

2016 Lake Waramaug Frost Basin Zooplankton Hatchery

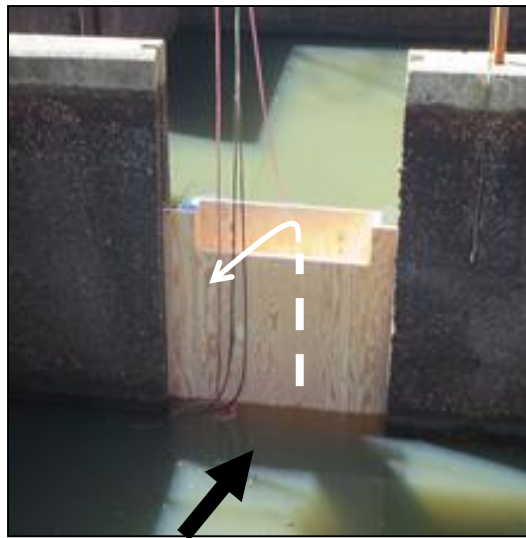




The Frost Hypolimnetic Treatment System was used to process deep water withdrawn from Lake Waramaug to decrease phosphorus concentrations and Cyanobacteria blooms from 1982 to 2015. In 2015, a Layer Aeration System was designed and installed in Lake Waramaug, driven by a compressor in the pump house on Arrow Point. The idea for converting the Frost Basins to a “Seed Stock Zooplankton Hatchery” was developed during the conversion to Layer Aeration.



A walkway was installed to provide access to all four Cells.



An airlift pump chamber was installed to circulate water from Cell 4 to Cell 1.



A slide gate was installed on the outlet pipe, with a riser overflow pipe to establish water level.



An airlift pump chamber was installed to circulate water from Cell 3 to Cell 4 through zooplankton collection nets.

A submersible pump on a timer was used to refill the basins from the catch basin after zooplankton release.





Frost Basin

40 100 5 ft dimensions

20000 cu ft volume
 149600 gallons total
 112200 gallons 3 cells
 74800 gallons 2 cells

