Lake Papakeechie Sustainability Initiative, Inc.

Report to the Papakeechie Protective Association Board
04/14/2018

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web site: www.nd.edu/~aseriann/LAPSI.html

LaPSI Members 2018

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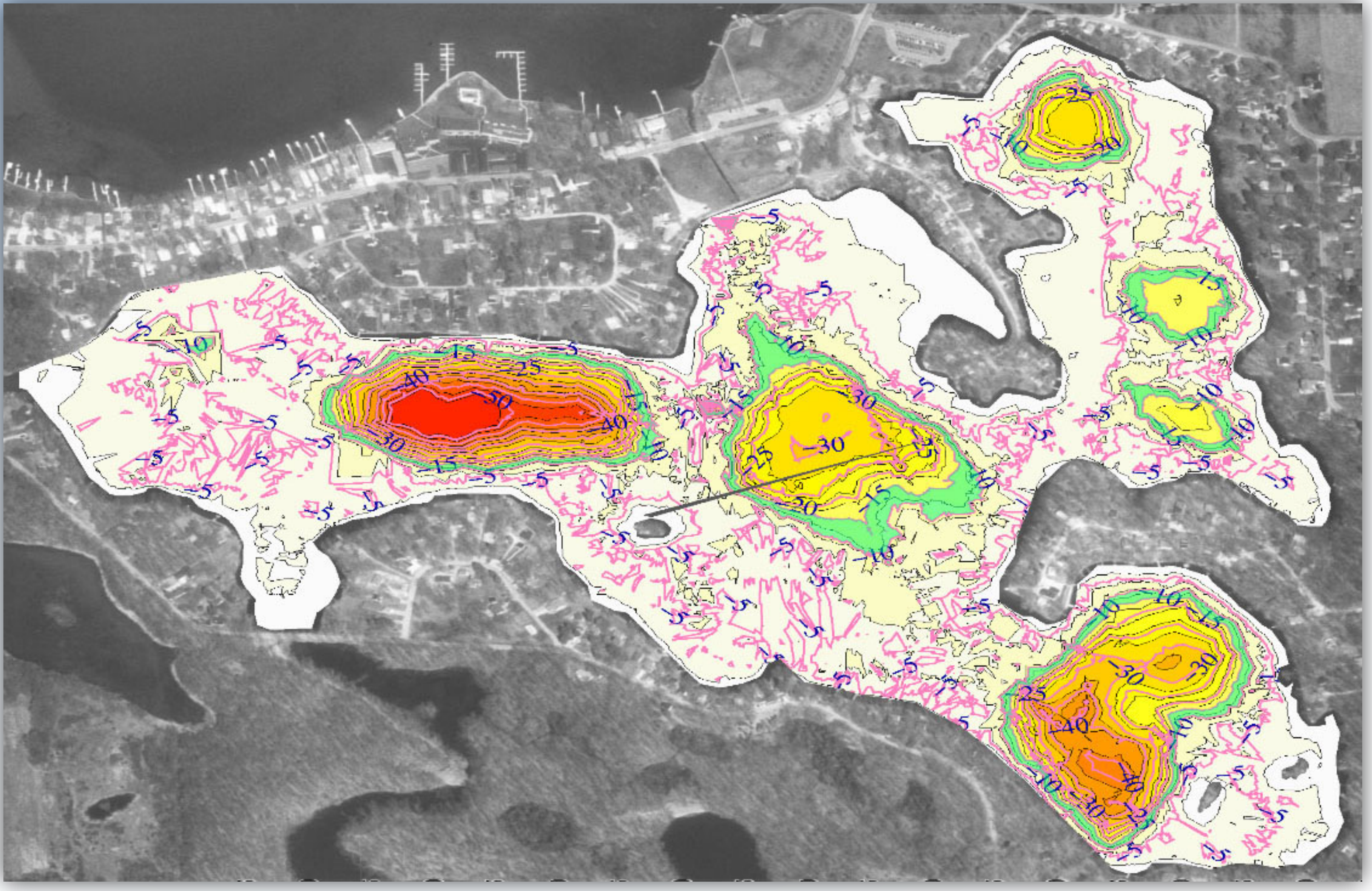
Jody and Mac Hedges
Charlotte Hill
Jan and Mark Laurent
Barbara and Brian Quandt
Ann and Anthony Serianni
Rosalie Sorg
Virginia Surso
Diane Tulloh – Leader

Bathymetric (depth) map of Lake Papakeechie

Summer 2013



Portion of the Wawasee sub-watershed

Area surrounding Lake Papakeechie

Lake Papakeechie
2016 Aquatic Vegetation Sampling Report
Aquatic Control, Inc.
November 15, 2016
Key Conclusions/Recommendations

Only one invasive species, curly-leaf pondweed, was detected in the 2016 survey. This is somewhat surprising given the amount of invasive milfoil and starry stonewort thriving in public lakes in the surrounding area.

For 2017, it is recommended that treatment with low rates of fluridone be continued. The Association may want to consider an earlier spring treatment (the exact timing is dependent on weather conditions and product formulation, but some treatments start as early as April 1).

Follow-Up

a. Definition of <u>low rates</u> of fluridone treatment (quantify)
b. PPA policy regarding documentation of herbicide application – <u>standardized annual report</u>
c. <u>Rotation</u> of (systemic) herbicides to minimize the onset of plant resistance and/or widen the scope of effectiveness

Treatment of Lake Papakeechie with the Systemic Herbicide, Fluridone
DRAFT (Nov 13, 2014)

Report Date: ______________________________
Submitted by:______________________________
Reviewed by: ______________________________

A. Commercial Supplier of Fluridone (Sonar; Avast; etc)
   - Product number
   - Product specifications
   - Product formulation
   - MSDS safety sheet(s) for product

B. Calculations To Determine the Amount of Fluridone Applied to Lake
   - Target concentration in lake after uniform mixing (provide justification)
   - Calculation of water volume in lake
   - Calculation of fluridone solution concentration for application to lake

C. Preparation of Final Fluridone Solution for Lake Application
   - Describe specific procedure used, including equipment involved and cleanup/disposal of waste

D. Factors That Determine the Time of Application
   - Desired lake level (show data)
   - Desired water temperature (show data)
   - Desired air temperature (show data)
   - Desired TOD/weather conditions
   - Other factors

E. Procedures to Notify Residents of Herbicide Application
   - Describe current methods and procedures
   - Date of Notification: _____________________

F. Date of Application: ___________________

G. Method(s) Used to Apply Fluridone Solution to Lake
   - Method of application
   - Areas of distribution (how determined)

H. Date on Which Resident Notification Announcements Were Removed: _________________

I. Methods of Disposal of Herbicide-contaminated Materials and Supplies

J. Methods to Monitor Herbicide Lifetime in Lake

K. Metrics To Assess Effectiveness of Herbicide Treatment

FISH SURVEY REPORT
Lake Papakeechie
Aquatic Control, Inc.
December 12, 2016
Key Conclusions/Recommendations

However, the survey indicates Papakeechie Lake has an imbalance in relation to the bluegill / largemouth bass fishery. It appears that the over-abundant largemouth bass population is over cropping bluegill.

The following recommendations, **listed in order of importance**, will help protect and enhance the fishery in Lake Papakeechie:

1. Implement a 12 to 16 inch slot limit. Under this limit, 5 bass under 12 inches and 1 bass over 16 inches can be harvested per angler per day. One bass over the slot could be kept, but catch and release of larger fish should be encouraged. This limit will only be effective if smaller bass are harvested.
2. Limit bluegill harvest to 15 fish per angler per day for the next two years.
3. Limit red-ear sunfish harvest to 5 fish per angler per day for the next two years.
4. Conduct a Standard Fish Survey in 2019 in order to monitor the effects of the above recommendations and assess needs for further management activities.
5. Remove all warmouth, common carp, spotted gar, yellow bullhead, and bowfin that are caught.
6. Maintain 20–40% coverage of native vegetation with focus on control of invasive species.

Follow-Up

a. How were recommendations <u>communicated</u> to the lake community?

b. Will a <u>follow-up study</u> be commissioned in 2019 as recommended?

c. Is biodiversity, or lack thereof, a concern?

Data from Site 40 (presumably)

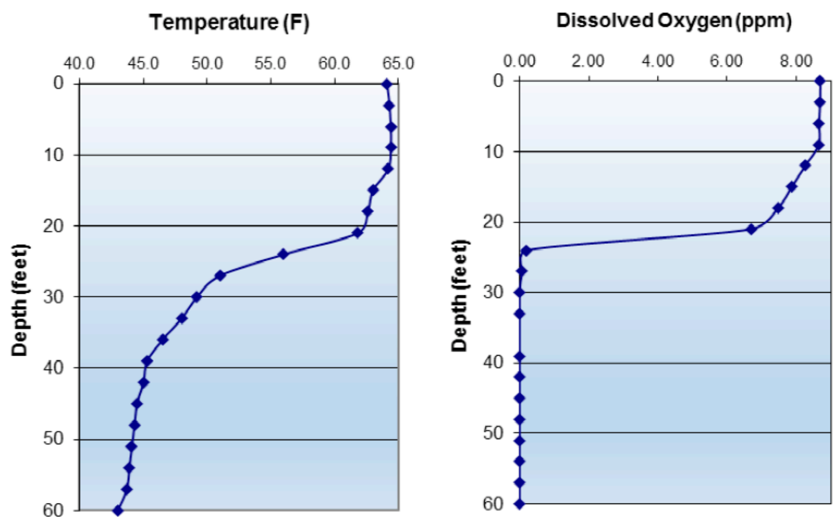
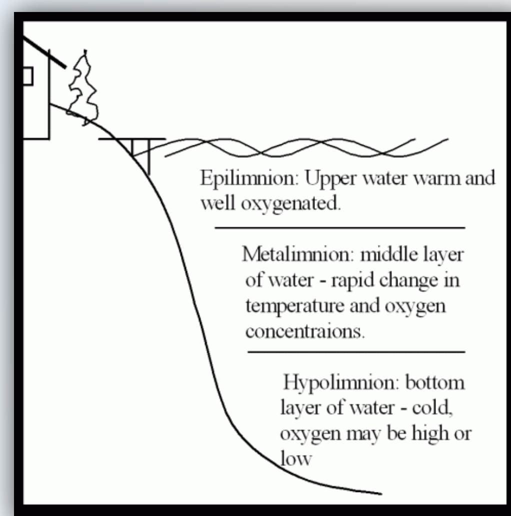
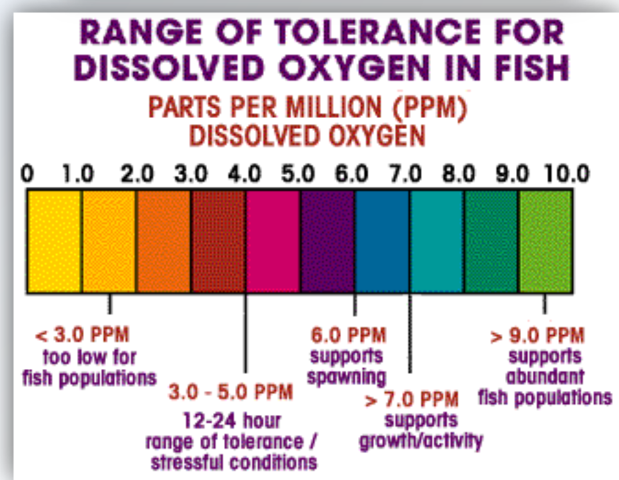


Figure 1. Temperature and dissolved oxygen profiles for Papakeechie Lake, October 20, 2016.





