Seasonal Variations of Water Quality and Algal Growth in the Heinrich-Martin Dam Impoundment

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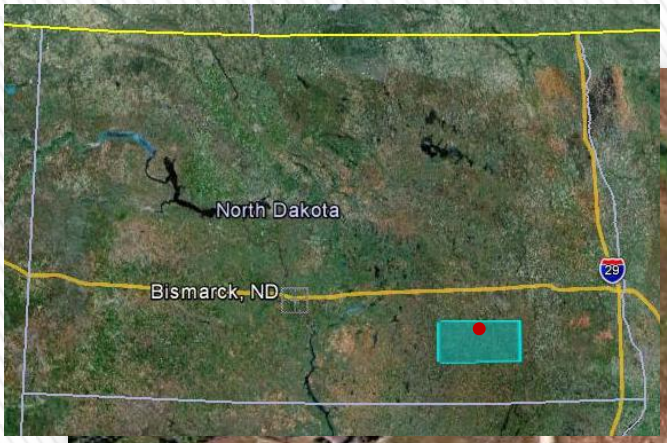
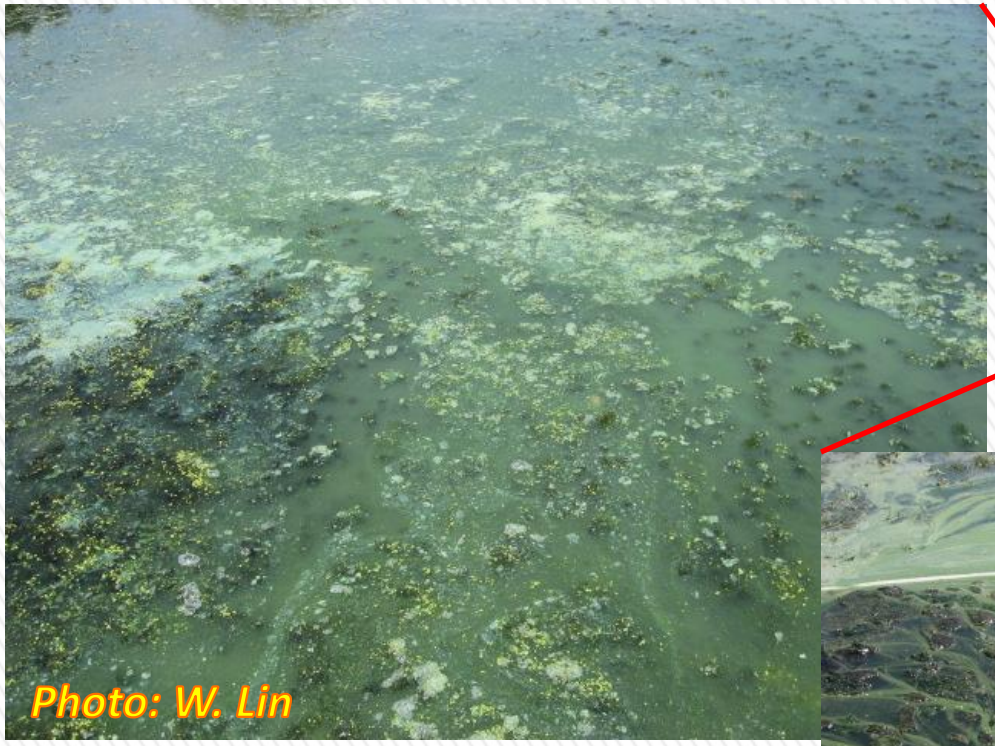
Background of the Heinrich-Martin Dam (HMD)

- Located in LaMoure County, ND.
- Surface area 18.8 acres.
- Up to 10 m (35ft) deep.
- Water is maintained by an overflow structure.
- Naturally stratified in summer.
- Eutrophic reservoir.
- Algal boom in summer.
- Anoxic hypolimnion.
- Aeration system installed to improve summer dissolved oxygen concentrations.

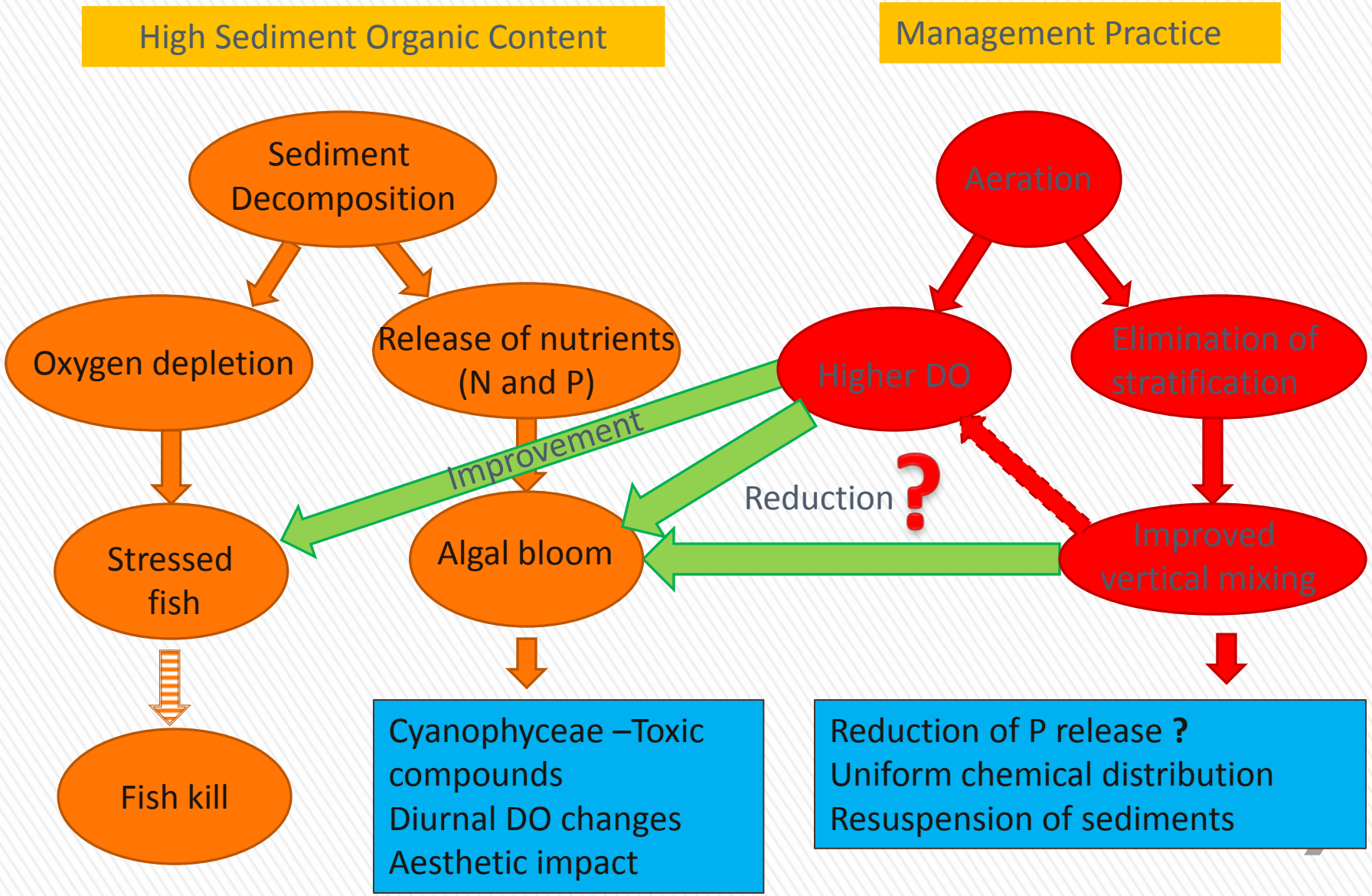


Algal Bloom in Summer of 2011



Fish kill in July 2011

Eutrophic Lake



Objectives of the Research

- Monitoring and analyze seasonal variation of water quality and phytoplankton species shift;
- Identifying the main nutrient source(s);
- Determining the impact of aeration on nutrient availability and other water quality parameters; and
- Studying phytoplankton population dynamics in response to seasonal and water quality changes.

Field Sampling

Sampling period

- **2010 –** June 4th to Oct 15th – aerated
- **2011 -** June 30th to Nov. 8th (July 13th to Sep. 1st -period of without aeration)

Sampling locations (A-D)

A (8-10 m) deepest and close to aeration system;

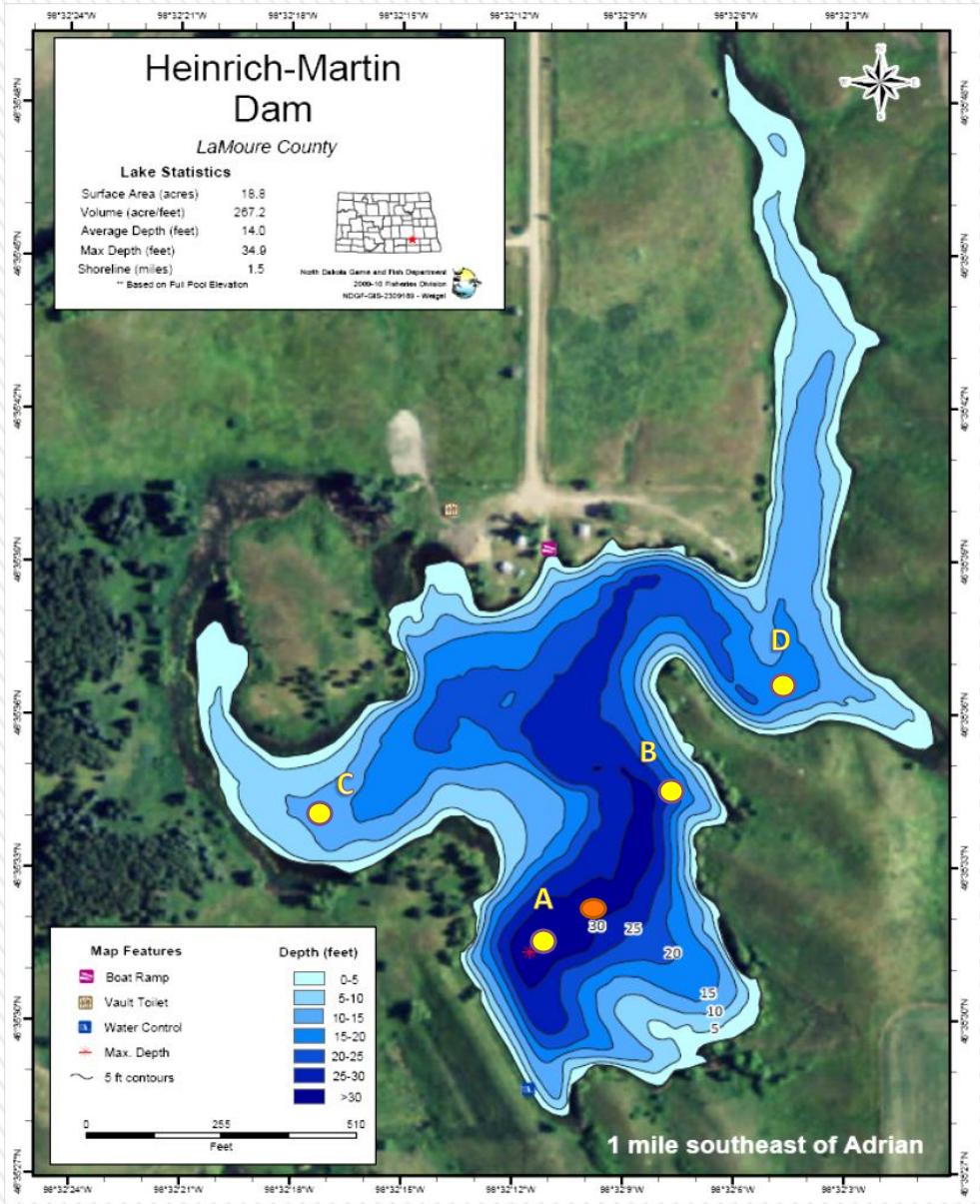
B(6.5m) less affected;

C (4m); and **D**(5m) unaffected shallow sites.

