MORSES POND ANNUAL REPORT: 2024

PREPARED FOR THE TOWN OF WELLESLEY

BY WATER RESOURCE SERVICES, INC.

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This report documents the implementation of the 2005 Comprehensive Morses Pond Management Plan through 2024 with a focus on the most recent year of activity. Program elements have included: 1) phosphorus inactivation, 2) plant harvesting, 3) low impact development demonstration, 4) education, and 5) dredging. Dredging was completed in 2013 and low impact development demonstration was done earlier than dredging, and these elements have been covered in past reports to the extent that further inclusion is unnecessary. The history of the other elements has also been covered in a cumulative fashion in past reports, most recently December of 2017, so this report has been streamlined to cover mainly the actions of 2024 within the context of the overall management plan and past progress and related data. The main actions in recent years at Morses Pond include phosphorus inactivation to improve water clarity and aquatic plant harvesting to maintain access and habitat value. Benthic barrier has also been laid in the swimming area and maintained over the past 7 years. Additionally, some of the approach applied to Morses Pond was extended to additional, smaller ponds within Wellesley as of 2018 and those efforts are included in this report for completeness.

Phosphorus Inactivation

Operational Background

Phosphorus entering through Bogle Brook and Boulder Brook was determined to be the primary driver of algae blooms in Morses Pond. Dry spring-summer periods fostered fewer blooms than wetter seasons in an analysis of over 20 years of data, although very wet conditions can flush the pond fast enough to also limit blooms. The worst-case scenario is a wet spring followed by a dry summer, allowing high spring inputs to foster summer algal blooms. Work in the watershed to limit phosphorus inputs is a slow process and has limits related to urbanization that are very difficult to overcome. Reduction in the phosphorus content of lawn fertilizer is believed to be reducing inputs to the pond, but with so much developed land in the watershed, loading is still excessive. Inactivation of incoming phosphorus can counter those inputs and has been used extensively and successfully in Florida and with increasing frequency in other states to limit the impact of development on urban lakes. The comprehensive plan called for a similar effort at Morses Pond.

A phosphorus inactivation system was established at Morses Pond in the spring of 2008. After testing and initial adjustment in 2008, the system has been operated in the late spring and part of summer in 2009 through 2024. The system has been modified over time, with simplification and a different aluminum chemical applied since 2014. The system has been automated since 2016, with control from a smart phone as needed. The system is being overhauled between the 2024 and 2025 seasons to establish a more permanent system with limited maintenance needs.

The current and expected future operation involves automatic start up when a set amount of precipitation has occurred (normally 0.1 inch). The pumps turn on and polyaluminum chloride is fed into the Bogle Brook and Boulder Brook tributaries slightly upstream of the pond at rates of 40 to 80 gallons per hour. The tank serving Bogle Brook holds 2000 gallons, while the tank serving Boulder Brook holds 1000 gallons; Bogle Brook provides roughly twice the flow provided by Boulder Brook and is therefore treated at twice the rate. The system ran for 4 hours in response to a triggering precipitation event through 2023, although the duration is adjustable, and the Bogle Brook pump was set to run for 8 hours in 2024. The system is activated from the week before Memorial Day until about the week after 4th of July, although this is also adjustable as warranted and leftover aluminum product is applied during summer when available. By treating incoming stormwater during the late spring period and into summer, Morses Pond can achieve a low enough phosphorus concentration to avoid algae blooms for the summer. If there is enough inflow to raise the phosphorus level, this also translates into increased flushing that tends to minimize algae blooms as well.

A total of 7800 gallons of polyaluminum chloride were applied to Morses Pond in 2024, representing 4602 lbs of aluminum, the most since 2015 (Table 1). A third delivery of aluminum polychloride was made in July to allow further treatment, based on monitoring data leading up to that time. Precipitation during the May-June 2023 period was 8.9 inches, the most for that period since 2013. Precipitation for May-August was 14.0 inches, slightly below average as the wet spring was followed by a relatively dry summer. There were 13 treatment days in 2024, similar to recent years, but with more product applied per storm. All equipment functioned properly in 2024, with no downtime for pumps and no missed storms. After multiple years with pump issues, this was a favorable treatment year, but the need to replace many system components is apparent and will occur before 2025 operation.

Analysis of Program Results

Water quality is assessed prior to the start of treatment, normally in May, again in early summer, usually in the last week of June, and yet again at least once and more often twice later in the summer in up to three areas: the north basin, the transition zone to the south basin just south of the islands, and near the town beach at the south end of the pond (Figure 1). The sampling near the beach includes the actual swimming area and a point to the NW in the deepest part of the pond. Visual and water quality checks are made on an as needed basis, as part of normal operations or in response to complaints, major storms, or town needs. The water quality record for 2024 (Table 2) incorporates field and laboratory tests at multiple sites. A summary of phosphorus data for key periods since 2008 is provided (Table 3) to put the treatments and results in perspective. It is intended that total phosphorus will decrease through the treatment, such that values in the south basin, assessed in the swimming area near the outlet of the pond, will be lower than in the north basin, with the transition zone exhibiting intermediate values. Based on data collected since the early 1980s, total phosphorus in the south basin in excess of 20 µg/L (0.02 mg/L) tends to lead to algal blooms, while values <20 µg/L minimize blooms and values near 10 µg/L (0.01 mg/L) lead to highly desirable conditions.

Total phosphorus concentrations in 2024 (Table 2) were acceptable in early May (near 15 ug/L), but the concentration of P in water coming from Bogle and Boulder Brooks (67 and 86 ug/L, respectively, in one sampling event) remain high. However, the inlet concentrations recorded during the one monitored storm were appreciably lower than the approximately 130 ug/L long-term average for these inlets, suggesting that reduced P in lawn fertilizer is having a positive effect. Inputs during the wet spring increased the P concentration in Morses Pond at the beach to near 31 ug/L by late May. Yet treatment starting on May 28, 2024, reduced the P concentration in and near the swimming area to 18-20 ug/L by late June, as intended. Further treatment in July reduced the P concentration to just over 10 ug/L, the low end of the target zone. Treatment ended on August 9th but no further monitoring occurred until September 22nd, when the P

Table 1. Summary of Phosphorus Inactivation Effort, 2008-2024.

Year	Applied Alum (gal)	Applied Aluminate (gal)	Aluminum Mass (lbs)	# of Treatment Days	May-June Precipitation (in)	May-August Precipitation (in)	Notes
2008	2000	1000	2240	5	6.2	16.7	Testing and adjustment phase, most treatment in July
2009	6002	2900	6595	16	5.9	16.1	Some elevated storm flow untreated
2010	4100	2080	4630	13	6.1	14.5	Additional chemical applied after early July
2011	5000	2475	5569	14	8.0	17.8	Some equipment failures. Additional chemical applied in August in response to bloom
2012	6000	3000	6720	19	6.9	14.4	Equipment problems hampered dosing during treatment
2013	6055	2785	6476	20	13.7	19.1	Very wet June (26.7 cm), unable to treat all storm flows; continued treatment through July
	Polyaluminum chloride						
2014	5985		3531	12	5.5	11.8	No treatment after 1st week of July, first year using polyaluminum chloride
2015	7900		4661	14	6.2	10.5	Leftover chemical used in summer, but little treatment after first week of July
2016	5800		3422	13	4.7	7.3	Only a little over half of the chemical was used by early July, remainder by August 15th
2017	6000		3540	17	8.3	13.9	Two deliveries of chemical were made and all was used by early July
2018	5400		3186	11	4.9	14.1	Two deliveries of chemical were made and all was used by the end of July
2019	5100		3009	14	8.5	17.8	Three deliveries (the 1st was a half load and portions of loads 2 and 3 were used on other ponds) of chemical were made and all was used by the mid-July
2020	4668		2754	9	4.9	9.1	Two deliveries made, parts of both used on other ponds. Limited treatment in June due to dry weather, extended treatment in to August
2021	5395		3183	12	7.5	24.6	Two deliveries made, parts of both used on other ponds. All Al used by early July , while it rained most of July, adding a lot of untreated water to Morses Pond
2022	5188		3061	16	3.7	10.2	Two deliveries made, but only 2500 gal added to Morses Pond before July. Additional treatments in July, Aug, and Sept.
2023	5277		3113	14	5.7	22.6	Two deliveries made, all used by July 4th. Considerable additional rain in July and August.
2024	7800		4602	13	8.9	14.0	Three deliveries made, treatment extended into early August, limited rain in July

Figure 1. Current system layout and water quality sampling sites in Morses Pond.

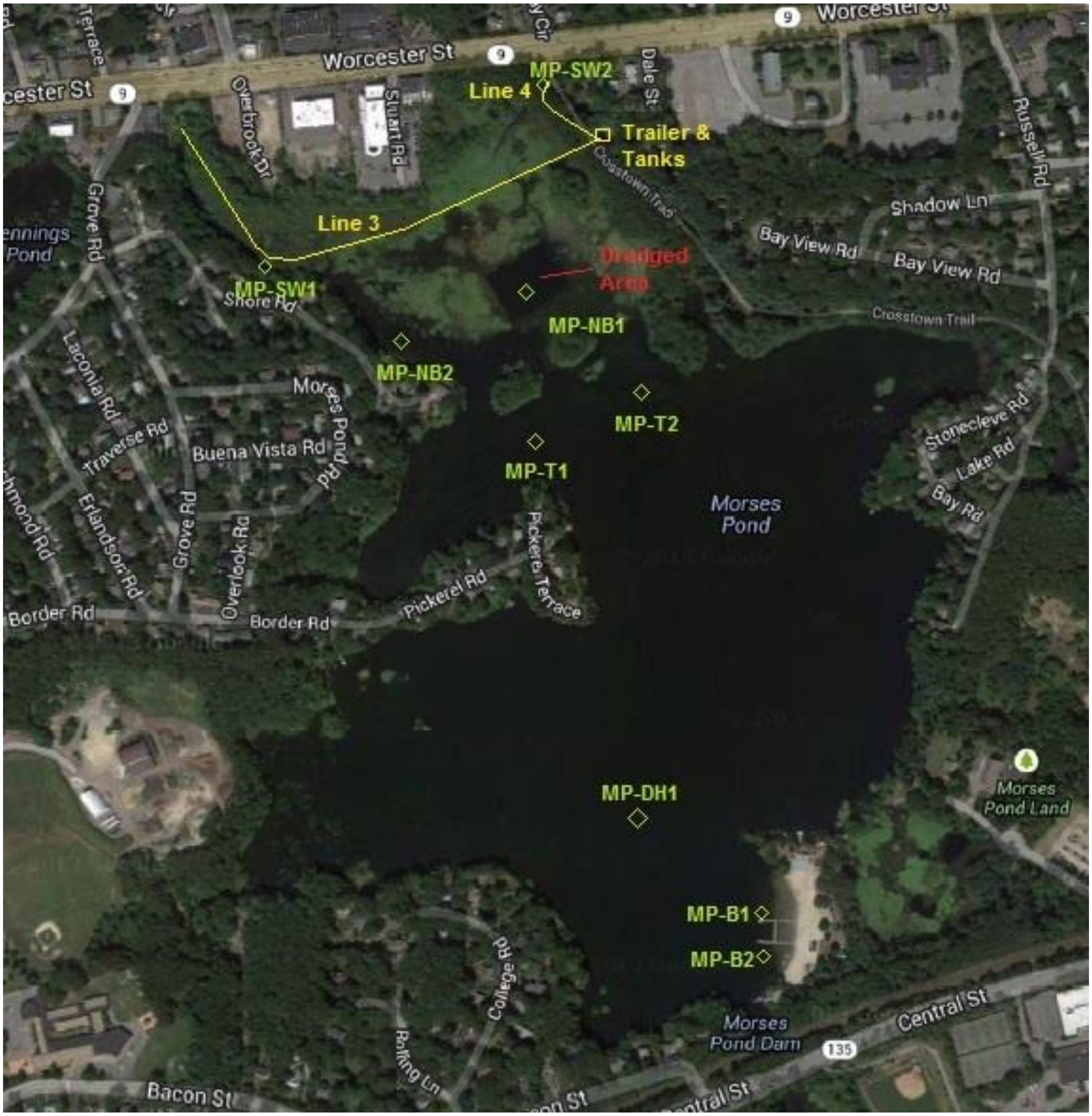


Table 2. Water quality record for Morses Pond in 2024.