Bluegill: prefer shallow water with good vegetation

Largemouth bass: require higher DO than bluegill; feed on bluegill

Lake plant harvesting

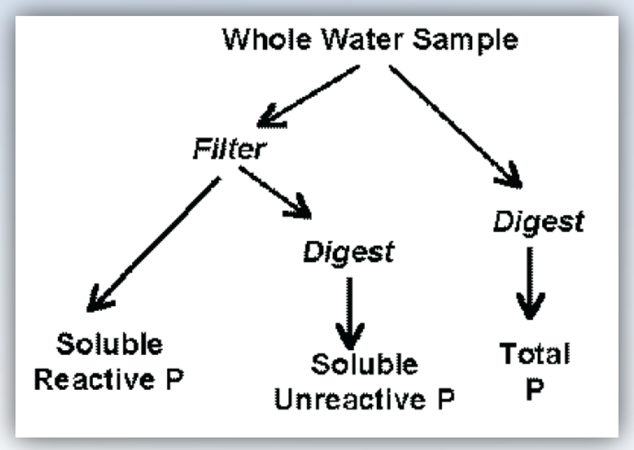
Data provided by Terry Radke and Gary Lamberti (ND)

a. ~200,000 lbs of wet plant mass harvested per season on average (Radke)

b. ~94% of wet mass is water; 200,000 x 0.06 = ~11,700 lbs of dry mass

c. Ratio of C/N/P in dry mass = 100/16/1 (Lamberti)

d. In the ~11,700 lbs of dry mass: ~10,000 lbs of carbon, ~1600 lbs of nitrogen, and ~ 100 lbs of phosphorus



- **Dissolved *ortho* phosphate (as inorganic PO_4^{-3}): > 0.045 mg/L or > 45 ppb can stimulate algal blooms**
- **Total P levels that exceed 300 ppb – eutrophic state**

http://www.secchidipin.org/index.php/monitoring-methods/

Natural eutrophication

Lake Trophic Status

Oligotrophic

Low productivity, clear water, life more sparse

Mesotrophic

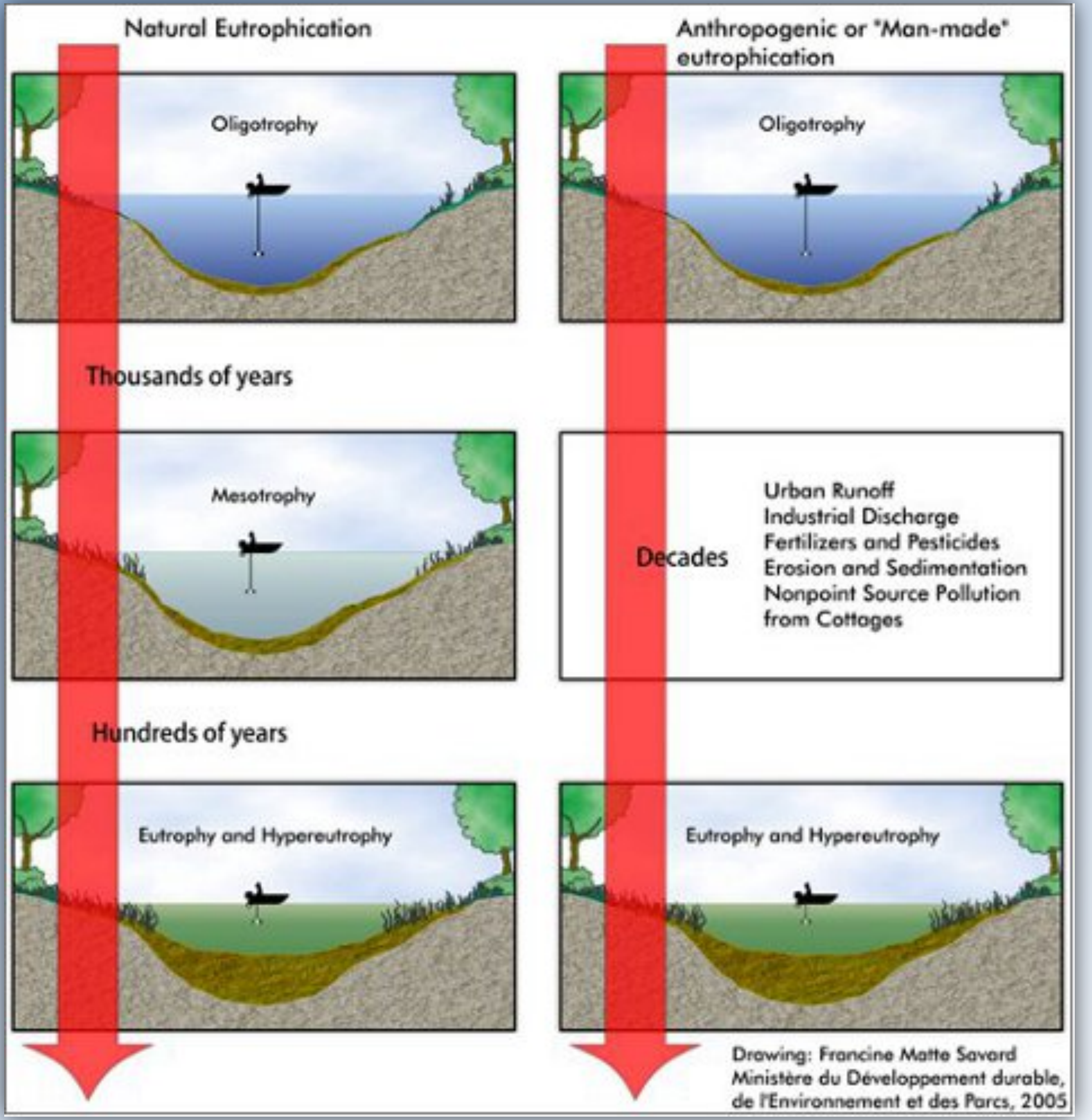
Eutrophic

High productivity, murkier water, but more life

Productivity of lakes is determined by a number of factors:

- Geology and soils of watershed
- Water residence time
- Lake morphometry
- Water mixing regime

Over thousands of years, these factors gradually change, resulting in lakes becoming more productive (eutrophic).



Natural *vs* anthropogenic (man-made) eutrophication

Lake trophic status

Trophic State Index (TSI) (Carlson Index)

The TSI value is a way to rate lakes in terms of their productivity. Its value is calculated in several different ways.

Using Secchi data

TSI = 60 – 14.41 ln SD

(SD = Secchi depth in m)

Using total phosphorus (TP)

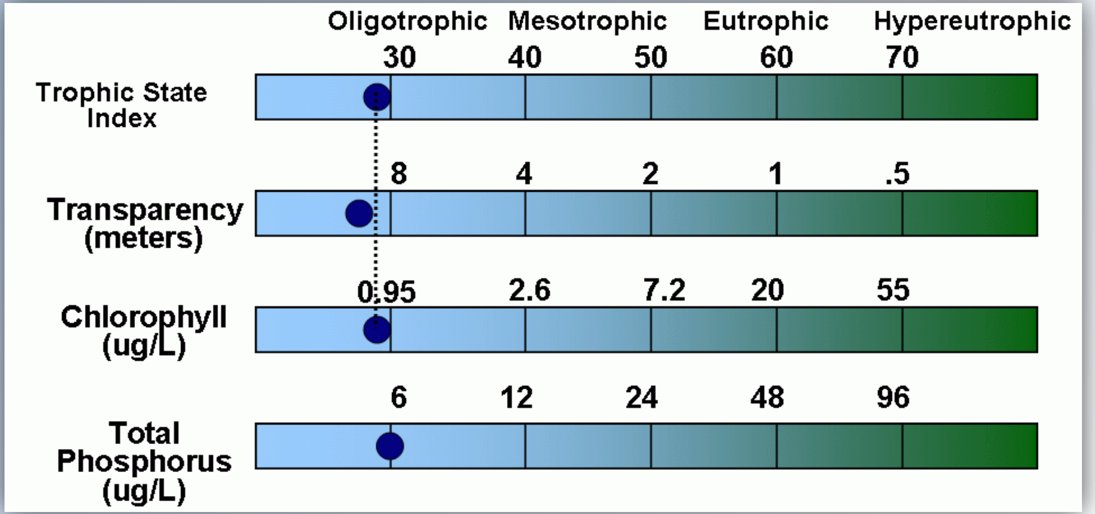
TSI = 14.42 ln TP + 4.15

(TP = total phosphorus concentration in surface water in μg/L)

Using chlorophyll a (Chl a)

TSI = 9.81 ln Chl a + 30.6

(Chl a = chlorophyll a concentration in μg/L)



Interpretation of TSI values

- Data need to be collected for many years to establish trends.
- It is best to calculate TSI values more than one way for comparison.
- In general, chlorophyll a is the best indicator to use for measurements in the summer, and TP is the best indicator for the remainder of the year.

