Restoration and maintenance of native macrophytes in lakes of the

Riley Purgatory Bluff Creek Watershed District

Proposal to Riley Purgatory Bluff Creek Watershed District
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Background

Aquatic macrophytes provide critical fish and invertebrate habitat (Valley et al. 2004), stabilize sediments (Madsen et al. 2001), and help maintain water clarity in the littoral zone (Hanson and Butler 1994, Scheffer 1998). However, high densities of invasive species of macrophytes may reduce abundance of native plants (Madsen et al. 1991) and reduce fish growth (Olson et al. 1998, Cheruvellil et al. 2005) in addition to causing undesirable nuisance conditions for boaters and recreational users. Thus, healthy native aquatic vegetation is important to maintaining lake quality, and restoration and maintenance of native vegetation is a common management goal (Scheffer 1998, Valley et al. 2004, Cooke et al. 2005).

In many shallow lake systems, high abundances of benthic fish can uproot macrophytes, stir up sediment, and release nutrients into the water column, resulting in poor water clarity and loss of submersed vegetation (Hanson and Butler 1994, Scheffer 1998). Common carp (*Cyprinus carpio*) are super-abundant in some Minnesota lakes (Bajer and Sorensen 2010) and are known to reduce native vegetation and water clarity (Crivelli 1983, Parkos et al. 2003). Thus there is concern that high densities of common carp may reduce water quality in Minnesota lakes and reduce the abundance of native plants that help retain water clarity (Valley et al. 2004, Valley and Drake 2007). Reducing abundance of common carp thus appears to be a useful approach to improve water quality in lakes with dense carp populations (Bajer et al. 2009). However, once carp are removed or water clarity returns, it is important to reestablish native plants to help stabilize the sediments, maintain water clarity and to prevent establishment and dominance by invasive plants (Hussner et al. 2017, Hilt et al. 2018). Rapid recovery of native plant communities after fish removal or control of invasive species is not ensured and integration of strategies to promote revegetation by native plants is needed (Cooke et al. 2005). For example, it has typically taken several years for aquatic macrophytes to return to high densities after complete fish removals in Lake Christina (Hanson and Butler 1994, Hanson et al. 2006). In several lakes where dominant invasive species were eliminated with herbicides, native plant communities had not increased several years after treatment (Valley et al. 2006). Furthermore, improvements in water clarity and reduced bioturbation expected with the removal of carp could favor dense growths of invasive macrophytes such as Eurasian watermilfoil (*Myriophyllum spicatum*) or curlyleaf pondweed (*Potamogeton crispus*).

Work in the Riley Creek basin has focused on the reduction of common carp to improve water quality and clarity. Initial efforts focused on Lake Susan (DOW 10-0013), a 38 ha, shallow (max depth 5.2m, 80% < 4.6m depth), hyper-eutrophic lake. In winter 2009 approximately 80% of the carp were removed from the lake in an attempt to determine if removal of carp would enhance water clarity (Bajer and Sorensen 2014). Water clarity did improve in spring and early summer 2009 (3m Secchi depth in early June). Eurasian watermilfoil and curlyleaf pondweed, which were previously present in the lake but at low abundance presumably due to poor water clarity (Bajer and Sorensen, University of Minnesota, personal communication) became more abundant and a cause for concern. The increase in invasives resulted in a concern for the native plant community and our ability to enhance it. A project to assess the Lake Susan plant community in more detail and to assess the potential to restore a native plant community by transplanting native plants was initiated in 2009 and expanded to a more comprehensive effort to restore and enhance native submersed plant communities within the Riley Purgatory Bluff Creek Watershed in 2010, particularly after carp removal in Riley and Staring in addition to Lake Susan. That project was further expanded in 2015 to include assessment of Eurasian watermilfoil control in addition to curlyleaf pondweed control and to assess the effects of enhancing water clarity via alum treatments on plant restoration in Lake Riley and again in 2018 to assess plant management and restoration in Lakes Riley, Staring and Susan.