Station	Date MM.DD.YY	Time HH:MM:SS	Depth meters	Temp °C	DO mg/l	DO % Sat	Sp. Cond µS/cm	pH Units	Turbidity NTU	CHL µg/l	Secchi meters	Total P mg/L	TKN mg/L	Nitrate N mg/L	Total N mg/L
MP-NB1	05.06.24											0.0319	0.4310	0.2450	0.676
MP-NB2	05.06.24											0.0372	0.3240	0.2440	0.568
MP-T1	05.06.24											0.0306	0.3490	0.2160	0.565
MP-T2	05.06.24											0.0340	0.5570	0.2100	0.767
MP-1	05.06.24	10:42:32	0.3	15.8	10.7	109.6	408.0	7.7	1.1	4.1	2.3	0.0138	0.4640	0.3390	0.803
	05.06.24	10:42:53	1.0	15.4	10.9	110.8	407	7.8	1.3	10.4					
	05.06.24	10:43:26	2.0	15.0	10.5	105.4	407	7.8	1.6	12.6					
	05.06.24	10:43:53	3.0	13.3	11.1	107.1	400	7.8	1.9	20.6					
	05.06.24	10:44:38	4.0	10.6	7.8	71.5	387	7.5	2.1	16.4					
	05.06.24	10:45:11	5.0	8.4	6.6	57.2	381	7.2	2.2	12.0					
	05.06.24	10:45:52	6.0	7.7	5.4	45.4	382	7.1	2.5	9.6		0.0213	0.3440	0.2490	0.593
MP-B	05.06.24	10:46:25	6.5	7.6	5.0	42.5	383	7.0	2.7	8.5		0.0149	0.4140	0.2510	0.665
Bogle	05.28.24		0.1	21	7.8		405	7.3	3.8	2.7		0.0669	0.4920	0.5810	1.073
Boulder	05.28.24		0.1	18.4	7.3		228	7.2	3.6	2.6		0.0861	0.3830	0.6700	1.053
MP-B	05.28.24		0.1	24.8	9.0		416	7.9	2.0	2.0		0.0308	0.3800	0.2260	0.606
MP-NB1	06.28.24		0.5	23.3	5.2		354	6.8	0.1			0.0213	0.3720	0.1810	0.553
MP-NB2	06.28.24		0.5	22.8	7.1		477	7.1	8.1			0.0521	0.3700	0.2390	0.609
MP-T1	06.28.24		0.5	24.5	6.4		474	7.1	0.0			0.0340	0.2000	0.1460	0.346
MP-T2	06.28.24		0.5	25.1	7.9		526	7.4	1.4			0.0468	0.2680	0.1490	0.417
MP-1	06.28.24		0.3	25.2	8.7		516	7.9	7.8		3.1	0.0202	0.2560	0.0975	0.354
	06.28.24		0.9	25.2	8.7		516	7.8	7.7						
	06.28.24		1.8	25.2	8.6		515	7.7	8.1						
	06.28.24		2.7	24.8	8.3		515	7.5	8.5						
	06.28.24		3.6	19.0	6.2		479	7.0	8.9						
	06.28.24		4.5	13.3	0.0		465	6.8	8.4						
	06.28.24		5.5	10.0	0.0		479	7.0	8.3						
	06.28.24		6.4	9.4	0.0		496	7.0	8.0			0.0436	1.1000	0.0500	1.150
MP-B	06.28.24		0.5	25.8	9.5		518	7.9	0.0			0.0181	0.2000	0.0966	0.297
MP-B	07.30.24		0.5								3.1	0.0106	0.5050	0.0505	0.050
MP-NB1	09.22.24		0.5	18.8	3.5		582	7.6	1.1			0.0255	0.4660	0.0500	0.516
MP-NB2	09.22.24		0.5	17.9	6.7		566	7.2	3.9			0.0538	0.2680	0.0538	0.322
MP-T1	09.22.24		0.5	19.0	6.8		582	7.3	2.4			0.0308	0.3830	0.0500	0.433
MP-T2	09.22.24		0.5	19.2	7.5		585	7.4	4.3			0.0404	0.3920	0.0500	0.442
MP-1	09.22.24		0.3	20.2	8.0		564	7.6	6.3		1.8	0.0187	0.3090	0.0500	0.359
	09.22.24		0.9	20.2	8.0		564	7.6	6.5						
	09.22.24		1.8	20.2	7.9		564	7.6	6.7						
	09.22.24		2.7	20.1	7.9		565	7.6	7.0						
	09.22.24		3.6	20.1	7.8		564	7.5	7.5						
	09.22.24		4.5	19.9	7.3		562	7.5	7.9						
	09.22.24		5.5	14.9	0.0		561	7.4	9.4						
	09.22.24		6.4	12.0	0.0		718	7.4	7.0			0.0563	2.2400	0.0500	2.290
MP-B	09.22.24		0.5	20.3	8.4		565	7.7	3.5			0.0191	0.3220	0.0500	0.372

Table 3. Water quality testing results relative to the phosphorus inactivation system

Year	Location	Pre-Application TP (ug/L)	Early Summer TP (ug/L)	Late Summer TP (ug/L)	Observations
2008	North Basin	0.028	0.018	0.013	Mats observed, some cloudiness
	Transition Zone	0.031	0.022	0.014	Some cloudiness, brownish color
	Swimming Area	0.021	0.012	0.012	No blooms reported, first year without copper treatment in some time
2009	North Basin	0.035	0.040	0.063	Cloudy, some green algae mats
	Transition Zone	0.035	0.039	0.045	Cloudy
	Swimming Area	0.015	0.010	0.027	Generally clear, no blooms reported
2010	North Basin	0.026	0.046	0.053	Cloudy, green algae mats evident
	Transition Zone	0.028	0.021	0.032	Brownish color, minimally cloudy
	Swimming Area	0.019	0.015	0.043	Generally clear, no blooms until late August (Dolichospermum)
2011	North Basin	0.053	0.033	0.130	Cloudy, green algae mats evident
	Transition Zone	0.048	0.029	0.095	Slightly brownish
	Swimming Area	0.030	0.029	0.060	August bloom (Dolichospermum), dissipated after just a few days without treatment
2012	North Basin	0.032	0.024	0.048	Very dense plant growth, associated green algae mats
	Transition Zone	0.028	0.037	0.028	Brownish most of summer
	Swimming Area	0.020	0.027	0.024	Had bloom in mid-July (Dolichospermum), treated with copper
2013	North Basin	0.036	0.047	0.030	Water brownish, little visible algae; 1st year with newly dredged area within north basin
	Transition Zone	No Data	0.078	0.032	Generally elevated turbidity, but much of it is not living algae
	Swimming Area	0.024	0.033	0.028	Treatment lowered TP but not to target level; June flushing minimized algae biomass
2014	North Basin	0.030	0.022	0.020	Dense plant growths and green algae mats outside dredged area, water fairly clear
	Transition Zone	0.021	0.020	0.018	Dense plant growths, but water fairly clear
	Swimming Area	0.012	0.013	0.017	Water clear; Secchi to bottom in swimming area, no blooms reported
2015	North Basin	0.012	0.017	0.023	Dense plant growths and green algae mats outside dredged area, water fairly clear
	Transition Zone	0.008	0.015	0.014	Dense plant growths, but water fairly clear
	Swimming Area	0.005	0.005	0.014	Water clear; Secchi to bottom in swimming area, no blooms reported
2016	North Basin	0.012	0.009	0.005	Very dense plant growths after mild winter, but water still clear
	Transition Zone	0.019	0.016	0.005	Dense plant growths but water clear
	Swimming Area	0.014	0.005	0.005	Water clear; Secchi to bottom in swimming area, no blooms reported
2017	North Basin	0.031	0.031	0.013	Dense rooted plants, some algae mats
	Transition Zone	0.027	0.034	0.014	Dense rooted plants, few algae mats
	Swimming Area	0.017	0.018	0.015	Some cloudiness, but no visible algae blooms
2018	North Basin	0.030	0.018	0.016	Dense rooted plants, some algae mats
	Transition Zone	0.031	0.015	0.016	Some cyanobacteria in June, less in August
	Swimming Area	0.017	0.012	0.011	Some cyanobacteria in June, less in August, but water green at 20 ft of depth in early Sept
2019	North Basin	0.025	0.030	0.028	Water turbid with suspended sediment on most visits
	Transition Zone	0.020	0.034	0.022	Water turbid but on obvious cyanobacteria or algae mats
	Swimming Area	0.019	0.015	0.018	No cyanobacteria and few green algae mats observed in May-Aug, some cyanobacteria in
2020	North Basin	0.025	0.018	0.012	Plants very dense but few algal mats
	Transition Zone	0.042	0.030	0.012	Plants dense on most visits, water murky but few visible particles
	Swimming Area	0.038	0.011	0.015	Some cyanobacteria particles early in summer but clarity acceptable at all times
2021	North Basin	0.025	0.030	0.051	Much rain, samples from Bogle and Boulder with TP >0.6 mg/L 1st flush, >0.06 post-storm
	Transition Zone	0.023	0.039	0.051	Plants dominated by fanwort, harvesting effort high but could not keep up with growth
	Swimming Area	0.021	0.025	0.035	Water murky much of summer, but from rain, particulates, and natural color, not high algae
2022	North Basin	0.022	0.028	0.019	Very dry spring and summer, limited Al treatment before July
	Transition Zone	0.027	0.031	0.017	Plants dominated by fanwort, harvesting effort high but could not keep up with growth
	Swimming Area	0.018	0.021	0.015	Algal bloom of Planktothrix in late August into September
2023	North Basin	0.037	0.035	0.048	Average spring precipitation, very wet July and August
	Transition Zone	0.034	0.035	0.033	Plants dominated by Eurasian milfoil, harvesting effort high but could not keep up with growth
	Swimming Area	0.020	0.031	0.031	Decreased clarity included color, suspended sediment, and some cyanobacteria
2024	North Basin	0.035	0.037	0.040	Wet May-June, dry July-August
	Transition Zone	0.032	0.040	0.036	Plants dominated by curlyleaf pondweed and fanwort, extensive harvesting effort
	Swimming Area	0.015	0.018	0.016	Clarity low 6 weeks after treatment ended but high through beach season

concentration near the beach has increased to just under 20 ug/L as the result of untreated August and September storms and possibly some internal loading from the deep zone of the pond.

Total Kjeldahl nitrogen values were moderate to high in 2024 (Table 2), mostly 0.3 to 0.5 mg/L in surface samples from the pond and up to 2.2 mg/L in the deepest water. A portion of the pond stratifies and loses oxygen, allowing ammonium to build up through decomposition with minimal mixing in that zone. Ammonium is not measured directly but is the dominant form of nitrogen in deep water with the elevated TKN values.

Concentrations of TKN and nitrate in inflows from Bogle and Boulder Brook were moderate. Nitrate was much lower but not negligible in the pond (Table 2) than in the inflows, declining from a high near 0.2 mg/L in late May to the detection limit at 0.05 mg/L by mid-summer and remaining low into late September. The loss of nitrate favors cyanobacteria, which utilize this nitrogen source less than other algae, making the minimization of available P that much more important.

There are usually summer oxygen deficiencies in the deep hole area (MP-1) with depressed or depleted oxygen by mid-summer in many years. Oxygen has been depleted at relatively shallow depths in recent years, with minimal oxygen at 2 to 4 m (7 to 14 feet) of depth. Conditions have been worse in wet years like 2021 and 2023 suggesting that watershed inputs of organic matter, flushed from upstream wetlands by more intense precipitation, are a factor in pond oxygen levels. Yet those inputs mostly remain in the lake and add to the oxygen demand from sediment in coming years. Warmer summers also increase water temperature which in turn increases bacterial metabolism and oxygen demand, leading to lower oxygen concentrations. Additionally, warmer water accelerates rooted plant growth, which adds oxygen by day and removes it by night, causing higher high values and lower low values with substantial daily variability. This is a climate change effect, and the variation can be troublesome at the increased frequency of low oxygen levels.

The affected area in many years before 2020 has been <20% of the pond area and <10% of the pond volume, and no fishkills or even stress were observed in the pond. Low oxygen conditions in Morses Pond have affected at least 33% of the lake bottom in recent years and may have impacted more than half the area in some years with both oxygen demand in deep water and excessive rooted plant growth in shallow water. Low oxygen is a negative influence on water quality and pond ecology, and there were more dead fish in spring 2023 than any recent year. Some dead fish were reported in 2024, but not nearly as many as in 2023. Aside from not supporting aquatic life based on the state standard for oxygen (5 mg/L), low oxygen allows phosphorus to be released from the affected sediment and can foster development of cyanobacteria at the sediment-water interface that later rise to form a bloom. This occurred in each of 2020-2023 but not in 2024. Cyanobacteria accumulation was localized and not a threat to most lake uses, but the trend is concerning. The additional aluminum treatment in 2024 is likely responsible for less cyanobacteria this year.

Conductivity is high in surface waters of Morses Pond and very high in deeper water, indicating large amounts of dissolved solids in the water, although conductivity does not reveal the nature of those solids. Salts from road management are a likely source, but natural inputs from upstream wetlands are also likely substantial. The pH is slightly elevated near the surface and declines with depth, with decomposition adding acids and lowering pH at deeper locations. The pH also tends to increase as water moves through the pond, with photosynthesis by algae and rooted plants removing carbon dioxide and raising pH. Values for pH in 2024 were between 6.8 and 7.8, an acceptable range that is slightly narrower than in recent years. Maintaining pH <8.0 is desirable and is mainly a function of preventing algal blooms (aluminum treatment) and excessive rooted plant growth (harvesting).

Turbidity is moderate in most of the water column but was high enough to limit clarity to <2 m in late September 2024, well after the swimming season and 6 weeks after treatment ceased. Turbidity is caused by suspended solids, which in turn are a mix of algae and non-living particles, either organic or inorganic. In Morses Pond, most suspended solids are organic, either living algae or dead plant material, and these affect both clarity and oxygen.

Summer water clarity in 2024 was moderate but back in the intended range as a result of aluminum treatment (Figures 2 and 3). Clarity dropped off in September after treatment ceased, but all recreational pursuits were supported through the summer. The high precipitation over the summers of 2021 and 2023 resulted in lower clarity than the much drier summers of 2020 and 2022, despite treatment limitations in all those years, but conditions in 2024 were more indicative of what is expected from the treatment system. The wet spring followed by a relatively dry summer would have been a recipe for algal blooms, especially by cyanobacteria, but treatment between the end of May and early August kept P low enough to prevent blooms. There is some concern over internal P loading, a product of exposure of P-rich sediments to low oxygen, but the additional treatment in 2024 appears to have countered that effect.

Experimentation with the timing and amount of aluminum has suggested a lower limit of about 3500 lbs per May-June application period or about 400 lbs per inch of precipitation for best results. Just over 3100 lbs of aluminum were applied by early July of 2023, representing 546 lbs per inch of precipitation in May and June, but the almost 17 inches of precipitation in July and August added a lot of untreated runoff. Consequently, conditions in 2023 were not appreciably better than before treatment was initiated in 2008. In contrast, in 2024 the application rate was 330 lbs per inch of precipitation, but treatment extended from late May through early August and addressed all storms during that period. The distribution of treatment appears as important as the amount of aluminum applied.

The phosphorus inactivation history for Morses Pond has been divided into 3 periods: 2008-2010, 2011-2013, and 2014-2024, both in terms of system function and average summer water clarity and P data (Figures 2 and 3). The system worked well for 3 years, had equipment and operational problems for the next 3 years, then was modified and improved, leading to 6 years of low summer phosphorus and superior clarity. Conditions in 2020 and 2022 were not quite as desirable as in preceding years, but met the clarity target of >3 m (10 feet). Conditions in 2021 and 2023 were less desirable, given excessive inflows after the treatment period was over. The system ran as intended and was operated longer in 2024, providing the desired results. Clarity and algae remained acceptable for contact recreation in all years, but the phosphorus inactivation system has yielded variation in results and has practical limits on its effectiveness. Problems with pumps in recent years have also created limitations and an overhaul of the system is planned prior to the 2025 treatment season.

Figure 2. Average summer water clarity and total phosphorus in Morses Pond, 1994-2024.