Sampling frequency

Aerated periods – biweekly

Non-aerated period –weekly



http://gf.nd.gov/gnfapps/maps/lakecontours/heinrichmartin2.pdf

Field Sampling

Field measurements-

Secchi depth – Secchi disk

Water temperature, Conductivity, DO, pH -YSI Sond

DO, pH, Turbidity – portable meters

Chemical analyses –

NO_2^-,NO_3^-, NH_4^+, TDN,TN

SRP, TRP, Hydrolysable P, and TP

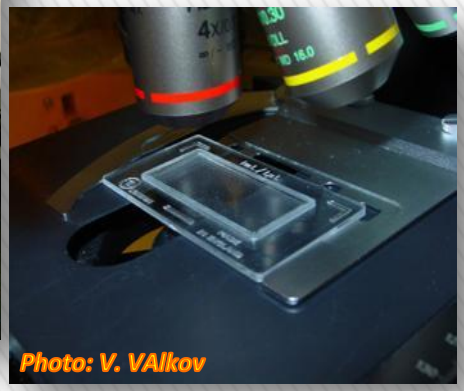
TSS and VSS

Biological analyses -

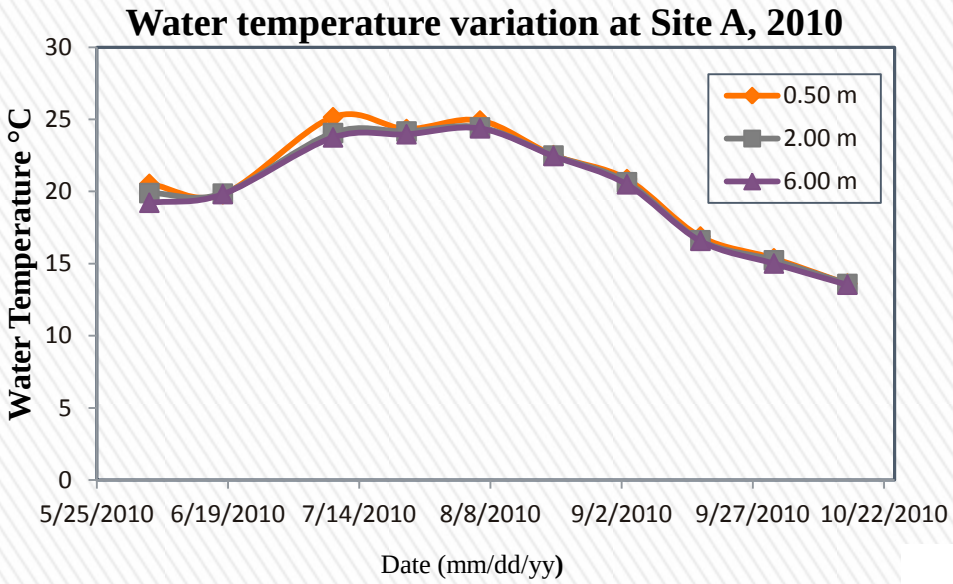
Chlorophyll *a* (Chl *a*)

Phytoplankton abundance

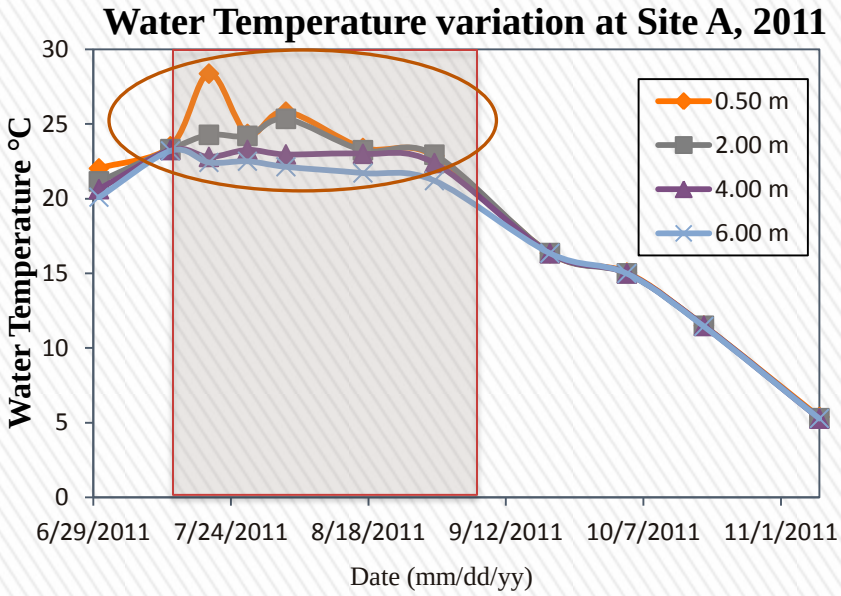
Phytoplankton speciation

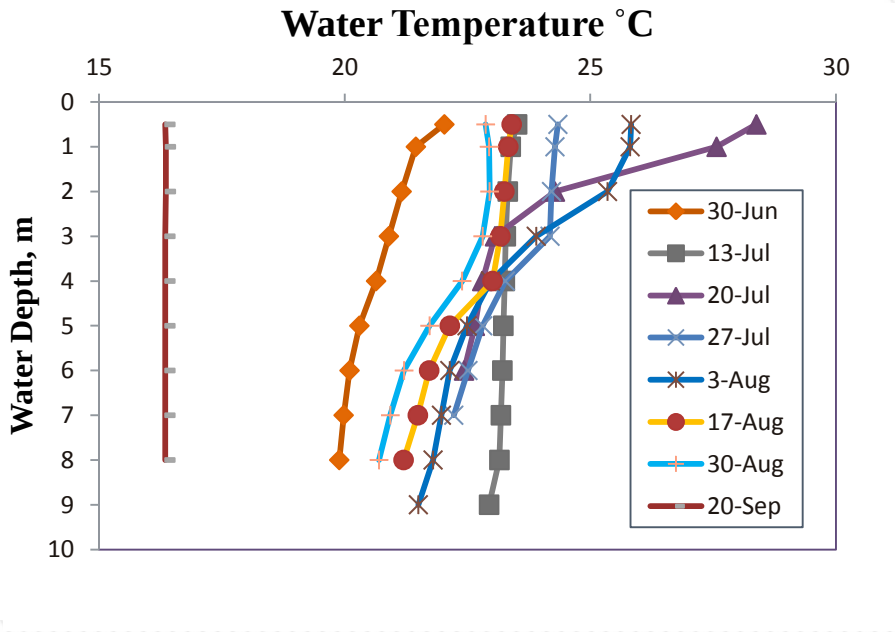


Variation of water temperature

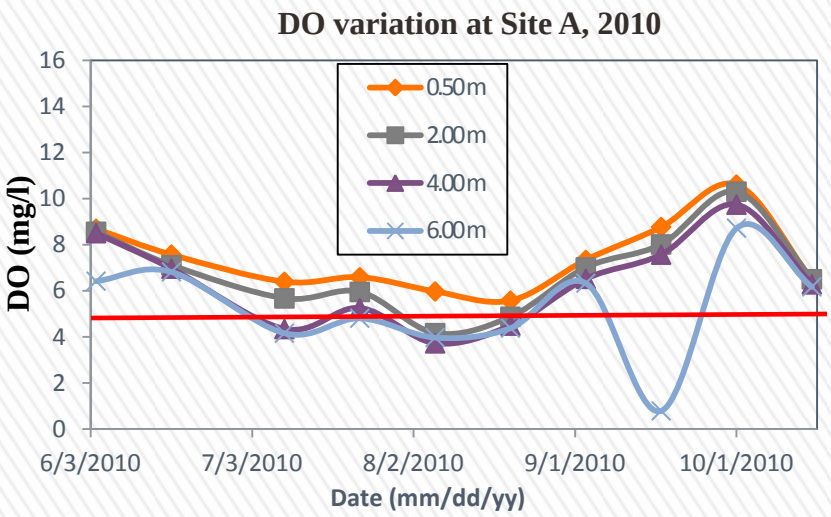


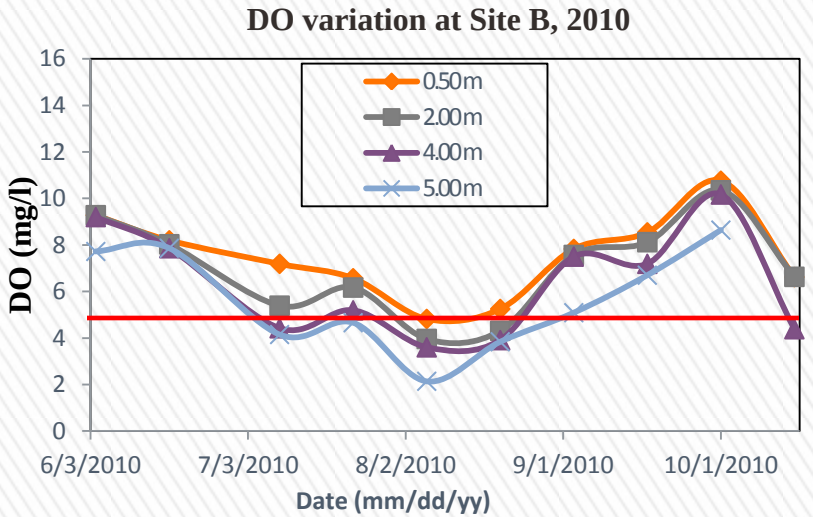
- Aeration off between July 13th and September 1st
- A weak thermal stratification was developed.

