INTEGRATED PEST MANAGEMENT PLAN (IPM) FOR COMMON CARP

5/4/2017

Prior Lake-Spring Lake Watershed District

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PART 1 - INTRODUCTION

Common carp (*Cyprinus carpio*), a non-native fish originating in Eurasia, and are widely distributed in Minnesota. Carp can have direct and indirect negative effects on water quality by uprooting submergent and emergent aquatic vegetation which is habitat for macroinvertebrates and fish, and releasing phosphorous sequestered in lake sediments; making it available to free floating algae and leading to increases in Chlorophyll-a concentrations and decreases in water clarity. Multiple studies have documented the carps' ability to bioengineer the aquatic environment they inhabit.

While an overabundance of carp can lead to negative effects on water quality, in most cases they constitute one of multiple pollutant sources to a specific waterbody. Additionally, common carp populations can be perceived as high through casual observations of surface activity as well as spawning aggregations. Similarly, TMDL internal load allocations may be assigned to rough fish without definitive knowledge of those rough fish populations within a specific waterbody.

Minnesota Pollution Control Agency (MPCA) data shows that the 10 year summer sample average (2006-2015) for total phosphorous is 88 parts per billion (ppb) which exceeds the 60 ppb site specific standard. Upper Prior Lake currently exceeds it state standard of 60 ppb as MPCA data shows that the total phosphorous concentration for the same time period is 65 ppb. Lower Prior Lake exhibits good water quality (23 ppb, 2006-2015 summer average) and meets MN state standards.

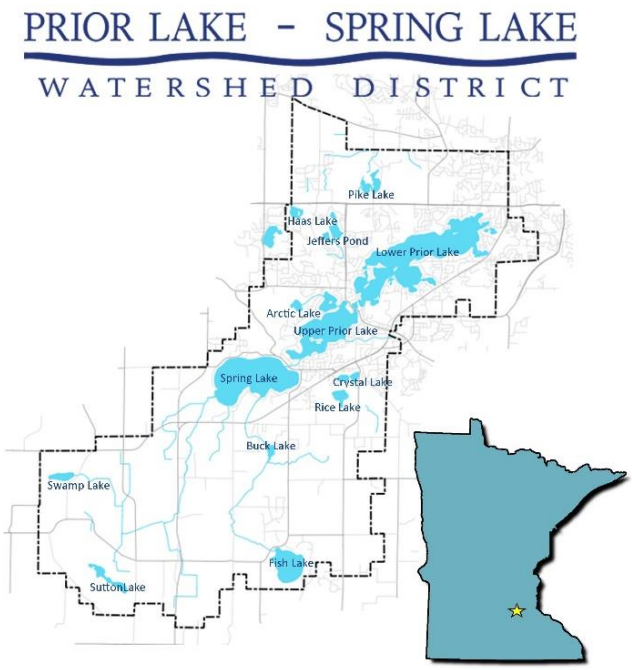
The 2011 Spring lake-Upper Prior Lake TMDL concluded that 49% of the Spring Lake phosphorus load can be attributed to internal loading through a combination of rough fish, curly leaf pondweed senescence, and anoxic sediment release. The same TMDL identified internal lading contributed to 50% of the total phosphorous load to Upper Prior Lake, and 38% of the total load was coming from Spring Lake.

As part of the TMDL implementation plan to improve water quality in Spring and Upper Prior Lakes and protect the water quality of Lower Prior Lake, the Prior Lake-Spring lake Watershed District began implementation of a common carp management program.

This plan is intended to be a living document; using adaptive management that may develop new management strategies and plan goals through data collection and analysis. As new data is collected and analyzed, current approaches, data collection efforts, and prioritization may change.

PART 2 - WATERSHED DESCRIPTION AND ASSOCIATED WATERBODIES

Prior Lake Spring Lake Watershed District (PLSLWD) is located in Scott County, MN and covers roughly 42 square miles of land area and over 2,500 acres of open water (Figure x). Spring Lake, Upper Prior Lake and Lower Prior Lakes are the largest waterbodies within the district and provide boating, fishing and other recreational opportunities. Since 1970, the PLSLWD has strived to conserve, protect, and manage the water



