

Management of Water Soldier in Southern Ontario's Trent-Severn Waterway

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Certified Lake Manager



SOLITUDE
LAKE MANAGEMENT


Restoring Balance. Enhancing Beauty.

May 4, 2018


Water Soldier

(Stratoides aloides)


- Perennial of the Hydrocharitaceae (Frog-bit family)
- Native to Europe and Northwest Asia
- Similar in appearance to an aloe plant, spider plant, top of a pineapple
- Forms dense mats of floating and submerged vegetation
- Hinders recreational activities




(Buchanan, 2015)




(Wensink, 2014)



(Sallaway, 2015)



www.invasivespecies.com • Invasive Species Hotline 1-800-563-7711



Water soldier is an invasive perennial aquatic plant that is native to Europe and northwest Asia. The only known wild population in North America was found in the Trent River in 2008, near the Hamlet of Trent River, Ontario. Water soldier is used as an ornamental plant in water gardens, which is the likely source of its introduction to the Trent River.

Why is it a problem

Forms dense mats of floating or submerged vegetation.

Crowds out native vegetation resulting in decreased plant biodiversity.

Has the potential to alter surrounding water chemistry, which may harm phytoplankton and other aquatic organisms.

Dense floating mats of water soldier can hinder recreational activities, such as boating, angling and swimming.

Sharp serrated leaf edges can cut swimmers and individuals who handle water soldier plants. Caution should be taken whenever handling the plant.

Habitat

- Slow moving or still meso-eutrophic waters
- Not commonly found in fast moving water
- Not found where water levels fluctuates
- Prefers soft muddy sediments
- Grows in 0.5' -10+' of water (0.5'-6' primarily in Ontario)
- Prefers back bays and shorelines in Trent-Severn Waterway - Lake Seymour



(Smith, 2014)



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The typical habitat of water soldier is still or slow-flowing, meso-eutrophic water. It is not found in very shallow water, fast flowing water, or in areas where water fluctuates due to the sinking and floating behavior of the plant. The plant is lightly rooted and prefers soft muddy sediments.

Under conditions of low light the leaves do not develop enough gas in their air-canals and intercellular spaces to become emergent, and it is normal to find water soldier as a bottom-dwelling plant in water between 1 - 5 m deep, with low light conditions


Describe the pic taken the bathymetry and turned into colour ramp darker deeper

Morphology


- Rosette leaves can grow up to 24+ inches
- Sword shaped leaves
- Bright green in color
- Leaves are rigid, brittle and have a serrated margin of sharp spines
- Flowers are white with 3 petals
- Asexual reproduction by way of offsets and turions
- Lightly rooted in soft sediments




(Gilhooley, 2015)




(Gilhooley, 2015)




(Sallaway, 2014)



(Smith, 2014)



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Rosette leaves can grow up to 60 cm

Bright green in colour

Leaves are Sword shaped ,rigid, brittle and have a serrated margin of sharp spines

flowers are white with 3 petals

Asexual reproduction by way of offsets and turions

Lightly rooted in soft sediments (can be mobile)

Ecology

- In the fall outer leaves get water logged and help to sink the plant
- Water soldier lays dormant on bottom of lake for the winter
- Offsets and turions dormant over the winter
- New leaves fill with photosynthetic gas and help plant rise to the surface in the spring




(Sallaway, 2015) (Sallaway, 2015)

(Sallaway, 2015) (Smith, 2013)

ONTARIO'S INVADING SPECIES PREVENTION PROGRAM

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Seasonal changes in temperature result in ecological and morphological changes to the water soldier plants, water soldier becomes submerged in water in the fall, and over winters in a rootless state. You can see the outside leaves are brown, this is what helps the plants sinking behaviour. Outer leaves loose photosynthetic gas this helps it to become buoyant in the summer and in the fall these leaves loose the gas and become waterlogged which helps the plant to sink.

In the winter, the leaves together with the stem perform a storage function keeping starch in their cells and this helps it to survive the winter

These rosette shoots and turions survive the winter season on the bottom of the lake under the ice


In the spring as a rootless rosette rises toward the water surface and forms new additional roots, the offsets become active, and the vegetative reproduction begins again

Reproduction


- Vegetative reproduction through offsets and turions
- No viable seed (no sexual reproduction)
- Each plant can have multiple offsets and turions
- Fate of turions not well known



(McGowan, 2014)



(McGowan, 2014)




(Smith, 2014)



(Smith, 2014)



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Water soldier relies primarily on vegetative reproduction through offsets. The offsets develop directly into open rosettes resembling small versions of the parent and become detached by late summer. Offsets that develop late in the growing season are almost bud-like and are called “turions”. Turions will remain attached to the mother plant until the following spring when they detach.