TSI 0–40: oligotrophic lake

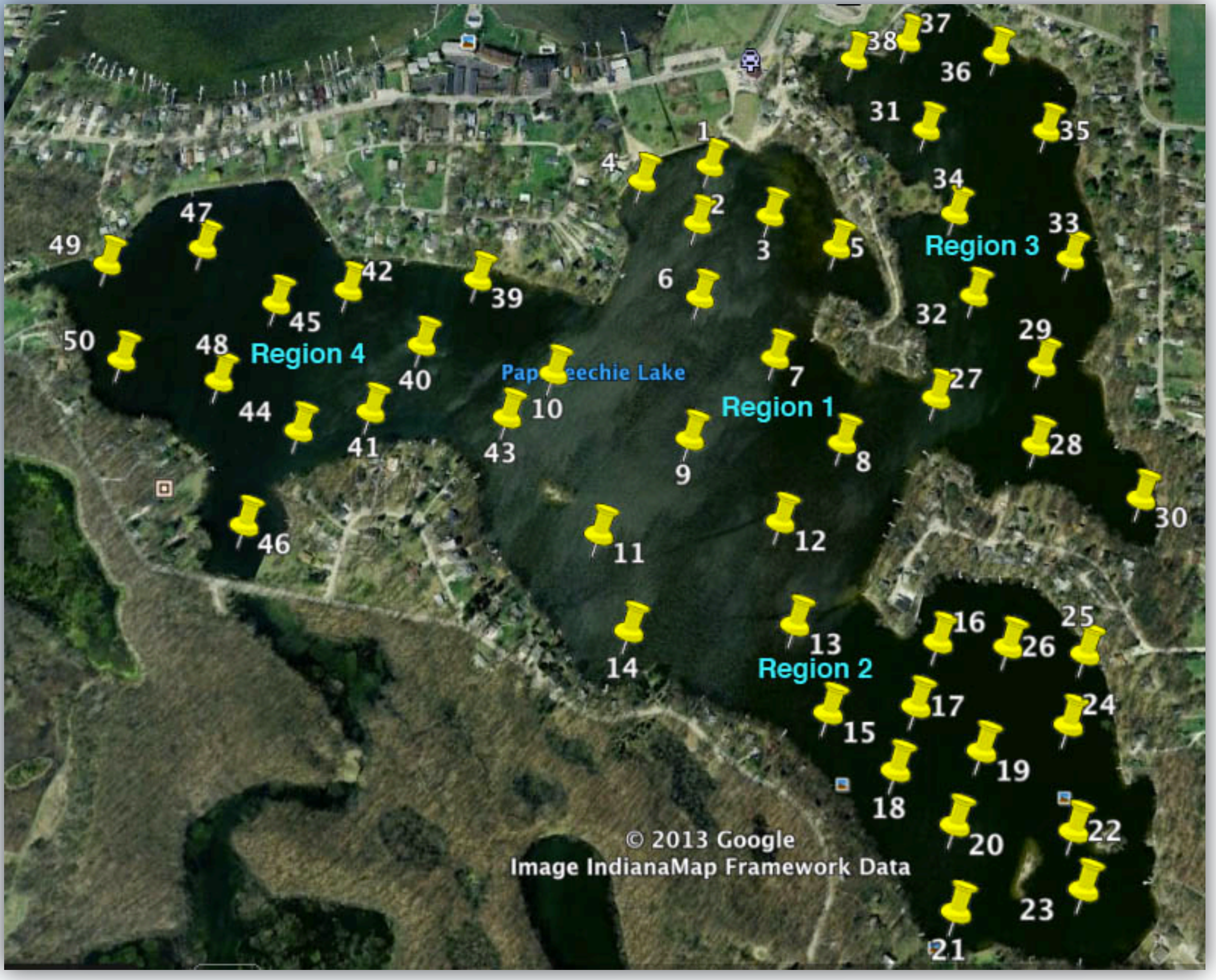
TSI 40–60: mesotrophic lake

TSI 60–100: eutrophic lake

LaPSI Lake Water Testing Slate

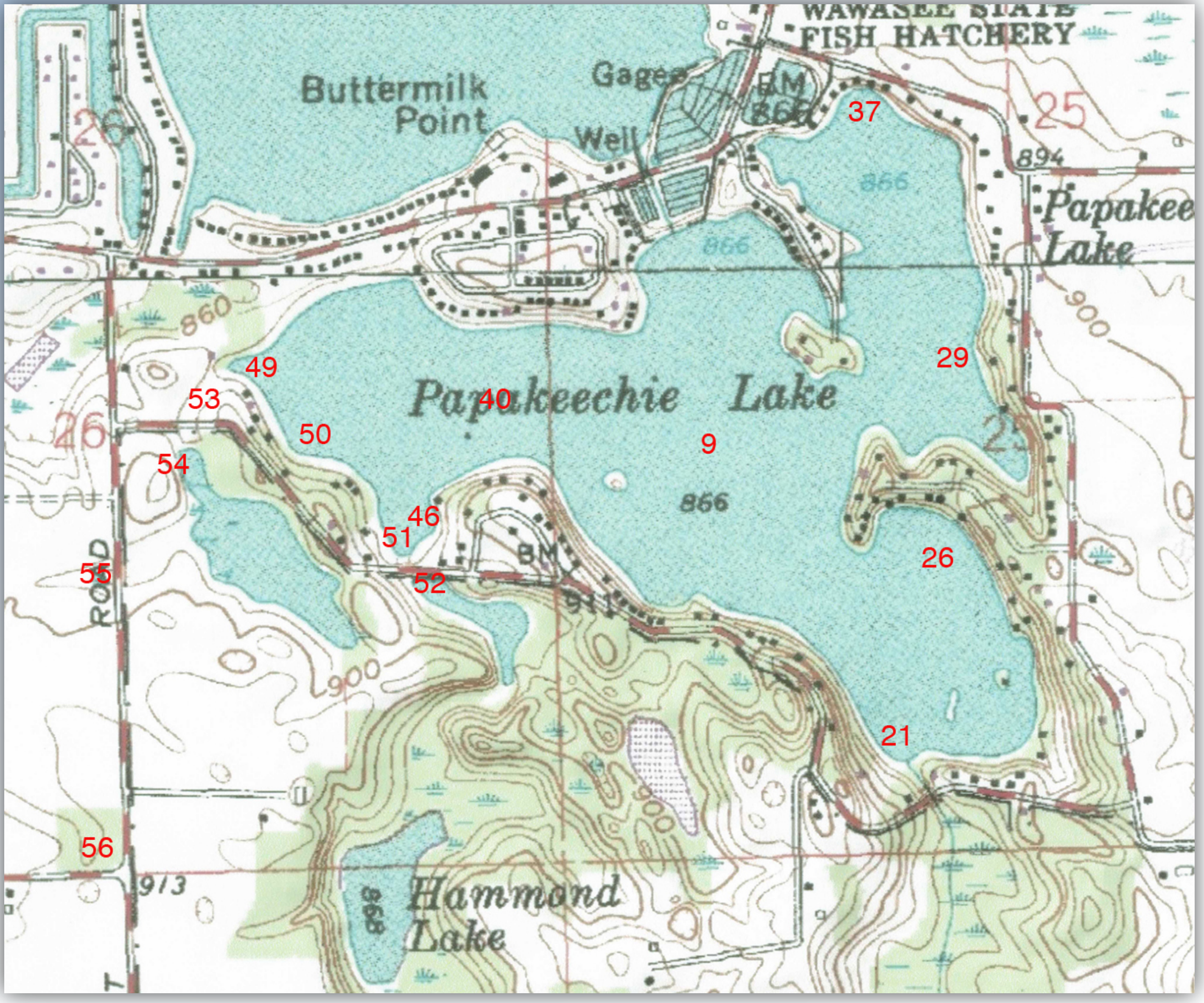
- turbidity (Secchi disk) – self-test
- temperature – self-test
- dissolved oxygen (YSI DO meter) – self-test
- *E. coli – (Coliscan)* – self-test
- dissolved inorganic nitrogen (mainly as nitrates): < 0.3 mg/L or < 300 ppb (greater values are associated with eutrophic lakes) (NECi self-test)
- dissolved *ortho* phosphate (as inorganic PO_4^{-3}): > 0.045 mg/L or > 45 ppb can stimulate algal blooms (NECi self-test)
- total phosphate (>300 ppb – eutrophic state) (Element, Inc.)
- microcystin testing (EnviroScience, Inc.; Abraxis, Inc.)
- acidity (pH) – not yet implemented
- chlorophyll a – not yet implemented

Partitioning of LP into fifty GPS-defined test sites
Regions 1–4
Summer 2013

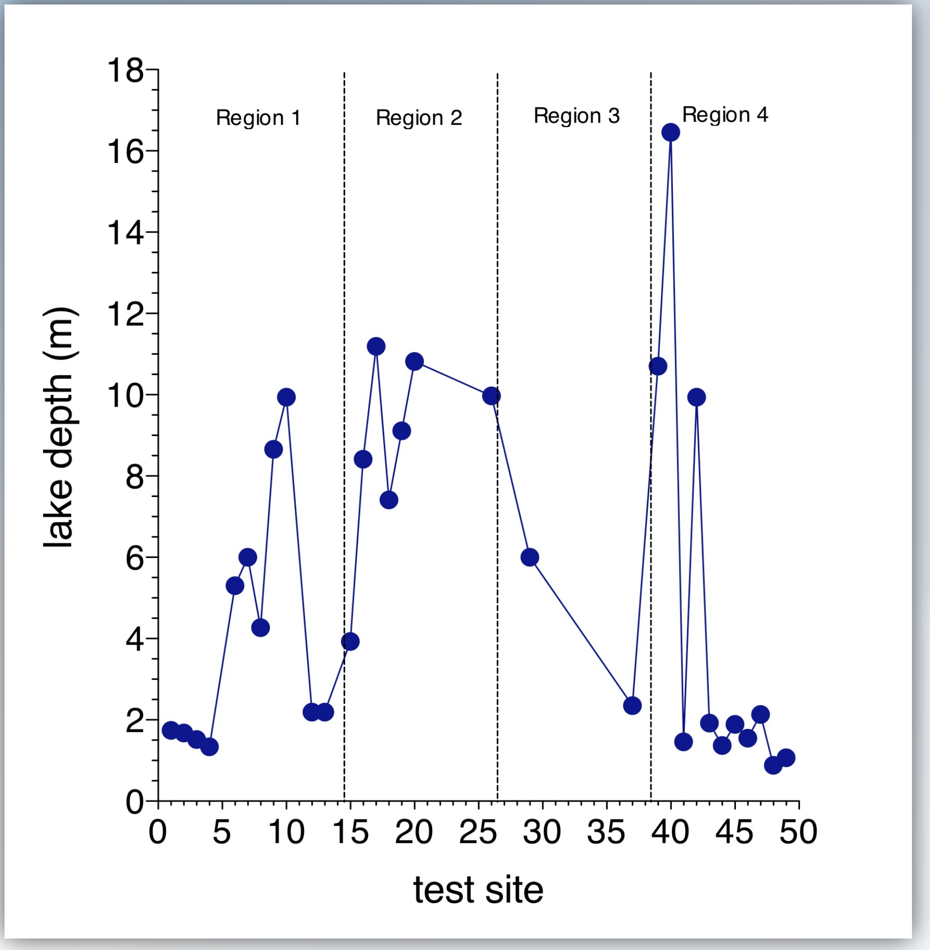


Modified water testing map

Summers 2016–18



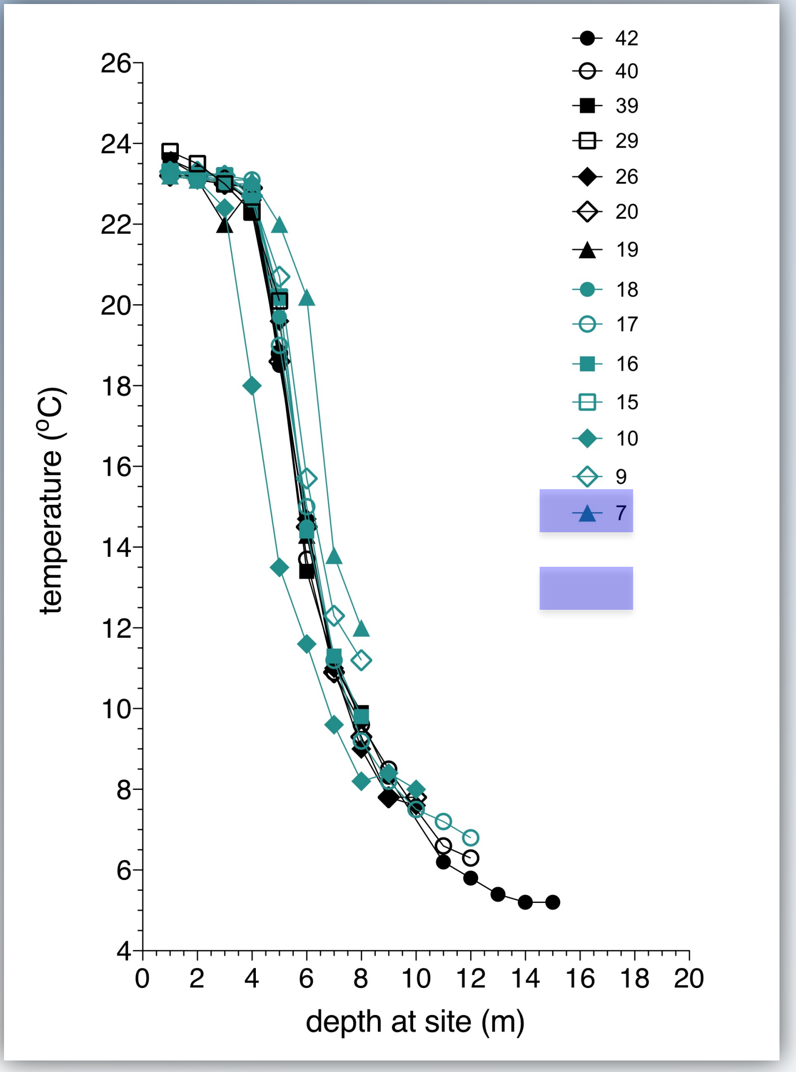
Lake depth as a function of location



07/09/13 – 07/12/13

Lake depth varies widely, even within a given Region. The deepest area of the lake resides in Region 4 (near Site 40) (~17 m or ~56 ft).