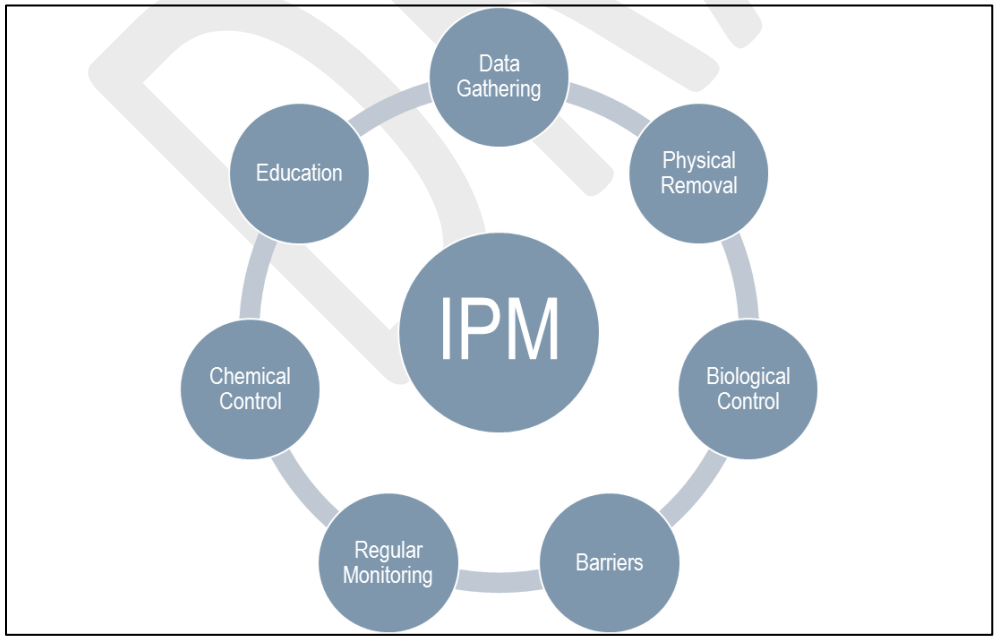
resources within the district and have taken steps to improve water quality by implementing a carp management program with WSB and Associates in 2015 with support from the Minnesota Pollution Control Agency.

The carp management program is currently focused on the three large lakes listed above, however, this proposed management plan addresses the possibility of the carp population utilizing several of the lakes and ponds within the watershed. In an interconnected system such as the PLSLWD, it is important to consider what effect these nearby waterbodies have on the overall health of the watershed to fully address the issue. Spring and Upper Prior lakes are listed on the MPCA's impaired waters list due to excess nutrients which can limit recreational opportunities as well as waterfowl habitat, native aquatic vegetation abundance, and native game fish populations, this proposed integrated carp management plan aims to mitigate the effect that common carp are having on the water quality.

PART 3 - MANAGEMENT PRIORITIES

For many years management agencies and other entities attempted to manage and mitigate carp populations simply through removal of biomass. This management method proved to be ineffective as mangers did not or were not able to quantify the extent of the invasion and carp recolonized waterbodies since a holistic and long term approach was not implemented. This approach was abandoned in the late 1900s.

In the mid-2000s the University of Minnesota Aquatic Invasive Species Research Center (MAISRC) instituted research to develop a sustainable approach to effectively mitigating and controlling common carp by studying movement, recruitment, and behavior patterns of carp. Some of these ideas had been successfully implemented by fish managers in Australia whose ultimate goals we eradication of carp.



This research showed that by addressing different life stages and developing an understanding of the entire system or watershed, the hope of sustainable carp control was possible.

Basic biological concepts can be applied to carp management parallel to

controlling other invasive and terrestrial and aquatic invasive species. The diagram above illustrates considerations to be made in the development of a carp IPM. Carp IPM should be specific to the system in which it is to be applied and some methods may not be applicable to all systems.

Existing qualitative and quantitative data show that applying data collection, physical removal, biological control, barrier technology, followed by regular monitoring and education to the Prior Lake Spring Lake Watershed may result in achieving successful management of carp to mitigate their deleterious effects on the system.

3.1 Data Collection

Before implementation of management activities such as removal and barrier technology, the extent of the problem needs to be addressed. This can be defined as:

1.) How many carp are in the system (abundance), and
2.) How do carp use the system (spawning, feeding, overwintering)?

PRIORITY 3.1.1: CARP ABUNDANCE

Goal 3.1.1a- *Establish baseline abundance estimates for each of the waterbodies in the PLSLWD*

The abundance of carp, for this plan, is defined as the number of individuals and the amount of biomass. To determine the abundance of carp within the system and ultimately how many would have to be removed, we employed two methods; a mark recapture population estimate and an electrofishing catch per unit effort model.

A previous attempt had been made to complete a mark recapture population estimate for Spring Lake in 2012. In winter 2012 the District marked 1,752 adult carp by inserting floy tags in the dorsal area. The carp were captured using a commercial fishing crew that deployed a seine net. The carp were captured weighed, measured for length, tagged, and released. An attempt was made to recapture the carp in 2013, but was unsuccessful.

In 2014, St. Marys University electrofished Spring and Arctic Lakes to develop a CPUE model of carp abundance. The study showed that Spring Lake supported 343.5 kg/ha (68.7 carp/ha) carp biomass and Arctic supported 264.5 kg/ha (52.91 carp/ha) carp biomass. Biomass estimates are based on a 5 kg average weight. These densities are well above the ecologically damaging threshold of 100 kg/ha identified in published studies.

