DRAFT- Lake Minnetonka- Starry Stonewort Protection & Emergency Action Plan

Key Highlights of this Plan:
Characteristics of starry stonewort and its distribution nationally and locally
Suitability of starry stonewort in Lake Minnetonka based on water quality information
Protection Plan – including information on prevention and early detection actions
Emergency Action Plan – including information on steps to respond if starry stonewort is introduced in Lake Minnetonka and the most viable management options
Roles and responsibilities of partner entities regarding the protection plan steps and the emergency action plan steps
Funding and resources available to take the necessary steps in this plan

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1. SUMMARY AND INTRODUCTION

This Starry Stonewort (SSW) Protection and Emergency Action Plan is written for the purpose of outlining the necessary steps for 1) preventing the introduction of SSW into Lake Minnetonka, 2) early detection of SSW if it is introduced, and 3) acting quickly to contain and remove SSW if it is detected. It is expected that this plan be used for guidance in managing SSW in Lake Minnetonka.

The information found in this plan is based on research and results from other projects. However, it is important to recognize that these practices are based on limited information and experience on how SSW might spread in Lake Minnetonka's aquatic community. Additionally, the management approaches for SSW changes over time with the evolution of the science and management practices. New chemicals, technology, and research can change the way we respond to aquatic invasive species (AIS). Therefore, as science evolves, the plan should be expanded and modified to be consistent with those changes.

2. BACKGROUND

2.1. STARRY STONEWORT

SSW is a freshwater green algae in the Characeae family and is native to Europe and Asia. It is characterized as macro-algae, and has large, bright green branching branchlets. It produces distinctive white star-shaped bulbils that can produce new growth. It grows in a bushy manner underwater and can reach depths up to 9 meters (29.5 feet), but primarily occurs at a depth of 4.8 meters (15.7 feet) or less. Because it is dioecious, meaning that individuals are either male or female, it is capable of reproducing both sexually and asexually. SSW can spread via oocytes, which attach to the fur of animals or moving objects, or via fragmentation. However, only male clones are known in the United States.

2.2. EXPANSION OF STARRY STONEWORT IN THE UPPER MIDWEST

SSW was first documented in the St. Lawrence River in the 1970's, likely via international ballast water. Since then, SSW expanded eastward into Michigan in the mid-2000s before being discovered in Indiana in 2008. Starry stonewort was first found on Little Muskego Lake in Wisconsin in September of 2014, and on Lake Koronis in Minnesota in 2015. Currently, SSW is known to occur in Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Vermont, Wisconsin, and Ontario (**Figure 1**).

All recorded populations in the United States are male though there may be undiscovered females. The star-shaped bulbils (where the plant gets its name) are the most likely transport mechanism. Bulbils are short-lived (less than 24 hours) and can only be transported over short distances (Larkin et. al., 2018), therefore the most likely method of movement is via human movement of fragments from lake to lake rather than waterfowl movement of zygotes (or oospores) or other natural pathways (MAISRC, 2019). Because the arrival of SSW is so new to the Upper Midwest, there is an information gap with regards to the potential ecological impacts this species will have on the ecology and economics of Upper Midwest Lakes, including Lake Minnetonka. Data collected to date suggests that the impacts of SSW can vary from lake to lake. For example, when SSW was

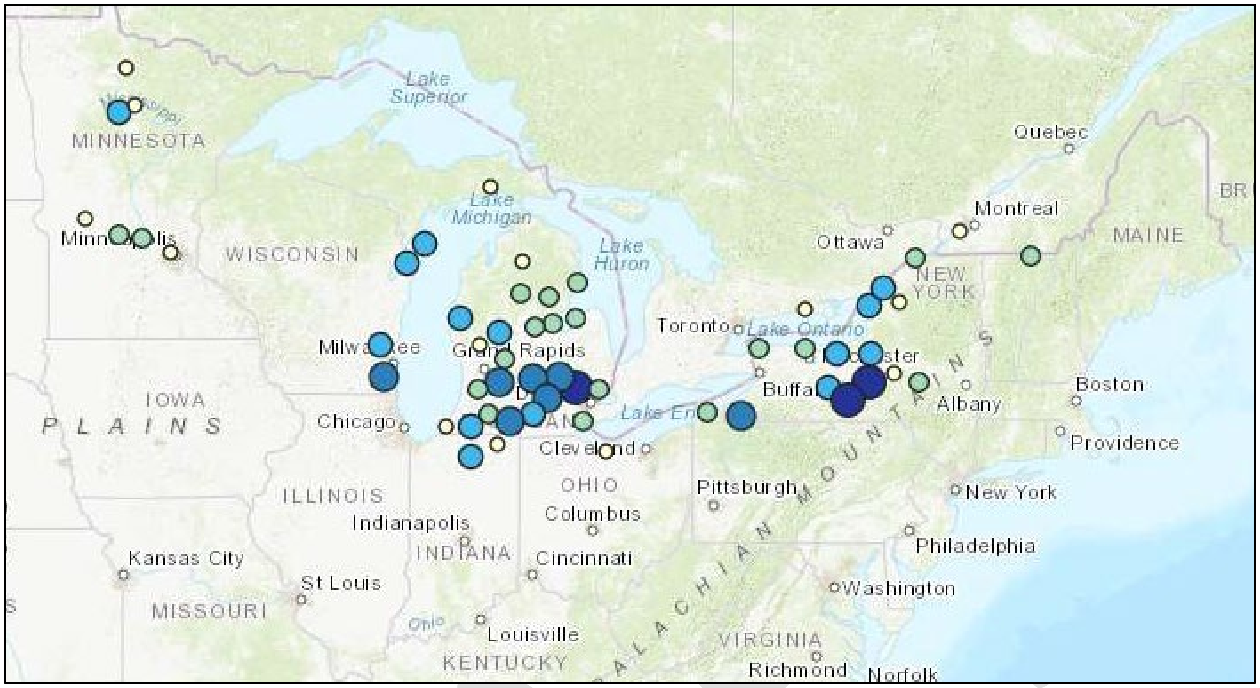


Figure 1. Starry Stonewort Distribution. (Source: USGS)

found in Lake Koronis in 2015, it had already occupied an area exceeding 250 acres. Survey efforts conducted three years later in 2018 found that its distribution had increased. However, in Pike Lake (Washington County, Wisconsin), SSW abundance has started to decrease, despite no active management. In general, SSW containment/control efforts can best be described as experimental with most control efforts producing mixed results. Since SSW has not been eliminated from any lakes, the best management strategy currently available is prevention.

2.3. OCCURENCES IN MINNESOTA AND LAKE MINNETONKA

At the end of 2018, thirteen lakes in Minnesota were listed for SSW (**Figure 2**)**.** This is an early stage of lake infestation in Minnesota and theoretically, if SSW was not transported out of these 13 infested lakes, infestations into new lakes including Lake Minnetonka would be minimal.

There are currently no observations of Starry Stonewort in Lake Minnetonka through the end of the summer in 2019.

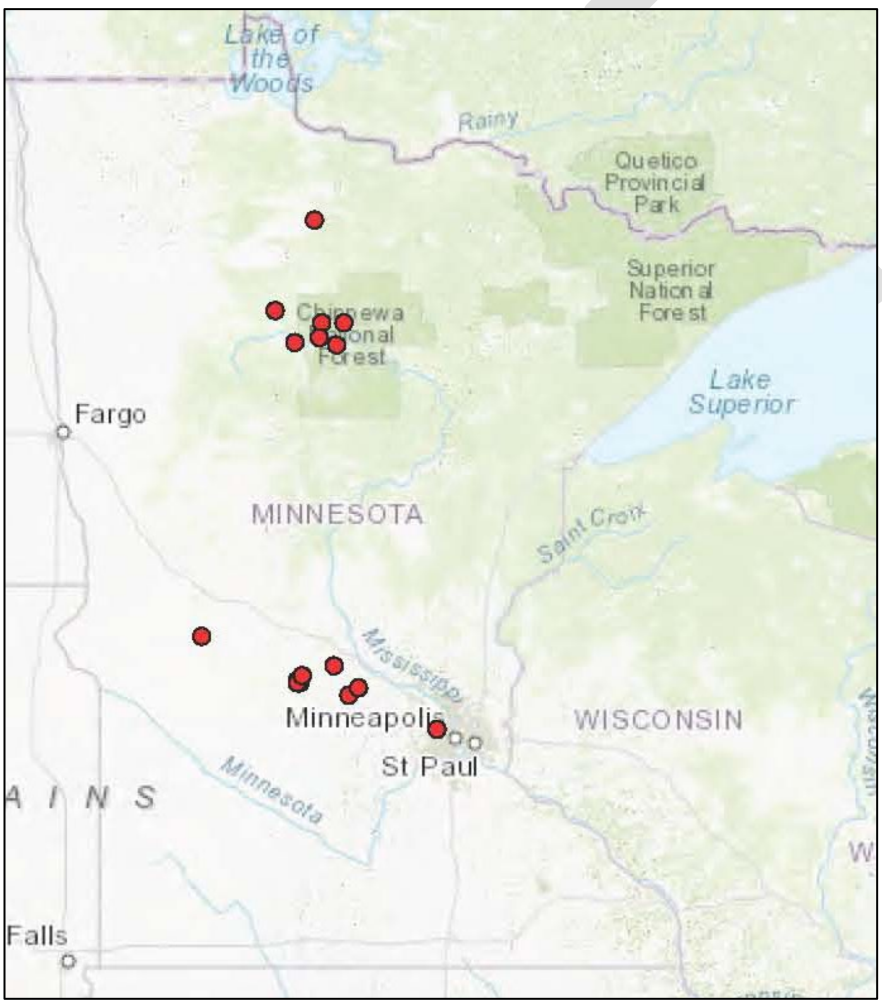


Figure 2. The thirteen known lakes with SSW infestations in Minnesota (source: USGS). Lake Koronis is shown with 2 dots.