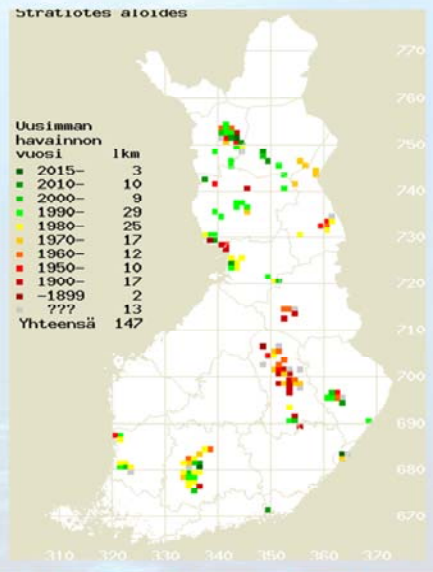
Potential mechanisms for turion or offset dormancy are not clearly addressed in the literature and this information is critical in developing long-term management plans.

Potential pathways of introduction

- **Hitchhiking/fouling of boats**
 - Trent-Severn Waterway (TSW) connects to Great Lakes, St Lawrence River
- **Stocking/Planting/Escape from Culture**
 - Source of TSW infestation (OMNRF)
 - Available from water garden suppliers
- **Water movement**
 - Buds easily dispersed (26 miles between upstream and downstream TSW infestations)
 - 84% of propagules resprouted (Sarneel, 2013)
 - *Stratoides* buds increased buoyancy in Spring (Sarneel, 2013)
- **Waterfowl?????**

Water soldier in Finland

- “Arrived around 11,000 years ago”
- “The plant’s vegetative spread is quite limited”
- “Necessary for Finland’s rarest dragonflies, who won’t lay their eggs anywhere else”
- NatureGate
(www.luontoportti.com)



Water soldier in New South Wales, AUS

- “has the potential to become a serious weed of freshwater lakes, ponds in Australia”
- “can grow in depths of up to 5 meters”
- herbicide use limited to glyphosate on emergent parts of plant
- “NSW Weedwise”



Water Soldier in the UK

Native in England & Wales, Invasive in Ireland



North American Infestations

Trent-Severn Waterway/Lake Seymour and Black
River, Ontario





This is a picture of a land owners water front in 2013, she has been keeping photos to document the spread of water soldier in front her dock.



You can see in one year that the water soldier has filled spaces in between the offshore popns and the shoreline .



As you can see, the water soldier popn has exploded along this water front in a very short period of time.

Biological control

- Experiment in 10 Dutch wetlands
- 1 year old water soldier plants
- Grazing by waterbirds measured
- Reduced biomass by 60%
- Decreased survival of *Stratoides*
- GF (Ciska) Veen, et al. *Freshwater Biology*, September 2013

Physical Control

- Hand removal effort in Trent River (*Snyder et al. 2016*)
 - Initially as effective as herbicides, but less efficient
 - Difficulties with dense stands, turbidity
- Mechanical methods not evaluated (*Snyder*)
 - Prevalence of stumps, shallow water would be prohibitive in Lake Seymour
- Benthic barrier – 3 sites in Ontario (*OISAP 2016*)
 - Plants deceased after 2 months

