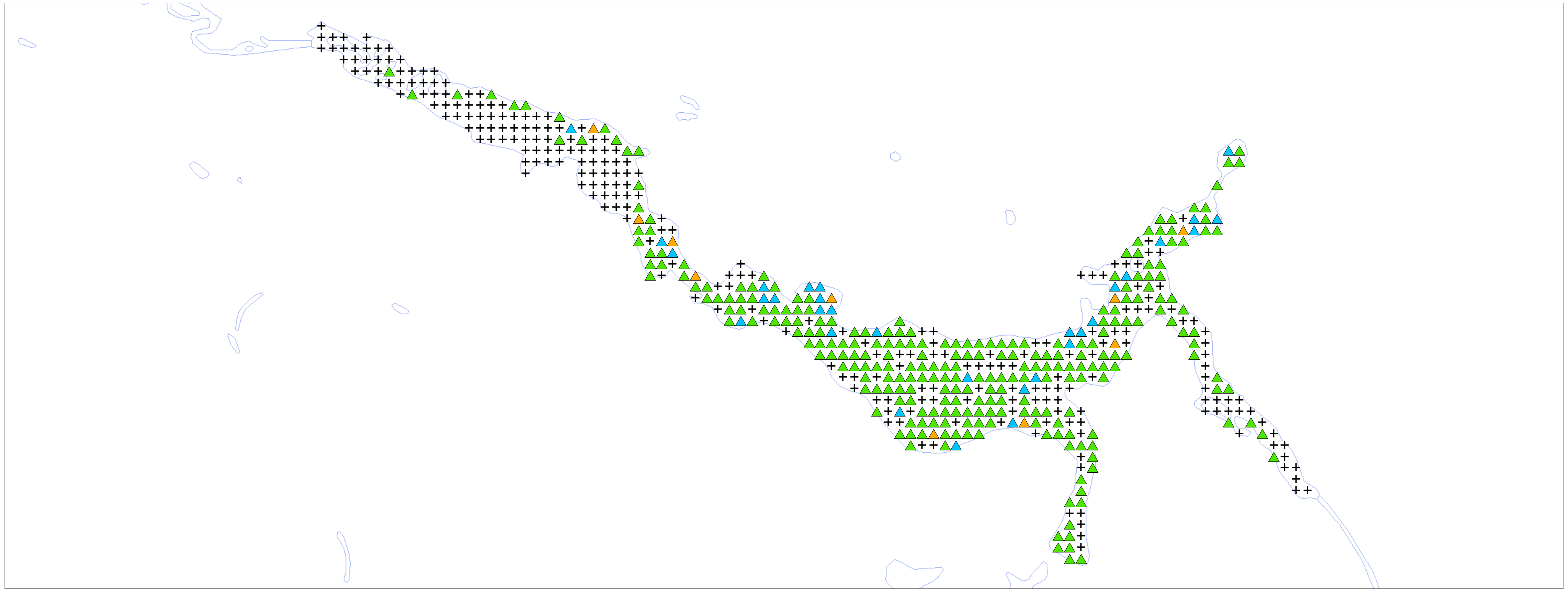
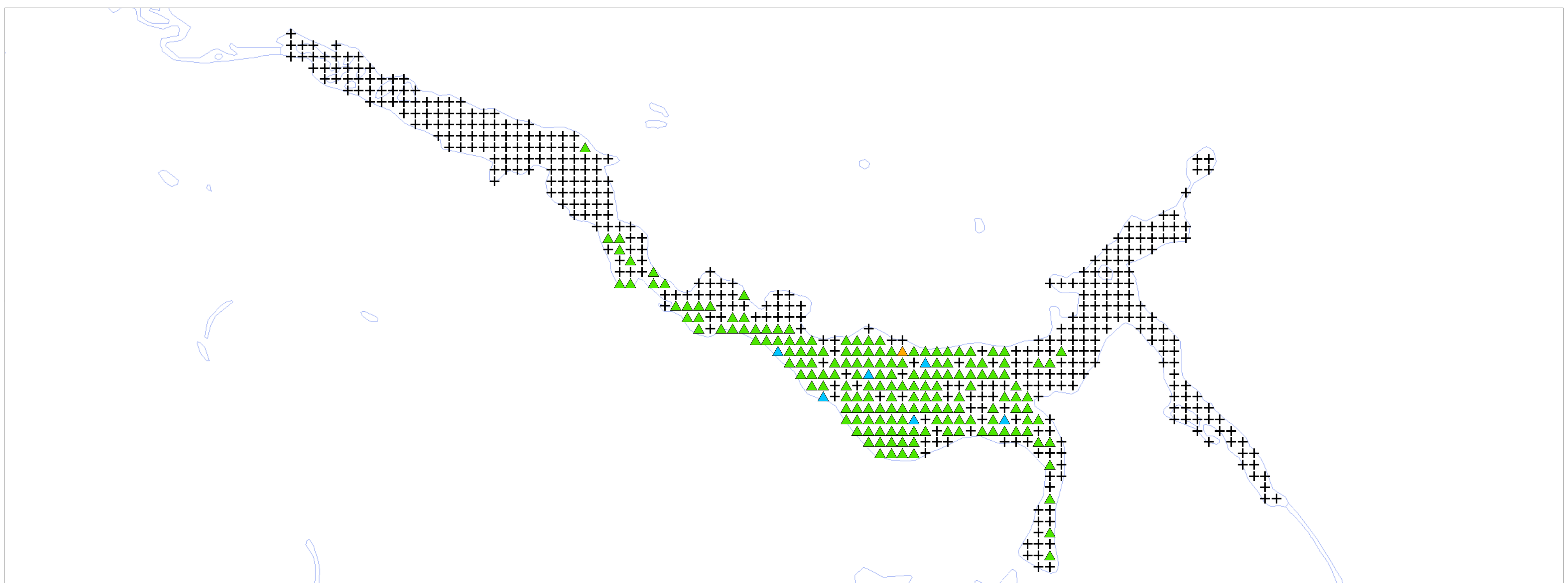
Coontail *(Ceratophyllum demersum)*