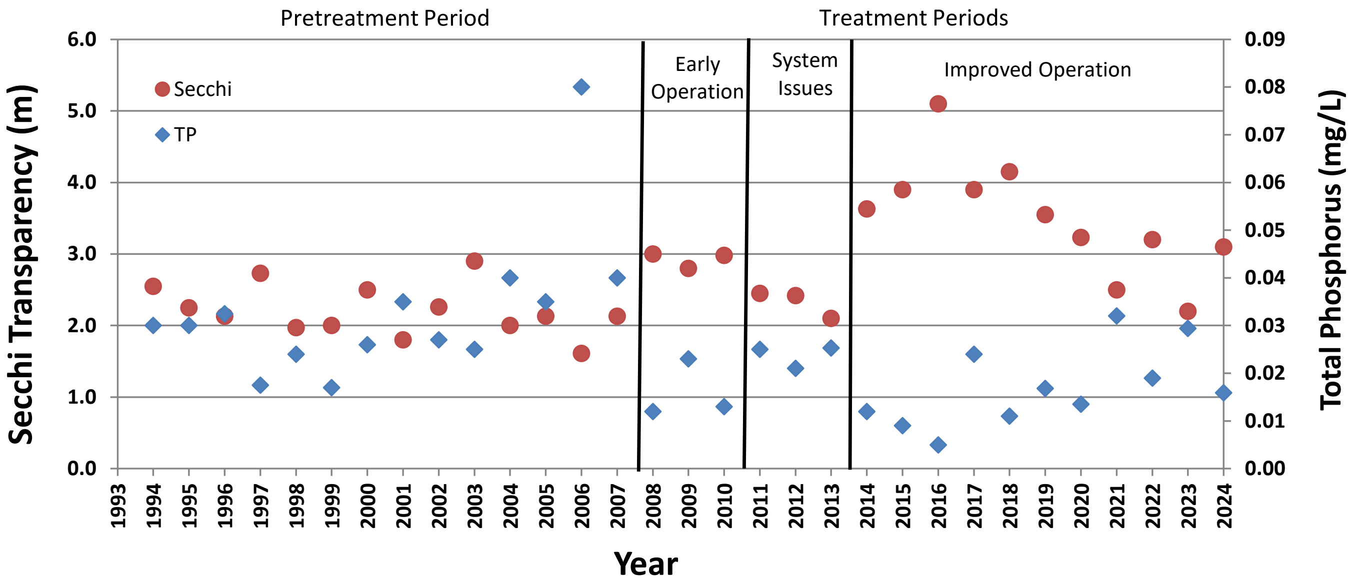
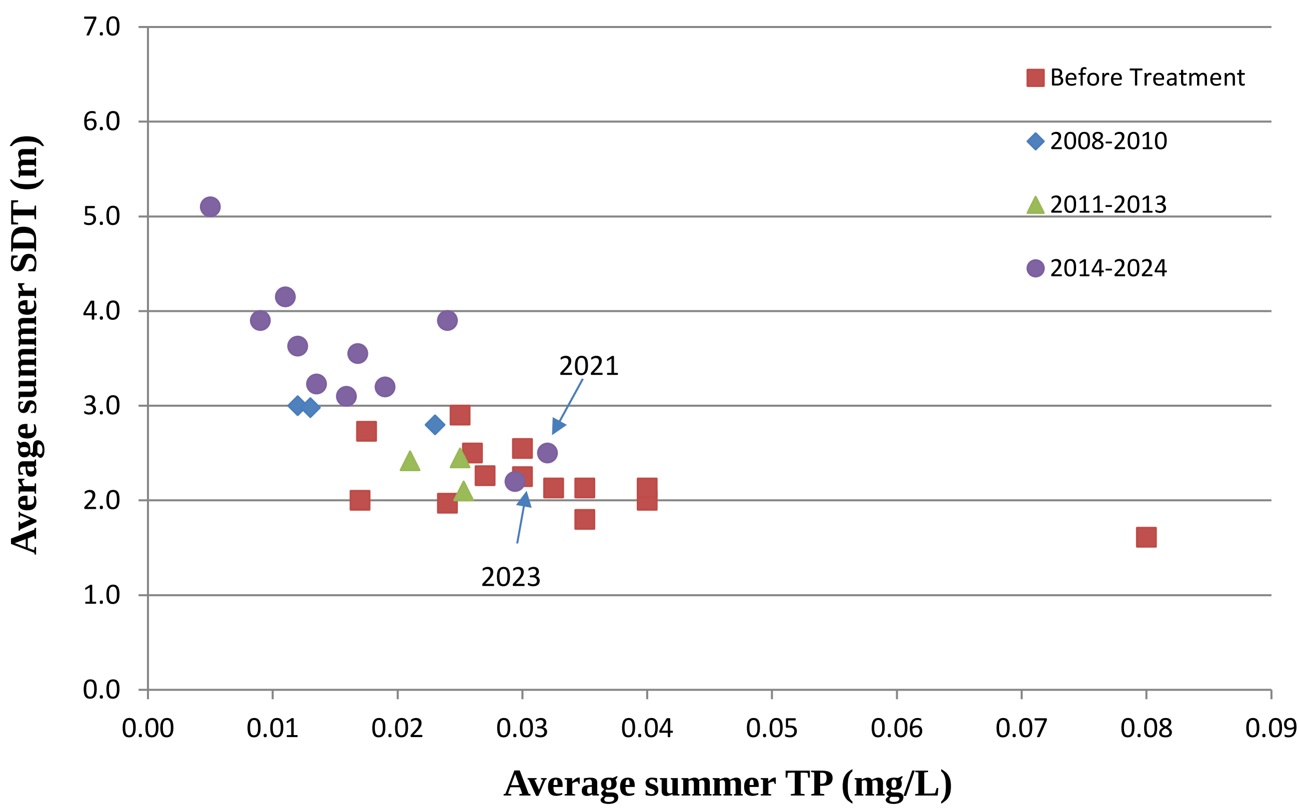


Figure 3. Relationship between summer water clarity and total phosphorus in Morses Pond.



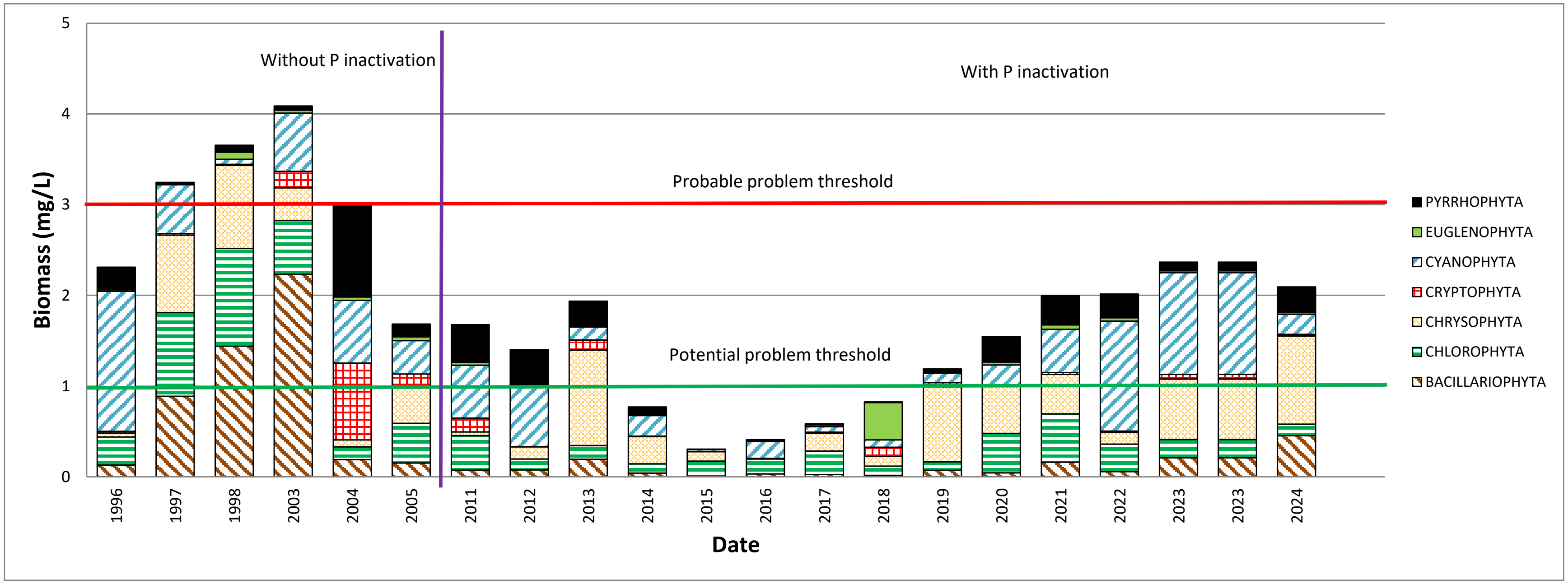
Algal data for 1996-2024 indicate that algae biomass and composition can be very variable, depending on combinations of nutrient levels, light, temperature, and flushing. Morses Pond phytoplankton biomass was frequently elevated prior to spring phosphorus inactivation, but since then average biomass values (Figure 4) have not exceeded the general threshold of 3 mg/L that signals low clarity (note that there is no official threshold for algae, but the red line in Figure 4 is a useful guide). Phytoplankton biomass as an annual spring/summer average was below the 1 mg/L threshold indicative of low biomass after the system adjustments of 2014 until 2019 and cyanobacteria have represented only a small amount of biomass each year until 2022. In 2019 the 1 mg/L threshold was just slightly exceeded, but the average algal biomass increased further in 2020 through 2023. Algal biomass was reduced somewhat and cyanobacteria were minimized by the more successful treatment of 2024. There have been small peaks in biomass at times, but no blooms that would prompt beach closure or other recreational impairment since improved operation of the phosphorus inactivation system in 2014.

In 2018-2023 some cyanobacteria of the problem genus *Aphanizomenon* were present, and have increased each year, but no surface blooms developed, and no beach closure was needed. While cyanobacteria were still well below the abundance threshold at which the MA DPH recommends posting waterbodies with warnings to avoid contact, the inactivation system was not able to deliver the level of control enjoyed prior to 2020 in the 2020-2023 treatment seasons. The progression of increasing algae overall and increasing cyanobacteria since the minimum in 2015 was reversed in 2024 by the additional treatment, highlighting the need for effective treatment through at least July.

An eastern shoreline accumulation of the cyanobacterium *Planktothrix*, which grows in deeper water with elevated phosphorus concentrations and rises to form surface scums, was observed in 2022 but did not occur in 2023 or 2024. Those scums are often blown by the wind into dense shoreline accumulations, as was the case in Morses Pond in mid- to late August of 2022. This alga can be toxic and shoreline accumulations have been implicated in dog deaths at other lakes, so the affected shoreline was posted with warning signs for several weeks in 2022. No toxicity was reported, and the accumulations dissipated within two weeks. High inflows and pond flushing in 2023 appeared to prevent such accumulations, while additional aluminum treatment in 2024 appears to have prevented such growths.

The increase in cyanobacteria in recent years suggests a need for additional management. Keeping the deep water oxygenated or treating the pond area deeper than about 10 feet directly with aluminum represent proactive steps that could be taken to minimize cyanobacteria. An overhaul of the phosphorus inactivation system to maximize performance and an extension of treatment further into summer as needed when precipitation is substantial represents an alternative, and the additional treatment in 2024 appears to have worked. The system is being overhauled now and will be operational in 2025. The unpredictability of climate change effects is a factor and the ability to continue treatment as warranted provides flexibility. Current permits for the inactivation system allow treatment through August but purchase of aluminum products has been kept to no more than 6000 gallons per year since 2016. Application of more aluminum may be necessary is some years, and the new system being constructed for 2025 is intended to improve reliability and performance.

Figure 4. Summer average algae biomass divided into major algae groups for 1996-2024.



Zooplankton have also been sampled, and while not as tightly linked to nutrients as algae, provide important information on the link between algae and fish (Figures 5 and 6). Zooplankton biomass varies strongly between and within years. Values <25 µg/L are minimal, and values higher than 100 µg/L are preferred as rough thresholds, with high values desired for both algae grazing and fish food. Morses Pond values span that range and more. Values in later summer are expected to be lower than in late spring or early summer, as fish predation by young-of-the-year fish (those hatching that year) reduces populations of zooplankters. Spring levels will depend on water quality, predation by adult fish, and available algae, which are food for zooplankton. The dominant zooplankton groups are cladocerans and copepods, both groups of micro-crustaceans. *Daphnia*, among the larger cladocerans, filter the water to accumulate algae as food, and can increase water clarity markedly.

Daphnia were present in Morses Pond in all monitored years, a good sign, and abundance was elevated in many samples. The late summer zooplankton population was sometimes sparse but overall the zooplankton community has adequate biomass to support the food web and provide substantial grazing capacity for algae consumption, which helps maintain water clarity. Biomass averages >100 µg/L and the mean crustacean zooplankton length is mostly in the range (0.5 to 0.8 mm) that suggests good balance between gamefish and their prey species. There is no indication of any aluminum toxicity to zooplankton; the treatment protocols minimize this probability.

Zooplankton biomass in 2024 was lower than in most recent years but still in the desirable range (Figure 5) although there were fewer cladocerans than usual. Mean length of crustacean zooplankton was in the desirable range (Figure 6), indicating high grazing capacity and substantial food for fish that eat zooplankton. The lower biomass of zooplankton may have been a result of fish predation if 2024 was a banner year for fish reproduction, but we do not have any recent fish data for Morses Pond.

Zooplankton represent an important consumer of algae in Morses Pond and contribute to clarity even when phosphorus concentrations are higher than desired. However, most zooplankton cannot consume the larger filaments and colonies of bloom-forming cyanobacteria, and it is therefore important to exercise control over phosphorus concentrations to limit threats from that group of algae.

Relevance of Inactivation Program Results to MS4 Requirements

Wellesley is covered under a Municipal Separate Storm Sewer System (MS4) permit under the federal National Pollutant Discharge Elimination System (NPDES), which is intended to limit P inputs to the Charles River. A substantial reduction has been assigned to Wellesley and can be achieved by a variety of means, some more standard than others. P inactivation with aluminum is a standard practice in water and wastewater treatment facilities but has not been considered under the NPDES program for non-point sources like the stormwater that dominates P inputs to the Charles River. The system in operation at Morses Pond may be eligible for P reduction credit.

Calculating the amount of P removed by the P inactivation system is not easy, as we do not have extensive data for the concentrations in the water being treated or for the treated water at a suitable time after treatment to allow all reactions to occur and for the precipitate to settle. The amount of aluminum added will remove a similar mass of P based on theoretical stoichiometric reactions. Yet it is generally accepted

Figure 5. Zooplankton abundance for 1996-2024.

