Paw Paw Lake Water Quality Monitoring Summary 2016

Contents:

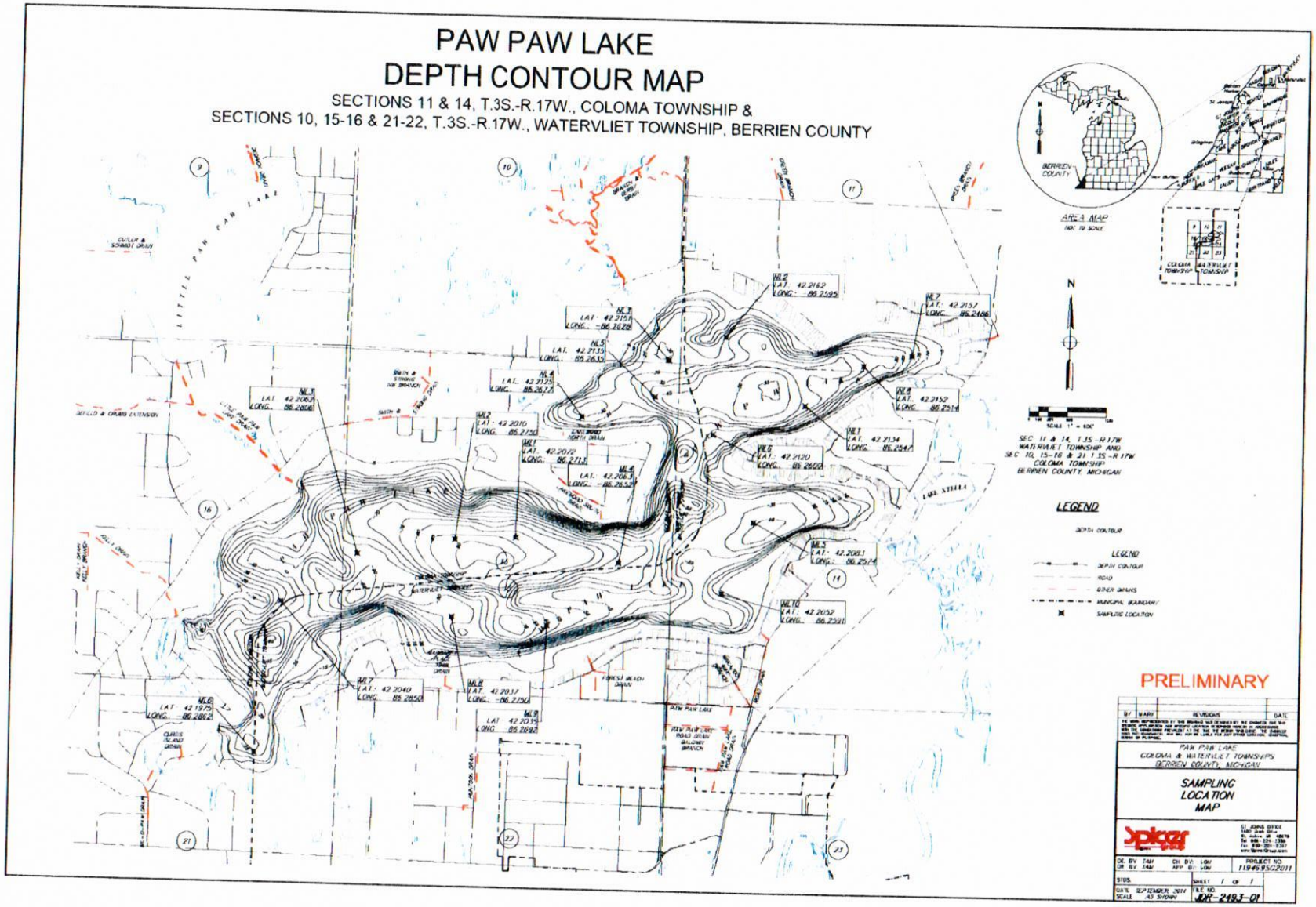
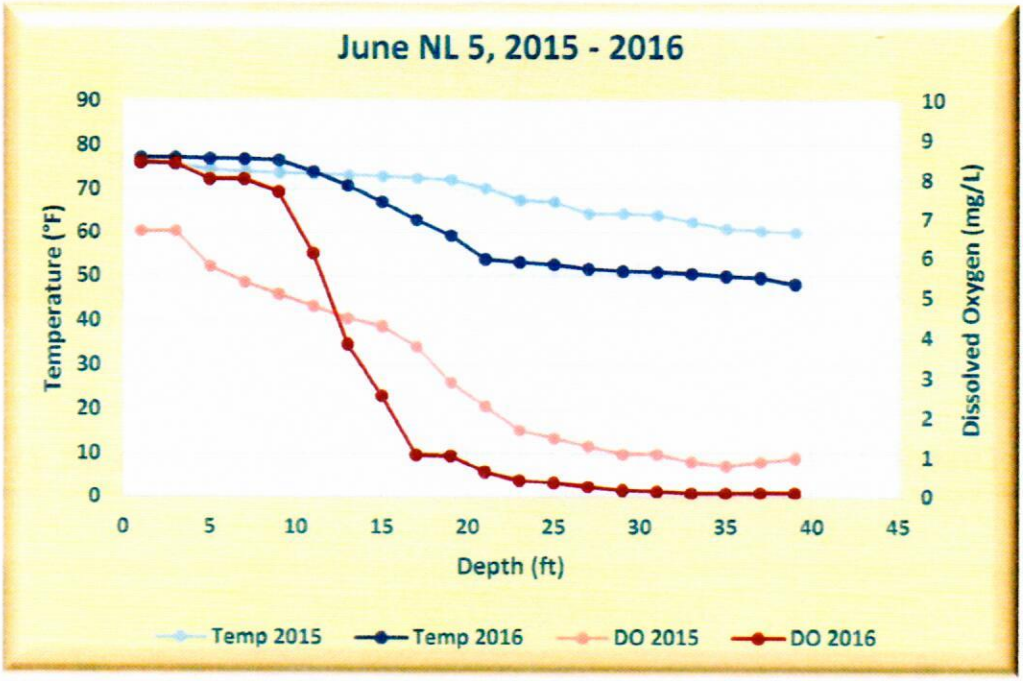
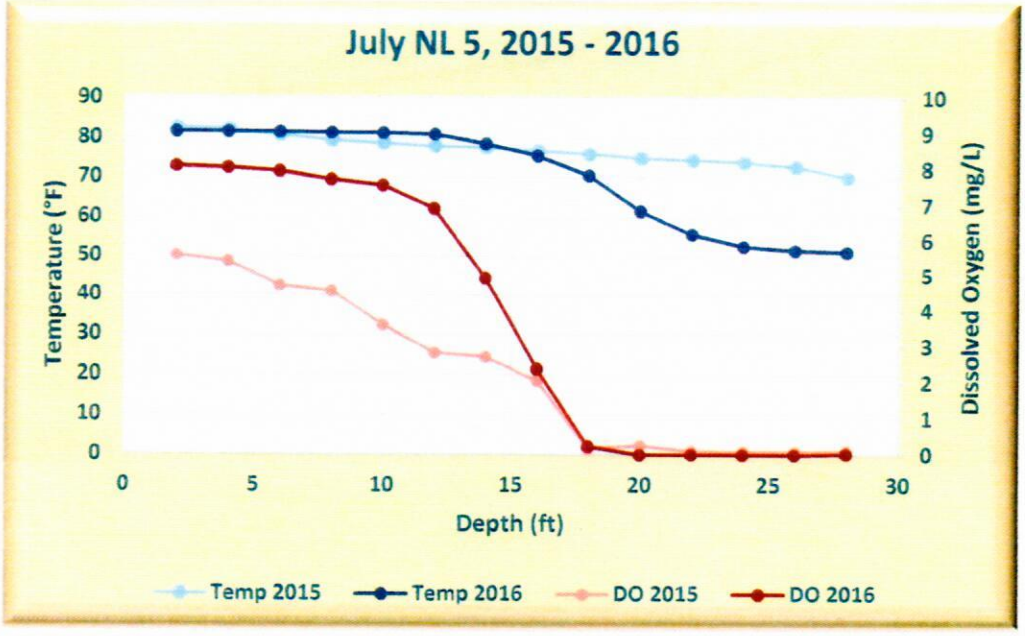