Muskgrass *(Chara sp.)*

Figure No.
1.1

Title

2014 PI Survey - Pigeon Lake Coontail and Chara

Client/Project

Pigeon Lake Protection & Rehabilitation District

Project Location
Waupaca Co., WI

193702900
Prepared by KAS on 2014-09-03
Technical Review by AB on 2014-09-03
Independent Review by JS on 2015-02-05

0 700 1,400 Feet

N

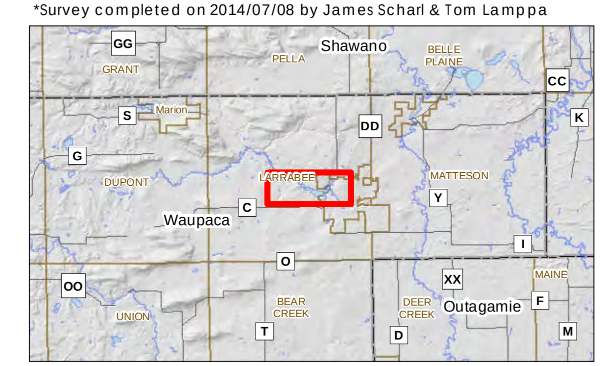
1:16,000 (At original document size of 11x17)

Legend

- + GPS Sample Points*
- ▲ Fullness Rating of 1
- ▲ Fullness Rating of 2
- ▲ Fullness Rating of 3