As part of a three year project started in 2015, WSB & Associates collaborated with the District to quantify the abundance of carp in Spring Lake and Upper and Lower Prior Lakes. A total of 52 carp were marked with a right pelvic fin clip between November 2015 and October 2016 using seine, electrofishing, and gill nets. Carp were netted and inspected for marks in January 2017 as part of a recapture and removal event. Of the 2,577 carp captured, 36 were marked. We calculated a pre-removal population of 3,623 (± 1,167) individual carp in Spring Lake. Using a 5.6 kg average, Spring Lake carp biomass was calculated at 84.9 (±27.3) kg/ha, close to the ecological threshold value of 100 kg/ha.

Electrofishing CPUE data from 2016 resulted in an estimate of 5,229 (± 4,503) individual carp or 122.5 kg/ha carp biomass. We relied on the mark recapture estimate since the confidence interval was much smaller and thus considered to be more reliable.

A number of carp were marked with a right pelvic and pectoral fin clip, radio tags, and passive integrated transponder (PIT) tags in 2015 and 2016. A successful recapture event was not completed to date, so no mark recapture estimate is available for Upper and Lower Prior Lakes. However, in fall 2016 two (2) electrofishing CPUE estimates were completed for Upper and Lower Prior Lakes. The electrofishing CPUE estate for Upper Prior is 342.45 kg/ha carp biomass and the same estimate for Lower Prior is 9.72 kg/ha carp biomass.

Action Item 3.1.1- Develop abundance estimates for the remaining lakes in Prior Lake Spring Lake Watershed (Buck, Cates, Crystal, Fish, Haas, Jeffers Pond, Pike, Rice, Sutton, and Swamp)

No abundance data for carp abundance exists for the lakes identified above. This prevents district staff from understanding the potential impact of carp on the water quality and ecological integrity of these waterbodies.

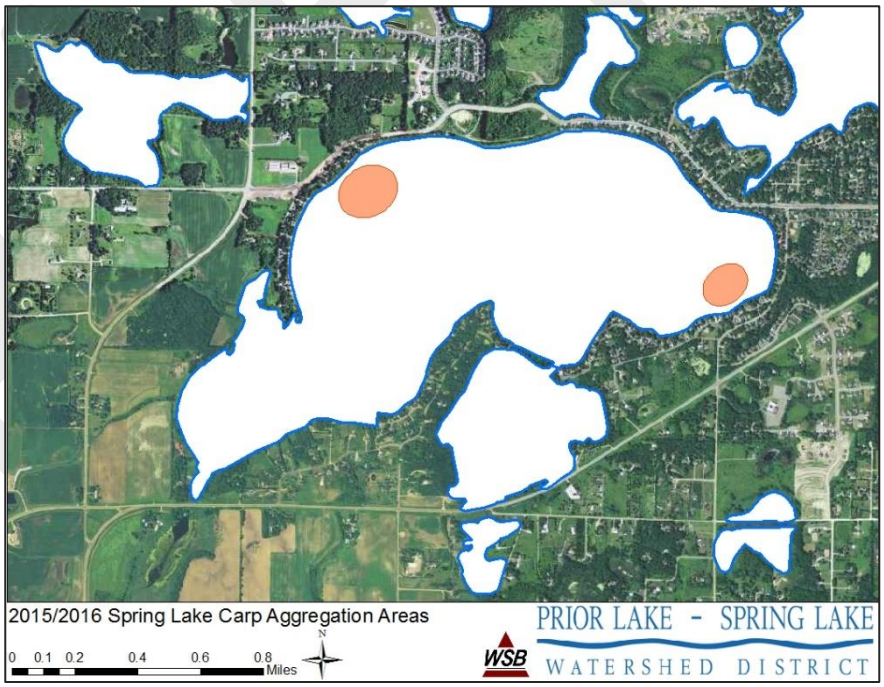
Goal 3.1.1b- *Track changes in carp abundance on managed lakes*

As the district implements carp management activities (removal, barriers, etc.), it will be important to monitor changes in carp abundance on these lakes to determine if these efforts are successful in suppression of carp population post management.

Action Item 3.1.2- While some carp biomass removal had been completed previously on Spring Lake, the District began a focused effort on carp biomass removal, as part of this long-term plan, in 2017. Therefore an effort to track changes in the Spring Lake carp population should start as soon as 2018 and be implemented as additional biomass removal activities are completed for each lake identified in the plan.

PRIORITY 3.1.2: CARP SPATIAL USAGE

Determining how carp use the system is critical to the development of the carp IPM. Understanding movement patterns will allow District staff to identify potential nursery sites, migration routes, and wintering areas where carp may be vulnerable to large scale biomass removal.