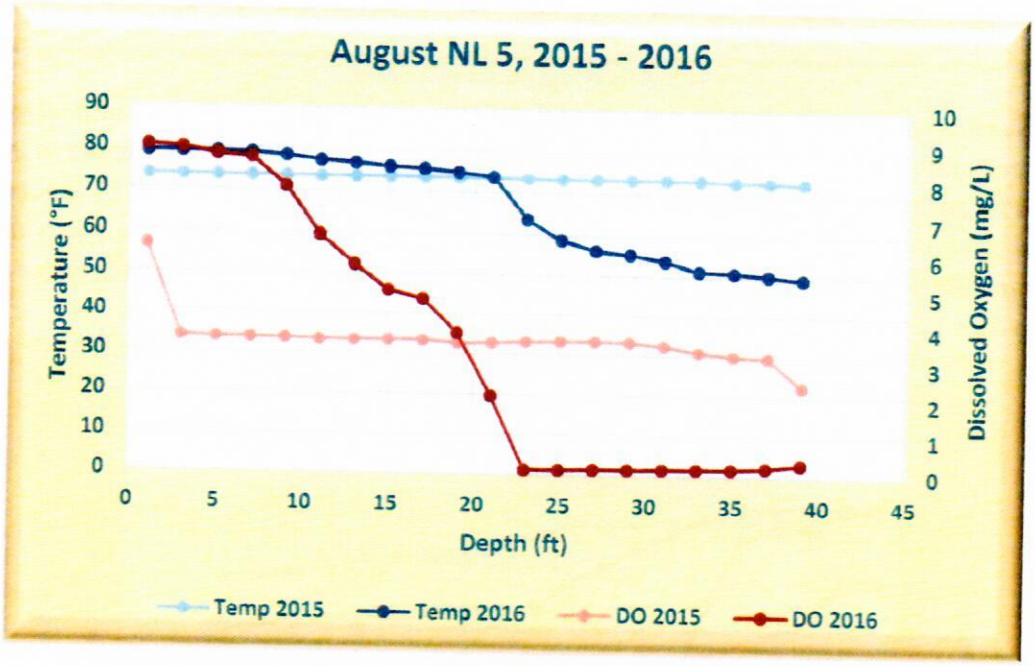
Figure 1 – Monitoring Sites for 2015 and 2016. There are 6 sites in the Northern Lobe portion of Paw Paw Lake (NL 1 – 6) and 6 sites in the Middle Lake portion of Paw Paw Lake (ML 1 – 5, ML7).

Dissolved Oxygen Depth Profiles – North Lobe (Site NL 5)

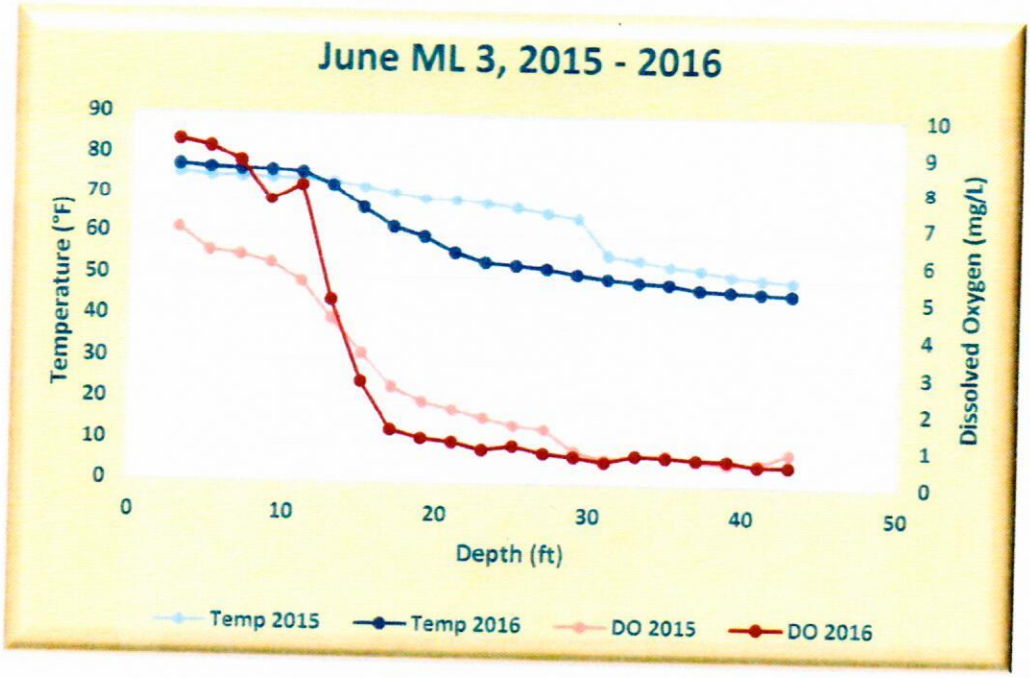
Overall, dissolved oxygen during 2016 was higher in the epilimnion, declined faster as depth increased and had a lower concentration in the hypolimnion compared to 2015 data. Temperature observed in 2016 was very similar to 2015's epilimnion data, however, temperature in the hypolimnion during 2016 tended to be lower than 2015's hypolimnion data. Two representative sites of Paw Paw Lake, one from the north lobe (NL 5) and one from the middle lake (ML 3) have been used to represent the trend observed in temperature and dissolved oxygen in Paw Paw Lake during the 2016 monitoring season and are depicted below.

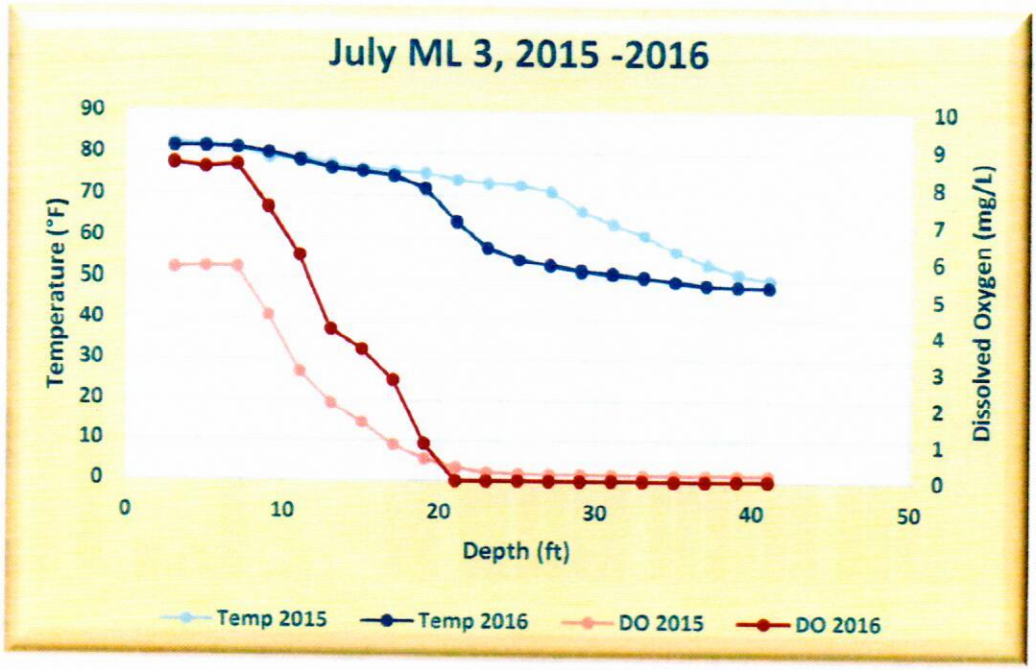


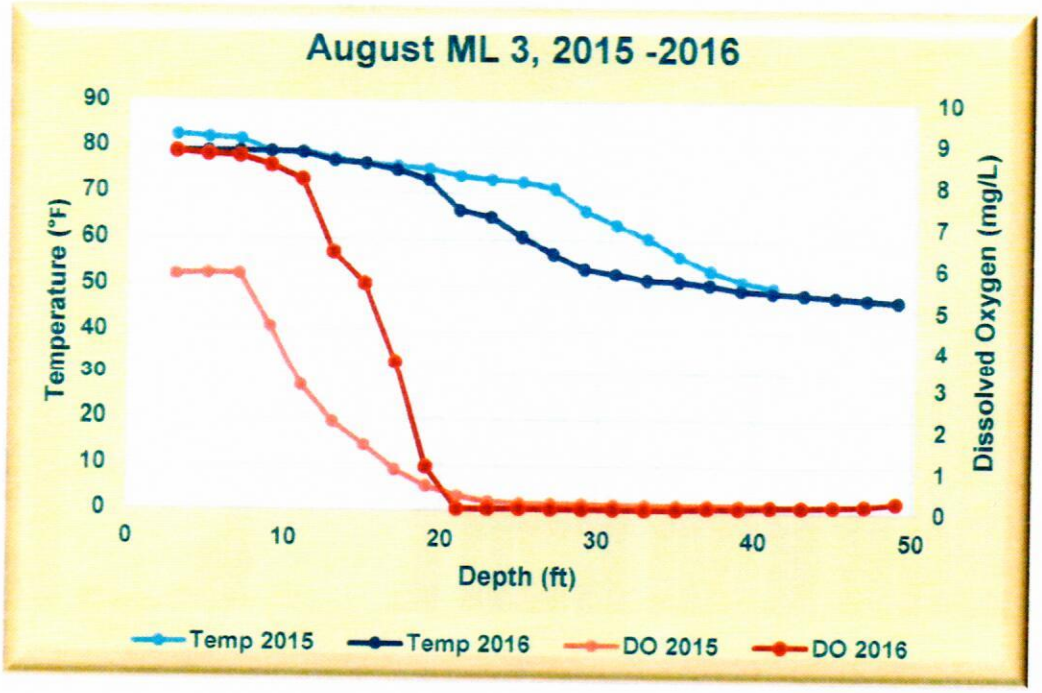




Dissolved Oxygen Depth Profiles – Middle Lake (Site ML 3)