factor up from 80 gal culture

Daphnia Food per feeding

1870 total volume

Total Basin Volume

1402.5 3 cells volume

grams pounds

935 2 cells volume

Yeast	2805	6.171
Flour	2805	6.171
Sugar	467.5	1.0285

Daphnia Food

grams

Yeast	1.5
Flour	1.5
Sugar	0.25

Mix in a glass of warm water
 Bring up to 2 liters

Feeds 80 gallon culture

Total 3 Cell Volume

grams pounds

Yeast	2103.75	4.62825
Flour	2103.75	4.62825
Sugar	233.75	0.51425

Total 2 Cell Volume

grams pounds

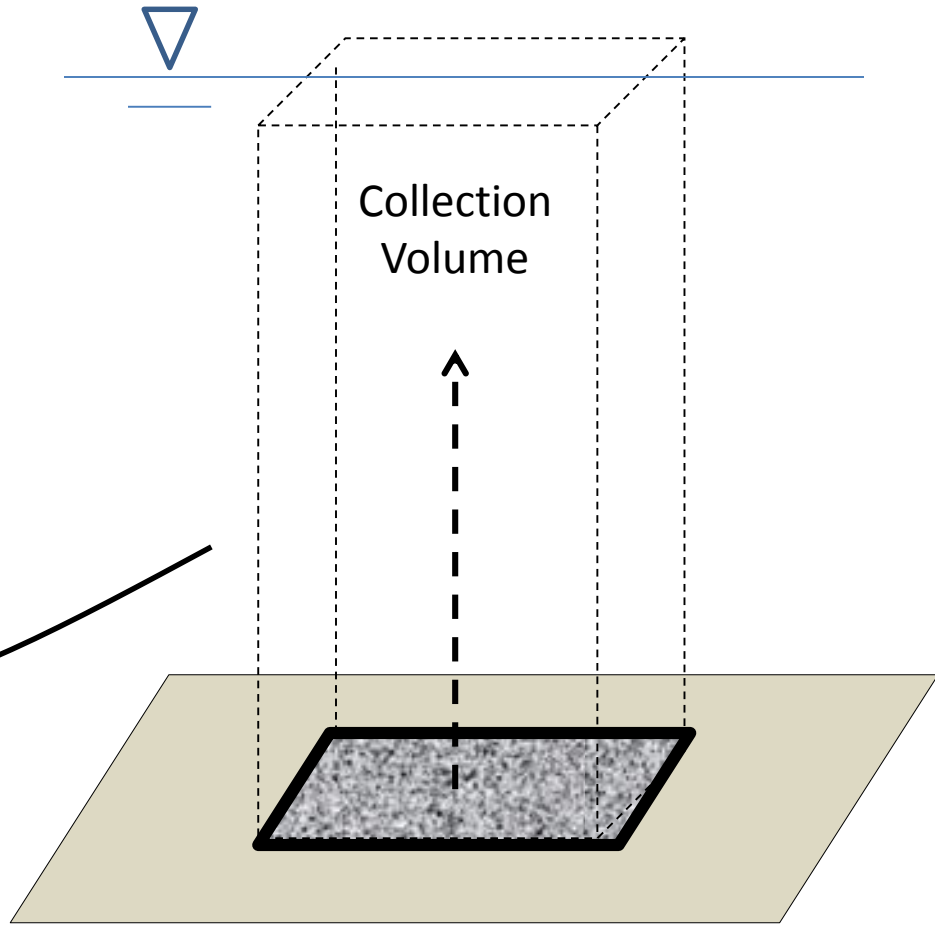
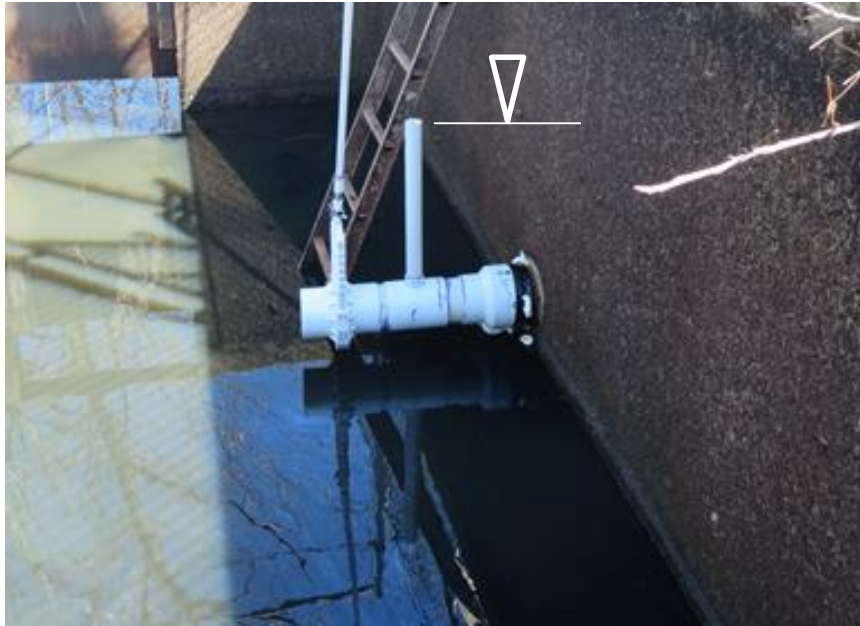
Yeast	1402.5	3.0855
Flour	1402.5	3.0855
Sugar	233.75	0.51425