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

*Survey completed on 2014/07/08 by James Scharl & Tom Lamppa



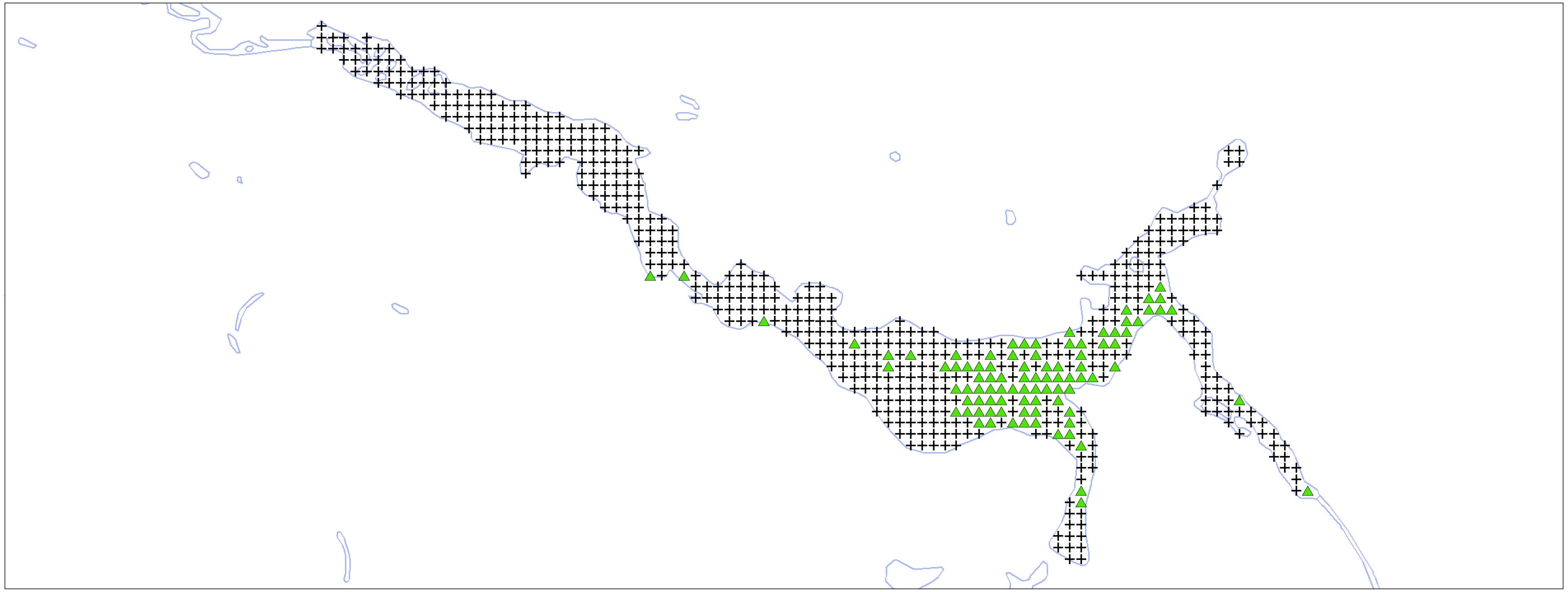
Notes

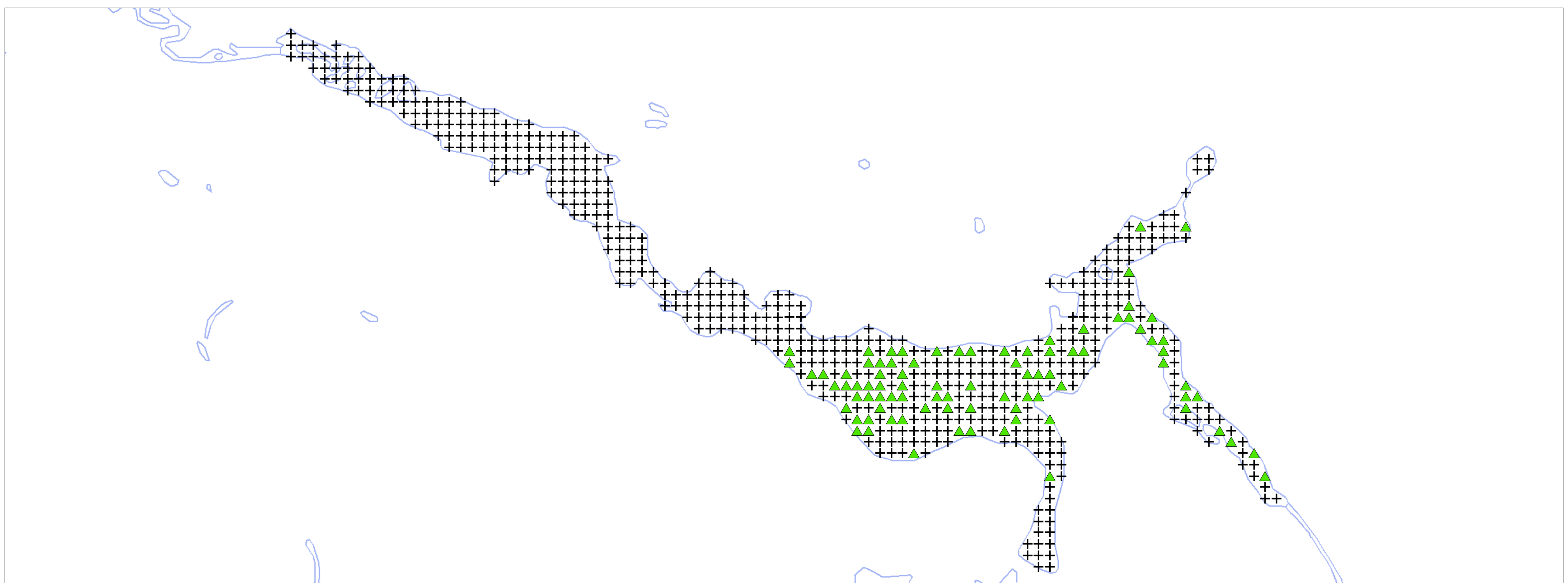
1. Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet
2. Data Sources Include: Stantec and WDNR

Stantec

R:\gis\other_PCs\193702713_AIS_PigeonLake\07_gis\mxds\PigeonLake_AquaPlantSurvey_Halves_CoonChara.mxd Revised: 2015-02-06 By: ksoltau

Slender Naiad *(Najas flexilis)*





Wild Celery *(Vallisneria americana)*

Figure No.
1.2

Title
2014 PI Survey - Pigeon Lake Slender Naiad and Wild Celery

Client/Project
Pigeon Lake Protection & Rehabillitation District

Project Location
Waupaca Co., WI

193702900
Prepared by KAS on 2014-09-03
Technical Review by AB on 2014-09-03
Independent Review by JS on 2015-02-06

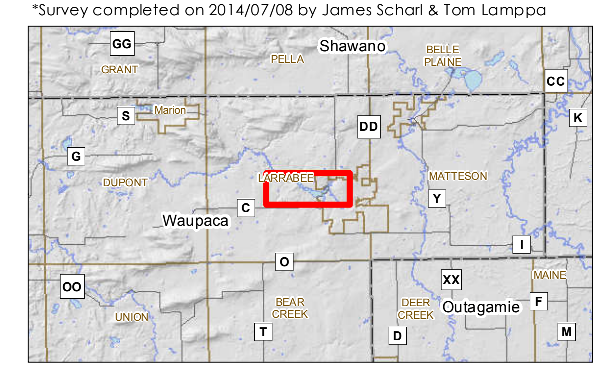
0 700 1,400 Feet
1:16,000 (At original document size of 11x17)

