# Consent Agreement Annual Report
# 2011

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# Table of Contents

# Summary - 2011

## Overview

The goal of the Consent Agreement is to restore and preserve the water quality of Big Platte Lake (Lake). This goal is being advanced by minimizing phosphorus loadings from the Platte River State Fish Hatchery (Hatchery, PRSFH) and by developing strategies to reduce non-point phosphorus loads from the watershed.

## Compliance with Consent Agreement

The PRSFH was in compliance with the Consent Decree during 2011 as summarized in Figure 1. The Consent Agreement mandates that the Hatchery net annual load shall be limited to a maximum of 175 lbs. per year. The corresponding maximum load for any consecutive three month period is 55 lbs. The actual net Hatchery annual loading for 2011 was 47.4 lbs, significantly less than the Consent Agreement limit. The maximum allowable load for any 3 month period of 55 lbs. was not exceeded during any period during 2011 as the highest 3 month loading was 25.48 lbs. The average water use at the Hatchery was 6.92 mgd which is 65% less than the Consent Agreement limit of 20 mgd.

The average volume-weighted total phosphorus concentration of Big Platte Lake was 7.52 $mg/m^3$ in 2011. The water quality goal of 8.0 $mg/m^3$ was achieved only 65% of the time. This is not consistent with the goal of 95% attainment as stipulated in the Consent Agreement.

A total of 15,018 adult coho and 377 adult Chinook salmon passed the Lower Weir in 2011. These numbers are in compliance with the Consent Agreement limits of 20,000 adult coho and 1,000 adult Chinook salmon.

## Major Accomplishments for 2011

- The task of measuring total phosphorus and chlorophyll has been transferred to the new PRSFH laboratory because of the retirement of key lab personnel at Central Michigan University. This change has decreased the time interval between sampling and obtaining results and has simplified bottle handing and tracking. It is anticipated that significant time and effort will be required to work out all QA/QC issues that will no doubt arise.

- The program to add ferric chloride to the backwash flow to precipitate phosphorus in the clarifier continues to work very well. Precipitated phosphorus is stored in the sludge tank and trucked away. The addition of ferric chloride has contributed to lower phosphorus discharges from the Hatchery and subsequent compliance with the Consent Agreement limits.

- A full-scale rearing experiment using 25,000 coho salmon measuring fish growth at different feeding levels was completed. The data from this unique experiment will be used to calibrate and validate the bioenergetics model currently under development.

- The flow capacities of the three waste pumps were measured using a modified bucket procedure. This allows accurate calculation of the flow from each waste pump as a function of running time based on electrical log data from the individual pumps. Additionally, the total flow to the Hot Pond that captures storm drainage was measured every day except weekends.

- Several measurements were made of the groundwater total phosphorus concentrations at the waste pump location. The average of these phosphorus measurements was 4.1 $mg/m^3$ which is within expected background concentration.

- The procedure to calculate the net total phosphorus load from the Hatchery has been modified to include the backwash water and waste pump flows. These flows were measured daily. The phosphorus associated with these flows was assigned a constant value of 4.1 $mg/m^3$ for load calculations. This assumption relieves the need to continue to measure total phosphorus at these sites.

- The Sigma and ISCO automatic sampling equipment were successfully programmed to obtain seventy-two hour composite samples. This schedule provides essentially continuous sampling of the phosphorus concentration of various inlet and output Hatchery flows. Recent data collected using this strategy has improved the accuracy of phosphorus mass balance calculations for the Hatchery.

- A comprehensive revision of the Platte River Watershed Plan has been largely completed. A draft of the new Watershed Plan is currently being reviewed by Greg Goudy from the DNR.

- The database is being improved and expanded on an ongoing basis.

**Immediate Program Recommendations for 2012**

- The goal of developing accurate annual phosphorus mass balances for the Hatchery continues to be elusive. Efforts should continue to improve the accuracy of the phosphorus mass balance calculations for the Hatchery. The top priority is to determine if phosphorus measurements in the sludge storage tank are affected (lowered) by iron interference.

- All Standard Operating Procedures (SOP) documents and equipment maintenance schedules should continue to be reviewed and updated annually. Certification letters regarding the accuracy of the net phosphorus loading, fish production, and weir numbers in the database should continue to be sent to the Implementation Coordinator for inclusion in the Annual Report.

- The Implementation Coordinator should continue to calibrate and validate the water quality models for the lake.

- The Implementation Coordinator should continue to calibrate and validate the fish bioenergetic and hatchery process model. This effort will be greatly facilitated by the successful recent completion of the controlled feeding experiment. It is recommended that measurements of the food composition and fish proximate composition resulting from this project be completed as soon as possible.

- The Implementation Coordinator should continue efforts to define the minimum number of samples needed to characterize the annual average phosphorus concentration of Big Platte Lake and to determine compliance with the Consent Agreement water quality standard.

- The Implementation Coordinator should continue efforts to define the minimum number of samples needed to characterize the phosphorus loading into Big Platte Lake from all sources. This effort should include resumption of intensive sampling during storm events at key locations in the watershed. These additional samples will allow quantitative

analysis of the extent of improvements attained through future Best Management Practices (BMP) projects in the watershed.

- The Implementation Coordinator should continue to determine the extent of Secchi depth improvements expected as lake phosphorus concentrations are reduced and attain the numerical phosphorus standard of 8.0 mg/$m^3$. It is expected that improvements in water clarity may be limited by marl formation.

- The functionality and reliability of the database requires continuous maintenance, thus is critical that these efforts continue and database management redundancy be developed.

**Other Long-Term Goals and Recommendations**

The following are long-term recommendations that should be pursued in the event that external sources of funding can be secured.

- It is recommended that work continue on the watershed plan and that it be expanded to include the upper watershed. Additionally, the current BASINS model should be re-calibrated for the lower watershed using the current data set and expanded to include the upper watershed. This will require additional data for the upper watershed to support the development of the BASINS model and models for total phosphorus for Long Lake and Lake Ann.

- It is recommended that a simplified database be developed. This version should eliminate outdated and redundant features of the current database that overly complicate the computer calculations and algorithms. A detailed user manual be written for the new simplified version.

- It is recommended that sampling of Little Platte Lake and secondary tributaries throughout the entire watershed be resumed if funds are available. The cycling of various forms of nitrogen is of particular importance. An annual mass balance budget for various forms of nitrogen should be constructed.

- It is recommended that a shoreline water quality survey be conducted around Big Platte Lake every 5 years. The survey should consist of two sampling periods. The first sampling should be conducted in the early summer and should measure indicator bacteria

and document growth of *Cladophora* as an indicator of sources of phosphorus. The second survey should be conducted in late summer to determine if summer residents increase local concentrations of phosphorus or the number of indicator bacteria. The methodology should be similar to that used for Glen Lake where shoreline surveys have been regularly conducted for a number of years.

**Acknowledgements**

The Implementation Coordinator would like to take this opportunity to again thank Gary Whelan (MDNR Fisheries Division) and Wil Swiecki (PLIA) for their continuing contributions to this project. Gary has extraordinary leadership and management skills and has kept this project focused and moving forward. Wil has been tireless in his efforts to ensure the reliability of the data and has displayed incredible perseverance working toward the PLIA goal of preserving the water quality of the Lake. As a result, excellent coordination and communication has been maintained within our group as well as with many outside organizations and individuals. The minutes of our coordination meetings in 2011 are contained in the Appendix A.

Aaron Switzer has for many years done an absolutely outstanding job of collecting the field data. In addition, his commitment to excellence and professionalism has spread throughout the facility. Aaron's efforts are now directed more toward overseeing fish production activities and Paul Stowe has taken over sample collection activities. Nikki Sherretz is heading up efforts to analyze total phosphorus and chlorophyll samples at the Hatchery. We also acknowledge and appreciate the support and assistance of all of the outstanding staff at PRSFH along with Edward Eisch (MDNR Fisheries Division) for his overall management of the facility.

Jim Berridge (PLIA) deserves a gold star medal for outstanding service to Platte Lake. He has contributed his talents and endless hours of his time to create an MS Access database for the laboratory and field data collected on this project. This daunting task is an ongoing process. All those interested in preserving the water of Big Platte Lake owe him their gratitude.

The authors would also like to thank and acknowledge the valuable contribution of many individuals from CMU. Jenny Estabrook and Scott McNaught have left no stone unturned in their efforts to evaluate and improve their laboratory methods. Scott McNaught has reviewed the historical plankton data, recommended much improved methods for sample collection, added biomass measurements, and contributed reports on his work.

Finally, several additional individuals associated with the PLIA have made significant

contributions to this project: Mike Pattison has done a terrific job developing and maintaining the PLIA web site with the latest version of the database along with providing continuous contributions as a key PLIA member who attends all of our calls and meetings. Tom Inman has worked with the Hatchery staff for many years counting the Fall Salmon Runs, and Sally Casey has been making weekly open water Secchi Depth measurements for over 25 years. Steve Peterson (PLIA) has made significant strides in marketing the efforts of all to the public.

# Hatchery Operations

## Net Total Phosphorus Load

The water used to culture fish becomes enriched with phosphorus as it passes through the Hatchery from fish excretion, egestion, and from unconsumed feed. The net phosphorus daily loading from the Hatchery for 2011 is defined as the difference between the daily phosphorus loading that leaves the system (usually from the Upper Discharge or any by-pass) and the daily phosphorus entering the system from the three possible water sources (Brundage Spring, Brundage Creek, and the rarely used Platte River). Negative net loads on any day are set equal to zero for calculation purposes as specified in the Consent Agreement. Linear interpolation is used to determine the net load on days when no measurements are taken. This requires the use of the last measurement of the proceeding year and the first measurement of the following year to complete the calculation. The summation of daily net loads for the year gives the annual net phosphorus loading. Figure 2 shows the history of total annual net phosphorus loads from the Hatchery from 1990 through 2011. The net phosphorus load was 47.4 lbs. for 2011, a value that is about 6% of the 1990 load.

The concentrations of total phosphorus and turbidity of the Hatchery inlet and outlet flows were measured on 72-hour composite samples during 2011. Figure 3 shows the concentration of total phosphorus in the Upper Discharge during 2011. Note that there are three distinct periods. High concentrations were typical during the first 100 days of 2011, followed by a slow general decline during the summer, then a general rise for the remainder of the year. Figure 4 shows the corresponding 3-month net phosphorus loads for 2011. Note that the loads for the first 4 months correspond to a period when water temperatures at the Hatchery are increasing. The Chinook salmon from the current year along with the coho and Atlantic salmon from the proceeding year class are reaching maximum size just before being planted. The lower loading period between Days 100 and 250 occurs during a period where the sizes of the current year class coho and Atlantic salmon are still relatively small and no Chinook salmon are in the hatchery. Normally, rapid growth and increased feeding of the current year class coho and Atlantic salmon results in a higher loading between Days 250 and 310. However, this increase was be offset by the addition of ferric chloride in higher amounts during 2011 as shown in Figure 5.

## Phosphorus Mass Balance

Mass Balance can be used to help understand and develop a model for changes in the net load from the Hatchery as a function of production activities and facilities operation. The mass

balance equation requires that the accumulation of phosphorus in the Hatchery is equal to the difference between the amount of phosphorus that enters the system (Inputs) and the amount leaving the system (Outputs).

Accumulation of P in the Hatchery = Sum on Inputs – Sum of Outputs (1)

The input terms refer to any phosphorus that enters the Hatchery, these terms include:

1. Food P. This term is the amount of phosphorus associated with the food that is fed to the fish in the Hatchery starter building and raceways. The total amount of phosphorus from feeds is calculated by multiplying the weight of the food fed times the phosphorus content of the feed. We are assuming that the manufacturer labeled phosphorus concentration is accurate and consistent throughout the feed lot.

2. Source Water P. This is the amount of phosphorus contained in all of the Hatchery source water and is measured by Hatchery staff. The sources are Brundage Spring and Creek, the Platte River (only used rarely), and Service water used to backwash the disk filters. The input phosphorus loading is determined by multiplying the flow rate times the phosphorus concentration.

3. Fry Tissue P. This term refers to the phosphorus introduced to the system when fry are added into the fish inventory. It is calculated by multiplying the wet weight biomass of the fry times the measured percent phosphorus in the fry tissue. Note that this approach avoids the need to count or weigh the egg harvest and egg mortalities.

The output terms refer to phosphorus that leaves the Hatchery, these terms include:

1. Shipped, Planted, and Mort Fish Tissue P. This term refers to all the phosphorus that leaves the Hatchery in the form of fish tissue. It is not relevant to the mass balance equation if the fish are shipped to another watershed, planted in the Platte River, or disposed as mortalities. The phosphorus value of this term is calculated by multiplying the whole wet weight biomass of the fish times the measured percent phosphorus in the fish tissue.

2. Discharge P. This term refers to the gross loading of phosphorus that leaves the system as flowing water. These flows and phosphorus concentrations are measured by Hatchery staff and include the Upper and Lower Discharges along with any

bypassed flows. Currently, the Upper Discharge is only outlet flow. Note that the phosphorus value of this term is calculated by multiplying the measured discharge flow rate times the measured phosphorus concentration. The Net Discharge is the difference between the phosphorus measured in the Gross Discharge and the sum of the measured phosphorus inputs. The Net Discharge value is used for NPDES permit and Settlement Agreement purposes.

3. Trucked P. This term refers to the amount phosphorus that is trucked away from the Hatchery, predominately the result of emptying and cleaning the solids storage (sludge) tank. The phosphorus value of this term is calculated by multiplying the measured number of gallons of sludge trucked away times the average measured phosphorus concentration of this material.

The accumulation terms are calculated by subtracting the outlets from the inputs. Accumulation can be positive or negative. There are three major accumulation terms.

1. Fish Tissue P. This term refers to the phosphorus present in fish at any given time in the Hatchery Building and raceways. The phosphorus value of this term is calculated by multiplying the whole wet weight biomass of the fish times the measured percent phosphorus in the fish tissue. If the fish tissue phosphorus is greater at the end of the year than the start of the year the accumulation term is positive. If the fish tissue phosphorus is less at the end of the year than the start of the year then this term is negative. Note that additions, transfers, or removals of fish from the system are not considered in the calculation because such factors are accommodated by other terms in the mass balance equation.

2. Tank P. This term refers to the amount of phosphorus in the solids storage tank. The phosphorus value of term is the average phosphorus concentration of the solids in the tank multiplied by the estimated tank volume. This term can also have a positive or negative value depending on the amount of phosphorus in the tank at the start and end of the year. Phosphorus removed by truck is included in a separate term in the mass balance equation.

3. Pond P. This term refers to the amount of phosphorus that settles and is permanently stored in the bottom of the settling pond. Phosphorus that settles to the bottom is prevented from leaving by a clay liner. The phosphorus value of this term cannot be easily measured directly, but is estimated by subtracting all the inputs of phosphorus to

the pond from that leaving via the outlets. Normally, the inputs are greater than the outputs. Other terms in the mass balance would need to be added to cover the case where the pond is drained and bottom materials removed.

The steady state form of the Mass Balance equation can be applied to the Hatchery on an annual basis and expressed in terms of regulatory, fish production, and facilities operation as in Equation 2.

Net P Load = Food – Production – Tank Retention – Pond Retention (2)

The "Net P Load" is the difference between the measured Gross Discharge Loading and the summation of the loadings from the various source waters. All the input terms are routinely measured. "Food In" represents the phosphorus in the food fed to the fish. The "Production" term is the annual amount of phosphorus associated the net growth of new fish biomass. The net annual production of fish is defined as the phosphorus equivalent of the fish that leave the Hatchery as Morts, Shipped or Planted or contributes to an increase in the fish inventory in the raceways. Increases or decreases in inventory and the transferred fish are offset by the amount of fry that annually enter the system. The remaining terms are losses or retentions of phosphorus due to cleaning and trucking tank phosphorus, phosphorus settling to the bottom of the pond, or storage of phosphorus in the sludge tank.

