MINNEHAHA CREEK WATERSHED DISTRICT

QUALITY OF WATER QUALITY OF LIFE

Six Mile Creek – Halsted Bay Subwatershed

Carp Management Implementation Plan

Updated: March 12, 2018

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Executive Summary

The Six Mile Creek – Halsted Bay Subwatershed (SMCHB) is located in the western portion of the Minnehaha Creek Watershed District, in Carver County and parts of Hennepin County. It is composed of several deep and shallow lakes, has numerous wetlands, and is the headwaters of Lake Minnetonka, flowing into Halsted Bay. Several lakes in this subwatershed are impaired for excess nutrients, and can be characterized as generally turbid with poor water clarity and degraded aquatic plant communities that provide poor habitat for fish and waterfowl. Common carp (*Cyprinus carpio*) are abundant in the SMCHB, and are a known driver of poor water quality and ecological conditions. Managing carp is a top priority for management and restoration of this subwatershed, and is part of a broader plan in the District's 2017 Comprehensive Plan to improve water quality and ecological conditions across the entire system.

In 2014, the Minnehaha Creek Watershed District (MCWD) partnered with the University of Minnesota (U of M) to complete a 3-year assessment of common carp in SMCHB. Its purpose was to determine the abundance, recruitment patterns, and seasonal movements of carp to enable the development of carp control strategies for habitat restoration and water quality improvements. Adult carp biomass in 12 of the 15 lakes was found to exceed 100 kg/ha (89 lbs/acre), a threshold where ecological damage can occur. Several carp nurseries were identified, with South Lundsten Lake being a top management priority. South Lundsten was found to be an active carp nursery, contributing high abundances of juvenile common carp to several lakes in the subwatershed, including downstream to Parley Lake, upstream to Auburn Lake, and even as far as Wassermann Lake. Other carp nurseries were identified, although some have not produced juvenile carp in many years, but likely provided successful carp recruitment in harsh winter conditions, or drought years, that allow winterkill of bluegill sunfish. Movement data of common carp identified four distinct populations in the subwatershed, which can be managed separately with some use of barriers. For management purposes, one of these populations will be separated into two management units to facilitate adult carp removal by adding a barrier between Mud Lake and Halsted Bay. The following are the carp management units for this system: 1) Pierson-Marsh-Wassermann, 2) Auburn-Lundsten-Turbid, 3) Parley-Mud, 4) Carver Park Reserve Lakes and 5) Halsted Bay.

There are two approaches to managing carp in this subwatershed. The first approach would be an aggressive, short-term approach that could provide management over a 3 to 5 year time period across the entire subwatershed concurrently. Alternatively, management could be implemented in a more phased approach over 7 to 8 years, first addressing carp recruitment system-wide in priority areas, and then removing adult carp biomass one management unit at a time. The first approach is preferred, as an aggressive, short-term timeframe for carp management can lead to earlier implementation of additional restoration strategies, and earlier restoration of the subwatershed; however, the approach chosen will be directed mainly by funding and resources available. It is expected that even with an aggressive, short-term approach, continued management will be needed to meet all goals beyond the 3-year time-frame, and long-term monitoring and maintenance will be needed indefinitely regardless of the approach chosen. Management will need to be adaptive, as the results of each action taken can inform and possibly change future actions. With either approach, there will be three main objectives: 1) Suppress

carp recruitment system wide, 2) Separate carp populations between Mud Lake and Halsted Bay by installing a barrier/fish trap, and 3) Adult carp biomass removal.

Suppressing carp recruitment is a top priority to prevent new carp from being produced into the system. This will be accomplished by using winter aeration in some waterbodies to prevent winterkill of bluegill sunfish, which feed very effectively on carp eggs. In other waterbodies, physical barriers will prevent access by adult carp in nearby lakes.

Concurrently, a barrier/trapping system between Mud and Halsted Bay should be installed, and adult biomass removal can begin in waterbodies that exceed the damaging carp biomass threshold. A carp barrier/trap between Mud and Halsted Bay will separate carp populations in the Six-Mile Creek Lakes from Lake Minnetonka, containing the populations, and improving removal strategies for Halsted Bay and Parley and Mud Lakes. This corridor is frequently used as a carp migration route, and including a trapping system in the design will facilitate removal of carp from both management units.

Adult carp removal will involve three main strategies: winter or open-water seining, baited box-net trapping, and trapping migratory carp in stream channels. Strategies will vary by management unit, waterbody, and progress towards achieving removal goals. Based on carp population data from the U of M assessment, target numbers of carp for removal have been set for each waterbody to bring the carp population under 100 kg/ha (89 lbs/acre).

As carp removal occurs, ongoing monitoring is necessary to track carp removal progress and monitor for carp recruitment. Monitoring will also occur to document changes in water quality and ecological conditions. Metrics that will be tracked include: total phosphorus, chlorophyll-a, water clarity, total suspended solids and aquatic plant community metrics.