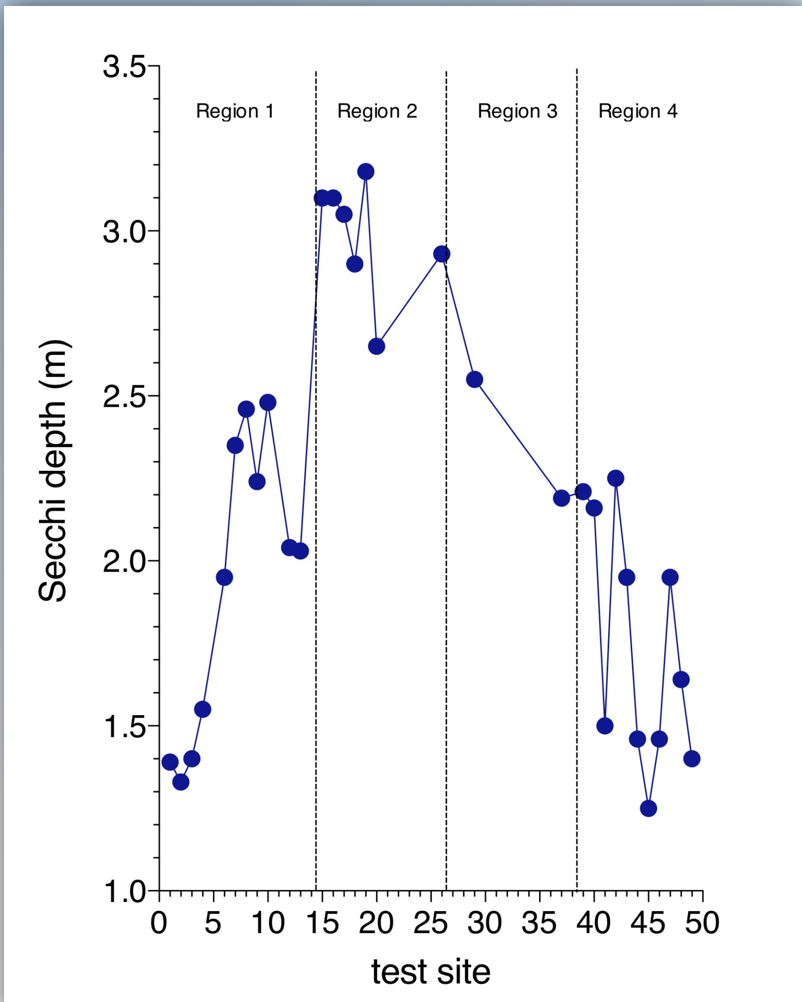
Temperature *vs* depth curves are essentially independent of test site



07/31/13 - 08/03/13

Epilimnion: 0–4 meters
Thermocline: ~6–10 meters
Hypolimnion: ~ >10 meters

Secchi depth as a function of location

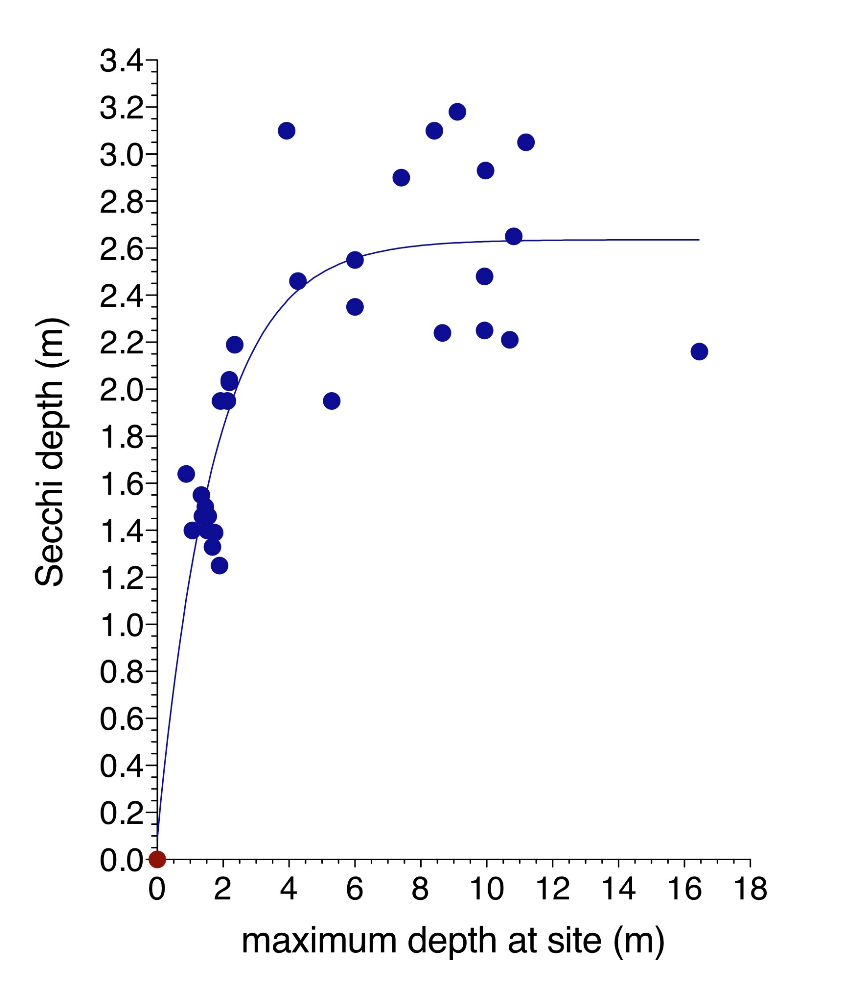


07/09/13 - 07/12/13

$Secchi^{max}$ = 3.2 m (10.5 ft)

$Secchi^{min}$ = 1.3 m (4.3 ft)

On average, the least turbid region of LP is Region 2.



There is a very weak correlation between maximum lake depth and water clarity – other factors are at work – argues against minimizing the number of data points in lake studies.

07/09/13 - 07/12/13

Using Secchi data:

TSI = 60 – 14.41 ln SD

(SD = Secchi depth in m)