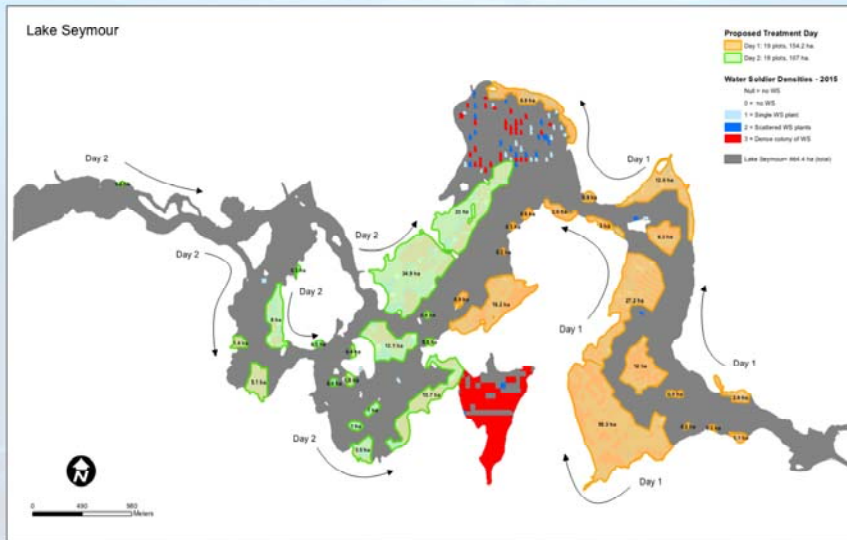
2015 Herbicide Control Project

- Ontario Federation of Anglers and Hunters
- Ontario Ministry of Natural Resources and Forests
- Ontario Ministry of Environment and Climate Change
- Trent University
- University of Florida
- SOLitude Lake Management

2015 Herbicide Control Project

- Only one herbicide approved in CA – Reward
- OMNRF consulted with Dr. Mike Netherland (U of Florida) on rate, timing.
- Ontario applicators lacked equipment and experience (failed trial), so US firms invited to bid
- Treat after Canada Thanksgiving
 - Avoid “cottage season”
 - Avoid native plant impact
 - Treat in 48 hours!
- Thank you NAFTA

Lake Seymour Water Soldier Control **Fall 2015 Treatment Plan – Reward for 370 acres**



LAKE SEYMOUR
Reward Treatment (As Applied)
October 14 & 15, 2015
Area treated: 146.5 hectares
Reward applied: 724 gallons



2016

South Shores – 2015 & 2016



Lake Seymour - October 2016 282 acres

LAKE SEYMOUR Water Soldier Treatment - Fall 2016

Map prepared by Solihule Lake Management
11/2/16, Revised 12/1/16

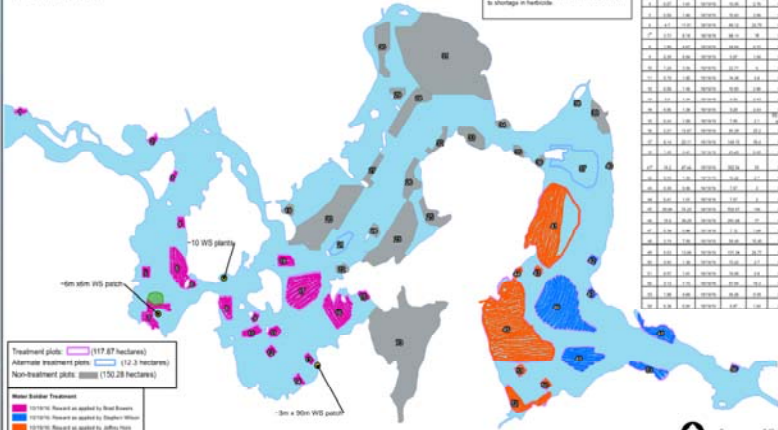
NOTES
S0 - Surface spray treatment
Plot 2: Additional area treated adjacent to
this plot due to increased plant growth
Plot 4: Some 100 ft. treatment treated in this plot due
to overgrowth in this plot