Feed Cell 1 from walkway

Valved Drip Feed

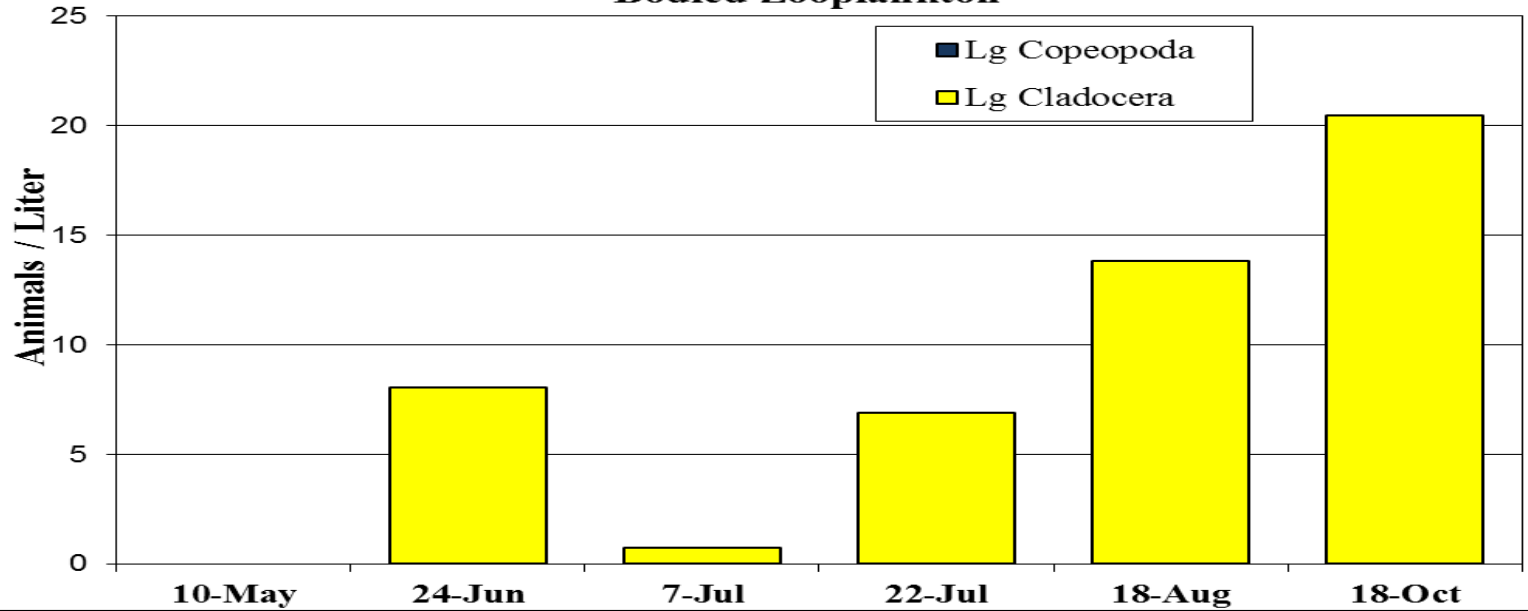
30 gallon drum set up with warming & mixing