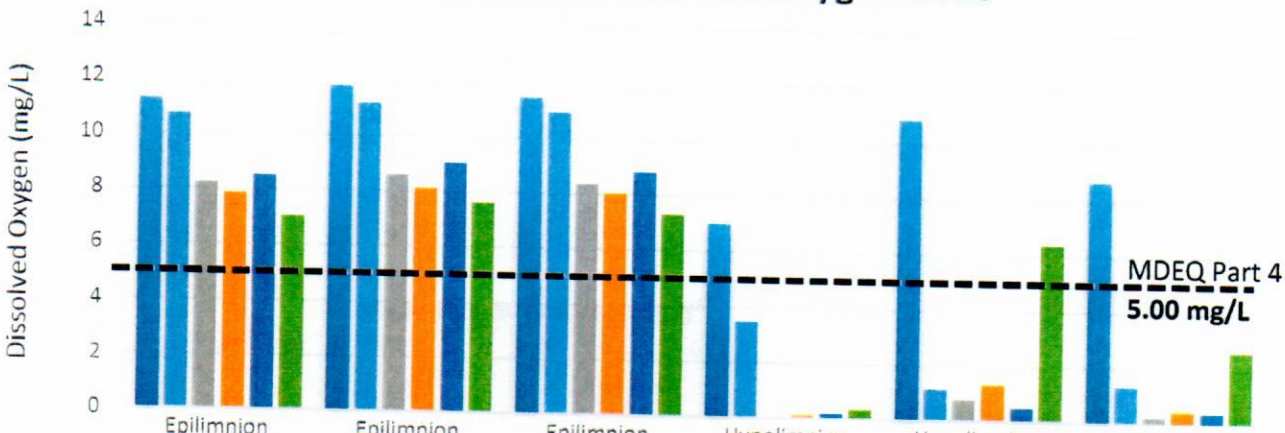



July ML 3, 2015 -2016
Temperature (°F)
Dissolved Oxygen (mg/L)
Depth (ft)
Temp 2015
Temp 2016
DO 2015
DO 2016


August ML 3, 2015 -2016
Temperature (°F)
Dissolved Oxygen (mg/L)
Depth (ft)
Temp 2015
Temp 2016
DO 2015
DO 2016

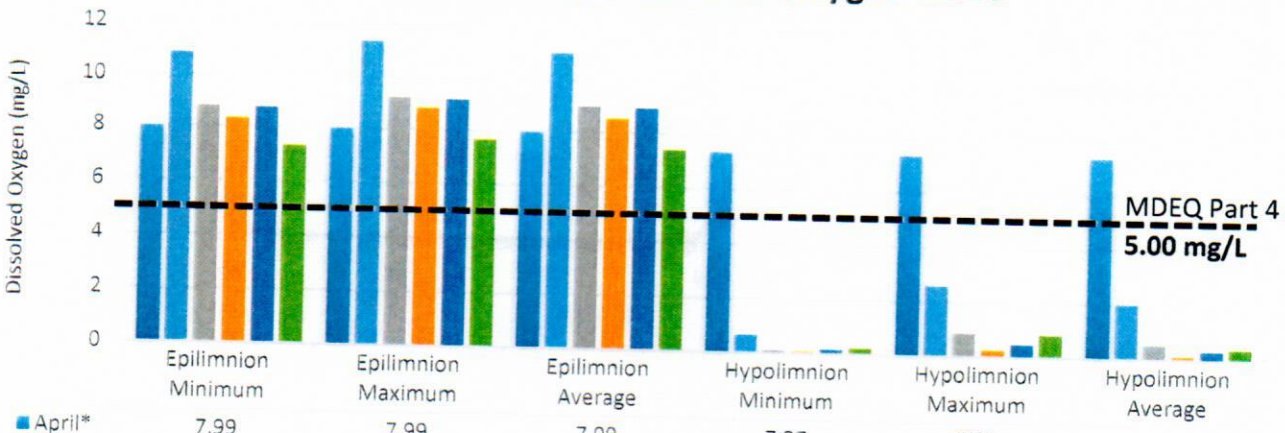
Dissolved Oxygen Summary 2016

North Lobe Dissolved Oxygen 2016



	Epilimnion Minimum	Epilimnion Maximum	Epilimnion Average	Hypolimnion Minimum	Hypolimnion Maximum	Hypolimnion Average
April	11.27	11.8	11.5	7.01	10.9	8.71
May	10.74	11.16	10.98	3.52	1.14	1.3
June	8.23	8.6	8.37	0.06	0.78	0.24
July	7.85	8.12	8.04	0.11	1.33	0.44
August	8.51	9.07	8.84	0.19	0.51	0.4
October	7.02	7.62	7.29	0.34	6.4	2.64

Middle Lake Dissolved Oxygen 2016

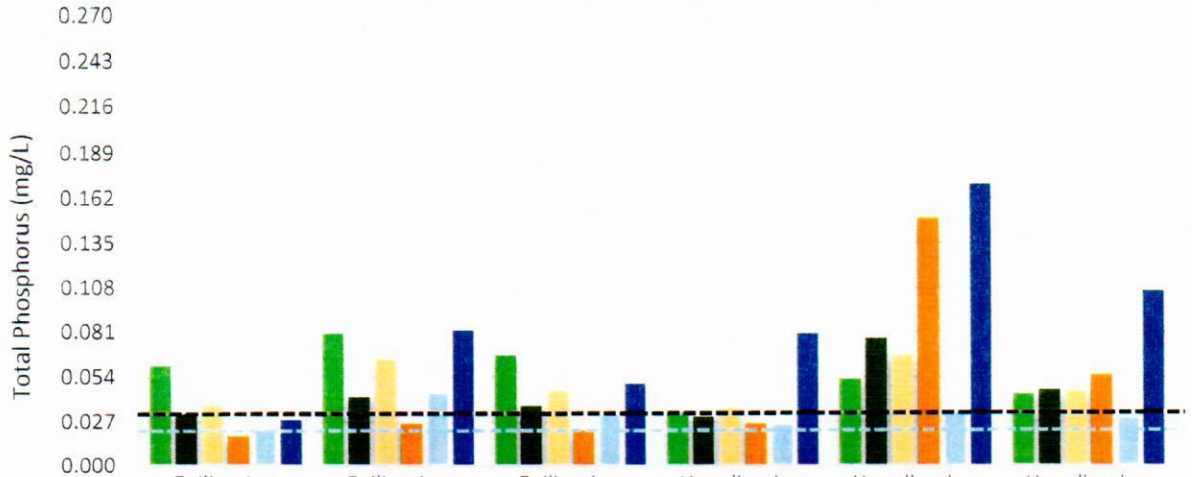


	Epilimnion Minimum	Epilimnion Maximum	Epilimnion Average	Hypolimnion Minimum	Hypolimnion Maximum	Hypolimnion Average
April*	7.99	7.99	7.99	7.37	7.37	7.37
May	10.84	11.36	11.03	0.67	2.6	2.03
June	8.78	9.21	8.99	0.11	0.86	0.52
July	8.28	8.76	8.49	0.08	0.24	0.14
August	8.74	9.16	8.91	0.16	0.46	0.33
October	7.3	7.65	7.4	0.22	0.83	0.41

