

MEMORANDUM
Comfort Lake-Forest Lake Watershed District

To: Board of Managers

Date: March 4, 2021

From: Mike Kinney

Subject: Parson's Wetland (Hayward Ave N) Cattail Harvest Feasibility Report

Background/Discussion

During the summer 2020, District staff conducted a study to investigate the feasibility and logistics of cattail harvesting as a mechanism to reduce phosphorus from a wetland environment. The study occurred in the Parson's wetland located along Hayward Avenue North, east of Forest Lake's West basin. District Project Coordinator Blayne Eineichner will present the findings from the study for the Managers to discuss.

Recommended Action

Proposed Motion: Manager _____ moves to approve the Parson's Wetland Cattail Harvest Feasibility Report. Seconded by Manager _____.

Attached: Parson's Wetland Cattail Harvest Feasibility Report

Hayward Avenue North Cattail Harvest

Parson's Wetland

2020 Feasibility Study



Blayne Eineichner
Project Coordinator
Comfort Lake - Forest Lake Watershed District



Introduction

Forest Lake is a 2,271-acre lake near the City of Forest Lake in Washington County, MN. The City and Lake are located approximately 28 miles north of Minneapolis and Saint Paul, MN. Forest Lake is the largest lake in Washington County and has an 8,160-acre drainage area. It is on the 303(d) impaired waters list for impairment of aquatic consumption usage due to the presence of mercury and polychlorinated biphenyls (PCBs) in fish tissue. The water quality of Forest Lake is considered fair with DNR lake grades ranging from B- to C+ depending on the basin (west, middle, or east). In recent studies excess nutrient, primarily phosphorus, was identified as the main factor for degraded water quality of the lake. The Comfort Lake – Forest Lake Watershed District is working to improve water quality in the lake with long-term goals of achieving a five-year mean summer phosphorus concentration at or below 30 µg/L and maintaining a mean summer Secchi depth no less than 7 ft by 2031.

Several studies have been completed recently that identify the sources of the excess phosphorus entering Forest Lake and lists potential projects that could be implemented to reduce these phosphorus sources. The 2018 Forest Lake Diagnostic Study identified the Hayward Avenue subwatershed as contributing 9% of the total phosphorus load entering Forest Lake and set a 123 lb/yr reduction goal for this subwatershed ([link](#)). The 2019 Hayward Avenue Assessment and Feasibility Study further investigated the 6 catchments within this subwatershed and identified the Parson's wetland (R15 catchment) as a potential location for a phosphorus reduction project ([link](#)). This assessment recommended the exploration of a cattail biomass harvest as a mechanism to remove excess nutrients found in the soils of this wetland and prevent them from leaching into Forest Lake.

The Parson's Wetland is 40-acre wetland complex located east of Forest Lake's West basin along Hayward Avenue North. It is considered by Minnesota Department of Natural Resources as a Public Water basin. Two of the multiple parcels of land that comprise the wetland are owned by the City of Forest Lake (Figure 1). These parcels contain approximately 10.5 acres of land with 8.2 acres of wetland habitat primarily consisting of a monoculture of hybrid cattails (*Typha x glauca spp.*). The City of Forest Lake has given permission to pursue cattail biomass harvesting efforts on these parcels and has signed a formal cooperative agreement to grant access for such efforts. The MN DNR has also been consulted and is agreeable to a potential harvest.

The practice of harvesting cattail biomass to deplete nutrients in wetland soils is supported in the literature (Grosshans, 2014) and has been used successfully in parts of Canada (Grosshas and Grieger, 2013). Cattails accumulate nutrients in the above ground leaf material at much higher rates than other wetland plants. The mechanism for nutrient removal is physical removal of the nutrient rich above ground leaf material at peak nutrient content in lake summer before those nutrients can be transported and stored in the plant roots (over winter for use next spring) and potentially released into wetland soils from plant decomposition.