2.4. CASE STUDY: LAKE GENEVA, WALWORTH COUNTY, WISCONSIN

Lake Geneva is a 5,401 acre lake located in Walworth County, Wisconsin. Analogous to Lake Minnetonka, Lake Geneva supports a large number of recreational boaters from destinations throughout the Midwest. Visitors have access to the lake from public boat landings, public beaches and via privately owned marinas and boating clubs. The lake's water clarity is very clear and the lake supports a wide variety of aquatic plants including both native and non-native species. Starry stonewort was found for the first time in Lake Geneva in the fall of 2018 near a privately operated marina (Trinke Lagoon). Since this finding, EOR has remained in contact with Ted Peters, President of the Geneva Lake Association to learn more about their process for reducing the spread of SSW. Furthermore, reviewing results from lake-wide point intercept studies has provided EOR with an opportunity to learn more about the potential ecological impact of this species in addition to available management options. The timeline presented below provides a snapshot of SSW growth in Lake Geneva from introduction to current. As time progresses and new management approaches are implemented, this timeline should be revisited from which potential lessons can be learned that could potentially be applicable to Lake Minnetonka. Creating a similar timeline for Lake Minnetonka represents one means of maintaining transparency amongst lake users, this is critical when managing lake-user expectations. If SSW is found, a similar timeline of events should be posted on the LMCD website and the Social Pinpoint page so that all parties involved are aware of management actions being implemented. Preliminary results from Lake Geneva should be interpreted with caution as these findings are subject to change.

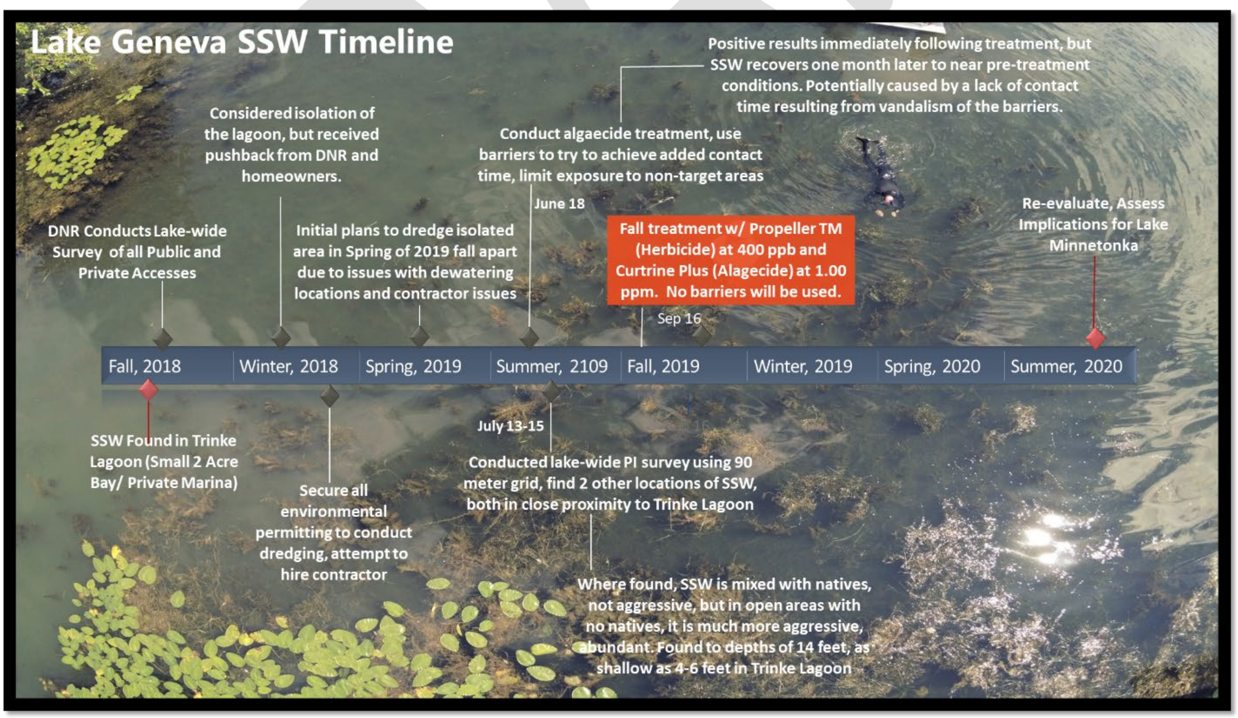


Figure 3. Timeline of events following the 2018 discovery of Starry Stonewort in Lake Geneva, Wisconsin.

3. SUITABILITY OF STARRY STONEWORT IN LAKE MINNETONKA

3.1. PARAMETERS ASSOCIATED WITH SSW GROWTH

Information on the suitability of SSW growth in lakes is increasing, but at the present time, critical growth factors are speculative. Based on available information, oligotrophic and mesotrophic lakes present the most suitable conditions whereas eutrophic lakes may support limited growth. Suitability of water quality parameters for SSW growth in Lake Minnetonka is listed in Table 1. It appears several of the eutrophic Lake Minnetonka bays would not be suitable for SSW growth (**Figure 4**).

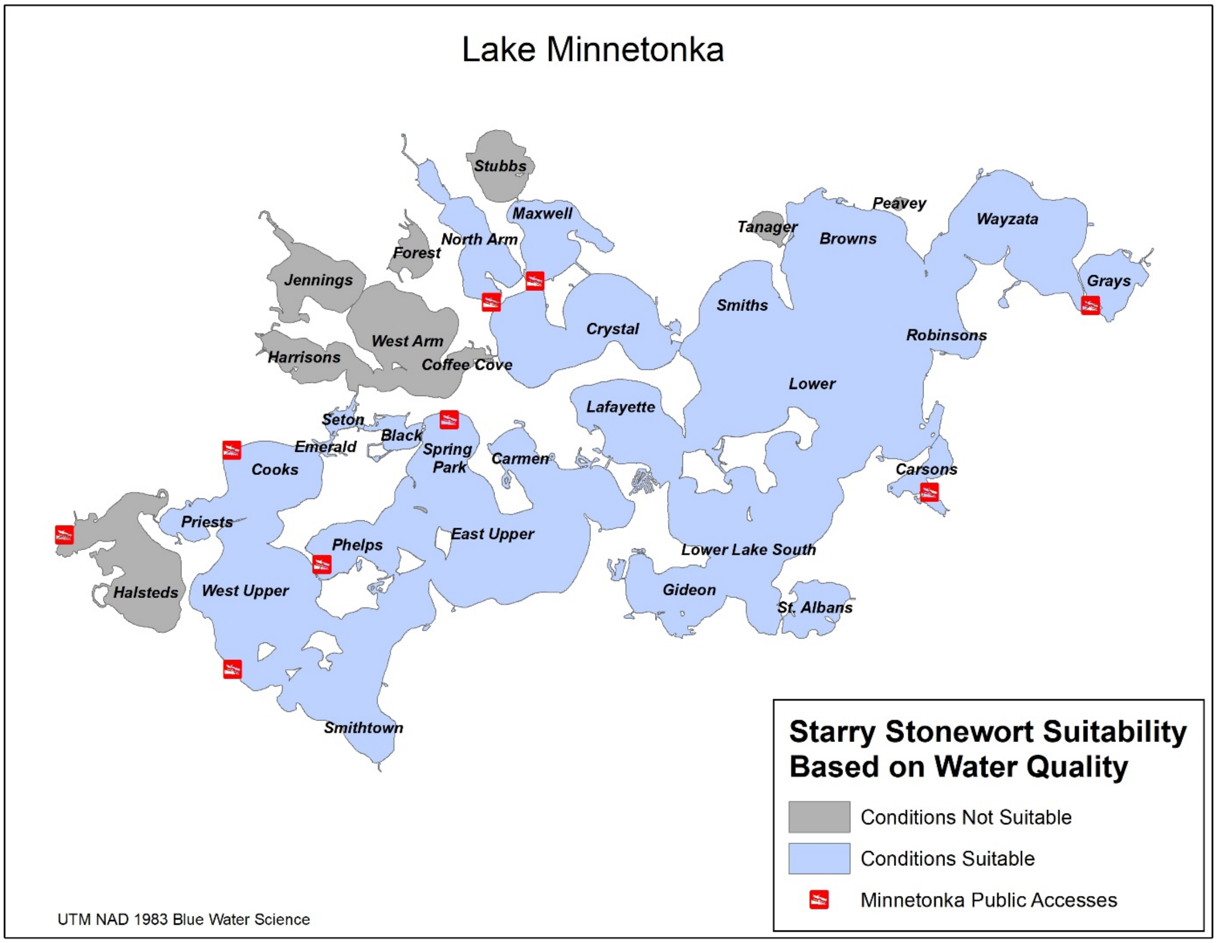


Figure 4. Suitability of starry stonewort growth in Lake Minnetonka based on water quality conditions. Suitability for SSW growth was derived from several sources.