Figure 1. Carp Biomass Results from University of Minnesota Carp Assessment

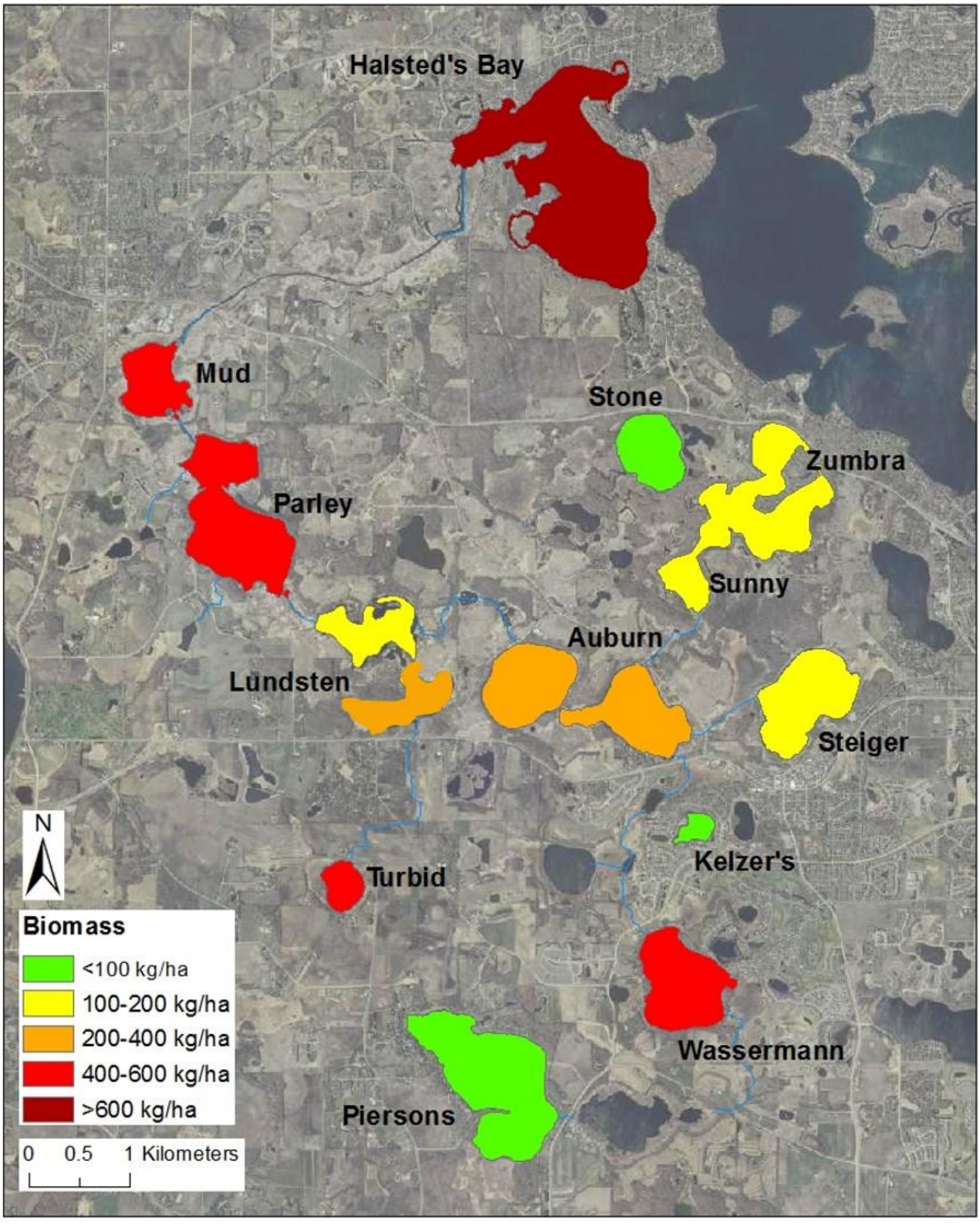
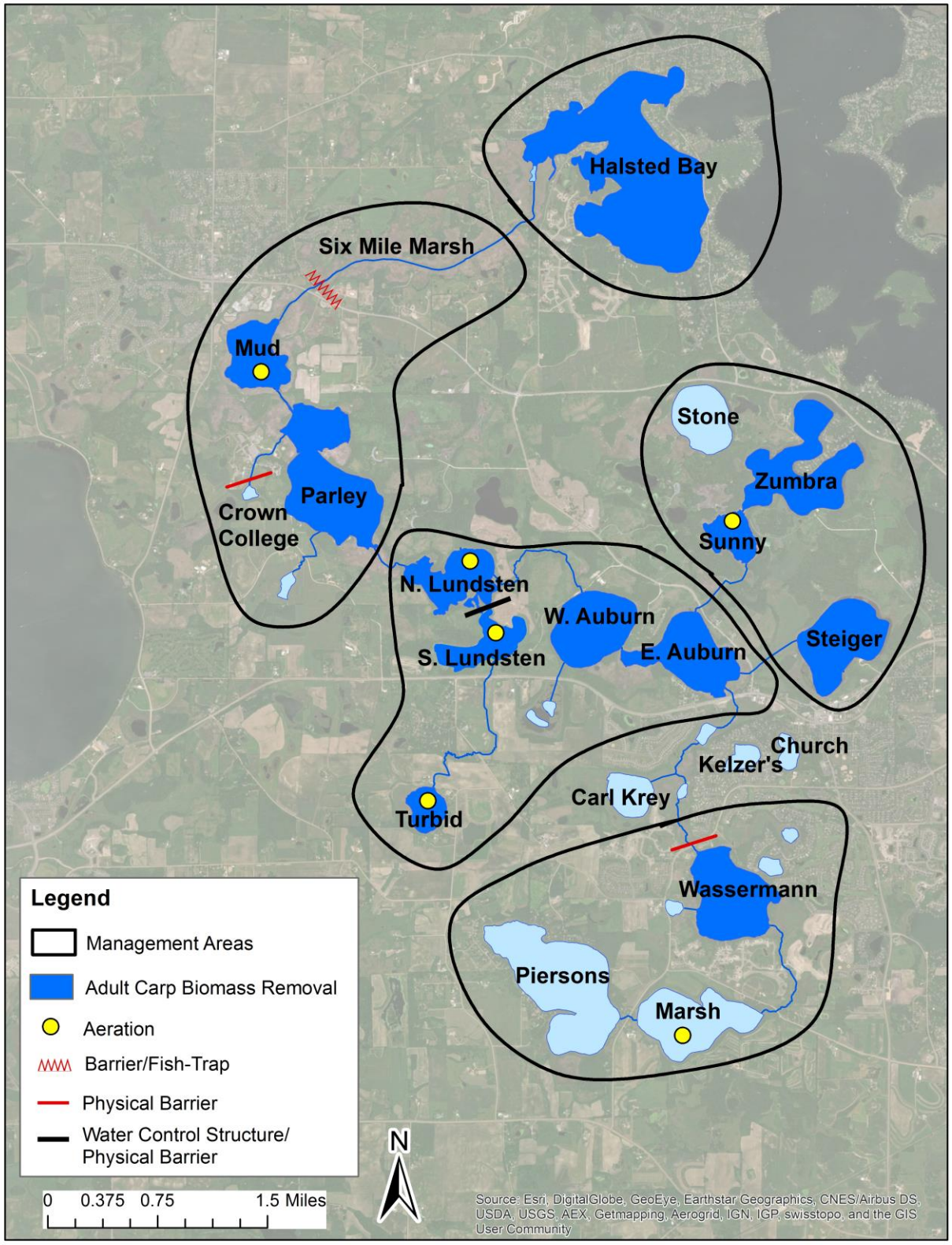