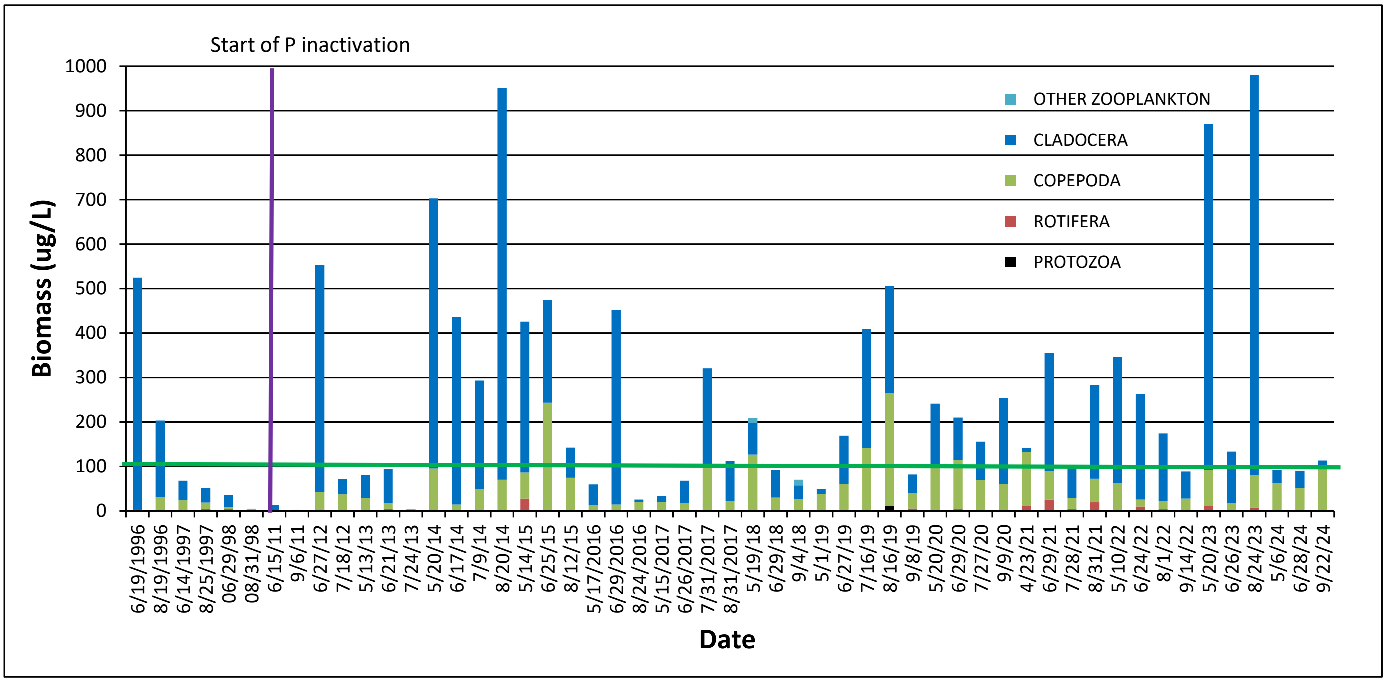
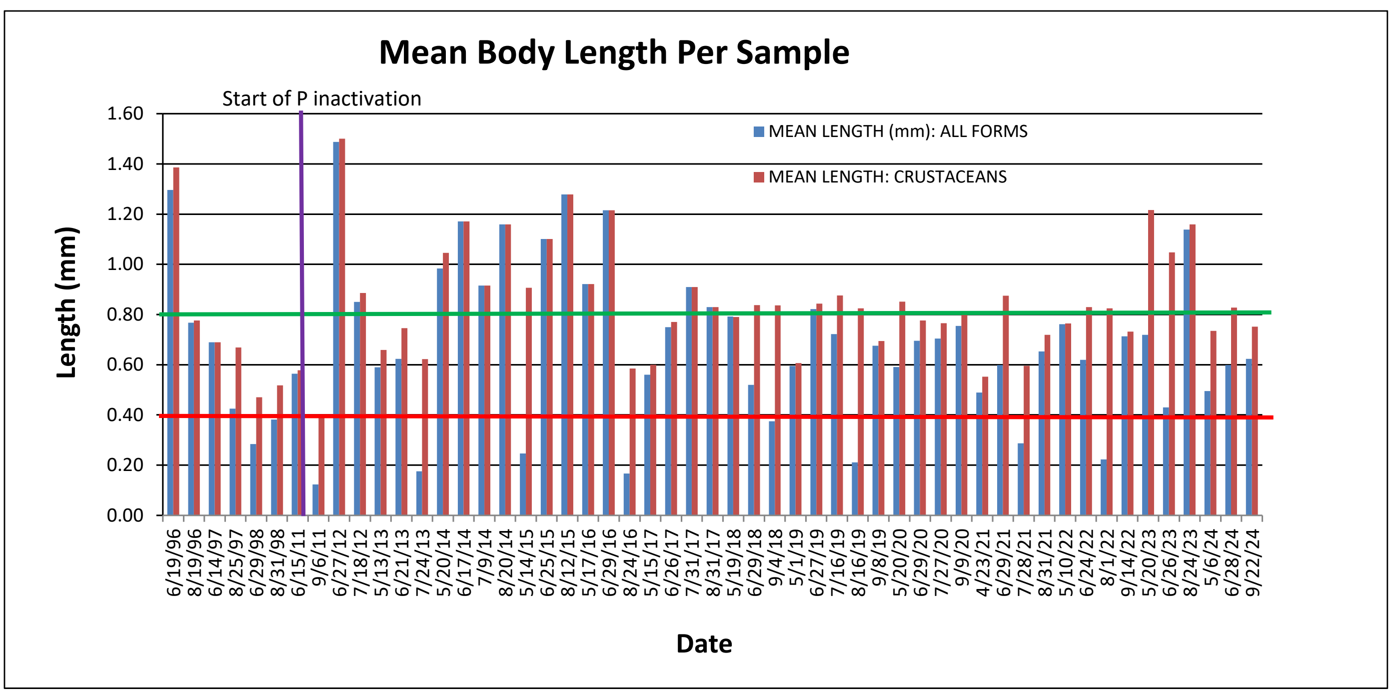


Figure 6. Crustacean zooplankton mean length, 1996-2024.



that it takes about ten times as much aluminum as phosphorus to achieve successful inactivation, as many other compounds can bind with aluminum and take up possible P binding sites. In more P-rich water, that ratio can be more favorable, and the water entering Morses Pond during storms from Bogle and Boulder Brooks is certainly P-rich. The average aluminum input for the last 17 years has been 4135 lbs/yr, or 1880 kg/yr. If we assume that one unit of P is inactivated for every ten units of aluminum added, the average P removal per year from the P inactivation system would be 188 kg/yr. If we assume a higher binding efficiency for P-rich water, the P removed could be larger.

The jar tests conducted to evaluate aluminum polychloride for use at Morses Pond yielded 97% reduction in total P in the tested samples. The amount of inflow treated each year is not precisely known, but the targeted aluminum concentration (1-3 mg/L) is consistent with the jar tests. If 1880 kg of aluminum are added on average and a concentration of 1-3 mg/L is achieved, that would represent treatment of 0.63 to 1.88 million m^3 of inflow. At an average inflow concentration of 130 ug/L and a 97% reduction from treatment, that equates to P removal of 79 to 237 kg/yr.

Variation among years based on the amount of aluminum applied and treated water characteristics is to be expected. However, it is evident that a substantial amount of P that would otherwise move through Morses Pond and eventually into the Charles River is being removed by the P inactivation unit. In the absence of treatment, some P will settle out in Morses Pond or downstream areas like Paintshop Pond or Lake Waban, but some of that P can be released later, so it is not inactivated and made as unavailable as it is with aluminum treatment. As other reduction credits are based on estimates, often with very little site-specific data, it is not unreasonable to claim some credit for the P inactivation at Morses Pond. A credit on the order of 200 kg of P per year seems reasonable from what we know of the process and conditions at Morses Pond.

Mechanical Plant Harvesting

Harvesting Strategy

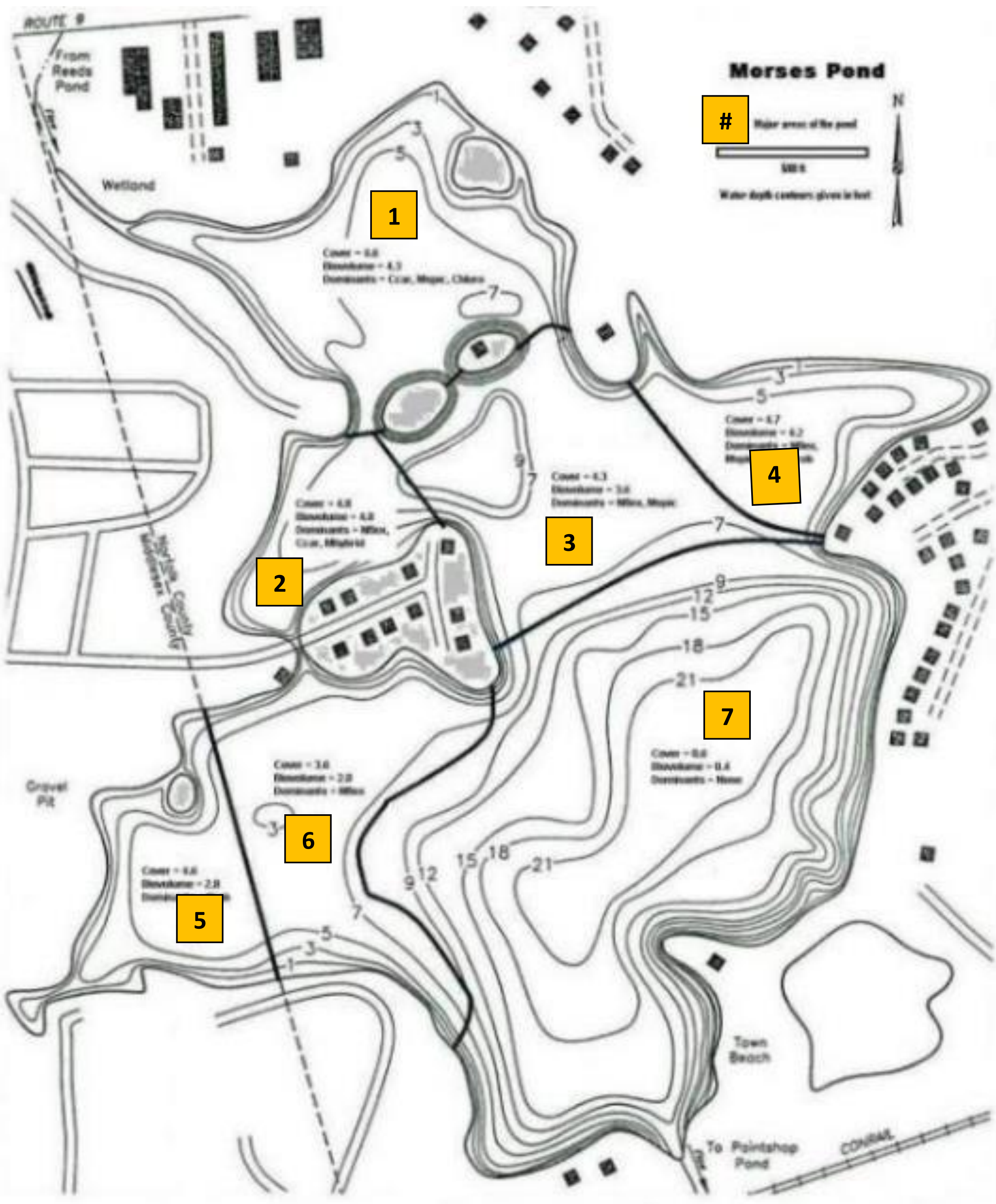
The Town of Wellesley initiated the enhanced Morses Pond vegetation harvesting program in 2007. The zoned vegetation harvesting strategy originates from the 2005 pilot program and comprehensive management plan written that year. For the pilot program, Morses Pond was divided into seven zones in order to better track the harvesting process. Figure 7 shows these zones and Morses Pond bathymetry. Harvesting protocols have been adjusted through experience to maximize effectiveness and minimize undesirable impacts, such as free fragments that accumulate along shore. The goal is to complete one harvest of all targeted areas by the end of June, sometimes using two harvesters, with a cutting order and pattern that limits fragment accumulation, especially at the town swimming beach. This usually involves cutting in area 6 first, with any work around the edge of area 7 second, followed by work in areas 2, 3 and 4 in whatever order appears warranted by conditions. Area 5 is in Natick and is usually not cut, and area 1 is the north basin and is also not cut, except for a channel for residences along the western side. A second cutting occurred from August into October until 2015, when the second cutting was initiated in late July and usually completed by sometime in September. More frequent plant surveys are now used to inform harvesting priorities, with occasional shifts in which zone is addressed in which order to best meet user needs.

The keys to successful harvesting include:

- Initiating harvesting by the Memorial Day weekend, sooner if plant growths start early in any year.
- Cutting with or against the wind, but not perpendicular to the wind, to aid fragment collection.
- Limiting harvesting on very windy days (a safety concern as well as fragment control measure).
- Using a second, smaller harvester to pick up fragments if many are generated.
- Cutting far enough below the surface to prevent rapid regrowth to the surface, but not so far as to cut desirable low growing species such as Robbins' pondweed.
- Minimizing travel time on the water with a cutting pattern that does not end a run any farther from the offloading point near the outlet than necessary.
- Preventive maintenance in the off season to minimize down time during the harvest season.
- Using trained personnel who know what to cut, where to cut, and how to avoid damage that would necessitate maintenance of the harvester.

The town has owned harvesters for over 35 years, with the oldest one retired almost a decade ago and the second oldest, and largest, retired in 2023 after a new large harvester was delivered. In 2019 a new, smaller harvester was put into service and was used instead of the larger, older harvester on many days, as the larger, older harvester was prone to breakdown at its age. This reduced efficiency by virtue of the smaller size of the new harvester and need for smaller loads and more transport time but was intended to minimize downtime. Operation of the larger harvester is what the plan was based on, and breakdowns that last for more than about a week during the harvesting season create conditions from which it can be difficult to recover. Harvesting to maintain open water over much of the pond can be a challenging exercise even with properly functioning equipment, given issues with staffing, weather, and simultaneous needs in different parts of the pond. The area that affects the town beach complex has priority when resources are limited.

Figure 7. Plant Management Sectors for Morses Pond.



A decrease in efficiency when plant growth is dense can have a cascading effect that leads to unacceptable conditions over a larger area. The key is to cut before weeds get too dense but not before there is enough biomass to allow substantial collection during a harvesting run (the time between leaving the offloading area and returning to it). Aquatic plant harvesting is very much like mowing a lawn; if grass is allowed to get too high, cutting becomes difficult in one pass, clogging is an issue, and more frequent unloading of the grass catcher is needed. In the aquatic environment this problem can be magnified, as travel time to dump each load can be substantial. It is therefore important to stay ahead of plant growth when harvesting, maintaining maximum cutting rate and minimizing travel time. Equipment issues that reduce cutting time and allow plants to grow high and dense can prevent achievement of goals.