N

Legend
+ GPS Sample Points*
▲ Fullness Rating of 1

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

*Survey completed on 2014/07/08 by James Scharl & Tom Lamppa

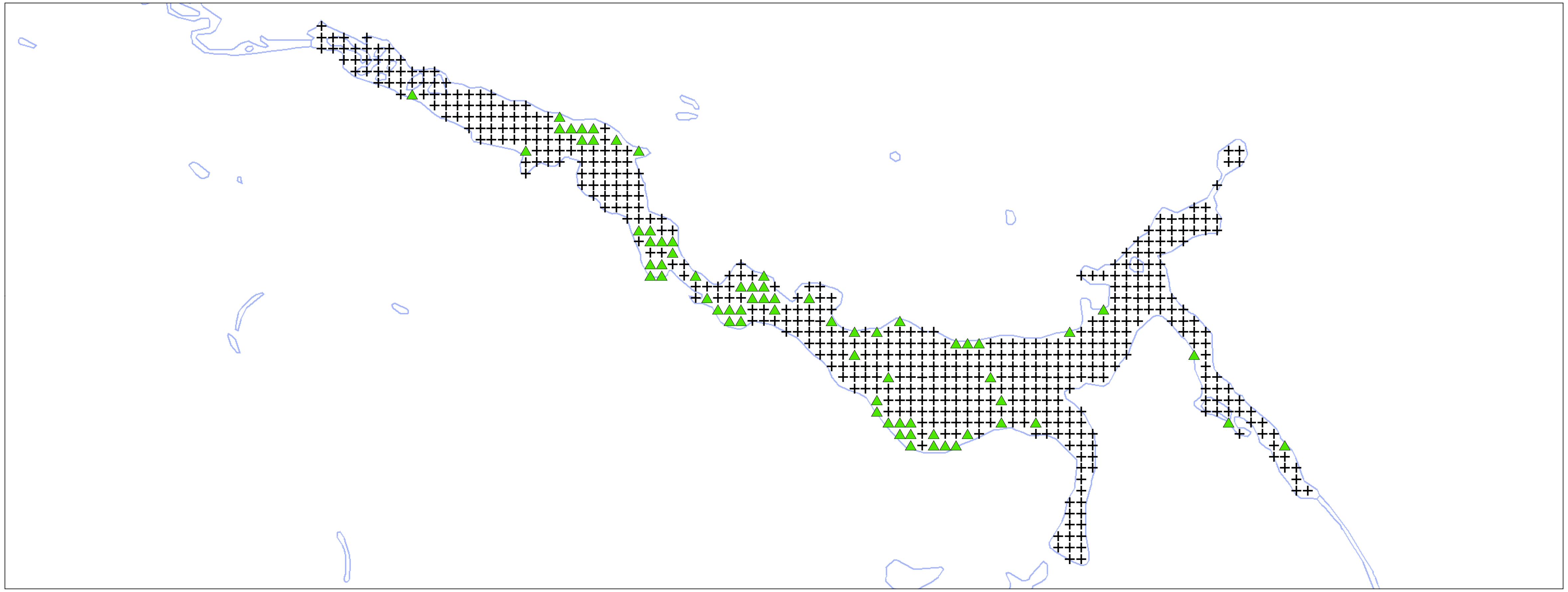


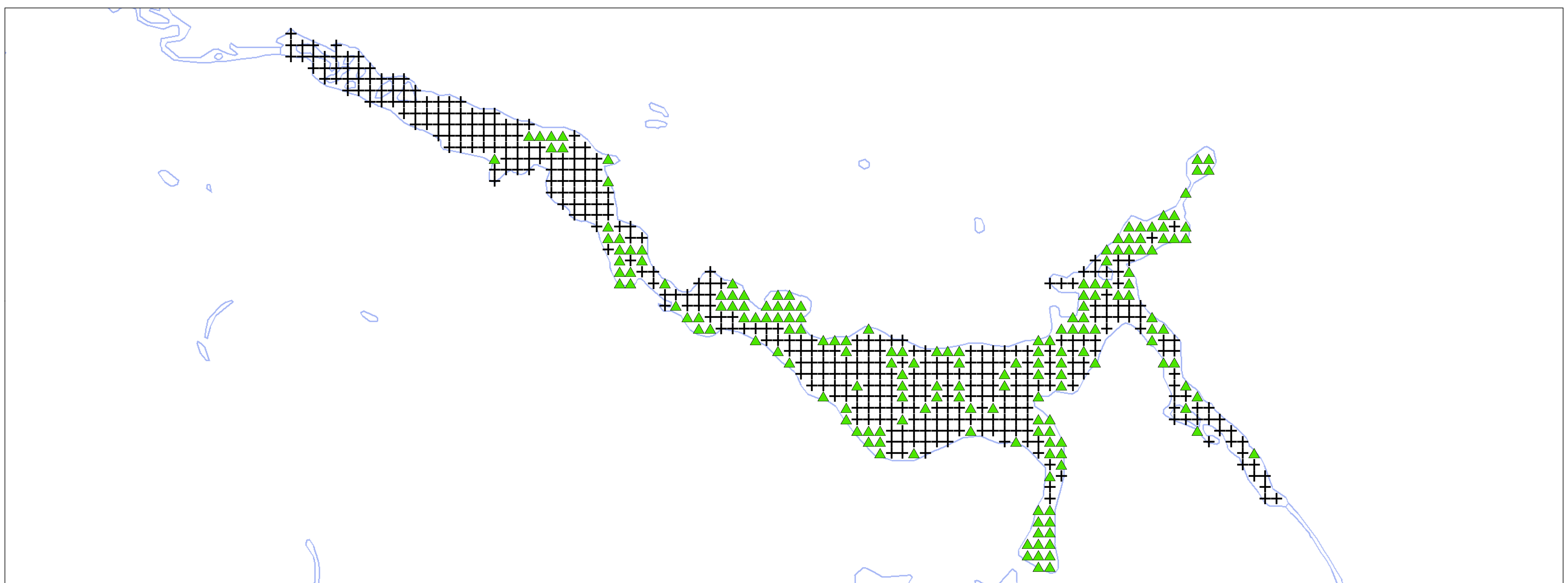
Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet
2. Data Sources Include: Stantec and WDNR