To track movement the District has deployed several high frequency radio tags (Judas fish) and PIT tags and installed three (3) PIT tag monitoring stations. District and WSB staff are actively tracking radio tags using a 3-element Yagi antennae. Survey frequency is greatest during the spring spawning period (once/week) and during the winter aggregation period when ice conditions are safe enough for foot travel (once/week). The remainder of the year radio telemetry surveys are completed on an infrequent and irregular basis.

Goal 3.1.2a- *Identify winter carp aggregations on Spring Lake and Upper and Lower Prior Lakes*

The identification of carp wintering areas on Spring Lake and Upper and Prior Lakes was determined to be a key step in sustainably managing carp populations within the system. Ten (10) carp were surgically implanted with high frequency radio tags between fall 2015 and spring 2016 in Spring Lake and 16 carp were surgically implanted with high frequency radio tags during the same time period in Upper Prior Lake.

Radio tagged carp have been continuously monitored since 2015 to identify winter carp aggregation areas for carp biomass removal. Two (2) distinct sites were identified during the winter of 2015/2016 and one was

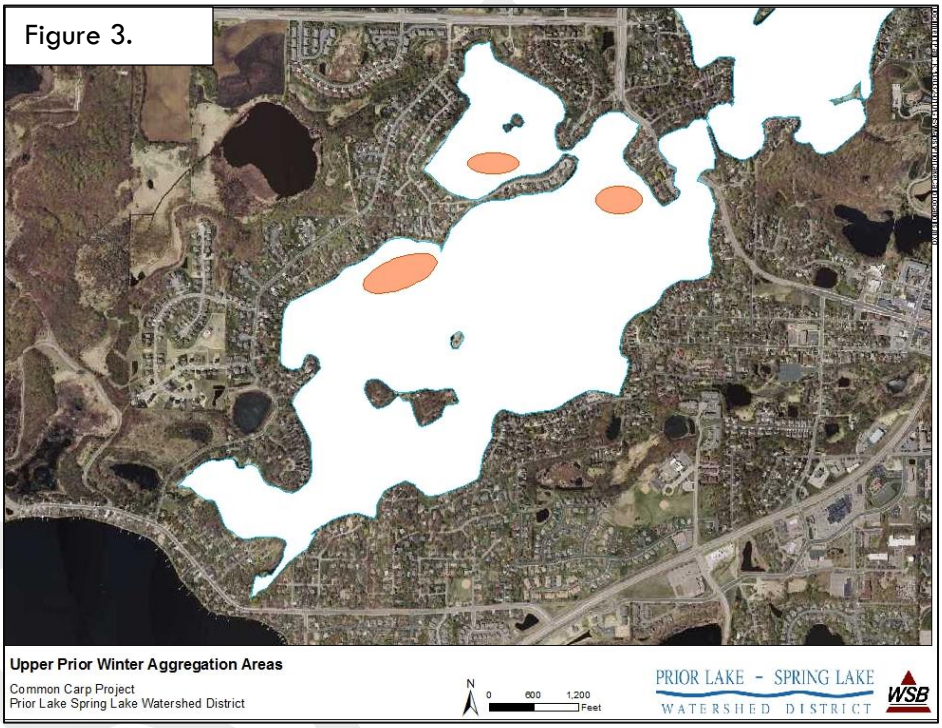
identified during the 2016/2017 winter on Spring Lake. The 2015/2016 surveys showed that carp primarily aggregated in the northwest and eastern portion of Spring Lake.

Carp were not radio tagged in Upper Prior Lake until January 2016, so only one full winter of telemetry data is available to identify winter aggregation areas on Upper Prior Lake.

During the winter of 2016/2017 one aggregation area was identified in the north central portion of the lake (Figure 3.)

Carp were well aggregated in the easternmost site early in the winter of 2016/2017. Commercial fishing crews attempted to prepare a removal area in mid-January 2017. The aggregated carp reacted to the activity and moved to aggregation areas identified in Mud Bay and the eastern side of the lake; however radio tag density was not as equal to what was observed in the original aggregation.

Figure 3.



Telemetry surveys show that carp did not overwinter in Lower Prior Lake.

Action Item 3.1.3 Continued monitoring of radio tagged carp in Spring and Prior Lakes to confirm identified aggregation sites will be necessary.

Goal 3.1.2b- *Map migration routes and identify connected nursery sites*

Nursery sites and the migration routes that carp exploit to access them are the support mechanism for carp recruitment in those systems where carp spawn outside the main basins. Carp seek these sits out since they are typically devoid of predator fish species like bluegill.