Table 1. Starry stonewort suitability for establishment in Lake Minnetonka based on Lake Minnetonka water quality for each bay. Dark blue shading indicates water chemistry that is out of the range of known SSW established populations. Suitability ranges are from various sources.

	Bay size (Acres)	Year Data Collected	Secchi Disc (Meters)	Total Phosphorus (ug/L)	Chlorophyll a (ug/L)	pH	Alkalinity (mg/L)	Calcium (mg/L)	Conductivity
Median			**3.8**	**23**	**26**	**8.5**		**51**	**301**
(Range)			**(1-6)**	**(3-35)**	**(0-36)**	**(7.3-9.2)**	**(120-184)**	**(29-107)**	**(161-499)**
Black Lake	97	2015	2.68	32	18	7.9-8.3	130	33-34	405
Browns Bay		2015	5.53	16	3.3				
Carman Bay	413	2018	4.45	15	2.0	7.5-8.1	138	35	415
Carsons Bay	109	2015	5.58	23	2.0	7.8-8.4	123	32-36	420
Coffee Cove Bay		2014	1.15	89	62				
Cooks Bay	355	2018	2.69	25	7.2	7.8-7.1	128	35-36	400
Crystal Bay	805	2018	3.03	22	3.7	7.4-7.7	138	37-38	460
East Upper Bay		2015	5.44	19	2.6				
Forest Lake		2015	1.08	56	46	7.5-8.0	138	32-39	470
Gideon Bay		2015	5.26	18	4.0				
Grays Bay (Dam)	184	2018	3.69	18	2.4	8.0-8.4	135	35-36	420
Halsted Bay	571	2018	0.76	81	46	7.7-8.1	145	40-42	380
Harrisons Bay	255	2018	0.78	52	27	7.8-8.4	141	37-40	430
Jennings Bay	330	2015	0.74	115	56	7.9-8.5	152	43-44	440
Lafayette Bay		2015	5.19	20	3.8	7.7-8.5		35	425
Lower Lake	5909	2015	5.53	16	3.3	7.6-8.2	135	35-36	435
Lower Lake South	930	2018	3.71	19	1.7	7.4-8.0		36	435
Maxwell Bay	301	2015	3.76	27	7.5	7.4-7.8		38	450
North Arm Bay	314	2018	2.05	25	5.8	7.3-7.7	134	35-37	437
Peavey Lake		2015	1.48	86	9.3	6.6-6.7	215	72-80	1,640
Phelps Bay		2015	5.44	18	3.8	7.4-8.4		34	400
Priests Bay	158	2018	1.58	36	14	7.8-8.3	134	35-37	400
Robinsons Bay		2015	5.53	16	3.3				
St. Albans Bay	160	2018	4.03	19	3.8	7.8-8.5	114	28-33	405
St. Louis Bay		2015	5.53	16	3.3				
Smithtown Bay	843	2018	4.19	19	2.9	7.2-8.0		34-35	405
Spring Park Bay		2015	5.44	18	3.8	7.8-8.4	137	34-35	410
Stubbs Bay	197	2015	0.90	48	29	7.7-8.1		41-42	460
Tanger Lake	53	2018	0.74	83	39	7.8-8.4	152	44-46	430
Upper Bay	4229								
Wayzata Bay	720	2018	3.65	18	2.9	8.0-8.3	135	34-36	430
West Arm Bay	808	2018	0.84	56	25	7.8-8.3	146	38-41	440
West Upper Bay	901	2018	3.66	20	3.7	7.2-7.8		34-35	415

No data for Emerald Lake and Seton Lake.
pH, alkalinity, calcium, conductivity collected in 2009.

3.2. PROBABILITY OF SSW INTRODUCTION IN LAKE MINNETONKA

Based on boater movement analyses, there is a strong likelihood of SSW being introduced into Lake Minnetonka by 2025 (Phelps 2018) (Table 2). Therefore, watercraft inspections have to be effective to delay a potential new introduction.

Table 2. Starry stonewort: high-risk lakes by 2025 through boater movements (source: Phelps, N. 2018. Estimating AIS risk for Minnesota lakes. MAISRC Research and Management Showcase).

MN DNR Division of Waters (DOW) Number	Lake Name	Predicted Boater Risk (2025)
11020300	Leech	15.94%
48000200	Mille Lacs	15.88%
2713300	Minnetonka	14.20%
25001700	U.S. Lock & Dam # Pool	13.87%
56014100	Rush	13.77%
45000200	Mud	13.35%
25000100	Pepin	13.30%
19000100	U.S. Lock & Dam #2 Pool	12.98%
69061700	Sand Point	12.95%
3010200	Shell	12.87%
32005700	Heron	12.83%
43011500	Cedar	12.71%
77021500	Osakis	12.63%
18030800	Pelican	12.63%
15024500	Kiwosay Pool	12.62%
40009200	Jefferson	12.61%
37004600	Lac Qui Parle	12.55%
11030500	Gull	12.51%

4. INTRODUCTION OF STARRY STONEWORT

If SSW is introduced into Lake Minnetonka, four outcomes are possible using nomenclature from Blackburn et al (2011). Four possible outcomes after an introduction include failure, establishment, naturalization, or invasive growth (**Figure 5**).

At this time, not enough information of the phenology (life cycle and suitability conditions) of SSW is known to predict what type of SSW growth could be expected in various bays of Lake Minnetonka. A review of Starry Stonewort littoral zone percent frequency data for Wisconsin Lakes with recent SSW infestations suggests that the SSW may increase or decrease in abundance regardless of the management approach used. For example, SSW frequency has declined in Pike Lake in Washington County, Wisconsin despite no management efforts being attempted in this waterbody. In Little Muskego Lake, Waukesha County, Wisconsin, SSW has significantly increased despite aggressive management techniques including lake drawdowns and dredging. In Lake Koronis and other Minnesota lakes with SSW infestations, SSW appears to be displacing native *Chara* spp. Preliminary results from a 2019 survey following a 2018 finding of SSW in Lake Geneva in Walworth County, Wisconsin have found that SSW appears to be intermixed with native species in areas with healthy native plant communities. In other areas that are non-vegetated, SSW was observed to be more aggressive, and was the dominant species observed.

Although prevention of an introduction of SSW is the goal, early detection methods are critical as well. Currently, the sort of impacts this species will have in terms of ecology and economics are speculative. Because of the uncertainty, an emphasis should be placed on prevention with a strong rapid response plan in place as well.

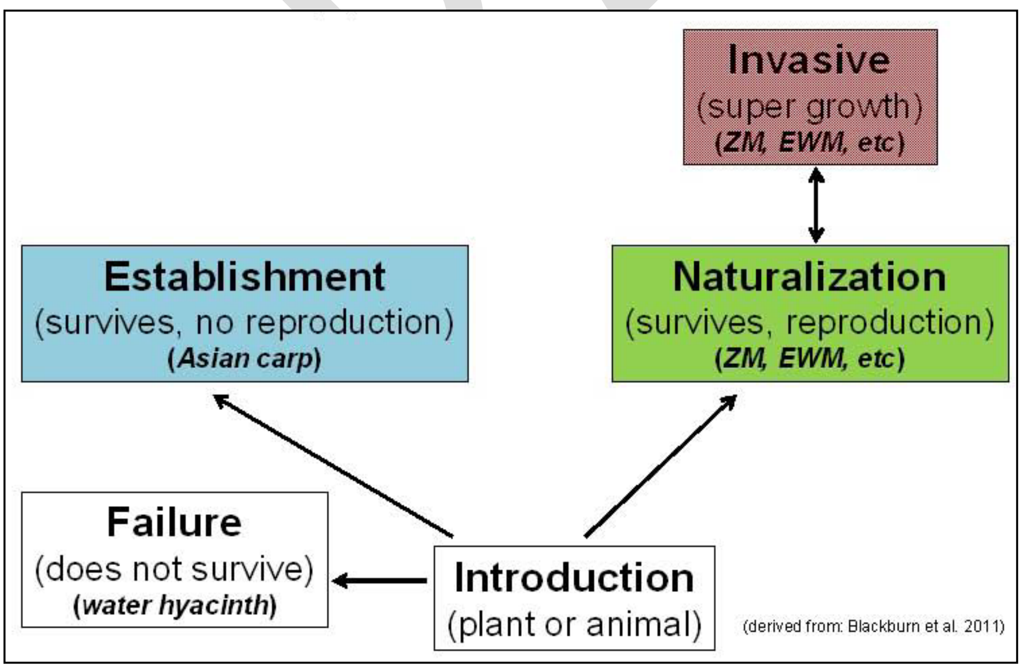


Figure 5. Possible outcomes of SSW introduction into Lake Minnetonka using nomenclature from Blackburn et al 2011.