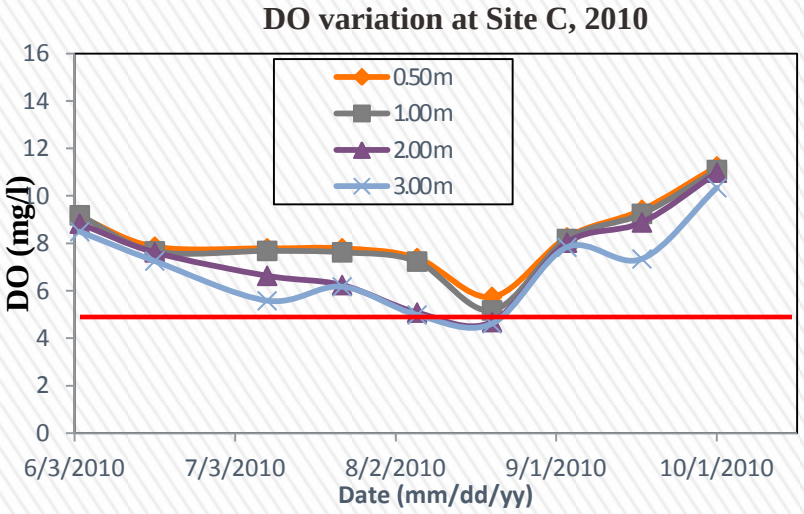


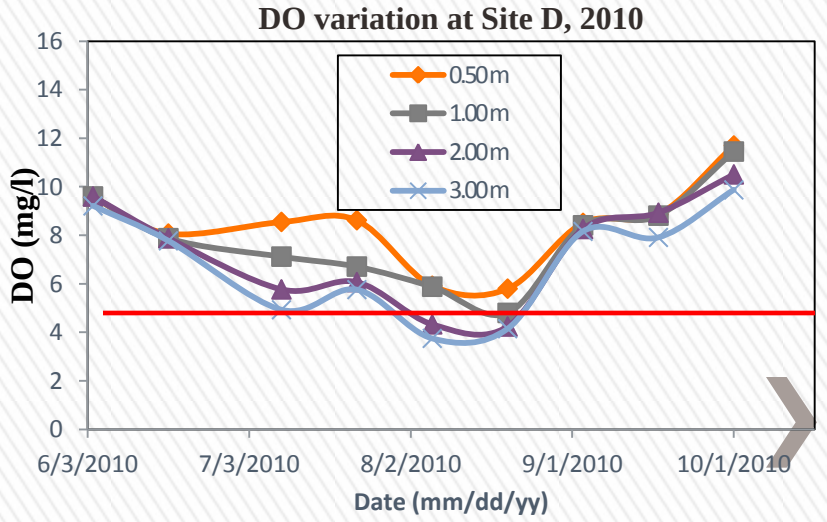


Dissolved Oxygen (DO) 2010









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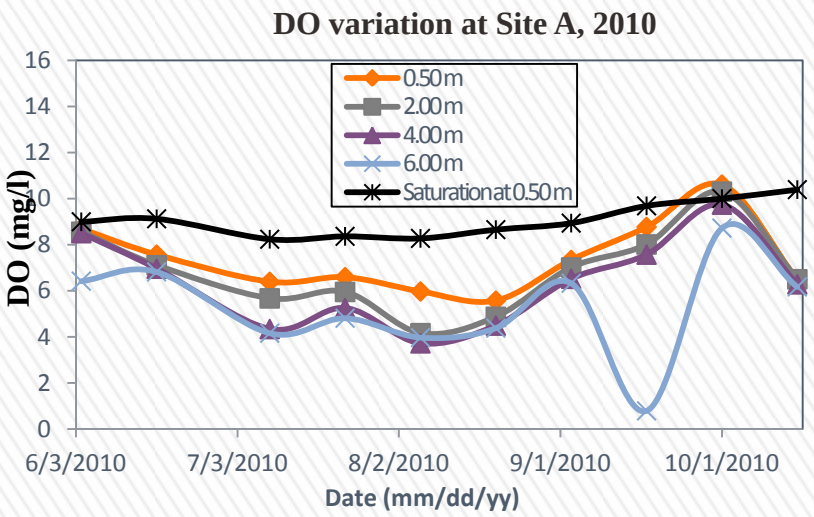
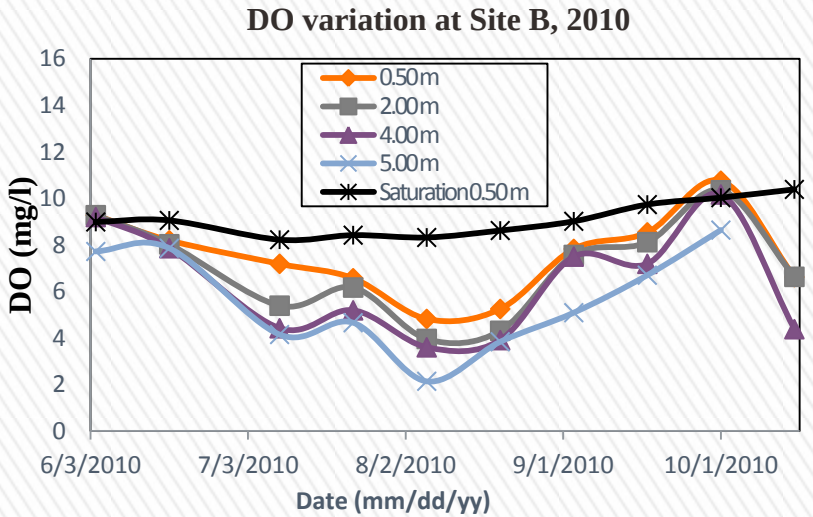
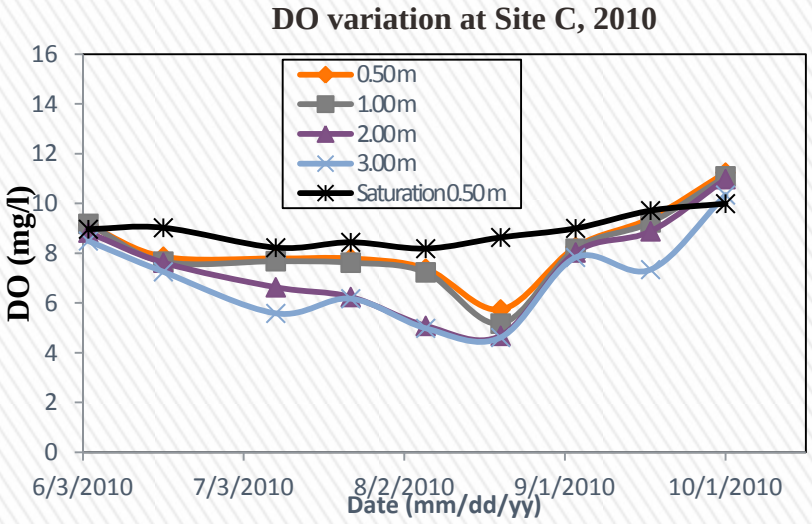
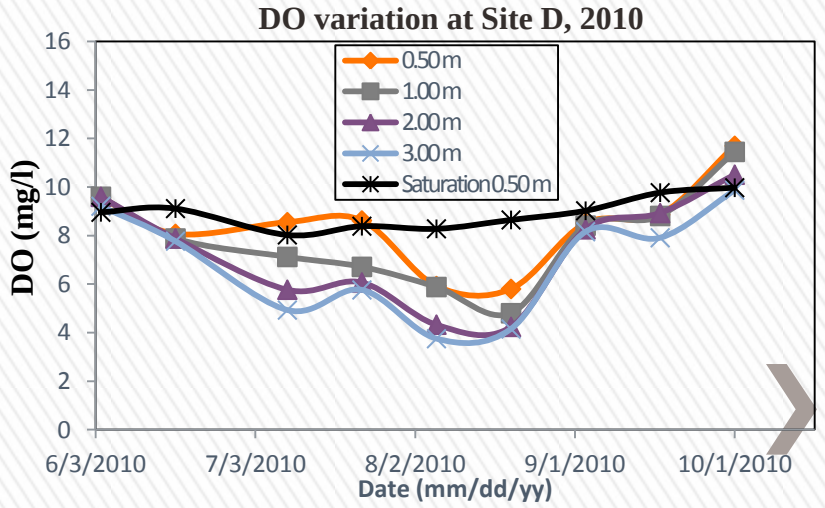
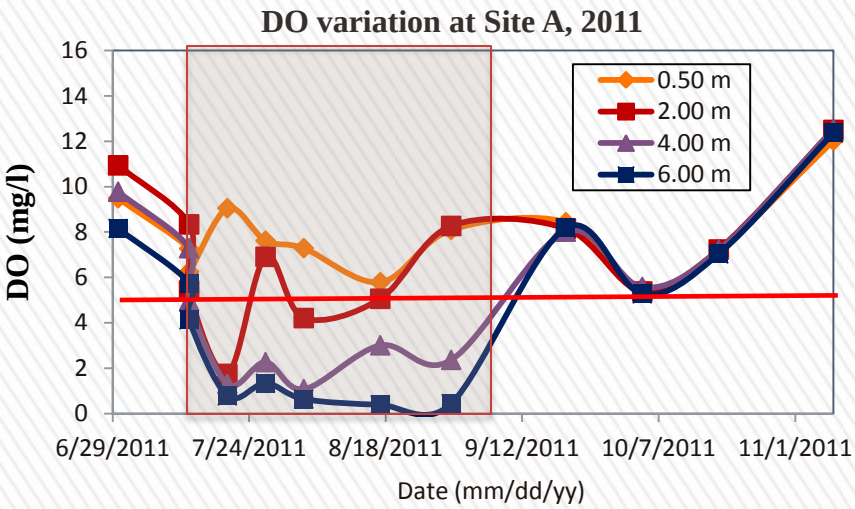