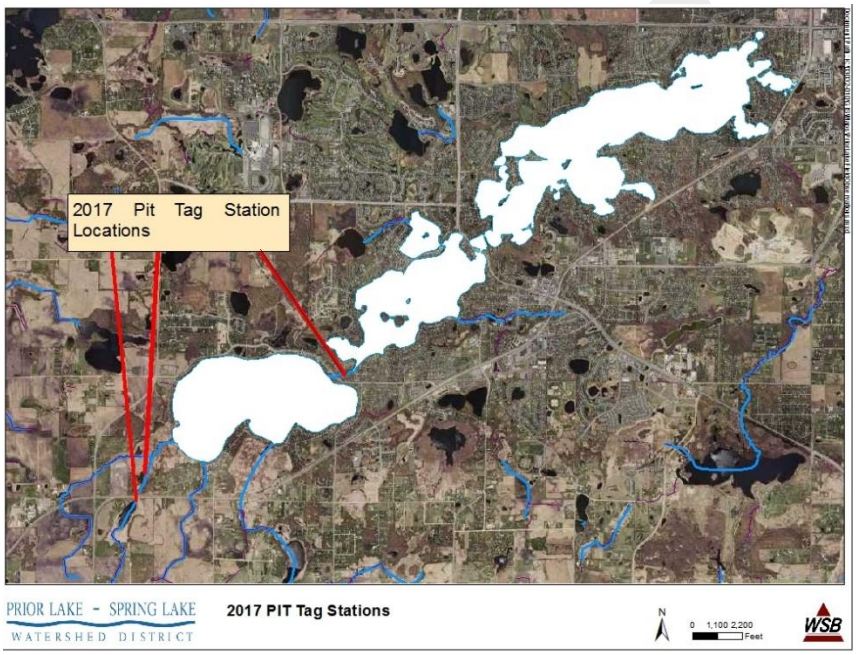
Like the Judas fish technique used to find carp winter aggregations, the District has deployed radio tags to document carp movement out of the Spring and Prior main basins. Several apparent surface connections exist on Spring and Upper and Lower Prior Lakes. Anecdotal information suggested that carp were using a connection from Mud Bay in Upper Prior to gain access to Arctic Lake. The observation of many young of year carp during the 2014 electrofishing survey may support the idea that Arctic was in fact a nursery for Upper Prior.

A barrier was installed on this connecting channel before the first spawning run after radio tags had been deployed in Upper Prior, so use of this route was not documented.

The first spawning run after tag deployment in Spring revealed that carp were traveling upstream from Spring Lake using County Ditch 13, and spawning in the desiltation pond 0.4 miles upstream of the lake. Movement above the desiltation pond and the ferric chloride site was not documented.

Observations by landowners adjacent to the connecting channel between Spring and Upper Prior, suggest that carp are also moving between these basins. To increase the frequency of data collection, a PIT tag station was installed on the connecting channel between the two lakes. Roughly 150 carp were PIT tagged on Upper Prior in December 2016 and another 150 will be PIT tagged on Spring in May 2017. Additional PIT tag stations will be installed at the outlet of the desiltation pond and on County Ditch 13 just below the ferric chloride site. Theses station will be deployed at these locations throughout the 2017 growing season.

Since the PIT tags do not require an internal power source, but rather are charged by the reader as they pass by the antennae, these tags will remain operational for decades. The District may then deploy the PIT tag stations throughout the watershed in subsequent years to aid in understanding fish movement on other hydrologic connections.



Action Item 3.1.4 While the District has collected spatial data on carp within Spring Lake, Upper and Lower Prior, and a few connected waterbodies, there are several other waterbodies within the watershed that are known to support carp populations. To holistically manage the carp population within the entire watershed and reduce the potential impact of carp on the Spring and Prior Lake basins, the District may deploy additional radio tags or PIT tags throughout the system and continue to monitor the movement associated with each of the carp populations to support the use of additional carp IPM strategies.

3.2 Physical Removal

Quantifying the carp population in terms of biomass density and number of individual carp, provides a basis for determining the level of removal necessary to achieve water quality and ecological restoration goals. As described in section 3.1, previous studies demonstrate that carp biomass densities of 100 kg/ha are ecologically damaging. Using this threshold, carp should be managed well below 100 kg/ha. A density of 30 kg/ha may be appropriate. BY managing at a lower level, even if the adult age classes can spawn successfully, early detection of this recruitment event may provide managers an opportunity to address the increase in biomass by proactively removing biomass before it negatively effects water quality.

Multiple methods may be employed to physically remove carp biomass. These may include electrofishing, gill netting, trap netting, box nets, fish traps, and to a lesser extent bowfishing. Seine netting may be the most effective and efficient method for removal if the lake is free of obstructions on the bottom, the lake contours are not too steep, and substrates are not too flocculent.

***Goal 3.2.1a**- Reduce and sustainably manage carp biomass*

The goal is to reduce carp biomass to and sustainably manage carp biomass at 30 kg/ha in lakes within the Prior Lake Spring Lake Watershed District

After developing the abundance estimate for Spring Lake using the electrofishing CPUE, the District commissioned the removal of carp biomass in the winter of 2016/2017. Commercial fishing crews were guided to the carp winter aggregation on Spring Lake using the Judas fish technique described in section 3.1.3. These crews were able to remove 2,577 individual carp or 31,800 pounds of carp. This represented roughly 71% of the Spring Lake carp population. The residual biomass in Spring Lake is 24.5 kg/ha, below the 30 kg/ha goal.