**Hatchery Mass Balance for 2011**

Hatchery mass balance terms for 2011 are displayed in Figure 6. The phosphorus associated with the source water and discharge was measured using the Sigma-72 sampling method. The fish production terms were calculated using a previously measured fish tissue phosphorus content of 0.42% of the gross wet weight. During 2011, there was a net increase of 46 lbs. of phosphorus associated with fish resident in the system at the end of the year when compared to values at the start of the year. The measurements show that the filters removed about 61% of the phosphorus that leaves the Hatchery Building and Raceways. Approximately 97% of the phosphorus removed by the filters is retained in the sludge storage tank with about 14.6 lbs of phosphorus flowing to the pond as clarifier overflow. Approximately 45.4 lbs is removed by the pond resulting in a net discharge of 16 lbs based on mass balance that gives credit for negative discharge days. The net Hatchery loading increases to approximately 47 lbs. when no credit is given for negative days. The sludge storage tank was emptied and cleaned at the end of August 2011. The measured phosphorous removed was 163.9 lbs. Linear extrapolation can be used to estimate that an additional accumulation of approximately 55 lbs would be in the tank at the end

of the year. This amount is essentially offset by 57 lbs that were present in the tank at the beginning of 2011. Mass balance calculations suggest that 465 lbs of phosphorus must be accumulated in the tank in 2011. The mass balance calculated amount in the tank is about 300 lbs greater than the measured amount. Overall, the measured input of phosphorus to the Hatchery was 1,840.6 lbs. in 2011 compared to 1,539.4 lbs. that can be accounted for from known or measured losses.

This large difference suggests the following possible explanations:

1. The source water phosphorus loading is lower than is being measured.
2. The discharge loading is actually larger than that being reported.
3. The actual pond losses are greater than those being measured.
4. The phosphorus in the food is actually lower than that reported by the supplier.
5. The biomass of the fish leaving the system is larger than that reported.
6. The phosphorus associated with fish tissue is greater than 0.42%.
7. The actual tank losses are greater than those being measured.

It is imperative that significant efforts be continued to accurately measure all the inputs and outputs of phosphorus from the system so that mass balance calculations can be verified each year. The most immediate task is to determine if iron interference lowers the measured total phosphorus concentrations in the sludge storage tank. Understanding of the operation of the Hatchery and the ability to track movement of various phosphorus pathways comes under significant question without such mass balance closure.

## Lake Water Quality of Big Platte Lake

*Total Phosphorus:* The annual average of the volume-weighted total phosphorus concentrations in Big Platte Lake for 2011 was 7.52 mg/$m^3$ and all measured values are shown in Figure 7. There were 129 days when the total phosphorus concentration exceeded the 8.0 mg/$m^3$ goal. The Consent Agreement mandates that the volume-weighted total phosphorus concentration of Big Platte Lake be maintained below 8.0 mg/$m^3$ 95% of the time. The actual attainment was 65% compared to the 95% requirement.

*Chlorophyll A:* The data from all measurements of chlorophyll A in the surface water of Big Platte Lake is shown in Figure 8. The 2011 annual average chlorophyll A concentration was 2.49 mg/$m^3$. Note that the high chlorophyll A concentrations that occur between days 190 and 280 coincide with the high total phosphorus concentrations shown in Figure 7 and low Secchi depth

readings as discussed below.

*Secchi Depth:* Secchi depth is used to measure water clarity and is an important indicator of visual water quality. The PRSFH and the PLIA have measured the Secchi depth of Big Platte Lake since 1990. The 2011 seasonal variation of Secchi depth in Big Platte Lake is shown in Figure 9. This variation shows gradual decrease in water clarity that is generally consistent with the increases in chlorophyll A shown in Figure 8. The 2011 annual average Secchi depth was 14.2 feet. The minimum Secchi depth was 8 feet.

Secchi depth dynamics are a complex function of calcite precipitation and the concentrations of plankton and phosphorus in the Lake. These relationships have been recently described by mathematical models developed by Homa and Chapra (2011) for nearby Torch Lake, Michigan. Such models can be used to calculate increases in water clarity as a function of decreases in Hatchery and watershed phosphorus loading. It is likely that as phosphorus concentrations in the Platte Lake decrease, corresponding increases in water clarity may be less than expected due to the precipitation of calcite (marl). It is recommended that a model similar to the Torch Lake model be developed for Big Platte Lake.

*Dissolved Oxygen:* Figure 10 shows the 2011 dissolved oxygen concentrations in Big Platte Lake. Dissolved oxygen concentrations dropped below 2 mg/L in waters deeper than 90 feet for 86 days in 2011. This is a critical period for phosphorus dynamics in the Lake because dissolved phosphorus will be released from the sediments during this anoxic period. Shallower water depths at 75, 60, and 45 feet experience shorter periods of low dissolved oxygen conditions. Another key period of phosphorus release from sediments is during the winter ice cover when there is significant potential for oxygen depletion. The number of days the dissolved oxygen concentration is less than 2 mg/L are used to calculate the phosphorus release from the sediments. The internal loading and cycling of phosphorus can be compared to both non-point and point sources and are used to calculate an annual phosphorus budget for the lake as demonstrated in Figure 16. Ultimately, the magnitude of the internal cycling of phosphorus determines how quickly the lake will respond to changes in input phosphorus loadings.

Figure 11 shows the long-term trend of the number of low dissolved oxygen concentrations days at depths greater than 90 feet. There is some indication that the number of such days is decreasing over time. However, this trend is obscured by the fact that dissolved oxygen concentrations in the bottom waters of Big Platte Lake are significantly influenced by year to year variations in temperature and wind induced vertical temperature gradients.

# Watershed Flow and Phosphorus Balances

## Watershed Flow and Phosphorus Balance

The long-term trend of mean annual flow of the Platte River as measured by the U.S. Geological Survey (USGS) (Station ID 04126740) is displayed in Figure 12. The mean annual Platte River flow was 113.6 cubic feet per second (cfs) in 2011. This flow is lower than the long-term average flow of 122.8 cfs since 1990. Thus, 2011 can be characterized as a drier than average year.

The daily hydrograph of the Platte River as well as the days sampled for water quality is summarized in Figure 13. Note that only one sample was taken during the peak of a high flow event, while the remaining samples characterize baseline flow conditions. Inspection of the hydrograph suggests that there were about 27 storm events when higher than baseline flow and total phosphorus concentrations are expected.

The annual average flow, concentration, and phosphorus load balances for the lower watershed starting at Fewins Road and extending to the outlet of Big Platte Lake are displayed in Figures 14, 15 and 16. The flow balance includes the tributary flows into the Platte River along with the discharge by the Hatchery. Tributary, non-point flows and flows at intermediate locations on the Platte River are based on previously developed correlations with the USGS measured flows at US-31. These relationships were developed over a four-year period (2003 to 2006) using flow measurements at intermediate locations in the watershed. These correlations are a component of the database. The flow at the USGS location is generally about 2.2 times the flow at Fewins Road, and the Lake outlet is about 2.7 times that of the flow at Fewins Road. Data shown in Figures 14 through 16 include 27 storm events in 2011 where flows rapidly increased and then receded over a one or two day period. The peak event storm flows accounted for about 9.2% of the total flow during 2011. Baseflows are generally associated with groundwater inputs and in 2011 accounted for the remainder of the flow or 90.8% of the total discharge.

The development of an accurate annual phosphorus balance for the watershed is not a trivial task because the Platte River and tributary loadings are highly affected by high flow events that occur during several storm events throughout the year. The temporally systematic random sampling program for the Platte River for total phosphorus only sampled one of these storm events in 2011 from a total of about 27(see Figure 13). Thus, estimates of the total phosphorus loading into Big Platte Lake based on the 24 routine measurements are not expected to accurately estimate the loading because of the inaccurate and under representation of storm events. Unfortunately, it is

impractical to measure flow and phosphorus concentration during every storm event at all key locations in the watershed every year.

Extensive storm event measurements were taken from 2004 to 2006 at the Old Residence location on Brundage Creek and at the Stone Bridge and USGS Gauging Station at Honor, MI sites on the Platte River using continuous water sampling equipment. The mean storm event total phosphorus concentrations at these locations were 67.95, 45.35, and 51.07 $mg/m^3$, respectively. The storm event concentrations at the Fewins site and North Branch sites were assumed to be identical to those measured at the Stone Bridge site. The measured storm event total phosphorus concentrations at the Old Residence site on Brundage Creek were also used to characterize storm events for the Stanley, Carter, and Collision Creek sites because these sub-watersheds have both similar sizes and land-uses. The total phosphorus concentrations during baseflow conditions were averaged for all years for Stanley, Carter, and Collision Creeks because limited measurements are available for these sites and these were consistent with other sampling sites in the watershed, thus they are no longer included in the regular monitoring program. These data, along with the regular monitoring data for 2011, were used to determine the total phosphorus loads into Big Platte Lake as shown in Figure 16.

The annual phosphorus load at the USGS Gauging Station site was 3,414.4 pounds in 2011. Storm events contributed 17.3% of total phosphorus load compared to only 9.2% of the flows. The total phosphorus concentration at the USGS Gauging Station at Honor, MI site was measured 24 times during 2011. The average total phosphorus concentration was 13.3 $mg/m^3$ and the annual average flow was 113.6 cfs. This is equivalent to an annual phosphorus load of 2,979 lbs., an amount that is about 13% lower than the annual load that accounts for increases during storm events. The difference is the result of storm event flows with their higher total phosphorus concentrations being disproportionate greater than corresponding phosphorus loads from dry weather or baseflow conditions.

The above calculations are considered adequate representations of the hydrologic and phosphorus watershed balances despite the assumptions and approximations used in the analyses. Practical alternatives to this approach are problematic. The monitoring program needed to compile a more accurate phosphorus balance for the total watershed is monumental and outside of the current budget for this program. Given these difficulties and limitations, the above approach is considered a good alternative and a reliable screening tool that can be reliably used for planning applications. However, it is recommended that the full dry and wet weather monitoring program be resumed and the BASINS model be re-calibrated if watershed planning issues arise in the future that involve significantly alter watershed land use.

# Monitoring Program Recommendations

## Hatchery

The net Hatchery total phosphorus load is evaluated by subtracting the inlet load from the total outlet load. It is recommended that measurements of flow, total phosphorus concentration, and turbidity be taken at six locations using the Sigma samplers. The Sigma equipment should collect 72 hour composite samples twice each week. In addition, all flow rates should be calibrated annually. The flow rate of the clarifier and waste pumps should be calculated daily based on the capacity and the running times of the pumps. The flow rates of the backwash pumps are added to the flows from Brundage Creek and Brundage Spring to calculate the total flow of the Upper Discharge.

## Watershed

The sampling plan for 2012 involves collecting data from watershed streams and Big Platte Lake. The proposed lake and watershed sampling program for 2012 does not include sampling of Little Platte Lake or analyses for nitrogen or total dissolved phosphorus in Big Platte Lake. Three samples are planned for phytoplankton and zooplankton in Big Platte Lake.

The tributary sampling program is designed to estimate the non-point phosphorus loading into Big Platte Lake. Measurements of flow, phosphorus, and turbidity are taken on a temporally systematic random schedule using fixed sampling sites independent of flow conditions. These data allow evaluation of water quality for various hydrologic conditions, provide sub-watershed loading estimates, and assist in defining high priority remediation areas. The recommended monitoring program for 2012 should sample three sites on the Platte River – one just upstream of the Hatchery, another at the USGS Station on US31, and the last below Big Platte Lake on M-22. The North Branch of the Platte River at Deadstream Road is a major tributary stream and should continue to be sampled.

Big Platte Lake should continue to be sampled at two locations every two weeks during the year, whenever it is safe to do so. A calibrated Yellow Springs Instruments (YSI) meter should continue to be used to measure dissolved oxygen, temperature, pH, conductivity, and oxidation–reduction potential (ORP) using approved SOPs. Discrete depth and tube samples should be analyzed for total phosphorus, turbidity, and chlorophyll. Vertical net hauls should be taken for zooplankton one time during the spring, summer, and fall. A surface composite (tube sampler) and grab

bottom sample should be taken during these same periods for phytoplankton. Secchi depths should be measured with a standard Secchi disk and collected during each lake sampling.

## References

Homa, E.S. and S.C. Chapra. (2011). Modeling the impacts of calcite precipitation on the epilimnion of an ultra-oligotrophic, hard-water lake. Ecological Modelling 222:76-90.

# APPENDIX B

# APPENDIX B
# Platte River State Fish Hatchery
# Summary of 2011 Production and Operational Activities

**Antibiotic Use**

The antibiotic use at the Platte River State Fish Hatchery (Hatchery) in 2011 only focused on disease treatment. In the past, Chinook salmon were fed oxytetracycline coated feed to produce a readable mark on the vertebra of hatchery produced fish. In 2011, all Chinook salmon were coded wire tag marked by mass marking trailers.

In January 2011, Atlantic salmon in the outdoor raceway complex contracted bacterial coldwater disease. The recommend treatment was 15 mg/L Chloramine-T flow-through for one hour per day for three consecutive days. These fish, located in two small raceways (A-2 and A-4) were treated January 10 through January 12, 2011. There was a total of 3.39 kg of Chloramine-T used for treating fish. These same fish were prescribed and fed, a feed top dressed with Florenicol (antibiotic). The fish received 40 kg (0.4% Florenicol) of treated feed for a 10 day period from January 13 through January 24, 2012. The hatchery discharge during the treatment period averaged 6.96 million gallons per day (MGD).

In May 2011, the same group of Atlantic salmon contracted bacterial cold water disease and furunculosis. The prescribed treatment was Florenicol top dressed feed for 10 consecutive days. These fish received 40 kg (0.4% Florenicol) of treated feed from May 4 through May 13, 2011. The hatchery discharge during the treatment period averaged 6.74 MGD.

In October 2011, a new year class of Atlantic salmon contracted bacterial cold water disease. The recommend treatment was 10 mg/L Chloramine-T standing bath for one hour per day for three consecutive days. These fish, located in one raceway (C-1) were treated October 18 through October 20, 2011. There was a total of 1.90 kg of Chloramine-T used for treating fish. The hatchery discharge during the treatment period averaged 7.00 MGD.

In December 2011, the Atlantic salmon (C-1) began to show signs of bacterial cold water disease and furunculosis. The prescribed treatment was Oxytetracycline (antibiotic) top dressed feed for 10 consecutive days. These fish received 120 kg (3% Oxytetracycline) of the treated feed from December 13 through December 22, 2011. The hatchery discharge during the treatment period averaged 6.97 MGD.

**Disinfectant Use**

Parasite-S and Formacide-B were used in 2011 to control bacterial biofilm and fungus on fish eggs. Parasite-S is Western Chemical's and Formacide-B is B.L. Mitchell's trade name for formalin that consists of 37% formaldehyde by weight in water and is FDA approved for use in aquaculture. The standard treatment used is a 15-minute flow-through with formalin at a concentration of 1,667 ppm. Formalin was used from October 4, 2011 through December 31, 2011 to treat fungus on salmon eggs and 369.94 gallons of formalin were used. The maximum treatment was 5.85 gallons per day, during a 15 minute period. Hatchery flows averaged 6.98 MGD during the 2011 salmon incubation season.

**Weir Operations**

The Consent Agreement with the Platte Lake Improvement Association (PLIA) allows 20,000 adult coho salmon to be passed upstream of the Lower Platte River Weir during the fall salmon run. This number ensures that sufficient eggs and milt can be obtained in order to maintain the coho salmon production program. The Consent Agreement also allows for passage of up to 1,000 adult Chinook salmon to maintain the feral run in this stream and to provide sportfishing opportunities.

The Lower Weir grates were installed on August 15, 2011 and removed for the season on November 9, 2011, after consultation with the Consent Agreement parties. As fish collected below the weir in sufficient numbers, coho salmon were passed upstream for egg take purposes, and surplus Chinook and coho salmon were harvested and removed from the watershed by the American-Canadian Fisheries Inc. of Traverse City, Michigan under contract to the DNR. Fish were passed upstream of the weir by raising the boat gate slightly and manually counting the number of fish by species that swam upstream under the gate. For harvest operations, the pumps were turned on and fish were allowed into the holding pond, where they were later removed. Members of the PLIA were contacted prior to passing fish upstream and were invited to observe the passage and harvest operation.

In 2011, a total of 377 adult and 150 jack Chinook salmon, and 15,018 adult and 3,690 jack coho salmon, 34 steelhead trout, and four brown trout were passed upstream of the Lower Weir during the period from August 15 to November 9, 2011. A total of 788 adult and 111 jack Chinook salmon, and 823 adult and 517 jack coho salmon were harvested at the Lower Weir and removed

from the watershed by American-Canadian Fisheries Inc. Biological sampling of the spawning fish was conducted at the Traverse City processing plant by DNR Fisheries Division staff.

All of the dam boards for the Upper Weir were installed by September 2, 2011, after consultation with the Consent Agreement parties. Any migrating salmon were directed to the maturation ponds after this time. Coho salmon egg take occurred between October 17 and October 26, 2011. After eggs and milt were collected, all fish were harvested and shipped to the American-Canadian Fisheries Inc. processing plant in Traverse City. In 2011, a total of 67 adult and 26 jack Chinook salmon, and 8,656 adult and 2775 jack coho salmon were harvested from the Upper Weir and shipped to the same processing plant. On October 26, 2011, the ponds were harvested for the final time, and Upper Weir operation was suspended for the season.