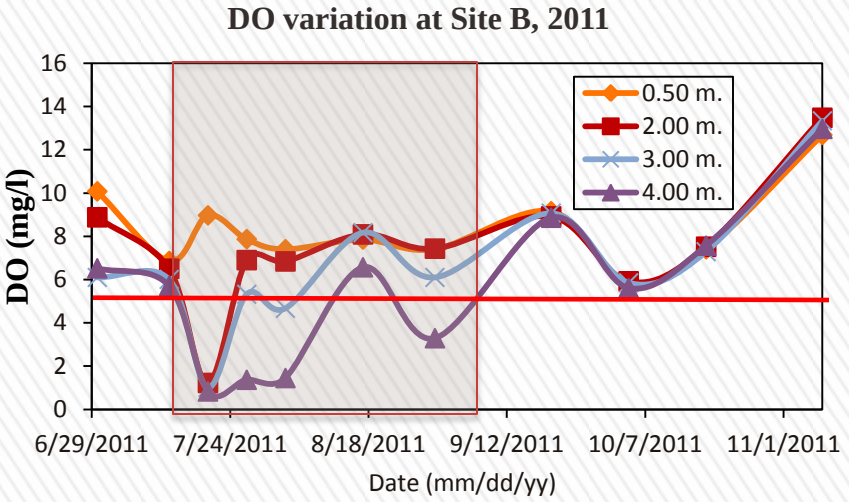


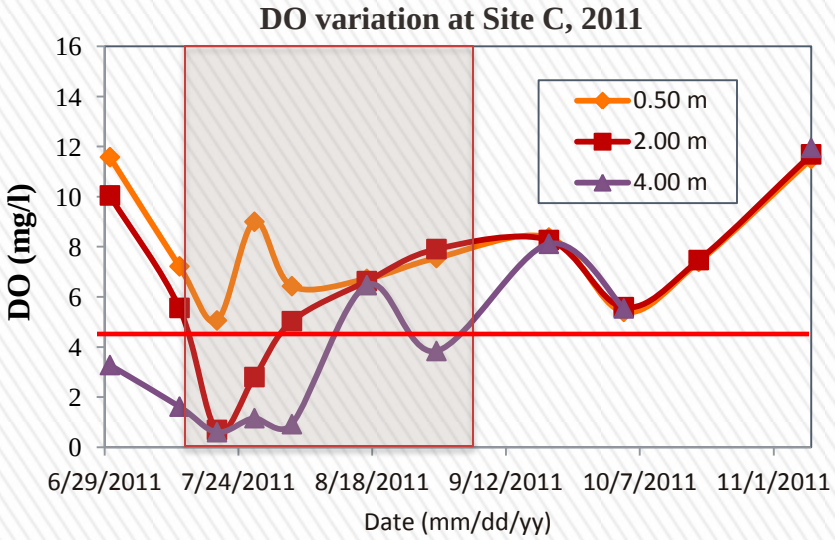


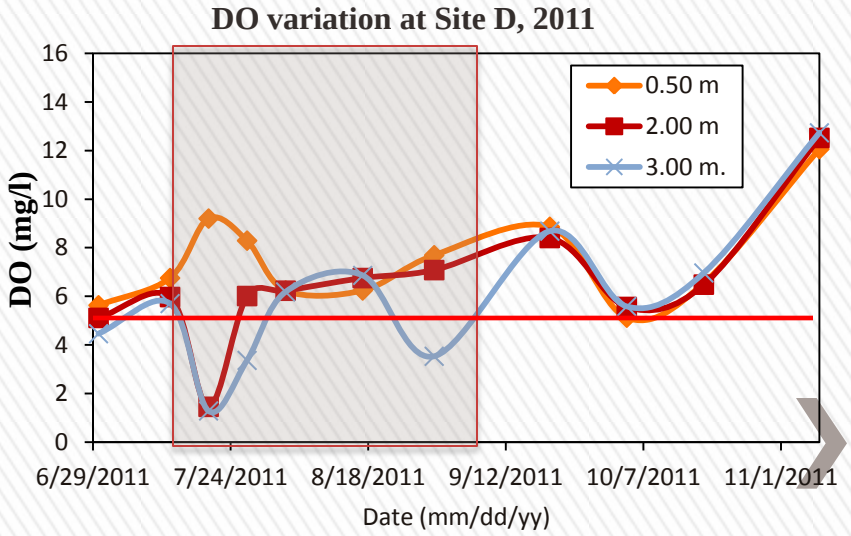


Dissolved Oxygen (DO) 2011









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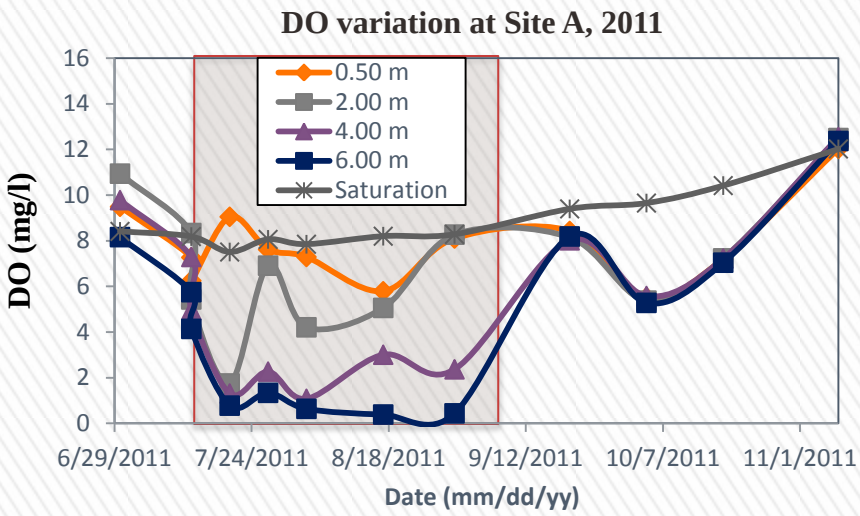
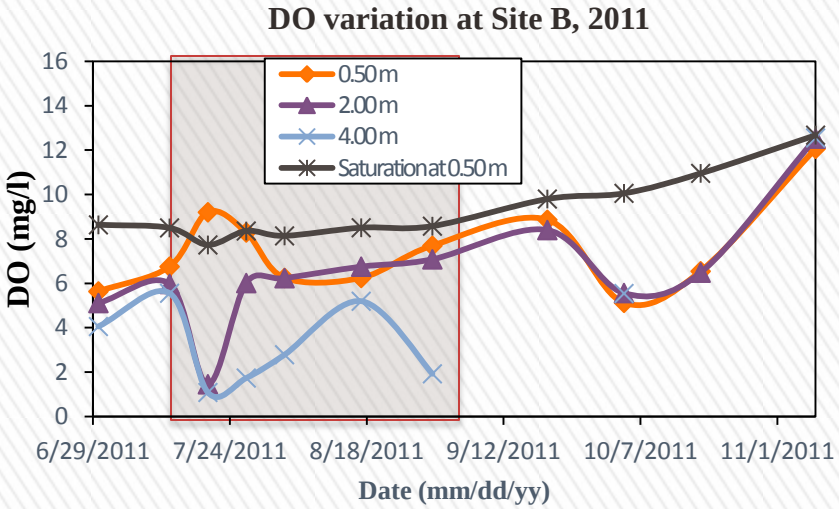
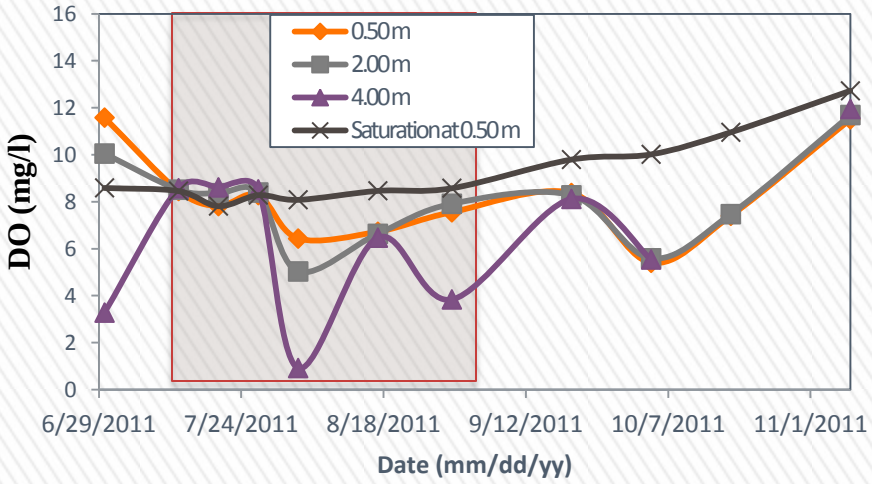
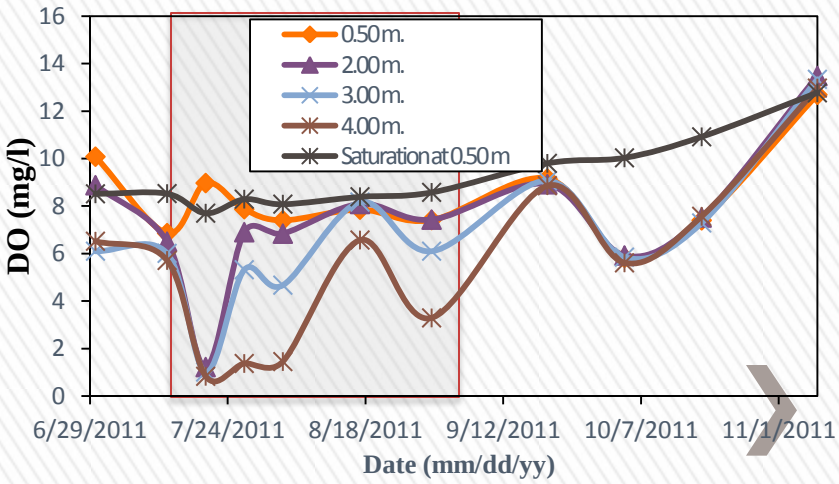