Figure 2. Carp Implementation Map



Overview of Carp in Six Mile Creek – Halsted Bay Subwatershed

Adult carp biomass in 12 of the 15 lakes in the subwatershed were found to exceed the 100 kg/ha (89 lbs/acre) threshold; a threshold known to be ecologically damaging in shallow Midwestern lakes (Bajer et al. 2009). In the remaining sections of this plan, carp biomass will be referenced as pounds per acre (lbs/acre). Lakes with very high biomass ranging from 226 to 1,128 lbs/acre include: Wassermann, Turbid, West Auburn, East Auburn, Parley, Mud, and Halsted Bay. These are priority lakes for management. Halsted Bay had the highest carp biomass ever observed by the Sorensen Lab (U of M), with an estimated biomass of 1,128 lbs/acre, twelve times the threshold for ecological damage. Several lakes had more moderate densities ranging from 139 to 182 lbs/acre and included: North Lundsten, South Lundsten, Steiger, Sunny and Zumbra. Carp removal is warranted in these lakes, but make up a second tier priority for management. Carp biomass was generally low (≤ 88 lbs/acre) in Piersons, Stone and Kelzer's lakes, and requires no current management. Removal efforts may be conducted in Piersons Lake, as it is close to the threshold. Carp populations can mix between different lakes in each unit, so while there are target removal numbers for each lake, the most important number is the total number of carp removed from the management unit.

Several carp nurseries were identified in the subwatershed, with South Lundsten being especially important. South Lundsten appears to be the primary source of carp for North Lundsten, West Auburn and East Auburn. It also contributes low numbers of carp to downstream lakes including Parley, and as far upstream as Wassermann Lake. Other nurseries that need to be addressed include North Lundsten, Marsh Lake, Sunny Lake, Turbid Lake, Crown College Pond, Big SOB Lake and Mud Lake. Carl Krey is another lake that needs more monitoring, it was inaccessible during most of the study period. Each will be discussed further in context of their management units.

A number of carp in each waterbody were also radio-tagged and tracked frequently throughout the assessment. Movement patterns of carp were observed over a variety of seasonal conditions, and indicated there were several mostly distinct populations of carp in the subwatershed. These distinct carp populations form separate management units that will require unique goals and strategies to manage. For management purposes, one of these units will be separated by adding a barrier between Mud Lake and Halsted Bay to facilitate adult carp removal. The following will be the carp management units for this system: 1) Pierson-Marsh-Wassermann, 2) Auburn-Lundsten-Turbid, 3) Parley-Mud, 4) Carver Park Reserve Lakes and 5) Halsted Bay.

Management Unit Goals

For each management unit and individual lakes, a target number for carp removal was calculated based off current population estimates in comparison to the aforementioned ecological threshold. Updated population surveys will be conducted as management occurs to track population changes and determine progress in achieving management goals. The following are carp management goals for each management unit.

Piersons-Marsh-Wassermann (Management Unit 1)

Suppress carp recruitment in South Lundsten and Marsh Lake, and reduce carp population in Wassermann Lake by at least 4,920 carp to achieve a carp biomass of less than 89 lbs/acre. Monitor carp population in Piersons Lake, and remove carp as needed to remain below the 89 lbs/acre threshold.

Auburn-Lundsten-Turbid (Management Unit 2)

Suppress carp recruitment in South Lundsten, North Lundsten and Turbid Lakes, and reduce carp population in the management unit by at least 12,750 carp to achieve a carp biomass of less than 89 lbs/acre.

Parley – Mud (Management Unit 3)

Install barrier/fish-trap between Mud and Halsted Bay. Suppress carp recruitment in South Lundsten, Big SOB, Crown College Pond and Mud Lake, and reduce carp population in the management unit by at least 17,800 carp to achieve a carp biomass of less than 89 lbs/acre.

Carver Park Reserve Lakes (Management Unit 4)

Suppress carp recruitment in Sunny Lake, and reduce carp population in the management unit by at least 4,400 carp to achieve a carp biomass of less than 89 lbs/acre.

Halsted Bay (Management Unit 5)

Install barrier/fish trap between Mud Lake and Halsted Bay, and reduce carp population in Halsted Bay by at least 59,350 to achieve a carp biomass of less than 89 lbs/acre. Future management will be needed to address carp immigrating and emigrating from the rest of Lake Minnetonka via the channel between Priests Bay and Hasted Bay.

Carp Management Objectives

There are three main objectives to sustainably manage carp in this system.

- Objective 1. Suppress carp recruitment system-wide
- Objective 2. Separate carp populations between Mud Lake and Halsted Bay by installing a barrier/fish trap
- Objective 3. Removal of adult carp biomass

Suppressing carp recruitment is the top priority for carp management, as it prevents new carp from being produced into the system. Installation of a barrier/trapping system between Mud Lake and Halsted Bay, as well as removal of adult carp biomass, could be conducted concurrently while suppressing carp recruitment, however, without achieving objective 1, long-term sustainability of carp removal cannot occur.

Implementation Plan

Initial management will be focused on suppression of carp recruitment areas across the subwatershed. This will occur by providing winter aeration on several waterbodies that are prone to winterkill, and installing barriers to prevent carp access to others. Preventing winterkill by using winter aeration should help maintain a healthy bluegill population, which feed on carp eggs very effectively. Installation of a barrier/fish-trapping system will be installed to prevent carp passage from Mud Lake to Halsted Bay and vice versa, which will allow Halsted Bay and Parley-Mud to be separate management units. Halsted Bay will require long-term management due to its connection to greater Lake Minnetonka, and may even require carp management in other areas of Lake Minnetonka and adjoining subwatersheds to achieve carp management goals in Halsted Bay.

Removal of existing adult carp biomass is also needed. Depending upon the approach used and resources available, concurrent removal across all management units could occur. If a more phased implementation approach is selected, initial carp removal could begin in the headwaters of the subwatershed and continue to other management units once good progress has been made in meeting management goals in the headwaters area.

Monitoring will be necessary to both inform ongoing management decisions, as well as to document water quality and ecological changes following carp management. This adaptive management framework will be a critical component of how this plan is implemented. Each strategy and action will have certain results that will inform, and possibly change subsequent strategies and actions taken. A monitoring section is included with more details.