Total Treated Area: 114.19 hectares

Plot	Area (ha)	Treated Area (ha)	Percent Treated (%)	Notes
1	0.05	0.05	100	
2	0.05	0.05	100	
3	0.05	0.05	100	
4	0.05	0.05	100	
5	0.05	0.05	100	
6	0.05	0.05	100	
7	0.05	0.05	100	
8	0.05	0.05	100	
9	0.05	0.05	100	
10	0.05	0.05	100	
11	0.05	0.05	100	
12	0.05	0.05	100	
13	0.05	0.05	100	
14	0.05	0.05	100	
15	0.05	0.05	100	
16	0.05	0.05	100	
17	0.05	0.05	100	
18	0.05	0.05	100	
19	0.05	0.05	100	
20	0.05	0.05	100	
21	0.05	0.05	100	
22	0.05	0.05	100	
23	0.05	0.05	100	
24	0.05	0.05	100	
25	0.05	0.05	100	
26	0.05	0.05	100	
27	0.05	0.05	100	
28	0.05	0.05	100	
29	0.05	0.05	100	
30	0.05	0.05	100	
31	0.05	0.05	100	
32	0.05	0.05	100	
33	0.05	0.05	100	
34	0.05	0.05	100	
35	0.05	0.05	100	
36	0.05	0.05	100	
37	0.05	0.05	100	
38	0.05	0.05	100	
39	0.05	0.05	100	
40	0.05	0.05	100	
41	0.05	0.05	100	
42	0.05	0.05	100	
43	0.05	0.05	100	
44	0.05	0.05	100	
45	0.05	0.05	100	
46	0.05	0.05	100	
47	0.05	0.05	100	
48	0.05	0.05	100	
49	0.05	0.05	100	
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69	0.05	0.05	100	
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81	0.05	0.05	100	
82	0.05	0.05	100	
83	0.05	0.05	100	
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91	0.05	0.05	100	
92	0.05	0.05	100	
93	0.05	0.05	100	
94	0.05	0.05	100	
95	0.05	0.05	100	
96	0.05	0.05	100	
97	0.05	0.05	100	
98	0.05	0.05	100	
99	0.05	0.05	100	
100	0.05	0.05	100	

Treatment plots: (117.87 hectares)
Adjacent treatment plots: (12.3 hectares)
Non-treatment plots: (152.28 hectares)

Water Soldier Treatment
S0 (10/16) Resistant as applied by Boat Boats
S1 (10/16) Resistant as applied by Boat Boats
S2 (10/16) Resistant as applied by Boat Boats
S3 (10/16) Resistant as applied by Boat Boats
S4 (10/16) Resistant as applied by Boat Boats
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S99 (10/16) Resistant as applied by Boat Boats
S100 (10/16) Resistant as applied by Boat Boats



CHOWE BAY Water Soldier Treatment - Fall 2016

Map prepared by: Solihull Lake Management
2016/17

Water Soldier Treatment

- 100% treated
- 50-75% treated
- 25-50% treated

Total Treated Areas - 16.75 hectares

Zone	Area (ha)	Percentage	Notes
1	1.75	10.4%	100% treated
2	1.75	10.4%	100% treated
3	1.75	10.4%	100% treated
4	1.75	10.4%	100% treated
5	1.75	10.4%	100% treated
6	1.75	10.4%	100% treated
7	1.75	10.4%	100% treated
8	1.75	10.4%	100% treated
9	1.75	10.4%	100% treated
10	1.75	10.4%	100% treated
11	1.75	10.4%	100% treated
12	1.75	10.4%	100% treated
13	1.75	10.4%	100% treated
14	1.75	10.4%	100% treated
15	1.75	10.4%	100% treated
16	1.75	10.4%	100% treated
17	1.75	10.4%	100% treated
18	1.75	10.4%	100% treated
19	1.75	10.4%	100% treated
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37	1.75	10.4%	100% treated
38	1.75	10.4%	100% treated
39	1.75	10.4%	100% treated
40	1.75	10.4%	100% treated
41	1.75	10.4%	100% treated
42	1.75	10.4%	100% treated
43	1.75	10.4%	100% treated
44	1.75	10.4%	100% treated
45	1.75	10.4%	100% treated
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47	1.75	10.4%	100% treated
48	1.75	10.4%	100% treated
49	1.75	10.4%	100% treated
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52	1.75	10.4%	100% treated
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57	1.75	10.4%	100% treated
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59	1.75	10.4%	100% treated
60	1.75	10.4%	100% treated
61	1.75	10.4%	100% treated
62	1.75	10.4%	100% treated
63	1.75	10.4%	100% treated
64	1.75	10.4%	100% treated
65	1.75	10.4%	100% treated
66	1.75	10.4%	100% treated
67	1.75	10.4%	100% treated
68	1.75	10.4%	100% treated
69	1.75	10.4%	100% treated
70	1.75	10.4%	100% treated
71	1.75	10.4%	100% treated
72	1.75	10.4%	100% treated
73	1.75	10.4%	100% treated
74	1.75	10.4%	100% treated
75	1.75	10.4%	100% treated
76	1.75	10.4%	100% treated
77	1.75	10.4%	100% treated
78	1.75	10.4%	100% treated
79	1.75	10.4%	100% treated
80	1.75	10.4%	100% treated
81	1.75	10.4%	100% treated
82	1.75	10.4%	100% treated
8			