To assess the viability of a cattail harvest project in the Parson's Wetland, District staff developed and implemented a Cattail Harvest Feasibility Study during the summer of 2020. The goal of the study was to refine the amount of phosphorus and other nutrients that could be removed from the wetland through a cattail harvest and investigate the associated costs and benefits of such a project.

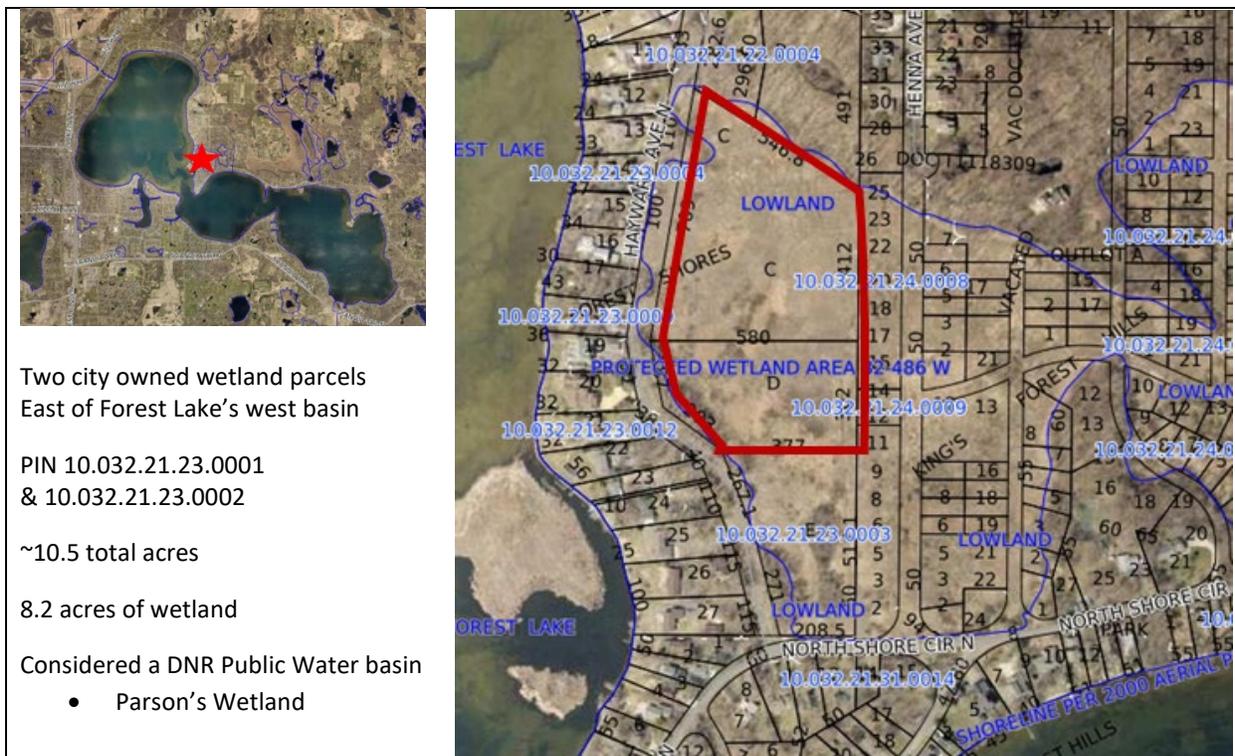


Figure 1. Locator maps of the Hayward Ave North Wetland. The City owned parcels are outlined in red.

Methods

The Cattail Harvest Feasibility Study consisted of harvesting five, one-square yard plots of cattails from the Parson's wetland. Sampling areas were identified in the office using GIS and were distributed throughout the wetland to represent the range of conditions and cattail densities throughout the wetland (Figure 2). Within each plot, all above-ground cattail vegetation was harvested, weighed, and five sub-samples were collected for chemical analysis at the University of Minnesota (UMN) Research Analytical Laboratory.