TSI = 60 – 14.41 ln 3.2

TSI = 60 – 17 = 43

TSI = 60 – 14.41 ln 1.3

TSI = 60 – 4 = 56

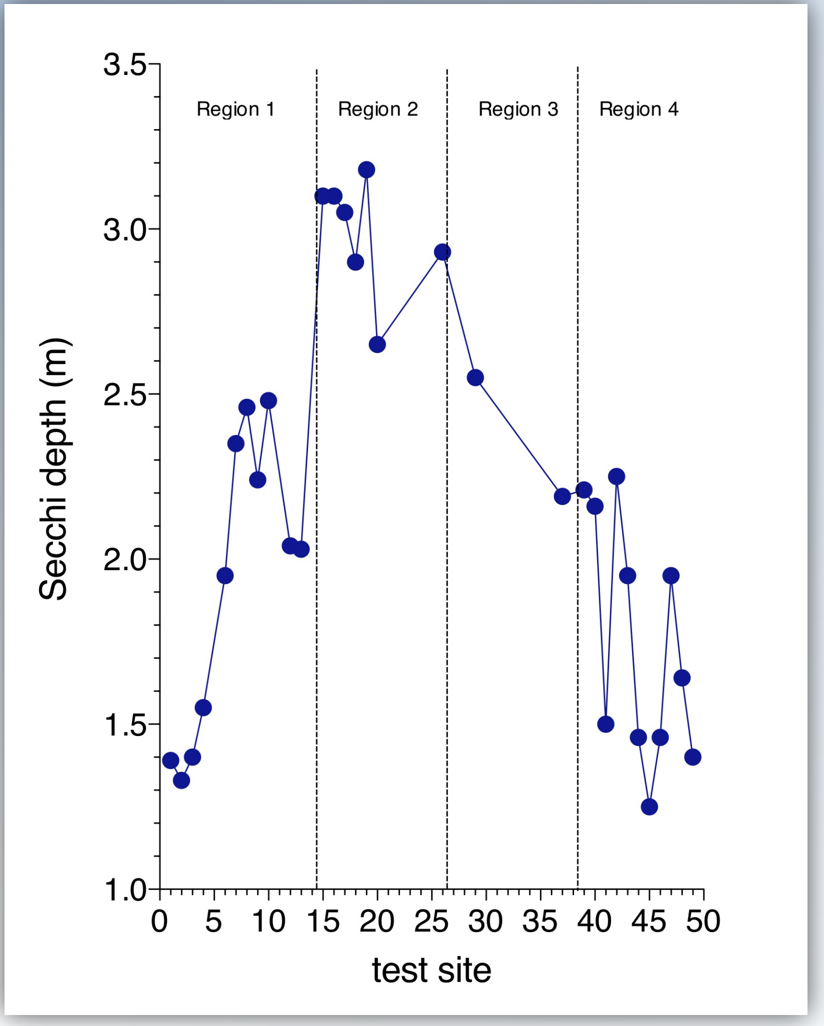
TSI 0–40: oligotrophic lake

TSI 40–60: <u>mesotrophic lake</u>

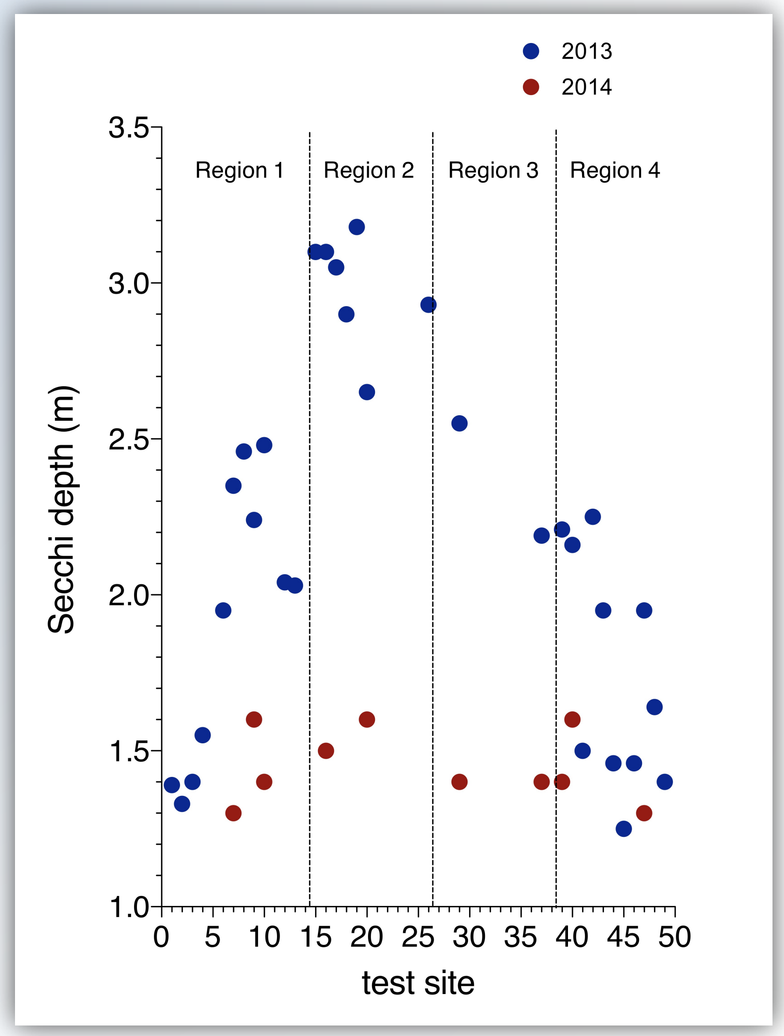
TSI 60–100: eutrophic lake

Secchi depth as a function of location

07/09/13 - 07/12/13

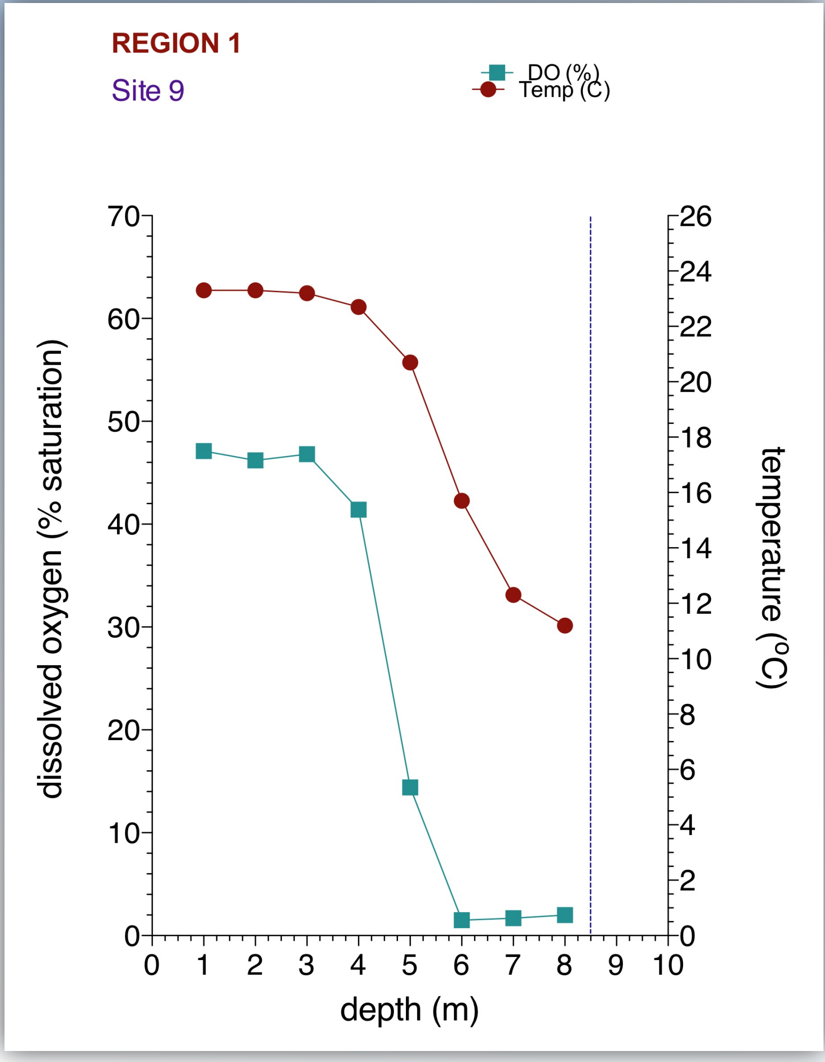


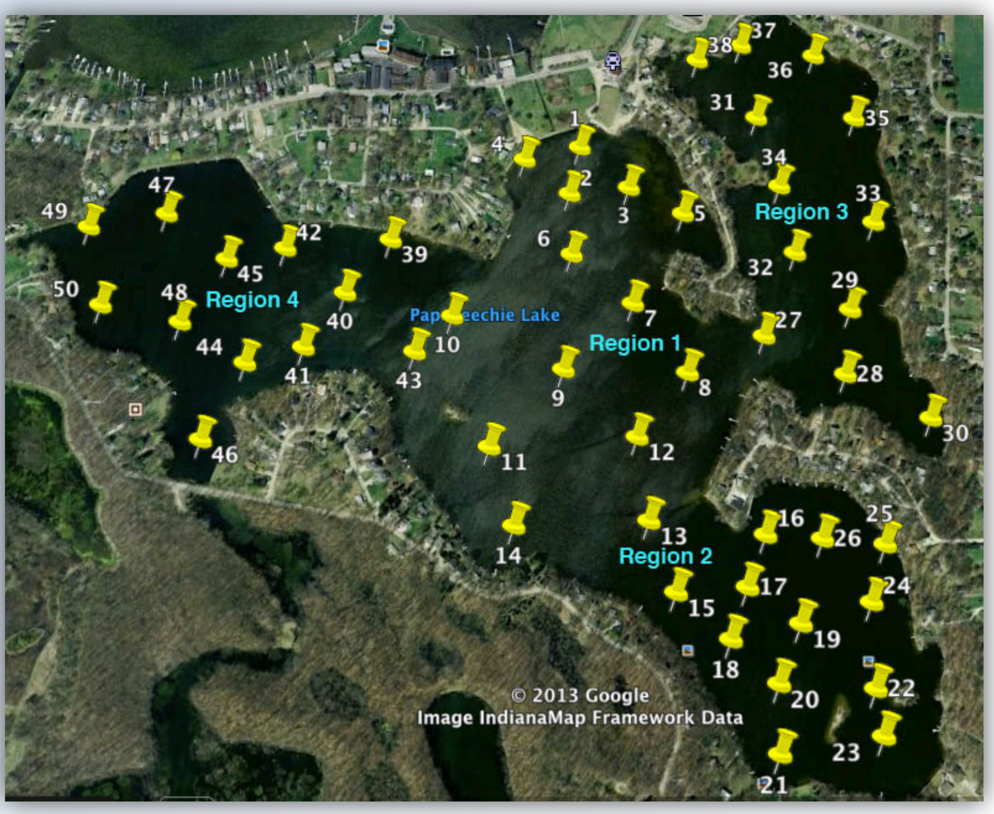
Plus 2014 data (07/29/14)



DO and T as a function of lake depth – SITE 9

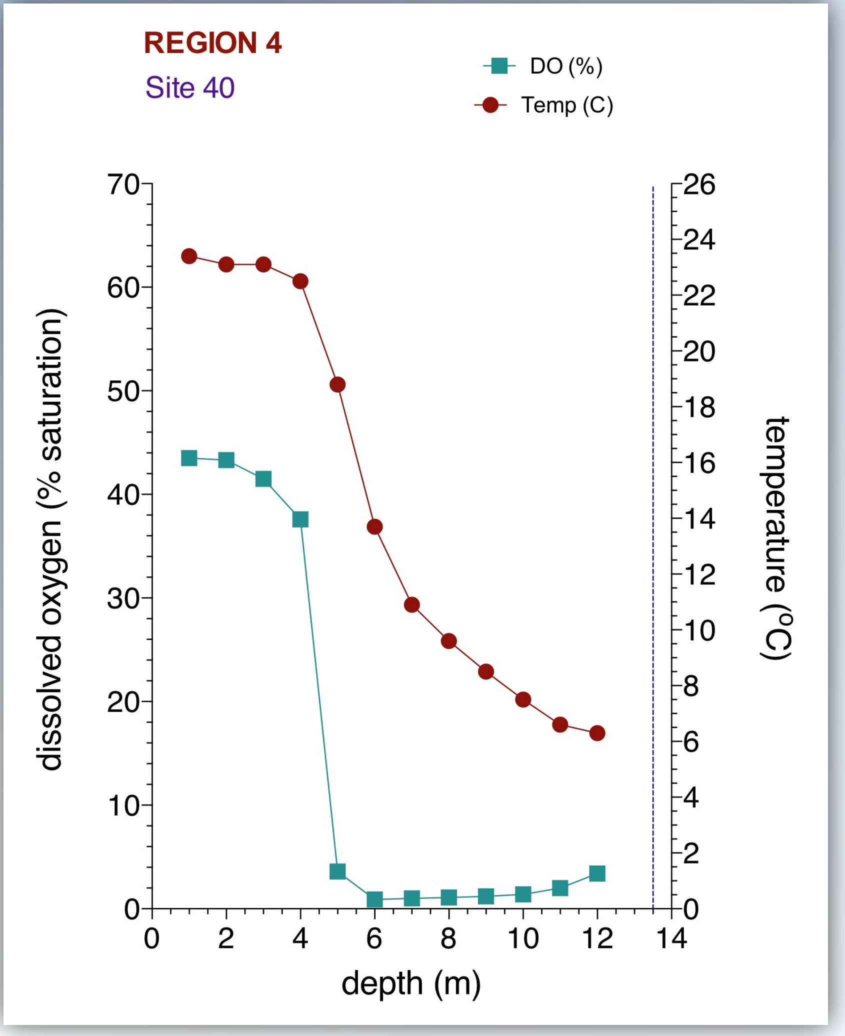
08/03/13





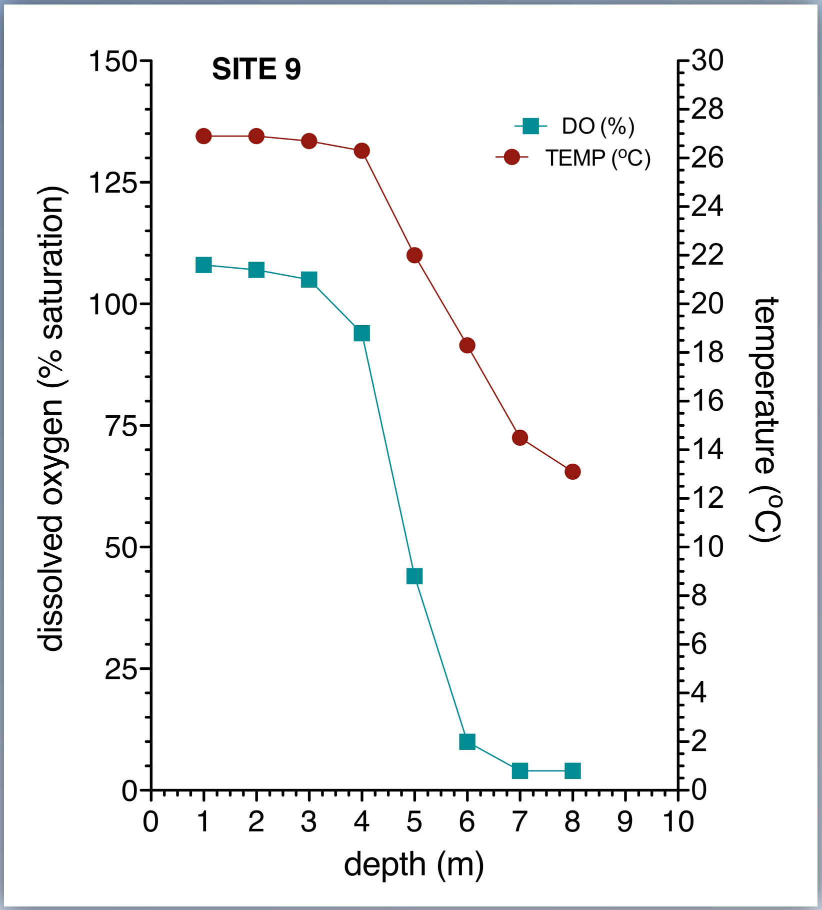
DO and T as a function of lake depth – SITE 40