Stantec

R:\gis\other_PCs\193702713_AIS_PigeonLake\07_gis\mxds\PigeonLake_AquaPlantSurvey_Halves_SlenderCelery.mxd Revised: 2015-02-06 By: ksoltau

Small Duckweed *(Lemna minor)*





Common Watermeal *(Wolffia sp.)*

Figure No.
1.3

Title
2014 PI Survey - Pigeon Lake Small Duckweed and Common Watermeal

Client/Project
Pigeon Lake Protection & Rehabillitation District

Project Location
Waupaca Co., WI

193702900
Prepared by KAS on 2014-09-03
Technical Review by AB on 2014-09-03
Independent Review by JS on 2015-02-06

0 700 1,400 Feet

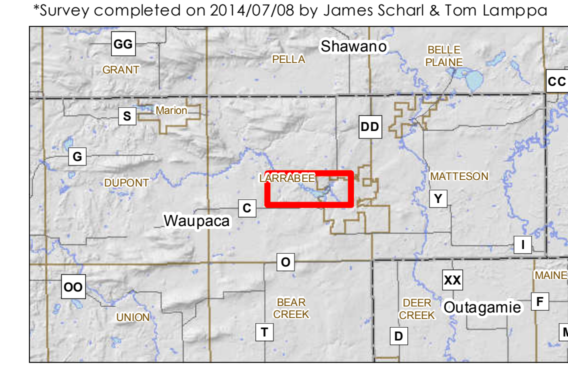
1:16,000 (At original document size of 11x17)

N

Legend
+ GPS Sample Points*
▲ Fullness Rating of 1

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

*Survey completed on 2014/07/08 by James Scharl & Tom Lamppa



Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet
2. Data Sources Include: Stantec and WDNR

Stantec

R:\gis\other_PCs\193702713_AIS_PigeonLake\07_gis\mxds\PigeonLake_AquaPlantSurvey_Halves_DuckMeal.mxd Revised: 2015-03-20 By: ksoltau

Figure No.

2

Title

2014 PI Survey - Pigeon Lake Eurasian Water-Milfoil

Client/Project

Pigeon Lake Protection & Rehabillitation District

Project Location

Waupaca Co., WI

193702713

Prepared by KS on 2014-09-11
Technical Review by AB on 2014-09-11
Independent Review by JS on 2015-02-05

0 450 900 Feet

1:11,000 (At original document size of 11x17)

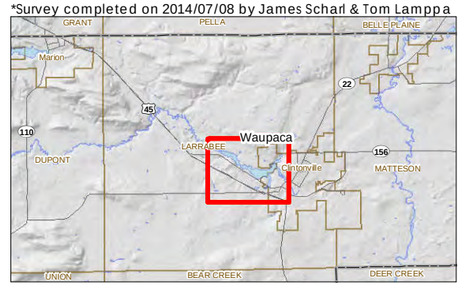
N

Legend

- \+ GPS Sample Points*
- Eurasian Water-Milfoil *(Rake Fullness of 1 Only)*
- Eurasian Water-Milfoil *(Rake head is about half full)*
- V Eurasian Water-Milfoil *(Visual)*
- Invasive Aquatic Plant Area