In December 2016, roughly 3,200 pounds of carp biomass removed from Upper Prior after a test seining. This is a small portion of the total biomass of carp in Upper Prior. Additional biomass was not removed from Upper Prior to date since carp have not aggregated in an area that is clear of obstructions for a long enough period for netting operations to commence. Carp did aggregate in the westernmost aggregation identified in Figure 4 for short period of time in the winter of 2017, but moved out of the area while commercial fishing crews were setting up to net and did not return. Large aggregations were not observed the rest of the winter.

Carp biomass on Lower Prior appears to be low. While carp can move freely between the two basins, radio telemetry suggest that carp do not move into Lower Prior often and stay near the western end when they do. In addition, electrofishing CPUE estimates are low for Lower Prior. Two electrofishing surveys completed in fall 2016, resulted in total catches of 2 and 0 individual carp for each survey. Based on these numbers, we estimate the carp biomass on Lower Prior is 9.7 kg/ha, well below the 30 kg/ha goal.

Anecdotal information suggests that carp biomass densities are elevated in Jeffers Pond, Arctic Lake, and Pike Lake. Implementation of goal 3.1.1a and 3.1.1b will provide an opportunity to quantify and locate these carp populations to achieve goal 3.2.1a.

Action Item 3.2.1 Continue carp biomass removal on Upper Prior Lake and remove carp biomass on other waterbodies if abundance estimates show that carp biomass is elevated.

***Goal 3.2.1b-** Develop alternative and/or innovative methodologies/techniques to remove carp*

Develop alternative or innovative methodologies/techniques to improve or facilitate removal of carp biomass on waterbodies where carp may not aggregate, where obstructions prevent traditional removal operations, or where telemetry/PIT tag data suggest carp may be vulnerable

In many instances carp may become aggregated, but cannot be removed in the aggregation area due to obstructions on the bottom or along the shoreline. By developing alternative removal methodology, the District will be able to expedite carp biomass removal and in some instances, make removal possible. By developing these techniques, the District may be able to assist other water resource management entities in addressing carp management; especially in areas where traditional methods are difficult to employ.

Action Item 3.2.2 Work collaboratively with researchers, agency staff, practitioners, and commercial fishing crews to develop alternative methodology.

3.3 Biological Control

Research completed by the MAISRC showed that bluegill sunfish are the main predator of carp by preying on the eggs and larvae of carp young of year. Carp actively seek out nursery sites that are devoid of these predator fish or proliferate in lakes where bluegill abundance is low. A robust panfish and gamefish population may act as biological control and compliments the other IPM strategies. Theses predator fish are necessary to prevent carp

recruitment after a significant portion of the carp biomass has been removed or to keep carp from establishing in lakes.

Larger gamefish may also prey upon carp young of the year, but that relationship is not as well documented. Also, carp growth rates are quite accelerated compared to other fish species. By the second growing season (age 1) carp may be > 12 inches, reducing the likelihood that piscivores will be able to prey upon them.

Goal 3.3.1a- *Manage lakes to support robust gamefish/panfish populations*

The goal is to manage lakes within the Prior Lake Spring Lake Watershed to support a robust gamefish and/or panfish population to effectively control carp as part of the IPM

MN DNR fisheries data is available for both Upper and Lower Prior Lakes, Spring Lake, Cates, Crystal, and Fish Lakes and two (2) studies have been completed on Arctic Lake. The remaining lakes in the watershed have not been assessed. Existing data for these lakes show a variety of fish assemblages and abundances.

Action Item 3.3.1 Analyze existing fisheries data to identify trends and determine typical fishery conditions

An analysis of all existing fisheries data will provide insights into each of the fisheries where such data is available, identify data gaps, and determine if the fishery is functioning to biologically control carp where necessary. Habitat improvements and other restorative efforts may be identified through this effort as well as waterbodies that may need additional survey work where minimal data is available.

Action Item 3.3.1 Complete baseline fisheries assessment for waterbodies that do not have existing fishery data within the Prior Lake Spring Lake Watershed to determine the status of the fishery

Several lakes listed in section 3.1.1 do not have fishery data available. These lakes may be functioning as carp nurseries, gamefish nurseries, or providing some other benefit to the system. To fully develop the biological control component and reduce or eliminate carp recruitment, a thorough understanding of how all the waterbodies within the watershed act as a system, will be necessary.

Baseline fishery assessment may be completed using a variety of methodologies including electrofishing and netting. Data collected during these assessments can be compared to existing fisheries data from action item 3.3.1 to prioritize where potential improvements could be made or wat areas should be protected.