*** April epilimnion and hypolimnion values are only one measurement due to the Quanta probe being lost.**

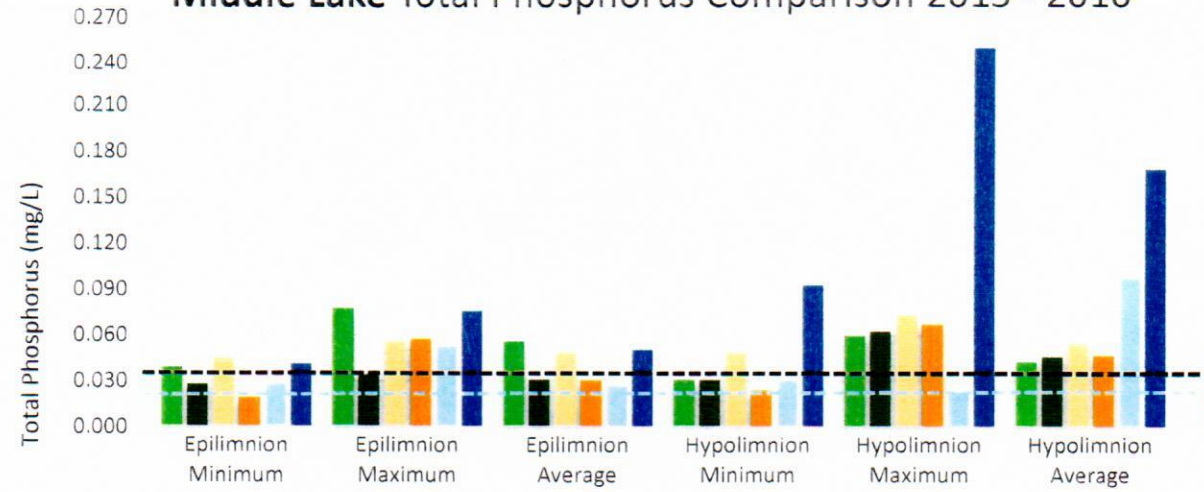
Total Phosphorus 2015 - 2016 Comparison Summary

Northern Lobe Total Phosphorus Comparisons 2015 - 2016



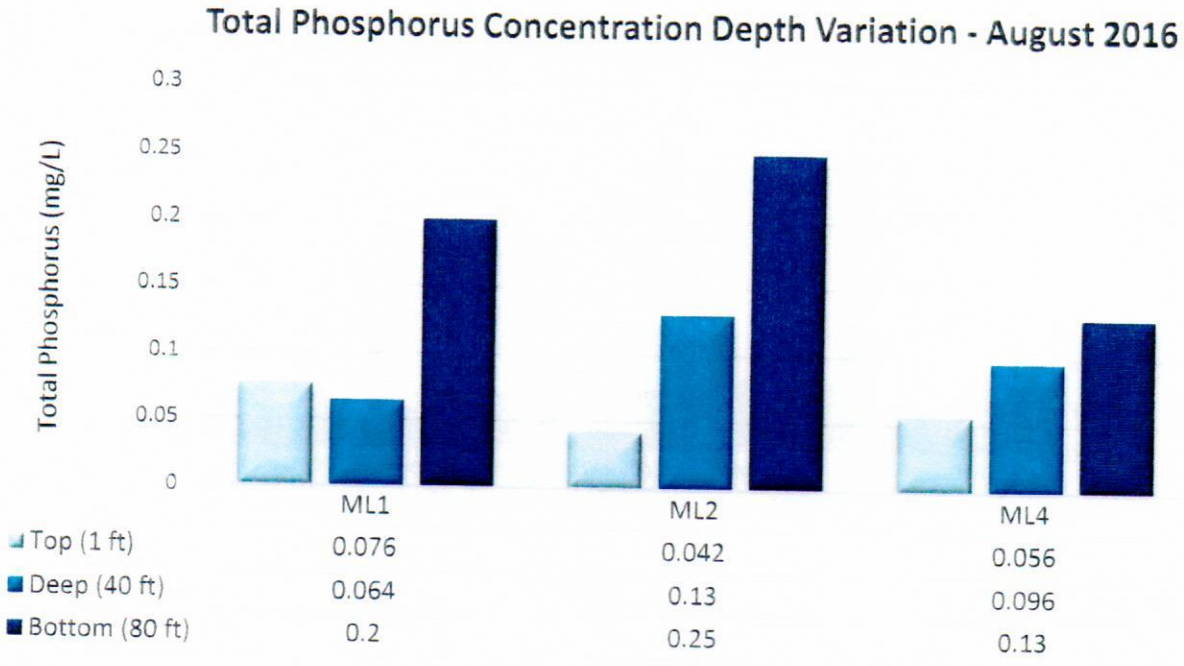
	Epilimnion Minimum	Epilimnion Maximum	Epilimnion Average	Hypolimnion Minimum	Hypolimnion Maximum	Hypolimnion Average
Jun-15	0.061	0.080	0.067	0.033	0.053	0.044
Jun-16	0.032	0.042	0.037	0.030	0.077	0.046
Jul-15	0.037	0.065	0.046	0.035	0.067	0.046
Jul-16	0.018	0.026	0.022	0.026	0.150	0.056
Aug-15	0.022	0.044	0.031	0.025	0.034	0.029
Aug-16	0.028	0.082	0.050	0.080	0.170	0.106

Middle Lake Total Phosphorus Comparison 2015 - 2016

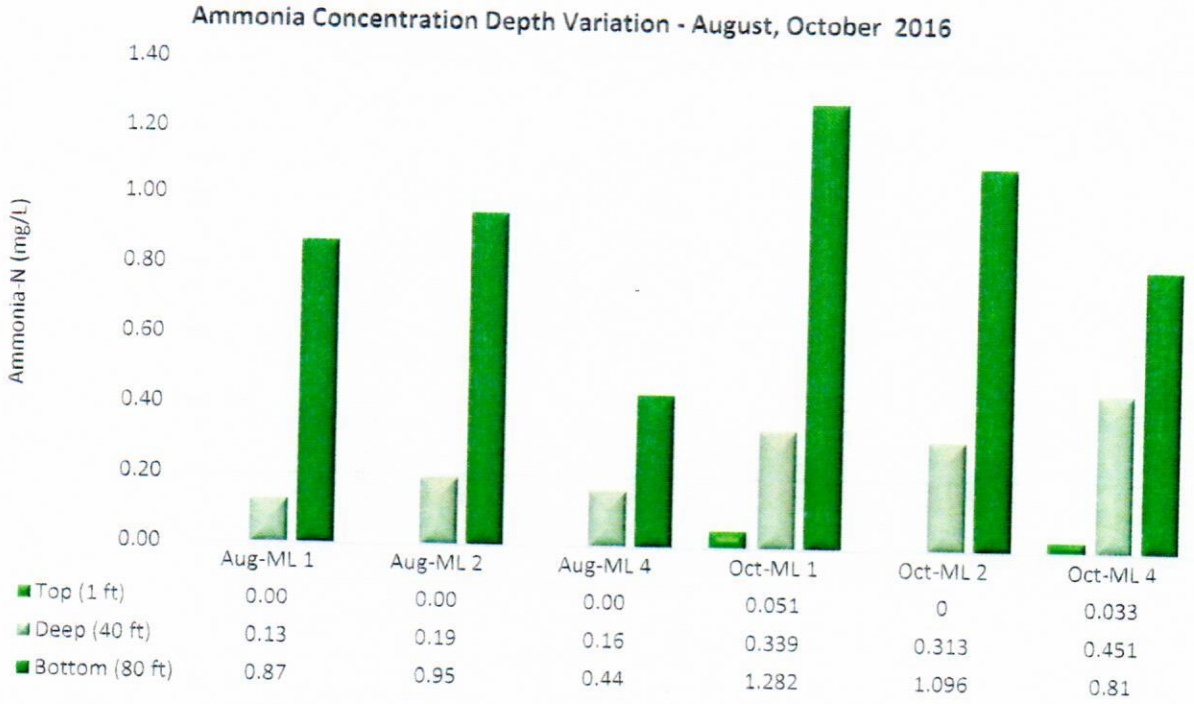


	Epilimnion Minimum	Epilimnion Maximum	Epilimnion Average	Hypolimnion Minimum	Hypolimnion Maximum	Hypolimnion Average
Jun-15	0.039	0.078	0.056	0.031	0.060	0.043
Jun-16	0.028	0.034	0.031	0.031	0.063	0.046
Jul-15	0.045	0.056	0.049	0.049	0.074	0.055
Jul-16	0.019	0.058	0.030	0.024	0.068	0.048
Aug-15	0.028	0.053	0.027	0.030	0.023	0.098
Aug-16	0.041	0.076	0.051	0.093	0.250	0.169