Feed Approximately 2x per week Spring and Early Summer

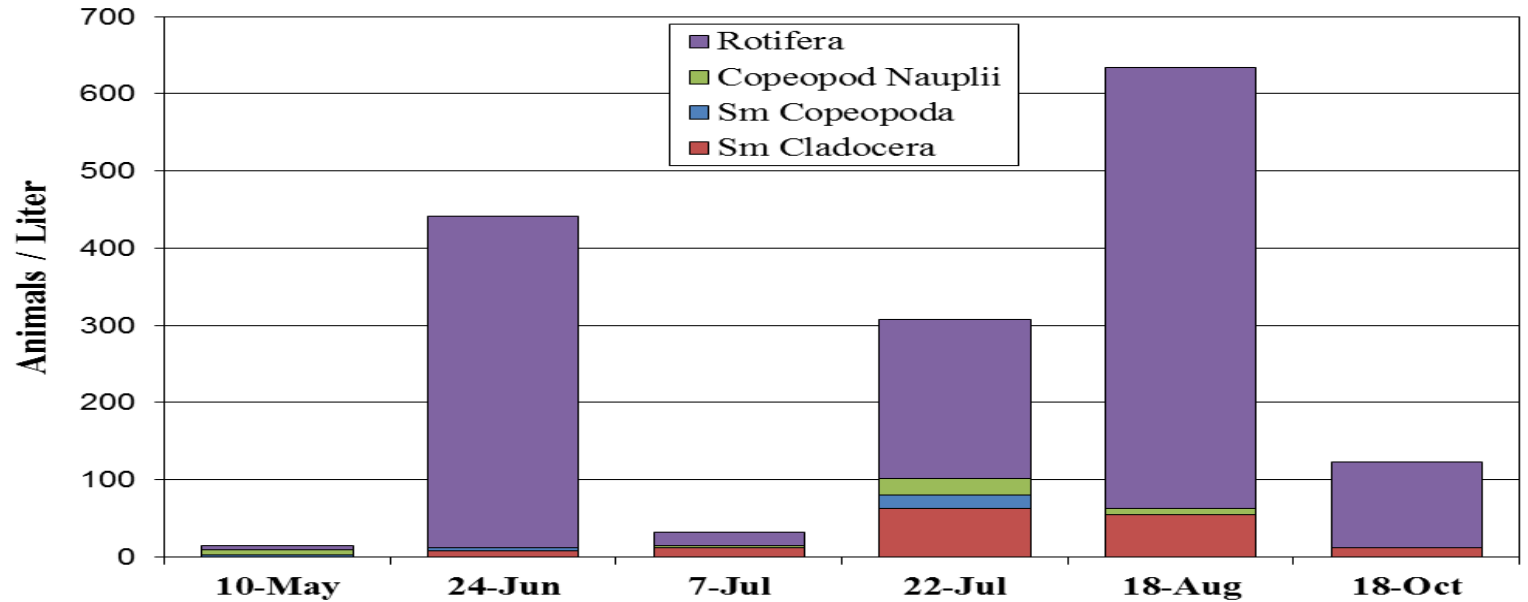


- Rectangular zooplankton net pulled vertically up from a fiberglass plate collects all animals in the identified volume. Counted to determine animal/liter density.
- The counted density is then used to multiply by the volume of water released to estimate animals released to the lake from the zooplankton hatchery.

Lake Waramaug Frost Zooplankton Hatchery 2016 Large Bodied Zooplankton



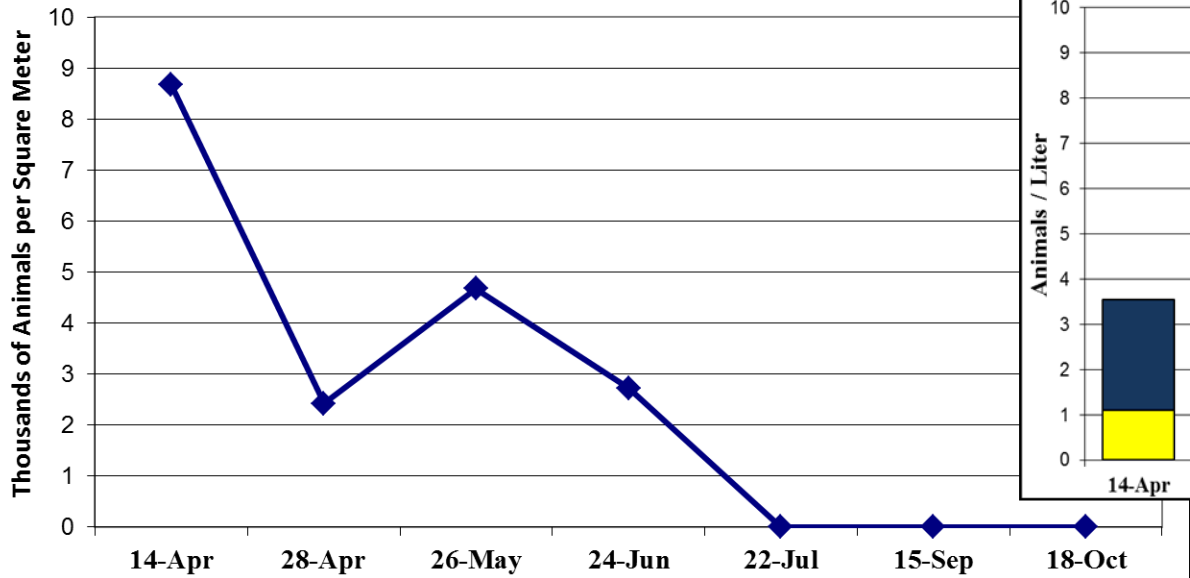
Lake Waramaug 2016 Small Bodied Zooplankton