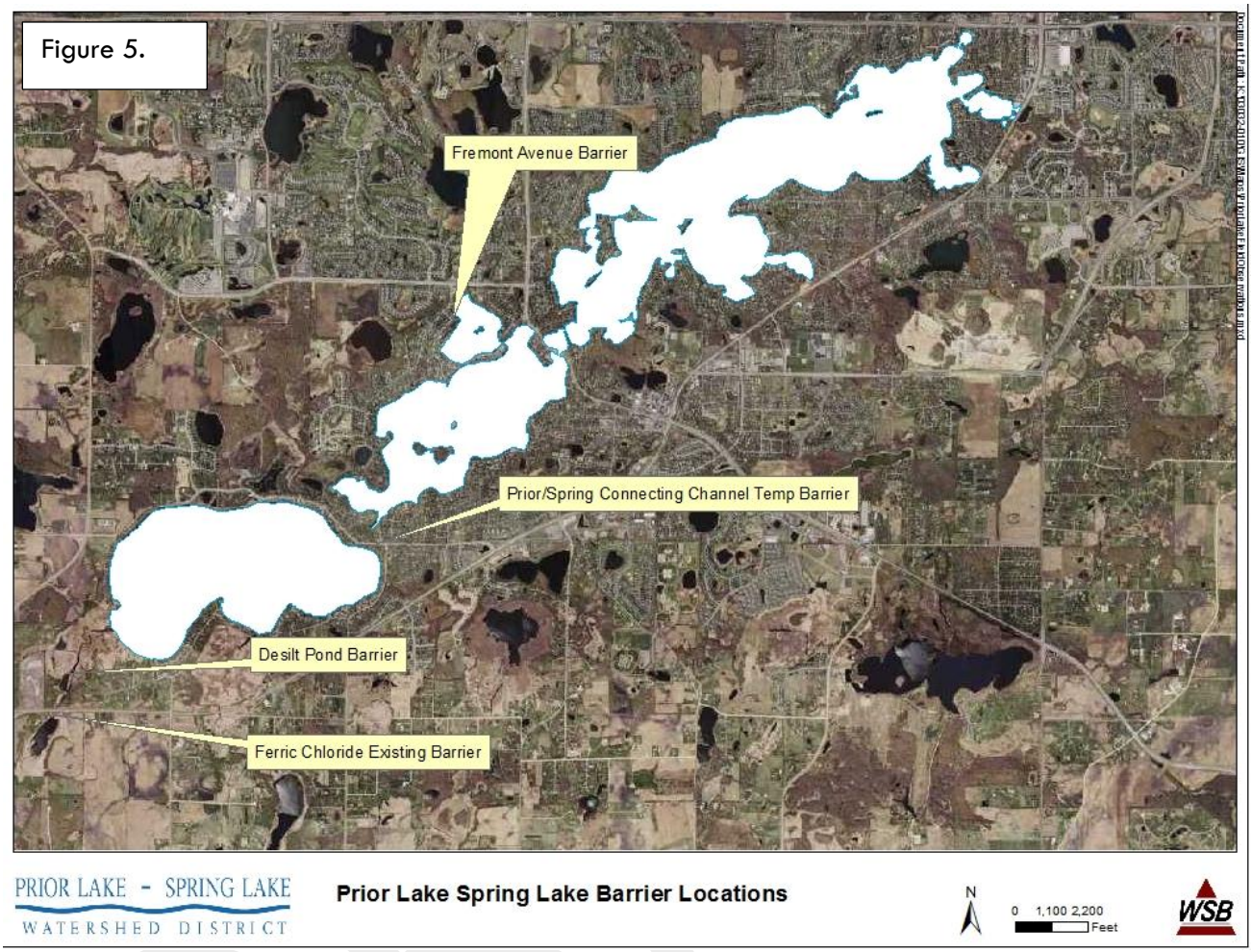
3.4 Barriers

Barriers may be an incredibly effective component of a carp IPM. Barriers may be employed to protect sensitive areas from the destructive foraging behavior of carp or prevent carp from exploiting migration routes to disrupt recruitment. Barrier placement should be balanced with the potential need for fish passage with respect to native gamefish. Placement of barriers is supported by the implementation of movement monitoring as described in section 3.1.2.

Goal 3.4.1 *– Install barriers within identified carp migration routes*

The goal is to install barriers within carp migration routes documented using PIT or radio tag technology or identified through fishery assessments

Currently two (2) barriers have been installed with the system to prevent carp migration to suspected nursery sites. The locations of these sites are shown in Figure 5 along with two (2) additional sites where barrier will be modified or installed.



The Fremont Avenue barrier was installed in spring 2016 at the inlet to Mud Bay from Arctic Lake to prevent carp movement between the two waterbodies. The barrier modified an existing culvert outfall by adding a series of moveable grates angled towards the downstream end of the culvert.