Nutrient Concentration Variation with Depth

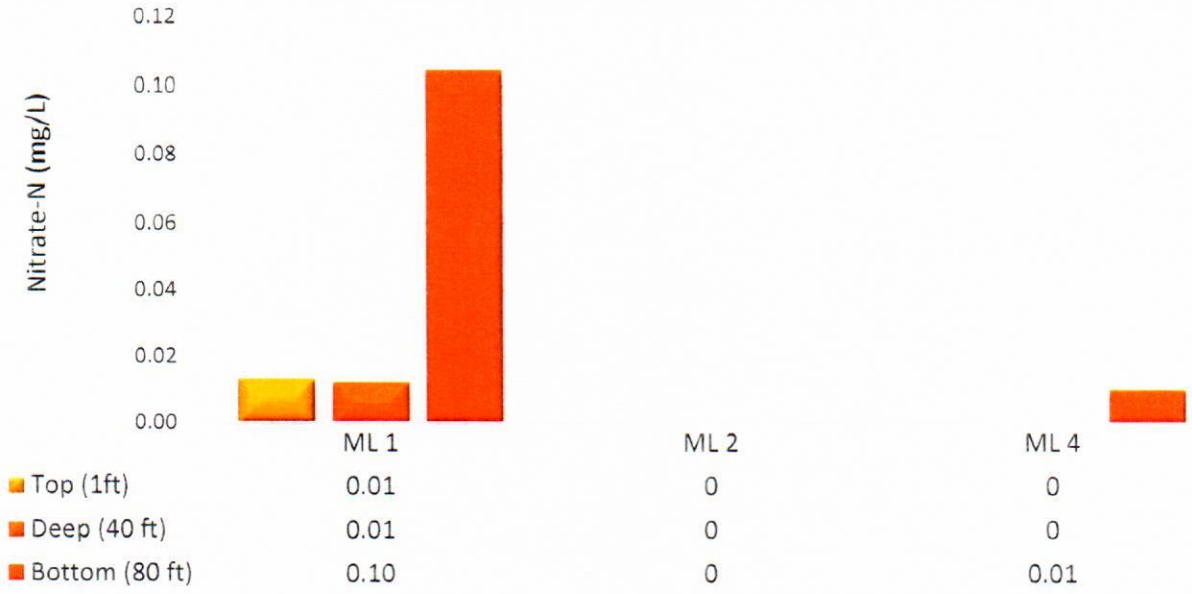


As depth increased, total phosphorus concentration also increased.



At all 12 sample sites, ammonia was non-detect in all epilimnion ("top") measurements, and detectable in all hypolimnion ("deep") samples, where concentrations ranged from 0.13 to 0.37 mg/L ammonia-N.

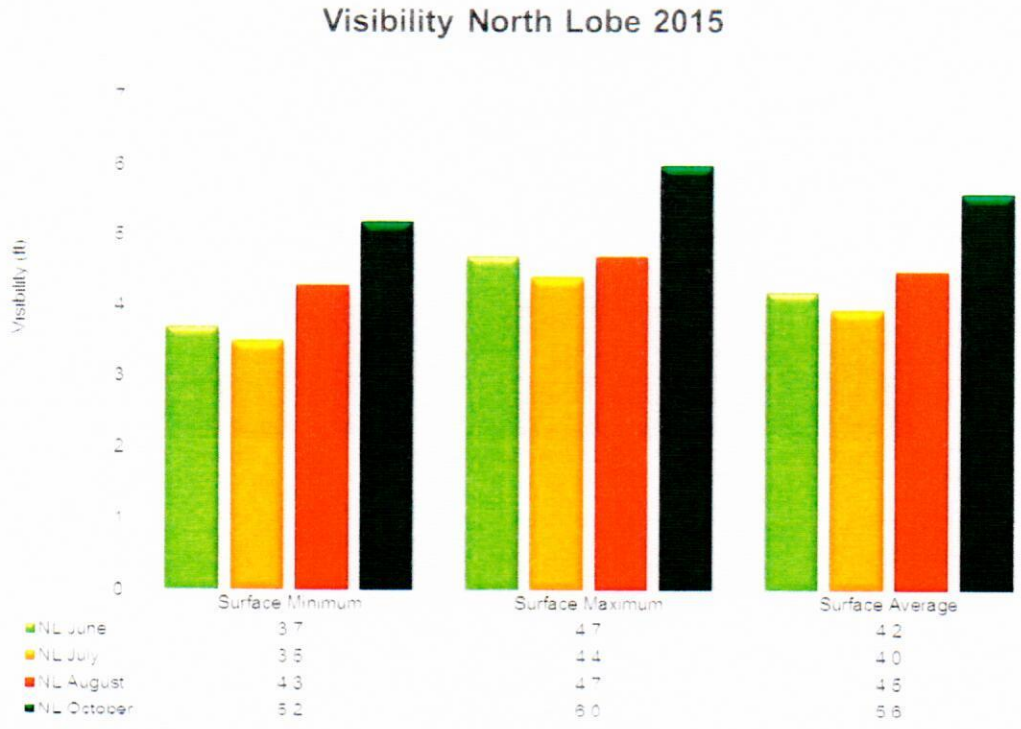
Nitrate Concentration Depth Variation - August 2016



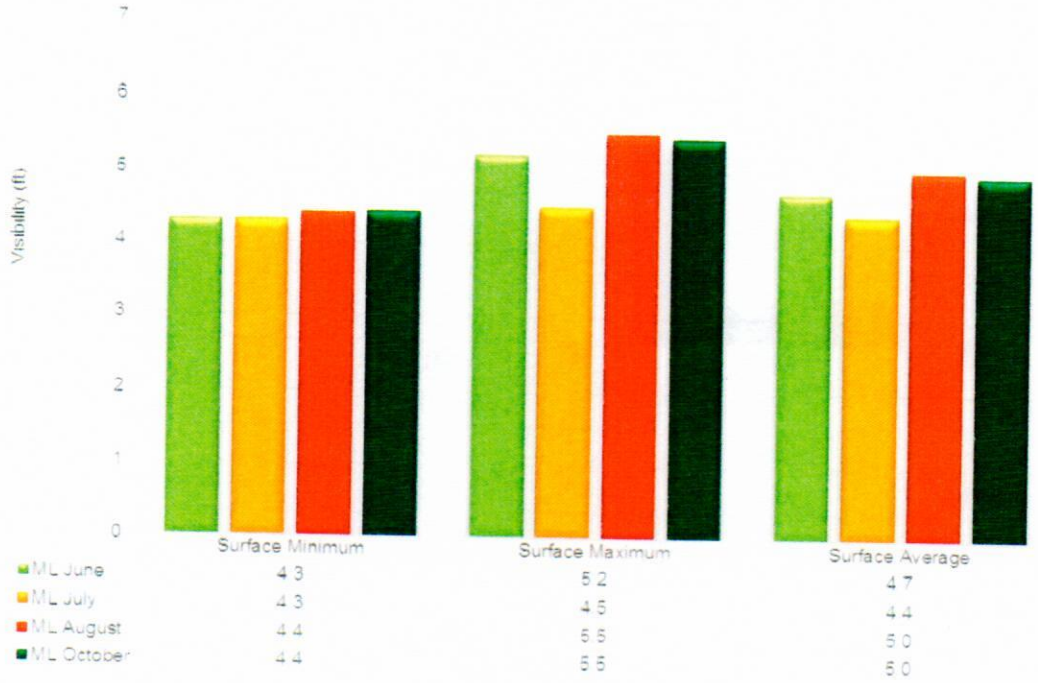
	ML 1	ML 2	ML 4
Top (1ft)	0.01	0	0
Deep (40 ft)	0.01	0	0
Bottom (80 ft)	0.10	0	0.01

For the month of October, all 12 samples at top, deep and bottom levels were non-detect for nitrate. However, nitrate concentration followed the same increasing trend observed in total phosphorus and ammonia as depth increased.