Six Mile – Halsted Bay Carp Management Timeline

		LSOHC Grant Period - July 1, 2018 - June 30, 2021															
	2017	2018				2019				2020				2021			
Objective/Task	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Acquire all necessary permits & landowner permissions	x	x	x	x		x				x				x			
Objective 1. Suppress Carp Recruitment																	
Task 1. Run electric for aeration units				x													
Task 2. Operation of aeration units					x	x			x	x			x	x			x
Task 3. Install permeable berm at outlet of Crown College Pond				x													
Task 4. Install barrier and water level control structure between North & South Lundsten								x									
Objective 2. Install barrier/fish-trap between Mud Lake and Halsted Bay				x													
Objective 3. Adult carp biomass removal																	
Task 1. Install barrier structure at Wassermann outlet				x													
Task 2. Implant Radio Tags				x													
Task 3. Box-Net Trapping				x	x		x	x	x		x	x	x		x	x	x
Task 4. Winter/Open-water Seining					x	x	x		x	x	x		x	x	x		
Task 5. Carp trapping in stream channels				x	x		x	x	x		x	x	x		x	x	x
Task 6. Maintain barriers				x	x		x	x	x		x	x	x		x	x	x
Monitoring																	
Task 1. Carp population surveys				x				x				x				x	
Task 2. Winter Dissolved Oxygen Monitoring		x				x				x				x			
Task 3. Spring Trap Net Surveys			x				x				x				x		
Task 4. Fall Trap-Net Surveys				x				x				x				x	
Task 5. Radio tag tracking					x	x	x		x	x	x		x	x	x		
Task 6. Aquatic Plant Surveys			x	x			x	x			x	x			x	x	
Task 7. Water Quality Monitoring			x	x			x	x			x	x			x	x	
Task 8. Water Quality Monitoring in aerated lakes					x	x	x		x	x	x		x	x	x		x
Reporting					x				x				x				x

Objective 1 - Suppressing Carp Recruitment

The goal of suppressing carp recruitment is to prevent the addition of new carp to the system. This is key to effective carp management, and is typically accomplished by either blocking movement of adult carp to these waterbodies, or preventing winterkill of bluegill sunfish by aerating carp nurseries during the winter.

Winter Aeration

Aeration units will be installed in North Lundsten, South Lundsten, Mud, Sunny, Turbid and Marsh Lake. These units will be operated in the winter only when dissolved oxygen at the surface gets well below 5 mg/L. Dissolved oxygen will be monitored throughout the winter to inform when deployment of the aeration units are needed. South Lundsten should be prioritized among these waterbodies, as it currently provides for frequent carp recruitment to several lakes in the subwatershed. The remaining waterbodies are still a priority to address, but would be considered a secondary priority to South Lundsten. Several of these lakes are very shallow, and will monitored closely to ensure aeration is being effective, and no incidental water quality impacts occur. Winter aeration requires a DNR permit, which has safety precautions required such as thin ice signage around the lake. Electricity is also required to operate the aeration units.

Barriers

A physical barrier will be constructed at a culvert just downstream of the outlet of Crown College Pond, which was found by the U of M assessment to also provide frequent carp recruitment. The pond does not support a permanent adult carp population because it freezes to the bottom most years and has a small outlet with intermittent flow, so the simplest measure here is to install a physical barrier to prevent carp from re-entering the pond. Installation of this barrier should be considered a priority management activity. DNR permits will be required for all barriers.

Between North and South Lundsten, in addition to aerating these waterbodies, a water control structure/fish barrier will be installed. The flexibility to be able to manipulate water levels and block carp passage provides another layer of protection if carp recruitment did occur. Manipulating water levels can also be a useful shallow-lake habitat restoration strategy, and could improve the aquatic plant community in the shallow lakes. A management plan for operating the water control structure will be required along with a DNR permit.

A physical barrier will be constructed at culvert just downstream of Wassermann Lake. This barrier will contain carp within the Piersons-Marsh-Wassermann Management Unit, and the Auburn-Lundsten-Turbid Management Unit. This will aid in carp removal from each area.

Big SOB Lake, which is a private and man-made lake that flows into Parley Lake, has also served as a carp nursery. The U of M sampled abundant young-of-year carp in this lake in 2014, but indicated it was likely the result of a rotenone treatment that occurred in 2013, which likely killed off any bluegill sunfish and was recolonized by carp during the spring flooding in 2014 which created for optimum conditions for carp recruitment. The property owner has since installed a barrier at the outlet of the lake and now aerates the lake annually in the winter. No management action is required at this time, but communication/coordination with the landowner should continue.

Objective 2 – Separate carp populations between Mud Lake and Halsted Bay by installing a barrier/fish trap

Preventing fish passage and installing a carp trap between Mud Lake and Halsted Bay will effectively separate the rest of the Six-Mile Creek lakes from Halsted Bay and greater Lake Minnetonka. This will additionally address Objective 3, facilitating adult carp removal in Parley-Mud and Halsted Bay management units, by trapping migrating carp by the barrier. The U of M assessment found that almost 50% of the carp in the Parley-Mud-Halsted original management unit use this passageway. Trapping fish in this location would be very effective in removing adult carp to achieve target population levels.

Objective 3 – Adult carp biomass removal

Removal strategies and goals for removal will be broken out by each management unit and individual lakes. For each unit, there will be a target number of carp to be removed to meet the 89 lbs/acre carp biomass threshold, which is the maximum carp density that the lakes can support before ecological damage could occur. Within each unit, there will be target removal numbers for each lake. Carp populations can mix between different lakes in each unit, so while there are target removal numbers for each lake, the most important number is the total number of carp removed from the management unit. These target numbers are meant to be a guide, and more removal could occur in one lake over another as carp move through the system, and still achieve the goals of each unit. It should also be noted that these target numbers are fluid, carp grow year to year and overall biomass will change. Updated population numbers will be gathered throughout implementation, and target numbers may change accordingly.

Various strategies will be used for removal of adult carp, including winter seining, open-water seining, open-water baited box-net trapping and trapping in migratory stream channel areas. Strategies used in each management unit will vary.