The total number of fish that were unaccounted for between the Lower and Upper Platte River Weirs included 310 adult and 124 jack Chinook salmon, and 6,362 adult and 915 jack coho salmon. It is assumed that these fish were either caught by anglers, or spawned and died in the river prior to reaching the Upper Weir. Normally, approximately 75% of the adult coho passed above the Lower weir are harvested at the Upper weir. In 2011, a significant number of fish were observed to have moved only slightly above the Lower weir and they appear to have stopped and tried to spawn in the lower Platte River.

**Egg Take and Egg Incubation**

The coho salmon egg take operation occurred at the Hatchery between October 17 and October 26, 2011. A total of 4,950,474 coho salmon eggs were collected and fertilized. This included 2,813,796 green eggs for the Hatchery, 2,052,678 green eggs for other state fisheries agencies (Bodine State Fish Hatchery in Indiana and the Jake Wolf State Hatchery in Illinois), and 84,000 for the continuing Thiamine Deficiency Study at Wolf Lake State Fish Hatchery. The number of green eggs taken for the Hatchery was similar to the number taken in the fall of 2010 because the rearing assignment for coho salmon was scheduled to remain at full production of approximately 1.57 million yearlings for the spring of 2013.

Chinook salmon eggs were taken at the Little Manistee River Weir and transferred as green eggs to the Hatchery in October 2011. A total of 2,807,640 eggs were incubated at the Hatchery, a number decreased 25% from 2010 due to reduced stocking requirements for Lake Huron. Incubation took place during the months of October, November and December, and the earliest hatching Chinook salmon were put in tanks at the end of December 2011.

Atlantic salmon eggs taken at Lake Superior State University were transferred as eyed eggs to the Hatchery in late December 2011. A total of 128,075 eggs were incubated at the Hatchery as part of an experimental rearing program. This was attempted in 2009-2010 and failed due to an infection of *Myxobolus cerebralis.* The Hatchery has since installed an ultra violet water filtration system on the spring water line. The new system is designed to eliminate many of the bacteria and *Myxobolus cerebralis* that infect juvenile salmonids. This new disinfection system is expected to allow full life cycle Atlantic salmon at the Hatchery.

**Fish Production**

In October 2011, an additional experimental lot of 85,440 (995.5 kg) fall fingerling Atlantic salmon from Thompson State Fish Hatchery were added to an outside raceway. There were 3,859,954 (1,434.1 kg) Chinook and coho salmon fry put down in to rearing units at the end of December for the 2012 production cycle.

The Chinook and coho salmon were reared for production purposes, and during calendar year 2011, the Hatchery raised and stocked 791,055 (25,459.9 kg) spring yearling coho salmon in the Platte River below the Upper Weir. In addition, 2,799,974 (32,749.99 kg) fish were raised and shipped to other locations outside the Platte River watershed. This includes 2,041,509 (9,816.15 kg) spring fingerling Chinook salmon, 736,723 (22,047.09 kg) spring yearling coho salmon, and 21,742 (886.75 kg) spring yearling Atlantic salmon that were part of the continuing experimental Atlantic salmon rearing program at the Hatchery.

During the course of the year a total of 47,802 kg of feed was fed to the production lots of coho and Chinook salmon and the experimental lot of Atlantic salmon. This feed was predominantly BioOregon BioDry 1000 LP diet (96.4% of the annual food fed). BioOregon medicated feeds where fed to the experimental lots of Atlantic salmon (0.4% of the annual food fed), and these diets contained between 1.2% and 1.4% phosphorous. A small amount of BioOregon BioVita Starter (3.2% of the annual food fed) was fed to fry and this diet was approximately 1.4% phosphorous.

At the end of the calendar year there were 1,839,203 (44,901.93 kg) yearling coho and Atlantic salmon on hand in the outdoor raceway complex. There were also 3,631,219 (1354.10 kg) coho and Chinook salmon fry that had just been put down in to the hatchery building rearing and starting tanks.

## Waste Handling

Throughout the production cycle, all egg and fish mortalities were removed from the incubators and rearing units on a daily basis. Mortalities were weighed or counted and disposed of at a certified landfill, or in the case of egg mortalities, to the salmon harvest contractor.

Fish waste was removed daily from the rearing units either by manual cleaning or automatic filtering of the wastewater by the disk filters. The filters were hot water (steam) power washed quarterly, while remaining in place during the year. Any filters (12) that received damage during the quarterly cleanings were replaced immediately. There were approximately 20 occasions where broken filters were discovered during daily preventative maintenance walk a rounds, these filters were replaced the same day.

Filtered waste was first treated with ferric chloride at the clarifier for phosphorus precipitation. This material was then stored in a sludge tank until disposal. The top six feet of sludge tank (ten feet total depth) was decanted and directed back to the clarifier, after consultation with all Consent Agreement parties. This process (decanting the top water) was achieved by slowly lowering the stand pipe during the week prior to emptying. The sludge tank was pumped out by BioTech Agronomics, Inc. on August 30, 2011 and a total of 106,000 gallons of sludge was removed. All sludge was land applied per the Michigan Department of Environmental Quality's (DEQ) Manure, Paunch and Pen Waste Exemption guidelines at a site (N 44 39'47" W 86 05'34") outside of the Platte River watershed.

## Ferric Chloride

A full scale ferric chloride injection system is located at the sludge tank and clarifier pump building. The system injects 37% ferric chloride solution into the center of the clarifier to precipitate additional phosphorus. During 2011, the Hatchery injected 2,473 gallons of ferric chloride to the effluent management system and the monthly use of ferric chloride in the clarifier in 2011 is shown in Table 1.

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gallons | 195 | 220 | 245 | 232 | 235 | 148 | 167 | 223 | 235 | 186 | 207 | 180 |

Table 1. Monthly use of ferric chloride in clarifier for 2011.

# APPENDIX C

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENT
LANSING

RICK SNYDER
GOVERNOR

# APPENDIX C

February 9, 2011

Dr. Raymond P. Canale
710 SW Manitou Trail
Lake Leelanau, MI 49653

Dear Dr. Canale,

The purpose of this letter is to certify that I have reviewed and updated the Water Sampling Preventive Maintenance and Calibration Schedule for the year 2010.

All equipment calibration and preventive maintenance has been completed. All equipment is in good working order. The LiCor meter is currently on loan to Central Michigan University. Please review and contact me with any questions.

Sincerely,

Aaron Switzer, Fisheries Technician
Platte River State Fish Hatchery
15210 US Hwy 31
Beulah, MI 49617

# Water Sampling Preventive Maintenance and Calibration Schedule

| | Maintenance | Calibration | Schedule | Notes |
|---|---|---|---|---|
| **Laboratory** | | | | |
| Drying Oven | Keep Clean | Plug In | Yearly | |
| Ohaus Balance | Keep Clean and Free of Debris | See Manual | 6 Months | |
| Ice Maker | Keep Clean | Open | Daily | |
| Refrigerator | Keep Clean | Open | Daily | |
| Stirrer/Hot Plate | Keep Clean | Plug In | Yearly | |
| Thermometer | Keep Clean and Free of Debris | Replace | When Needed | |
| Turbidimeter | Keep Clean and Free of Debris | See Manual | Monthly | |
| Vacuum Pump | Keep Clean | Plug In | Yearly | |
| Weed Spinner | Keep Clean and Free of Debris | Pull Cord | Yearly | |
| **Field** | | | | |
| Auger | Inspect for Damage or Leaks | Pull Cord | Before Use | 25:1 Fuel Mix |
| | Spark Plug | Check, Clean and/or Replace | 50 Hours | |
| | Gear Case | Check, Clean and/or Replace | 3 Months | |
| | Air Cleaner | Check, Clean and/or Replace | 3 Months | |
| Boat | Inspect for Damage or Leaks | Add Water | Before Use | |
| Dip Sampler | Inspect for Damage | Add Water | Before Use | |
| GPS | Inspect for Damage | Power Up | Before Use | |
| | 4 AA Batteries | Replace | When Needed | |
| Isco Sampler | Inspect for Damage | See Manual | 6 Months | |
| | Intake Tubing | Replace | 6 Months | |
| J/N Sampler | Inspect for Damage | Add Water | Before Use | |
| | Acid Wash | SOP | After Use | |
| Kemmerer | Inspect for Damage or Leaks | Add Water | Before Use | |
| LICOR Meter | Inspect for Damage | See Manual | Before Use | Air -133.69 Water -216.58 |
| | 9 Volt Battery | Replace | When Needed | Loaned to CMU - May 2008 |
| | Recalibration | Factory | 2 Years - December | Recalibrated 1/15/2007 |
| Life Jackets | Inspect for Damage and Fit | Add Water | Before Use | |
| Outboard Motor | Inspect for Damage or Leaks | Add Water | Before Use | 25:1 Fuel Mix |
| | Spark Plug | Check, Clean and/or Replace | 50 Hours | |
| | Gear Case | Check, Clean and/or Replace | 3 Months | |
| | Fuel Filter | Check, Clean and/or Replace | 3 Months | |
| Portable pH Meter | Inspect for Damage | See Manual | Before Use | |
| | Battery | Replace | When Needed | |
| | Electrode | Replace | When Needed | |
| Pumps and Drums | Inspect for Damage | Check, Clean and/or Replace | Weekly | |
| -pipes and hoses | Inspect for Damage | Check, Clean and/or Replace | Weekly | |
| PVC Staff Gage | Inspect for Damage | Add Water | Before Use | |
| Secchi Disc | Inspect for Damage | Add Water | Before Use | |
| Sigma Sampler | Inspect for Damage | See Manual | 6 Months | |
| | Intake Tubing | Replace | 6 Months | |
| Sludge Judge | Inspect for Damage or Leaks | Add Water | Before Use | |
| Tube Samplers | Inspect for Damage or Leaks | Add Water | Before Use | |
| YSI 650 and Sonde | Inspect for Damage | See Manual and/or SOP | Before Use | |
| | 4 C Batteries | Replace | When Needed | |
| | Dissolved Oxygen | See Manual and/or SOP | Before Use | |
| | Conductivity | See Manual and/or SOP | Before Use | |
| | pH | See Manual and/or SOP | Before Use | |
| | Recalibration | Factory | Yearly - December | Recalibrated 5/11/2010 |
| Water Level Logger | Inspect for Damage | See Manual | Before Use | |
| Zooplankton Net | Inspect for Damage or Leaks | Add Water | Before Use | |
| **Database** | | | | |
| Forms | Inspect for Changes | Update | Yearly - December | Send copies to Jim and Ray |

Edited and Revised
Aaron Switzer
3/17/07, 2/6/08, 2/13/09, 3/2/2010
Aaron Switzer and Nicole Sherretz
2/9/2011

# APPENDIX D

**Examination of Platte River Watershed Total Phosphorus Data Anomalies**

## Background

Platte River State Fish Hatchery (PRSFH) monitors total phosphorus (TP) levels in all water sources entering and exiting the facility in accordance with the Consent Agreement between the Michigan Department of Natural Resources (MDNR) and Platte Lake Improvement Association (PLIA). PRSFH regularly monitors TP levels throughout the watershed, including both Platte Lakes. All samples are collected by a Technician employed by PRSFH. The samples are analyzed under contract by Central Michigan University (CMU).

MDNR and PLIA have conference calls twice a month to discuss hatchery operations, sampling procedures, data analysis, etc. These conference calls include Ray Canale- Implementation Coordinator, Wil Swiecki- PLIA President, Gary Whelan- MDNR Fish Production Manager, Ed Eisch- MDNR, PRSFH Manager, and Aaron Switzer- MDNR, PRSFH Technician. In October of 2006 during these meetings it was determined that errors in data may be coming from CMU. A "face to face" meeting with CMU staff was set up to review their laboratory procedures.

## Methods

While examining TP data anomalies in the 2006 data it appeared that on occasion the cells on the spreadsheet appeared to be shift up or down. The determination was evident by examining "cut and paste" methods used at CMU during the "face to face" meeting. At this point it was decided that random insertion of a blank sample would capture any shifts in data. The blank is simply a TP sample bottle filled with distilled water. This method was adopted in November 2006.

PRSFH performs quality control/quality assurance (QA/QC) on all data returning from CMU. The QA/QC identifies blanks and any other data anomalies. PRSFH will notify CMU immediately of any blanks that return with a high TP concentration. The purpose is to help CMU identify the reasons samples were switched and to allow them to repeat the sample.

In November of 2007 a new format for reporting results was adopted. The Implementation Coordinator worked with CMU staff to implement a protected spreadsheet that would minimize "cut and paste" errors.

## Results and Discussion

At the end of 2010 there were 175 blank TP samples sent to CMU for analysis. In that time, 17 blanks have returned with TP levels greater than 4.00 ug/L. This indicates 10% of the samples have returned with TP levels that are considered unacceptable for distilled water blanks.

Twelve of the 17 samples returned high and were repeated because they fell out of the statistical parameters. All repeats returned with TP levels that were acceptable for distilled water blanks. CMU has explained this as carry over contamination from the prior sample. Therefore, 71% of the high blank returns have been affected by this circumstance.

Five of the 17 samples returned with high TP levels that were not acceptable for a blank. Two of these blank samples had a sample in the same data set, near the blank, return with a low TP level. These samples would indicate a shift in data and possible "cut and paste" errors. The other three have no clear explanation to high TP levels.

Repeats are done in duplicate and those samples are very consistent with each other. However, they can vary dramatically from the original reading. This is evident in the samples that are affected by carry over from a prior sample.

## Conclusions

Thus, five of the 175 (or 3%) of the distilled water test samples were mishandled by CMU. One of these five samples has occurred since the implementation of the protected spreadsheet; it appeared to be a shift in data. This conclusion is not concrete because a new employee at CMU accidentally discarded that sample and there is no repeat data.

At this point, we have eliminated the possibility of "cut and paste" errors. Prior to the implementation of the protected spreadsheet, there was an 8% chance of error, not acceptable. Since the implementation of the protected spreadsheet, there is a 1% chance of error. This is an acceptable number; there has been a dramatic increase in the reliability of the data returning from CMU. There is a high probability that the data anomalies occurring at the beginning of this project were directly related to "cut and paste" errors.

We have accomplished that there is a 3% error rate for mishandled samples since 2006, 1% since the implementation of the protected spreadsheet. The project has successfully eliminated the "cut and paste" errors. The project is an excellent means for monitoring the reliability of results returning from CMU. Barring consent of all parties, it is recommended we continue this project as a tool for QA/QC.

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENT
LANSING

RICK SNYDER
GOVERNOR

February 9, 2011

Dr. Raymond P. Canale
710 SW Manitou Trail
Lake Leelanau, MI 49653

Dear Dr. Canale,

The purpose of this letter is to certify that I have reviewed all data analysis results received from Central Michigan University's Water Research Laboratory for the year 2010.

I have compared all bottle tracking numbers that have left the laboratory at Platte River State Fish Hatchery with all bottle tracking numbers and results received from Central Michigan University's Water Research Laboratory. I certify that these results are accurate and correct. Any discrepancies have been clearly noted in writing to you and all involved with the Consent Agreement.

Sincerely,

Aaron Switzer, Fisheries Technician
Platte River State Fish Hatchery
15210 US Hwy 31
Beulah, MI 49617

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENT
LANSING

RICK SNYDER
GOVERNOR

February 8, 2011

Dr. Raymond P. Canale
710 SW Manitou Trail
Lake Leelanau, MI 49653

Dear Dr. Canale,

The purpose of this letter is to certify that I have reviewed and updated all Standard Operating Procedures related to water quality sample collection for the year 2010.

There was one Standard Operating Procedure added for operating the Spectronic 20 to determine real time total phosphorus. The Sampling – Hatchery, Standard Operating Procedure was modified to include all of the 72 hour sampling changes and the additions of Sites 28 and 39. Please review and contact me with any questions.

Sincerely,

Aaron Switzer, Fisheries Technician
Platte River State Fish Hatchery
15210 US Hwy 31
Beulah, MI 49617

# STANDARD OPERATING PROCEDURES FOR WATER QUALITY SAMPLE COLLECTION AT PLATTE RIVER STATE FISH HATCHERY

Edited and Revised
Aaron Switzer and Nicole Sherretz
2-8-2011

## SCOPE

The Platte River State Fish Hatchery collects water quality data from Big Platte Lake and its tributaries in an effort to quantify phosphorus concentrations in the watershed. This data will also be used to detect changes in water quality over time. The ultimate goal of this effort is to restore and preserve water quality in the Platte River watershed.