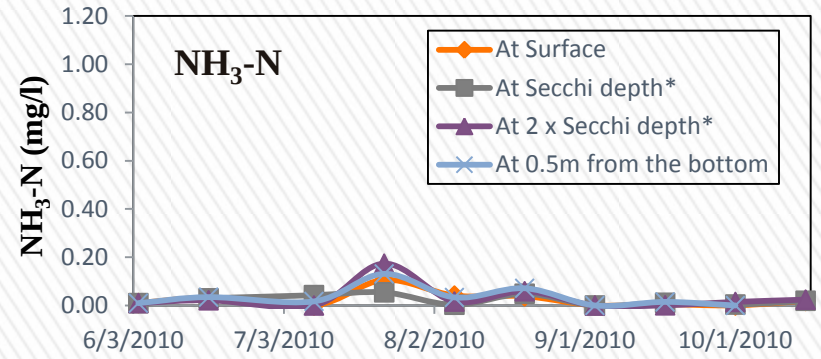


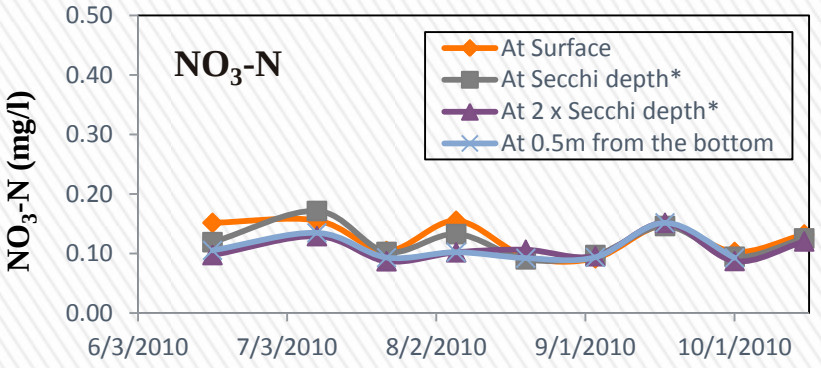


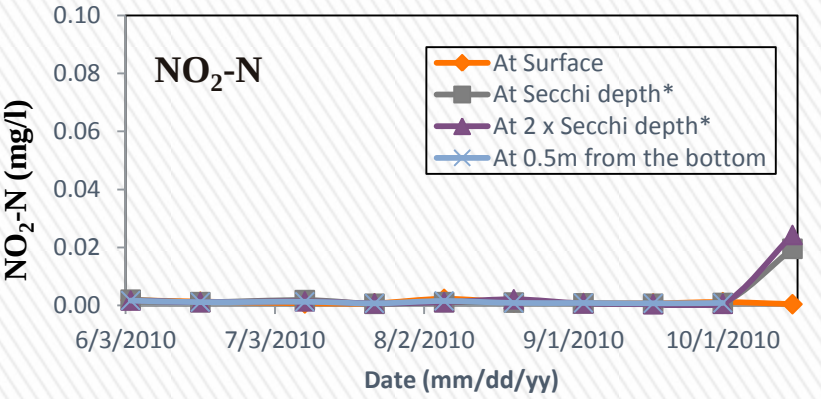


Soluble Inorganic Nitrogen

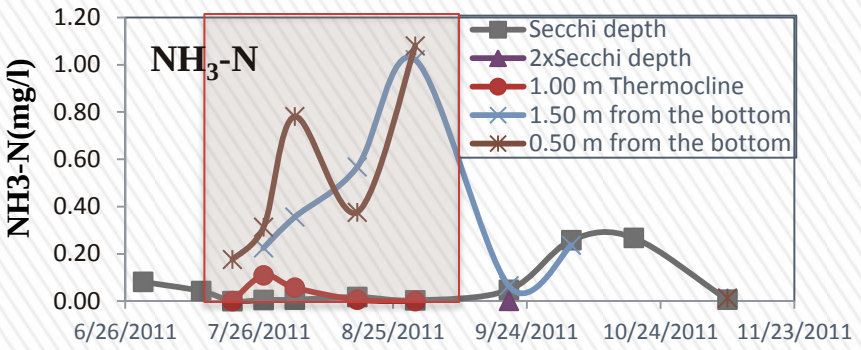
2010

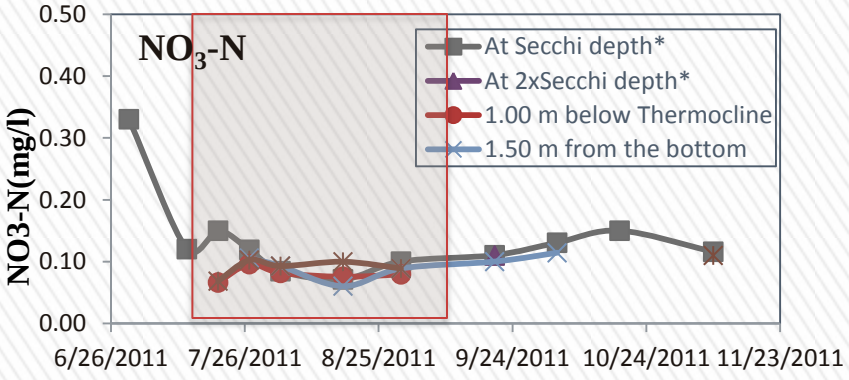


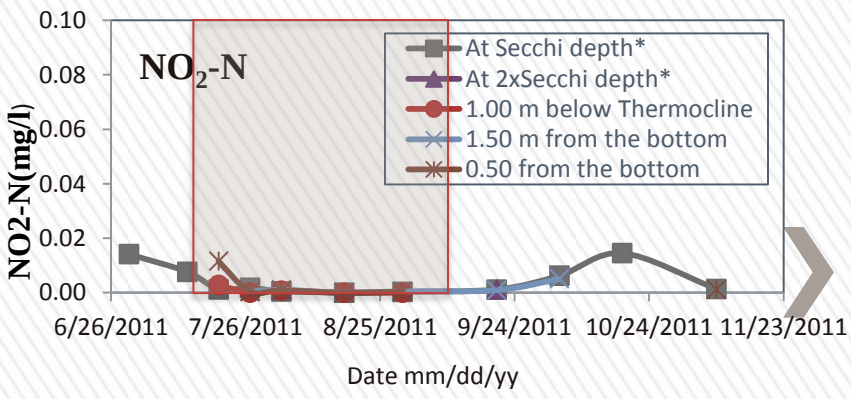




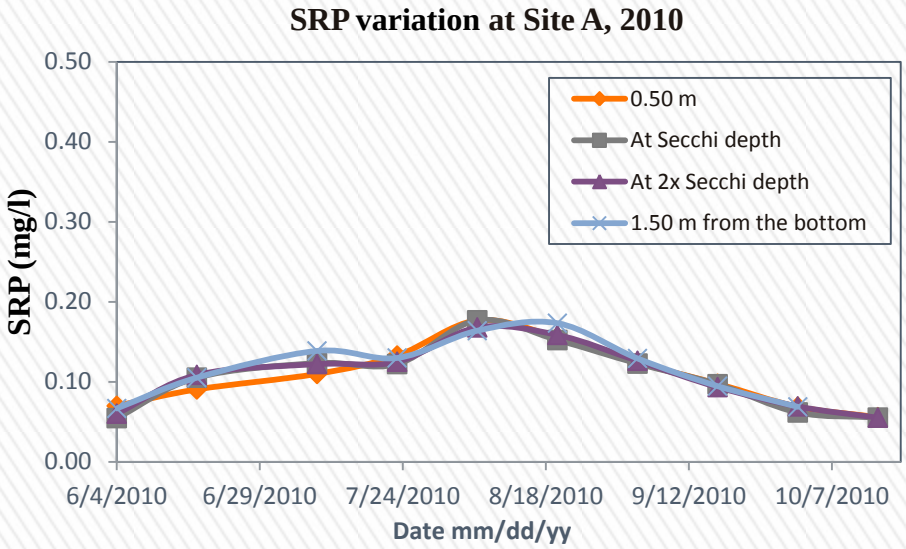
2011

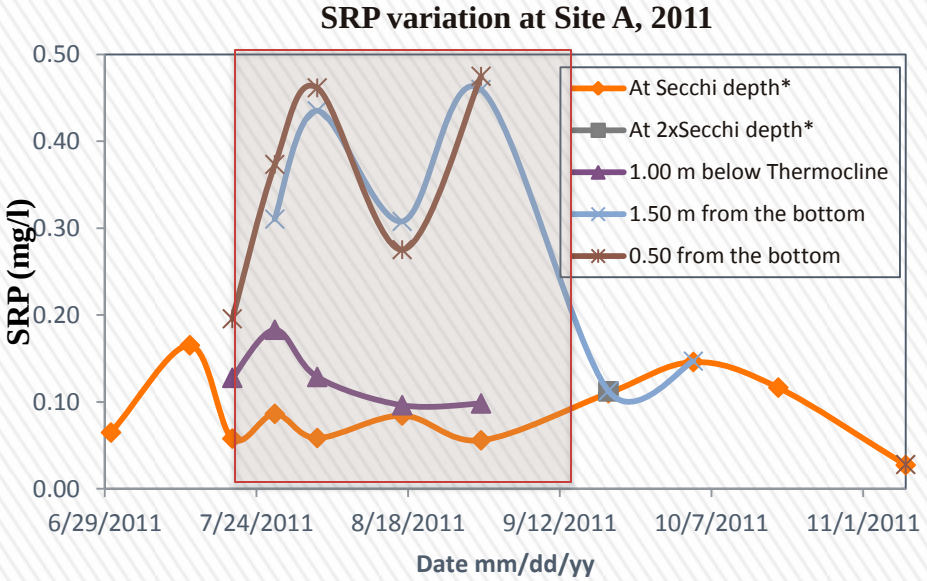






Soluble Reactive Phosphorus (SRP)

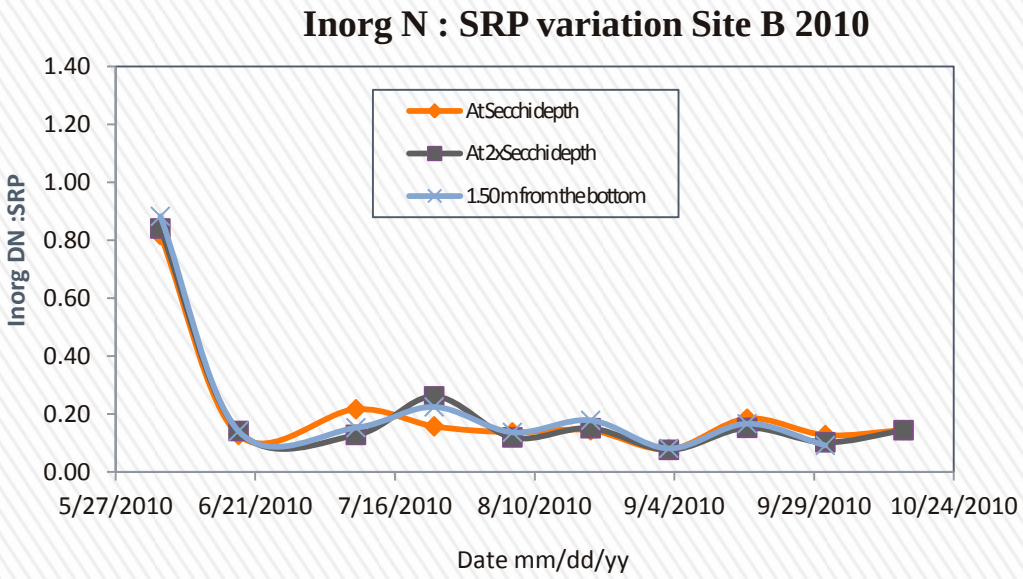


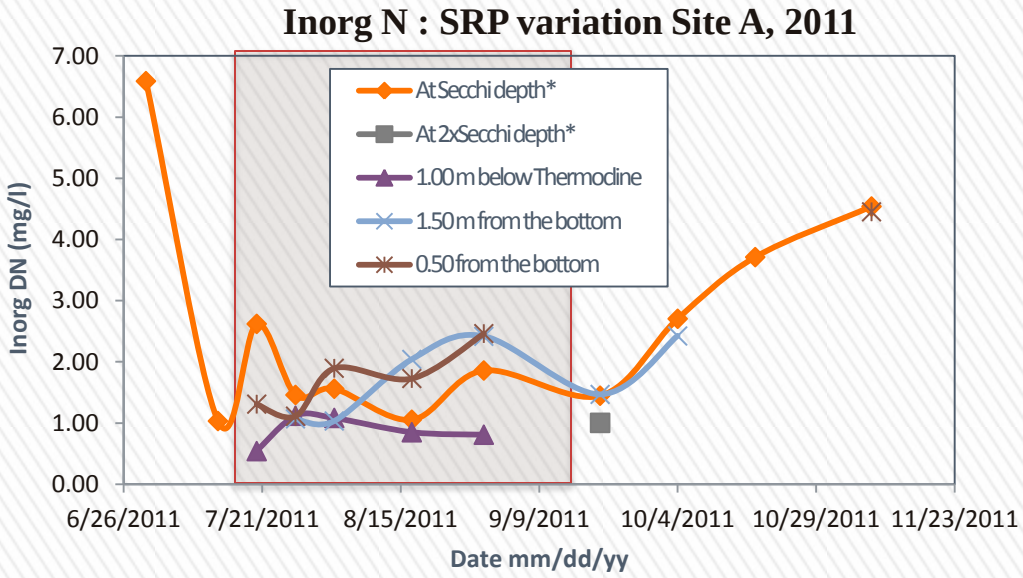


» The vertical distribution of SRP in 2010 shows uniform distribution during study period

» Similar to nitrogen data, accumulation of phosphorus near bottom was also observed during the period without aeration in 2011.