Fall 2017 Treatment

- Timing – Two weeks earlier – Oct. 2-3
- Area – 2x greater area – ~700 acres (all infestations)
- Expansion – from 1(2015) to 4 zones



Lake Seymour and downstream areas Fall 2017 Treatment Plan

**TRENT SEVERN WATERWAY
Water Soldier Treatment - Fall 2017**
Map prepared by Northlake Lake Management
Scale 1:1

Lake Seymour

Crown Bay

Wilson Island

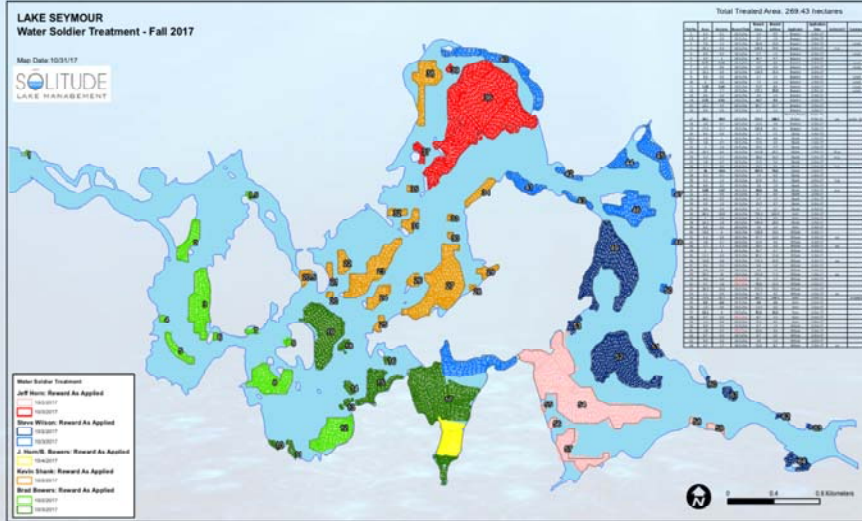
Percy Reach

0 1 km 2.5 km

Northlake Lake Management

Map 1:1

Lake Seymour - October 2017 Treatment 665 acres



CROWE BAY
Water Sample Treatment - Fall 2017

Map Date: 10/20/17

SOLITUDE
LIFE SCIENCE GROUP

PERCY REACH
Water Sample Treatment - Fall 2017

Map Date: 10/20/17

SOLITUDE
LIFE SCIENCE GROUP

Water Sample Treatment
10/20/17: Treated As Approved By Water Board
10/20/17: Treated As Approved By Water Board