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

*Survey completed on 2014/07/08 by James Scharl & Tom Lamppa

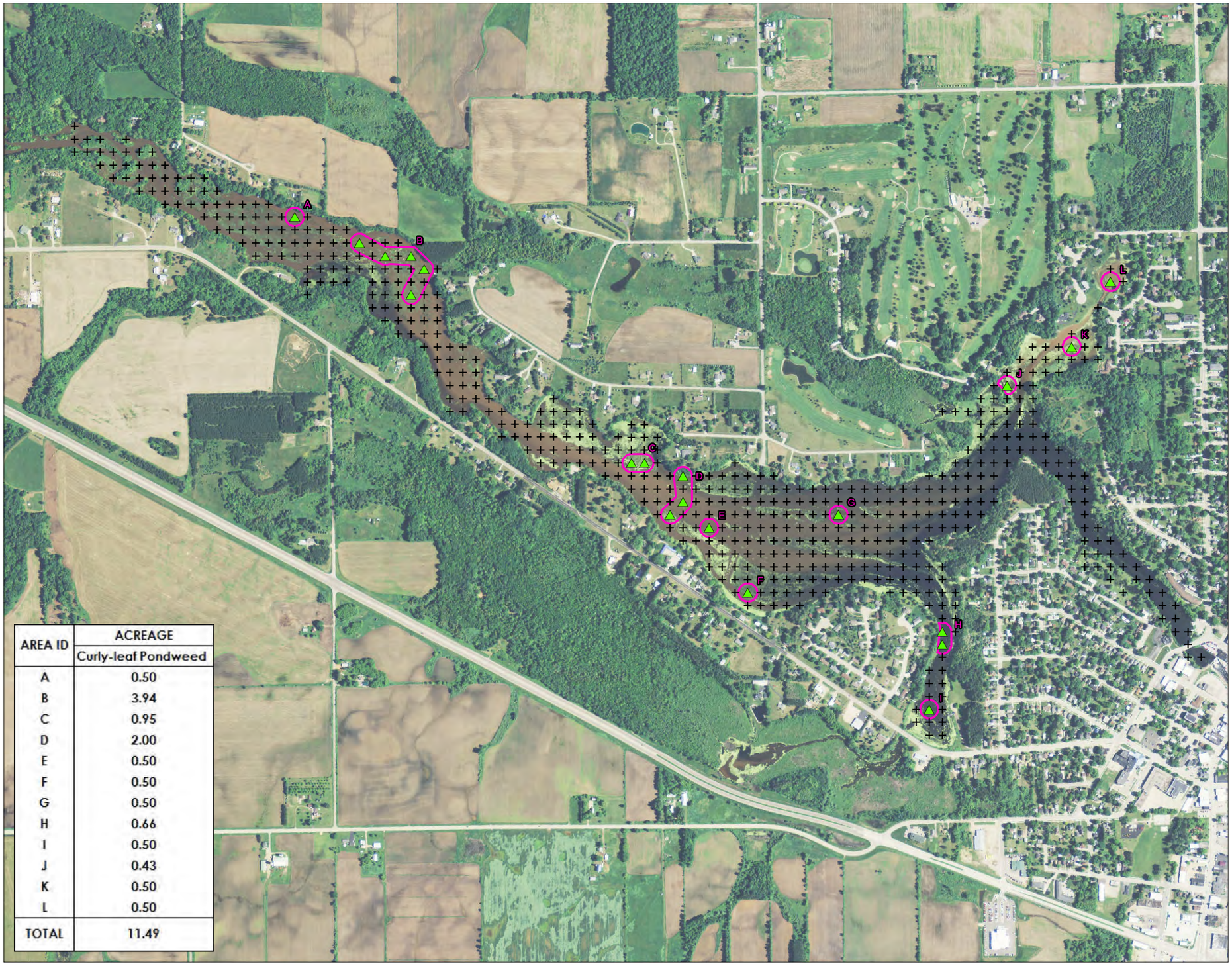


AREA ID	ACREAGE
	Eurasian Water-Milfoil
A	0.50
B	0.67
C	0.50
D	1.32
E	65.57
F	3.33
TOTAL	71.89

Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet
2. Data Sources Include: Stantec
3. Orthophotography: 2013 NAIP

Stantec



AREA ID	ACREAGE
	Curly-leaf Pondweed
A	0.50
B	3.94
C	0.95
D	2.00
E	0.50
F	0.50
G	0.50
H	0.66
I	0.50
J	0.43
K	0.50
L	0.50
TOTAL	11.49

Figure No.

3

Title

2014 PI Survey - Pigeon Lake Curly-leaf Pondweed

Client/Project

Pigeon Lake Protection & Rehabillitation District

Project Location

Waupaca Co., WI

193702713

Prepared by KS on 2014-09-11
Technical Review by AB on 2014-09-11
Independent Review by JS on 2015-02-05

0 450 900 Feet

1:11,000 (At original document size of 11x17)

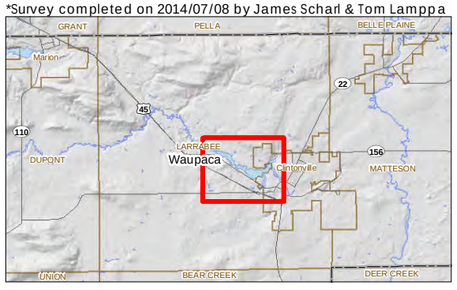
N

Legend

- \+ GPS Sample Points*
- Curly-leaf Pondweed *(Rake Fullness of 1 Only)*
- Invasive Aquatic Plant Area