## PURPOSE

The purpose of this document is to provide a detailed outline of the procedures used in sample collection. Adherence to a consistent sampling protocol is vital to ensure data is of a known quality and integrity.

**INDEX**

# STANDARD OPERATING PROCEDURES
# COLLECTING SAMPLES FOR CHLOROPHYLL *A* ANALYSIS

## 1. SCOPE/ PURPOSE

1.1 This Standard Operating Procedure (SOP) describes the procedure for using the chlorophyll *a* sampler to collect samples for Chlorophyll *a* analysis. This sample allows a composite water sample to be collected from the entire column of the photic zone. It is assumed that the photic zone of the lake being studied is two times the Secchi depth.

## 2. REFERENCES

2.1 Handbook of Common Methods in Limnology, Lind, Owen T., 1995.

## 3. DEFINITIONS

3.1 Chlorophyll *a* is a photosynthetic pigment found in plants, including phytoplankton. It constitutes about 1 to 2% of the dry weight of planktonic algae; therefore the total phytoplankton biomass may be estimated based on the chlorophyll *a* concentration.

3.2 Photic zone is the column of water reaching from the surface to the photic depth. The Photic depth is the depth that receives 1% of surface illumination.

## 4. MATERIALS

4.1 Tube sampler.

4.2 Brown bottles.

## 5. SAMPLE COLLECTION

5.1 The tube sampler is lowered 30 feet into the water column and then emptied into a 5L Nalgene brown bottle labeled “Platte Lake” or “Little Platte Lake”. This procedure is repeated three times to provide enough water for complete sample collection. At Little Platte Lake the sample is collected by the Kemmerer.

5.2 Once the sample water is collected and transported back to the lab, the 5L Nalgene brown bottle is shaken vigorously before pouring. This procedure is repeated following each chlorophyll *A* sample bottle fill.

5.3 The sample will then be poured into a 1000ml brown chlorophyll *A* bottle.

5.4 Carefully grab the edge of a 45 µ filter with tweezers and rinse filter with distilled water.

5.5 Place a 45µ filter (grid down) on the filtering apparatus on the vacuum pump.

5.6 Pour 200ml of each sample into the filtering apparatus and begin filtering.

5.7 Place the filter into a mini Petri dish and label with the date, bottle number and the amount sampled.

5.8 Wrap Petri dish in aluminum foil and place in freezer until shipping.

# STANDARD OPERATING PROCEDURES
# CLEANING SAMPLE BOTTLES

## 1. SCOPE

1.1 These Standard Operating Procedures (SOP's) describe the methods to be used for cleaning sample containers.

## 2. PURPOSE

2.1 It is critical that these procedures are followed to ensure that all sample bottles are contaminant free and that they are prepared in away that is suitable for the activities for which they are designed.

## 3. PROCEDURES

3.1 10 liter Nalgene plastic bottles

3.1.1 After samples are collected the bottles and tops should be rinsed with tap water and scrubbed with a brush to remove any dirt. The bottles are turned upside down in the sink and allowed to drain. Bottles should never be washed with detergents.

3.1.2 Rinse sample bottles with a 5% mixture of hydrochloric acid after each use. (950ml distilled water and 50ml Hydrochloric acid)

3.1.3 Rinse sample bottles with distilled water and allow them to drain and dry.

3.2 Erlenmeyer flask

3.2.1 Rinse flask with tap water and scrub with a brush to remove any dirt.

3.2.2 Rinse flask with a 5% mixture of hydrochloric acid.

3.2.3 Rinse flask with distilled water and allow it to drain and dry.

## 4 QUALITY CONTROL

4.1 It is critical that these procedures are followed to ensure that all equipment is contaminant free. All other sample bottles will be cleaned by CMU until further notice.

4.2 Any cleaned sample bottles with loose caps or caps missing should be return to CMU for additional cleaning.

# STANDARD OPERATING PROCEDURES
# USING A KEMMERER TYPE SAMPLER

## 1. SCOPE/PURPOSE

1.1 This standard operating procedure (SOP) describes the procedure for using the Kemmerer type sampler at discrete depths. The design of the sampler allows transfer of water into storage bottles without agitation.

## 2. REFERENCES

2.1 Handbook of Common Limnology Methods, Lind, Owen T., 1985

## 3. DEFINITIONS

3.1 The messenger is a lead device that is dropped down the line to which the sampler is attached. When it reaches the sampler it trips the device causing the plungers to close.

3.2 Water samples are collected for a variety of analysis including total dissolved solids, phytoplankton, zooplankton, phosphorous, calcium, and alkalinity.

## 4. PROCEDURE

4.1 The Kemmerer is opened and lowered to the depth of interest. This is determined by measured markings on the rope to which the sampler is attached.

4.2 When the desired depth is reached the messenger is dropped to close the sampler and it is raised to the surface and lifted into the boat.

4.3 The sample is then deposited into the appropriate bottles for each analysis required.

## 5. SAMPLER STORAGE

5.1 The sampler is stored in the open position to keep moisture from being trapped inside and to avoid plunger wear.

# STANDARD OPERATING PROCEDURES
# FOR COLLECTING SAMPLES FOR PHYTOPLANKTON ANALYSIS

## 1. SCOPE/ PURPOSE

1.1 This Standard Operating Procedure (SOP) describes the procedure for using the tube sampler to collect samples for phytoplankton analysis. This sample allows a composite water sample to be collected from the entire column of the photic zone. It is assumed that the photic zone of the lake being studied is two times the Secchi depth.

## 2. REFERENCES

2.1 Handbook of Common Methods in Limnology, Lind, Owen T., 1995.

2.2 Fish Hatchery Management, Piper, et al., 1982.

## 3. DEFINITIONS

3.1 Phytoplankton are minute plants suspended in water with little or no capability for controlling their position.

3.2 Photic zone is the column of water reaching from the surface to the photic depth. The Photic depth is the depth that receives 1% of surface illumination.

## 4. MATERIALS

4.1 Tube sampler.

4.2 One 5L brown Nalgene bottle.

4.3 One 10L Nalgene bottle.

4.4 Three 250ml bottles.

## 5. SAMPLE COLLECTION

5.1 Phytoplankton is collected seasonally (spring, summer, fall)

5.2 The tube sampler is lowered 30 feet into the water column and then emptied into a 5L brown Nalgene bottle labeled “Tube”.

5.3 The bottle is then shaken vigorously and one 250ml bottle is filled.

5.4 Add 10 drops of Lugol iodine to the 250ml sample bottle and mixed.

5.5 Pour the remaining sample into the 10L nalgene bottle. The contents will be processed at the hatchery lab.

5.6 This procedure is repeated three times to provide enough water for complete sample collection.

# STANDARD OPERATING PROCEDURES
# USING LI-COR RADIATION SENSORS

## 1. SCOPE/PURPOSE

1.1 This standard operating procedure (SOP) describes the procedure for using the Li-Cor Radiation Sensor in the atmosphere and at three foot depth intervals in Platte Lake.

## 2. REFERENCES

2.1 Li-Cor Radiation Sensors Instruction Manual, Li-Cor Inc., 1990

## 3. DEFINITIONS

3.1 The spherical quantum sensor is the light bulb like device on a lowering frame to which coaxial cable is attached. The Li-Cor model LI-250 Light Meter is attached at the other end of the coaxial cable.

3.2 The Li-Cor model LI-250 Light Meter measures photosynthetic active radiation.

## 4. PROCEDURE

4.1 The spherical quantum sensor and the lower frame are held in the atmosphere on the sunny side of the boat.

4.2 Attach the other end of the coaxial cable to the light meter.

4.3 Turn on the light meter by holding the ON/CAL button for at least two seconds. Pressing the ON/CAL button once more places the meter in calibration constant mode. The calibration constant for the atmosphere is -133.7. The constant can be changed by pressing the HOLD/MULTISELECT button.

4.4 Once the proper calibration constant is selected press the ON/CAL button again to put the meter in the read mode. The proper units for the read mode are umol.

4.5 A reading is taken by pressing the AVG button, which takes a 15 second average of the current readings. Take the reading for the atmosphere at this point and recorded on the data sheet. Pressing the HOLD/MULTISELECT button puts the meter back into read mode.

4.6 The meter must now be calibrated for reading in the water. Refer to 4.2 and 4.3 for this procedure. The calibration constant for the water is -216.6.

4.7 Refer to 4.4 for the procedure of taking readings. The first reading in the water is taken with the spherical quantum sensor just under the surface of the water on the sunny side of the boat.

4.8 Readings are then taken at three foot intervals until a reading of 1% of the surface reading is achieved.

4.9 The meter is then turned off by pressing and holding the OFF button. Unplug the coaxial cable from the light meter and prepare for storage. See Section 5.

## 5. SAMPLER STORAGE

5.1 The light meter is stored in a plastic zip lock type bag which is placed in the tool box.

5.2 The coaxial cord is reeled up on the cord reel and a sock is placed over the spherical quantum sensor. The entire apparatus is then placed in one of the Rubbermaid totes.

# STANDARD OPERATING PROCEDURES FOR FISH FOOD SAMPLING

## 1. SCOPE

1.1 The Platte River Fish Hatchery collects water quality data from Platte Lake and its tributaries as part of an ongoing water quality program. This data is used to detect changes in water quality over time. Part of this program includes modeling of a phosphorus budget for the Platte River State Fish Hatchery. The phosphorus contained in the food that is fed to the fish at the hatchery is a major component of the whole-hatchery phosphorus budget.

## 2. PURPOSE

2.1 The purpose of this document is to provide a detailed outline of the procedures used in sample collection when fish food is fed at the hatchery. Adherence to a consistent sampling protocol is vital to ensure data is of a known quality and integrity.

## 3. RESPONSIBLITIES

3.1 The Technician performing the preparation work shall be trained in standard procedures described within.

## 4. PROCEDURE

4.1 Day fish food shipment arrives –

4.1.1 Record food size and lot numbers on Fish Tissue and Food Sample Tracking spreadsheet.

4.1.2 Advise cultural staff to notify when feeding new food.

4.1.3 Make calendar with the projected start date.

4.1.4 Watch for sample from manufacturer to arrive on or near shipment date.

4.2 Manufacturer's food sample -

4.2.1 The sample is emptied into two Whirl-pak style bags that are labeled numerically. Please reference the Fish Tissue and Food Sample Tracking spreadsheet for the numbering system for each university.

4.2.2 Record all pertinent information into the Fish Tissue and Food Sample Tracking spreadsheet.

4.2.3 Ship or refrigerate samples depending on the day of the month and shipping schedule. Fish food samples are shipped once at the beginning of the month.

4.2.4 Enter data collected into Access database "Sample FP".

4.2.5 Create Export files, edit and print, put copies into binder in lab.

4.3 Fish Food received at the Hatchery -

4.3.1 Begin sampling fish food at the hatchery once the cultural staff has indicated they are feeding it to the fish.

4.3.2 Fish food at the hatchery is sampled in triplicate from three bags per lot code. If there are three or more pallets, sample one bag from each pallet. If there are less than three pallets, sample three bags form separate areas of the pallet. All of these samples are prepared for Central Michigan University.

4.3.3 The samples are collected with Whirl-pak style bags that are labeled numerically. Please reference the Fish Tissue and Food Sample Tracking spreadsheet for the numbering system for each university.

4.3.4 Record all pertinent information into the Fish Tissue and Food Sample Tracking spreadsheet.

4.3.5 Ship or refrigerate samples depending on the day of the month and shipping schedule. Fish food samples are shipped once at the beginning of the month.

4.3.6 Enter data collected into Access database “Sample FP”.

4.3.7 Create Export files, edit and print, put copies into binder in lab.

4.3.8 Send Export files to PLIA Contacts.

# STANDARD OPERATING PROCEDURES
# SAMPLING PREPARATION

## 1 SCOPE

1.1 The Platte River Fish Hatchery collects water quality data from Platte Lake and its tributaries as part of an ongoing water quality program. This data is used to detect changes in water quality over time.

## 2 PURPOSE

2.1 The purpose of this document is to provide a detailed outline of the procedures used in sample collection. Adherence to a consistent sampling protocol is vital to ensure data is of a known quality and integrity.

## 3 RESPONSIBLITIES

3.1 The Technician performing the preparation work shall be trained in standard procedures described within.

## 4 PROCEDURE

4.1 Day before event –

4.1.1 Conduct an inspection of YSI equipment and charge batteries if needed.

4.1.2 Inspect boat and trailer and make sure there is plenty of gas in can.

4.1.3 Gather together equipment.

4.1.4 Gather together bottles and coolers.

4.1.5 Clean any equipment or bottles that have not been cleaned.

4.2 Day of event -

4.2.1 Calibrate YSI following (SOP's) before departure.

4.2.2 Fill coolers with ice or ice packs if weather dictates.

4.2.3 Conduct sampling in accordance with (SOP's)

4.2.4 After sampling is completed. Return all equipment to designated storage location and conduct post calibration check on YSI.

4.2.5 Ship or refrigerate samples depending on the day of the week. The current schedule dictates that samples collect Friday are refrigerated and used to cool samples shipped on Mondays. Samples are shipped UPS at Platte River Printing.

4.2.6 Clean bottles and related equipment.

4.2.7 Enter data collected into Access database “Sample FP”.

4.2.8 Create Export files, edit and print, put copies into binder in lab.

4.3 Day after event -

4.3.1 If not done already, conduct any items not complete from the day before.

4.3.2 Conduct maintenance as needed on any equipment.

4.3.3 Send Bottle Export file to CMU.

4.3.4 Send all Export files to Ray Canale and Jim Berridge.

# STANDARD OPERATING PROCEDURES
# PLATTE HATCHERY, BIG PLATTE LAKE AND TRIBUTARY SAMPLING

## 1. SCOPE

1.1 The Platte River Fish Hatchery collects water quality data from Platte Lake and its tributaries as part of an ongoing water quality program. This data is used to detect changes in water quality over time.

## 2. PURPOSE

2.1 The purpose of this document is to provide a detailed outline of the procedures used in sample collection. Adherence to a consistent sampling protocol is vital to ensure data is of a known quality and integrity.

## 3. RESPONSIBILITIES

3.1 The individual technician responsible for sampling shall be trained in the standard operating procedures described within.

## 4. PROCEDURES

4.1 Platte Hatchery sampling - per location (NOTE: Sample only the water sources being used at the present time.)

4.1.1 Effluent Pond Intake (14)

Equipment and bottles (1400 series – green labels)
- (3) 250ml acid washed plastic bottles
- (1) Hatchery Data Sheet
- (1) Labeled Turbidity bottle

Step 1: Remove 10 liter Nalgene bottle from Sigma sampler.
Step 2: Take temperature of sample water from mixing drum, turn off pump and drain drum.
Step 3: Perform maintenance/cleaning on pump, assembly and drum.
Step 4: Shake sample container vigorously.
Step 5: Pour a small amount of water into 250ml plastic bottle. Recap shake and empty.
Step 6: Shake Nalgene bottle one more time.
Step 7: Refill to neck of bottle.
Step 8: Repeat for two remaining bottles. Swirl Nalgene bottle to keep sample well mixed before filling each bottle.
Step 9: Place sample bottles in refrigerator.
Step 10: Shake Nalgene bottle and collect sample for turbidity.

4.1.2 Upper Discharge (15)

Equipment and bottles (1500 series – red labels)
- (3) 250ml acid washed plastic bottles
- (1) Hatchery Data Sheet
- (1) Labeled Turbidity bottle

Step 1: Remove 10 liter Nalgene bottle from Sigma sampler.

Step 2: Take temperature of sample water from mixing drum, turn off pump and drain drum.
Step 3: Perform maintenance/cleaning on pump, assembly and drum.
Step 4: Shake sample container vigorously.
Step 5: Pour a small amount of water into 250ml plastic bottle. Recap shake and empty.
Step 6: Shake Nalgene bottle one more time.
Step 7: Refill to neck of bottle.
Step 8: Repeat for two remaining bottles. Swirl Nalgene bottle to keep sample well mixed before filling each bottle.
Step 9: Place sample bottles in refrigerator.
Step 10: Shake Nalgene bottle and collect sample for turbidity.