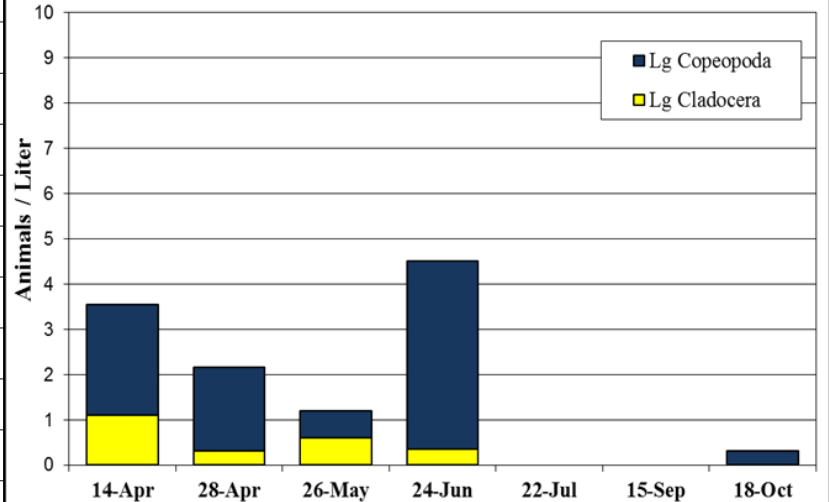
Waramaug Zooplankton Introductions 2016					
Date	To	From	Estimated Number		Est Avg or Based on Counts
			Low Est	High Est	
4/14/2016	Lake Center	Lab Culture	10000	12000	11,000
5/10/2016	Lake Center	Lab Culture	10000	12000	11,000
5/26/2016	Lake Center	Lab Culture	10000	12000	11,000
7/7/2016	Lake Shore	AirLift Nets			67,796
7/7/2016	Lake Shore	Gate Release			2,173,840
7/22/2016	Lake Shore	Gate Release		Est avg 7/7 8/18	2,717,300
8/18/2016	Lake Shore	Gate Release			3,260,759
10/18/2016	Lake Shore	Gate Release			8,695,359
				Estimated Totals	16,948,054

Waramaug Zooplankton Introductions 2016		
	Cumulative Introduction	Estimated Daphnia Introduced
4/14/2016	11,000	11,000
5/10/2016	22,000	11,000
5/26/2016	33,000	11,000
7/7/2016	100,796	67,796
7/7/2016	2,274,636	2,173,840
7/22/2016	4,991,936	2,717,300
8/18/2016	8,252,695	3,260,759
10/18/2016	16,948,054	8,695,359

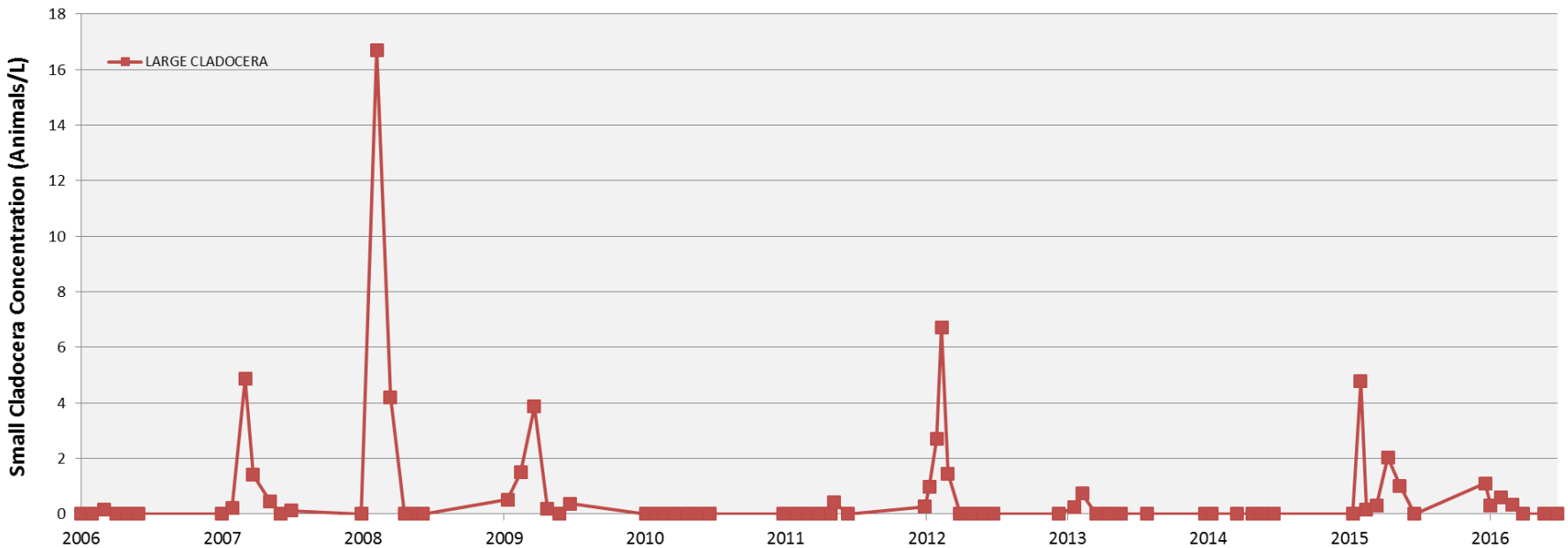
Lake Waramaug 2016 Large Cladocera Concentration