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

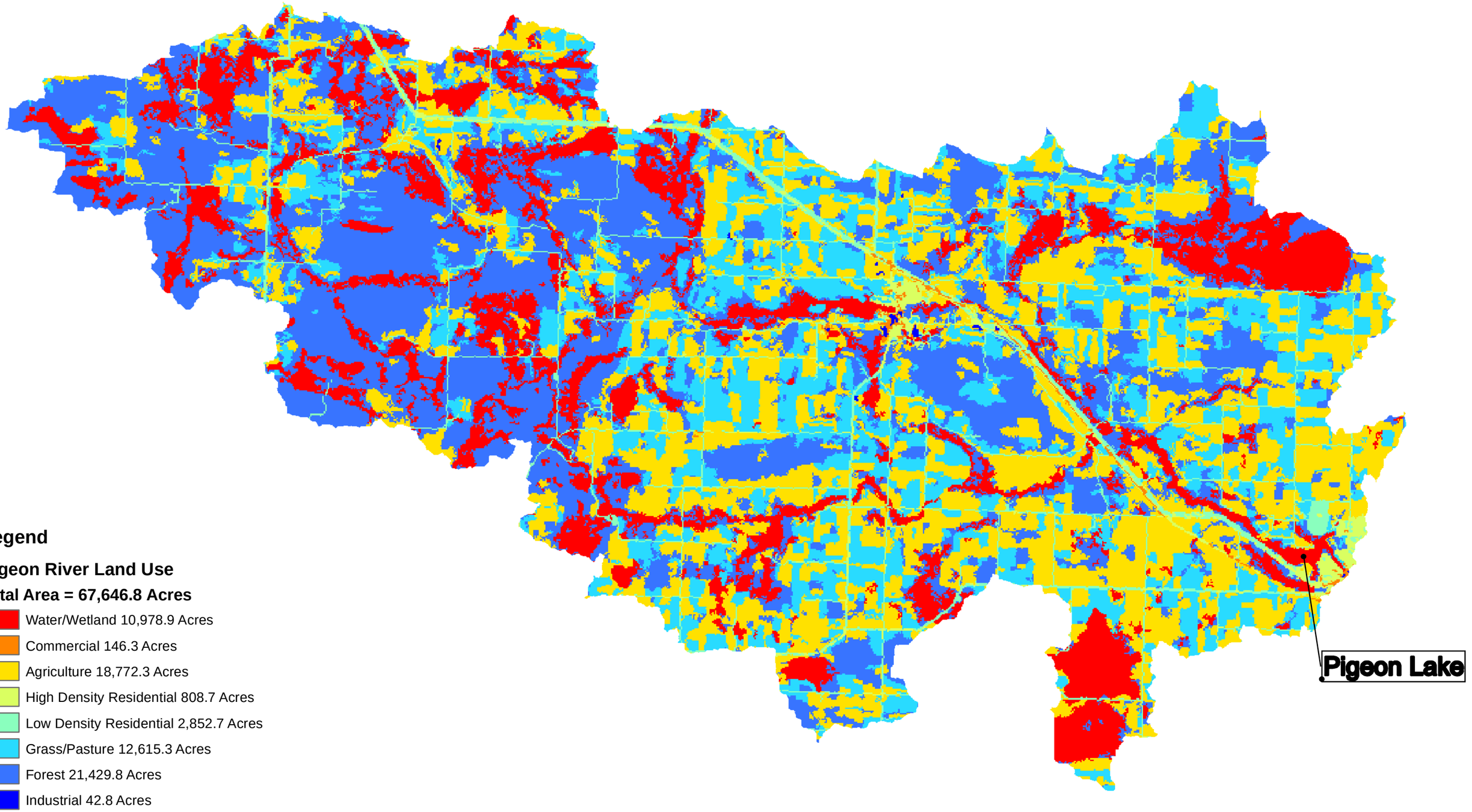
*Survey completed on 2014/07/08 by James Scharl & Tom Lamppa



Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet
2. Data Sources Include: Stantec
3. Orthophotography: 2013 NAIP

Stantec



Legend

Pigeon River Land Use

Total Area = 67,646.8 Acres

- Water/Wetland 10,978.9 Acres
- Commercial 146.3 Acres
- Agriculture 18,772.3 Acres
- High Density Residential 808.7 Acres
- Low Density Residential 2,852.7 Acres
- Grass/Pasture 12,615.3 Acres
- Forest 21,429.8 Acres
- Industrial 42.8 Acres