4.1.3 Brundage Creek (12)

Equipment and bottles (1200 series – yellow labels)
(3) 250ml acid washed plastic bottles
(1) Hatchery Data Sheet
(1) Labeled Turbidity bottle

Step 1: Remove 10 liter Nalgene bottle from Sigma sampler.
Step 2: Take temperature of sample water from mixing drum, turn off pump and drain drum.
Step 3: Perform maintenance/cleaning on pump, assembly and drum.
Step 4: Shake sample container vigorously.
Step 5: Pour a small amount of water into 250ml plastic bottle. Recap shake and empty.
Step 6: Shake Nalgene bottle one more time.
Step 7: Refill to neck of bottle.
Step 8: Repeat for two remaining bottles. Swirl Nalgene bottle to keep sample well mixed before filling each bottle.
Step 9: Place sample bottles in refrigerator.
Step 10: Shake Nalgene bottle and collect sample for turbidity.

4.1.4 Brundage Spring (11)

Equipment and bottles (1100 series – pink labels)
(3) 250ml acid washed plastic bottles
(1) Hatchery Data Sheet
(1) Labeled Turbidity bottle

Step 1: Remove 10 liter Nalgene bottle from Sigma sampler.
Step 2: Take temperature of sample water from mixing drum, turn off pump and drain drum.
Step 3: Perform maintenance/cleaning on pump, assembly and drum.
Step 4: Shake sample container vigorously.
Step 5: Pour a small amount of water into 250ml plastic bottle. Recap shake and empty.
Step 6: Shake Nalgene bottle one more time.
Step 7: Refill to neck of bottle.
Step 8: Repeat for two remaining bottles. Swirl Nalgene bottle to keep sample well mixed before filling each bottle.
Step 9: Place sample bottles in refrigerator.
Step 10: Shake Nalgene bottle and collect sample for turbidity.

4.1.5 Clarifier Overflow (28)

Equipment and bottles (2800 series – orange labels)

- (3) 250ml acid washed plastic bottles
- (1) Hatchery Data Sheet
- (1) Labeled Turbidity bottle

Step 1: Remove 10 liter Nalgene bottle from ISCO sampler.
Step 2: Shake sample container vigorously.
Step 3: Pour a small amount of water into 250ml plastic bottle. Recap shake and empty.
Step 4: Shake Nalgene bottle one more time.
Step 5: Refill to neck of bottle.
Step 6: Repeat for two remaining bottles. Swirl Nalgene bottle to keep sample well mixed before filling each bottle.
Step 7: Place sample bottles in refrigerator.
Step 8: Shake Nalgene bottle and collect sample for turbidity.

4.1.6 Backwash Line (39)

Equipment and bottles (3900 series – white labels)

- (3) 250ml acid washed plastic bottles
- (1) Hatchery Data Sheet
- (1) Labeled Turbidity bottle

Step 1: Remove 10 liter Nalgene bottle from ISCO sampler.
Step 2: Shake sample container vigorously.
Step 3: Pour a small amount of water into 250ml plastic bottle. Recap shake and empty.
Step 4: Shake Nalgene bottle one more time.
Step 5: Refill to neck of bottle.
Step 6: Repeat for two remaining bottles. Swirl Nalgene bottle to keep sample well mixed before filling each bottle.
Step 7: Place sample bottles in refrigerator.
Step 8: Shake Nalgene bottle and collect sample for turbidity.

4.1.7 Platte River (J/N sample - only sample if using river water)

Equipment and bottles

- (3) 250ml acid washed plastic bottles
- (1) Glass pocket thermometer
- (1) Hatchery Data Sheet

Step 1: Remove 10 liter Nalgene bottle from river just below pump house.
Step 2: Take temperature of sample water from 10 liter Nalgene bottle and record it with bottle numbers on data sheet.
Step 3: Shake sample container vigorously.
Step 4: Pour a small amount of water into 250ml plastic bottle. Recap shake and empty.
Step 5: Shake Nalgene bottle one more time.
Step 6: Refill to neck of bottle.
Step 7: Repeat for two remaining bottles. Swirl Nalgene bottle to keep sample well mixed before filling each bottle.

4.2 Big Platte Lake

Equipment Requirements

Boat and motor
Life jackets
YSI 600R/Sonde/cord
Kemmerer/messenger
Secchi disk/line
Zooplankton net/rope
Tube sampler/10L bottle
GPS
Extra batteries C/AA/ 9V
Pencil x2
Formalin
Tap water wash bottle
Lugols Iodine solution
Lake Data Sheet

Bottles

| | |
|---|---|
| (1) | 10L acid washed plastic bottle |
| (2) | 5L acid washed brown bottles |
| (2) | 125ml acid washed plastic bottles |
| (9) | 200ml rinsed plastic bottles |
| (27) | 250ml acid washed plastic bottles |
| (7) | 250ml acid washed plastic bottles |
| (1) | 500ml acid washed plastic bottles |

4.2.1

Step 1: Record the lake gauge height (by outhouse) on data sheet.
Step 2: Locate sampling waypoint (Bouy) on GPS unit and anchor boat at that position.
Step 3: Calibrate YSI 650 MDS and 600R sonde for depth (see YSI calibration SOP).
Step 4: Lower sonde on cable to each required depth. Allow values to stabilize approximately two minutes and record values for temperature, conductivity, D.O, pH and ORP on data sheet.
Step 5: Use Kemmerer to collect water at Surface, 7.5ft, 15ft, 30ft, 45ft, 60ft, 75ft, and 90ft, and fill bottles. The remaining water left in the sampler form depths of 45-90 shall be collected and mixed into the 5L brown bottle labeled 45+. (See Kemmerer SOP)
Step 6: Record bottle numbers on sheet.
Step 7: Determine Secchi Disk Depth (see Secchi Disk SOP)
Step 8: Record Secchi Depth on data sheet.
Step 9: Use tube sampler (x3) to collect a composite sample in the 5L brown bottle labeled tube. (see Phytoplankton SOP )
Step 10: Record bottle number on data sheet.
Step 11: Use tube sampler (x4) to collect a composite sample in the 10L bottle. Agitate sample and collect in respective bottles.
Step 12: Record bottle number on data sheet.
Step 13: Add 10 drops of Lugols Iodine solution to all phytoplankton bottles.
Step 14: Lower zooplankton net and collect a sample from three individual hauls. (See Zooplankton SOP)
Step 15: Record bottle number on data sheet.

4.3 Tributaries – per location

4.3.1 Platte River at M-22 Bridge

Equipment and bottles

| | |
|---|---|
| (1) | Dip Sampler |
| (3) | 250ml acid washed plastic bottles |
| (1) | 200ml rinsed bottle |
| (1) | Tributary Data Sheet |

Step 1: Lower Dip Sampler off center of bridge.
Step 2: Fill bottle, agitate and empty.
Step 3: Refill to neck of bottle.
Step 4: Repeat for two remaining bottles.
Step 5: Record bottle numbers on data sheet.
Step 6: Fill 200ml bottle for turbidity readings.
Step 7: Read gauge height and record value on data sheet.
Step 8: Take photo of water that includes substrate.

4.3.2 North Branch Platte River at Dead Stream Rd.

Equipment and bottles

| | |
|---|---|
| (1) | Dip Sampler |
| (3) | 250ml acid washed plastic bottles |
| (1) | 200ml rinsed bottle |
| (1) | Tributary Data Sheet |
| (1) | PVC Staff Gage |

Step 1: Lower Dip Sampler off center of catwalk.
Step 2: Fill bottle, agitate and empty.
Step 3: Refill to neck of bottle.
Step 4: Repeat for two remaining bottles.
Step 5: Record bottle numbers on data sheet.
Step 6: Fill 200ml bottle for turbidity readings.
Step 7: Read staff gauge height at the upper section of the fish ladder and record value on data sheet.
Step 8: Lower PVC staff gage along the north keyway on the dam read staff gage at the top of the keyway and record value on data sheet.
Step 9: Take photo of water that includes substrate.

4.3.3 Platte River at US Hwy31 Bridge below Honor

Equipment and bottles

| | |
|---|---|
| (1) | Dip Sampler |
| (3) | 250ml acid washed plastic bottles |
| (1) | 200ml rinsed bottle |
| (1) | Tributary Data Sheet |

Step 1: Lower Dip Sampler off center of bridge.
Step 2: Fill bottle, agitate and empty.
Step 3: Refill to neck of bottle.
Step 4: Repeat for two remaining bottles.
Step 5: Record bottle numbers on data sheet.
Step 6: Fill 200ml bottle for turbidity readings.
Step 7: Read gauge height and record value on data sheet.

Step 8: Take photo of water that includes substrate.

4.3.4 Featherstone Creek (Currently not Sampling)

Equipment and bottles

| | |
|---|---|
| (1) | Dip Sampler |
| (3) | 250ml acid washed plastic bottles |
| (1) | 200ml rinsed bottle |
| (1) | Tributary Data Sheet |

Step 1: Lower Dip Sampler off center of culvert.
Step 2: Fill bottle, agitate and empty.
Step 3: Refill to neck of bottle.
Step 4: Repeat for two remaining bottles.
Step 5: Record bottle numbers on data sheet.
Step 6: Fill 200ml bottle for turbidity readings.

4.3.5 Platte River at Stone Bridge

Equipment and bottles

| | |
|---|---|
| (1) | Dip Sampler |
| (3) | 250ml acid washed plastic bottles |
| (1) | 200ml rinsed bottle |
| (1) | Tributary Data Sheet |

Step 1: Lower Dip Sampler off center of bridge.
Step 2: Fill bottle, agitate and empty.
Step 3: Refill to neck of bottle.
Step 4: Repeat for two remaining bottles.
Step 5: Record bottle numbers on data sheet.
Step 6: Fill 200ml bottle for turbidity readings.
Step 7: Read gauge height and record value on data sheet.
Step 8: Take photo of water that includes substrate.

4.3.6 North Branch Platte River at Hooker Rd. (Currently not Sampling)

Equipment and bottles

| | |
|---|---|
| (1) | Dip Sampler |
| (3) | 250ml acid washed plastic bottles |
| (1) | 200ml rinsed bottle |
| (1) | Tributary Data Sheet |

Step 1: Lower Dip Sampler off center of culvert.
Step 2: Fill bottle, agitate and empty.
Step 3: Refill to neck of bottle.
Step 4: Repeat for two remaining bottles.
Step 5: Record bottle numbers on data sheet and NOX.
Step 6: Fill 200ml bottle for turbidity readings.

4.4 Little Platte Lake (Currently not Sampling)

Equipment Requirements

Boat and motor
Life jackets
YSI 600R/Sonde/cord

Secchi disk/line
Kemmerer
Tube sampler
GPS
Extra batteries C/AA/ 9V
Pencil x2
Lugols Iodine solution
Lake Data Sheet

Bottles

| | |
|---|---|
| (1) | 5L acid washed brown bottle |
| (5) | 125ml acid washed plastic bottles |
| (1) | 200ml rinsed plastic bottle |
| (3) | 250ml acid washed plastic bottles |
| (6) | 250ml acid washed plastic bottles |
| (1) | 500ml acid washed plastic bottles |

4.4.1

Step 1: Locate sampling waypoint on GPS unit and anchor boat at that position.
Step 2: Calibrate YSI 650 MDS and 600R sonde for depth (see YSI calibration SOP).
Step 3: Lower sonde on cable to required depth. Allow values to stabilize approximately two minutes and record values for temperature, conductivity, D.O, pH and ORP on data sheet.
Step 4: Use Kemmerer to collect water at Surface and fill all sample bottles. (See Kemmerer SOP)
Step 5: Record bottle numbers on sheet.
Step 6: Determine Secchi Disk Depth (see Secchi Disk SOP)
Step 7: Record Secchi Depth on data sheet.
Step 8: Add 10 drops of Lugols Iodine solution to all phytoplankton bottles.

# STANDARD OPERATING PROCEDURES
# SLUDGE HAULING

## 1 SCOPE

1.1 The Platte River Fish Hatchery collects water quality data from Platte Lake and its tributaries as part of an ongoing water quality program. This data is used to detect changes in water quality over time. Part of this program includes modeling of a phosphorus budget for the Platte River State Fish Hatchery. The phosphorus contained in the sludge that leaves the hatchery is a major component of the whole-hatchery phosphorus budget.

## 2 PURPOSE

2.1 The purpose of this document is to provide a detailed outline of the procedures used in sample collection while the sludge tank is being emptied. Adherence to a consistent sampling protocol is vital to ensure data is of a known quality and integrity.

## 3 RESPONSIBLITIES

3.1 The Technician performing the preparation work shall be trained in standard procedures described within.

## 4 PROCEDURE

4.1 Day before event –

4.1.1 Notify PLIA contacts via email.

4.1.2 Gather together 250 ml sample bottles labeled in red lettering - sludge.

4.1.3 Print waste collection data sheets.

4.1.4 Gather together digital camera and GPS.

4.2 Day of event -

4.2.1 Meet with truck drivers to discuss sampling protocol.

4.2.2 Collect three samples from each load leaving the hatchery grounds. Collect samples at the beginning, middle and end of each load.

4.2.3 Record date, time, gallons loaded and sample bottle numbers.

4.2.4 It is essential that the Technician ride along or follow truck drivers to the injection site. Digital photographs should be taken at the site and GPS coordinates recorded. Photos should include the injection unit during the actual injection process. Send this information, including photos, to the PLIA contacts.

4.2.5 Ship or refrigerate samples depending on the day of the week and shipping schedule.

4.2.6 Enter data collected into Access database “Sample FP”.

4.2.7 Create Export files, edit and print, put copies into binder in lab.

4.3 Day after event -

4.3.1 Send Export files to PLIA Contacts.

4.3.2 Monitor level of sludge tank and fill rate.

# STANDARD OPERATING PROCEDURES
# SLUDGE TANK AND CLARIFIER OVERFLOW SAMPLING

## 1. SCOPE

1.1 The Platte River Fish Hatchery collects water quality data from Platte Lake and its tributaries as part of an ongoing water quality program. This data is used to detect changes in water quality over time. Part of this program includes modeling of a phosphorus budget for the Platte River State Fish Hatchery. This data is used to detect changes in water quality over time.

## 2. PURPOSE

2.1 The purpose of this document is to provide a detailed outline of the procedures used in sample collection. Adherence to a consistent sampling protocol is vital to ensure data is of a known quality and integrity.

## 3. RESPONSIBLITIES

3.1 The Technician performing the preparation work shall be trained in standard procedures described within.

## 4. PROCEDURE

4.1 Clarifier Overflow Sampling - Site 28

Equipment and bottles

- (3) 250ml acid washed plastic bottles - RED labels
- (1) 200ml rinsed bottle – RED labels
- (1) Production Waste Data Sheet

Step 1: Check clarifier to assure it is full and overflowing.
Step 2: Collect samples at the pipe that enters the effluent pond on the east side bank.
Step 3: Fill bottle, agitate and empty.
Step 4: Refill to neck of bottle.
Step 5: Repeat for two remaining bottles.
Step 6: Record bottle numbers on data sheet.
Step 7: Fill 200ml bottle for turbidity readings.
Step 8: Place 250ml bottles in Ziploc bag and store in refrigerator.
Step 9: Run turbidities and record on data sheet.

4.2 Sludge Tank Overflow Sampling - Site 27 (Only Sample if bypass is Open)

Equipment and bottles

- (3) 250ml acid washed plastic bottles - RED labels
- (1) 200ml rinsed bottle – RED labels
- (1) Production Waste Data Sheet

Step 1: Check sludge tank to assure it is full and overflowing.

Step 2: Collect samples at the pipe that enters the effluent pond on the east side bank.
Step 3: Fill bottle, agitate and empty.
Step 4: Refill to neck of bottle.
Step 5: Repeat for two remaining bottles.
Step 6: Record bottle numbers on data sheet.
Step 7: Fill 200ml bottle for turbidity readings.
Step 8: Place 250ml bottles in Ziploc bag and store in refrigerator.
Step 9: Run turbidities and record on data sheet.

# STANDARD OPERATING PROCEDURES
# SECCHI DEPTH TRANSPARENCY

## 1. SCOPE/ PURPOSE

1.1 Secchi disk transparency is used to estimate photic depth.

## 2. REFERENCES

2.1 Handbook of Common Methods in Limnology, Lind, Owen T., 1985.

## 3. DEFINITIONS

3.1 The Secchi dick is a 20-cm disk on which opposite quarters are gloss black and gloss white.

3.2 Photic zone is the column of water reaching from the surface to the photic depth.

3.3 The photic depth is the depth that receives 1% of surface illumination.

## 4. MATERIALS

4.1 Secchi disk.

4.2 Calibrated line.

## 5. PROCEDURES

5.1 Lower the Secchi disk on the calibrated line until it disappears from view. Record this depth.

5.2 Raise disk until it reappears and record depth.

5.3 The average of these depths is “Secchi Disk Transparency.”

5.4 Make the determination of Secchi disk transparency in the shade of the boat.

5.5 Do not wear sunglasses when making the determination.

# STANDARD OPERATING PROCEDURES FOR WATER SAMPLE SHIPPING

## 1. SCOPE

1.1 The Platte River Fish Hatchery collects water quality data from Platte Lake and its tributaries as part of an ongoing water quality program. This data is used to detect changes in water quality over time. Part of this program includes modeling of a phosphorus budget for the Platte River State Fish Hatchery. This data is used to detect changes in water quality over time.