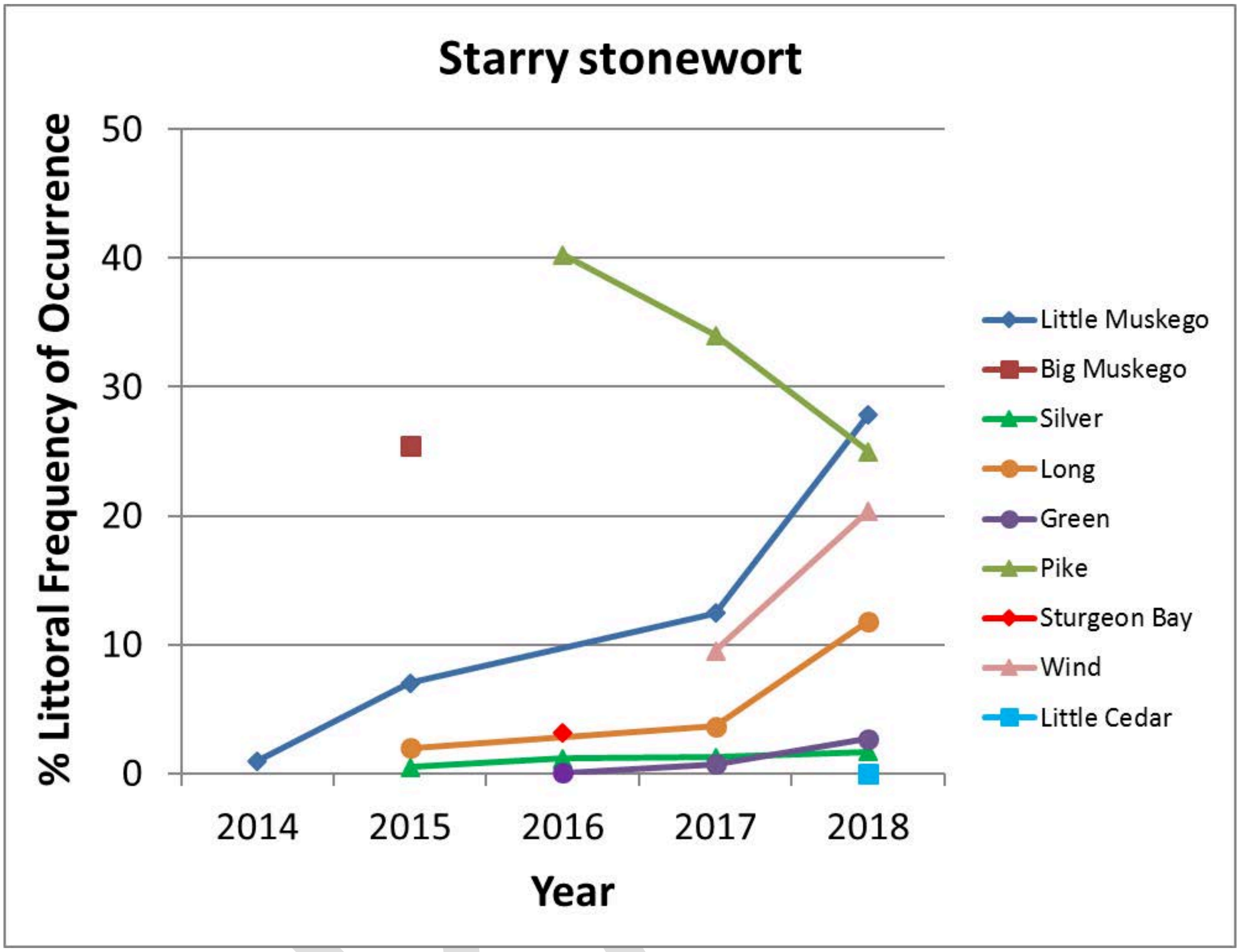


Figure 6. Frequency of occurrence for SSW for 9 Wisconsin lakes (source: WDNR).

5. STARRY STONEWORT PROTECTION PLAN

The following sections outline the components of an AIS management program that include prevention, early detection, rapid response, and management following invasion. The objective of the Starry Stonewort (SSW) Protection Plan is to first prevent a SSW introduction into Lake Minnetonka and to outline a sequence of events that follow an initial detection of starry stonewort in Lake Minnetonka.

Inspection and prevention programs are the foundation for aquatic invasive species (AIS) comprehensive management programs and represent an important component of an AIS management program. Unfortunately, existing inspection and prevention programs have not demonstrated a capacity to prevent the spread of other AIS such as Eurasian watermilfoil or zebra mussels in Lake Minnetonka as well as other Minnesota lakes. Therefore, the following sections outline critical measures that should be taken to enhance the existing inspection and prevention program. These measures include:

1) Lake Minnetonka Conservation District website information and citizen reporting.

The Lake Minnetonka Conservation District (LMCD) should maintain AIS information on its website and provide links to AIS identification pages to help lake residents identify AIS. Set-up a network for citizen reporting of any AIS observation. LMCD staff will develop and maintain additional tools (ArcGIS Online Maps, Social Pinpoint) to allow vested citizens to review spatial information, including mapped areas of infestation, identify areas where management actions may be needed, and inform citizens about critical AIS issues such as the potential discovery of SSW.

2) Development of a fundamental understanding of the suitability of SSW.

A preliminary evaluation of critical growth parameters was performed on a bay-by-bay basis to determine where SSW is most likely to result in the largest ecological/economic impact based on data collected to date. New data regarding SSW suitability and population abundance trends is currently being collected in the Upper Midwest. New information should be evaluated in an effort to better determine the suitability of SSW growth and subsequent potential for ecological and economic impacts on a bay-by-bay basis.

3) Optimizing boat inspections.

Two-types of boat inspections are recommended. One type of inspection involves exit inspections at all 13 Minnesota lakes with SSW present. The other type of inspection is for incoming boats to Lake Minnetonka with enhanced inspection for boats that have recently been in any of the 13 SSW lakes. There are five priority public accesses on Lake Minnetonka that should have extra inspection hours.

4) Enhanced starry stonewort early detection search programs:

Contract for bi-weekly searches using scuba diving, snorkeling, wading, and rake sampling from July-October. In addition, boat inspectors at the public access should spend a minimum of 1 hour a week using rake sampling to search for SSW. If starry stonewort is found, verify with DNR, produce a press release, notify lake residents, and implement a control plan.

5) Licensed Multiple Dock Facility Inspections:

The first infestation of SSW in Lake Geneva, Wisconsin came in an area immediately adjacent to a private marina licensed to provide storage for multiple boats. In addition to boat inspections conducted at public accesses, the LMCD should spend a minimum of 1 hour a week using rake sampling to search for SSW at private marinas and licensed boat storage facilities.

5.1. ROLES OF BOAT INSPECTIONS FOR SSW PREVENTION IN LAKE MINNETONKA

Inspections of incoming boats have value for educating the boating public and possibly slowing the spread of AIS. Boat inspections by themselves have not stopped the spread of Eurasian watermilfoil or zebra mussels into Minnesota and Wisconsin lakes (**Figure 7**).

The DNR places a significant emphasis on conducting watercraft inspections on Lake Minnetonka. In 2015, the DNR and Local Government Units conducted 36,133 watercraft inspections on Lake Minnetonka, equivalent to 11% of the total inspections conducted throughout the state.

Table 3. 2015 Watercraft Inspection Data

Month	Total Minnetonka Inspections	State-wide Monthly Inspections
April	299	1006
May	4639	42386
June	10113	78970
July	10060	85004
August	5281	49839
September	3777	26949
October	1964	9995
Total	**36,133**	**294,149**

Boat inspections continue to play a role but their ability to stop new introductions of AIS into lakes should be evaluated based on the pattern and spread of other AIS. Starry stonewort is a relatively new invader and it is difficult to predict its future rate of invasion into uninvaded lakes. Zebra mussels and Eurasian watermilfoil have had different rates of invading lakes. In Minnesota the Eurasian watermilfoil infestation rate has been linear (R^2=0.96) and the zebra mussel infestation rate has been exponential (R^2=0.97). It is possible that more efficient boat inspections could likely reduce the rate of new AIS infestations.