N:P Ratio

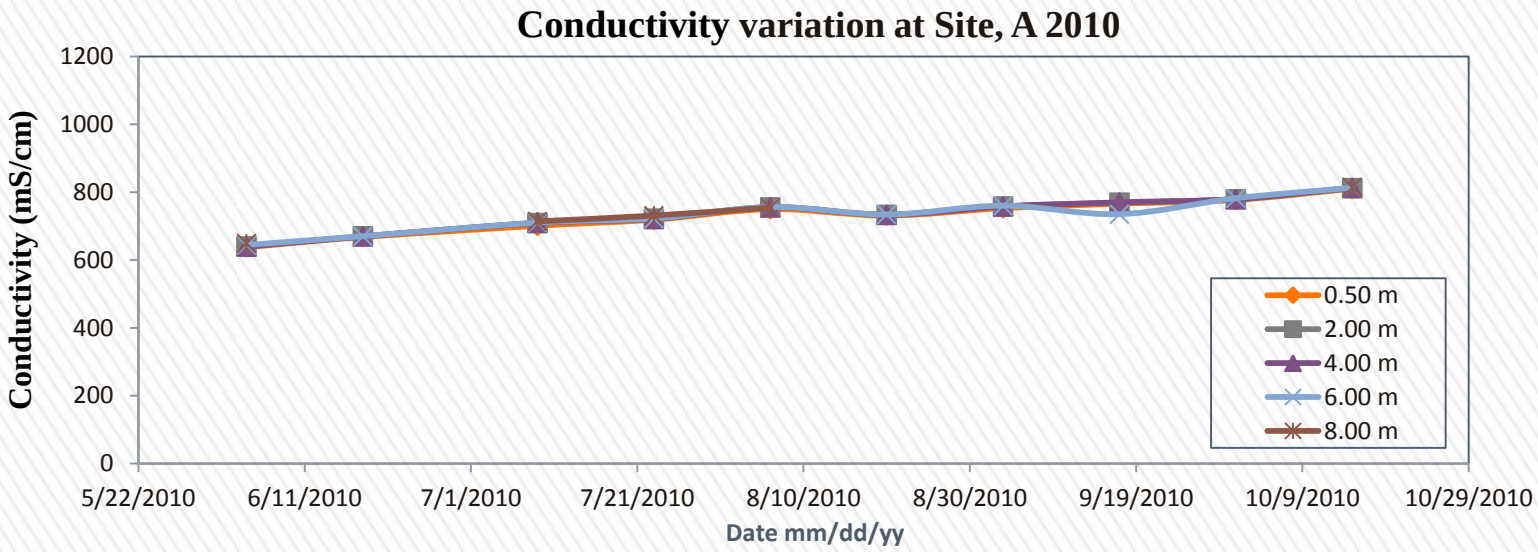


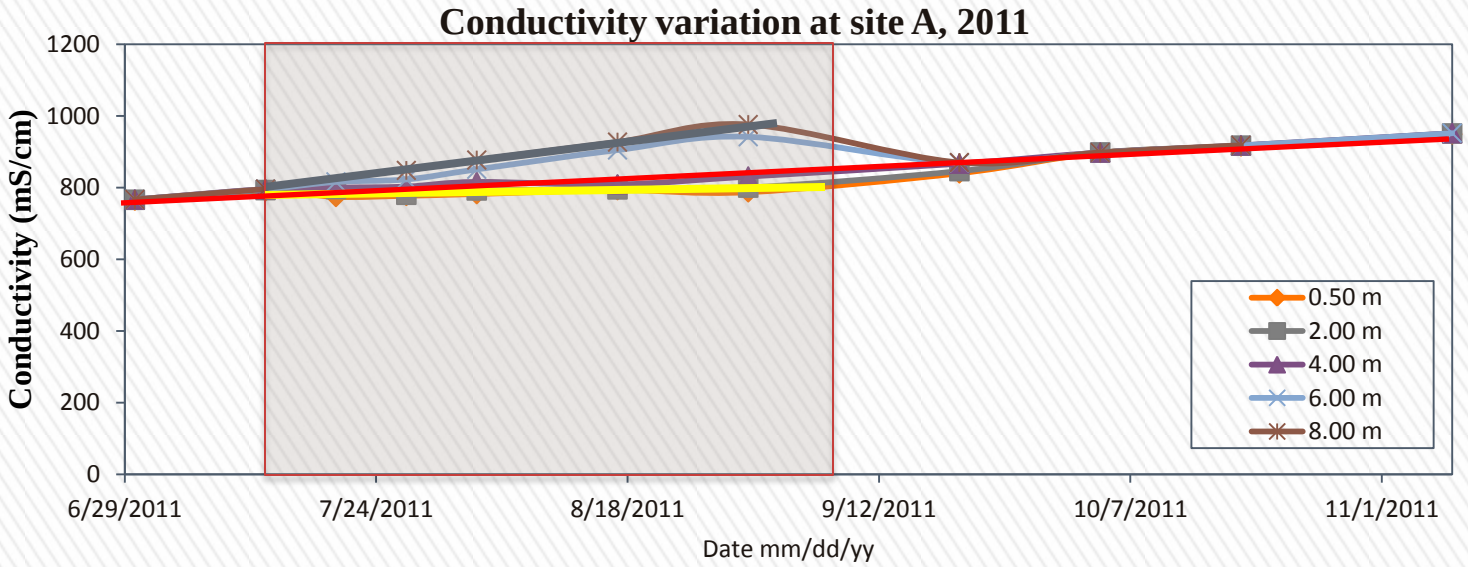


- The Redfield ratio (1958) N/P = 7.2 empirically determinate amounts of N and P that are needed by phytoplankton to growth.
- Low N:P ratio indicating N limiting condition.

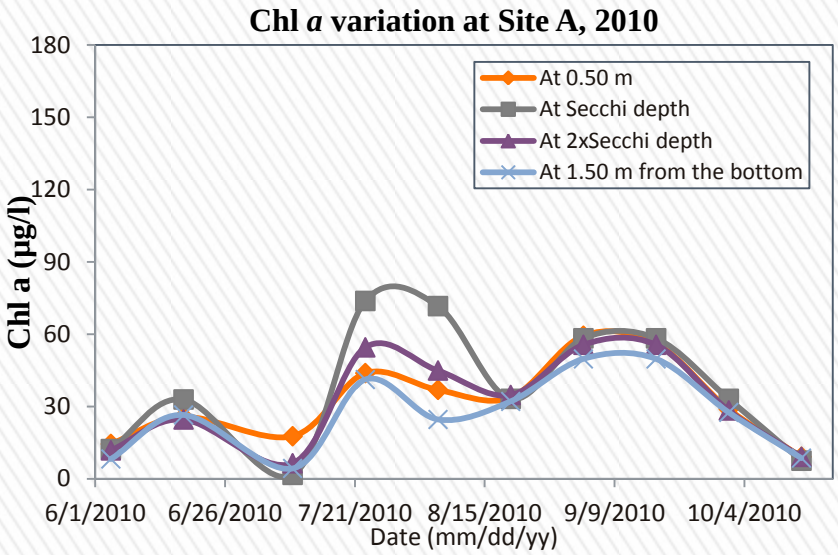
Redfield A (1958) The biological control of chemical factors in the environment. Am Sci 46:205–221