## 2. PURPOSE

2.1 The purpose of this document is to provide a detailed outline of the procedures used in sample preparation collection. Adherence to a consistent sampling protocol is vital to ensure data is of a known quality and integrity.

## 3. RESPONSIBLITIES

3.1 The employee performing the preparation work shall be trained in standard procedures described within.

## 4. PROCEDURE

4.1 Gather together cooler.

4.2 Be sure to check each bottle cap and bottle to ensure that they are securely fastened, not damaged and not leaking.

4.3 Add the bottle export hard copy and any additional packing material.

4.4 Place an ice pack in the cooler and close the lid tight.

4.5 Use the clear packing tape in the lab to secure the cooler lid.

4.6 Photograph and load into truck for shipping via UPS at Platte River Printing.

# STANDARD OPERATING PROCEDURES
# SIGMA MODEL 900 PORTABLE SAMPLER

## 1. SCOPE/PURPOSE

1.1 This standard operating procedure (SOP) describes the procedure for using the Sigma 900 portable samplers. There are five of these samplers located on the hatchery grounds. The design of the sampler allows it to sample a calibrated volume of water at programmed time intervals over a 72 hour period.

## 2. REFERENCES

2.1 Model 900 Standard Portable Sampler – Instrument Manual, American Sigma, 2002

## 3. DEFINITIONS

3.1 Platte River State Fish Hatchery uses this type of automated sampler to monitor the amount total phosphorus entering and exiting the hatchery.

## 4. PROCEDURE

4.1 The Sigma sampler is opened by removing the cover that contains the keypad.

4.2 The properly labeled acid washed 10L wide mouth poly carboy is placed inside the unit.

4.3 The cap on the carboy is removed and placed into the Ziploc bag inside the unit.

4.4 Replace cover.

4.5 Press the START button located in the center of the keypad at the top.

4.6 The display will read “START OR RESUME PROGRAM?” - press the START button.

4.7 Within 30 seconds the display will read “PROGRAM RUNNING”.

4.8 Return in approximately 72 hours.

4.9 Press the CHANGE/HALT key, #2 on the keypad. The display will read “PROGRAM HALTED”. Collect the sample and replace cover.

## 5. SAMPLER MANTENANCE

5.1 The sampler tubing should be replaced at least once every six months or as needed.

5.2 The sampler should be calibrated at the time of tube replacement or as needed. Refer to the Sigma binder in the lab for these methods.

5.3 Any maintenance and/or modifications to the program is recorded and entered into the Sigma Log - Access database and the Sigma binder.

# STANDARD OPERATING PROCEDURE
# FOR BAUSCH & LOMB SPECTRONIC 20

## 1. SCOPE/PURPOSE

1.1 This standard operating procedure (SOP) describes the procedure for using the Spectronic 20 at the Platte River State Fish Hatchery water quality lab. The Spectronic 20 is used to read absorbencies to determine total phosphorus readings. These readings can be used to make real time adjustments at the Hatchery.

## 2. REFERENCES

2.1 Instruction Manual, Bausch & Lomb, 1967

## 3. DEFINITIONS

3.1 The Spectronic 20 is a single-beam, ratio-indicating spectrophotometer.

## 4. PROCEDURE

4.1 Turn ON Hach DRB 200 Digester - select PRFH (150° C for 30 minutes).

4.2 Label Test ‘N Tube (TNT) cuvette (Total Phosphate Set # 27426-45) with site ID.

4.3 Use labeled pipette to transfer 5ml of agitated sample into corresponding TNT cuvette.

4.4 Add one Potassium Persulfate ($K_2S_2O_8$) power pillow to each TNT cuvette – cap and shake 20 times.

4.5 Place TNT cuvettes into Hach DRB 200 Digester and press start.

4.6 When digestion is complete place TNT cuvettes into a test tube rack and allow cooling to room temperature.

4.7 Once cooled, add 2ml Sodium Hydroxide (NaOH) to each TNT cuvette and invert three times.

4.8 Place TNT curvettes in to the Champion E-33 centrifuge turn ON and set timer for 5 minutes.

4.9 Turn ON Spectronic 20 – turn left knob to the right. Run at 850 wavelength.

***Note: next steps are for each sample individually; do not try to run all samples together as these steps are time sensitive.***

4.10 Transfer liquid sample from TNT cuvette to Spectronic 20 (S20) cuvette using the properly labeled pipette.

4.11 Zero Spectronic 20 by adjusting the left knob and zeroing on the Percent Transmittance scale.

4.12 Clean outside of S20 cuvette and insert in to Spectronic 20 Sample Holder.

4.13 Zero Spectronic 20 by adjusting the right knob and zeroing on the Absorbance scale.

4.14 Remove S20 cuvette and add one PhosVer 3 (PV3) power pillow to sample in the S20 cuvette.

4.15 Lightly mix by inverting 20 times in 30 seconds – place in rack and allow a four minute reaction time (set timer).

4.16 Insert S20 cuvette in to Spectronic 20 Sample Holder and record Absorbance on data sheet.

4.17 Once all samples are complete enter Absorbance data into Operations Real Time spreadsheet to get real time total phosphorus data. Send out one week prior to conference calls.

4.18 Please share results with Hatchery Biologist, so they can make any necessary adjustments to daily operations.

# STANDARD OPERATING PROCEDURES
# STREAM FLOW METER

## 1. SCOPE/PURPOSE

1.1 This standard operating procedure (SOP) describes the procedure for ensuring accurate meter performance (Pygmy and Price AA) in the field.

## 2. REFERENCES

2.1 USGS, Office of Surface Water Technical Memorandum No. 89.07

## 3. DEFINITIONS

3.1 The current meters are used to determine flow and velocity of the flowing waters in the Platte Lake Watershed.

## 4. PROCEDURE

4.1 The meters are visually inspected before field measurements are made. Bent cups and other signs of wear will give inaccurate flow results.

4.2 Before taking field measurements, a full timed spin test should be performed. A spin test simply means spinning the cups and recording the time it takes for the cups to stop moving.

Minimum acceptable spin test times are:
Pygmy meter: 0:45 seconds
Price AA meter: 2:00 minutes

4.3 A record of spin tests is kept in the current meter log.

4.4 Between measurements in the field, the cups are spun (not timed) to check for smooth operation.

## 5. SAMPLER STORAGE

5.1 The meters are dried and stored in their protective cases provided by the manufacturer.

# STANDARD OPERATING PROCEDURES
# HACH TURBIDIMETER OPERATION

## 1. SCOPE/PURPOSE

1.1 This standard operating procedure (SOP) describes the procedure for using the Hach Turbidimeter (Model Number 2100N) in the Platte River State Fish Hatchery water quality lab. Turbidity in water is the presence of suspended solids, which reduce the transmission of light either through scattering or absorption.

## 2. REFERENCES

2.1 Laboratory Turbidimeter Instruction Manual, Hach Company, 1999

## 3. DEFINITIONS

3.1 The turbidimeter is used to measure the presence of suspended solids.

## 4. PROCEDURE

4.1 Warm samples to room temperature to avoid condensation on the sides of the sample tube.

4.2 Turn ON turbidimeter and allow warm up time of 30 minutes.

4.3 Fill sample tube to the white line at the top. Apply a thin bead of silicone oil to the surface of the sample cell. Spread the oil uniformly across the surface using the black oiling cloth. The surface should appear dry, not wet.

4.4 The sample cell is then placed into the turbidimeter. Open the cover and line up the white down arrow on the sample cell with the arrow on the turbidimeter. Close cover and press ENTER.

4.5 The first number to appear on the display is used for the first reading, readings are NTU. Readings are done in triplicate, repeat procedure with two more samples.

4.6 The meter must be checked monthly to verify the instruments calibration using Gelex Secondary Standards.

4.7 Refer to the laminated Quick Reference Guide for clarification on the above procedure and calibration of the meter.

4.8 When finished using the turbidimeter turn OFF and replace transparent dust cover.

# STANDARD OPERATING PROCEDURES
# HOBO WATER LEVEL LOGGER

## 1 SCOPE/ PURPOSE

1.1 The HOBO water level logger is used to as an aid in calibrating flow rates entering and exiting the hatchery.

## 2 DEFINITIONS

2.1 The water level logger is a 6” x 1” solid stainless steel cylinder.

2.2 The Optic USB Base Station is device used for communication between the water level logger and the computer. It is located in the laboratory at the hatchery.

2.3 The stilling well is a 4” PVC pipe that is used to stabilize the water surrounding the level sensor.

## 3 MATERIALS

3.1 HOBO water level logger.

3.2 Optic USB Base Station.

## 4 PROCEDURES

4.1 Launching Logger

4.1.1 Insert water level logger into optic USB base station and open HOBOware program on computer desktop.

4.1.2 Follow onscreen prompts to launch logger.

4.1.3 Once logger is successfully launched remove from base station and transfer to clarifier stilling well.

4.1.4 Insert water level logger into screw cap and lower into the stilling well.

4.2 Retrieving Logger

4.2.1 Remove water level logger from the stilling well.

4.2.2 Insert water level logger into optic USB base station and open HOBOware program on computer desktop.

4.2.3 Follow onscreen prompts to retrieve data from logger.

4.2.4 Transfer data into an Excel spreadsheet and email to implementation coordinator.

# STANDARD OPERATING PROCEDURES FOR CALIBRATION OF YSI 650 MDS AND 600R SONDE

## 1 SCOPE

1.1 The Platte River Fish Hatchery collects water quality data from Platte Lake and its tributaries as part of an ongoing water quality program. This data is used to detect changes in water quality over time.

## 2 PURPOSE

2.1 This (SOP) describes the proper procedure for calibration of YSI 650 MDS and 600R sonde units. These instruments are used for the collection of water quality data on Big Platte Lake and its tributaries. Adherence to a consistent calibration protocol is necessary to ensure effective and consistent water quality data collection.

## 3 REFERENCES

3.1 YSI Environmental Operation Manual

## 4 CALIBRATION

4.1 The YSI 650 MDS and 600R sonde are calibrated in the lab at Platte River State Fish Hatchery. All calibration solutions are stored in the lab. The YSI 650 MDS and 600R are always calibrated prior to use on the day that it is used in the field.

### 4.2 Conductivity Calibration

4.2.1 Rinse the calibration cup twice with distilled water, then once with 0.02N KCL solution. Fill the calibration cup with the 0.02N KCL solution such that the conductivity block is fully submerged. Tap the sonde unit to dislodge any possible air bubbles.

4.2.2 Select “Sonde Menu”, then “calibrate”, “conductivity”. Then “spcond”.

4.2.3 Enter the value 2.76 ms/cm for calibration of (0.02N KCL). The display will then return to the data display screen, with the option “calibrate” highlighted. Record the displayed spcond value as the initial reading. Then select enter; the calibration will stabilize and be completed. Record the displayed value in the YSI calibration logbook as the calibrated value. Select the highlighted option “continue” by pressing enter. The display will then continue with options. Advance to “sonde run”.

4.2.4 Rinse the calibration cup twice with distilled water then once with 0.01N KCL solution. Fill the calibration cup with the 0.01N KCL solution such that the entire conductivity block is fully submerged. Tap the unit to dislodge any air bubbles.

4.2.5 Record the displayed conductivity value in the logbook as the “initial reading”.

4.2.6 After use in the field, conduct the post-calibration procedure by repeating 4.2.1 and 4.2.3. The displayed value for each solution should be recorded as the "after use" value. The difference between the "after use" value and the "calibrated value" (for 0.02N KCL) and "initial value" (for 0.01N KCL) should be recorded as drift.

## 4.3 Oxidation Reduction Potential (ORP)

4.3.1 To determine if the sensor is functioning correctly place the probe in 3682 Zobell solution and monitor the millivolt reading. The probe should read in the range of 221-241 at normal ambient temperature (17-32 degrees Celsius). If the reading is out side this range, the probe can be calibrated to the correct value outlined in section 2.6.1 of the operations manual.

## 4.4 Temperature

4.4.1 The temperature sensor is factory calibrated.

## 4.5 Depth Calibration

4.5.1 Calibration of depth should occur in the field immediately prior to use.

4.5.2 Suspend sonde unit so that the probe is just above water surface. Select "sonde menu", then "calibrate", then "pressure –ABS" on display unit. Enter calibration value (0.0 feet). The display will then return to the data display screen, with the option "calibrate" highlighted. Select enter, and the calibration will stabilize and be complete.

## 4.6 pH Calibration

4.6.1 Remove the weighted probe guard from sonde. Rinse calibration cup and probes with distilled water. Thoroughly mix container of pH 7 buffer, making sure the solution is dated and fresh. Rinse the probes in the calibration cup with pH 7 buffer, and then fill the cup with buffer until all probes are submerged. Allow readings to stabilize for approximately 90 seconds.

4.6.2 Select "Sonde Menu", then "Calibrate", then "pH" then "3 point cal" on the display unit. Enter the first pH buffer for calibration (pH 7). The display will then return to the data display screen, with the option "calibrate" highlighted. Record the displayed pH value as the initial reading in the YSI calibration logbook. Then select enter, the calibration will stabilize and be completed. Record the new displayed value in the YSI calibration logbook as the calibrated value. Select the highlighted option "continue" by pressing enter.

4.6.3 Repeat for both pH 10 and pH 4.

4.6.4 After use in the field conduct the post-calibration procedure by repeating 4.6.1 for all three-pH solution. The displayed values should be recorded as the after use value in the YSI calibration logbook. The difference between the "after use" value and the "calibrated" value is the drift.

4.7 **Dissolved Oxygen (DO) calibration**

4.7.1 Start the vacuum pump attached to air stones. The air stones are in two 10L glass bottles, one refrigerated and one at room temperature. Let the vacuum pump run at least one half hour to completely saturate the water.

4.7.2 Place sonde (with attached weighted probe guard) into five-gallon DI water bucket in lab. Allow the unit to stabilize in bucket for 10 minutes.

4.7.3 Obtain the current barometric pressure from weather station, read in inches (in.) of Hg. Convert this value to millimeters (mm) of Hg through a multiplication factor of (25.4). Record the mm of Hg value in YSI calibration logbook.

4.7.4 Select "Sonde Menu", then "Calibrate", then "DO%" on the display unit. Enter the calculated barometric pressure "mm/Hg". The display will return to the data display screen, with the option "calibrate" highlighted. Press enter and the calibration will stabilize and be completed.

4.7.5 Place the sonde into the refrigerated 10L glass bottles from 4.7.1 which are now saturated with oxygen. Let the 650 stabilize approximately 90 seconds. Record the value for DO% and DO mg/L. Repeat this procedure for the 10L glass bottle at room temperature. Compare these readings to the Oxygen Saturation at Temperature spreadsheet posted on the side of the refrigerator. The 650 DO mg/L readings should be within the hundredth. If not consult the YSI Operations Manual for proper recalibration procedures.

4.7.6 After use in the field, conduct the post-calibration procedure repeating 4.7.1 through 4.7.5 as listed above. The difference between the displayed DO value recorded in the logbook and the post-calibration reading is the drift, which should be recorded in the logbook.

# STANDARD OPERATING PROCEDURES
# AND MAINTENANCE OF YSI 650 MDS AND 600R SONDE

## 1 SCOPE

1.1 The Platte River Fish Hatchery collects water quality data from Platte Lake and its tributaries as part of an ongoing water quality program. This data is used to detect changes in water quality over time.

## 2 PURPOSE

2.1 This (SOP) describes the proper procedure for care maintenance and storage of the sonde and probes that will maximize their lifetime and minimize the time required getting ready for a new application.

## 3 REFERENCES

3.1 YSI Environmental Operation Manual

## 4 PROCEDURE

4.1 After use the YSI 650 MDS and 600R sonde should be cleaned and stored in the lab.

4.2 The cable is cleaned and recoiled. Clean and lubricate the rubber connectors. Store the sonde unit with ~ ½ inch of tap water in storage cup.

4.3 Replace Dissolved Oxygen (DO) membrane every 30 days. Avoid over stretching the membrane, invert sonde unit several times; check for trapped air bubbles under the membrane.

4.4 Rinse pH bulb with tap water to remove any film or debris. If good readings are not established, soak the probe in a dishwashing liquid 10-15 minutes. A cotton swab can be used gently to clean the bulb if needed.