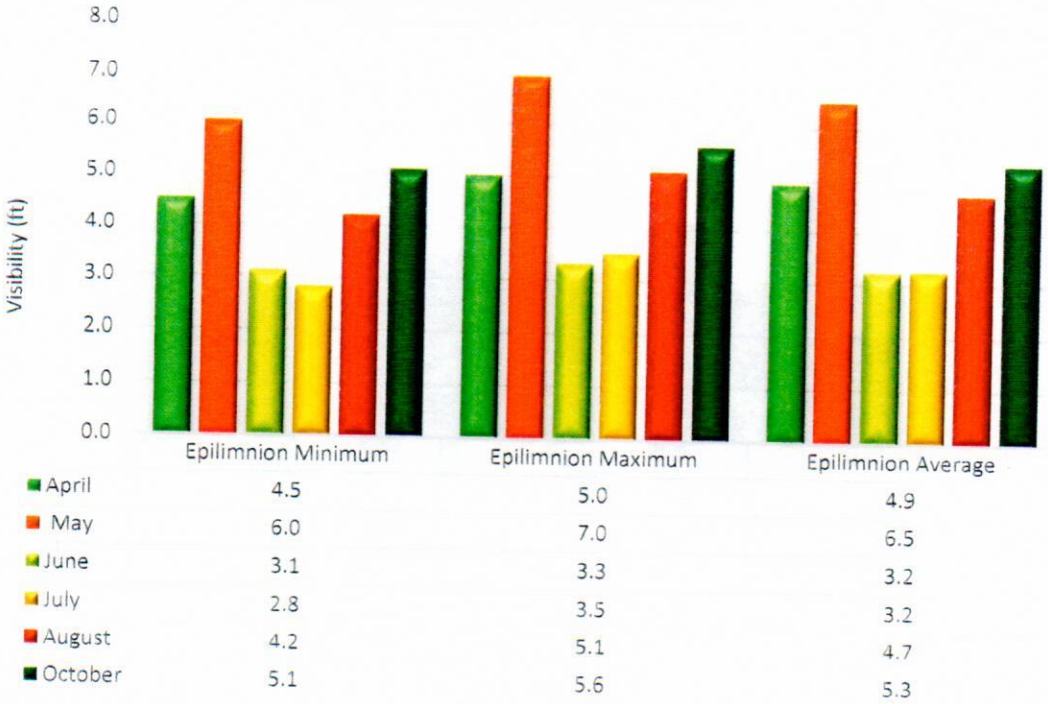
Visibility 2015 – 2016 Comparison



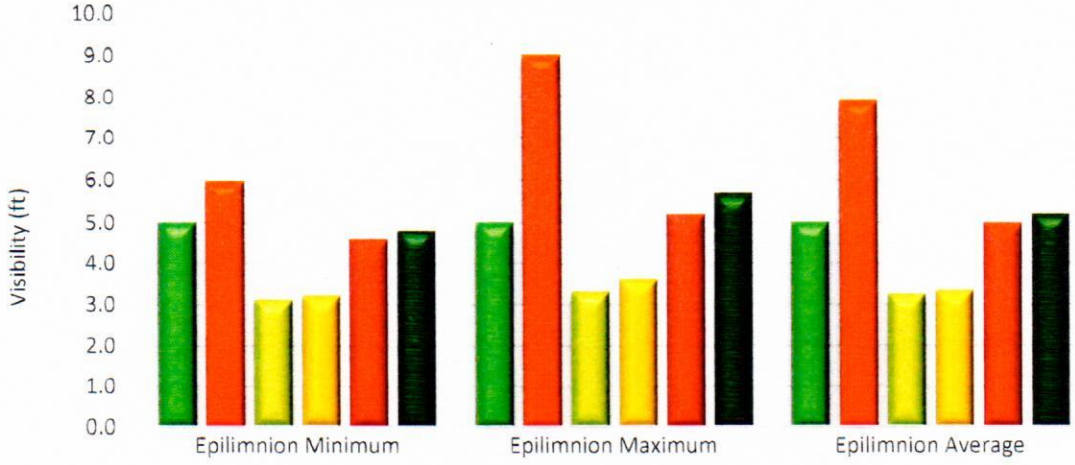
Visibility Main Lake 2015



Visibility North Lobe 2016



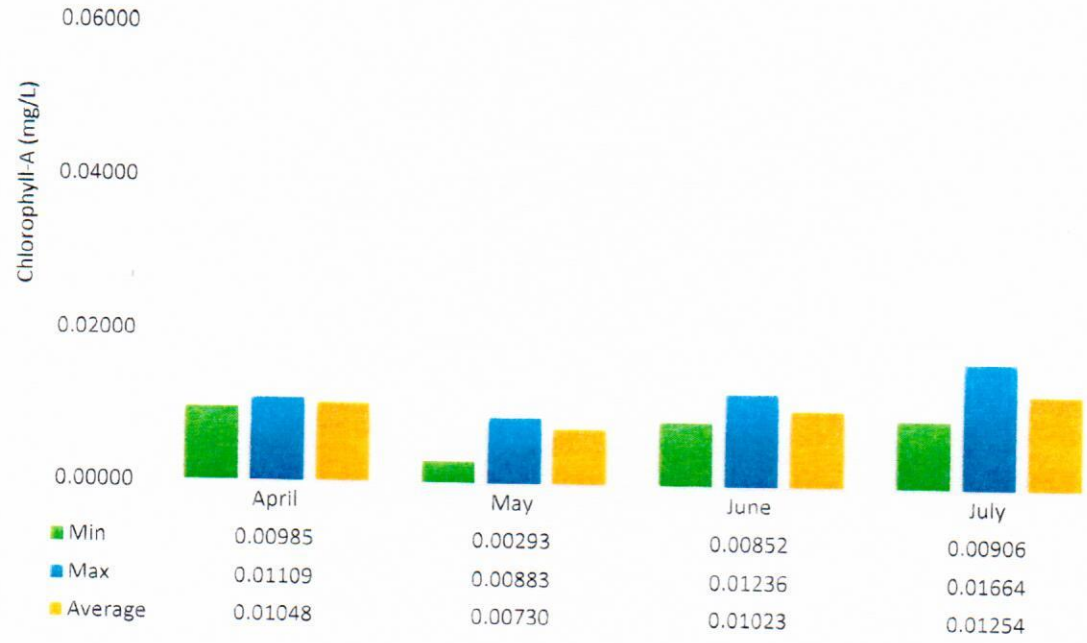
Visibility Main Lake 2016



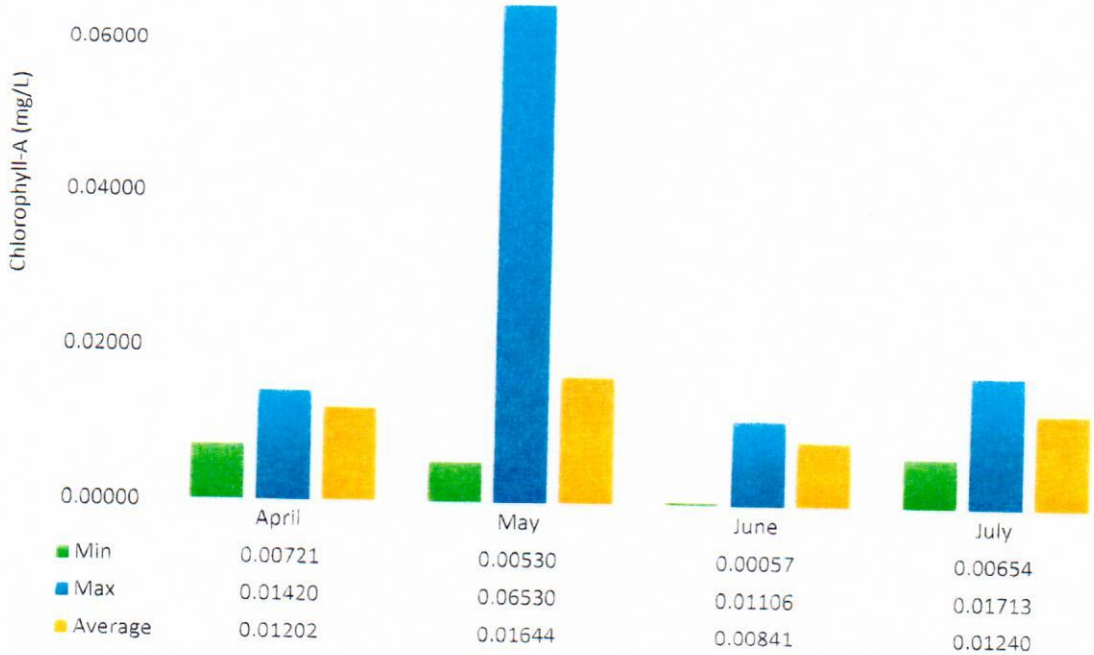
	Epilimnion Minimum	Epilimnion Maximum	Epilimnion Average
April	5.0	5.0	5.0
May	6.0	9.0	7.9
June	3.1	3.3	3.2
July	3.2	3.6	3.3
August	4.6	5.2	5.0
October	4.8	5.7	5.2