Prioritization for removal should be given to waterbodies with the highest abundances of common carp, and includes the following waterbodies: Wassermann, East Auburn, West Auburn, Turbid, Parley, Mud and Halsted Bay. Of moderate priority, is removal of carp in: Zumbra, Steiger, Sunny, North Lundsten and South Lundsten. No removal is currently required in Piersons, Kelzers or Stone Lakes. This prioritization can be useful if resources are limited.

Costs and management strategies for each unit are estimated over a three-year time period. It is expected that good progress towards meeting management goals in each unit will be made within the first three years, however, the timeline in each unit will vary depending upon success of the actions taken. Some may take longer than three years, such as removal in Halsted Bay, which will require ongoing removal over a longer time period due to its connection to Lake Minnetonka. To achieve management goals in Halsted Bay, removal and recruitment suppression may even need to occur in other areas of Lake Minnetonka. Once management goals are achieved, there will be a need for ongoing management and occasional removal to maintain those levels.

Piersons-Marsh-Wassermann Management Unit

Management Goal:

Suppress carp recruitment in South Lundsten and Marsh Lake, and reduce carp population in Wassermann Lake by at least 4,920 carp to achieve a carp biomass of less than 89 lbs/acre. Monitor carp population in Piersons Lake, and remove carp as needed to remain below the 89 lbs/acre threshold.

Piersons-Marsh-Wassermann Summary Table

Surface area (acres)	Total Carp Abundance
460	10,411

Individual Lakes Summary Table

Lake	Surface area (acres)	Avg. carp weight (lbs)	Carp Abundance	Carp biomass (lbs/acre)	Total carp abundance to equal 89 lbs/acre	# carp to be removed to achieve 89 lbs/acre
Piersons	297	7.3	3,580	88	3,616	0
Wassermann	163	7.6	6,831	318	1,914	4,917

Management Strategies

Carp removal in Wassermann Lake could involve a combination of winter seining, box-net trapping and trapping of fish in the channel at the outlet of Wassermann Lake. A barrier will be installed to contain the populations during removal.

Barrier at Wassermann Outlet

A barrier will be installed and maintained at the Wassermann outlet. This will prevent carp from downstream lakes from re-colonizing Wassermann Lake while removal occurs. The barrier will be maintained frequently, especially around heavy rain events to keep the barrier clear of debris. A plan will be developed to watch for game fish, such as Northern Pike, who are trying to move past the barrier, and help will be provided where possible to help facilitate their natural movement.

Carp Movement Tracking

To aid in removal, 15 radio-tagged carp will be tracked as needed to inform management in Wassermann Lake. 4 of these tags were implanted in the fall of 2016 by the U of M, and 11 more were implanted on April 17, 2017 with funds remaining from the U of M Assessment.

Winter Seining

Two to three seine attempts per year could be attempted in Wassermann Lake as needed. Winter seining is the best opportunity to remove a larger number of carp all at once, but can have variable success.

Baited Box-Net Trapping

Baited box-net trap removals will be scheduled as needed during the open water season. This can be a labor intensive process, and typically can remove anywhere from 200 to 1,000 carp per removal.

Trapping in channel at Wassermann outlet

As opportunities arise, there may be a chance to trap fish in the channel area at the Wassermann outlet. Based off of tracking data during the U of M study, carp don't leave Wassermann Lake every year, and when they do, it typically involves only a portion of the population moving to downstream lakes. If carp are observed stacking up at the upstream side of the culvert barrier, a second temporary barrier could be installed behind them (closer to the lake) to effectively trap carp in this stream. Both the barrier and removal will require DNR permits.

Management Progress

Management progress will be tracked and updated as removals and new population surveys occur. Population surveys will occur annually on Wassermann once removal efforts begin, until management goals are achieved.

Auburn-Lundsten-Turbid Management Unit

Management Goal:

Suppress carp recruitment in South Lundsten, North Lundsten and Turbid Lakes, and reduce carp population in the management unit by at least 12,750 carp to achieve a carp biomass of less than 89 lbs/acre.

Auburn-Lundsten-Turbid Summary Table

Surface area (acres)	Total Carp Abundance
471	21,802

It is expected that the total carp abundance in this management unit is greater than what is listed here. There are approximately 750 carp from Wassermann Lake that are currently somewhere in this management unit. The 750 carp represents one radio tagged carp that was initially tagged in Wassermann Lake, but last tracked in East Auburn Lake. A barrier at the Wassermann Lake outlet prevents these fish from moving back into Wassermann. Additionally, the juvenile carp from the 2015 year class spawned in South Lundsten are now almost 3 years old, and are likely dispersed among lakes in this management unit. Updated population surveys will be needed.

Individual Lakes Summary Table*

Lake	Surface area (acres)	Avg. carp weight (lbs)	Carp Abundance	Carp biomass (lbs/acre)	Total carp abundance to equal 89 lbs/acre	# carp to be removed to achieve 89 lbs/acre
East Auburn	116	4.3	6,121	227	2,418	3,703
West Auburn	133	5.1	7,201	276	2,307	4,894
North Lundsten	108	5.6	2,793	145	1,704	1,089
South Lundsten	74	5.6	2,414	183	1,178	1,236
Turbid	40	8.1	2,273	460	442	1,831
Total			**20,802**		**8,049**	**12,753**

**Carp populations in this management unit mix fairly frequently, especially between East and West Auburn and North and South Lundsten. Management goals for each waterbody are approximate targets, but overall reductions are needed across the management unit as a whole.*

Management Strategies

Management strategies in these lakes could involve a combination of winter seining, open-water seining, box-net trapping and trapping of migratory fish in stream channels. Lakes conducive to winter seining and potentially open-water seining include East Auburn, West Auburn and Turbid Lakes. North and South Lundsten, given their shallow depth, mucky substrate, and limited accessibility, would be difficult to seine. A more likely carp removal strategy for these lakes would be to either trap the carp as they migrate from North Lundsten to West Auburn, or remove them once they enter West or East Auburn. The installation of a water control structure between North and South Lundsten would allow for the future option to drawdown South Lundsten Lake, possibly facilitating a rotenone treatment if needed. Drawdown could also be a rapid response tool if aeration fails, and carp recruitment occurs. Temporary barriers would also be needed to aide in trapping and removal between North Lundsten and West Auburn.