The aquatic plant community of Lake Susan responded positively to carp removal (Bajer and Sorensen 2014). In June 2009, 9 native species occurred in over half the littoral zone (depth ≤ 4.6m); coontail (*Ceratophyllum demersum*) and lilies were the dominant native plants and Eurasian watermilfoil and curlyleaf pondweed occurred at 35 and 17% of the points sampled respectively. Although water clarity declined to 0.9m in late July and to 0.5 m in August, native plant biomass increased and native plants persisted. Over the next 4 years, Eurasian watermilfoil declined and remained at very low densities for several years, controlled by the milfoil weevil, but curlyleaf pondweed continued to expand to over 40% of the littoral in 2011 and 2012 necessitating herbicide treatments. Early season lakewide (c.a. 6 ha or 20% of littoral) treatments with endothall were conducted in spring 2013 and 2014 to successfully control curlyleaf. Turion production was effectively halted and curlyleaf was reduced to < 25% occurrence in 2013 and < 10% in 2014. Native plants expanded although water clarity tended to decline to <1m by late June or early July of each year (JaKa and Newman 2014). Curlyleaf was not treated in 2015 and it promptly rebounded requiring early season endothall treatments in 2016 and 2017 and a diquat treatment in 2018, all of which contained curlyleaf to <10% of the lake. Lack of treatment in 2019-2021 has resulted in June curlyleaf coverage of 30-40%. Eurasian watermilfoil remained below detection in 2018-2020.

To further enhance the native plant community, transplant experiments using native plants from nearby Lake Ann were conducted. Bushy pondweed (*Najas flexilis*), water stargrass (*Zosterella dubia)* northern watermilfoil (*Myriophyllum sibiricum*), water celery (*Vallisneria americana*) and muskgrass (*Chara*) were transplanted into shallow (0.3 to 0.7m depth) and deeper sites (1.25-1.5 m depth; flatstem pondweed, *P. zosteriformis* in lieu of water stargrass) in 2009, 2010 and 2011. Transplants, particularly water stargrass, wild celery and bushy pondweed, were generally successful in shallow water and by 2013 these three taxa has expanded at a number of sites (Knopik and Newman 2018). Transplants in deeper water were generally unsuccessful due to the poor water clarity in summer. The transplants increased the number of species present (some were found in point intercept surveys) but poor water clarity continued to limit the native plant population (Knopik and Newman 2018) and by 2016 the transplants had failed to further expand and were only sporadically detected. It appears that water clarity improvements, particularly in June to August are needed to establish a more diverse native plant community. A long planned but often delayed alum treatment will allow us to test this hypothesis.

Carp were also removed from Lake Riley in 2009. Although Riley had some native plant taxa, Eurasian watermilfoil was more abundant and both curlyleaf pondweed and Eurasian watermilfoil began to increase after carp removal. A high density of sunfish likely keeps the milfoil weevil population too low (<0.2/ stem) to control Eurasian watermilfoil. An increase in fall curlyleaf turion abundance from $41/m^2$ in 2011 to $132/m^2$ in 2012 and a high density of both Eurasian watermilfoil and curlyleaf pondweed in spring 2012 led to development of a Lake Vegetation Management plan and lakewide treatment of curlyleaf pondweed in spring 2013 and 2014. These treatments controlled the curlyleaf pondweed, but abundant Eurasian watermilfoil remained problematic and August 2014 Eurasian watermilfoil biomass and frequency were the highest found in August surveys from 2011-2014 (JaKa and Newman 2014). Herbicidal treatment of Eurasian watermilfoil with 2,4-d was initiated in 2015 and treatments in 2015 and 2016 reduced milfoil abundance but the plant persisted at 25% of sites (Newman 2018). Poor (<1m) midsummer Secchi depths limited recruitment of native plants. An alum treatment in spring 2016 improved water clarity (Secchi depths >2m throughout summer) and 17 native species were found (Newman 2018; Dunne and Newman 2019). However, aggressive herbicidal treatment with granular 2,4-d and granular triclopyr in 2017 reduced Eurasian watermilfoil frequency to 3% of sites but also reduced number of native taxa found to 8. Eurasian watermilfoil remained <10% occurrence through 2020 but increased in 2021 to 30% of sites (Johnson 2021). Curlyleaf pondweed remains controlled with early season treatments. An alum treatment in 2021 further improved water clarity but native diversity remains below the peak of 2016 and the potential from the seedbank (Dunne and Newman 2019), although it is much better than Lake Susan. With good water clarity, careful and targeted control of Eurasian watermilfoil may allow native plants to expand but care will be needed to not also harm native plants.