Total Treated Sites: 9 of 20 locations

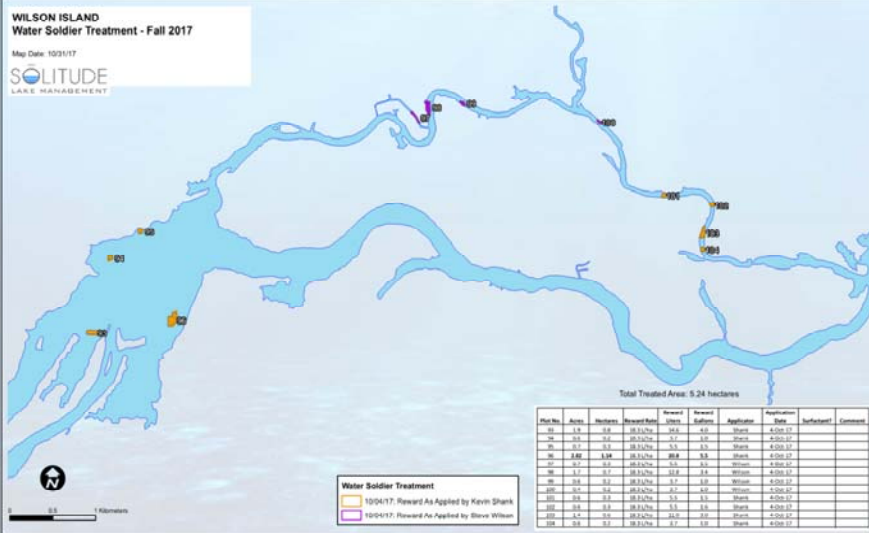
Date	Site	Depth	Species	Species Count	Date	Site	Depth	Species	Comments
10/20/17	1	10m	1	1	10/20/17	1	10m	1	
10/20/17	2	10m	1	1	10/20/17	2	10m	1	
10/20/17	3	10m	1	1	10/20/17	3	10m	1	
10/20/17	4	10m	1	1	10/20/17	4	10m	1	
10/20/17	5	10m	1	1	10/20/17	5	10m	1	
10/20/17	6	10m	1	1	10/20/17	6	10m	1	
10/20/17	7	10m	1	1	10/20/17	7	10m	1	
10/20/17	8	10m	1	1	10/20/17	8	10m	1	
10/20/17	9	10m	1	1	10/20/17	9	10m	1	
10/20/17	10	10m	1	1	10/20/17	10	10m	1	
10/20/17	11	10m	1	1	10/20/17	11	10m	1	
10/20/17	12	10m	1	1	10/20/17	12	10m	1	
10/20/17	13	10m	1	1	10/20/17	13	10m	1	
10/20/17	14	10m	1	1	10/20/17	14	10m	1	
10/20/17	15	10m	1	1	10/20/17	15	10m	1	
10/20/17	16	10m	1	1	10/20/17	16	10m	1	
10/20/17	17	10m	1	1	10/20/17	17	10m	1	
10/20/17	18	10m	1	1	10/20/17	18	10m	1	
10/20/17	19	10m	1	1	10/20/17	19	10m	1	
10/20/17	20	10m	1	1	10/20/17	20	10m	1	