Carp Movement Tracking

To aid in removal, carp in East and West Auburn and Turbid will be implanted with 5 to 8 radio tags each to track movement and inform timing of management strategies. Radio-tagged carp will be tracked as needed to inform management.

Winter Seining/Open-Water Seining

Winter and/or open-water seining is expected to be a strategy for carp removal in East Auburn, West Auburn and Turbid Lake. Turbid Lake, given its small size, may be a good candidate for an open-water or winter seine, however, accessibility and bottom debris may be an issue. Two to three seine attempts per year could be attempted in East Auburn, West Auburn and Turbid Lakes as needed. North and South Lundsten are not good candidates for seining due to depth and accessibility, and will primarily be managed as carp move from these lakes into stream channels or other lakes. Seining provides the best opportunity to remove a larger number of carp all at once, but can have variable success

Baited Box-Net Trapping

Baited box-net trapping is an option for West and East Auburn and Turbid Lake, conditions are likely not suitable in either Lundsten Lakes due to soft bottom substrates, and accessibility. Baited box-net trap removals will be scheduled as needed during the

open water season. This can be a labor intensive process, and typically can remove anywhere from 200 to 1,000 carp per removal.

Drawdown

The installation of a water control structure between North and South Lundsten will provide the flexibility to manipulate water levels. The weir will also block the movement of carp between the lakes. The installation of this structure will require the current trail crossing between the two lakes to be built up to reduce flooding potential and potential fish passage. A drawdown is not planned as an initial strategy, but the option will be there if other strategies are not effective. A management plan for operating the water control structure will need to be developed.

Trapping carp in the channel between North Lundsten and West Auburn

The stream between North Lundsten and West Auburn is a frequent migratory passageway for carp in this management unit. The U of M Assessment observed that around 43% of carp originally tagged in West and East Auburn pass through this channel annually, on their way to North Lundsten, and there is likely a similar number that returns to West Auburn. With proper timing, installing a couple of temporary barriers in this location could effectively trap carp for removal. Trapping would likely be most effective just downstream of the culvert located between West Auburn and North Lundsten. To catch carp coming to North Lundsten from Auburn Lake, a barrier will be installed downstream of the culvert, and once carp pass the culvert area, a second barrier will be installed in front of the culvert on the downstream side to effectively block carp in. This strategy can be reversed as fish attempt to leave North Lundsten and move upstream. Tracking of radio-tagged fish, in combination with analyzing historical tracking data from the U of M Assessment will guide the timing of trapping. There could be some costs for equipment and disposal of removed carp. DNR permits are required for the barriers and removal.

Management Progress

Management progress will be tracked and updated as removals and new population surveys occur. Population surveys will occur annually once removal begins on each waterbody until management goals are achieved.

Parley-Mud Management Unit

Management Goal:

Install barrier/fish-trap between Mud and Halsted Bay. Suppress carp recruitment in South Lundsten, Big SOB, Crown College Pond and Mud Lake, and reduce carp population in the management unit by at least 17,800 carp to achieve a carp biomass of less than 89 lbs/acre.

Parley-Mud Summary Table

Surface area (acres)	Total Carp Abundance
351	21,315

Individual Lakes Summary Table

Lake	Surface area (acres)	Avg. carp weight (lbs)	Carp Abundance	Carp biomass (lbs/acre)	Total carp abundance to equal 89 lbs/acre	# carp to be removed to achieve 89 lbs/acre
Parley	258	8.9	16,167	558	2,592	13,575
Mud	93	9.1	5,148	504	912	4,236
Total			**21,315**		**3,504**	**17,811**

Management Strategies

Carp removal in these lakes could involve a combination of winter seining, open-water seining, baited box-net trapping and trapping of migratory fish in stream channels. Removal in this management unit will be facilitated by the barrier/trapping system to be installed between Mud Lake and Halsted Bay. Carp in Mud Lake often move to Parley Lake by late fall, over-winter in Parley, and move back to Mud early spring. Management strategies will take advantage of that movement pattern, and focus on removing carp from this management unit when all carp are in Parley Lake during the winter. Carp also move frequently between Mud and Halsted Bay, and with the presence of a trapping system between these two lakes, additional removal could occur in this location.

Carp Movement Tracking

To aid in removal, 10 carp in each of the two lakes will be implanted with radio tags to track movement and inform timing of each management strategy. Radio-tagged carp will be tracked as needed to inform management.

Winter Seining/Open-Water Seining

Winter and/or open-water seining is expected to be one of the primary strategies for carp removal in Parley Lake. Carp from Mud Lake over-winter in Parley, making winter removal in Parley ideal for removing carp from the management unit. Two to three seine attempts per year could be attempted as needed. Winter and open-water seining provide the best opportunity to remove a larger number of carp all at once, but can have variable success.

Baited Box-Net Trapping

Baited box-net trap removals is another option during the open water season. This can be a labor intensive process, and typically can remove anywhere from 200 to 1,000 carp per removal. The substrate in Mud Lake is not conducive to box-netting, so all attempts would occur in Parley Lake.

Trapping carp Six-Mile Creek

The U of M Assessment found that 50% of carp in this management unit move annually through the channel between Mud and Halsted Bay. With the installation of barrier/trapping system in this channel, removal could occur throughout the open-water season.

Management Progress
Management progress will be tracked and updated as removals and new population surveys occur. Population surveys will occur annually once removals begin on Parley and Mud until management goals are achieved.

Carver Park Reserve Management Unit

Management Goal:
Suppress carp recruitment in Sunny Lake, and reduce carp population in the management unit by at least 4,400 carp to achieve a carp biomass of less than 89 lbs/acre.

Carver Park Reserve Lakes Summary Table

Surface area (acres)	Total Carp Abundance
532	10,247

Individual Lakes Summary Table

Lake	Surface area (acres)	Avg. carp weight (lbs)	Carp Abundance	Carp biomass (lbs/acre)	Total carp abundance to equal 89 lbs/acre	# carp to be removed to achieve 89 lbs/acre
Zumbra	221	6.6	5,953	178	2,984	2,969
Sunny	48	7.2	981	147	595	386
Steiger	166	8.0	2,886	139	1,851	1,035
Stone	97	10.5	427	46	821	0
Total			**10,247**		**6,251**	**4,390**

Management Strategies
Carp removal in the Carver Park Reserve Lakes could involve a combination of winter or open-water seining and baited box-net trapping.