In Staring Lake, attempts at carp removal in 2012 and 2013 were only partly successful but in winter 2014 an additional 5500 carp were removed and the plants responded positively. Further reduction of carp in 2015 to 10% of the 2011 population resulted in further increases in clarity and plant abundance. In addition to better Secchi depths, 10 submersed and 2 floating leaf taxa were found in 2014 compared to 6 submersed taxa (and the two lilies) in 2011 and 2013 and only four taxa in 2012 and by 2016 11 submersed taxa were found. Although curlyleaf pondweed and coontail were dominant, the appearance of Chara, Canada waterweed, water stargrass and naiad in addition to sago and narrowleaf pondweed was encouraging. Curlyleaf pondweed expanded to over 65% of sites in June 2016 and and early endothall treatment was completed in spring 2017. It was successful and curlyleaf has not required treatment since. Small patches of Eurasian watermilfoil were found in 2015, 2016 and 2017 and were controlled by hand pulling and targeted granular triclopyr treatments. However, Eurasian watermilfoil continued to expand and reached 19% in 2020 (Olson and Newman 2021) and 34% in 2021 (Johnson 2021c). The high abundance of macrophytes (> 90% of entire lake) is likely helping to maintain water clarity and sustain the plant community.

One concern with current management is determining if and when we have reached a restored condition. At all three lakes invasive plants eventually increased more than native plants and required control. Although herbicide treatments have been effective at reducing curlyleaf pondweed and Eurasian watermilfoil, and native species have incrementally increased in number and occurrence, continue control of invasives is needed and native plants have not become the dominant components of the plant community. Transplanting can be useful to increase species richness but good clarity is needed for transplants to expand into deeper water (Knopik and Newman 2018). It is likely that further increases in water clarity may be needed in Staring and Susan and must be maintained in Riley if diverse native plants are to become dominant. Such a community would help sustain good summer-long water clarity (Hilt et al. 2006). The ideal community would be relatively stable and require minimal control of invasives over several years. However, it is not known what is the best or practical descriptor of a restored community, particularly when data on the pre-impact plant community is not available and restoration to a pre-human settlement condition is likely not feasible or even desirable.

Whole lake treatments with fluridone were assessed in Minnesota in the early 2000's and in a eutrophic lake with low diversity (dominated by Eurasian watermilfoil and coontail) control resulted in a further loss of diversity and more importantly a large reduction in total plant coverage and loss of water clarity that persisted for several years (Valley et al.2006). Coontail is susceptible to fluridone and thus most of the plant coverage was eliminated with fluridone. In contrast, in a lake with better clarity and more diversity, control with fluridone resulted in reductions in milfoil but not a lakewide reduction in coverage or clarity (Crowell et al. 2006). Although some native taxa were temporarily reduced, they tended to rebound in the year or two after treatment. Some desirable taxa such as Chara tended to increase after treatment. Thus water clarity and plant community composition can have a large effect on response to control and managing for clarity in addition to invasives will be important.

Many studies have failed to see increases in diverse native species after invasive control, particularly curlyleaf pondweed control (e.g., Jones et al. 2012, McComas et al. 2015, Valenty and Vlach 2018a, 2018b). For example, in Gleason Lake three years of lakewide treatment followed by annual spot treatments reduced curlyleaf abundance and enabled a large increase native plants (>80% occurrence) but the native were dominated by coontail and the three other native taxa together occurred at <10% of sites (McComas et al. 2015). Similarly after 5-6 years of good curlyleaf control in two Twin Cities Metro lakes, native plants and not increased substantially and 5 or fewer submersed native taxa are typically found, an increase of only 2 or 3 taxa since control was initiated (Valenty and Vlach 2018a,b). Managers at least, believe a more diverse community is possible and desirable in these lakes. In two of these lakes (Rebecca and Gleason) water clarity was improved, so low light was not the only factor influencing native plant response. Kovalenko et al. (2010) also found that Eurasian watermilfoil control did not harm native communities in Twin Cities Metro Lakes, but they also found native plants may not increase after invasive control. Studies of milfoil control (mainly with lakewide 2,4-d) in Wisconsin have also shown more negative effects or no effects on native species than positive responses of natives to milfoil control (Kujawa et al. 2017, Nault et al. 2018, Mikulyuk et al. 2020). Thus it is likely that separate considerations for native and invasive plant occurrence criteria will be needed to determine success (e.g. < X% invasive and > Y species or occurrence of natives). Developing criteria that address both invasive species as well as habitat suitability and water quality will be a challenge.