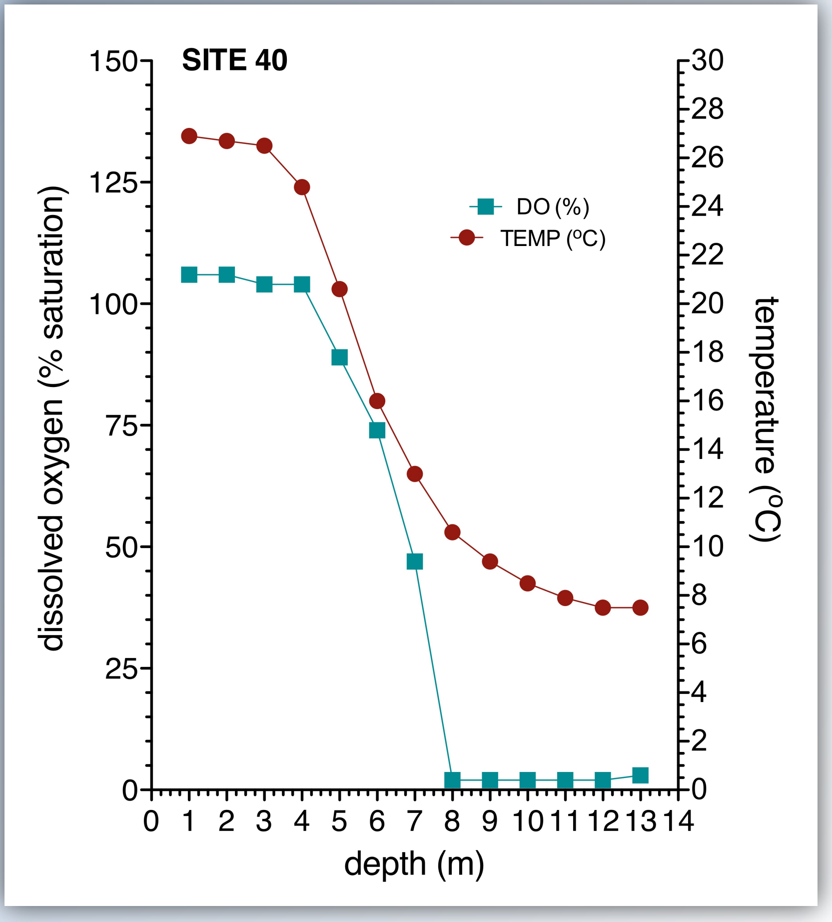
08/03/13



- DO drops off rapidly below ~4 meters.
- Hypolimnion essentially anoxic at ~6 meters.

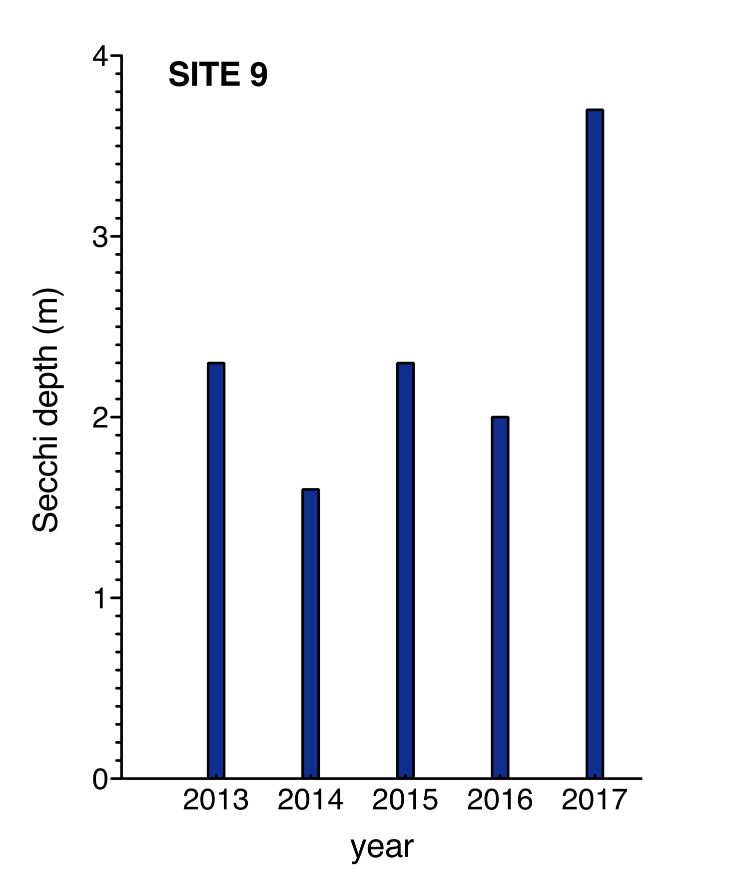
2015 DO/T Testing of Sites 9 and 40: 07/26/15

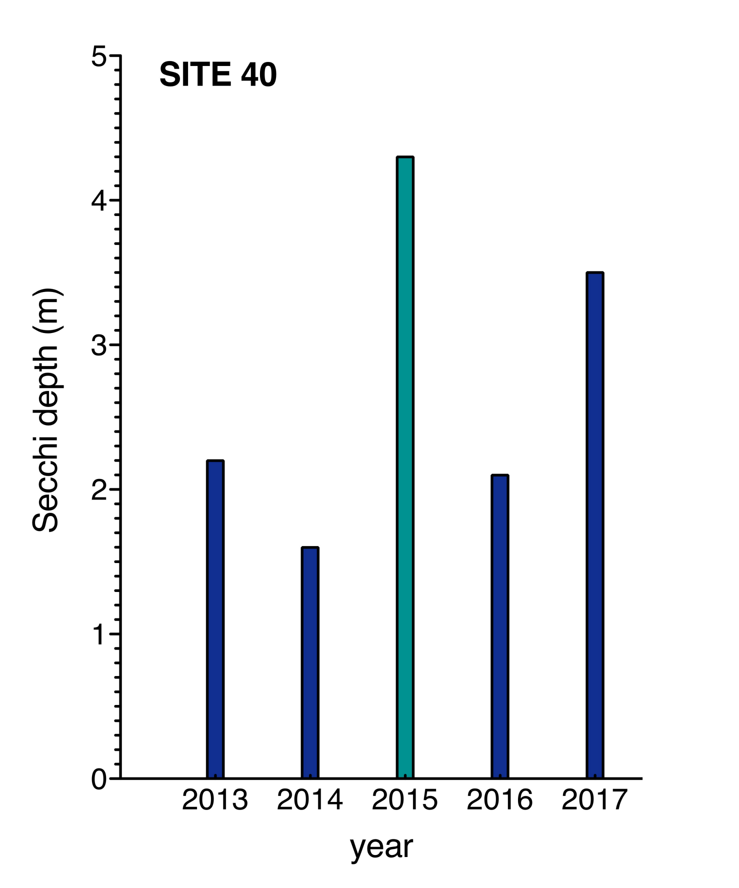




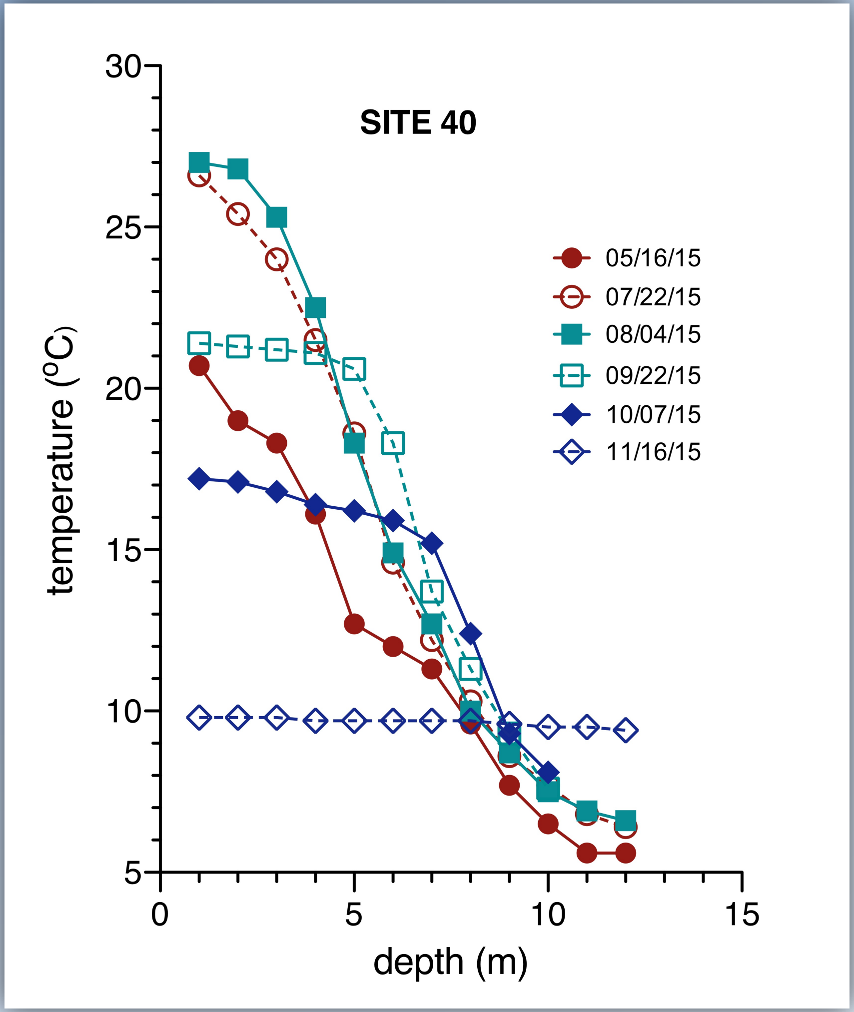
Secchi data for Sites 9 and 40 for 2013–2017

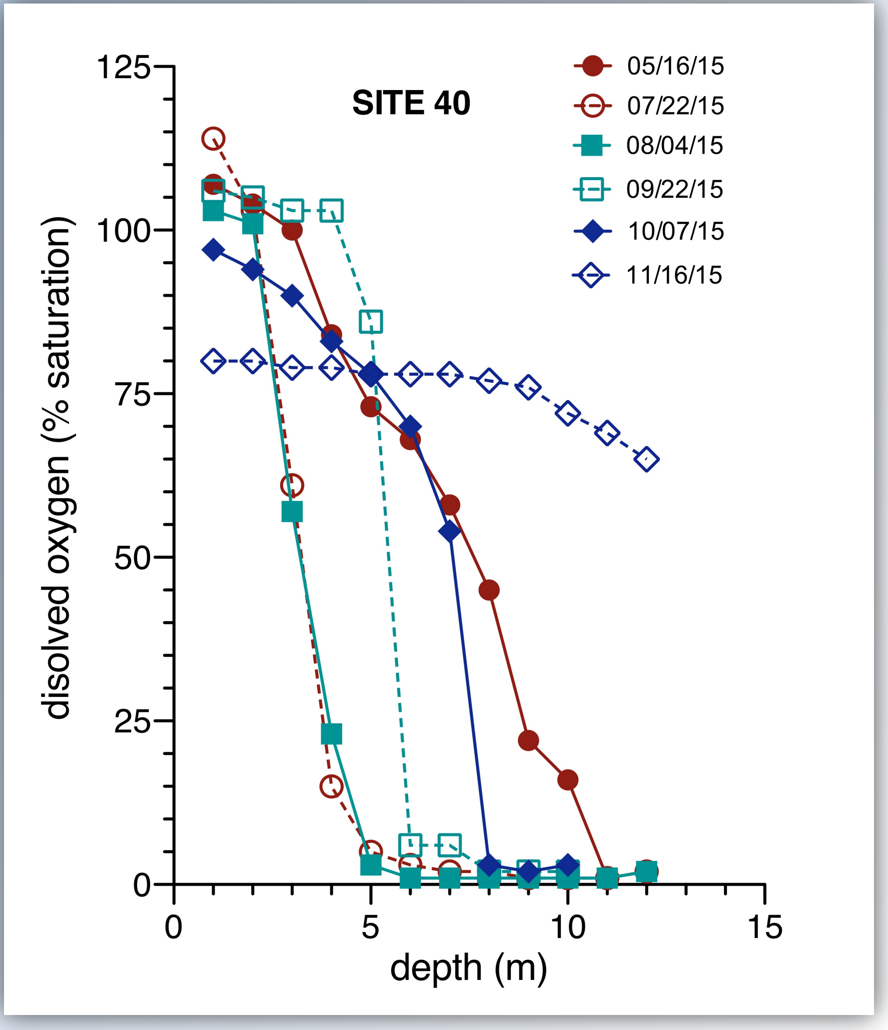
(Data collected mid-summer except for 40/2015 [mid-Sept])





Seasonal variation of T and DO *vs* depth plots at Site 40 (2015)





Stratification affects lake chemistry and biology

- During stratification, the hypolimnion is cut off from the oxygen in the air.
- If the lake is productive, there will be organic matter from the epilimnion settling into the hypolimnion.
- This organic matter will be broken down by microbial respiration resulting in a decrease in dissolved oxygen.
- This may leave the hypolimnion critically deficient in dissolved oxygen so that it cannot support many animals like fish.