The cattail test plot harvest occurred on the morning of August 6th, 2020. District staff collected samples from 9am to 11am. Standing water was present within the wetland making travel difficult at times. A one-square-yard PVC quadrat was constructed to ensure proper data collection and harvest consistency. All cattail vegetation within the quadrat was harvested from above the ground or water surface using hedge shears. The vegetation was then piled into a tarp and weighed with a digital scale. Five sub-samples (~2 oz each) were taken from each plot for laboratory analysis. Samples were individually bagged, labeled, and stored on ice in coolers. All samples were delivered to the University labs by 1pm of the same day. Laboratory results were received on September 7, 2020. At the laboratory, samples were weighed and dried, and then tested for percent moisture and the presence of 15 elements – including phosphorus.

The data collected from the test plots was extrapolated to represent the entire wetland. The average weight per plot was applied to the total acreage of the wetland to estimate the total weight of vegetation that could potentially be harvested. The average percent moisture was subtracted from this total weight and then this number was multiplied by the average mg/kg of phosphorus of dry material for all the samples to estimate the maximum potential pounds of phosphorus that could be removed with a cattail harvest. As the Parson's wetland has several large unmapped areas of non-cattail (sedges, reeds, shrubs), the calculations were run for two separate acreages – 7.2 and 6.2 acres of monoculture cattails (estimates of cattail acreage based on aerial photography).



Figure 2. Map of the five test plots for the 2020 Cattail Harvest Feasibility Study.

Results

As phosphorus is the main element influencing water quality in Forest Lake, the results of this study focus mainly on the phosphorus content of the cattail vegetation and its potential to be depleted from the wetland soils through cattail harvesting. A summary of all elemental concentrations in the test plot vegetation from the UMN laboratory analysis can be found in Table 1.

The average weight of the vegetation harvested from the five test plots was 3.53 lbs per one square yard. Extrapolating this out to the full acreage of the monoculture cattails (6.2-7.2 acres) results in a total weight between 105,928 lbs (~53 tons) and 122,940 lbs (~62 tons) of wet cattail vegetation.

The average moisture content of the 25 sub-samples was 2.17%. Subtracting this percentage from the total weights result in only minor reductions in total weight; ~51.8 tons and ~60.6 tons, respectively.

The average content of phosphorus from the 25 sub-samples was 2,333 mg/kg of dry plant material. After converting from kilograms to pounds, calculations indicate that approximately 4.5 lbs of phosphorus per ton (0.22% by weight) could be removed from the wetland with a cattail harvest. This would be between 241 lbs and 280 lbs of phosphorus for the entire monoculture of cattail acres (6.2 acres and 7.2 acres; respectively) within the City of Forest Lake owned parcels of the Parson’s wetland. Another, perhaps more familiar way of looking at this data would be pound of phosphorus per acre, with an estimated 39 lbs of phosphorus removed per acre of cattail harvested.

Note that these calculations estimate the total amount of phosphorus removed in plant material but does not directly estimate reductions in soil phosphorus content nor phosphorus load reductions from wetland discharge due to cattail harvesting. The main purpose of this test was to determine a practical amount of cattail vegetation that could be removed by hand and to measure the phosphorus content of cattails in Parson’s Wetland.

Table 1. Cattail Harvest Test Plot data. All values are in mg/kg for dry weight of cattail vegetation, except for Moisture – represented as a percentage. Phosphorus is highlighted in yellow. Note: Nitrogen was not included in the 15-element suite offered by the UMN Research Analytical Laboratory.