5.2. OPTIMIZING BOAT INSPECTIONS FOR PREVENTING SSW INTRODUCTIONS

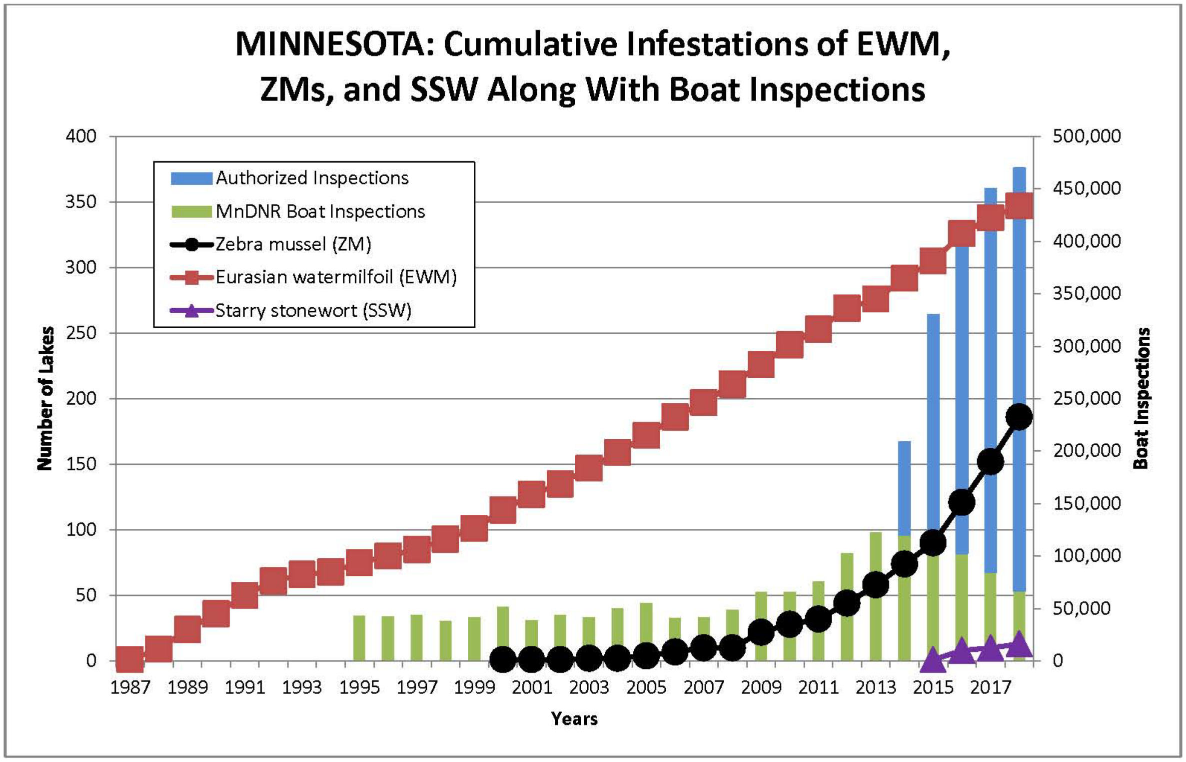
Boat inspections are valuable. They slow the spread of AIS but do not prevent the spread of AIS. To delay the infestation of SSW into Lake Minnetonka for as long as possible, a two-pronged inspection program is recommended. The first component is to inspect boats leaving all Minnesota SSW infested lakes. The second component is to add additional inspection hours for incoming boats at priority accesses on Lake Minnetonka.

Conducting Exit Inspections at Lakes with Starry Stonewort: Based on available data from boat inspections, it was found that of the lakes with current SSW populations, Medicine Lake has the most inspected boats exiting the lake and then visiting Lake Minnetonka (**Figure 8**). As part of the exit inspection process, watercraft users are asked where they plan to take their watercraft next, and what county the waterbody is located in. Of the 10,187 respondents, nearly 70% of watercraft inspectors planned to return to waterbodies within Hennepin County. It should be noted that the DNR inspection data represents a fraction of the boats entering the lake in a given year. Extra hours of inspection for boats leaving Medicine Lake are recommended. Exit inspections at the other 12 lakes are recommended as well. Funding for additional exit inspections is not currently allocated at this time. Furthermore, it should also be noted that out of state boaters frequently visit Lake Minnetonka. Inspection data collected in 2018 found that a portion of these boaters were from States which contain waterbodies that are infested with Starry Stonewort (**Figure 9**).

Conducting Incoming Boat Inspections for Lake Minnetonka: Using incoming boat inspections to prevent the introduction of SSW is a goal for Lake Minnetonka. Public access inspections have been prioritized based on the probability of SSW introductions on a scale of high, moderate, or low priority (**Table 4** and **Figure 10**). The 5 high priority public accesses would be staffed for 10 hours per day, 7 days a week from June through October. The 2 moderate priority accesses would be staffed for 50 hours per week and the 2 low priority accesses would use existing inspection levels.

Even with this enhanced level of inspections, an unknown percentage of incoming boats would still not be inspected. For a large lake like Lake Minnetonka with multiple access points, 100% inspection of incoming boats is not practical. An enhanced boat inspection program could delay a SSW introduction, but there is no guarantee there would be 100% prevention of a SSW introduction over the next 50 to 100 years.

At this time, only drastic and expensive options could give close to 100% prevention, but cost and accessibility to the lake would not be publically acceptable.



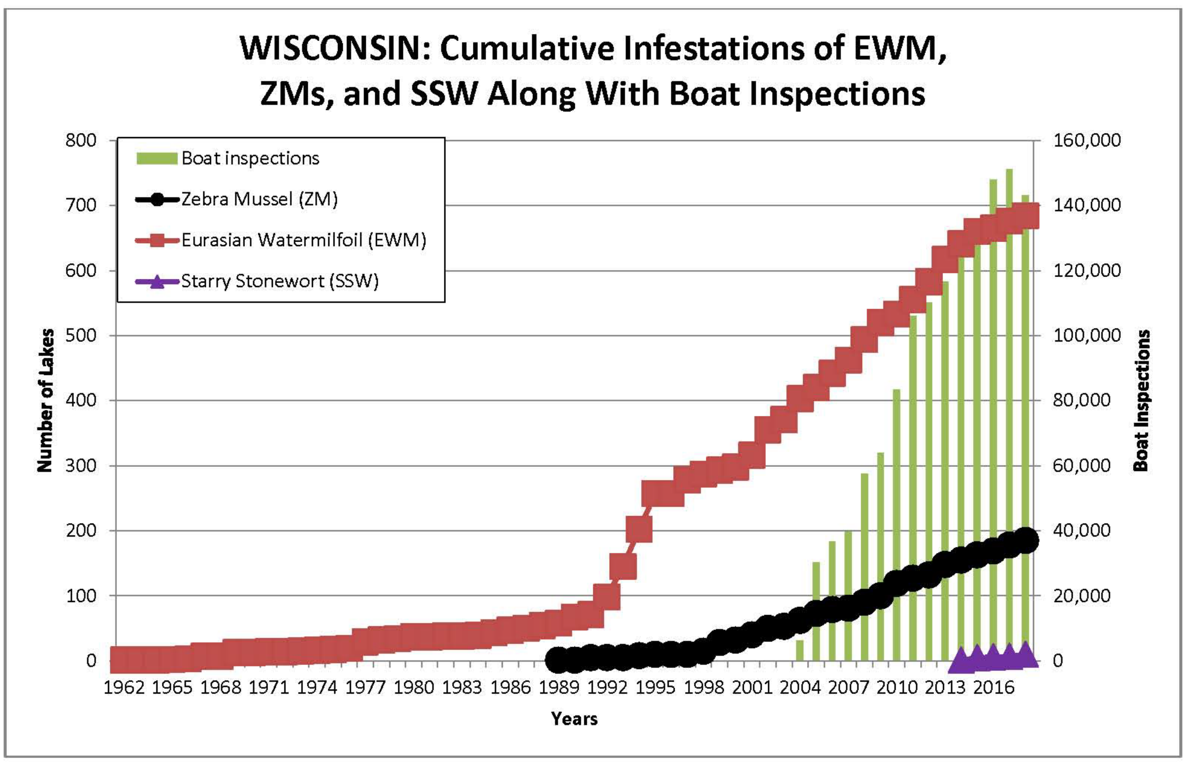


Figure 7. Cumulative number of lake infestations by year for Minnesota and Wisconsin lakes for Eurasian watermilfoil, zebra mussels, and starry stonewort along with annual boat inspections (source: DNR and WDNR AIS lists and boat inspection reports, various years).