A number of criteria and indicators have been examined to assess for impacts and these may be suitable for determining a restored state. These include percentage of the littoral (or potential littoral) vegetated or plant volume inhabited (Hilt et al. 2006), frequency of occurrence

(Beck et al. 2014), maximum depth of colonization (Hilt et al. 2006, Beck et al. 2014), species richness (total, per point or of certain species; Beck et al. 2014), occurrence or frequency of indicator taxa (Hilt et al. 2006, Beck et al. 2014), or quality indices such as floristic quality or biotic integrity (Nichols 1999, Radomski and Perleberg 2012, Beck et al. 2014). In Minnesota, some groups have used a Floristic Quality Index and total species richness as indicators of nutrient impairment (MN DNR 2020 based on Radomski and Perleberg 2012). With invasive species present, criteria such as < X % occurrence or coverage of invasive species might be an important indicator for management (Hilt et a. 2006). Although these metrics have been used to assess impacts (Beck et al. 2014) only total vegetative coverage, biovolume or biomass been commonly used to declare success in restoration (e.g., Hilt et al. 2006, Pot and ter Heerdt 2014). Bakker et al. (2013) point out that sustaining water clarity is a key factor to long term success of native vegetation and that dominance by eutrophic species often does not result in stable vegetation. Presence of invasive species further clouds restoration criteria and goals and the need for continued management. Kovalenko et al. (2010) suggest repeated treatments will be necessary to sustain control even while stressing the need to restore native macrophytes and habitat complexity.

The aim of this proposed plant project is to determine if invasive plant control and management to improve water clarity after carp removal can restore native submersed aquatic plant communities in Lakes Riley, Staring and Susan. The intent is to restore native submersed plant communities to a self-sustaining state that does not require intensive annual management. We will also evaluate criteria to determine when submersed plant communities have been sufficiently restored and propose criteria to be used by the district and other metro lake management agencies. The project will partially fund a graduate student (funding from other sources will be sought and leveraged) and will complement and provide data to a larger project funded by USGS to assess the relationship of native and invasive plant communities to water quality improvements in lakes in the Twin Cities Metro and western Wisconsin. That project will also allow us to compare responses to water quality and plant management approaches in Riley, Susan, and Staring to other lakes in the Twin Cities Metro Region and develop regional recommendations.

The specific objectives are to:

1. Continue efforts to restore native plants and control invasives in Lakes Riley, Susan and Staring.
2. Assess response of native and invasive macrophytes to herbicide treatments to control curlyleaf pondweed and Eurasian watermilfoil in Lakes Riley, Susan, and Staring and to water clarity improvements via alum treatments in Riley (2016 and 2021) and Susan (proposed in near future). Integrate these results into a larger USGS study to assess the response of native and invasive plants to water quality improvements.
3. Recommend and assess further approaches to enhance establishment and growth of native macrophytes while controlling or preventing development of nuisance populations of curlyleaf pondweed and Eurasian watermilfoil including use of alum treatments to improve water clarity and stocking or transplanting if natural recruitment does not occur and the propagule bank is depleted.
4. Using RPBCWD data and data from the literature and other metro lakes, determine plant community target criteria for quality plant communities in the metro for shallow and

deeper lakes. These criteria may range from whole-lake or sampling point species richness, to occurrence or abundance of invasives and indicator species or IBI scores.
5. Apply these approaches and the restoration criteria to lakes in the RPBCWD and make management recommendations.

Methods

Restoration of native plants in lakes Riley, Susan and Staring

Assessing plant community: Aquatic macrophyte species composition, frequency of occurrence, and relative abundance (scale of 0 to 5) will be assessed in late spring or early summer (June; peak curlyleaf) and late (August) summer in each lake (Riley, Staring and Susan) using the point intercept method (Madsen 1999). We will also assess biomass for these suveys (Johnson and Newman 2011). The fixed grid approach, which has been the basis for prior assessment on these lakes (Olson and Newman 2021), will allow us to detect range and depth expansions as they occur and frequency of occurrence and biomass can also be compared across a standard sampling area. We may sample other lakes (e.g., Ann, Hyland or Lotus) for comparison of plant communities but our focus will be on Riley, Staring and Susan. We will also assess fall curlyleaf pondweed turion densities and viability in the three lakes in late September or October each year.