Sample	Al	B	Ca	Cd	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	Zn	Moisture
CP1A	10.2	10.3	10,223	0.62	0.98	2.5	66.4	7,572	2,675	570	3,948	0.63	2,234	0.09	16.8	1.8
CP1B	8.1	8.7	10,103	0.69	0.54	1.5	45.3	6,279	2,656	468	4,201	0.52	1,628	0.08	13.9	1.7
CP1C	7.4	10.3	11,457	0.11	0.40	2.4	67.6	7,194	2,459	408	4,516	0.45	2,263	0.11	16.4	1.7
CP1D	7.4	10.1	14,280	0.09	0.52	1.4	49.2	8,170	2,463	515	3,128	0.38	2,173	<0.004	15.0	1.8
CP1E	7.2	9.7	10,205	0.38	0.45	2.7	56.0	14,389	1,962	469	2,566	0.64	2,894	0.12	19.7	1.6
CP2A	5.5	8.8	9,953	0.34	0.35	1.4	48.3	8,150	2,508	548	3,280	0.40	2,272	0.08	12.8	2.4
CP2B	8.8	8.0	10,976	0.16	0.44	1.6	72.1	7,442	2,639	516	3,937	0.41	2,468	0.12	15.0	2.4
CP2C	5.8	9.8	11,989	0.36	0.40	1.1	50.1	8,667	2,647	710	3,109	0.57	2,070	<0.004	14.5	2.4
CP2D	5.1	8.4	11,420	0.07	0.35	0.9	39.9	8,826	2,507	579	2,112	0.27	2,206	0.10	14.6	3.0
CP2E	4.1	9.4	8,568	0.05	0.25	1.0	38.1	10,524	2,147	467	1,990	0.21	2,185	<0.004	11.0	1.5
CP3A	4.5	9.8	9,046	0.17	0.71	1.6	48.1	7,207	3,071	514	1,292	0.46	2,865	<0.004	17.5	1.8
CP3B	4.4	11.3	13,296	0.04	0.41	1.7	52.0	6,756	3,731	790	1,174	0.31	2,875	<0.004	18.4	2.7
CP3C	4.5	9.9	11,913	0.05	0.56	1.6	45.8	6,196	3,681	588	1,338	0.32	2,469	0.14	16.7	2.8
CP3D	4.8	10.6	7,064	0.05	0.48	1.9	42.9	7,250	2,486	434	1,877	0.38	2,801	<0.004	19.3	3.4
CP3E	5.1	10.3	12,360	0.04	0.47	1.4	48.7	6,084	3,809	604	946	0.41	2,705	<0.004	19.5	3.2
CP4A	8.1	8.4	7,838	0.11	0.29	1.5	39.6	11,299	2,100	489	2,865	0.24	2,200	0.08	16.1	3.0
CP4B	8.6	7.4	8,403	0.40	0.39	2.9	33.6	8,063	2,367	399	2,603	0.48	2,164	0.11	16.6	1.8
CP4C	8.6	8.4	14,147	0.04	0.41	1.9	40.3	6,443	3,239	516	4,837	0.36	1,836	0.17	15.5	2.0
CP4D	7.1	8.9	11,805	0.26	0.28	1.5	34.6	10,309	3,046	595	3,108	0.27	1,833	0.10	13.9	2.2
CP4E	4.9	7.1	9,342	0.05	0.30	1.0	27.7	5,297	2,431	422	2,616	0.32	1,774	0.09	11.9	1.7
CP5A	4.7	9.5	9,207	0.33	0.32	1.7	39.9	12,336	2,160	430	2,820	0.26	2,441	0.08	19.1	1.9
CP5B	5.5	7.5	9,950	0.07	0.27	1.8	36.8	10,580	2,146	462	3,162	0.28	2,291	0.10	18.2	1.7
CP5C	4.1	8.7	8,343	0.05	0.29	1.8	45.7	11,737	1,942	329	2,882	0.28	2,457	0.08	22.1	1.7
CP5D	4.5	10.8	8,716	0.05	0.30	1.4	35.6	11,538	1,961	429	2,952	0.30	2,219	0.07	15.8	1.6
CP5E	5.9	9.8	10,003	0.06	0.28	1.9	38.4	9,803	2,297	509	2,236	0.33	2,434	0.11	18.4	2.4
Average	6.2	9.3	10,424	0.19	0.42	1.7	45.7	8,724	2,605	510	2780	0.38	2,310	0.10	16.3	2.2

Discussion

Phosphorus Load Reductions:

Results indicate that a substantial amount of phosphorus could be removed from the wetland vegetation through a cattail harvest in Parson's Wetland – possibly over 250 lbs. Note that these calculations estimate the total amount of phosphorus removed in plant material but does not directly estimate reductions in soil phosphorus content nor phosphorus load reductions from wetland discharge due to cattail harvesting. The main purpose of this test was to determine a practical amount of cattail vegetation that could be removed by hand through a harvest effort.