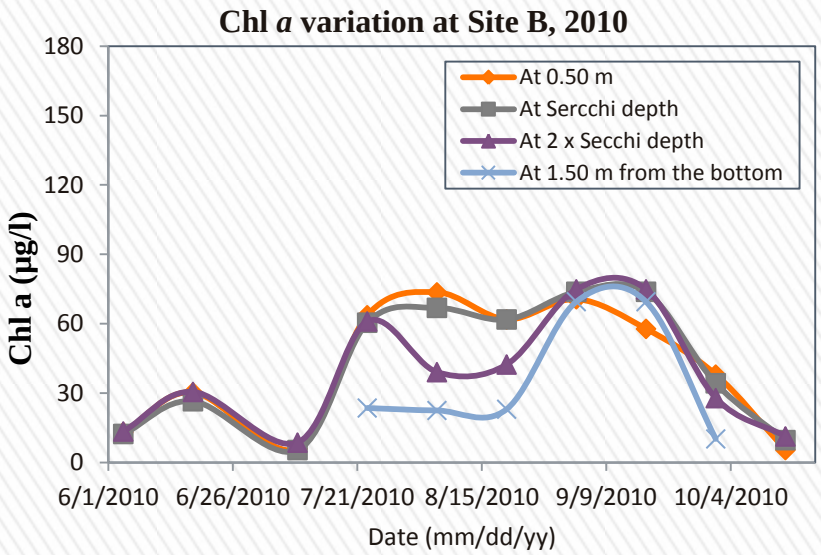
Variation of Conductivity

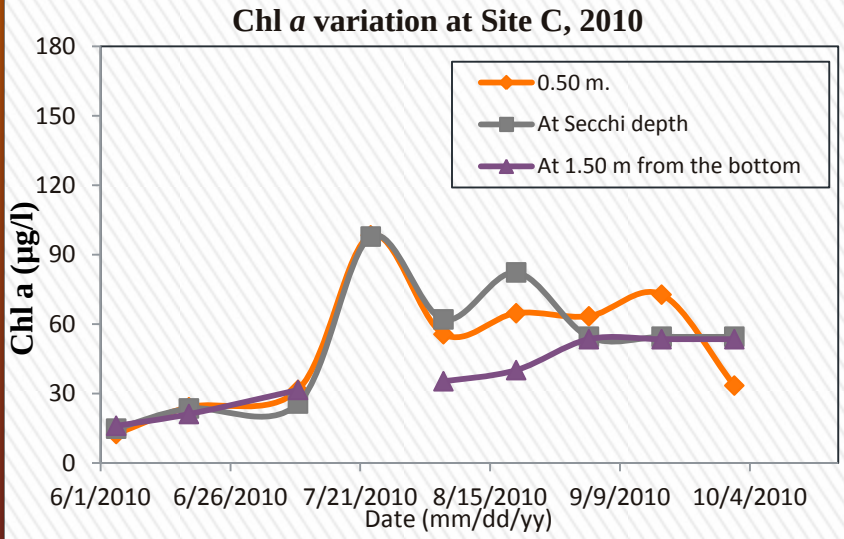


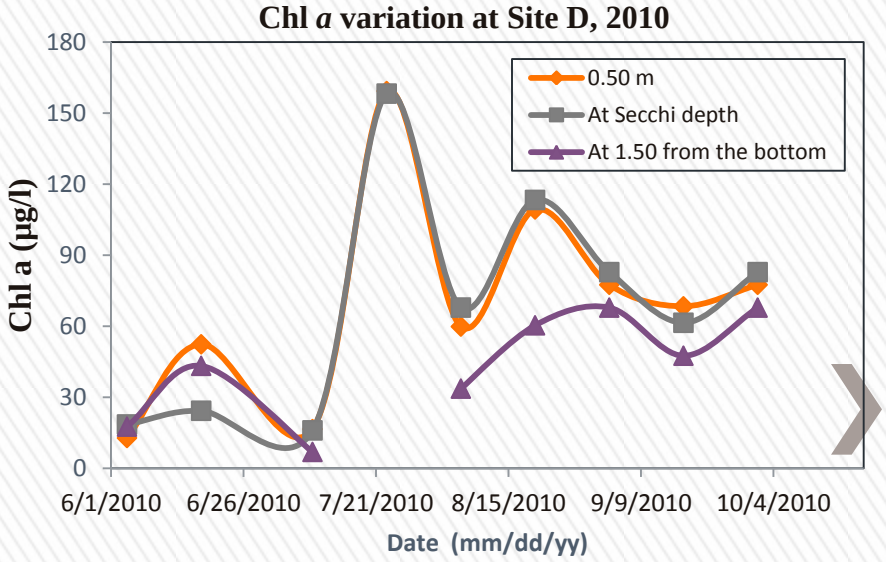


Variation of Chlorophyll a 2010

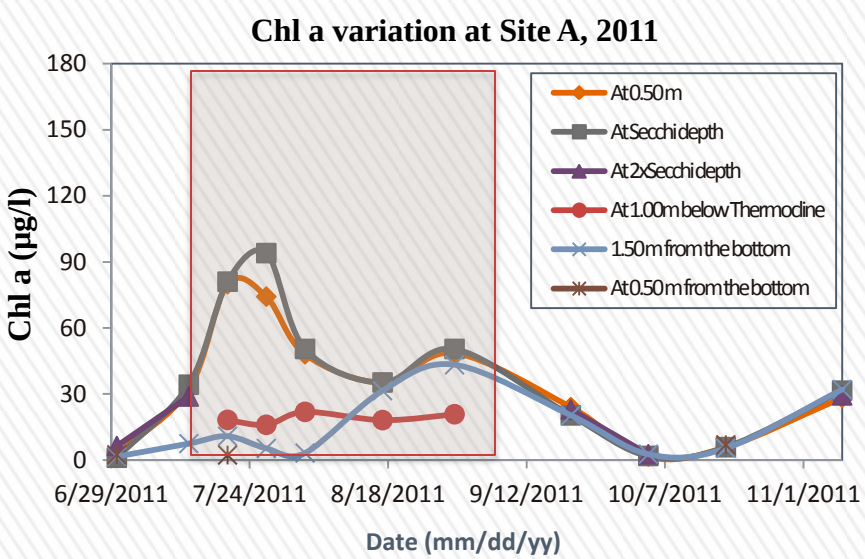


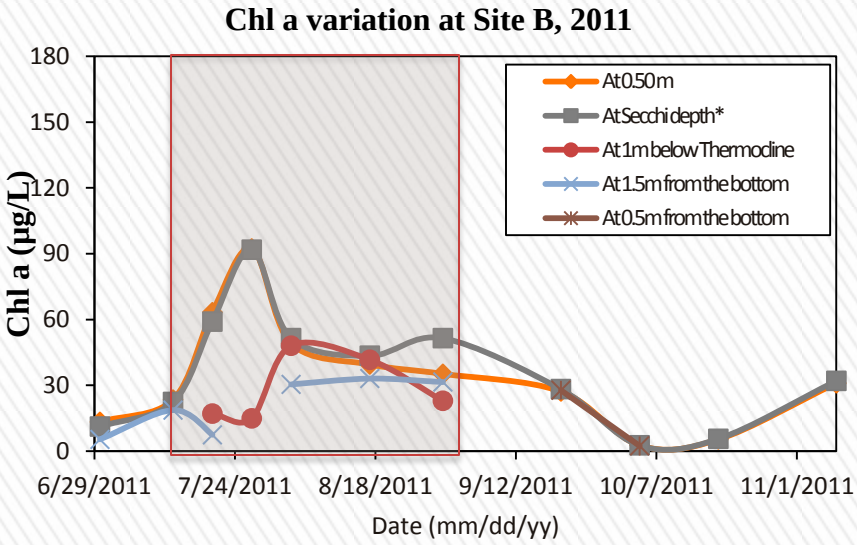


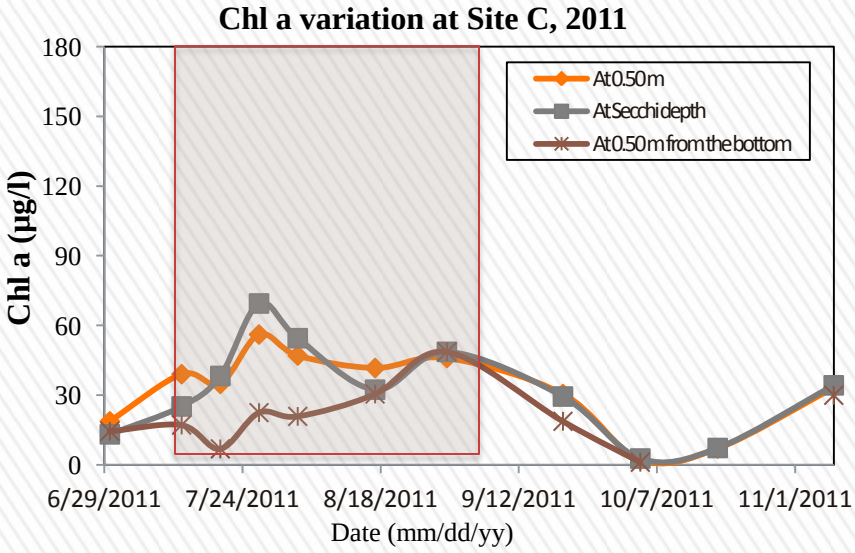


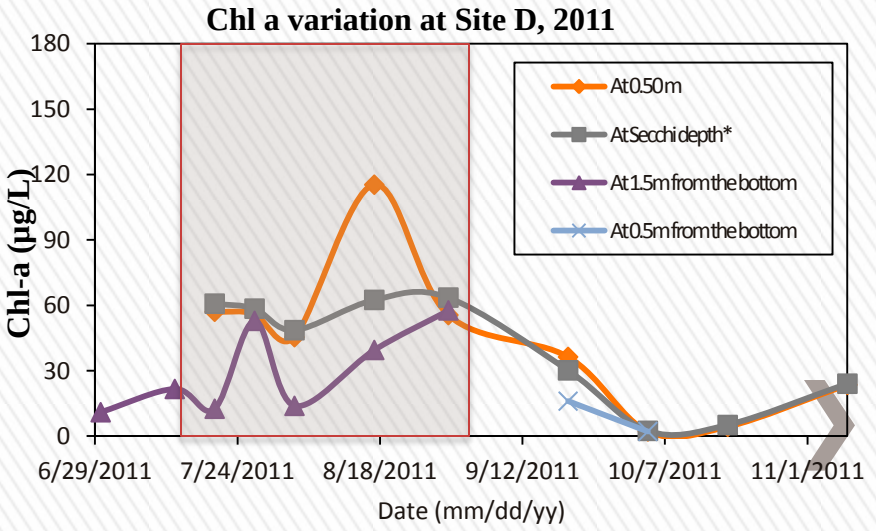


Variation of Chlorophyll a 2011









Algal Bloom
July 13th, 2011

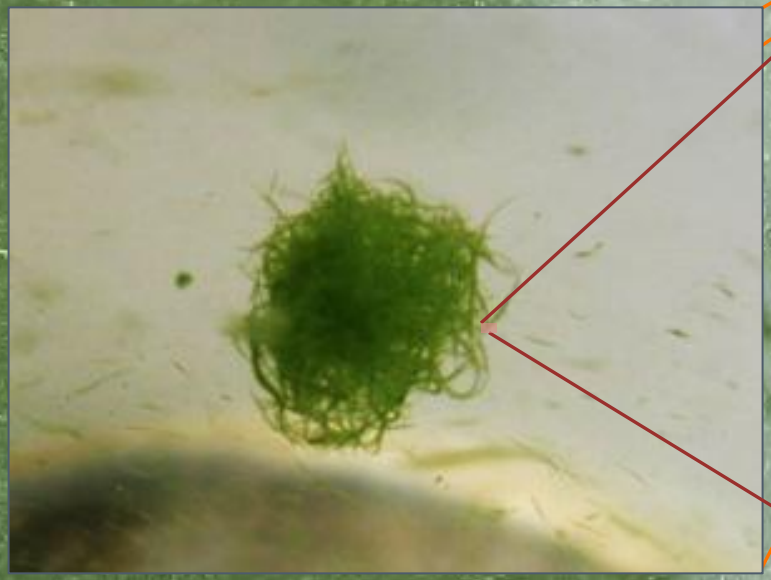
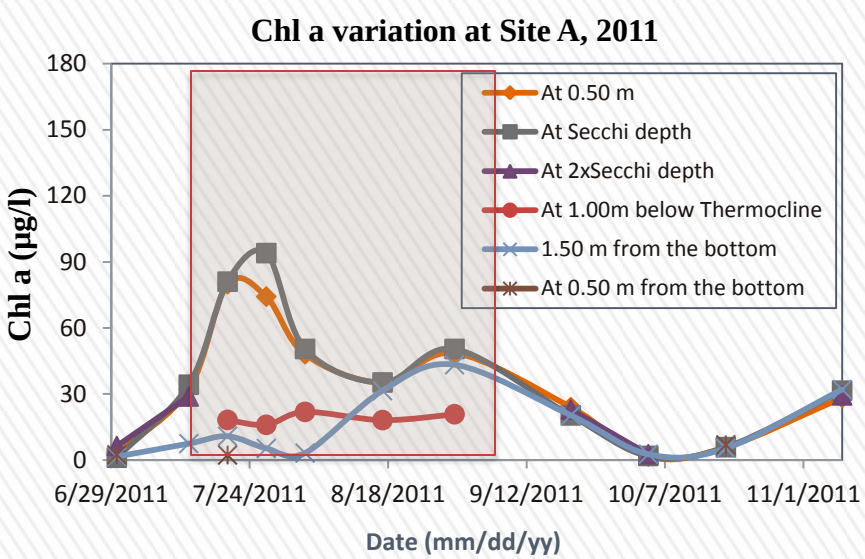
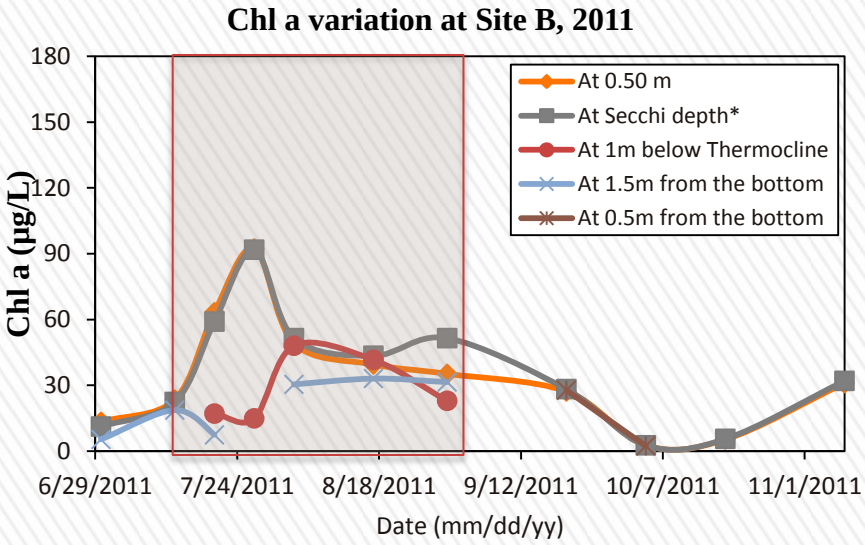
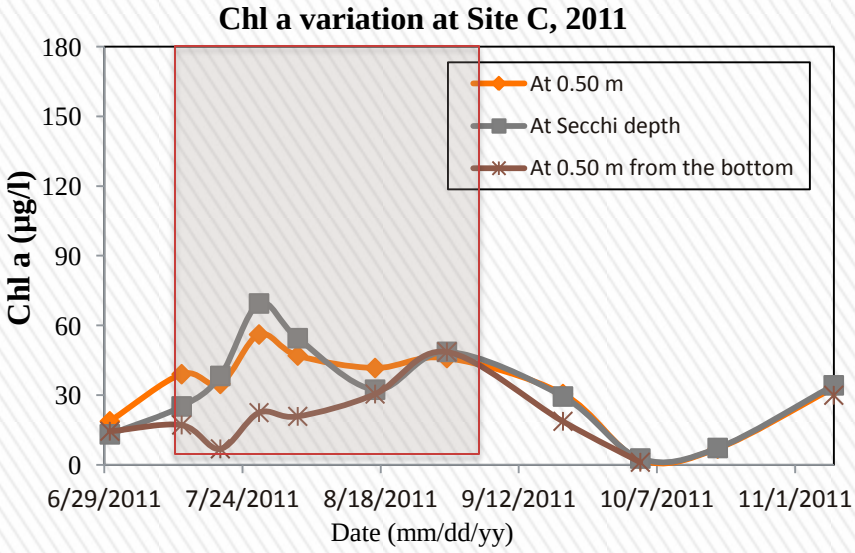