Restoring native plants: Desirable native plant species may start to establish naturally, particularly if water clarity remains good through the summer. Stocking (transplants) in Lake Susan was successful in getting plants to establish, but significant expansion of native plants will likely require further increases in clarity (Knopik and Newman 2018). An alum treatment, now being planned, should increase clarity and enable expansion of native plants and provide a test of plant community response to clarity.

The plant community in Lake Riley responded well to the alum treatment in 2016 with an increase to 14 submersed native taxa compared to 10 the prior year and 7 in the first years following carp removal. We suspect that aggressive milfoil control in 2017 with a combination of granular triclopyr and granular 2,4-d suppressed the native plants (only 5 submersed native taxa were found after treatment). Based on our seedbank assessment in Riley and plant recruitment in 2016 (Dunne and Newman 2019), we expected the native plant community to recover to 2016 levels with the reduced milfoil population from 2017 and no milfoil treatment in 2018. However recovery and expansion of native plants was slow and we await to see if a further increase and a return to 2016 levels occurs after the second alum treatment in 2021. If more natives do not return to the 2016 level (12-14 submersed natives), despite good clarity, we will investigate transplanting of propagules of desirable plants that have not been (e.g., *P. richardsoni, P. amplifolius, Z. palustris*) and possible examine enclosures to enhance native plant recruitment.

In Lake Susan, the poor water clarity will likely defeat attempts to enhance plant diversity, but if an alum treatment or other management approaches to improve clarity are implemented and successful, we expect an expansion of native (and invasive) plants and an increase in the number of native taxa. We will monitor the plant community in the year of and year after treatment. A seedbank assessment (Dunne and Newman 2019) should be conducted to determine what viable propagules are in the lake and suggest new taxa worth adding if plants do not naturally recruit during these two years. If few viable propagules are found, stocking or transplanting may be effective. In contrast to past efforts, transplants will be done on a broader scale and with a coarser level of assessment. A similar approach will be taken in Staring after whole lake herbicide treatments are conducted (see below). A seedbank assessment will be conducted to determine if propagules are lacking and if natural recruitment does not occur determine the best taxa to introduce.

Natural recruitment is preferred in all of these lakes and transplanting will only be attempted if natural recruitment is low but environmental conditions are good (low carp and good clarity). The seedbank assessment on Hyland Lake indicated that 14 species were present; several of these taxa increased after alum treatment and 2 new species appeared. Four taxa found in the seedbank have not yet been found in the lake (Valenty and Hess 2022). Hyland Lake will give us one more case to assess the hypothesis that water clarity is limiting diverse plant community persistence in district lakes.

Assessing herbicide treatments: When invasive plants are present they may become problematic when carp are removed or water clarity enhanced and measures to control the invasive may be needed. Control efforts have been ongoing in Riley, Staring and Susan for curlyleaf pondweed and Eurasian watermilfoil. The aim of these treatments has been to reduce nuisance levels of the invasives while protecting and enhancing native plant communities. In general the treatments have controlled the invasives with minimal harm to natives, but native plants have only incrementally increased with invasive plant control. In coordination with Lake Vegetation Management Plans, we will continue to assess native and invasive plant response to herbicide treatments to control curlyleaf pondweed and Eurasian watermilfoil in Riley, Staring and Susan. Plants surveys will be timed to obtain June, peak curlyleaf (but pre-milfoil treatment) data and mid-summer (August) surveys to capture peak native plant biomass. We will work with the district to help implement treatments including providing background data to the DNR and applicators and conducting delineations for treatment when feasible. Our analyses will focus on assessing herbicide efficacy and effects on native plants. We will modify our approach as needed if and when the opportunity arises to try new control approaches or herbicides. The pause of milfoil treatment in Riley allowed us to determine that native plants rebounded slowly with the greatly reduced milfoil population and a lack of further herbicide stress in 2018-2021. Future treatments might employ the successful application of granular auxin mimics but at lower dose or more targeted application to reduce non-target impacts.