Phosphorus depletion may not directly translate to an observable phosphorus load reduction to Forest Lake since the total amount of phosphorus in the wetland soils is unknown nor the rate at which soil phosphorus will decline in response to cattail harvesting efforts.

The next step for testing the feasibility of cattail harvesting to reduce phosphorus loads to Forest Lake would be to set up a multi-year cattail harvest trial and measure phosphorus concentrations in the wetland soil and porewater.

The depletion of phosphorus in the wetland soils might also increase the capacity of the wetland to absorb, store, and process additional phosphorus load found in the runoff entering the wetland. But the effects of this increase in phosphorus sorption capacity may not be noticeable for years or decades, nor result in measurable long-term load reductions from the wetland.

Potential Costs:

To remove the 250 lbs of phosphorus a total of 50-60 tons of cattails must be harvested from Parson's Wetland. The weight of a cubic yard of cattails is unknown, however we do have an analog that offers an approximate weight - hay. A cubic yard of loose hay weighs approximately 135 lbs and based on surface area and compatibility, is likely to weigh a bit more than a cubic yard of cattails. If we assume the weight of a cubic yard of cattails to be between 120 lbs and 135 lbs, the cost to haul this material off-site would be around \$20,000. Sixty tons of cattail vegetation would require approximately 95 dump truck loads at an estimated cost of \$200 per load [assuming \$100/hr for a two hour round trip (load, haul, unload, return)]. This cost could increase if disposal fees were incurred.

Loading this volume of material would require a backhoe or trackhoe type piece of equipment and would need to be operated during the winter, after ground freeze. This type of equipment typically costs between \$125 to \$175/hr with an operator. Keeping this piece of machinery busy would be key to maximizing efficiency and lowering the associated costs of this aspect of the project. As such, several dump trucks would need to be actively hauling while the hoe is operating. Estimated machine time to load the cattail vegetation would be around 24 hours – with tracking time within the wetland included. The total cost for the trackhoe, operator, and mobilization would be around \$8,000 – \$10,000.

Based on wetland conditions during the test plot field work (standing water), harvest of the cattail vegetation would likely need to be done by hand as standard agriculture machinery (tractors, balers, etc.) could not operate in these wet conditions. Harvesting vegetation from +6 acres of wetland by hand, with limited mobility due to the wetland muck and vegetation may prove to be an expensive and time-consuming task. Cutting the vegetation with weed whips or other power tools should be fairly

quick, however piling of the vegetation (for removal after ground freeze) may be rather slow going – considering the difficulty in walking through sections of the wetland with deeper standing water. Additionally, repeated accessing and walking within the wetland will undoubtedly disturb the wetland soils, stirring up sediments and the phosphorus stored within the soils. While the harvest may remove phosphorus from the soil, the act of removing the vegetation might release a flush of phosphorus into Forest Lake. Erosion control measures would need to be put in place to ensure that this does not occur. These measures could be as simple as installing biologs, or silt curtain at the wetland outlet culvert or waiting until the wetland dries significantly enough that there is no outflow during harvest efforts.

During the winter 2019/2020 District staff investigated sources of a work crew for the cattail harvest. Two potential crews were identified:

- Conservation Corps of Minnesota and Iowa
- MN Department of Corrections Institutional Community Work Crew.

Clean Water Fund grants from the Board of Water and Soil Resources (BWSR) are available to fund the Conservation Corps Crew. In the Spring of 2020, District staff submitted a grant application for several weeks of funding for this crew to assist with a Cattail Harvest Pilot Project in the Parson’s wetland. The 2020 Clean Water Fund grant cycle was very competitive and unfortunately, a grant was not awarded to the District for this project. Future efforts could be made to secure this funding, or the crew could be hired outright for a negotiable fee.