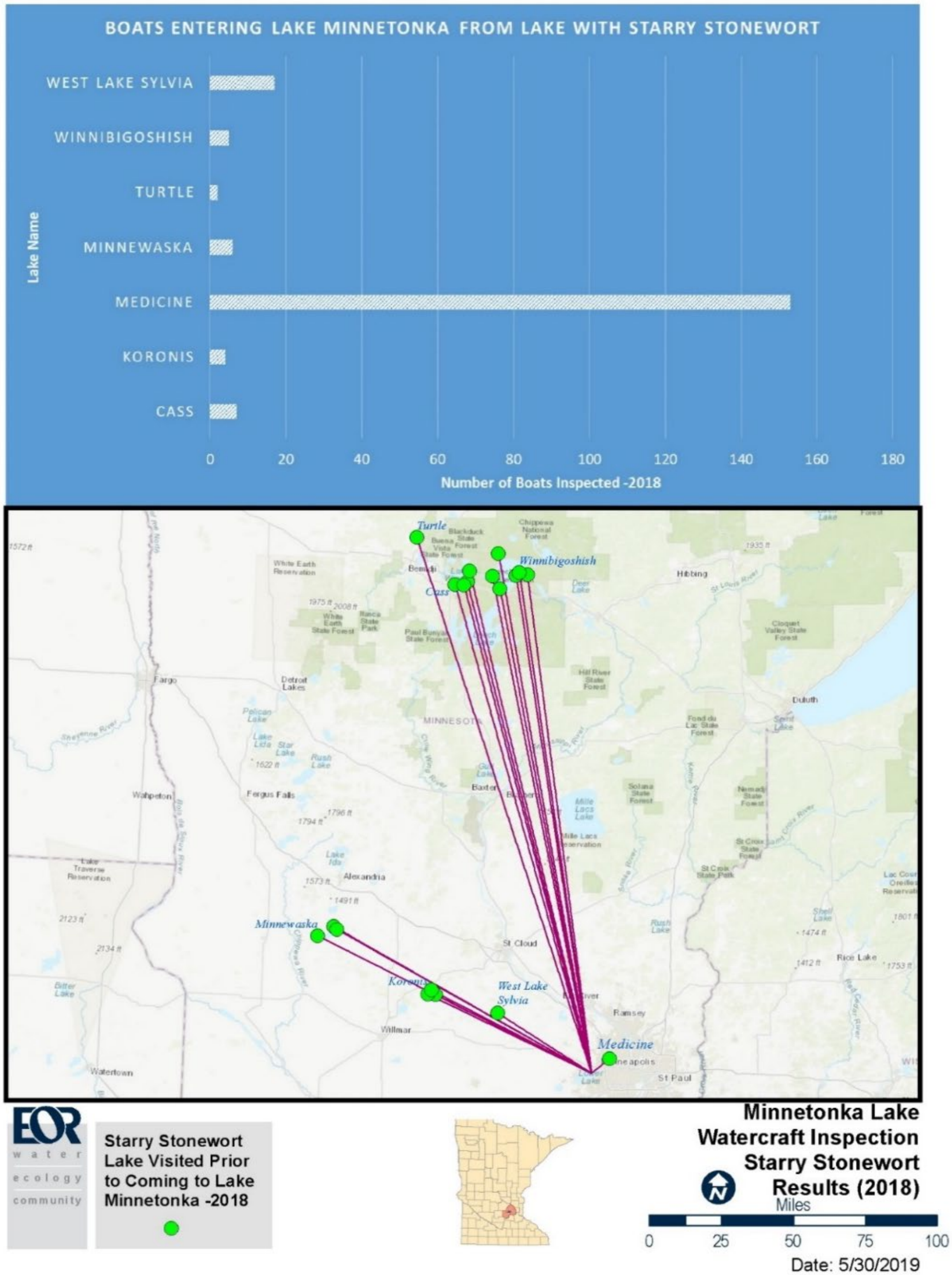


Figure 8. Inspected boats leaving starry stonewort lakes and then launching at Lake Minnetonka in 2018 (source: DNR). Bar graph (top) shows the number of DNR inspected boats in 2018 leaving SSW infested lakes and launching at Lake Minnetonka. Data is based on more than 20,000 watercraft inspections conducted on Lake Minnetonka in 2018. Inspected boats represent a small fraction of the total number of boats launching on Lake Minnetonka.

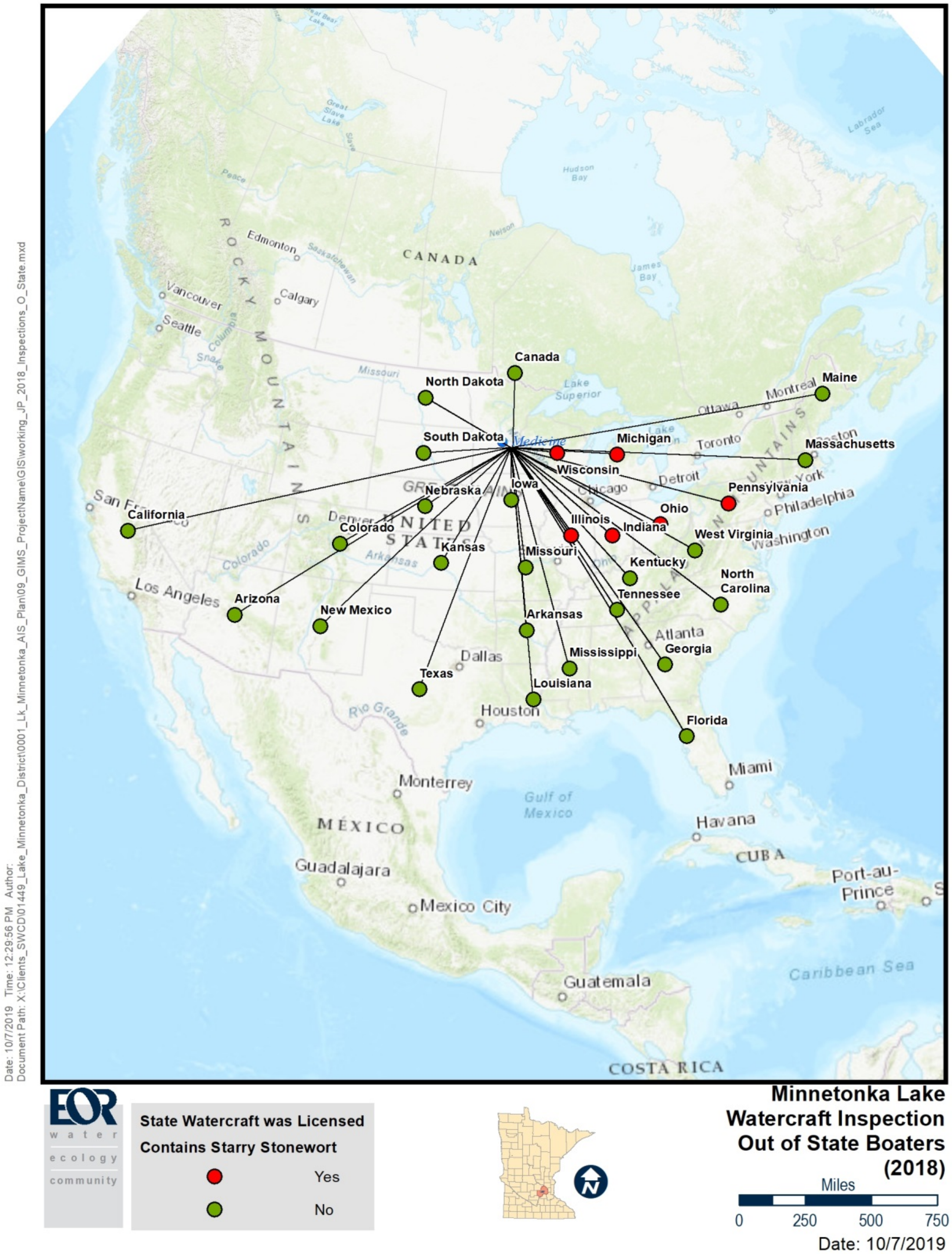


Figure 9. Boaters from 28 states and Canada visited Lake Minnetonka in 2018 including several boaters from states in which Starry Stonewort has been found.

Table 4. Lake Minnetonka public access priority inspection areas

Bay	Percent of Bay in Littoral Zone (Acres)	Public Access Parking Spaces	Multiple Dock Licenses Boat Storage Units (BSUs)	Priority for Inspection at Public Access
Carsons Bay	76% (88)	17 trailer plus additional nearby parking	203	**High**
Cooks Bay	31% (131)	17 vehicle/8trailer	30	Moderate
Grays Bay	71% (127)	20 vehicle/107 trailer	88	**High**
Halsted Bay	59% (322)	14 vehicle	153	Low
Maxwell Bay	58% (174)	15 vehicle/80 trailer	239	**High**
North Arm Bay	58% (186)	10 vehicle/51 trailer/3 accessible	6	**High**
Phelps Bay	79% (272)	1 vehicle/2 trailer	123	Low
Spring Park Bay	37%(141)	2 vehicles/8 trailer plus nearby parking/1 accessible	236	Moderate
West Upper Bay	22% (193)	100 vehicle/53 trailer/ 6 accessible	63	**High**

*** Private accesses, and local fire lane accesses are not included.While these accesses are lower risk do to a lower number of boaters, they do represent potential vectors for starry stonewort to become introduced.**