Lake Waramaug 2016 Large Bodied Zooplankton



Lake Waramaug 2006-2016 Cladocera Concentrations



Frost Basin Sampling Data				
	26-May-16	22-Jul-16	18-Aug-16	15-Sep-16
Temperature (°C)	19.3	22.3	24.5	19.6
ODO mg/L	7.0	7.2	6.0	6.9
ODO % Saturation	78.6	85.4	74.0	77.1
Specific Conductivity (mS/cm)		162		160.06
pH	8.8	8.8	8.5	8.87
ORP (mV)	109	141	82	82
Turbidity (NTU)				

Waramaug 2016: Phycocyanin Levels (ug/l)									
Site 14	Depth	14-Apr	29-Apr	26-May	24-Jun	22-Jul	18-Aug	15-Sep	18-Oct
	Surface Grab								
	1m	12.30	9.25	11.74	9.36	8.65	15.33	15.17	27.79
	3m								
	5m			11.70	16.52	11.35	21.79	19.84	16.76
	7m								
	9m			16.99	13.20	24.41	13.96	27.70	12.70
	11m			19.68	20.77	25.02	27.47	36.43	72.57
	OB	15.10	15.05		20.77				
Site 8	1m		13.55	10.77	15.52	9.78	14.05	14.32	16.91
	Mid								
	OB		11.86	11.98	16.70	18.44	29.02	13.72	13.98
Streams	Ash Swamp						13.83		
	Sucker Brook						9.03		
	Frost Basin			16.97	12.60	19.92	49.07	53.21	

Lake Waramaug 2016 Frost Basin

Total Phosphorus - P (ug/L)

Date	26-May-16	24-Jun-16	22-Jul-16	18-Aug-16	15-Sep-16	18-Oct-16
Frost Basin	61	35	48	77	81	63

Ammonia - N (ug/L)

Date	26-May-16	24-Jun-16	22-Jul-16	18-Aug-16	15-Sep-16	18-Oct-16
Frost Basin	14	48	34	8	23	68

Nitrite-Nitrate - N (ug/L)

Date	26-May-16	24-Jun-16	22-Jul-16	18-Aug-16	15-Sep-16	18-Oct-16
Frost Basin	48	56	18	ND	ND	67