4.5 Clean the conductivity block and electrodes with dishwashing liquid solution every four months.

4.6 The temperature sensor is factory set and requires no maintenance.

4.7 The function of the Redox (ORP) sensor should be checked quarterly against a standard Zobell's solution.

# STANDARD OPERATING PROCEDURES
# COLLECTION AND PRESERVATION OF ZOOPLANKTON SAMPLES

## 1 SCOPE/ PURPOSE

1.1 A zooplankton tow net is used to collect zooplankton in Platte Lake. The samples are preserved and sent to the lab for analysis.

## 2 DEFINITIONS

2.1 The zooplankton net is conical in shape and has a metal frame at the large opening and a male plastic connection at the small opening.

2.2 The plankton bucket attaches to the male plastic connection at the smaller opening on the zooplankton net.

## 3 MATERIALS

3.1 Zooplankton net and plankton bucket.

3.2 Calibrated line.

## 4 PROCEDURES

4.1 Connect the calibrated line to the frame at the large end of the zooplankton net.

4.2 Lower the zooplankton net slowly into the water. Make sure there are no air bubbles trapped in the net. Continue to lower the net until the 85' mark is reached. The 85' mark is bright red edged with black.

4.3 Once the 85' mark is reached allow the line to become taut and begin retrieving the net. The average rate of retrieval is 60 seconds.

4.4 When the net reaches the surface hold vertically above the water surface and splash surface water onto the sides of the net to wash down any zooplankton stuck to the inside of the net.

4.5 Remove the plankton bucket form the net and pour its contents into a 250ml sample bottle, be sure to record the bottle number on the Laboratory Data Form.

4.6 Spray down the inside of the plankton bucket with a squeeze bottle filled with tap water from the hatchery. Repeat.

4.7 Add formalin to the sample bottle to preserve the zooplankton. The amount of formalin is approximately 20% of the total sample volume.

## 5 STORAGE

5.1 Following sampling the net is rinsed and hung in the lab to dry. The plankton bucket is removed, rinsed and inverted for drying.

5.2 Once dry the plankton bucket is placed back on the net. A sock is used to cover the bucket to prevent damage to the net. The net is carefully folded up in a towel and put into storage.

# APPENDIX E

# Seasonal Dynamics and Food Web Interactions of Planktonic Organisms in Big Platte Lake, Benzie Co., Michigan in 2010.

Scott McNaught, Ph.D.
Central Michigan University

Report to the Michigan Department of Natural Resources and the Platte Lake Improvement Association

16 June 2011

**Objectives:**

- Describe the plankton composition and seasonal dynamics of plankton populations in Big Platte Lake, MI during 2010.
- Compare plankton composition and seasonal dynamics in 2010 with composition and dynamics in 2006- 2009.
- Describe the planktonic food web of Big Platte Lake, MI in 2010 and how it has changed during the past 5 years.

**Methods:**

Phytoplankton and zooplankton samples were collected from Big Platte Lake seasonally in 2010 (April, August, and December). MDNRE personnel sampled epilimnetic phytoplankton at 3 locations near the deep hole in Big Platte Lake by dropping a 2-cm diameter silicone tube sampler vertically through the water column (0-30 ft.). The tube sampler was outfitted with a one-way foot valve on the lower end to facilitate sample collection. As the tube sampler was withdrawn from the water, its contents were released into a clean container. One 250-mL bottle was filled with well-mixed tube sampler water from each sample location. MDNRE personnel also collected discrete samples from 45, 60, 75 and 90 feet at one location using a Van Dorn bottle sampler. Samples from individual depths were combined in a single container to produce an integrated 45-90 foot sample. One 250-mL sample bottle was filled with well-mixed hypolimnetic water. All algal samples were preserved with Lugol's solution.

MDNRE personnel collected zooplankton samples from Big Platte Lake using a 30-cm diameter, 64-μm mesh net. Three vertical net tows were collected from 1 m above the sediments to the surface at separate locations near the deep hole. The net was hauled no faster than 1 m/sec. The contents of each net tow was washed into separate, labeled 250-mL bottles and preserved with formalin.

Phytoplankton samples were examined by placing 5 ml of well-mixed sample into a settling chamber for 24 hours. Algal species were enumerated at 200-400x magnification using a Zeiss inverted compound microscope. All colonial and large solitary algal species in the sampling chamber were enumerated at 200x magnification (Table 1). Cell counts for large algal species were multiplied by 200 to get cells/liter. Small algal species in the sampling chamber were enumerated at 400x magnification using a sub-sampling technique (Table 1). All algae along a single transect through the middle of the counting chamber (38 rectangular fields of view) were counted. Cell counts for small algal species were divided by the proportion of rectangular field examined in the chamber (38/1663) and multiplied by 200 to get cells/liter. For some colonial and filamentous species (Table 1), it was easier to measure colony length or area and apply a correction formula to estimate the number of cells.

**Table 1:** Counting procedures used for algal types and genera found in Big Platte Lake, Benzie Co., Michigan.

| Algae type | Counting Procedure | Algal Genera |
|---|---|---|
| Large/Colonial | magnification = 200<br>count entire chamber<br>cells/L = counts * 200 | *Stephanodiscus, Cyclotella, Cocsinodiscus, Cymatopleura, Amphipora, Asterionella, Diploneis, Pleuro/Gyrosigma, Rhizosolenia, Cymbella, Tabellaria, Pediastrum, Coelastrum, Mugeotia, Zygnema, Spirogyra, Gymnodinium, Peridinium, Chrysophaerella, Ceratium* |
| Small | magnification = 400<br>count fields<br>cells/L = counts ÷ prop. chamber * 200 | *Synedra, Achnanthes, Navicula Hantschia, Nitschia, Pinnularia, Mastigloia, Scenedesmus, microgreens, Golenkinia, Closterium, Mallamonas, Cryptomonas, Dinobryon, Epipyxis* |
| Filament | magnification = 200<br>count entire chamber<br>counts = length * 5.5<br>cells/L = counts * 200 | *Fragilaria* |
| Filament | magnification = 200<br>count entire chamber<br>counts = length * 1.0<br>cells/L = counts * 200 | *Melosira* |
| Colony | magnification = 200<br>count entire chamber<br>counts = area * cells/area<br>cells/L = counts * 200 | *Microcystis* |

**Table 2:** Shapes and geometric formulas for the volume of select algal taxa found in Big Platte Lake, Benzie Co., Michigan. Symbols: D = diameter, L = length, W = width, H = height.

| | *Fragilaria* | *Melosira* | *Scenedesmus* | *Microcystis* | *Dinobryon* |
|---|---|---|---|---|---|
| Cell shape | elliptic prism | cylinder | prolate spheroid | sphere | ellipsoid |
| Volume | $L*W^{*}H*\pi/4$ | $H*D^2*\pi/4$ | $L*W^2*\pi/6$ | $D^3*\pi/6$ | $\frac{1}{2}(\frac{2}{3}L*W*T)*\pi/6$ + $\frac{1}{2}(\frac{1}{3}L*W*T)*\pi/6$ |

Algal biomass was calculated as the product of cell density and average cell volume. Average cell volume was determined by measuring length, width, and depth of 20 randomly selected cells from 2003 Big Platte Lake samples and applying a published geometric formula that closely approximated the shape of each taxon (Table 2). The volume of colonial green algae was calculated as the product of colony density and average colony volume. Cell volumes ($\mu m^3$) were multiplied by $10^{-9}$ to give biovolume

(µl). If one assumes that algal cell density is approximately 1.0 g/ml, biovolume (µl) is equivalent to dry biomass (mg). This assumption is good for green algae and cyanobacteria. It severely underestimates diatom biomass.

Zooplankton species were enumerated by counting 5-ml sub-samples in a Bogorov tray at 25x magnification using a Leica stereomicroscope. Zooplankton biomass was calculated as the product of species density and average individual dry weight. Average individual dry weights of copepod (calanoid, cyclopoid) and cladoceran (*Bosmina*, *Daphnia*, and *Holopedium*) species was determined by measuring 30 individuals of each taxon from 2004 Big Platte Lake samples and applying a published length-weight regression to the average length (Culver et al. 1985). Average individual dry weights of rotifer species (*Polyarthra*, *Keratella*) found in Lake Michigan (Makarewicz et al. 1994) were used to estimate average individual dry weights in Big Platte Lake. Average individual dry weights of *Alona* and *Chydorus* in Lake Michigan (M. Edwards, unpublished data) were used estimate dry weight of animals found in Big Platte Lake. Average individual dry weight of *Leptodora* in Big Platte Lake was estimated by applying a published length-weight regression (Manca et al. 2000) to a 6 mm animal.

**Results:**

*Phytoplankton in Big Platte Lake*:

Planktonic algae were most abundant in August 2010 when peak cell counts were 2.8 million cells per liter (Fig. 1). In Big Platte Lake, phytoplankton have exhibited spring and summer abundance maxima since 2003, even though the dates of peak abundance have varied slightly from year to year. The spring abundance peak occurs between late April and early May and the summer abundance peak occurs between late July and August.

Flagellates and blue-green bacteria were co-dominant in the epilimnion of Big Platte Lake in 2010 (Fig. 1). The most common green algae were *Scenedesmus, Coelastrum* and other colonial species, and single-celled micro-greens. The most common flagellates were the cryptomonads *Cryptomonas* and *Chroomonas*. Blue-green bacteria were dominated by the colonial genera *Chroococcus, Merismopedium,* and *Microcystis*; however, the filamentous genera *Anabaena* and *Oscillatory* were occasionally abundant. Diatoms were less abundant than other phytoplankton groups in 2010 (Fig. 1). Common diatoms included colonial species such as *Fragilaria*, pennates such as *Navicula, Cymbella* and *Synedra*; and small centrics.

The phytoplankton composition of the deep waters (45-90 ft.) of Big Platte Lake mimicked that of the epilimnion except that diatoms were relatively more abundant. Centric and small pinnate diatoms were more abundant in deep waters than in the epilimnion. The heavy, filamentous diatom *Melosira* was common in deep water during April and August 2010.

There was a seasonal shift in phytoplankton composition in Big Platte Lake during 2010. Green algae, flagellates and diatoms were consistently abundant throughout the year. Blue-green bacteria though numerically dominant throughout the year became even more abundant in the summer (Fig. 1). The species composition in 2010 was similar to

that in 2009 and 2008. Blue-green bacteria in recent years (2008-2010) were more prominently represented than in past years (2006-2007) in the epilimnion of Big Platte Lake.

Although flagellates and blue-green bacteria were numerically dominant in Big Platte Lake, diatoms represented a substantial portion of algal biomass particularly in the deep water (Fig. 2). Diatom cells are much larger than the cells of most other algal taxa in Big Platte Lake. Only the dinoflagellate *Ceratium* has larger cells. Diatom biomass may be underestimated because mass of the glass frustule (cell wall) is not included in the biomass calculation. Diatoms comprised the majority of algal biomass (≥50%) in the epilimnion (0-30 ft.) of Big Platte Lake during April and December 2010 when the lake was mixing (Fig. 2). Mixing events are required to keep heavy diatoms suspended in the water column.

In 2010, epilimnetic algal biomass in Big Platte Lake ranged from 0.4 to 1.1 mg/L. Algal biomass was low (< 1.0 mg/L) during December 2010 (Fig. 2). A bloom of colonial green algae and blue-green bacteria was responsible for the large biomass peak in August. Mean algal biomass in 2010 (0.75 mg/L) was lower than that in 2006-2008 (0.94-2.2 mg/L). During the past 4 years, diatoms have dominated algal biomass in Big Platte Lake, particularly during spring and fall mixing periods. Only during August and early September are diatoms not an important contributor to algal biomass (Fig. 2).

The distribution of algal biomass with depth reflects the mixing status of Big Platte Lake in 2010. In April, algal biomass was similar in the epilimnion and deep waters of Big Platte Lake suggesting that the lake was mixing (Fig. 2). In August, algal biomass was greatest in the deep waters indicating that the lake was stratified. Diatom biomass in the deep water increased as heavy species sank toward the bottom.

*Zooplankton in Big Platte Lake*:

The zooplankton community of Big Platte Lake includes 5 copepod taxa (*Diacyclops thomasi*, *Mesocyclops edax*, *Diaptomus* spp., *Epischura lacustris*, and harpacticoids), 9 cladoceran taxa (*Bosmina*, *Eubosmina*, *Ceriodaphnia*, *Diaphanosoma*, *Daphnia*, *Holopedium*, *Sida*, *Chydorus*, *Leptodora*) and many rotifer species. The copepods *Diacyclops* and *Diaptomus* (both naupliar and copepodid stages) and the cladocerans *Bosmina* and *Daphnia* were the most common microcrustaceans in 2010. *Polyarthra* and *Keratella* were the most common rotifers.

Planktonic crustaceans and rotifers were most abundant during summer 2010 (Fig. 3). Crustaceans and rotifers exhibited peak abundance of 17 animals per liter in August. Larval and adult copepods dominated the crustacean plankton in 2010 (Fig. 3).

Zooplankton abundance and seasonal dynamics have changed during the past 5 years. Crustaceans were most abundant in 2006 (peak = 94 per liter), and since then abundance has decreased steadily. In 2009 and 2010, peak abundance of crustaceans was less than 25 per liter. Crustaceans typically exhibit 2-3 abundance peaks per year depending on the number of copepod cohorts (nauplii abundance peaks) and cladoceran blooms. There were two distinct cohorts in 2006, two weak cohorts in 2007, and only one cohort in 2008. Rotifer abundance has also decreased from a peak in 2006 (180 per liter) to a low of 17 per liter in 2010. Rotifers typically exhibited one large early-summer abundance

peak and smaller abundance peaks in spring and fall. Data from 2009 and 2010 are too sparse to assess seasonal dynamics.

In 2010, zooplankton biomass in Big Platte Lake ranged from 8.2 μg/L in December to 26 μg/L in August (Fig. 3). Mean annual zooplankton biomass was 15 μg/L. Although rotifers were numerically dominant during most of the year, they only comprised a small portion of total zooplankton biomass in 2010. Juvenile and adult copepods dominated zooplankton biomass in April and December. Copepods and cladocerans were co-dominant in August (Fig. 3).

Mean zooplankton biomass in Big Platte Lake decreased from 30 μg/L in 2006 to 15 μg/L in 2010. Cladocerans were responsible for summertime biomass peaks except during 2007 and 2008 when cladocerans were low in abundance. Low cladoceran biomass in recent years may be caused by increased fish predation or zebra mussel filtering.

**Discussion:**

Planktonic organisms in Big Platte Lake include bacteria, protozoans, algae, rotifers, and crustaceans. Bacteria and protozoans interact closely in a "microbial food web". Bacteria ingest organic molecules dissolved in lake water and protozoans eat the bacteria. Algae, rotifers, and crustacean plankton interact with one another, and with larger invertebrates and fish, in a traditional grazing food web (Fig. 4). The Big Platte Lake food web has remained unchanged since 2002. No unique or exotic plankton species were discovered in 2010. However, the filtering effect of exotic zebra mussels may be responsible for reduced abundance of phytoplankton and zooplankton, which could translate to lower fish abundance higher in the food web.

Algae (phytoplankton) constitute the basis for the grazing food web in Big Platte Lake (Fig. 4). Algae use photosynthetic pigments to acquire energy from the sun. They use this energy to create sugars, which are eventually stored as starch or oil. Heavy algal taxa such as the diatoms are abundant during spring and fall overturn when the lake is mixed, top to bottom, by the wind. Diatom biomass can also be high in the epilimnion following strong wind events during the summer. Strong winds can re-suspend diatoms that have settled to the bottom in shallow water.

When Big Platte Lake is not mixed, it stratifies into warm surface and cool deep-water layers. Heavy diatoms sink into the hypolimnion and lighter phytoplankton taxa such as green algae and flagellates become abundant. Small green algae and flagellates thrive during the spring and early summer when epilimnetic nutrients (nitrogen and phosphorus) are plentiful. During calm periods in late summer, epilimnetic nitrogen concentrations become low. Colonial blue-green algae become abundant because they can tolerate low nitrogen concentrations and have gas vacuoles that allow them to float near the surface. Added phosphorus during the late summer can enhance the growth of blue-green algae.

When diatoms, flagellates and green algae are abundant in Big Platte Lake, populations of herbivorous zooplankton (rotifers, copepod nauplii, and cladocerans) increase. Nauplii and rotifers are small (80-300 μm) and can only ingest single celled or

small colonial green algae and flagellates (Fig. 4). Cladocerans such as *Bosmina* and *Daphnia* are large (300-2500 μm) and can ingest diatoms as well as small green algae and flagellates. Because they can eat a wider range of food sizes, cladocerans may out-compete rotifers and nauplii for food in June when all algal types are abundant.