District staff also contacted the MN Department of Corrections regarding their work crew. Their crew of 6-8 minimum security inmates and a corrections officer chaperone are available on weekends at a rate of \$1,500 – \$1,900 per day, depending on crew size. They do come with some tools but may need to be outfitted with waders or other specialty equipment.

It is unknown how long a hand harvest of +6 acres of cattails might take. A rough estimate would be 12 days with a crew of 6-8 working a 10-hour day. At a cost of \$1,700 dollars per day for the crew, the cattail harvest itself would be an estimated \$20,000.

The costs listed above represent best estimates based on rates and information gathered during this feasibility study. As such, they should be regarded as a starting point as actual costs may be significantly different. According to these numbers, a cattail harvest of +6 acres of wetland habitat would cost in the ballpark of \$45,000 to \$55,000 (Table 2).

Table 2. Summary of Cattail Harvest cost estimates.

Item	Detail	Amount and Rate	Total
Harvest	<i>Work Crew (6-8 crew)</i>	12 days @ \$1,700	\$20,000
Material Load	<i>Excavator w/mobility charge</i>	24 hours @ \$150/hr + mob.	\$9,000
Material Haul	<i>dump truck(s)</i>	95 loads @ ~\$200/load	\$20,000
Material Disposal	-	unknown	unknown
		Total	\$49,000

Conclusion

Cattail harvesting has been proven to be an effective means of depleting soils of nutrients. Much of the research and field work has been completed in Canada, facilitated with the use of agricultural machinery in wetlands with controllable hydrology. Unfortunately, these ideal conditions are not present within the Parson's wetland, resulting in more complex project logistics. Moreover, some uncertainty of the actual effectiveness of the phosphorus load reduction to Forest Lake lingers.

To address these lingering questions/concerns, a small one-acre or less, multi-year pilot project could be implemented to further investigate the cattail harvest effectiveness in reducing the phosphorus load to Forest Lake. The pilot project would consist of an annual harvest of one-acre (or less) of cattails and study the effects of the harvest for 3-5 years. A series of water quality grab samples, both upstream and downstream of the one-acre harvest area, phosphorus concentration sampling of wetland soils and porewater, along with soil borings could be used to help evaluate project success. Annual cost for such a project would be in the \$10,000 range for the harvest crew, excavator, haul, and monitoring. Several years of harvest should be completed or until soil and porewater phosphorus concentrations stop declining and stabilize, with a transition to only monitoring for several years after harvesting ends to evaluate the long-term benefits.

A winter harvest could also be considered after ground freeze; however, the phosphorus removal would be substantially lower than the estimated 4.5 lbs. per acre from this study as much of the nutrients would have already been transported to the roots of the plant in late fall. The harvest could likely be accomplished with agricultural machinery, but haul cost would remain high and thus the cost effectiveness of a winter cattail harvest would be further diminished.

Note: the total cost for this feasibility study was ~\$1,900 with lab costs, staff time, and report preparation and review.

References

Forest Lake Diagnostic Study

https://www.cflwd.org/documents/ForestLakeUpdatedImplementationPlan_6-30-2018.pdf

Grosshans, Richard E. 2014. Cattail (*Typha* spp.) Biomass Harvesting for Nutrient Capture and Sustainable Bioenergy for Integrated Watershed Management. Graduate Thesis, University of Manitoba, Winnipeg.

Grosshas, R and L. Grieger. 2013. Cattail Biomass to Energy: Commercial-scale harvesting of cattail biomass for biocarbon and solid fuel. March International Institute of Sustainable Development Report. Winnipeg, Manitoba, Canada. www.lisd.org.

Hayward Avenue Subwatershed Assessment

<https://www.cflwd.org/documents/HaywardAveSubwatershedAssessmentFinalReport.pdf>