Carp Movement Tracking
To aid in removal, 10 carp in Zumbra Lake will be implanted with radio tags to track movement and inform timing of management strategies. Each lake in this management unit is a somewhat contained population with limited to no movement between lakes. Because of management strategies planned for Sunny and Steiger, tracking fish in those lakes will not be critical. Radio-tagged carp will be tracked as needed to inform management.

Winter/Open-Water Seining
Seining is expected to be a strategy for carp removal in Zumbra Lake, and possibly Sunny Lake. It is expected that two to three seine attempts per year could be attempted as needed. Seining provides the best opportunity to remove a larger number of carp all at once, but can have variable success.

Baited Box-Net Trapping

Baited box-net trapping is an option for Zumbra, Steiger and Sunny Lakes. Removals will be scheduled as needed during the open water season. This can be a labor intensive process, and typically can remove anywhere from 200 to 1,000 carp per removal.

Management Progress

Management progress will be tracked and updated as removals and new population surveys occur. Population surveys are tentatively scheduled to occur annually once removal begins on each waterbody until management goals are achieved.

Halsted Bay Management Unit

Management Goal:

Install barrier/trapping system between Mud Lake and Halsted Bay, and reduce carp population in Halsted Bay by at least 59,350 to achieve a carp biomass of less than 89 lbs/acre. Future management will be needed to address carp immigrating and emigrating from the rest of Lake Minnetonka via the channel between Priests Bay and Hasted Bay.

Halsteds Bay Summary Table

Lake	Surface area (acres)	Avg. carp weight (lbs)	Carp Abundance	Carp biomass (lbs/acre)	Total carp abundance to equal 89 lbs/acre	# carp to be removed to achieve 89 lbs/acre
Halsteds Bay	552	9.65	64,441	1128	5,091	59,350

Management Strategies

Management strategies for Halsteds Bay will be complex, and may need to involve removal in other areas of Lake Minnetonka to reach management goals. A barrier/trapping system will be installed between Mud Lake and Halsted Bay, which will aid in containing the population to Halsted Bay and Lake Minnetonka, and also be a primary removal tool. The U of M assessment observed Six Mile Creek between Mud Lake and Halsted Bay to be a frequent migratory route for carp. Almost 50% of carp in this bay pass through this channel annually. Both open water seining and winter seining will also be management strategies for this lake. Baited box-net trapping could also be successful in this lake, but will not be used until a significant number of carp have already been removed through seining and trapping

Barrier & Trapping System in Six Mile Creek between Mud Lake and Halsted Bay

This system is described in Objective 2 of this carp management plan. The U of M assessment found that almost 50% of carp in Halsted Bay use this passageway to reach Mud Lake and Parley Lake. By cutting that passageway off with a barrier/trapping system, it not only contains the population in this management unit to Halsted Bay and greater Lake Minnetonka, but it also acts as primary carp removal tool by removing carp on an ongoing basis as carp pass through the trap.

Carp Movement Tracking

To aid in removal, 15 carp in the lake will be implanted with radio tags to track movement and inform timing of each management strategy. Radio-tagged carp will be tracked as needed to inform management. A portion of the carp population in Halsted Bay are known to go out into greater Lake Minnetonka, so it is expected that tracking will need to occur in other areas of the lake as well.

Winter Seining/Open-Water Seining

Winter and open water seining are expected to be a main strategy to remove carp in Halsted Bay. Two open water seining attempts could occur annually, as well as up to three winter seining attempts, all as needed. Seining provides the best opportunity to remove a larger number of carp all at once, but can have variable success. As more carp are removed from the lake, the costs to get commercial fisherman to seine the lake becomes greater.

Baited Box-Net Trapping

Baited box-net trapping is an option for Halsted Bay as numbers are reduced. Its unlikely box-nets will be required in the first three years of management due to the large number of carp in this bay, seining will be a more cost-effective solution to begin with.

Assessing Carp in greater Lake Minnetonka

Assessing carp in greater Lake Minnetonka is not directly part of the initial carp management plan for Halsted Bay, however, as carp biomass is removed from the lake, it may become necessary to start addressing carp in other bays of Lake Minnetonka, and other connected subwatersheds. For instance, during the U of M assessment, carp tagged in Halsted Bay have been observed moving into nearby Priests Bay and Cooks Bay, and even as far as Jennings Bay. Jennings Bay is connected to both the Dutch Lake Subwatershed and Painters Creek Subwatershed, both of which carp are suspected of being an issue. Addressing carp in those subwatersheds and Jennings Bay would likely provide positive benefits in achieving management goals in Halsted Bay.

Management Progress

Management progress will be tracked and updated as removals and new population surveys occur. Population surveys will occur annually once removal occurs on Halsted Bay until management goals are achieved.

Additional Information

Equipment & Operational Needs

One-time costs for equipment will include the purchase of trap-nets, electrofishing boat, box-net, backpack electrofisher and supplies in year one of management. The District already owns telemetry equipment to track carp. The District will use trap-nets to monitor potential carp recruitment areas. If carp recruitment occurs, a rapid response would need to occur to control the new juvenile carp produced. An electrofishing boat will be used to provide updated carp population surveys that will track management progress, as well as monitor populations long-term. Box-net traps will be baited with corn, and used to trap and remove carp. Backpack electrofisher will be used to stun carp trapped in stream channels to aid in removal. Operational needs include supplies and other materials needed for repair and maintenance of equipment and barriers, operating costs of running aeration units, as well as permit fees for winter aeration and thin ice signage as required by the MN DNR. Funds may also be used for clearing submerged debris in lakes that interfere with the success of seining and other management strategies, and equipment rental to aid in removal of carp in stream channels.

Contingency

If an aeration system fails, or barriers are compromised, carp recruitment could occur. If recruitment occurs, a rapid response would need to occur to control the new juvenile carp population. Rapid response could include strategies such as drawdowns, fish poisonings, trapping fish in migratory streams or removal as adults once they move into other waterbodies. Different scenarios need to be developed.

Monitoring Plan

Monitoring will be necessary to inform management, track progress on achieving management goals, and assessing ecological changes as removal occurs.