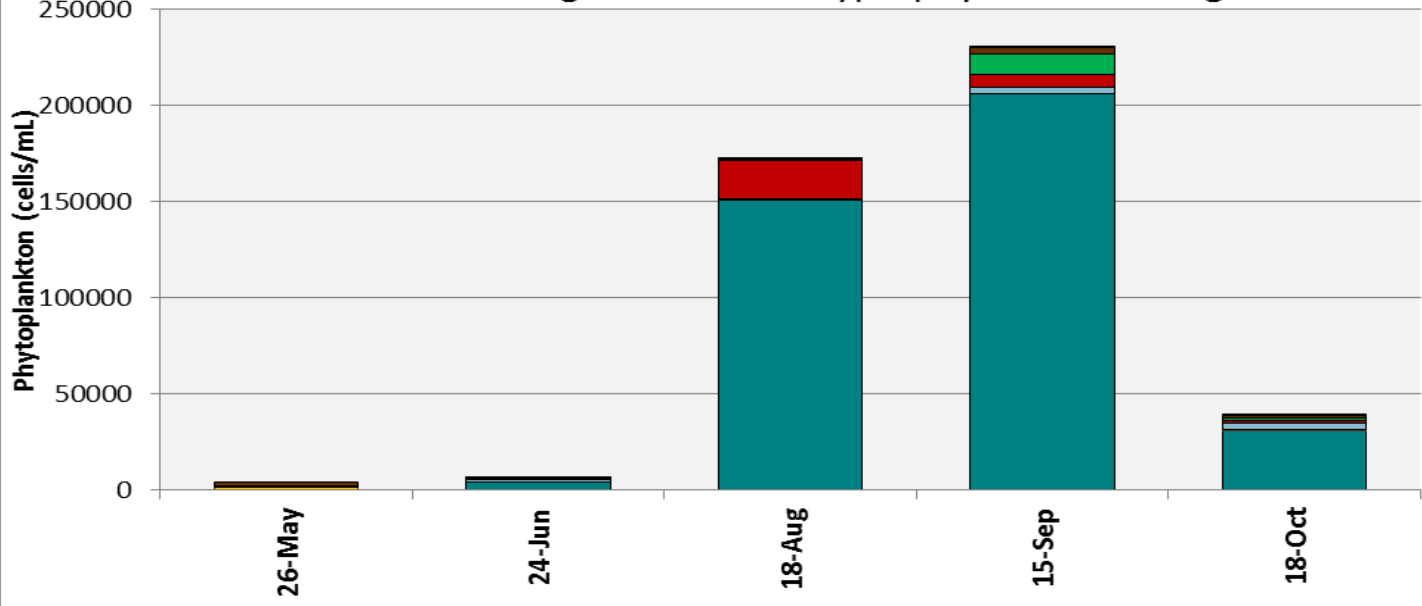
Silica (mg/L)

Date	26-May-16	24-Jun-16	22-Jul-16	18-Aug-16	15-Sep-16	18-Oct-16
Frost Basin	4.788	2.661	0.116	0.031	2.351	4.171



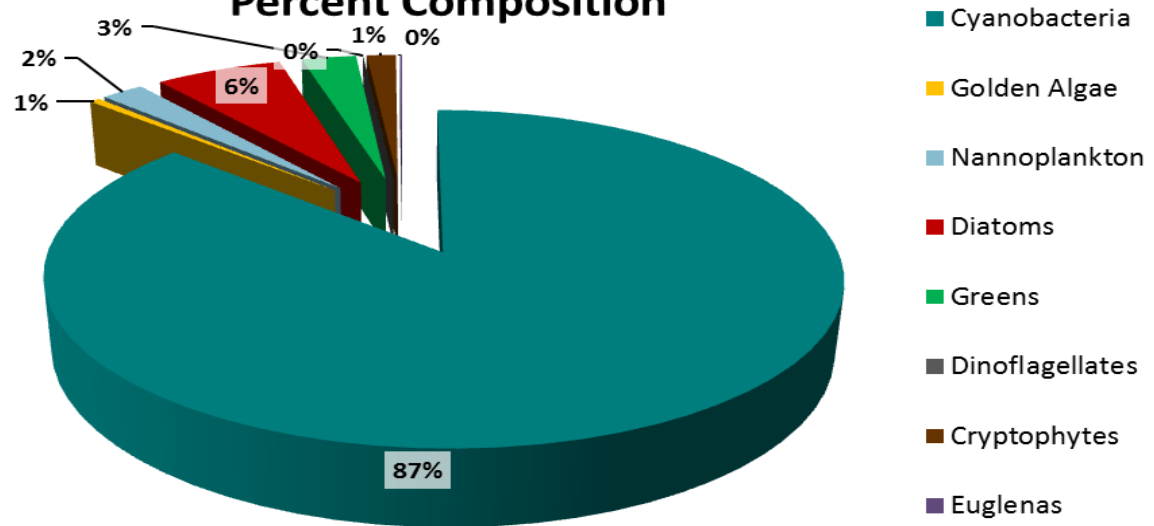
Lake Waramaug Site 14 2016 Total Algae

- Cyanobacteria
- Golden Algae
- Nannoplankton
- Diatoms
- Greens
- Dinoflagellates
- Cryptophytes
- Euglenas