Table 1.2016. LaPSI External Water Test Results: 2016 Season

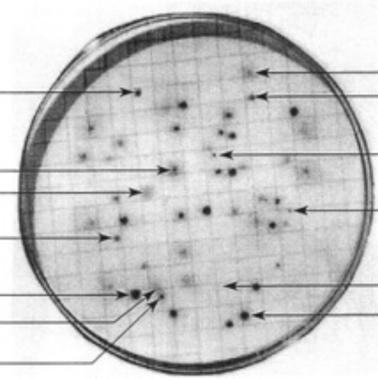
Collection Date	Testing Firm	Site	Test	Result (ppb)	Conclusion
					Limit TP: >300 ppb (eutrophic) **Limit DP: >45 ppb (algal blooms)** **NO_2/NO_3: >300 ppb (eutrophic)**
05/11/2016	Element	26	NH_3 (as N)	<100	
			NO_2/NO_3	<100	
			TP	<40	
		53	NH_3 (as N)	280	
			NO_2/NO_3	**250**	
			TP	80	
06/23/2016	Element	53	NH_3 (as N)	275	
			NO_2/NO_3	**300**	
			TP	131	
07/14/2016	Element	53	TP	131	
		54	TP	**46700**	
		56	TP	146	
07/19/2016	Element	46	TP	52	
		51	TP	56	
		49	TP	58	
		26	TP	20	
		21	TP	20	
		52	TP	54	
07/26/2016	Element	53	TP	129	
07/27/2016	Element	54	TP	**11900**	
		54	NH_3 (as N)	**5170**	
		54	NO_2/NO_3	140	
10/17/2016	Element	9	TP	20	
		46	TP	57	
		49	TP	35	
		52	TP	<20	

Table 1.2017. LaPSI External Water Test Results: 2017 Season

Collection Date	Testing Firm	Site	Test	Result (ppb	Conclusion
01/16/2017	Element	53	TP	**268**	
04/17/2017	Element	53	TP	81	
		54	TP	88	
05/15/2017	Element	53	TP	67	
			NO_2/NO_3	**410**	
		54	TP	**390**	
			NO_2/NO_3	132	
		51	TP	68	
			NO_2/NO_3	51	
		52	TP	70	
			NO_2/NO_3	23	
		40 (A)	TP	72	
			NO_2/NO_3	15	
		40 (B)	TP	100	
			NO_2/NO_3	13	
06/19/2017	Element	53	TP	198	
		54	TP	**325**	
		40 (1 ft)	TP	18	
		40 (10 m)	TP	26	
07/26/2017	Element	26 (1 ft)	TP	13	
		40 (1 ft)	TP	17	
		40 (13 m)	TP	**272**	
		49 (1 ft)	TP	51	
		46 (1 ft)	TP	34	
		9 (1 ft)	TP	17	
		9 (7 m)	TP	99	
		37 (1 ft)	TP	17	
		37 (7 m)	TP	78	
		38 (1 ft)	TP	16	
		52	TP	47	
		26 (7 m)	TP	49	
08/17/2017	Element	40 (1 ft)	TP	<80	
		40 (13 m)	TP	124	
		53	TP	115	
		54	TP	**733**	

Coliscan *E. coli* test

Coliscan® Colony Color Guide



Original color photo below.

Specific colonies above are designated 1, 2, 3, 4 or 5 and their interpretation is described below with the corresponding number.

- Colonies with (1) are interpreted as *E.coli*. (glucuronidase +, galactosidase-)
- Colonies with (2) are interpreted as coliform. (glucuronidase-, galactosidase +)
- Colony with (3) could be *E.coli*, *Salmonella*, *Shigella* or other genus. Specific ID would require further tests. Do not interpret as *E.coli* or coliform without further tests. (glucuronidase+, galactosidase-)
- Colony with (4). The color is from the bacteria, not the chromogens. Identified as *Pseudomonas* sp. Do not interpret as *E.coli* or coliform. (glucuronidase-, galactosidase-)
- Colony with (5) has no color. Do not interpret as *E.coli* or coliform. (glucuronidase-, galactosidase-)

For lake water to meet recreational standards, the geometric mean of 5 samples over a 30-day period is required to be less than 125 CFU/100 mL, with no sample testing higher than 235 CFU/100 mL.

E. coli data: 2013 – 2015

2013 (summer):
Site 21

2013 (fall):
Site 5, 31, 36 and 46

2014:
Sites 5, 7, 35 and 36

2015:
Sites 46, 47 and 49

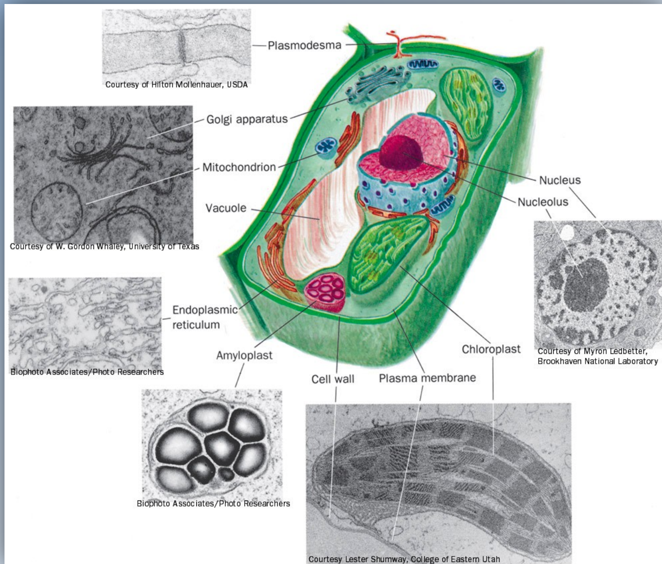
Microcystin testing (HAB) – Fall 2016

Testing Firm: EnviroScience, Inc.
<u>Single sample</u> collected: 10/19/16 (analyzed 10/24/16)
Result: **191 ppb microcystin**

Microbiological tests (phase contrast microscopy):
(a) *Microcystis botrys* and *wesenbergii* and *Woronichinia naegleria* (dominate; both microcystin producers)
(b) Other producers of saxitoxins, anatoxin-a, cylindrospermopsin detected

Indiana guidance values:
Low risk: 4 ppb
Moderate risk: 4–20 ppb
High risk: >20 ppb

Current LaPSI microcystin testing plan: Will use <u>test strips</u> provided by Abraxis, Inc.; will test as circumstances dictate.



Future Testing: Chlorophyll a

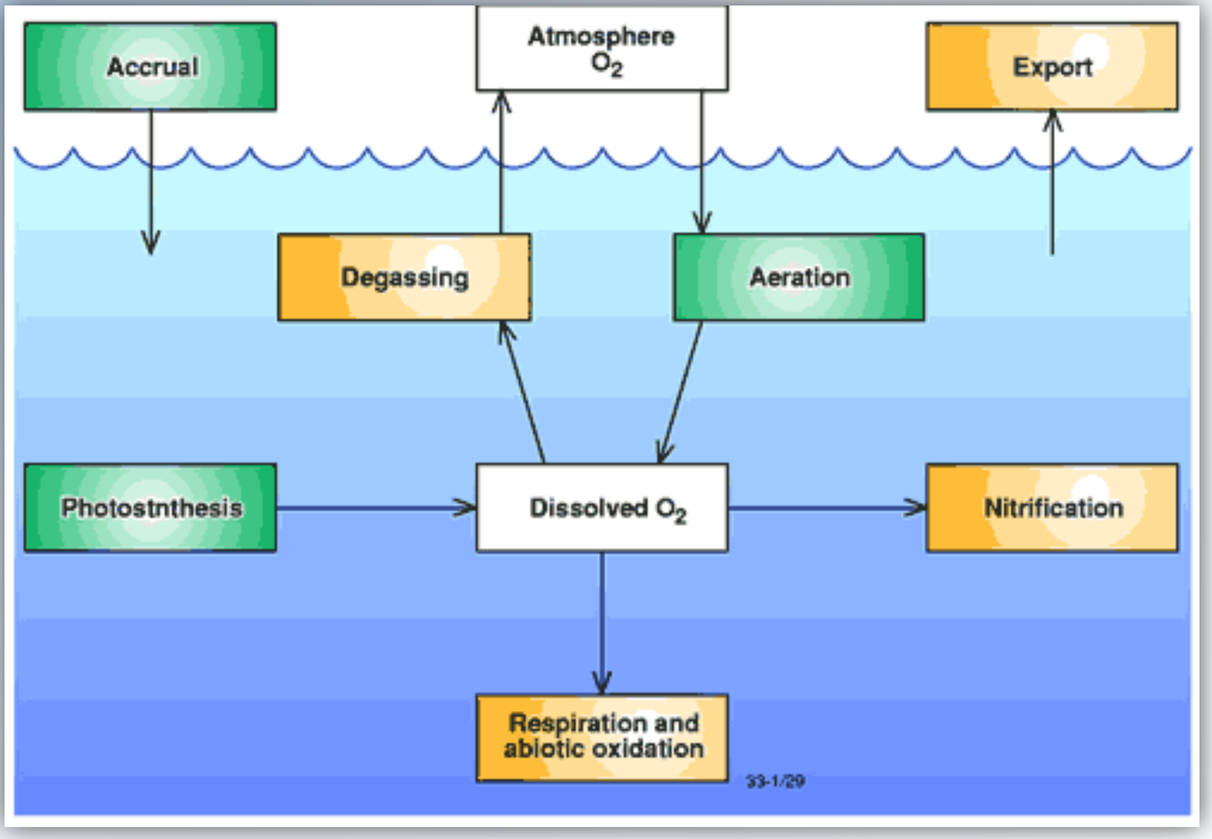
Chlorophyll is the green pigment found in all plants that allows them to use the sun's energy to convert CO_2 and water into oxygen and cellular material (photosynthesis).

Lake testing for chlorophyll provides an estimate of the amount of algae growing in the lake. Algal growth reflects the level of nutrients in a lake (mainly N and P), but is affected by other factors (*e.g.*, water temperature, water transparency, amount of zooplankton and fish). Water samples for chlorophyll analysis are taken from the upper layer of the lake called the epilimnion.