Chlorophyll-A Summary of Results

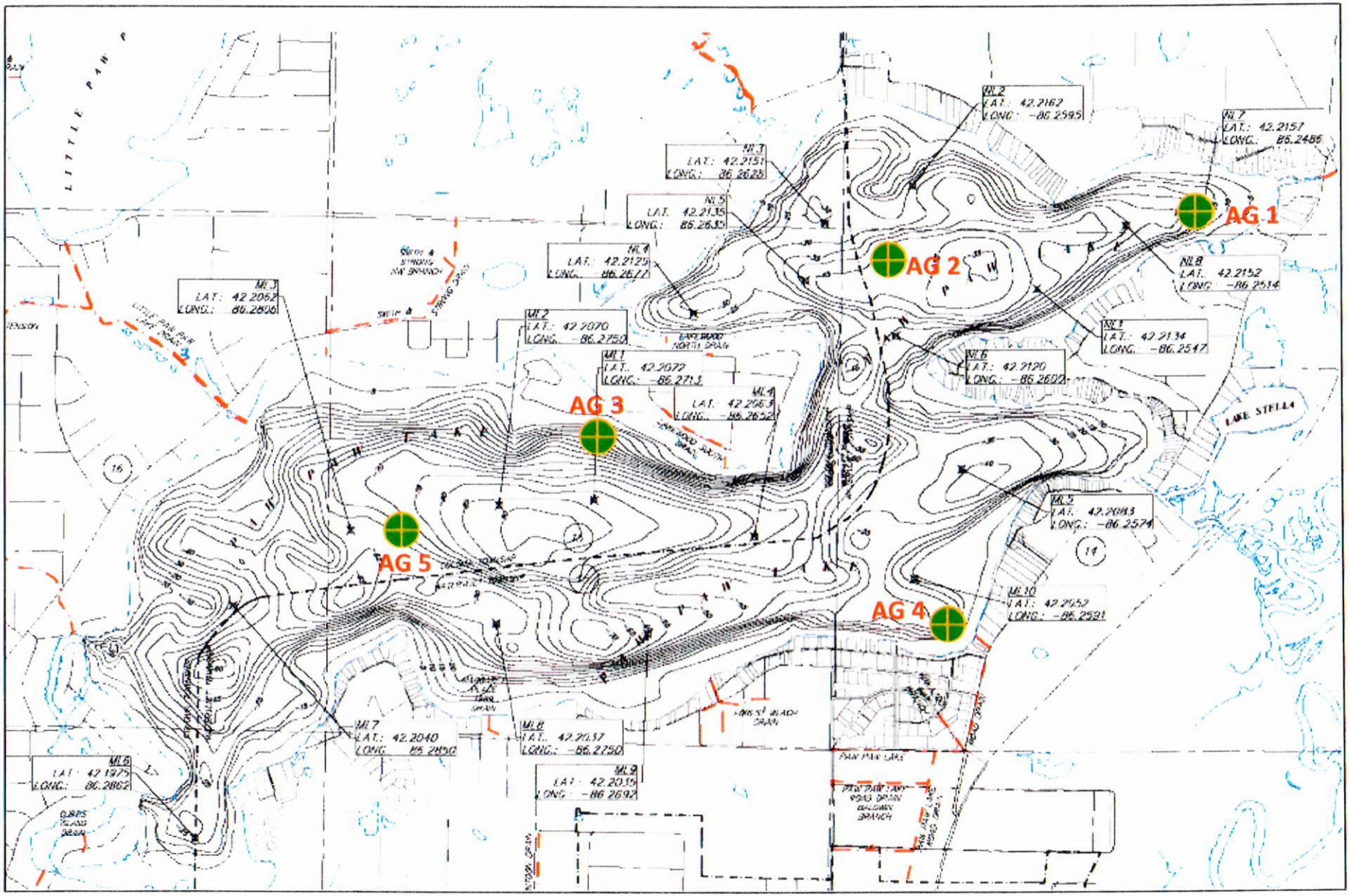
Chlorophyll-A Northern Lobe 2016



Chlorphyll-A Middle Lake 2016



2016 Algal Analysis Map



Algal Analysis Results

AG 1 - The dominant PTOX cyanobacteria observed were *Dolichospermum* spp., cyanobacteria unicells resembling *Microcystis* sp. and *Aphanizomenon* sp.

AG 2 - The dominant PTOX cyanobacteria observed were *Dolichospermum* spp., cyanobacteria unicells resembling *Microcystis* sp. and *Aphanizomenon* sp. The PTOX cyanobacterium *Woronichinia naegeliana* was also observed.

AG 3 - This sample appeared to be the most filamentous. Macroscopically, a denser film was observed at the surface of the sample. The dominant PTOX cyanobacteria observed were *Dolichospermum* spp., cyanobacteria unicells resembling *Microcystis* sp. and *Aphanizomenon* sp. The PTOX cyanobacterium *Woronichinia naegeliana* was also observed.

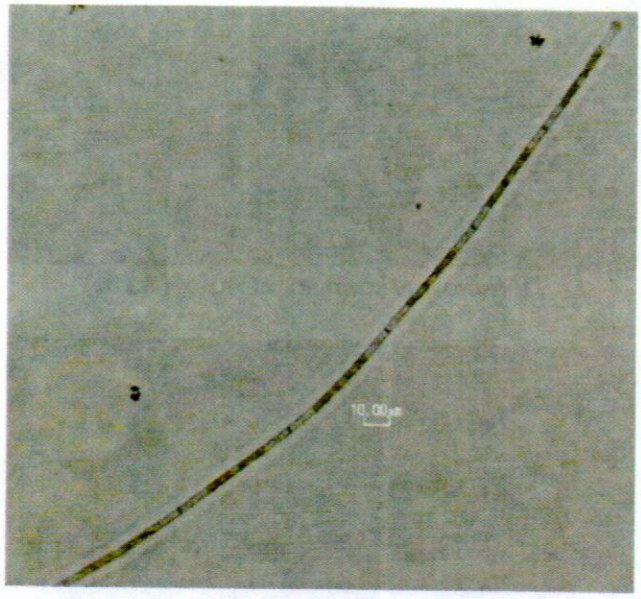
AG 4 - The dominant PTOX cyanobacteria observed were *Dolichospermum* spp., cyanobacteria unicells resembling *Microcystis* sp. and *Aphanizomenon* sp. The PTOX cyanobacterium *Woronichinia naegeliana* was also observed.

AG 5 - The dominant PTOX cyanobacteria observed were *Dolichospermum* spp., cyanobacteria unicells resembling *Microcystis* sp. and *Aphanizomenon* sp. Other PTOX cyanobacteria observed were *Woronichinia naegeliana* and colonies of *Microcystis* sp. This sample appeared to have the greatest abundance of *Woronichinia naegeliana*.

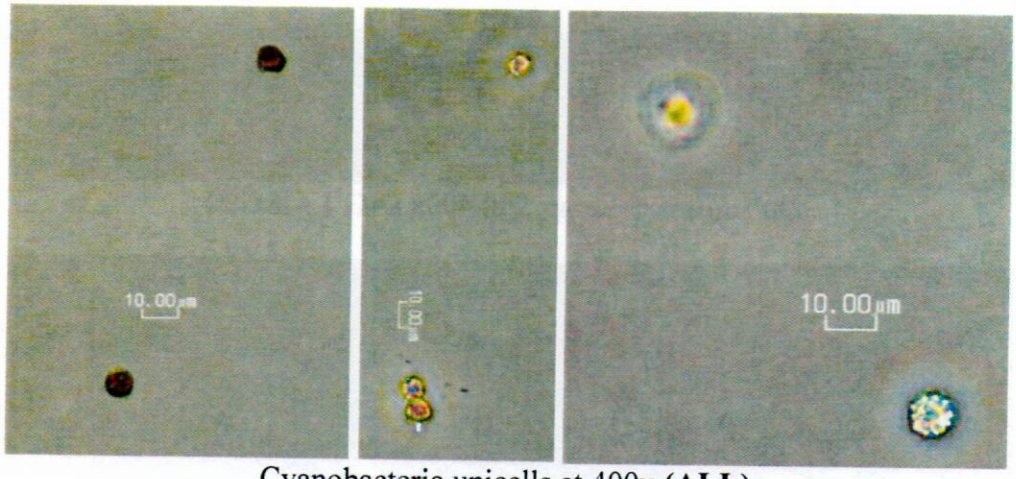
Notes - Every sample was dominated by non-toxin producing filamentous green algae, *Mougeotia* sp. The cyanobacterium *Limnoraphis* sp. was also observed in every sample, but is not currently a known toxin producer.

Of potentially toxigenic cyanobacteria, *Dolichospermum* spp. and free-floating cells resembling *Microcystis* sp. were observed in every sample. Based on these observations, toxin analysis for microcystins, anatoxin-a, cylindrospermopsin, and saxitoxin is currently recommended on all samples.