Lake Waramaug - Site 14 - 2016 Annual Average

Percent Composition



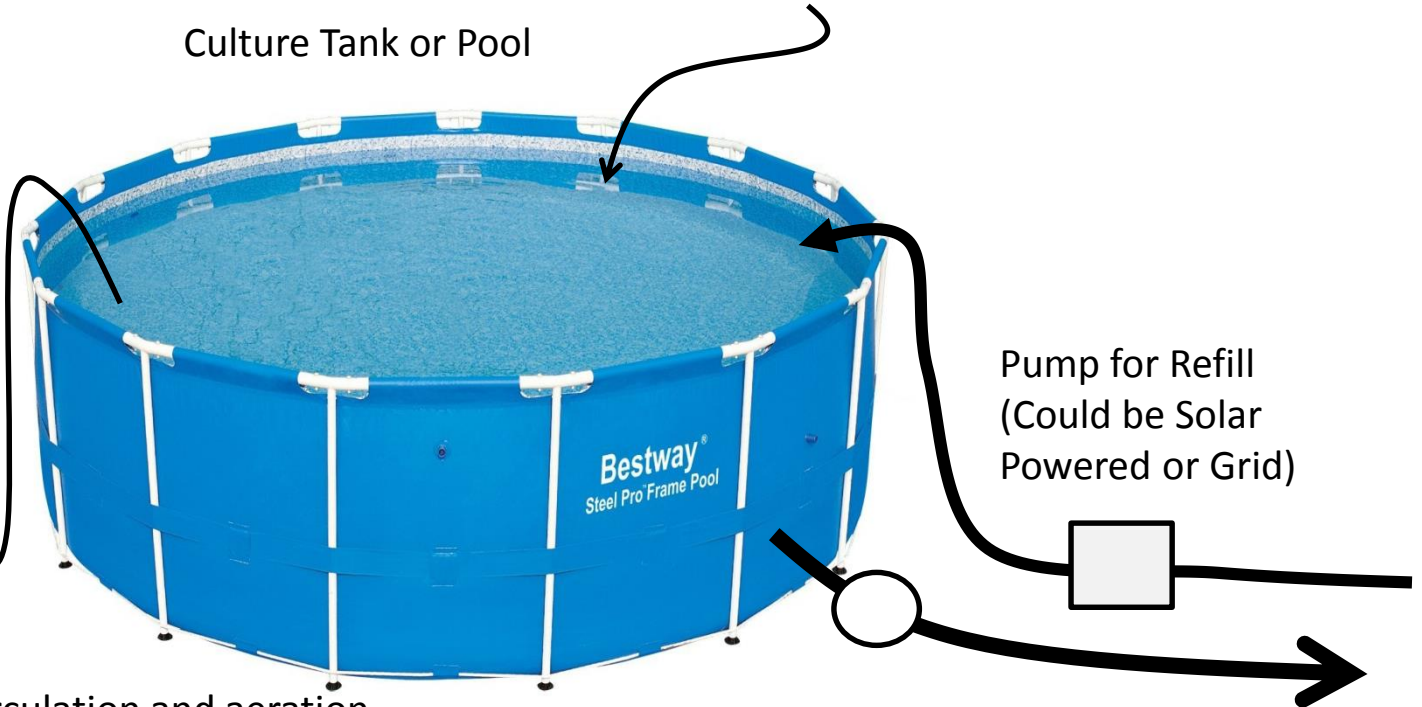
Lessons Learned

- Pump Refill System, pump prime, available solar input, refill rate
- Air-Lift Circulation Systems vs. Water Level
- Water Chemistry, Nutrients, Phytoplankton Composition
 - Optimizing Daphnia Growth, food resource
- Surface Duckweeds and Light Penetration
- Lake Level, Catch Basin Pump

Potential Technology Transfer

Activated Yeast used to feed Daphnia

Culture Tank or Pool



Pump for Refill
(Could be Solar
Powered or Grid)

Small diffused air circulation and aeration
(Could be Solar Powered)

Valved Release Pipe to Lake
(best from shaded section
of the pool or tank)