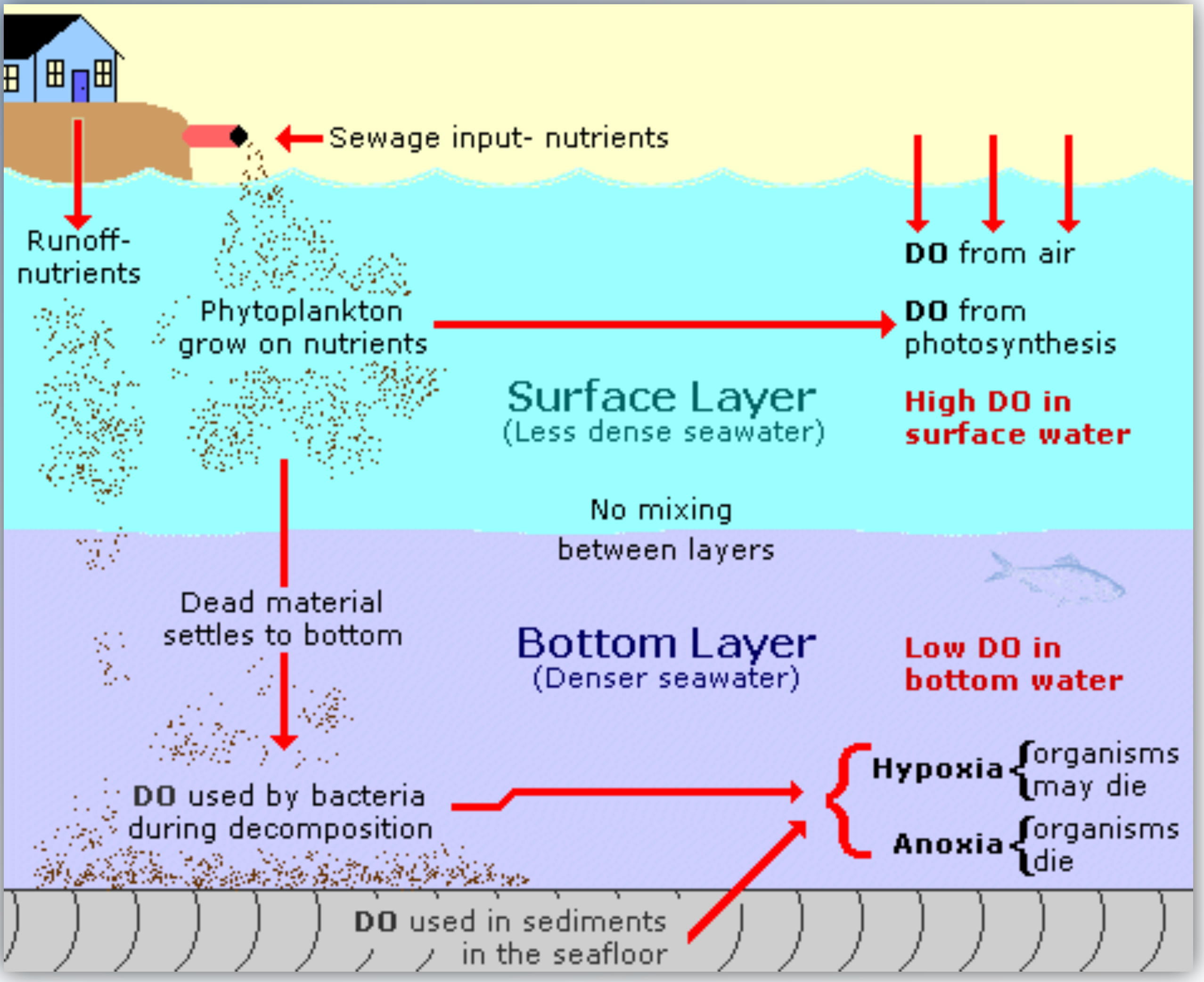
Chlorophyll measurements are made with a meter (similar to a DO/T meter) equipped with a specific probe.

END

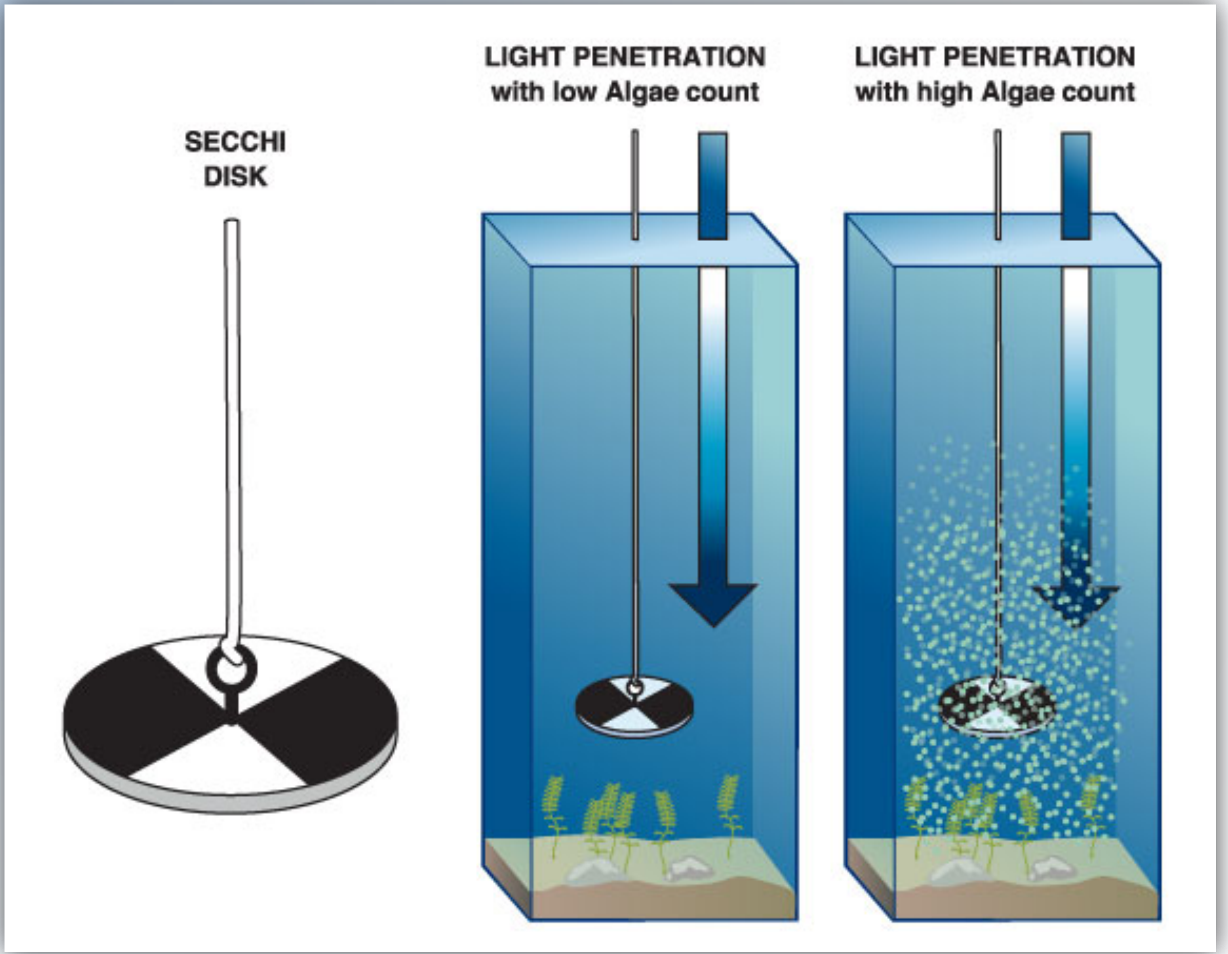
Sources and Sinks of Dissolved Oxygen



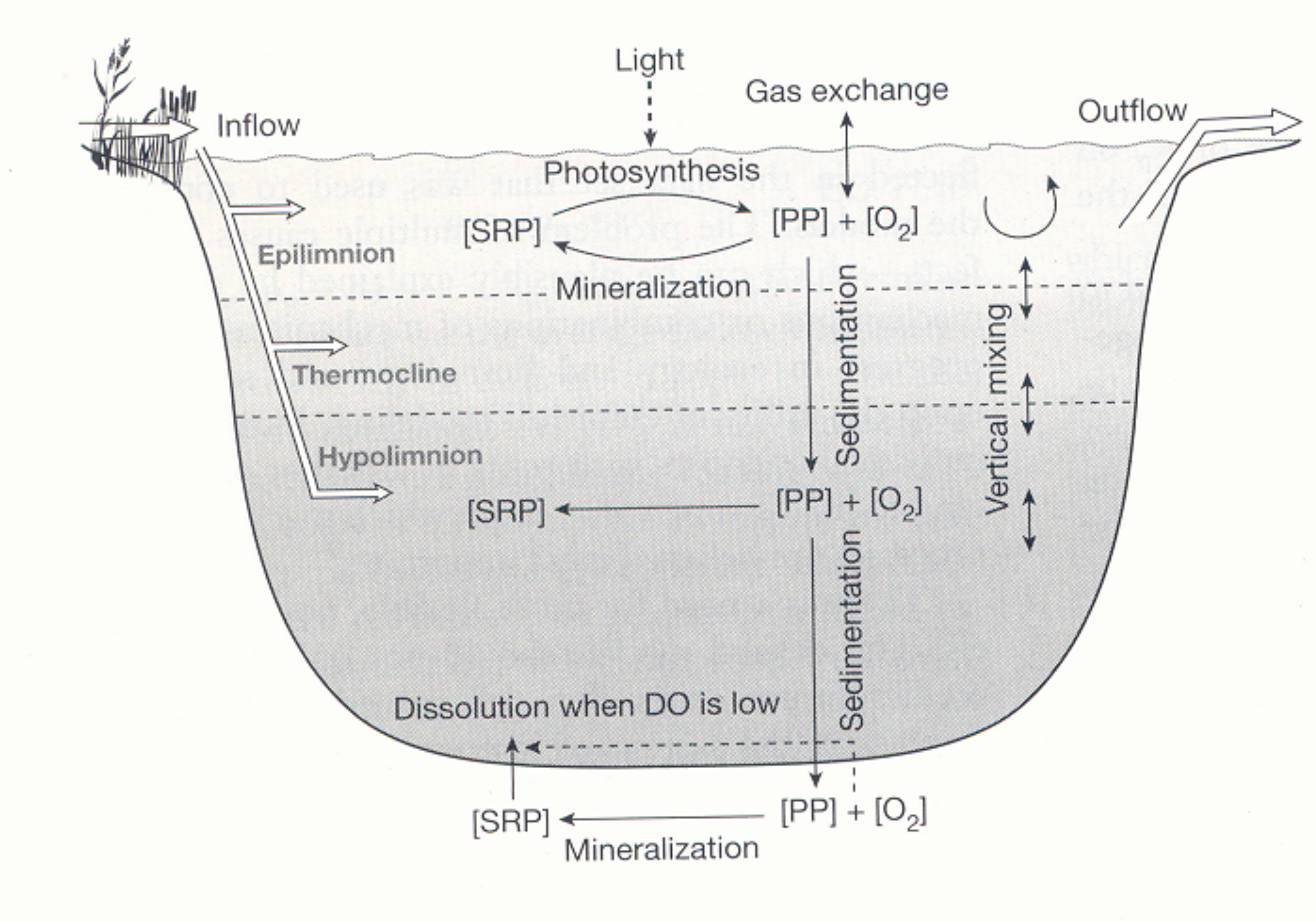
Chemical and Biological Factors Affecting DO in Water Bodies



Turbidity measurements with a Secchi disk



Lake Chemistry - Phosphorus



- P limits biological production in lakes
- P cycles in lakes
- P accumulates in the sediments