In Staring, the increase in Eurasian watermilfoil necessitates control and Staring should be a good location to try a whole lake fluridone treatment to control curlyleaf pondweed as well as Eurasian watermilfoil. There is some concern that the recent extreme dominance of coontail as the primary native taxa present (655 in 2019 and 2020 and 94% occurrence in 2021) would result in a decrease in native plants (Wagner et al. 2007) or the loss of the entire plant community and a shift to a turbid state (Valley et al. 2006) but more recent applications use much lower doses than these previous studies that should have less impact on native plants. Application timing can also be altered to reduce impacts.

Our main focus in all three lakes will be on retaining and restoring native plant communities while keeping non-native invasive plants below nuisance levels. The working hypothesis is that dense invasive populations can suppress native plants but also that rooted native plants will need good summer-long water clarity to expand and fill in where invasives have been controlled. If native plants can further expand they should be able to contrain the invasives and sustain a diverse plant community. Transplanting will be considered if conditions suggest it will be successful (low carp, good clarity and little natural recruitment) and weevil surveys will be conducted if herbivores are noted during plant surveys. Restoration of these plant communities does rely on low abundance of carp and we will rely on the district to monitor and if needed, control, the carp. We will use the criteria developed below to determine if and when the plant restoration has been successful.

Criteria for assessing restoration

As mentioned above, a number of metrics have been used to determine if plant communities are impaired or negatively affected but it is less clear when lake macrophyte communities have been sufficiently restored or if or when further management will provide little additional benefit. There is not current agreement on how many species, what species, or what plant community characters would indicate a suitable quality or restored condition for either metro shallow lakes or deeper lakes and lakes ranging from hyper eutrophic to mesotrophic. Neuman (2008) showed that species richness was related to water clarity, which was also related to location. Northern Minnesota Lakes had better clarity and more species than southern Minnesota Lakes. Within the Twin Cities Metro Region, lakes tended to have 7-12 or 13-18 species but poor quality lakes only had 1-6 species. Similarly, maximum depth of colonization ranged from 1.6-4.6 m with better quality lakes have species from 3.1-4.6m. The Minnesota DNR (2020) has proposed using floristic quality and total number of species from the Radomski and Perleberg (2012) IBI to assess lakes and they have thresholds for impaired and unimpaired deep and shallow lakes by ecoregion. In their assessment they give positive scores to invasive Eurasian watermilfoil and curlyleaf pondweed. In other treatments (e.g., Nichols 1999) invasives do not contribute positively to floristic quality scores. However, these indices only consider occurrence not abundance. Capers et al. (2007) found that there was little correlation with native and invasive species richness and further that occurrence of the invasives curlyleaf pondweed and Eurasian watermilfoil was not affected by the abundance of native plants. Thus it is likely that separate considerations for native and invasive plant occurrence criteria will be needed. Other criteria such as plant coverage or abundance, occurrence of indicator taxa or other community indicators may be useful.

We will review existing studies of macrophyte community indicators with a focus on North Central Hardwood Forests (aka Transition Forest). Composite metrics such as Floristic Quality, AMCI and Index of Biotic Integrity (Nichols et al. 2000, Radomski and Perleberg 2012, Beck et al. 2010) will be examined as well as their key components (e.g., Beck et al. 2014). We will also consult with DNR managers, consultants, watershed professional and lake association representatives for their perspective on suitable indicators. Based on analysis of statistical expectations (for shallow and deep and possibly by trophic state) we will propose criteria for restoration. Because lakeshore owners often do not highly value native macrophyte communities (Schroeder and Fulton 2013), input and interaction with lake shore owners and association members will be important to implementing criteria that will be acceptable to stakeholders. We will then assess study lakes to determine if criteria are met and sustained for 2 years.

Timeline

We propose two field seasons of work (summer 2022 and 2023). In addition to brief monthly progress updates, we will produce a progress and data report in January 2023, January 2024, and a final report by 31 May 2024. We propose a 15 April 2022 start and a 30 June 2024 end date. The budget is based on partially funding (40% time) an MS/PhD student thesis project and the budget in the second year reflects a 3% adjustment of salaries and tuition for inflation.