The barrier at the outlet of the desilt pond as installed in May of 2017. It is composed of a large drum wheel (16" diameter) that rotates with the flow of water. The drum is supported by a helical on each bank of the outlet and was installed to prevent carp from accessing the desilt pond as radio tags were documented in it in 2016.

Figure 7

Action item 3.4.1- Install temporary PVC barrier at connecting channel and repair ferric chloride weir structure

A temporary PVC barrier is planned to be installed in the connecting channel between Upper prior and Spring Lake to prevent carp movement between the two basins. While no radio tags have mixed between the two populations, anecdotal information suggests that carp have historically used this channel. A PIT tag monitoring station has been installed in this location to monitor for carp movement and determine barrier efficacy. The figure below provides an example of what this barrier will look like.

Figure 8

The final site that has been identified for a barrier is the existing ferric chloride injection site. The current structure is a weir wall with a cat walk above the top of weir to cross the stream, a series of rebar rods to act as trash racks, and a gate valve at the bottom of the weir wall. The rebar trash rack is in disrepair and is not capable of obstructing fish movement if the downstream water elevation is in equilibrium with the upstream water level.

Radio tags have not been documented in the waterbody above the weir, but anecdotal information suggests that carp have been observed splashing in the shallow water areas in the spring.

The structure should be modified to function as a barrier. Modification should focus on removal and replacement of the rebar fingers below the catwalk with panels or other structures that will provide for the flow of water over the weir wall, but restrict fish movement.

Figure 9

Action Item 3.4.2- Assess PIT and radio tags to identify other potential barrier sites along migration routes

Radio tags have only been monitored for roughly a year and half on Spring and a little over a year on Upper Prior. This constitutes one (1) spawning run on the Prior system and two (2) on the Spring system. Additional annual surveys will be necessary to capture additional potential migration routes as long term hydrologic cycles and other environmental factors that have not been observed influence and trigger carp movement.

To document these movements the district will continue monitoring radio and PIT tags to cite additional barrier sites.

3.5 Education

As with other long term restoration efforts, building public support through education and information sharing is critical in continuing the project from year to year and seeing it through until completion. In addition, creating stewards that work to further and foster restoration efforts rather than counteract those efforts promotes lasting efforts beyond initial project implementation.

Goal 3.5.1a - *Provide educational opportunities on common carp to local citizens within the watershed*

By educating youth about what aquatic invasive species (AIS) are, the impacts those species have on our natural environment, and what they can do to prevent or mitigate those effects, the district can create environmental stewards.

District staff have visited two local classrooms as part of its carp management efforts in 2016. Each visit involved a presentation on AIS with a focus on carp, hands on telemetry exercise, and an invasive species conceptual game. Students van also interact directly with the District's current efforts by accessing the mapping page on the District's website.

Action Item 3.5.1 Continue to engage local youth through classroom interactions and hands on field exercises.

Action Item 3.5.2 Create a platform to disseminate project information that will augment the District's current website or develop alternative outreach and education materials

Goal 3.5.1b *- Develop Citizen scientists to aid in collecting additional data on carp populations*

As part of a long-term effort, the District can engage its citizenry to assist with data collection through a program similar to the Citizen Assisting Monitoring Program (CAMP). Interested citizens can provide important observations and data that can inform this plan and management activities

Action Item 3.5.3 Train citizen scientists to collect data through field sessions

3.6 Continued Monitoring

As part of an adaptive management approach, the district should continue to collect data to determine the impact of implemented management activities, assess and adjust methodologies, and determine progress towards the goal identified in this Carp IPM Plan and the larger watershed plan with respect to water quality and ecological integrity.

Goal 3.6.1a *- Track changes in carp populations, fisheries, water quality, and aquatic vegetation*

This goal provides the District with the ability to assess if carp populations are being suppressed post management and determine the cumulative effect of the selected IPM strategy.

Action Item 3.6.1 Develop and implement assessment methodology for long term monitoring of priority waterbodies within the watershed.

PART 4 - SUMMARY

With the understanding that common carp play a role in the decline of water quality within the Prior Lake Spring Lake Watershed and with the knowledge that they are present, the goals and action items established in this plan will aid the PLSLWD in accomplishing its primary goal of managing and preserving the water resources across the watershed.

This plan is intended to be a living document; using adaptive management that may develop new management strategies and plan goals through data collection and analysis. As new data is collected and analyzed, current approaches, data collection efforts, and prioritization may change. The PLSLWD Carp IPM should be reviewed annually to provide updates to identified goals and action items and potentially add or modify goals as data collection may dictates. This plan incorporates an adaptive management approach. As data is collected and analyzed it will be used to inform the plan and possibly develop new objectives or approaches.

The PLSLWD Carp IPM has been developed as a guidance document for the management of common carp populations within the Prior Lake Spring Lake Watershed. The PLSLWD Carp IPM supports the goals of the 2011 Upper Prior and Spring lake TMDL and goals established for individual waterbodies throughout the watershed.