	---	475	87	8.2	180	51	---	---	5
6/19/10	C	---	---	---	---	---	694	90	7.9	200	96	---	---	7
6/20/10	C	---	---	---	---	---	386	128	7.9	260	43	---	---	5
6/23/10	C	---	---	---	---	---	3502	120	8.3	240	53	---	---	3
7/4/10	C	---	---	---	---	---	247	120	7.9	310	45	---	---	9
7/12/10	C	---	---	---	---	---	572	98	7.8	180	147	---	---	19
7/24/10	C	---	---	---	---	---	288	90	8.0	230	194	---	---	9
7/25/10	C	---	---	---	---	---	484	70	7.5	140	95	---	---	15
7/26/10	C	---	---	---	---	---	386	90	7.8	280	118	---	---	10