Funding requested in this proposal will be used to leverage funding from other sources that can help fully fund the student and provide assistance to sample and assess additional lakes.

Tasks

2022-2024

Assess response of native and invasive plant communities to carp removal and herbicide treatments to control invasive plants in Lakes Riley, Staring, and Susan including herbicide treatments for Eurasian watermilfoil and curlyleaf, and response to cessation of treatments.

Assess response of plant communities to alum treatments in Riley, and in Susan if they are conducted. We will also assess Hyland Lake in conjunction with the Three Rivers Park District. We will assess seed banks of lakes with Alum treatments to determine if natural recruitment of native plants should be expected.

Assess and develop criteria for quality macrophyte communities in metro lakes that can be used as a restoration endpoint and apply these to District Lakes.

Make recommendations for ongoing and future plant management in the Riley Purgatory Bluff Creek Watershed District based on results and restoration criteria.

Year-Specific Tasks

2022

Assess the response of native and invasive plant communities to carp removal, alum treatment and herbicide treatments to control invasive plants in Lakes Riley, Susan, and Staring including herbicide treatments for Eurasian watermilfoil and curlyleaf and response to cessation of treatments. Data collected will include late spring (May-June) and August point intercept plant surveys in all lakes as well as mapping of plant occurrence, biovolume and abundance.

Water quality variables (Secchi depth, temperature, oxygen and light profiles) will be collected during each plant survey period.

Collate and review literature on macrophyte communities and indictors of community health that might be used as restoration criteria.

Monthly progress reports will be submitted that summarize activities conducted and plans for the next month along with key observations.

An annual report will be submitted by the end of January 2023. The report will present methods and results for all data collected along with an interpretation of the results, and recommendations for future management and activities in the following years. Activities in future years may be altered based on the report.

2023

Assess the response of native and invasive plant communities to carp removal, alum treatment and herbicide treatments to control invasive plants in Lakes Riley, Susan, and Staring including early herbicide treatments for Eurasian watermilfoil and curlyleaf, and response to cessation of treatments. Data collected will include early season (May), late spring (May-June) and August point intercept plant surveys in all lakes as well as mapping of plant occurrence, biovolume and abundance. Delineations of areas to be treated with herbicide will be conducted if needed.

Assessment of seedbank in Lake Susan if it scheduled for an alum treatment will be conducted to assess the potential need for transplanting to increase native species. Sediment cores will be incubated in the lab with gibberellic acid to assess the seedbank. Seedbank of Staring may also be assessed if clarity remains high and native plants do not recruit.

Water quality variables (Secchi depth, temperature, oxygen and light profiles) will be collected during each plant survey period.

Collate and review literature on macrophyte communities and indictors of community health that might be used as restoration criteria and begin analysis of available Twin Cities Metro plant community data to conduct a preliminary analysis of potential indicators.

Host a workshop with DNR, consultants and watershed district personnel to discuss potential restoration criteria.

Monthly progress reports will be submitted that summarize activities conducted and plans for the next month along with key observations.

An annual report will be submitted by the end of January 2024. The report will present methods and results for all data collected along with an interpretation of the results, and recommendations for future management and activities in the following years. Activities in future years may be altered based on the report.

2024

Complete analysis of macrophyte indicators to be used as restoration criteria and develop manuscript and management plans to implement criteria.

Monthly progress reports will be submitted that summarize activities conducted and plans for the next month along with key observations.

A Final report will be submitted by the end of May 2024. The report will present methods and results for all data collected during the three years along with an interpretation of the results, and recommendations for ongoing management to maintain water quality, native plant communities and usability of the lakes.

Specific deliverables:

Monthly: brief progress reports that summarize activities conducted, key observations, and plans for the next month.

31 January 2023: an annual progress report that will present methods and results for all data collected along with an interpretation of the results, and recommendations for future management and activities in the following years.

31 January 2024: an annual progress report that will present methods and results for all data collected along with an interpretation of the results, and recommendations for future management and activities in the following years. Proposed restoration criteria will be presented and discussed.

31 May 2024: a completion report that will present methods and results for all data collected during the three years along with an interpretation of the results, and recommendations for ongoing management to maintain water quality, native plant communities and usability of the lakes. The report will also present our proposed criteria for success and recommend an approach to implement and evaluate the criteria.