Monitoring to Inform Management

Monitoring activities that inform management and track progress on achieving management goals include performing updated carp population surveys, monitoring for carp recruitment, and tracking radio-tagged fish to inform management. Monitoring for carp recruitment includes performing winter dissolved oxygen monitoring and trap-net surveys in suspected carp nurseries. Updated carp population estimates requires the completion of electrofishing surveys. Tracking radio-tagged carp involves the use of telemetry gear, and implanting radio tags in a subset of carp. A description of those activities is described further in this section.

Updated Carp Population Surveys

Carp population surveys will be conducted annually as carp removal occurs on lakes by performing electrofishing surveys on all accessible waterbodies to monitor management progress. Surveys will occur late summer/early fall, following protocol developed by the University of Minnesota. Three surveys will be conducted on each lake. Once management goals are met in each waterbody, the frequency of updated surveys could be decreased to once every five years.

List of lakes to receive population surveys as removal occurs

Piersons-Marsh-Wassermann	Auburn-Lundsten-Turbid	Parley-Mud	Carver Park Reserve Lakes	Halsted Bay
Wassermann	East Auburn	Parley	Zumbra	Halsted Bay
Piersons	West Auburn	Mud	Steiger	
	North Lundsten*		Sunny*	
	South Lundsten*			
	Turbid			

**Accessibility may be an issue for these lakes*

Winter Dissolved Oxygen Monitoring

Winter dissolved oxygen is monitored to assess the potential for winterkill of bluegill sunfish. Winterkill could result in optimum conditions for carp recruitment. Winter dissolved oxygen readings below 5 mg/L at the surface will prompt installation of aeration units. If winterkill is suspected, spring trap-net surveys may also be conducted to determine status of the sunfish community.

List of lakes to receive annual winter dissolved oxygen monitoring

Lake	Frequency
Marsh	2 to 3 times per winter
North Lundsten	
South Lundsten	
Sunny	
Mud	
Turbid	
Carl Krey	

Spring Trap-Net Surveys

Trap-Net surveys are used to sample young-of-year carp, as well as panfish like bluegill sunfish. Spring trap-net surveys will be performed on potential carp nursery lakes if the threat of winterkill is possible. If a winterkill occurred, rapid response planning will begin to address possible juvenile carp in the system. An early fall survey can confirm if carp recruitment actually occurred, and the rapid response can then be implemented.

Potential Spring Trap-Net Lakes	
Marsh	Sunny
North Lundsten	Mud
South Lundsten	Turbid
Carl Krey	

Fall Trap-Net Surveys

Trap-Net surveys are a way to sample young-of-year carp, as well as panfish like bluegill sunfish. Fall is the optimum time to sample for juvenile carp, as they would be large enough by this time to be trapped in the nets. These surveys will occur annually on the lakes below, and confirm if carp recruitment occurred.

List of lakes that will receive annual fall trap-net surveys

Fall Trap-Net Survey Lakes	
Marsh	Sunny
North Lundsten	Mud
South Lundsten	Turbid
Carl Krey*	

**If accessible*

Carp Tracking

Radio-tagged carp will be tracked as needed to inform management strategies such as seining or stream trapping.

Monitoring to Assess Ecological Changes

Carp are known to exacerbate internal phosphorus loading, reduce water clarity and uproot aquatic vegetation. Metrics for assessing changes in water quality and ecological conditions will include the following: in-lake monitoring of total phosphorus, chlorophyll-a, water clarity, total suspended solids and aquatic plant community metrics.

Monitoring Activities

A detailed description of the monitoring activities is described in this section. These monitoring activities will be conducted on each lake to assess ecological changes as carp are managed in the system.

Aquatic Plant Surveys

Updated aquatic plant surveys will be performed on each waterbody as carp removal occurs, as well as annually for at least 3 years once carp management goals are met. Surveys will follow standard point-intercept protocol established by the Minnesota Department of Natural Resources (MN DNR), and may occur in both early summer and late summer. Early summer surveys capture early season plant growth, including the invasive Curlyleaf Pondweed. Late summer plant surveys capture native vegetation when it should be at its peak biomass, as well provides a better representation of invasive Eurasian Watermilfoil. During all surveys, acoustic mapping may occur that will provide further metrics to evaluate the changes in the aquatic plant community. Metrics that will tracked from aquatic plant surveys include: Floristic Quality Index (FQI), percent occurrence of each species, maximum depth of plant growth, percent area of the lake vegetated, and average aquatic vegetation biovolume.

List of lakes receiving updated aquatic plant surveys

Halsted Bay	Steiger
Marsh	Sunny
Wassermann	North Lundsten
East Auburn	South Lundsten
West Auburn	Parley
Turbid	Mud
Zumbra	

Water Quality Monitoring

Water quality monitoring will occur annually during removal, and for least 3-years once carp management goals are met. Ongoing water quality monitoring needs will be reassessed after that 3-year post carp management time period.

Water quality monitoring will provide data to assess changes in nutrients, algal abundance and water clarity. Parameters being analyzed will include Total Phosphorus, Chlorophyll-a, Total Suspended Solids and Water Clarity. Sampling will occur monthly May – September in deep lakes, and twice per month May – September in shallow lakes.

List of lakes receiving water quality monitoring (TP, Chl-a, TSS, Clarity) once per month May – September

East Auburn	Zumbra
West Auburn	Steiger
Turbid	Sunny

List of lakes receiving water quality monitoring (TP, Chl-a, TSS, Clarity) twice/month May – September

North Lundsten	Mud
South Lundsten	Halsted Bay
Wassermann	Parley

Other Monitoring

Additional monitoring will occur in several waterbodies that are receiving annual aeration. Aeration in shallow lakes has the potential to impact sediment resuspension and sediment release of phosphorus. Grab samples will be collected to monitor for any water quality impacts from aeration. Samples will be taken three times during the winter while aeration is occurring; once before the aeration unit is turned on (November), once while in operation (Jan./Feb.), and once after the unit is shutdown at ice-off (March/April). Samples will be analyzed for Total Phosphorus and Total Suspended Solids. Monitoring will occur for three years to assess if aeration is having any detrimental effects on water quality.

Aeration lakes to receive water quality monitoring	
Marsh	Sunny
North Lundsten	Mud
South Lundsten	Turbid

Reporting

Annual reports will be generated to update progress on achieving management goals in each waterbody and management units, as well as provide any new updates to the management plan, as it is an adaptive process.