Wilson Island - October 2017 Treatment 13 acres

WILSON ISLAND
Water Soldier Treatment - Fall 2017

Map Date: 10/31/17

SOLITUDE
LAKE MANAGEMENT



Plot No.	Acres	Hectares	Revised Plot	Revised Acres	Revised Hectares	Application Date	Surfactant	Comments
10	1.8	0.8	10.1.1.1.1	1.8	0.8	Shank	4/10/17	
11	0.1	0.1	10.1.1.1.2	0.1	0.1	Shank	4/10/17	
12	0.1	0.1	10.1.1.1.3	0.1	0.1	Shank	4/10/17	
13	0.1	0.1	10.1.1.1.4	0.1	0.1	Shank	4/10/17	
14	0.1	0.1	10.1.1.1.5	0.1	0.1	Shank	4/10/17	
15	0.1	0.1	10.1.1.1.6	0.1	0.1	Shank	4/10/17	
16	0.1	0.1	10.1.1.1.7	0.1	0.1	Shank	4/10/17	
17	0.1	0.1	10.1.1.1.8	0.1	0.1	Shank	4/10/17	
18	0.1	0.1	10.1.1.1.9	0.1	0.1	Shank	4/10/17	
19	0.1	0.1	10.1.1.1.10	0.1	0.1	Shank	4/10/17	
20	0.1	0.1	10.1.1.1.11	0.1	0.1	Shank	4/10/17	
21	0.1	0.1	10.1.1.1.12	0.1	0.1	Shank	4/10/17	
22	0.1	0.1	10.1.1.1.13	0.1	0.1	Shank	4/10/17	
23	0.1	0.1	10.1.1.1.14	0.1	0.1	Shank	4/10/17	
24	0.1	0.1	10.1.1.1.15	0.1	0.1	Shank	4/10/17	
25	0.1	0.1	10.1.1.1.16	0.1	0.1	Shank	4/10/17	
26	0.1	0.1	10.1.1.1.17	0.1	0.1	Shank	4/10/17	
27	0.1	0.1	10.1.1.1.18	0.1	0.1	Shank	4/10/17	
28	0.1	0.1	10.1.1.1.19	0.1	0.1	Shank	4/10/17	
29	0.1	0.1	10.1.1.1.20	0.1	0.1	Shank	4/10/17	
30	0.1	0.1	10.1.1.1.21	0.1	0.1	Shank	4/10/17	
31	0.1	0.1	10.1.1.1.22	0.1	0.1	Shank	4/10/17	
32	0.1	0.1	10.1.1.1.23	0.1	0.1	Shank	4/10/17	
33	0.1	0.1	10.1.1.1.24	0.1	0.1	Shank	4/10/17	
34	0.1	0.1	10.1.1.1.25	0.1	0.1	Shank	4/10/17	
35	0.1	0.1	10.1.1.1.26	0.1	0.1	Shank	4/10/17	
36	0.1	0.1	10.1.1.1.27	0.1	0.1	Shank	4/10/17	
37	0.1	0.1	10.1.1.1.28	0.1	0.1	Shank	4/10/17	
38	0.1	0.1	10.1.1.1.29	0.1	0.1	Shank	4/10/17	
39	0.1	0.1	10.1.1.1.30	0.1	0.1	Shank	4/10/17	
40	0.1	0.1	10.1.1.1.31	0.1	0.1	Shank	4/10/17	
41	0.1	0.1	10.1.1.1.32	0.1	0.1	Shank	4/10/17	
42	0.1	0.1	10.1.1.1.33	0.1	0.1	Shank	4/10/17	
43	0.1	0.1	10.1.1.1.34	0.1	0.1	Shank	4/10/17	
44	0.1	0.1	10.1.1.1.35	0.1	0.1	Shank	4/10/17	
45	0.1	0.1	10.1.1.1.36	0.1	0.1	Shank	4/10/17	
46	0.1	0.1	10.1.1.1.37	0.1	0.1	Shank	4/10/17	
47	0.1	0.1	10.1.1.1.38	0.1	0.1	Shank	4/10/17	
48	0.1	0.1	10.1.1.1.39	0.1	0.1	Shank	4/10/17	
49	0.1	0.1	10.1.1.1.40	0.1	0.1	Shank	4/10/17	
50	0.1	0.1	10.1.1.1.41	0.1	0.1	Shank	4/10/17	
51	0.1	0.1	10.1.1.1.42	0.1	0.1	Shank	4/10/17	
52	0.1	0.1	10.1.1.1.43	0.1	0.1	Shank	4/10/17	
53	0.1	0.1	10.1.1.1.44	0.1	0.1	Shank	4/10/17	
54	0.1	0.1	10.1.1.1.45	0.1	0.1	Shank	4/10/17	
55	0.1	0.1	10.1.1.1.46	0.1	0.1	Shank	4/10/17	
56	0.1	0.1	10.1.1.1.47	0.1	0.1	Shank	4/10/17	
57	0.1	0.1	10.1.1.1.48	0.1	0.1	Shank	4/10/17	
58	0.1	0.1	10.1.1.1.49	0.1	0.1	Shank	4/10/17	
59	0.1	0.1	10.1.1.1.50	0.1	0.1	Shank	4/10/17	
60	0.1	0.1	10.1.1.1.51	0.1	0.1	Shank	4/10/17	
61	0.1	0.1	10.1.1.1.52	0.1	0.1	Shank	4/10/17	
62	0.1	0.1	10.1.1.1.53	0.1	0.1	Shank	4/10/17	
63	0.1	0.1	10.1.1.1.54	0.1	0.1	Shank	4/10/17	
64	0.1	0.1	10.1.1.1.55	0.1	0.1	Shank	4/10/17	
65	0.1	0.1	10.1.1.1.56	0.1	0.1	Shank	4/10/17	
66	0.1	0.1	10.1.1.1.57	0.1	0.1	Shank	4/10/17	
67	0.1	0.1	10.1.1.1.58	0.1	0.1	Shank	4/10/17	
68	0.1	0.1	10.1.1.1.59	0.1	0.1	Shank	4/10/17	