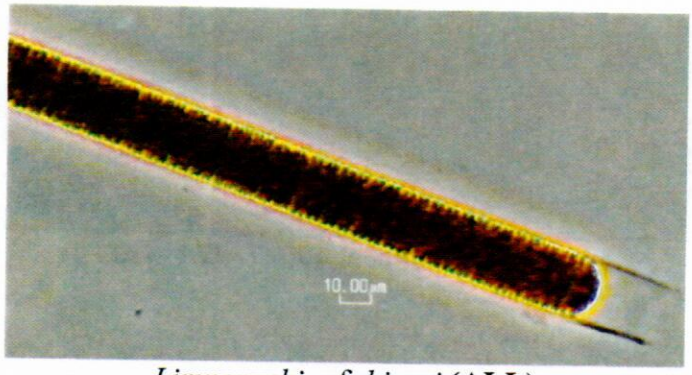
Micrographs



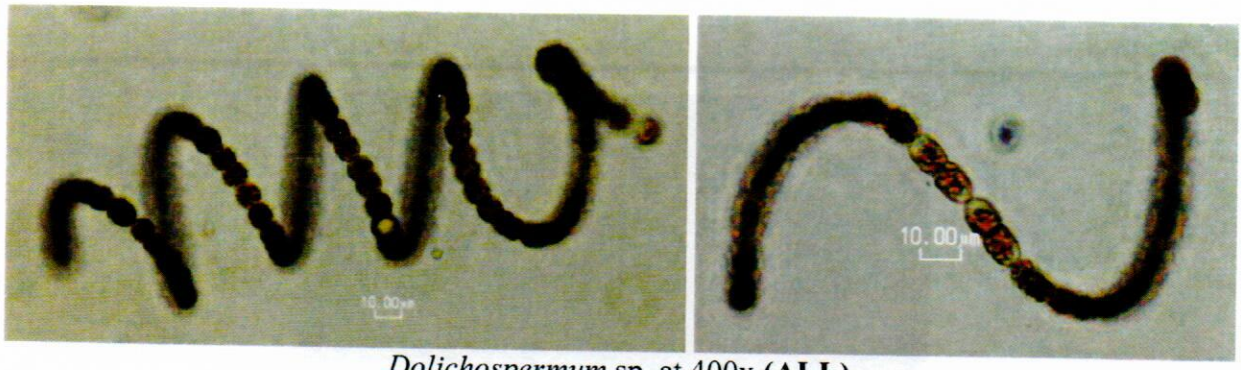
Mougeotia sp. (green alga) at 400x **(ALL)**



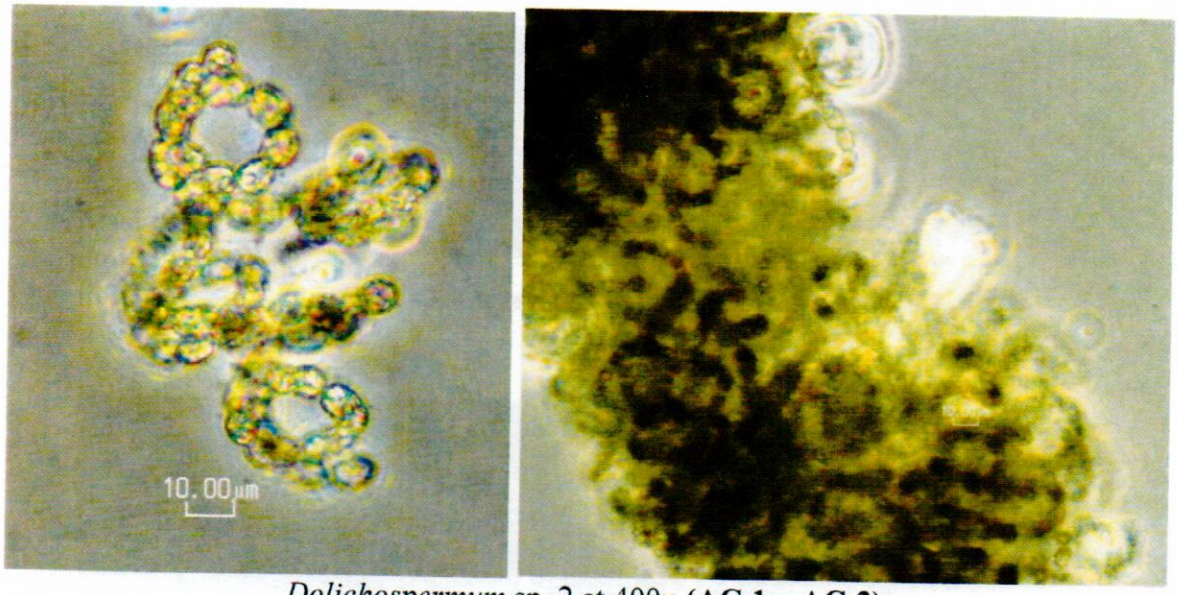
Cyanobacteria unicells at 400x **(ALL)**



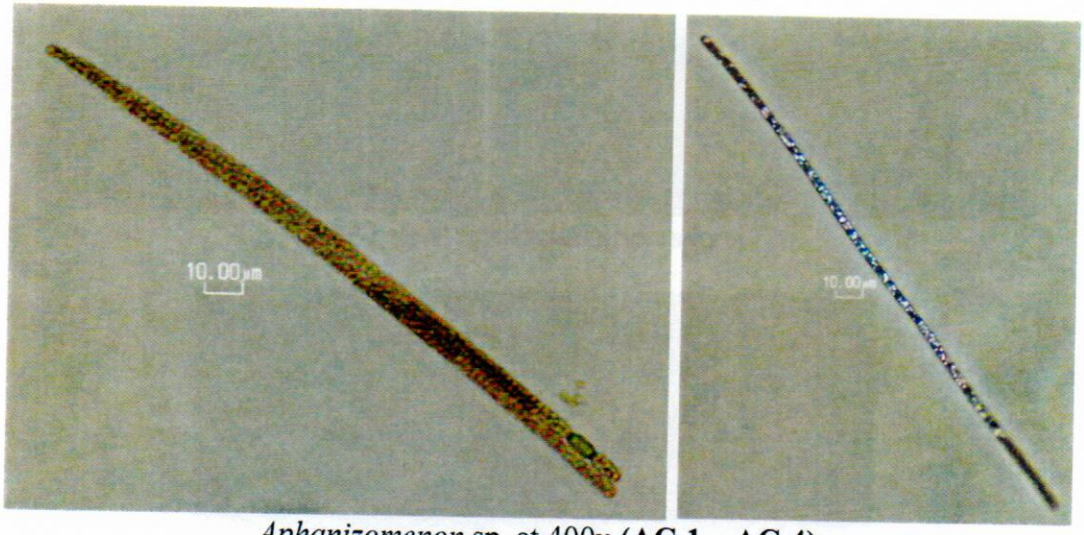
Limnoraphis cf. *birgei* **(ALL)**



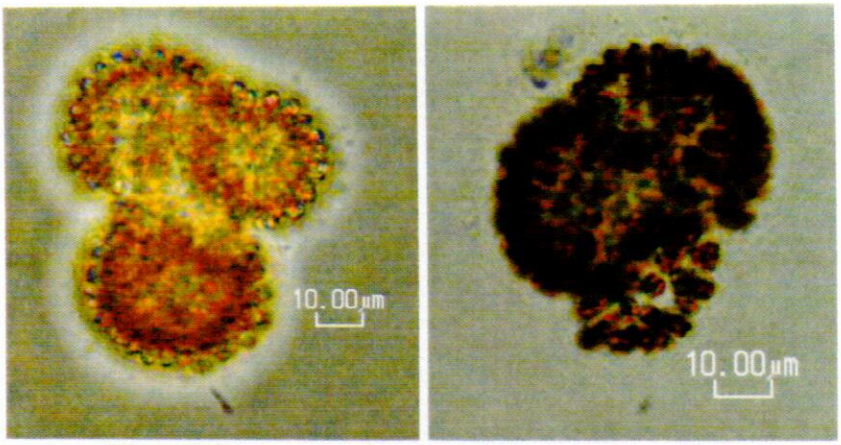
Dolichospermum sp. at 400x **(ALL)**



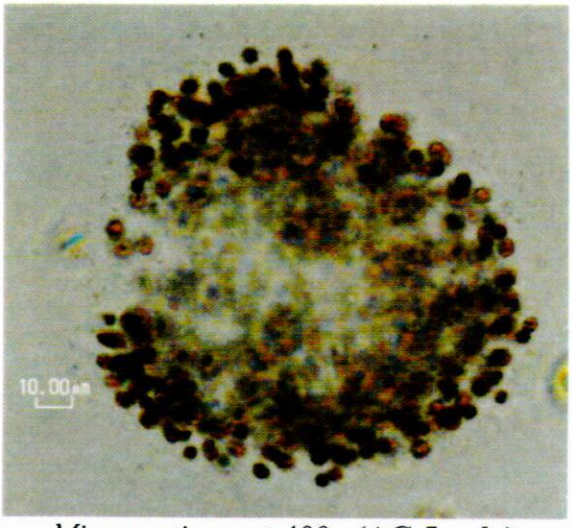
Dolichospermum sp. 2 at 400x **(AG 1 – AG 3)**



Aphanizomenon sp. at 400x **(AG 1 – AG 4)**



Woronichinia naegeliana at 400x **(AG 2 – AG 5)**



Microcystis sp. at 400x **(AG 5 only)**