Harvesting Record

Records provided by the Town of Wellesley document the harvesting effort expended on Morses Pond (Table 4). Although the record is not always complete, records have been kept since 2007. Between May and October, from 2007 through 2024, harvesting was conducted on a range of 43 to 76 days. This represents a range of 303 to 549 total hours devoted to some aspect of the harvesting program, and 184 to 335 hours of actual harvesting time. In 2024 harvesting occurred on 62 days for a total of 549 hours with 374.5 hours actually spent cutting, the total and cutting hours being the most in any year since program inception. Total loads of aquatic plants harvested have ranged from 54 to 211 per harvesting season, a wide range that reflects which harvester is being used and how full the hopper can be before offloading has to occur. Increased number of loads does not necessarily translate into more plants harvested. A total of 174 loads were offloaded in 2024, the third highest value recorded, and the actual weight of plants removed was the highest since 2016. Load size increased over recent years as well, with all of these summary statistics indicating the value of the new harvester. The primary targets are invasive species and bigleaf pondweed but the only selectivity offered is based on depth of cutting; lower growing species are favored.

Total weight of plants harvested, as measured upon entry to the composting facility (so there is some draining of water, but values are still wet weight) has ranged from 156,000 to 808,000 lbs. The 2024 biomass total was slightly more than 418,000 lbs and the average weight of a load of plants was just over 2400 lbs, the largest since 2019. The results are illustrated in Figures 8-10. The larger, older harvester was the primary limit to program success; its replacement in late July of 2023 appears to herald a return to more efficient and effective harvesting.

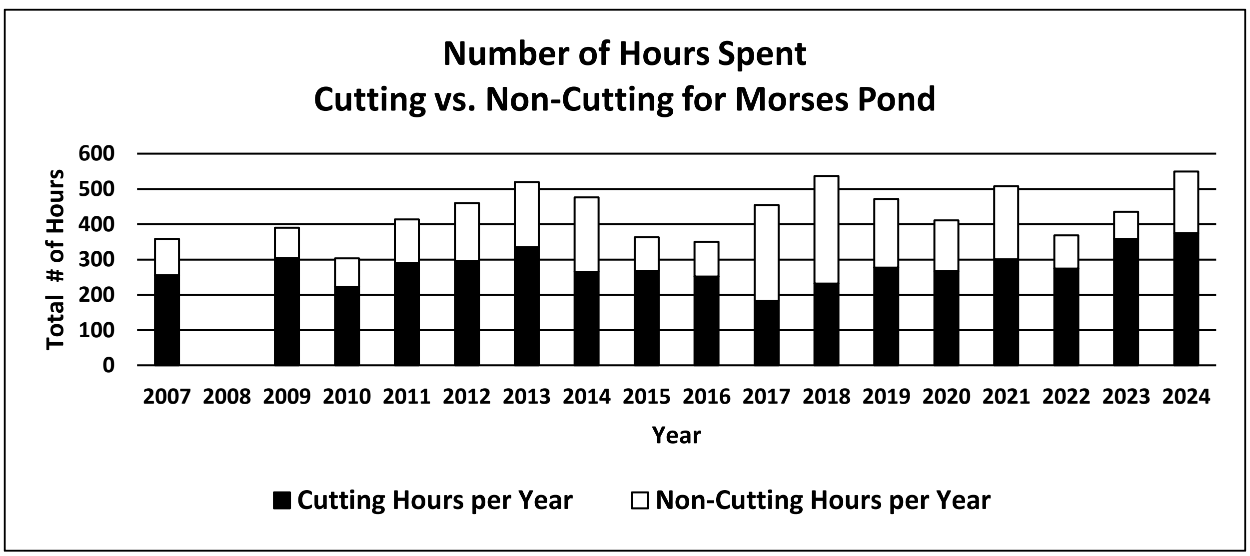
An increasing number of non-cutting hours was observed from 2009 through 2014 (Figure 8) and appeared related to increases in time for maintenance and travel. From 2014 through 2017, records were kept for non-cutting hours in categories including transport time on the water, transport time on land, and maintenance. With a renewed emphasis on efficiency, the 2015 record indicates that non-cutting time was roughly cut in half. Non-cutting time increased very slightly in 2016 but was still far less than in 2014 (Figure 8). Non-cutting time increased markedly in 2017, as the large harvester was working but not properly, resulting in low efficiency and an eventual breakdown. Note that this harvester experienced considerable downtime in 2016, but time not in use awaiting parts is not counted in the harvesting program.

Table 4. Harvesting record summary for Morses Pond.

Year	Days of Harvesting per Year	Total Hours per Year	Cutting Hours per Year	Total Hr/Day	Cutting Hr/Day	Total Loads	Total Weight	Weight/ Day	Weight/ Load	Weight/ Total Hr	Weight/ Cutting Hr
	(Days)	(Hr)	(Hr)	(Hr)	(Hr)	(Load)	(Pounds)	(Pounds)	(Pounds)	(Pounds)	(Pounds)
2007	49	359	255	7.3	5.2	109	NA	NA	NA	NA	NA
2008	43	NA	NA	NA	NA	NA	270320	6287	NA	NA	NA
2009	57	390	304	6.8	5.3	78	224060	3931	2891	575	738
2010	44	303	223	6.9	5.1	78	226960	5278	2900	749	1017
2011	54	414	291	7.7	5.4	102	292000	5407	2863	706	1003
2012	70	460	296	6.6	4.2	124.5	807760	11539	6488	1756	2729
2013	76	519.5	335	6.8	4.4	119.5	595277	7833	4981	1146	1777
2014	75	476.5	265.5	6.4	3.5	110	455220	6070	4138	955	1715
2015	57	363	268	6.4	4.7	90	607710	10662	6752	1674	2268
2016	48	350	252	7.3	5.3	85	521000	10854	6129	1489	2067
2017	43	454.5	183.5	10.6	4.3	54	348200	8098	6448	766	1898
2018	66	537	232	8.1	3.5	126.5	390185	5912	3084	727	1682
2019	62	472	277.5	7.6	4.5	126	344708	5560	2736	730	1242
2020	48	411	267	8.6	5.6	125.5	194525	4172	1550	473	729
2021	57	507.5	300.5	8.9	5.3	184	259084	4545	1408	511	862
2022	44	368.5	274.5	8.4	6.2	168	155534	3535	926	422	567
2023	48	435	358.5	9.1	7.5	211	302275	6297	1433	695	843
2024	62	549	374.5	8.9	6.0	174	418190	6745	2403	762	1117

For 2012 and 2013, harvesting includes Area 1 before dredging, which had very dense plant growths and accounts for additional weight removed.

Figure 8. Cutting and non-cutting hours associated with the harvesting program.



Non-cutting time was reduced steadily from 2017 through 2020 but rose slightly in 2021 to 41% of total hours devoted to the harvesting program. Non-cutting hours were reduced in 2022, down to a level comparable to 2015-2016, and total hours were also similar to 2015-2016 values. Even less non-cutting time was recorded in 2023 and the cutting hours were the highest recorded for the program. Yet the weight per load and total weight of plants removed from Morses Pond was much higher in 2015 and 2016 than in 2022 or 2023. The current primary factor in non-cutting hours is transport time from the harvesting area to the offloading area with smaller loads. This inefficiency is a function of harvester limitation and mostly not correctable by operators using the harvesters available until late July 2023. The increase in total plant mass removed in 2023 and 2024 (Figure 9) and increased weight per load (Figure 10) is partly a function of the increased hours and partly a result of getting the new, larger harvester.

The need to maximize cutting time conflicts with lower manageable load limits and more frequent trips back to the offloading location next to the outlet at the south end of the pond. Past efforts to establish other offloading points have met with resistance by shorefront residents and a renewed inquiry along those lines in 2020 raised similar concerns of truck traffic, noise, and odor. The new large harvester delivered in 2023 solves much of the problem, but operator inexperience and plant density are other factors of concern. Still, the improvement in program metrics in 2024 is evident and lake users and shoreline residents were happy with progress through much of summer. Excessive growths in some areas caused some complaints later in summer, and it appears that the harvester was used much more in area 3 than in any other part of the lake, and this shows in the plant data (discussed shortly in this report).

Plant density can be very high in areas of Morses Pond shallower than about 8 feet. Normally high density by natural growth is not achieved until sometime in June, by which time harvesting is in full swing and many problem areas should have been addressed. However, earlier growth has been an issue in several years, and there has been a gradual shift in earlier dominance by fanwort. Fanwort has been observed earlier and at greater dominance in other Massachusetts lakes as well in recent years, possibly a function of weather and climate changes. Eurasian and variable watermilfoil are perennial species that typically die back in a cold winter, but in both 2016, 2023, and 2024 the temperatures were high enough to allow continued growth. Additionally, curly leaf pondweed, an invasive species that achieves maximum abundance in spring, has surged in some years in Morses Pond. When plant growth achieves high density in late April or early May, before the harvesters are on the pond, it is very difficult to gain control even with fully functional harvesters. An earlier start to harvesting is needed but is difficult to achieve with other spring commitments by the same staff.

According to the harvesting activity logs, harvesting was conducted in sector 2 on 13 days, in sector 3 on 39 days, in sector 4 on 5 days, and in sector 6 on 13 days. Additionally, the western shoreline of sector 1 was cut on one day. Some days were split between sectors and on a few days both harvesters were working in different sectors. The log may have recorded work in sector 3 on some days when work was actually in sector 4, but it is apparent that sector 3 got the most attention in 2024. Harvesting started on May 13, earlier than usual, in response to dense growths of curlyleaf pondweed in many areas. Harvesting was last conducted on October 15th. On average, a harvester was working on the lake every other day. Control was achieved by early summer, but growths resurged in later summer despite a high degree of harvesting effort.

Figure 9. Total mass of plants removed by the harvesting program.

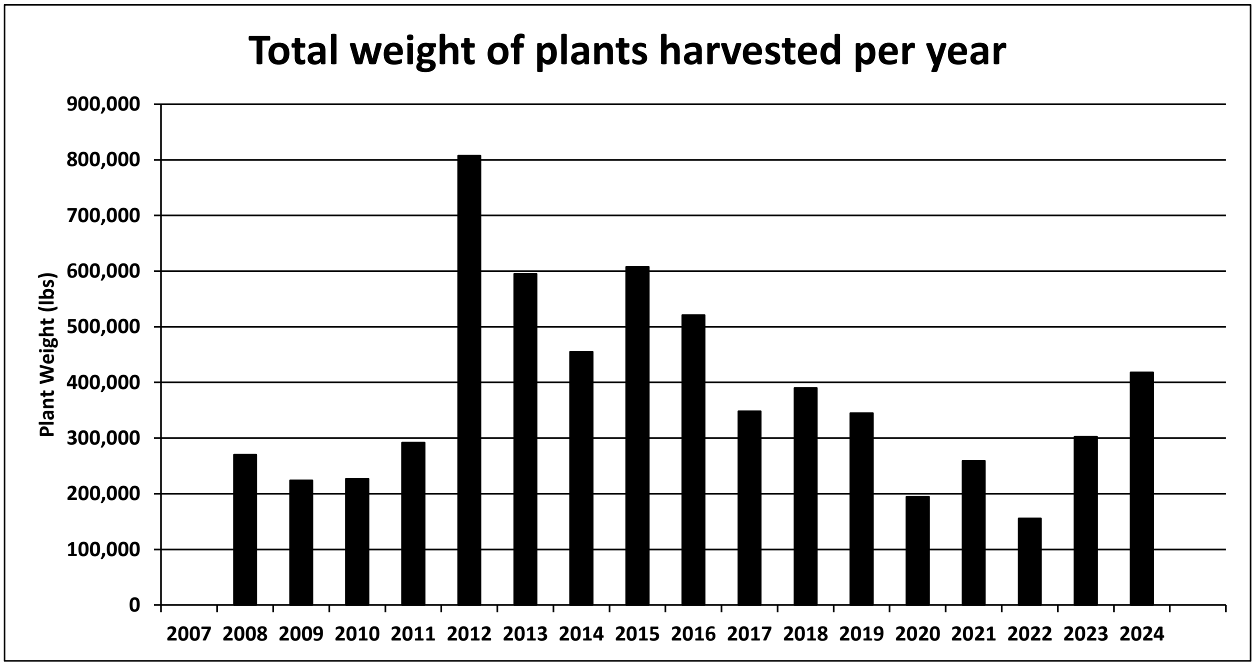
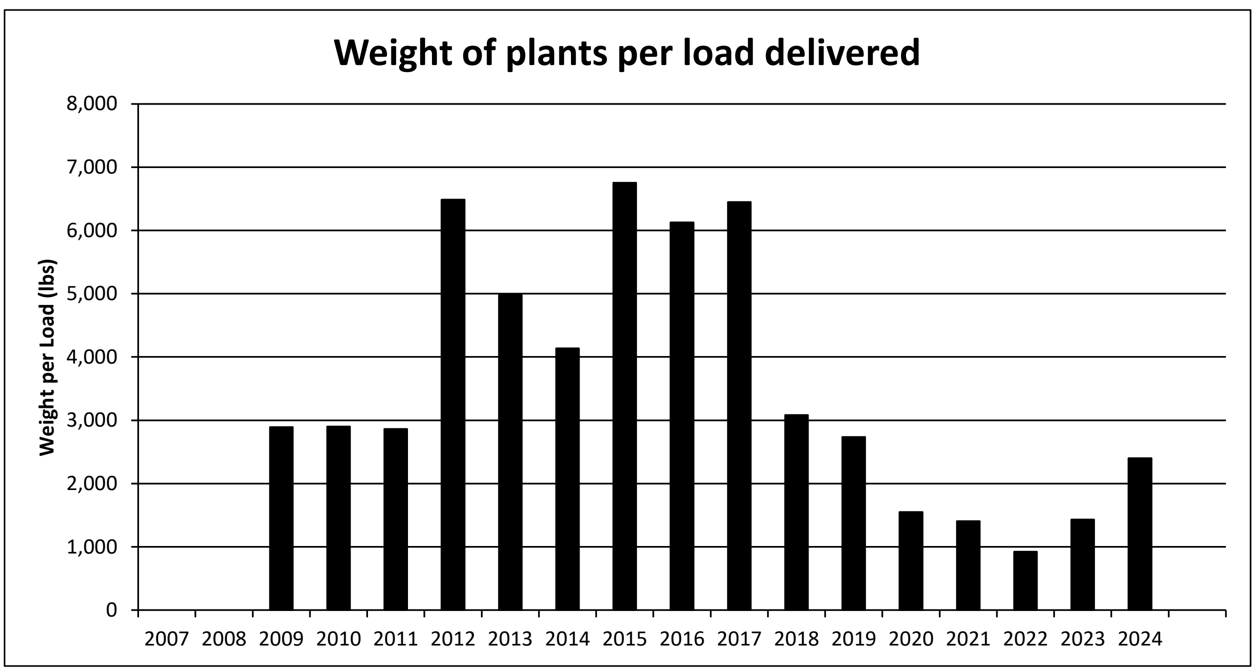


Figure 10. Mass of plants removed per load in the harvesting program.