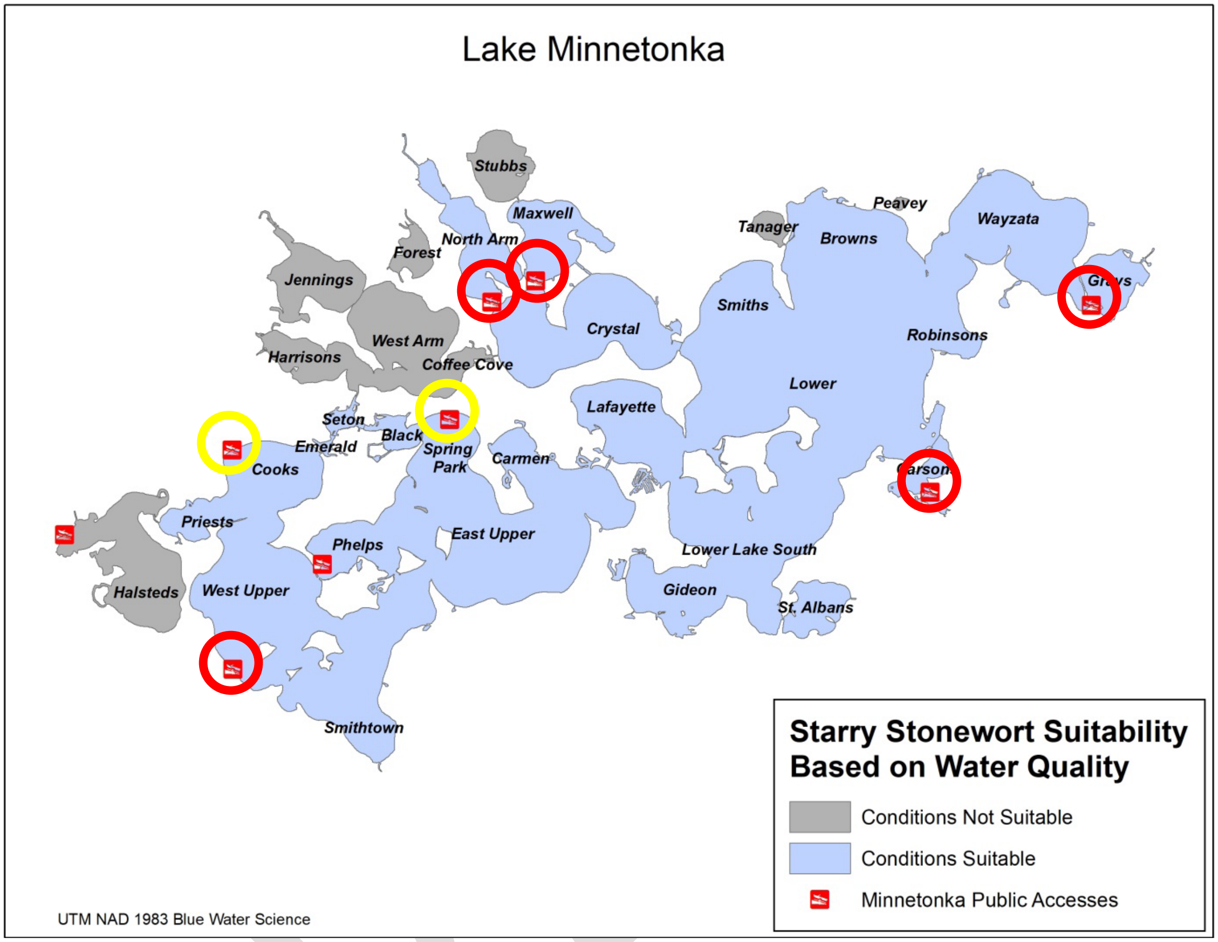


Figure 10. Suitability of starry stonewort survivability in Lake Minnetonka along with 9 public accesses. Public access inspection priorities are shown with red circles (high priority) and yellow circles (moderate priority). Four public accesses without a circle are lower priority for boat inspections.

5.3. PREVENTION AND EARLY DETECTION OPTIONS

Numerous proactive solutions are available to prevent a starry stonewort introduction into Lake Minnetonka, but few are practical and implementable. We have researched the literature and talked to the country's leading SSW experts. Based on available information we have formulated a SSW prevention option.

It should be noted that pre-emptive copper sulfate dosing at Lake Minnetonka accesses is not an introduction "prevention" strategy since this action would attempt to treat any SSW fragments already in the lake. Rather, a pre-emptive copper treatment is an early-detection option. A pre-emptive copper treatment could likely contain SSW but not eliminate it. For example, there have been 11 copper treatments in Lake Sylvia in the last 3 years. While these treatments have provided some control of SSW, they have not eradicated it.

The most realistic approach to preventing an introduction of SSW into Lake Minnetonka is a 2-step approach.

- First, exit inspections at all 13 lakes in Minnesota that currently have SSW should be conducted.
- Second, public access at all 13 SSW lakes should be treated with copper sulfate 2 to 4 times during the growing season

By keeping the SSW growth to a minimum at infested public accesses, the probability of a boat trailer picking up SSW is greatly reduced. Theoretically, this approach would insure the highest level of protection against transport of SSW into Lake Minnetonka as well as other lakes in Minnesota.

Following are two other introduction prevention methods our team evaluated that are not being endorsed at this time.

<u>Chemical/mechanical decontamination solution for incoming boats to Lake Minnetonka.</u>

This solution is not practical nor would it be 100% effective. As we learned in the first TAG meeting, only a fraction of the incoming boats are inspected. There are private accesses as well as uninspected marina accesses making it unreasonable to thoroughly inspect/treat 100% of the incoming boats. A point to note is the 2018 SSW infestation in Lake Geneva, WI occurred at a private access not a public access. Another case study is the Christmas Lake zebra mussel introduction. Even though 100% of the boats were inspected at the single public access and the access was closed when inspectors were not present, zebra mussels were still introduced into Christmas Lake.

<u>Chemical treatments and decontamination methods for boats exiting SSW infested lakes.</u>

Currently, SSW decontamination methods are being researched and it is unknown if they would be 100% effective. At this time, there are no algaecide/herbicides that have been proven to kill and eliminate 100% of the SSW. The WDNR has laid out some methods that they require WDNR employees to follow with regard to BMPs for boat, gear, and equipment AIS decontamination. Table 1 of the linked document below indicate there is not enough research available to determine what types of decontamination techniques are effective at killing SSW.

https://dnr.wi.gov/water/wsSWIMSDocument.ashx?documentSeqNo=113967385

A chart listing several prevention methods and the probability of a successful SSW prevention program for Lake Minnetonka is shown in Table 5. A combination of the first three methods has the best potential for preventing a SSW introduction based on politics, technical aspects, and costs. The highest initial priority is to work with the DNR, University of Minnesota and Lake Minnetonka Association to develop a pilot program to attempt preemptive copper sulfate applications at priority public access points in Lake Minnetonka.

Table 5. Evaluated methods to prevent a SSW introduction into Lake Minnetonka.

Method	Politically Acceptable	Technically Achievable	Economically Feasible	Probability of Preventing a SSW Introduction
1. Develop a Preemptive Pilot Study* which incorporates the use of pre-emptive copper sulfate dosing at prioritized Lake Minnetonka public accesses every 2 to 4 weeks during the growing season. Treatments are prioritized on a launch-by-launch basis, but focus will be on using pre-emptive copper sulfate at higher risk launches.	Unknown	Yes	Yes	**High**
2. Bi-weekly surveys at priority boat accesses.	Yes	Yes	Yes	**High**
3. Conduct exit inspections on 100% of the boats on all Minnesota lakes that currently have SSW. Also apply copper sulfate at public accesses at the 13 SSW lakes to reduce SSW biomass and prevent SSW transport by a boat trailer.	Unlikely – Who is responsible?	Yes	Yes	**High**
4. Extra boat inspections at priority Lake Minnetonka public accesses	Yes	Yes	Yes	**Moderate**
5. Inspect 100% of incoming boats.	No	No	No	**Moderate**
6. Put all boats and trailers through a chemical bath before entering Lake Minnetonka.	Unknown	No	No	**Moderate**
7. Don't allow any boats to visit Minnetonka, use a boat club approach.	No	Unlikely	Unlikely	**High**
8. I-LIDS: Motion detected video surveillance cameras at boat access are a potential option but rate as low priority.	Yes	Yes	Yes	**Low**
9. Using e-DNA monitoring for detecting SSW (not available at this time): Currently (as of 2019) there are no kits for sampling and identifying the presence of SSW in a lake using e-DNA. However, future research efforts may result in a method for detecting a low infestation.	Yes	No	No	**Low**

*note this is not an introduction prevention strategy. It assumes that SSW has already been introduced into Lake Minnetonka, but has not yet become fully established.

6. EMERGENCY ACTION PLAN

6.1. RAPID RESPONSE PROGRAM FOR STARRY STONEWORT INTRODUCTION

Rapid response assessment:
After the first verified observation of starry stonewort in a Lake Minnetonka bay, conduct an assessment effort. Contractors, DNR, and others should conduct an initial search in the most probable locations to determine the distribution of starry stonewort. From 10 - 20 hours of surveying should be conducted for a thorough assessment. All SSW locations should be sited with GPS.

Rapid response action:
If SSW is found only within a public access area (or an area less than 20-acres) after the rapid response assessment then the rapid response action could be a containment attempt. LMCD staff and managers would coordinate in decisions as to what type of a rapid response action should go forward. DNR permits are necessary for treatments and meetings should be conducted prior to any eradication treatments.