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Proposed Budget 2022 (15 April 2022 to 15 May 2023)

ITEM	
Personnel	2022
Salary - Grad Student 40%	$19,810
Undergraduate RA 184 hrs@ $12.50/hr	2,300
Total Salary	$22,110
Fringe and tuition - Grad Students (Fringe $4,676; Tuition $13,672)	$18,348
Total Fringe	$18,348
Total Personnel Salary and Fringe	$40,458
Supplies	
General Operating Supplies	300
Lab & Medical Supplies	200
Total Supplies	500
Travel	
Travel / Mileage / Moving	$2,000
Other Direct Costs	
General Operating Services	1,200
Repairs & Maintenance	250
Total Other Direct Costs	1,450
TOTAL DIRECT COSTS	$44,408
Facilities and Administrative Expenses IDC (16% MTDC)	$4,918
TOTAL COSTS	$49,326

Budget 2023 (15 May 2023 to 30 Jun 2024)

ITEM	
Personnel	2023
Salary - Grad Student 12 months 40%	$20,401
Undergraduate RA 184 hrs@ $12.50/hr	2,300
Total Salary	$22,701
Fringe and tuition - Grad Students (Fringe $4,815; Tuition $14,084)	$18,899
Total Fringe	$18,899
Total Personnel Salary and Fringe	$41,600
Supplies	
General Operating Supplies	200
Lab & Medical Supplies	100
Total Supplies	300
Travel	
Travel / Mileage / Moving	$2,000
Other Direct Costs	
General Operating Services	1,200
Repairs & Maintenance	250
Total Other Direct Costs	1,450
TOTAL DIRECT COSTS	$45,350
Facilities and Administrative Expenses IDC (16% MTDC)	$5,003
TOTAL COSTS	$50,353

Two Year Total Budget (15 April 2022- 30 June 2024)

ITEM	
Personnel	2 yr total
Salary - Grad Student 40%	$40,211
Undergraduate RA 368 hrs@ $12.50/hr	4,600
Total Salary	$44,811
Total Fringe and Tuition	$37,247
Total Personnel Salary and Fringe	$82,058
Supplies	
General Operating Supplies	500
Lab & Medical Supplies	300
Total Supplies	800
Travel	
Travel / Mileage / Moving	$4,000
Other Direct Costs	
General Operating Services	2,400
Repairs & Maintenance	500
Total Other Direct Costs	2,900
TOTAL DIRECT COSTS	$89,758
Facilities and Administrative Expenses IDC (16% MTDC)	$9,920
TOTAL COSTS	$99,678

Budget Justification:

Personnel:

Newman (the PI) will oversee the project and reporting. A graduate student (40% time; 12mo/yr) will conduct or oversee most of the work, which will become the basis of their thesis. Graduate student fringe covers required tuition and health insurance. An undergraduate assistant will help the graduate student with sampling and sample processing 184 hrs per year at $12.50/hr. Salaries are projected to increase 3% each year with the exception of undergraduates.

Supplies:

A total of $500 per year in year 1, $300 in year 2 is requested for supplies which include general supplies such as waterproof paper, toner, boat gas, oil, and rope ($500); lab supplies such as sampling and weighing bags, standard ($300); and expendable equipment such as a replacement plant hook or trailer tire. Money may be moved across these three categories and years depending on need (and expenditure classification).

Travel:

Rental and local travel is budgeted at $2000 per year in years 1 and 2. Vehicle rental (from Fleet services) and mileage is requested to go to and from research sites; rental will be split with other projects to save cost. Local vehicle mileage is also requested to go to and from research sites with the Aquatic Invasive Species (AIS) center vehicle when two trucks or needed or the rental is not available. Any remaining funds will be used for the PI and graduate student to attend and present results at state, regional or national meetings.

Other direct costs:

Operating services to cover photocopy and printing charges ($50/yr) for reports, posters and data sheets are requested along with a portion ($950/yr) of the cost for a ciBiobase sonar plant mapping subscription ($2750/yr) to map vegetation. Growth chamber rental to do seedbank assessments (133d @ $3/d). Other projects will pick up remainder of ciBiobase costs. Repair and maintenance costs are $250/yr. These include boat and trailer repairs and maintenance, and equipment repair and calibration.