Plant Surveys

Plant surveys are conducted to support harvesting operations, assessing where the need is greatest and evaluating success. The timing of surveys has varied, sometimes before harvesting, sometimes after, and comparisons have been useful but not always consistent. A point-intercept methodology was applied to document the spatial distribution and percent cover and biovolume of aquatic plants at specific re-locatable sites. At each point the following information is recorded:

- The GPS waypoint.
- Water depth using a metal graduated rod or a mechanical depth finder.
- Plant cover and biovolume ratings using a standardized system.
- Relative abundance of plant species.

For each plant species, monitoring staff recorded whether the species was present at trace (one or two sprigs), sparse (a handful of the plant), moderate (a few handfuls of the plant), or dense (many handfuls of the plant) levels at each site. Plant cover represents the total surface area covered in plants (2 dimensions). For cover, areas with no plants were assigned a “0,” areas with approximately 1-25% cover were assigned a “1,” a “2” for 26-50%, a “3” for 51-75%, a “4” for 76-99%, and a “5” for 100% cover. Like plant cover, a quartile scale was used to express plant biovolume, defined as the estimated volume of living plant material filling the water column (3 dimensions). For biovolume, 0= no plants, 1= 1-25%, 2=26-50%, 3=51-75%, 4=76-100%, and 5= 100% of plants filling the water column.

After 2017 this approach was adjusted to be more responsive to management needs, focusing on a smaller number of points in each designated zone of the pond and surveying at least three times, allowing for evaluation of conditions before cutting, after the first cut, and after the second cut. The target condition, based on the assessment methodology above, is to have each targeted harvesting area exhibit an average biovolume of about 2 (25-50% of the water column filled with plants, mainly the bottom quarter to half) but not to restrict the coverage except in key access areas like the public beach, such that sediment is stabilized and habitat is maximized.

2024 Results

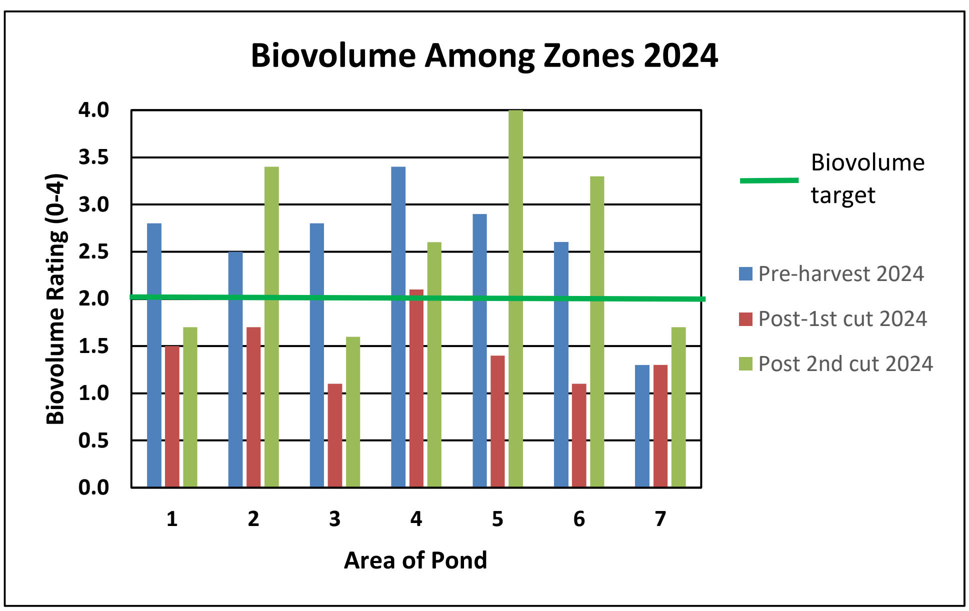
A total of 37 species are known from Morses Pond, with 22 plant species detected in 2024 (Table 5), slightly more than average for this waterbody. Eurasian watermilfoil, curly leaf pondweed, and fanwort, all invasive species, were abundant, as was the native white water lily. Only two more species were common, the native coontail and the invasive variable leaf milfoil. Remaining species were present but not common or abundant. Some species were not found, but this does not mean that they were necessarily absent, only that with high plant densities, finding other plants may have been challenging. Oscillations in species richness among years are largely a function of less common species being found or not found in any given year and the date of the survey. The shift to 3 or even 4 surveys since 2018 has increased species detection, but richness can still be low if there are very dense stands of plants that hinder the survey. The dominant suite of species remains the same, with 3 of the 4 invasive submerged aquatic plant species dominating in 2024.

Note that *Trapa natans*, water chestnut, is also known from Morses Pond, but owing to the efforts of volunteer water chestnut pullers, it has never been found in the standard survey. Also note that *Lythrum*

Table 5. Aquatic plants in Morses Pond.

		Plant Rating for Year																	
Scientific Name	**Common Name**	**2005**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Brasenia schreberi	Watershield							P	P					P					P
Callitriche sp.	Water starwort	P		P															
Cabomba caroliniana	Fanwort	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ceratophyllum demersum	Coontail	C	C	C	A	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Chlorophyta	Green algae	C	C	C	A		P	C	P	P	A	A	P	P	P	P	P	P	P
Cyanobacteria	Blue green algae		P		C	P	P		P	P	P			P			P		P
Decodon verticillatus	Swamp loosestrife	C	P		P	P								P	P	P	P	P	P
Elodea canadensis	Waterweed	C	C	C	C	C	C	C	C	A	A	A	C	P	P	P	P	P	P
Lemna Minor	Duckweed	P	P	P	P	P	P	P		P		P	P	P	P	P	P	P	P
Lythrum salicaria	Purple loosestrife	P	P	P	P	P	P			P				P	P	P	P	P	P
Myriophyllum heterophyllum	Variable watermilfoil	P	C	C	A	A	A	C	C	C	A	A	A	A	A	C	P		C
Myriophyllum spicatum	Eurasian watermilfoil	A	A	A	A	C	C	A	A	C	A	A	C	C	A	C	A	A	A
Najas flexilis	Common naiad	C	C	C	C	P	P	P	P	P	P		P	P	P	P	P	P	P
Nymphaea odorata	White water lily	C	C	C	C	C	C	C	P	P	P	P	P	P	C	C	C	C	A
Nuphar variegatum	Yellow water lily	C	P	P	P	P	P	P	P	P	P	A	C	C	C	C	C	C	P
Polygonum amphibium	Smartweed	P	P	P	P	P	P	P	P	P		P	P	P	P	P	P	P	P
Pontederia cordata	Pickerelweed	P		P	P			P		P			P	P	P	P	P		
Potamogeton amplifolius	Broadleaf pondweed	C	C	C	C	C	C		C	C	C	C	P	C	C	C	C	P	P
Potamogeton crispus	Crispy pondweed		C	C	C	P	P	P	C	C	A	A	P	P	P	P	C	A	A
Potamogeton epihydrus	Ribbonleaf pondweed		P	P	P	P	P	P	C	P		P	P	P	P	P	P	P	
Potamogeton perfoliatus	Claspingleaf pondweed					P	P		P	P			P	P	P	P	P	P	
Potamogeton pulcher	Spotted pondweed	P			P	P	P	P	P	P	P		P	P	P	P			
Potamogeton robbinsii	Fern-leaf pondweed	C	C	C	C	P	P	P	C	A	C	A	C	P	P	P	P	P	P
Potamogeton spirillus	Spiral seed pondweed					P	P	P	P	P	P			P	P	P	P		P
Potamogeton zosteriformis	Flatstem pondweed						P	P			P		P	P	P				
Ranunculus sp.	Water crowfoot										P				P				
Salix sp.	Willow				P														
Sagittaria gramineus	Submerged arrowhead	P	P	P		P	P			P			P				P		
Sparganium sp.	Burreed														P				P
Spirodela polyrhiza	Big duckweed	P				P		P											
Typha latifolia	Cattail			P										P	P	P	P	P	P
Trapa natans	Water chestnut																		
Utricularia geminiscapa	Bladderwort	P	P		P		P	P		P	P		P	P	P	P	P	P	P
Utricularia gibba	Bladderwort	C				P				P			P	P	P	P			P
Valisneria americana	Water celery				P	P	P			P		P	P	P	P				
Wolffia columbiana	Watermeal	P			P		P												
	# of Species	23	20	20	24	24	25	20	18	25	18	15	23	27	28	24	24	19	22
	P=Present, C=Common, A=Abundant																		

Figure 11. Biovolume comparison among designated areas with and without harvesting over time in 2024.



salicaria (purple loosestrife) is a peripheral invasive species that can be abundant but rarely picked up by the aquatic surveys.

Biovolume is a function of ice out date, the rate of plant growth, the date of the survey and any harvesting effort. The 3-4 survey per year approach allows tracking of conditions and progress of harvesting in target zones of the pond. Despite another mild winter, plants were not as dense as early in 2024 as in 2023. Curlyleaf pondweed was abundant but low in the water column in April, but topped out in early May, prompting the early start for harvesting in 2024. Eurasian watermilfoil was not nearly as abundant in early 2024 as in 2023, but fanwort was more common in early 2024 than in 2023 when it was competing with very dense Eurasian watermilfoil.

The biovolume pattern in 2024 (Figure 11) indicated moderately high biovolume prior to the first cut and much reduced biovolume at the end of the first cut. All areas had average biovolume ratings of 2.1 or less. Reductions were observed even where harvesting was not conducted; this appears related to a die-back of curlyleaf pondweed all over the pond. The harvesting reduced vegetative density, but the die off was also important to overall plant biovolume in the pond. The low density plant conditions did not last, however, as fanwort, water lilies, and Eurasian watermilfoil grew over the summer and achieved high densities in many places. Harvesting kept up only in area 3, where the most effort was located, and the target biovolume rating of 2 was achieved only in area 3 after the second cut.

Looking at the overall record of plant biovolume after the first and second cuts (Figures 12 and 13), 2024 represents one of the best years after the first cut and but was not better than other years after the second cut. Harvesting in many years has not been able to keep pace with fanwort growth over the summer. The effort devoted to area 3 allowed it to maintain desirable conditions in 2024, but lesser effort in areas 2, 3 and 6 caused them to exceed the biovolume target after the second cut. As another new harvester operator was used in 2024, some of the late summer issues may be a matter of experience, but then it may also be true that the early summer success may be largely a function of natural die-off.

The new harvester may provide the means to achieve the plant biovolume goal after the first and second cuts, but this will still require major effort by the harvesting staff. As that staff has other duties as well, and the weather plays an important but unpredictable role, there is a risk that not all target areas can be maintained at a desirable plant density all spring and summer. As the dominant species are all invasive species, herbicide treatment to reset the plant community is worth consideration. This was noted in the 2023 report but we wanted to evaluate results with the new harvester before proceeding further with any herbicide discussion. Another year of harvesting effort with the new harvester is advised.

Use of herbicides (or any chemical classified as a pesticide) is not generally allowed on public property in Wellesley, so use of any herbicide in Morses Pond represents a regulatory challenge. As the wells adjacent to Morses Pond are important to public water supply, use of herbicides is a concern for human health beyond the pond itself. The active ingredient fluridone has been used to control both species of milfoil and fanwort in many lakes, including water supplies, and is approved for such use in Massachusetts at concentrations up to 20 ppb, enough to greatly suppress growth in Morses Pond. Such control over the

Figure 12. Biovolume comparison over time for each sector after first cut.

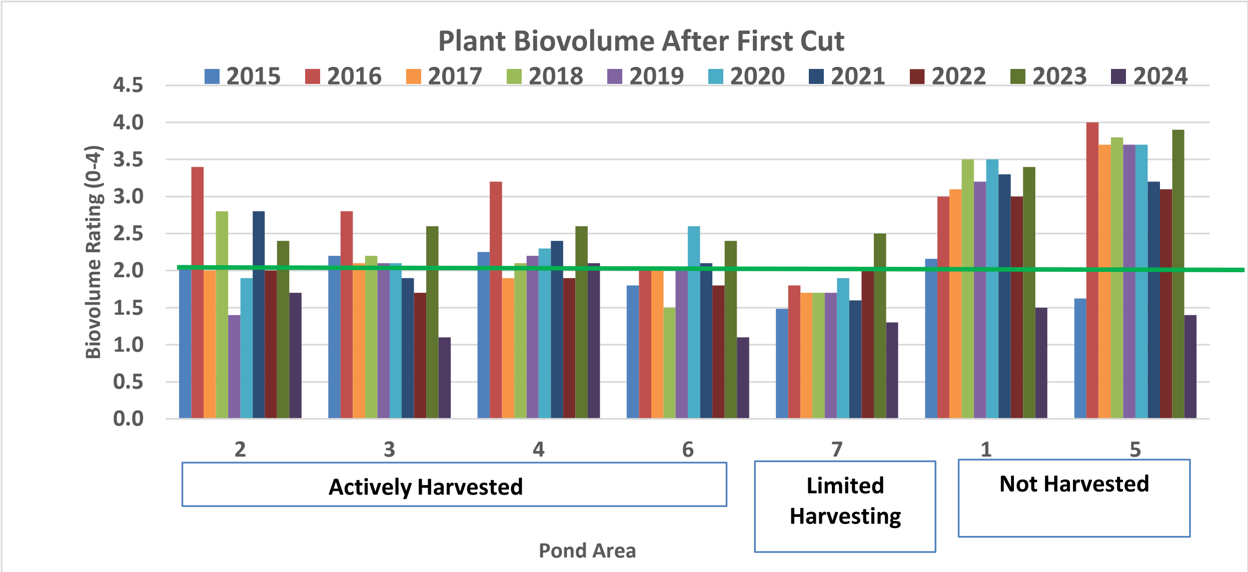
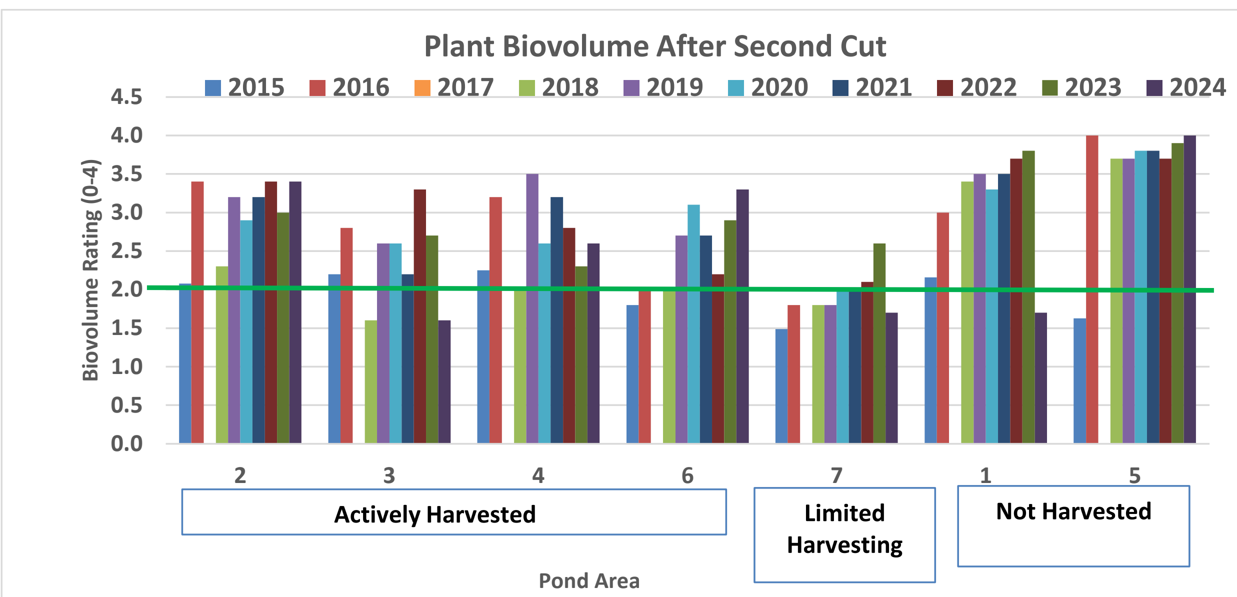