Starry stonewort containment:
When the management objective is to contain SSW in a small area, aggressive treatments should be considered. Apply a copper sulfate product to a delineated area, wait 2 weeks and resurvey. If SSW is found, treat with copper sulfate again. Repeat up to 4 times during the SSW growing season from June- October. A step by step description of the recommended rapid response action is provided in section 6.2, located on the next page of this document.

6.2. SUMMARY OF STEPS FOR A RAPID RESPONSE ACTION

1. Before the detection of an introduced species, a treatment action should be planned because the timing of rapid response to an initial observation is critical. Typically after the first detection for small areas (<20 acres), treatments can occur in 2-3 weeks.
2. After an early detection observation, meet with DNR AIS staff to discuss a protocol for actions and treatment.
3. Conduct the Rapid Response Assessment, beginning with priority accesses. If SSW is detected, move to a full search of the surrounding areas. If the extents of the infestation indicate a small, isolated location, the LMCD will consider placing physical barriers to prevent boat access through the infested areas. The LMCD has the jurisdiction to place physical barriers around any portion of Lake Minnetonka. The highest priority locations for barriers to be placed include public accesses and high traffic locations such as connecting channels where boaters are most likely to move SSW to new areas of the lake.
4. Evaluate the results of a rapid response assessment. Do results indicate conditions are suitable to contain the SSW in a small area? If a small area of SSW is identified within close proximity to a public landing, the LMCD will place physical barriers within the water which will effectively close the public access in which SSW was found. Boaters will be re-directed to other public accesses to minimize the ability for SSW to spread.
5. If treatment is to occur at a public access, determine if it needs to be closed. Discuss with DNR, LMCD, Angler Groups, and lake associations. Conduct an open meeting to discuss options.
6. Delineate a treatment polygon based on the full search survey results. For new infestations, the treatment area has ranged from 0.6 acres up to around 20 acres.
7. Containment of SSW should be measured based on results of a rapid response assessment. With early detection, the objective is to contain SSW in a small area of infestation. Previous projects (Sylvia, Rice, Pleasant) have found aggressive multiple treatments have successfully contained SSW at the public access. Once the initial infestation has spread and is widespread (> 50 acres) treatments are reduced to just the areas with the heaviest growth. Multiple treatments over large areas are not warranted due to excessive costs and ecological damage.
8. Estimated costs associated with the application and monitoring are up $20,000 for a containment treatment, dependent on the treatment dimensions and frequency of treatments.

7. MANAGEMENT OPTIONS

After reviewing SSW treatment results in Michigan, Wisconsin, and Minnesota, the most cost effective treatment has been the use of **copper sulfate.** Hand pulling can be considered for very limited infestations, but then a follow-up copper sulfate application should be considered. Other methods that have been attempted, but have been less effective include dredging, DASH (diver assisted suction harvesting), and drawdown. After a treatment, a post-treatment evaluation is necessary to determine the effectiveness of a containment treatment. This protocol is available from the DNR. Components will likely include a thorough search of the treatment area, and a post treatment survey of the treatment area and surrounding area. A flow chart showing a sequence of steps is shown in Figure 11.

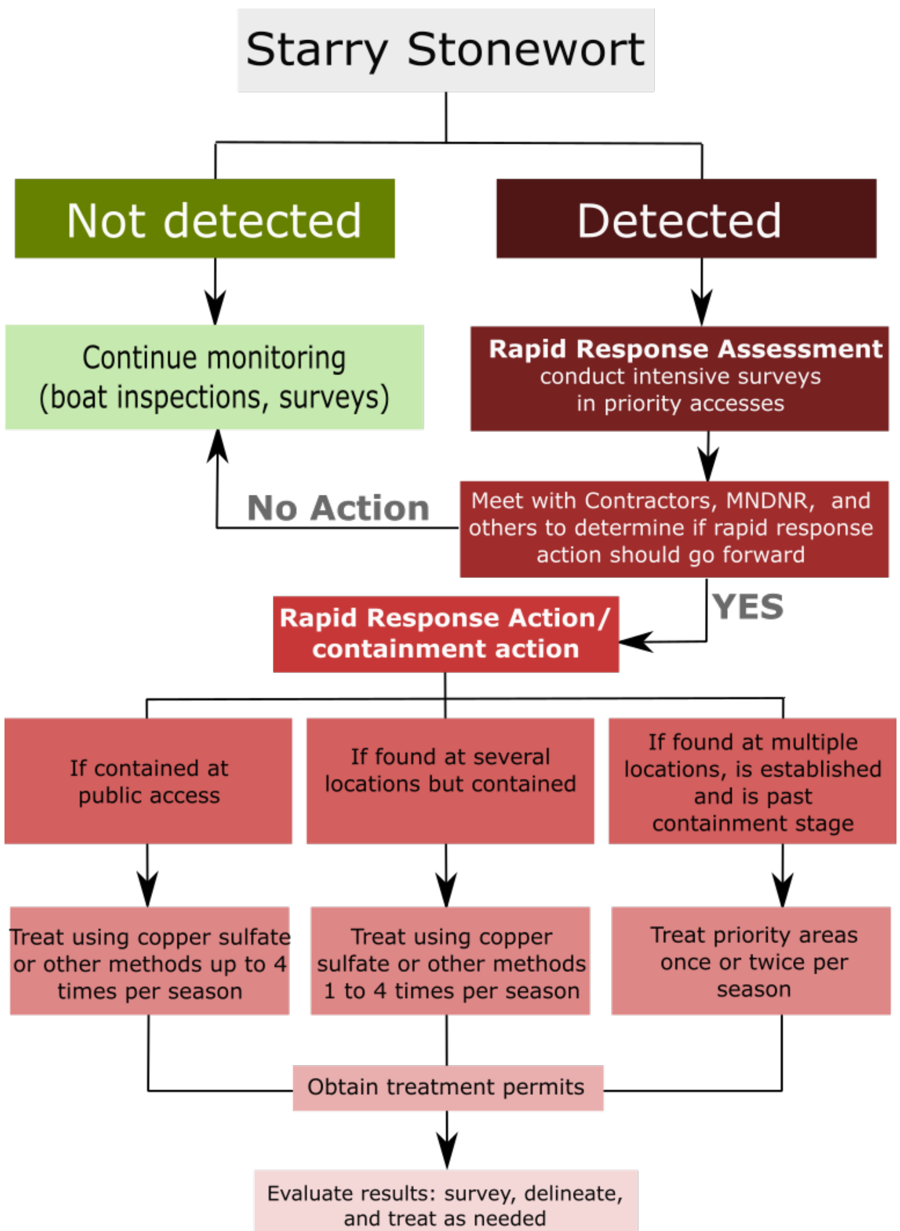


Figure 11. Starry Stonewort Rapid Response Plan Flow Chart.

8. ROLES AND RESPONSIBLITIES

	LMCD	DNR	MAISRC	Hennepin County	Three Rivers Park District	MCWD	LMA	LIDs	Treatment Contractors	Consultants	Bay Captains	Volunteers	Lake User Groups
Prevention & Early Detection													
Create website information.	X	X	X										
Designate contact person.	X	X		X	X	X	X						
Conduct training session for volunteer searchers (optional).													
Conduct monthly targeted searches (Jul-Oct).	X				?		?						
Boat Inspections	X	X			X								
Press release if AIS are found.	X	X											
Rapid Response Assessment													
Conduct an initial exploratory search after the first report of an AIS observation.		X		?	?	X				X			
Organize and train lake searchers for a full search effort.	?	X	X	?	?	X				?			
Conduct an expanded targeted search with diving.	?	X	?	?	?	X				X			
Meet to determine treatment options.	X	X			X	X	X						
Rapid Response Action													
Close public access, if necessary.	X	X											
Set-up containment area.		X		X						X			
Treat area within the containment area.										X			
Evaluate treatment (site dependent).		X	?			X				X			
Report all findings and results.	X	X				X							

9. FUNDING & RESOURCE OPTIONS

Funding and technical assistance for a SSW management program will have ongoing needs. A summary of potential participants along with funding and technical assistance possibilities is listed in Table 6.

Funding a comprehensive incoming boat inspection program for Lake Minnetonka would be challenging. For example to inspect incoming boats at 5 priority public accesses for 10 hours a day from June through October would take 7,000 inspection hours. Additional inspection hours at the 2 lower priority accesses would total an additional 2,000 hours. A total of 9,000 inspection hours would still not account for boat launching inspections at non-public accesses and marinas. The practicality and economics would dictate that 100% prevention based on incoming boat inspections is not likely feasible. A higher probability of SSW prevention is conducting exit inspections at Minnesota lakes with SSW, but that also involve around 10,000 hours of inspection. Therefore a second line of defense should be considered and the second line of defense is the rapid response action.

Table 6. Agencies or specialists that could provide funding, and/or technical assistance for a SSW program.

Agency	Funds	Technical Assistance
LMCD	X	X
DNR	X	X
Hennepin Co	X	X
MAISRC		X
Academic Professionals/ University Researchers		X
MCWD	X	X
LCCMR	X	

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