69	0.1	0.1	10.1.1.1.60	0.1	0.1	Shank	4/10/17	
70	0.1	0.1	10.1.1.1.61	0.1	0.1	Shank	4/10/17	
71	0.1	0.1	10.1.1.1.62	0.1	0.1	Shank	4/10/17	
72	0.1	0.1	10.1.1.1.63	0.1	0.1	Shank	4/10/17	
73	0.1	0.1	10.1.1.1.64	0.1	0.1	Shank	4/10/17	
74	0.1	0.1	10.1.1.1.65	0.1	0.1	Shank	4/10/17	
75	0.1	0.1	10.1.1.1.66	0.1	0.1	Shank	4/10/17	
76	0.1	0.1	10.1.1.1.67	0.1	0.1	Shank	4/10/17	
77	0.1	0.1	10.1.1.1.68	0.1	0.1	Shank	4/10/17	
78	0.1	0.1	10.1.1.1.69	0.1	0.1	Shank	4/10/17	
79	0.1	0.1	10.1.1.1.70	0.1	0.1	Shank	4/10/17	
80	0.1	0.1	10.1.1.1.71	0.1	0.1	Shank	4/10/17	
81	0.1	0.1	10.1.1.1.72	0.1	0.1	Shank	4/10/17	
82	0.1	0.1	10.1.1.1.73	0.1	0.1	Shank	4/10/17	
83	0.1	0.1	10.1.1.1.74	0.1	0.1	Shank	4/10/17	
84	0.1	0.1	10.1.1.1.75	0.1	0.1	Shank	4/10/17	
85	0.1	0.1	10.1.1.1.76	0.1	0.1	Shank	4/10/17	
86	0.1	0.1	10.1.1.1.77	0.1	0.1	Shank	4/10/17	
87	0.1	0.1	10.1.1.1.78	0.1	0.1	Shank	4/10/17	
88	0.1	0.1	10.1.1.1.79	0.1	0.1	Shank	4/10/17	
89	0.1	0.1	10.1.1.1.80	0.1	0.1	Shank	4/10/17	
90	0.1	0.1	10.1.1.1.81	0.1	0.1	Shank	4/10/17	
91	0.1	0.1	10.1.1.1.82	0.1	0.1	Shank	4/10/17	
92	0.1	0.1	10.1.1.1.83	0.1	0.1	Shank	4/10/17	
93	0.1	0.1	10.1.1.1.84	0.1	0.1	Shank	4/10/17	
94	0.1	0.1	10.1.1.1.85	0.1	0.1	Shank	4/10/17	
95	0.1	0.1	10.1.1.1.86	0.1	0.1	Shank	4/10/17	
96	0.1	0.1	10.1.1.1.87	0.1	0.1	Shank	4/10/17	
97	0.1	0.1	10.1.1.1.88	0.1	0.1	Shank	4/10/17	
98	0.1	0.1	10.1.1.1.89	0.1	0.1	Shank	4/10/17	
99	0.1	0.1	10.1.1.1.90	0.1	0.1	Shank	4/10/17	
100	0.1	0.1	10.1.1.1.91	0.1	0.1	Shank	4/10/17	
101	0.1	0.1	10.1.1.1.92	0.1	0.1	Shank	4/10/17	
102	0.1	0.1	10.1.1.1.93	0.1	0.1	Shank	4/10/17	
103	0.1	0.1	10.1.1.1.94	0.1	0.1	Shank	4/10/17	
104	0.1	0.1	10.1.1.1.95	0.1	0.1	Shank	4/10/17	
105	0.1	0.1	10.1.1.1.96	0.1	0.1	Shank	4/10/17	
106	0.1	0.1	10.1.1.1.97	0.1	0.1	Shank	4/10/17	
107	0.1	0.1	10.1.1.1.98	0.1	0.1	Shank	4/10/17	
108	0.1	0.1	10.1.1.1.99	0.1	0.1	Shank	4/10/17	
109	0.1	0.1	10.1.1.1.100	0.1	0.1	Shank	4/10/17	

Fall 2017 Treatment Notes

- 4 airboats and 2 support boats
- Surfactant used on emergent sites
- Better timing on monitoring reduced plot location discrepancies
- WS in Puffball Bay stacked 2-3 plants deep
- Did not snow the next day (like in 2015)



Post-treatment survey – November 3, 2017 (1MAT)



Untreated water soldier (Plot 17 south end)



Untreated water soldier (Plot 17 south end)



Treated water soldier (Plot 17 10/3, SW)



Treated water soldier (Plot 17, 10/3, BB, west side)



Treated water soldier (Plot 16, 10/3, BB)



Untreated/Treated water soldier (Plot 25, 10/2, KS)



Treated water soldier (Plot 23, 10/2, KS)



Treated water soldier (Plot 23, 10/2, KS)



Treated water soldier (Plot 16, 10/3, SW)



Lessons Learned

- Monitoring closer to application is valuable
- Earlier season application may:
 - reduce siltation on plants
 - Allow more rapid mortality
- Supplemental product (copper herbicide, sinking agent) may improve control on submersed plants
- Earlier Fall application isn't disruptive to recreation



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