Figure 13. Biovolume comparison over time for each sector after second cut.



primary invasive species would allow the harvesting program to be more focused and potentially stay ahead of problems, rather than requiring extreme effort to reduce already high plant biovolume in the pond. This topic might be raised again after the 2025 harvesting program.

Additional Plant Controls

Plant controls additional to mechanical harvesting have been applied in Morses Pond. Volunteer hand pullers search for and remove water chestnut each year. Hydroraking had occurred annually if needed in the public swim area, prior to setting up the ropes and docks, until use of benthic barrier in 2017 to limit plant growths. Shorefront owners had contracted to have hydroraking done in sections of shoreline in the same timeframe as the swim area was raked. A modified version of the hydrorake allowed sand to be moved below the water line and regrading of the swim area for better safety occurred in 2017 and 2018. Although the town no longer needs to have hydroraking on an annual basis, residents banded together and sponsored a hydroraking program in spring 2021.

Hand harvesting of water chestnut is practiced each year by a group of volunteers supported by the town. This effort has kept water chestnut in check, with only scattered plants found and removed each year. Preventing this invasive species from getting established in Morses Pond is an important function that a group within the Friends of Morses Pond has fulfilled well.

The benthic barrier chosen for use in the swim area, called Lake Bottom Blanket, has proven effective, durable, and relatively easy to install and remove. Three panels were installed in 2017 in late May and removed in early August. Those same panels, each 10 X 80 feet, were installed in late May of 2018 and left in place through early August 2019, with just inspection and light cleaning in May of 2019. Panels were removed, cleaned, and stored in August 2019. Sediment accumulation and plant growth suggests that the barrier can be installed and left in place for 2 summer seasons before removal is necessary to maintain effectiveness.

The pandemic resulted in suspension of normal beach operations and the benthic barrier was not installed in 2020. The beach was open without facilities, docks or lifeguards and with social distancing among family groups. “Beach rangers” checked people in and patrolled the beach area. The same mode of beach operation was employed in 2021 but the benthic barrier was re-installed with a new configuration and expanded coverage. Six 10 X 80-foot panels were installed, in a 3 X 2 panel arrangement that created a swimming area 240 X 20 feet just beyond the ropes at the top of the slope. These barriers keep a long area weed-free and facilitate “lap swimming”. The barriers remained in place until August of 2022 with just a light cleaning in June 2022. The panels were removed, cleaned, and stored in August 2022. Re-installation occurred in early June of 2023 and the barrier remained in place until late summer of 2024 with some maintenance in June of 2024. Benthic barrier panels were removed in August of 2024, cleaned, and stored. They should be re-positioned in early June of 2025.

Education

Education programs are ongoing in Wellesley, but no new initiatives were implemented by WRS in 2024. The NRC website has useful information on protection of the environment and living a more sustainable lifestyle as a resident of Wellesley. Included is information on:

- Understanding stormwater and its impact on our streams and ponds.
- The impact of phosphorus on ponds.
- The importance of buffer strips and how to establish and maintain them.
- Managing residential stormwater through rain gardens, infiltration trenches, rain barrels and other Low Impact Development (LID) techniques.
- Organic lawn and landscape management.
- Tree maintenance and related town bylaws.
- Recycling needs and options.
- Energy efficiency in the home.

Wellesley also has bylaws relating to lawn watering and other residential activities that affect water quality in streams and lakes. The extent to which residents understand these regulations is uncertain, but the website helps in this regard. The right messages are being sent, but reception and reaction have not been gauged recently. A conservation-oriented day camp has been run at Morses Pond and sessions on aspects of the pond were included. No in-person education was conducted in 2020-2022 as a consequence of the pandemic.

Management at Other Wellesley Ponds

There has been a desire to expand the success of the Morses Pond program to other waterbodies in Wellesley. This is a challenge, as many are small, shallow and receive considerable stormwater from highly developed watersheds. Not all are easily accessible for larger equipment. There is no economy of scale to be achieved, but it is possible to improve conditions to make these other ponds more favorable habitat, more aesthetically pleasing, and potentially to achieve other use goals, notably fishing. A report on the condition of eight ponds and the potential for improvement was prepared in 2017 based on 2016 field work. The ponds included were Abbotts, Bezanson, Duck, Farms Station, Icehouse, Longfellow, Reeds and Rockridge.

The new small harvester is used on Rockridge and Longfellow Ponds, where the previous small harvester had been used on a roughly annual basis. Harvesting occurred in July of 2020 and appeared to be successful. Only Rockridge Pond was harvested in 2021, for about 3 days with about 4000 pounds of plants removed. With water levels low in 2022, no harvesting was conducted outside Morses Pond. In 2023, Rockridge Pond received 3 days of harvesting effort with about 3500 lbs of vegetation removed. A similar level of effort was devoted to Rockridge Pond in July of 2024.

Prior to 2019, Farms Station Pond had a thick coating of duckweed that could be removed by harvesting, but not efficiently, and alternative treatment with aluminum appears to have been successful in 2019 through 2024. The harvester could also be used on Bezanson and Reeds Ponds if needed. Bezanson did not exhibit plant problems in 2019 through 2024, an apparent function of aluminum treatment, as the main problem plant, coontail, gets its nutrition from the water column and can be controlled by reduced phosphorus availability. Plant problems in Reeds Pond are mainly a function of infilling at the inlet end; dredging is needed as harvester access to that area is too limited. Abbotts Pond and Duck Pond are too shallow for harvesting, not very accessible for heavy equipment, and do not really have rooted plant problems. Icehouse Pond is not accessible to the harvester, but access could be created if so desired.

The other aspect of Morses Pond management with transferability was phosphorus inactivation. While creating injection stations at each pond is not cost effective, the potential to treat each with a portable system was recognized. A commercially available tree sprayer unit mounted on a truck was obtained and dedicated to treating five of the Wellesley Ponds: Abbotts, Bezanson, Duck, Farms Station and Rockridge. Longfellow might benefit from treatment but is too large to address without extra effort that does not seem warranted at this time.

Simply spraying polyaluminum chloride onto the pond surface is not as effective or efficient as mixing it with incoming stormwater, but as a low-cost alternative to dosing stations this was deemed a worthwhile experiment. All needed equipment cost <$10,000 and the chemical was obtained from the tanks serving the Morses Pond phosphorus inactivation system. An initial treatment was performed in late June of 2018 in accordance with the projected dose needs from the 2017 report on those ponds, requiring about 207 gallons of polyaluminum chloride spread over 4 ponds (Abbotts Pond was not treated in late June 2018). Phosphorus and algae were assessed prior to and one week following treatment. A second treatment with double the dose of the first treatment was performed in late July of 2018, this time including Abbotts Pond, and water quality and algae were again assessed a week after treatment.

Treatment was repeated on June 10 and July 22 in 2019, with about 417 gallons of polyaluminum chloride spread over 5 ponds in each application (Abbotts @ 80 gal, Bezanson @ 40 gal, Duck @ 22 gal, Farms Station @ 112 gal, and Rockridge @ 163 gal). Phosphorus concentration and general pond condition was assessed before and after each treatment. This process was repeated in 2020 on June 22nd and August 17th of 2020 for the same ponds at the same doses.

In 2021 the rains came before any treatment had been conducted. After initial cessation of rain in early July, a treatment was performed on July 6th. Duck Pond was not treated, as flushing was still high, and Farms Station received a different aluminum polychloride solution, one with a higher aluminum concentration that halved the application volume, as a test from a new supplier. Abbotts, Bezanson, and Rockridge Ponds were treated as in previous years with the same doses. Rain resumed and flushing was too high for the treatment to have made much difference. No further treatment was attempted in 2021.

Only one treatment was conducted on Bezanson, Farms Station, and Rockridge Ponds in early July of 2022. Results from Abbotts Pond and Duck Pond were not sufficient to support continued treatment, but the other ponds had responded well to treatment. A second treatment may not have been necessary in 2022, given very dry conditions, but staffing limitations prevented such treatment anyway in summer 2022.

Farms Station was treated with 55 gallons of the higher concentration polyaluminum chloride solution again on June 23, 2023, while 223 gallons of the polyaluminum chloride solution used in Morses Pond was applied to Bezanson (45 gal) and Rockridge (178 gal) Ponds on June 23, 2023. The very wet conditions of summer 2023 negated the value of further treatment that year.

Abbotts Pond showed limited response to treatment (Figure 14). Phosphorus did not decline to anywhere near the target level of 20 µg/L in 2018-2021 and the water was murky on all survey dates. Dominant algae included dinoflagellates and green algae in 2018 and green and blue-green algae in 2019 and 2020, with a return to green algae in 2021. Access was limited and coverage may not have been adequate. This is a very shallow pond dominated by stormwater inputs and more frequent treatment or a greater dose may be necessary if this approach is to succeed. Abbotts Pond has not been treated since 2021.

Bezanson Pond exhibited a desirable response to all treatments, showing declines in phosphorus (Figure 14) and algae to near desirable thresholds. No filamentous green algae mats formed in the years with treatment and microscopic algae were mostly desirable forms. Also striking was the decline in the vascular plant coontail (*Ceratophyllum demersum*), which is unusual among rooted plants in that it gets most of its nutrition from the water column instead of the sediment via roots. The treatment appears to have solved both algae and vascular plant problems in this pond (Figure 15), making it far better in its role as a dog swimming pool. Bezanson Pond did not develop algae or macrophyte problems in 2021 and 2023 but the water was murkier, a likely result of so much storm runoff input during these wet summers, and there was some floating coontail, probably dislodged by high inflows. Conditions were acceptable throughout the dry summer of 2022 and again in 2024.

The clarity of Duck Pond improved as a result of treatment; aluminum coagulates and settles suspended solids even if not algae. However, there were few algae in Duck Pond, owing to short residence time, so the increased clarity represents a reduction in suspended non-algal particles. This is desirable but short-lived, as even a small storm can completely change the water in Duck Pond. Also, with increased clarity the thick sediment deposits, within a few inches of the pond surface in many areas, become more visible. Duck Pond needs to be dredged to restore any pond functions. Duck Pond has not been treated since 2020.

Farms Station Pond had a problem with duckweed (*Lemna minor*), a floating aquatic plant, and while algae biomass can be high, it was not the main problem for this pond. The treatment had a partial impact on the duckweed in 2018 (Figure 15), but growths were apparent even before the first treatment. Phosphorus concentration decreased in 2018, but not to the degree desired. Treatment was conducted earlier in 2019 and the duckweed cover never formed. Duckweed is another vascular plant that gets its nutrition from the water column, so the treatment addresses duckweed as well as algae. Phosphorus was decreased (Figure 14), although not quite to the desired level, but there were only some peripheral algal mats and the pond looked good through the summer (Figure 15). Treatment in 2020 resulted in conditions similar to or slightly better than in 2019 (Figure 15), but there were some cyanobacteria mats that appeared near the outlet in August. No duckweed or algae problems were evident in 2021 but flushing was high. No duckweed was observed in 2022 through 2024 but some peripheral growths of filamentous green algae were observed. Overall, conditions in Farms Station Pond have been markedly improved by aluminum addition but continued addition appears necessary to maintain desired features.