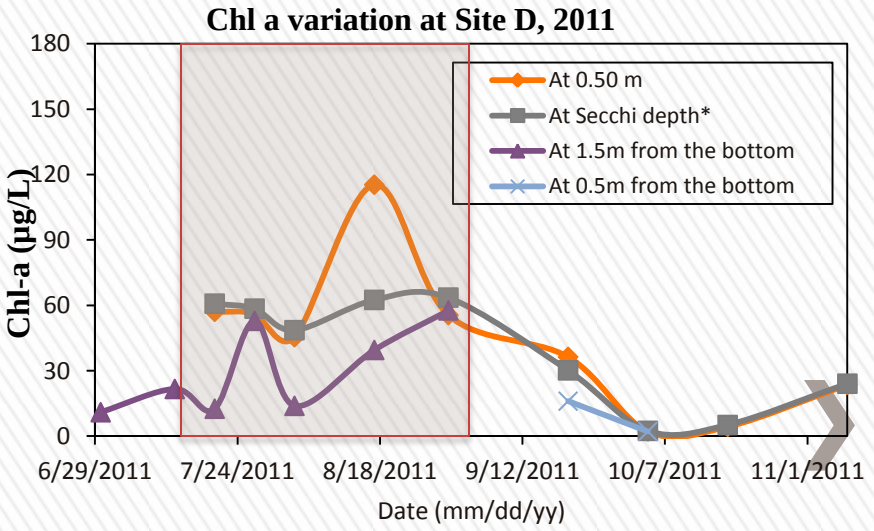
Photo: W. Lin

Variation of Chlorophyll a 2011







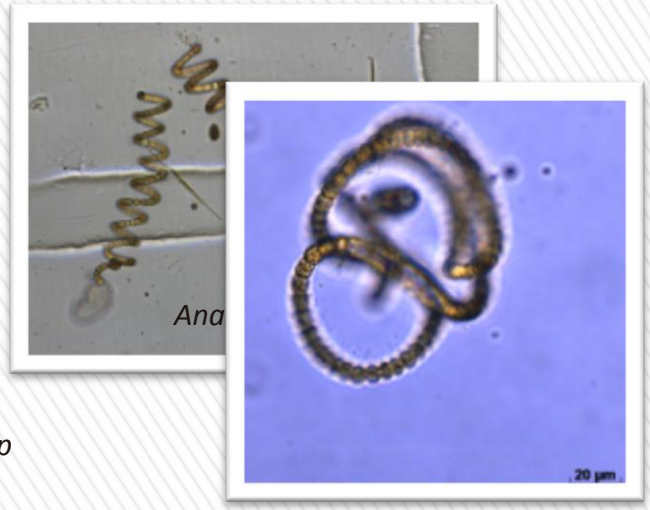


Major Phytoplankton Classes Identified

BACILLARIOPHYCEAE

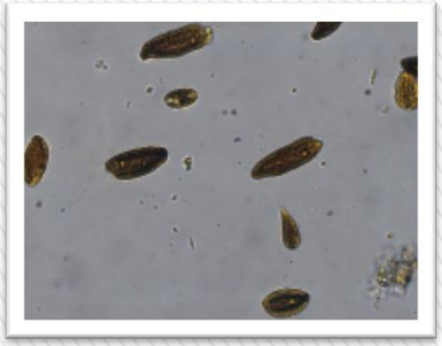
Stephanodiscus and Asteroinell a sp

CYANOPHYCEAE

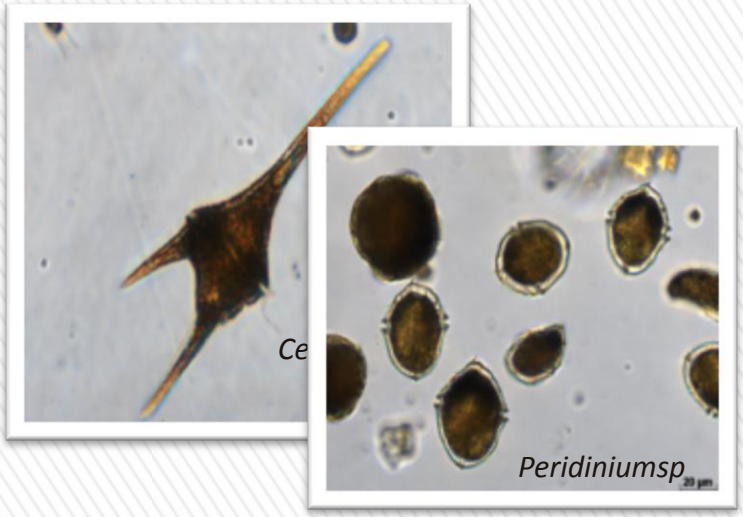


Ana

CRIPTOPHYCEAE



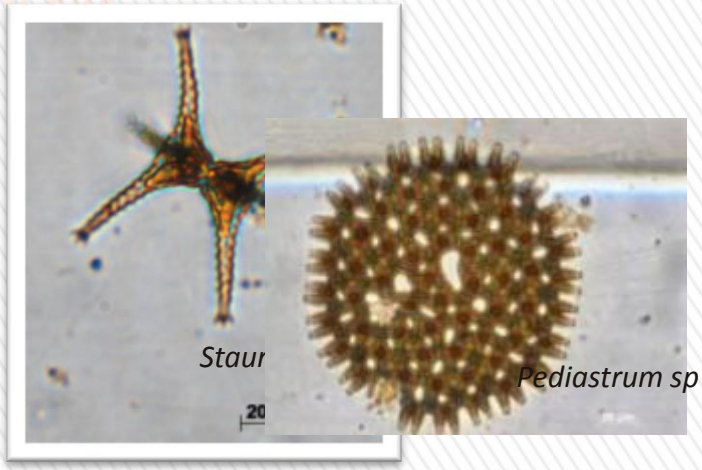
DINOPHYCEAE



Ce

Peridiniumsp

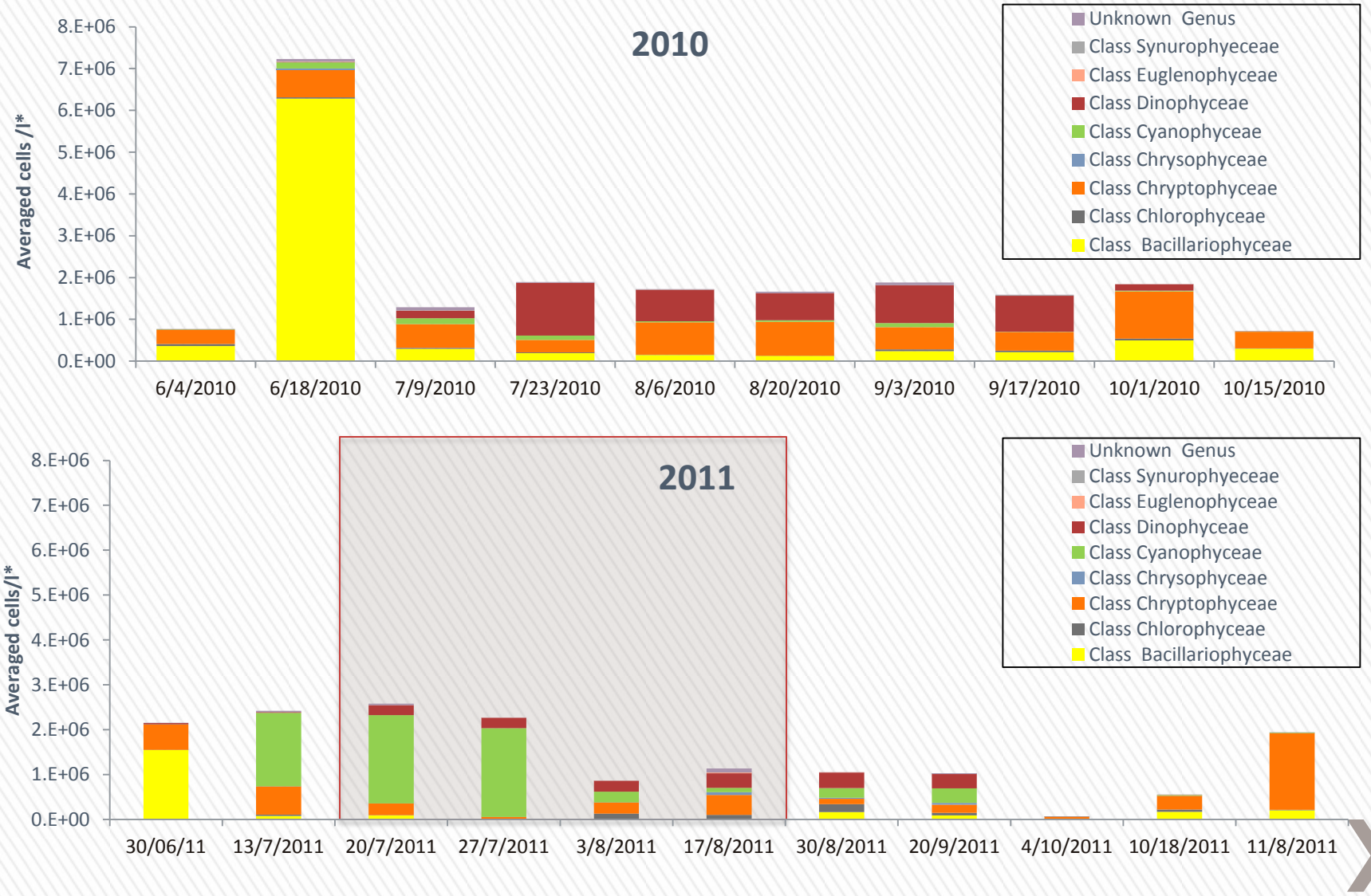
CLOROPHYCEAE



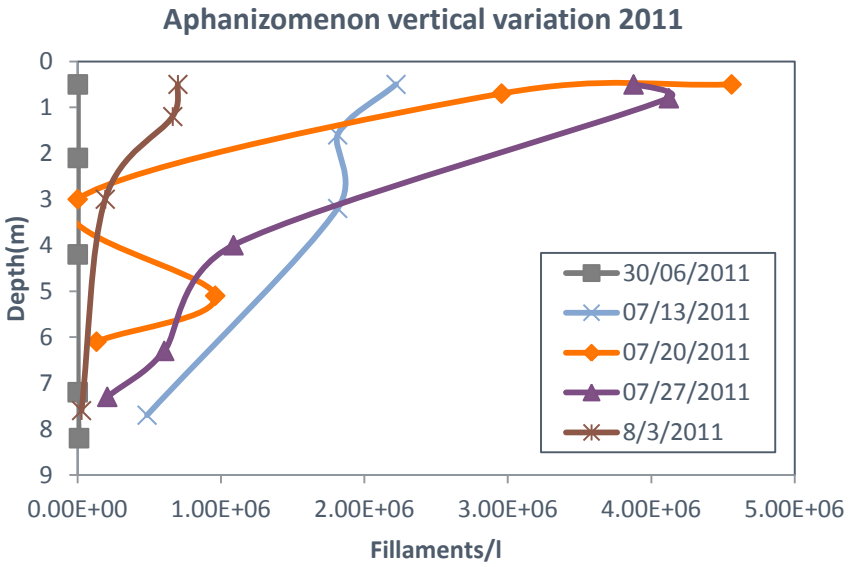
Staur

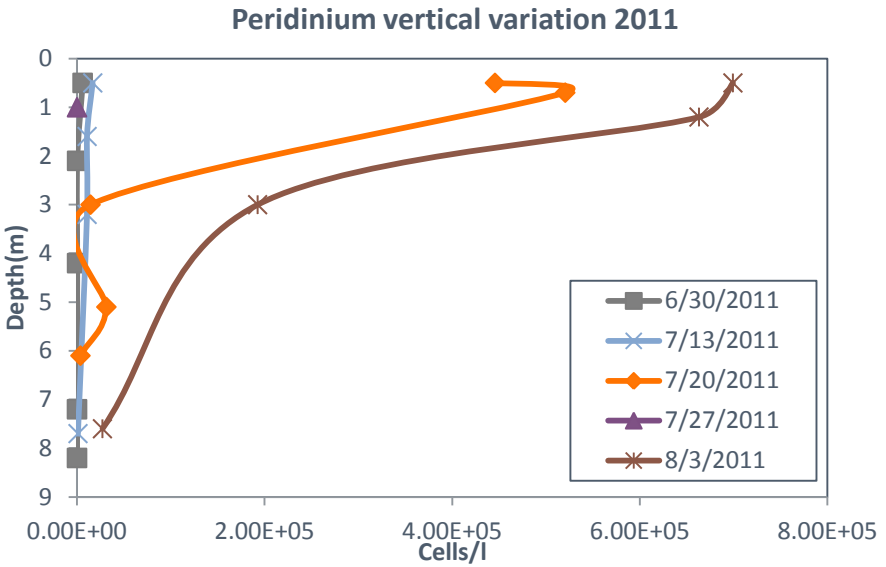
Pediastrum sp

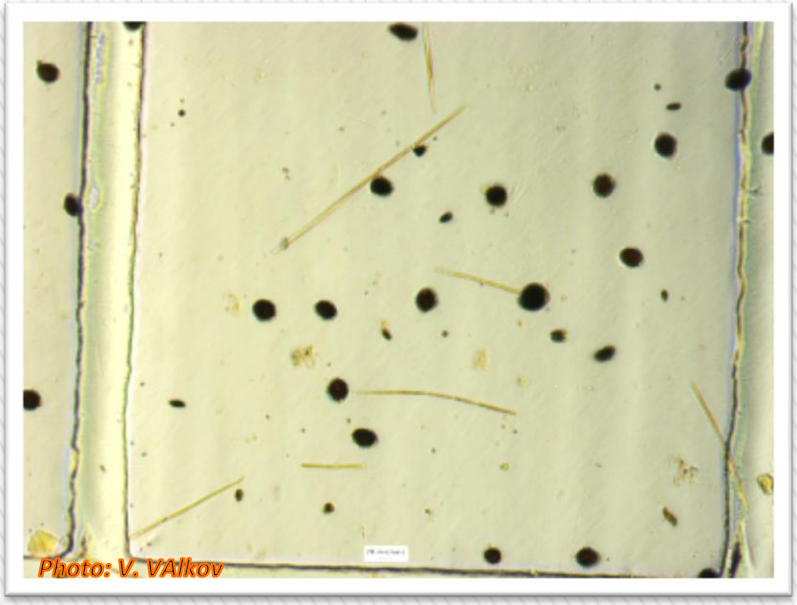
Algal Population Seasonal Variations



Vertical variation of Phytoplankton







Conclusions

- Aeration has eliminated thermal stratification and improved DO at bottom layer
- Accumulation of NH_3-N and SRP as well as increased conductivity near the bottom indicating sediment release as the major nutrient source
- Effects of eutrophication – algae bloom, decayed biomass and fish kill were observed on shallow outlying areas
- Stopping aeration and limited transportation of nutrients especially Phosphorus possibly cause collapse of *Aphanizomenon sp.*

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QUESTIONS ?

Dynobrion sp.

Photo: V. VAlkov