Planktonic herbivores in Big Platte Lake are most abundant when densities of green algae and flagellates are high. Peak rotifer abundance coincided with abundant flagellates and green algae during each year of this study (compare Figs. 1 and 3). Rotifers and cladocerans reproduce asexually and their populations can increase quickly when food is abundant. Copepods reproduce sexually and rarely produce more than three sets of nauplii in a year. The copepods in Big Platte Lake produced nauplii in late May and August when edible algae were most abundant.

Among the cladocerans, *Daphnia* replaces *Bosmina* in mid-summer because it grows quickly in warm water and out-competes *Bosmina* for flagellates and green algae. In August, the blue-green alga *Microcystis* becomes abundant. *Microcystis* can be toxic to *Daphnia* and is difficult to ingest. *Bosmina*, however, can avoid the blue-green colonies and feed on green algae and flagellates. Therefore, late in the summer *Bosmina* once again becomes the dominant cladoceran.

Abundance of planktonic crustaceans may have been lower in the past four years than in earlier years because the density of edible green algae was low during the summer. Abundant green algae fuel fast-growing populations of nauplii and cladocerans. Without abundant green algae, crustacean plankton cannot be abundant. Cladoceran abundance was low in 2006-2008 possibly as a result of increased fish predation or competition from zebra mussels that filter algae from the water (Fig. 4). Cladoceran abundance was higher in 2009 and 2010 possibly because there was a strong peak in green algae.

Predators in Platte Lake include cyclopoid copepods and planktivorous fish (Fig. 4). Cyclopoid copepods feed on protozoans and rotifers during all juvenile and adult (copepodid) life stages. Larval and juvenile fish are visual predators that actively select large prey such as adult copepods and cladocerans. Some fish species such as alewife, yellow perch, and sunfish also feed on plankton as adults. If fish predation is intense, small-bodied taxa (ex: rotifers, nauplii) will dominate the zooplankton.

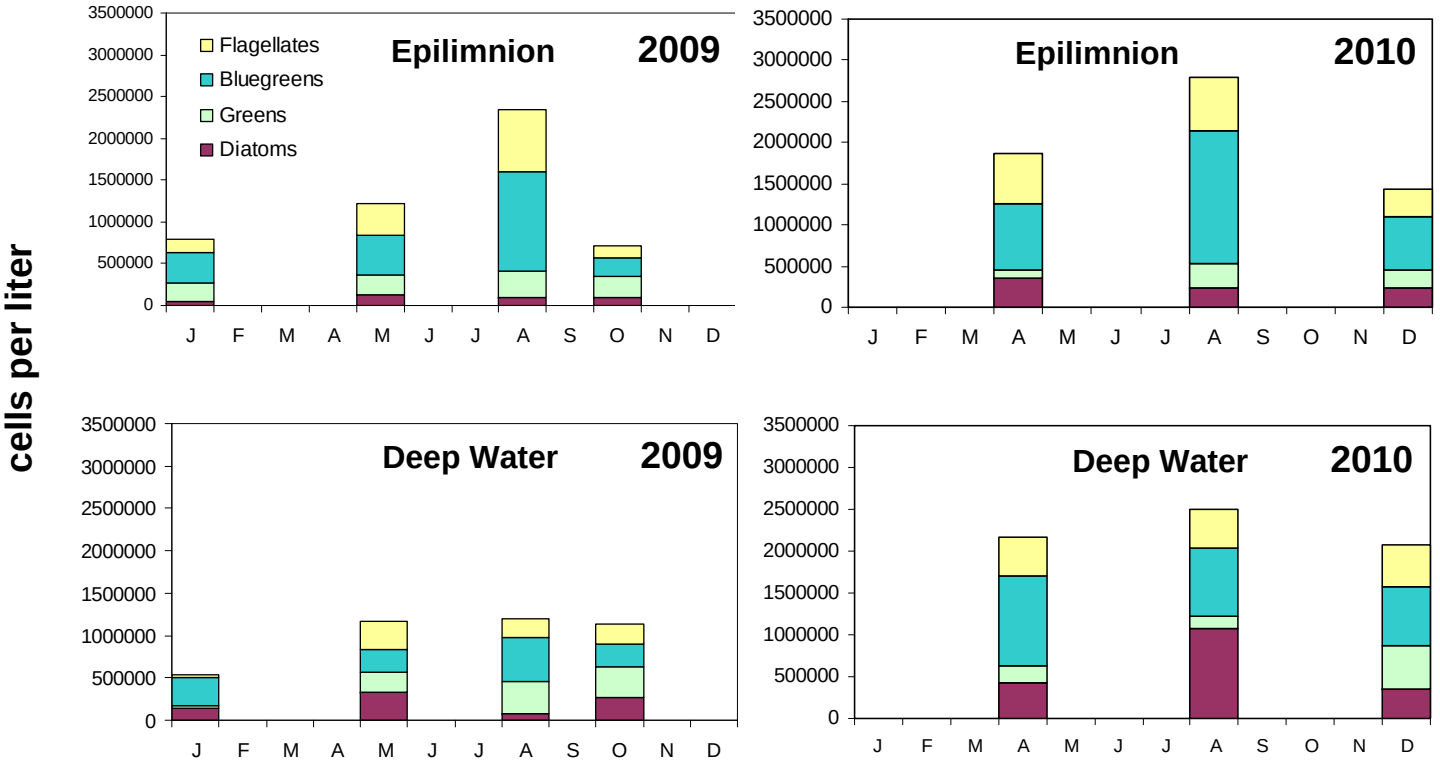


Figure 1: Epilimnetic (upper panels) and deep water (lower panels) phytoplankton density in Big Platte Lake, MI during 2009 and 2010.

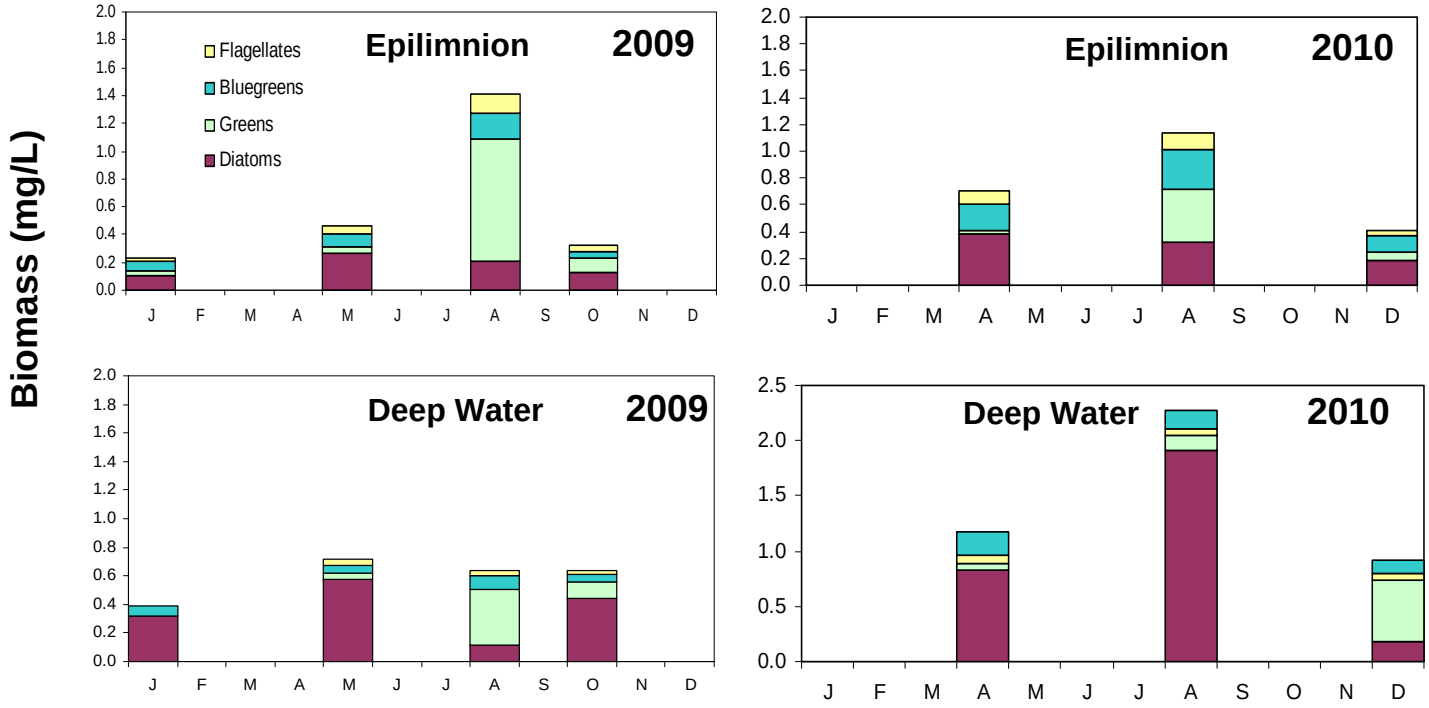


Figure 2: Epilimnetic (upper panels) and deep water (lower panels) phytoplankton biomass (wet wt.) in Big Platte Lake, MI during 2009 and 2010.

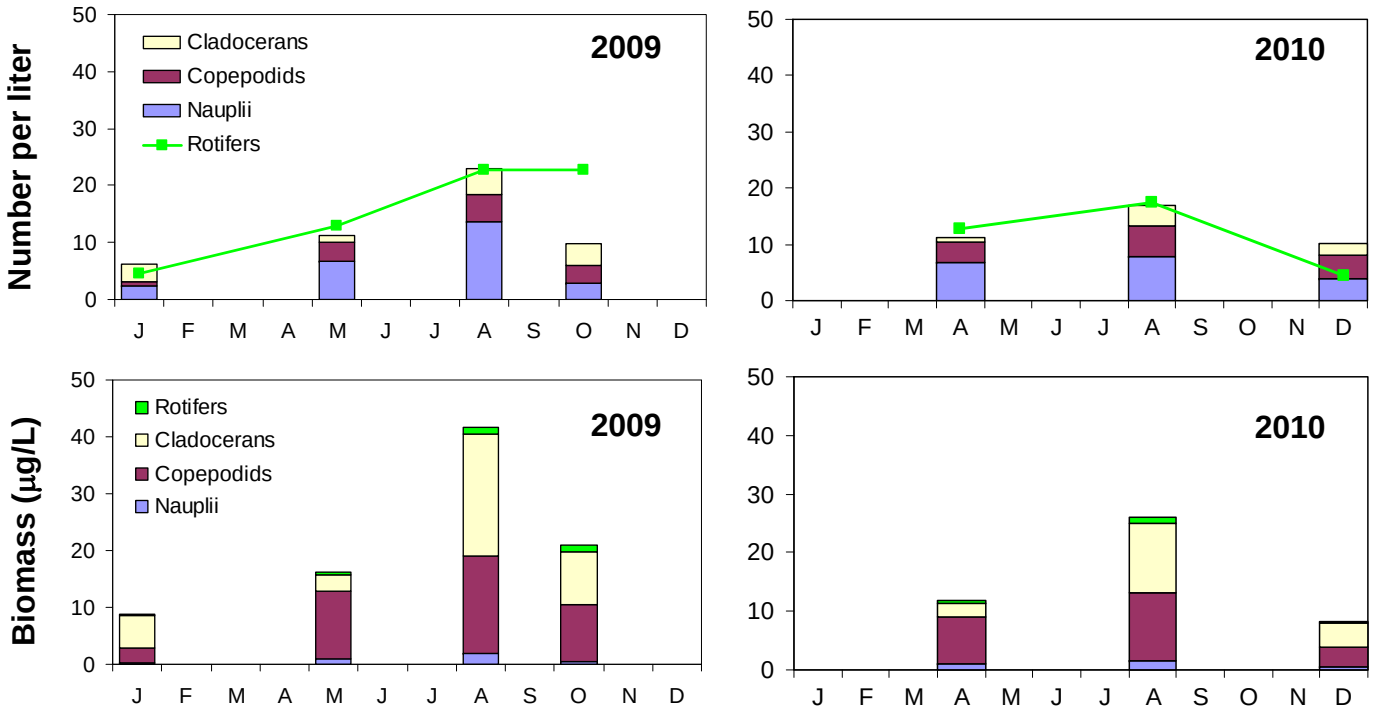


Figure 3: Average zooplankton density (upper panels) and biomass (lower panels) in Big Platte Lake, MI during 2009 and 2010.

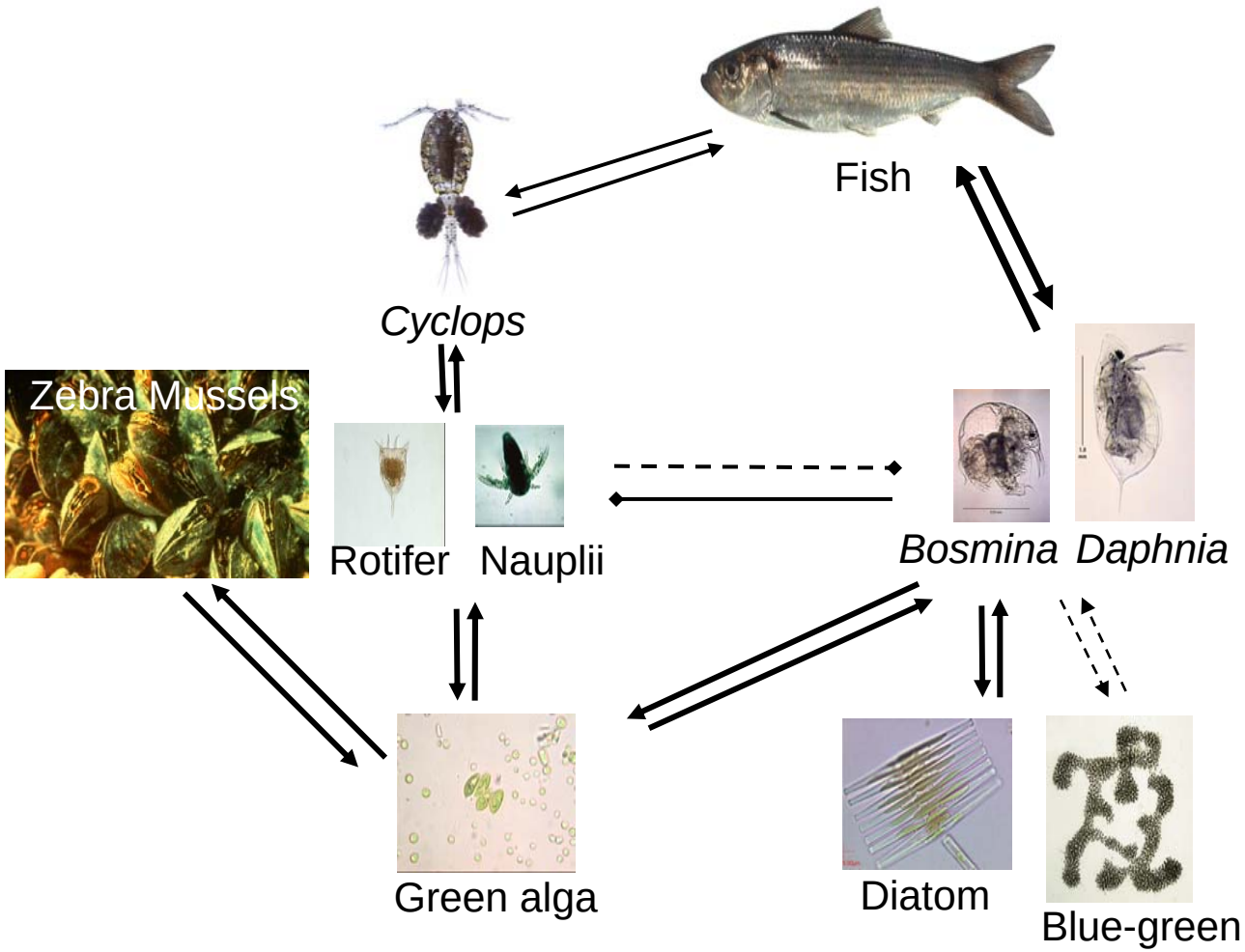


Figure 4: Platte Lake Food Web. Sharp arrow heads indicate direct feeding relationship (positive/negative interaction). Blunt arrow heads indicate indirect competition (negative/negative interaction). Thickness of arrow is proportional to strength of the interaction.