Figure 14. Phosphorus before and after aluminum treatments of five Wellesley Ponds

Green vertical lines indicate treatment dates, red horizontal line indicates target P concentration

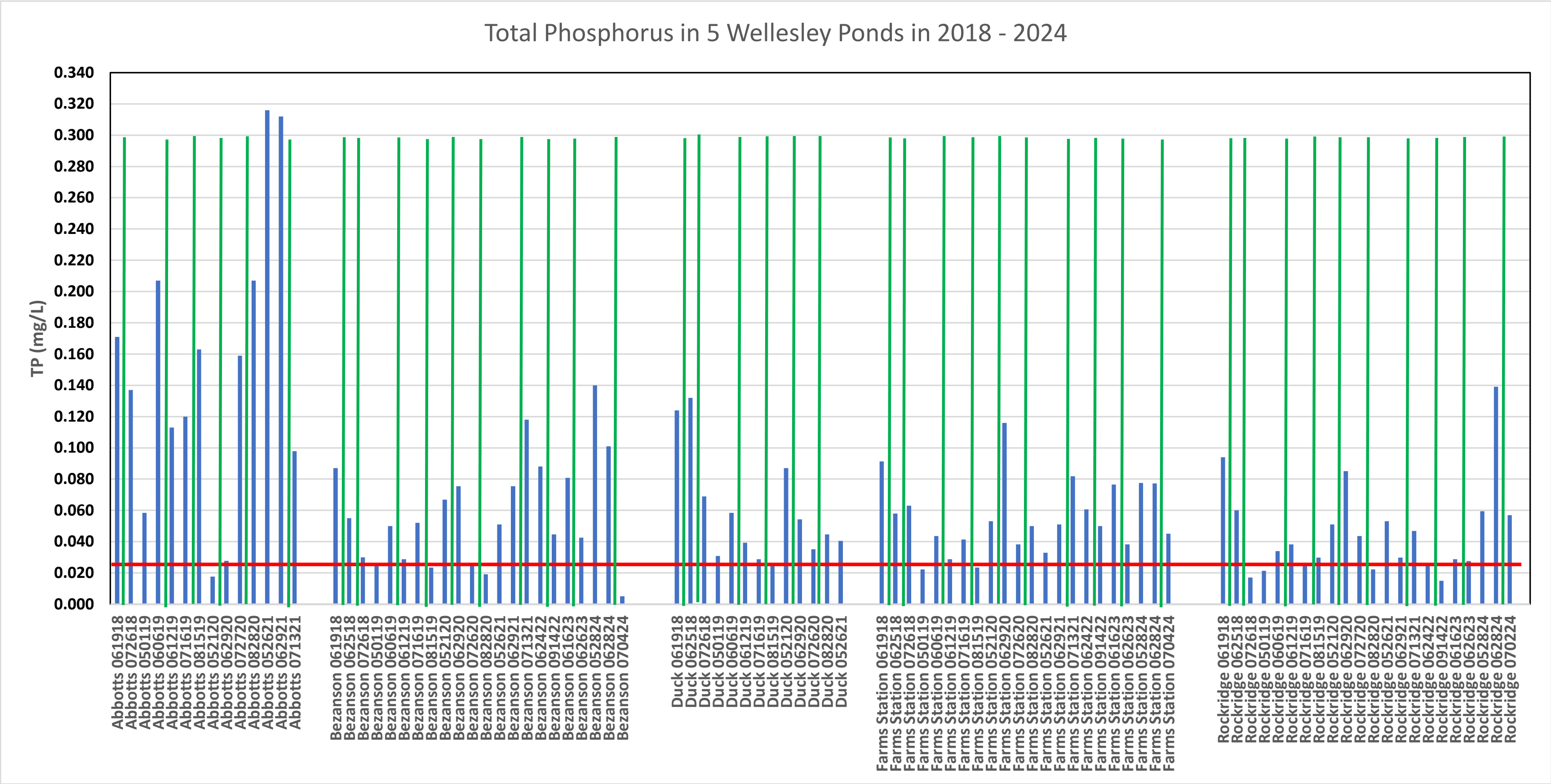


Figure 15. Photographic documentation of improvement in two Wellesley Ponds

Bezanson Pond August 2016

Bezanson Pond August 2020

Farms Station Pond Sept 2016

Farms Station Pond Aug 2018

Farms Station Pond Aug 2019

Farms Station Pond Aug 2020

Rockridge Pond exhibited desirable decreases in phosphorus (Figure 14), chlorophyll-a and algae biomass in response to treatment in 2018, approaching or achieving the target levels after the second treatment. In 2019 the treatment appeared to provide clear water, but phosphorus concentrations were not far above the desirable threshold even before treatment. There were some filamentous green algae, but not as much as in years prior to treatment, and there were no other problem species of algae detected. However, rooted plant growths were dense in the pond in May and June of 2019 and harvesting should probably have occurred earlier. The rooted plants may have limited algae as much as treatment did.

Phosphorus was higher in 2020 after the first treatment but the second treatment reduced it to the target level and algae were not a problem in 2020. Rooted plants were selectively harvested in July and that activity may have increased phosphorus by bottom disturbance. Treatment with aluminum should follow harvesting to achieve best results, but harvesting is not typically conducted until sometime in July and algae can be a problem in Rockridge Pond before that time. In 2021 there was just the one P inactivation treatment of Rockridge Pond, on July 6th, and harvesting was conducted for 3 days later in July, removing about 4000 pounds of vegetation. High inflow caused murky water and there was a visible oil sheen in a few areas on July 13th, but there were no substantial algae problems in 2021, probably a function of flushing.

No harvesting occurred at Rockridge Pond in 2022 and just a single aluminum treatment in early July was performed; conditions with respect to algae were generally desirable through summer 2022. Conditions in 2023 were similar to those in 2021, with dense plants in spring and considerable flushing during a wet summer. The single treatment in June did not greatly improve conditions and plant harvesting in July decreased clarity somewhat while opening the central area for fishing. Treatment in 2024 was delayed until the harvesting was completed and that seemed to improve conditions over previous years where treatment preceded harvesting.

The phosphorus inactivation program for these smaller ponds showed variable results, generally positive for Bezanson, Farms Station, and Rockridge Ponds but less impressive for Abbotts and Duck Ponds, which were dropped from the treatment program after 2021. Bezanson, Farms Station, and Rockridge Ponds can be treated once in early summer with a reasonable probability of maintaining acceptable conditions through summer. A different approach will be needed for Abbotts and Duck Ponds if improvement is to be gained. Dredging would help, but access to Abbotts Pond and the ratio of cost to potential benefits is questionable, this being more a wildlife area with minimal human use. Dredging Duck Pond, both to restore its detention capacity as a stormwater management feature and to enhance its aesthetic quality in a park setting adjacent to Town Hall, is desirable, and sediment testing was completed in 2023 to facilitate such dredging.

Dredging of Reeds and Duck Ponds has been recommended for several years and funds were allocated for testing in FY23. The soft sediment quantity in each pond was evaluated in fall of 2022. Duck Pond contains roughly 3500 cubic yards (cy) of mixed sand and organic sediment. Slightly less than 600 cy are in the eastern backwater area that may not be easily drained for conventional dredging, but almost 3000 cy could be removed by excavation equipment after removing the boards at the outlet and allowing the water level to decline. Duck Pond was last dredged in 1986 but it is not clear that all soft sediment was removed at that time. Reeds Pond contains about 5500 cy of mostly organic sediment, 3200 cy of which are in the upstream half of the pond and have virtually filled the pond in that area. All sediment could be removed by conventional excavation by lowering the pond level through a drain installed for that purpose when the pond was last dredged in 1999. The amount of sediment removed in 1999 is similar to what is now in the pond, although the small forebay at the upstream end of Reeds Pond has been excavated 8 times over the last 23 years with an average of about 100 cy removed each time.

Sediment quality testing was completed in spring of 2023 and a more detailed memorandum was submitted by WRS to the NRC with results. Metals and hydrocarbons are the most common contaminants that limit disposal options, and this was the case for both Reeds and Duck Ponds. Lead and arsenic were the metals of greatest concern, but cadmium, chromium, nickel and zinc were high enough to restrict disposal options in areas where human contact was possible. Aromatic petroleum hydrocarbons were also high enough to restrict disposal, but the sediment is not considered to be hazardous waste by normal regulatory definition. Urban lake sediments are routinely contaminated to a degree that restricts disposal, as was the case for the dredging in the northern portion Morses Pond in 2012-2013. Planning for dredging is continuing.

Summary and Needs for 2025

The Morses Pond management program in general and results from 2024 can be summarized as flows:

a. The phosphorus inactivation program has reduced phosphorus availability and algae abundance since 2008, with nearly ideal results between 2014 and 2019 with system modification. Water clarity and overall aesthetic appeal of Morses Pond have been increased as a result.
b. Results since 2019 have shown a decrease in phosphorus control and an increase in algal abundance. Thresholds that might lead to beach closure or other problems have not been exceeded, although peripheral accumulations of a potentially toxic cyanobacterium in late summer of 2022 did prompt posting to warn dog walkers of risks to pets. Cyanobacteria were partly controlled by high precipitation and flushing in 2021 and 2023.
c. Problems since 2019 can be traced to reduced application of aluminum and failures of equipment in an aging system that result in lower removal rates for phosphorus. An overhaul of the system with new pumps and tanks and some improvements to warning systems was advised to maximize performance. Extending treatment through July into August may also be beneficial when elevated precipitation occurs but will increase operating costs by up to 50%.
d. Results in 2024 were better than in the most recent years, owing to no pump breakdowns and treating into early August with more aluminum. An overhaul of the phosphorus inactivation unit is underway and the new system will be operational in 2025, improving reliability. Treatment of storm inflows in Bogle and Boulder Brook through July is recommended.
e. Low oxygen in water as shallow as 10 feet deep, representing about one third of the pond, is a concern. Low oxygen has occurred in the deeper parts of the pond in the past, but it is happening in shallower water for more of the growing season in recent years. Low oxygen limits habitat for fish and invertebrates and fosters internal recycling of phosphorus by mechanisms that favor cyanobacteria. This trend may be related to larger storms bringing more oxygen-demanding organic

matter to the pond and can be reversed by either removing the accumulated organic sediment (i.e., dredging) or adding oxygen. Oxygen saturation technology is the most applicable approach for adding oxygen, but no action is recommended just yet. Extended aluminum treatment will not counter the low oxygen but may mitigate its effect on algae.

f. The plant harvesting program has reduced plant abundance in targeted areas of Morses Pond compared to unharvested areas, but the program has been experiencing decreasing achievement of goals in recent years. Impediments have included harvester breakdowns and limitations due to age and earlier and more aggressive growth of invasive species after mild winters.

g. The level of effort by harvesting staff has been relatively stable, but non-cutting time had risen in recent years as a function of greater transport time caused by the need to carry smaller loads (offloading issues with older, larger harvester and capacity limit with newer, smaller harvester). Dedicated manpower to the harvesting effort has not been a major factor in any failure to achieve goals.

h. Delivery of a new, large harvester in July 2023 enhanced harvesting operations and increased load capacity. A new shore conveyor was also obtained, further aiding offloading operations. Off-season housing and care of equipment is a concern that should be addressed, but improved operation is expected for the foreseeable future.

i. An earlier start to harvesting is needed in years with mild winters, as early growth of plants can exceed harvesting capacity when active harvesting does not commence before late May. The pond manager should make a determination of projected plant growth in late March or early April and the DPW can consider starting harvesting by late April or early May in response.

j. In 2024 it was determined that plant growths were again starting earlier than usual and harvesting commenced in mid-May. The new harvester allowed more weight per load to be harvested and increased the overall weight of plants harvested for the year. More hours were put into harvesting than usual and the biovolume goal was met after the first cut. However, growth of fanwort over the summer was still greater than the harvester could counter and the biovolume goal was not met after the second cut except in area 3, which received more harvesting effort than all other areas combined.

k. The transfer of management approaches developed for Morses Pond to smaller ponds within Wellesley has resulted in improvements to three ponds: Bezanson, Farms Station, and Rockridge. All three have responded well to aluminum treatments and Rockridge has also been harvested in most years. Reeds and Duck Ponds need to be dredged and planning is underway for such projects. Abbotts Pond and Icehouse Pond are less accessible for management methods, are considered more as habitat features than recreational resources, and have not been accorded priority for improvement.

The following activities are recommended for 2025:

1. The Order of Conditions for the harvesting program was renewed in spring 2024. No permitting should be needed until 2027.
2. The phosphorus inactivation program was permitted through the Wetlands Protection Committee in spring of 2024. No permitting should be needed until 2027. This activity also requires an annual permit

from the MA DEP, an online process known as a License to Apply Chemicals. Wellesley has an account that should allow for easy renewal once a valid Order of Conditions is issued.

3. The phosphorus inactivation system operated well in 2024 but multiple potential issues with pumps, controls, and other components were identified. $100,000 was allocated by the Town for system upgrade, which is in progress as of November 2024 and will be complete before the 2025 treatment season. Apply a minimum of 5500 gallons of polyaluminum chloride starting in late May, but consider increasing the amount to as much as 8000 gallons with treatment extending through July as conditions dictate (based on achieved P concentration and expected weather).
4. Harvesting should commence no later than the third week of May (prior to Memorial Day) and may start as early as the beginning of May as warranted by plant growth. Spread the effort out more evenly over the designated harvesting areas of the pond than was done in 2024 and follow the priority order recommended by the pond manager after early spring assessment. Maximize efficiency and fragment generation. If biovolume goals are not met in 2025, re-open discussion about using herbicides to gain control over invasive species in Morses Pond.
5. Maintenance of harvesters and making the best possible use of them to keep up with plant growths is essential. Protective winter housing of harvesters is recommended, and preventive maintenance should be conducted.
6. The benthic barrier placement in the swimming area was given a negative Determination of Applicability by the Wetlands Protection Committee that required no further permitting, but any need for renewal should be addressed through the Wetlands Protection Committee; a negative Determination of Applicability does not necessarily extend indefinitely. Affirmation of continued negative Determination of Applicability should be sought in early 2025. The barrier was removed in August of 2024 and will need to be re-installed in early June of 2025.
7. While not a perceived need for 2025, any further hydroraking should probably be managed by the Town, given increasing permitting complexity and limited offloading sites with possible use conflicts. The work in 2021 required a lot of coordination effort and it may be best orchestrated by Town staff. Removal of more than 100 cubic yards of material is considered dredging under current regulations and would require more testing and permitting than previous hydroraking efforts.
8. The water quality monitoring program should be conducted as in recent years. Assess water quality at the seven locations in early May, late June, and early September at a minimum. Additional sampling at key locations can be conducted as needed, usually in July and August near the swimming area. Include algal analysis and pay attention to any increases in cyanobacteria. Plant monitoring should include a spot check in late March or early April to determine the needed starting date for harvesting and at least three full plant surveys, one before harvesting commences, one after the first cut, and one near the end of the second cut.
9. Continue to track dissolved oxygen over the range of depths in Morses Pond during the growing season. Extending aluminum treatment through at least July can counter the effect of low oxygen on nutrient dynamics and algae growth but will not greatly improve oxygen levels in deep water. If concentrations <5 mg/L persist in water less than about 15 feet, consider oxygenation to improve oxygen and associated pond health. An appropriate system would cost on the order of $150,000 to install and about $25,000 per year to operate.

10. Bezanson, Farms Station and Rockridge Ponds should be treated with aluminum in late June with an option for re-treatment in early August as needed. It would be desirable to time one treatment of Rockridge Pond to immediately follow any plant harvesting performed in that pond.
11. Plan for dredging Reeds Pond and Duck Pond as soon as funding can be secured. Sediment quantity and quality evaluation have been completed; engineering and permitting remain to be addressed.