PIGEON RIVER WATERSHED LAND USE MAP
WAUPACA COUNTY, WI

DATE: 2014-03-13

Project Path: V:\1937\active\193702713\07_gis\mxds\Pigeon River.mxd

N

Stantec

Design With Community In Mind

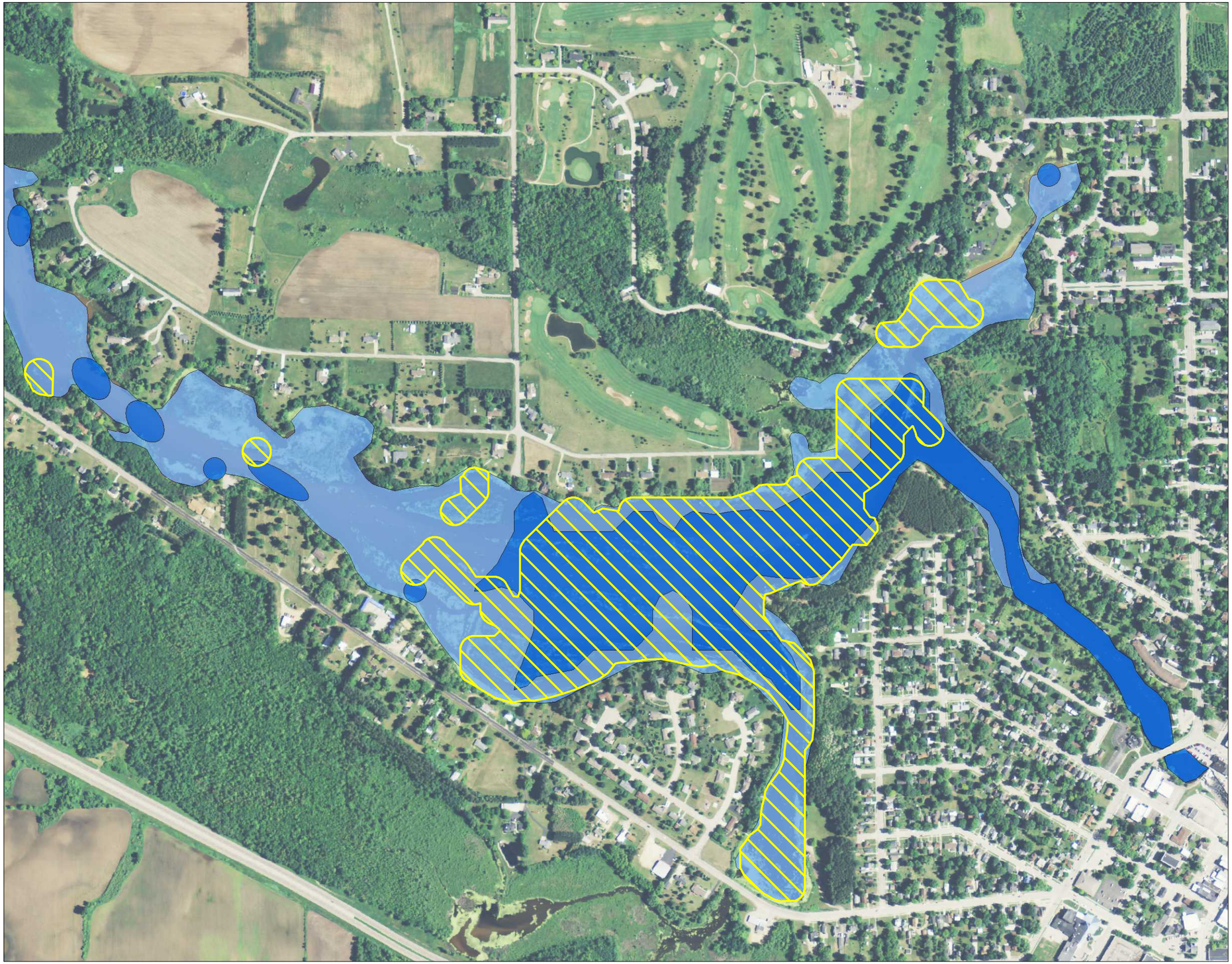


Figure No.
5

Title
Pigeon Lake
2015 Drawdown Plan

Client/Project
Pigeon Lake Protection &
Rehabillitation District

Project Location
Waupaca Co., WI

193702713
Prepared by KAS on 2015-03-13
Technical Review by BT on 2015-03-13
Independent Review by JS on 2015-03-13

0 300 600 Feet

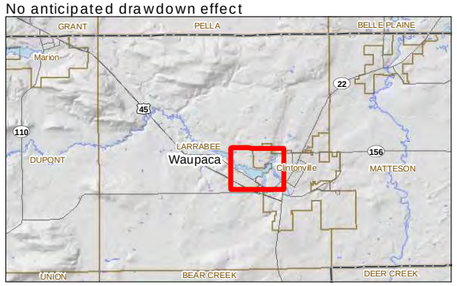
1:7,200 (At original document size of 11x17)

N

Legend
- Depth Less Than 4'
- Depth Greater Than 4'
- Eurasian Water-Milfoil

Drawdown Impact	
Depth Greater Than 4'	53.14 ac
Depth Less Than 4'	120.09 ac
AIS Impact	
Eurasian Water-Milfoil	35.54 ac

*Portions upstream of map extents are river channel only;
No anticipated drawdown effect



Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet
2. Data Sources Include: Stantec, WDNR, and WisDOT
3. Orthophotography: 2013 NAIP

Stantec

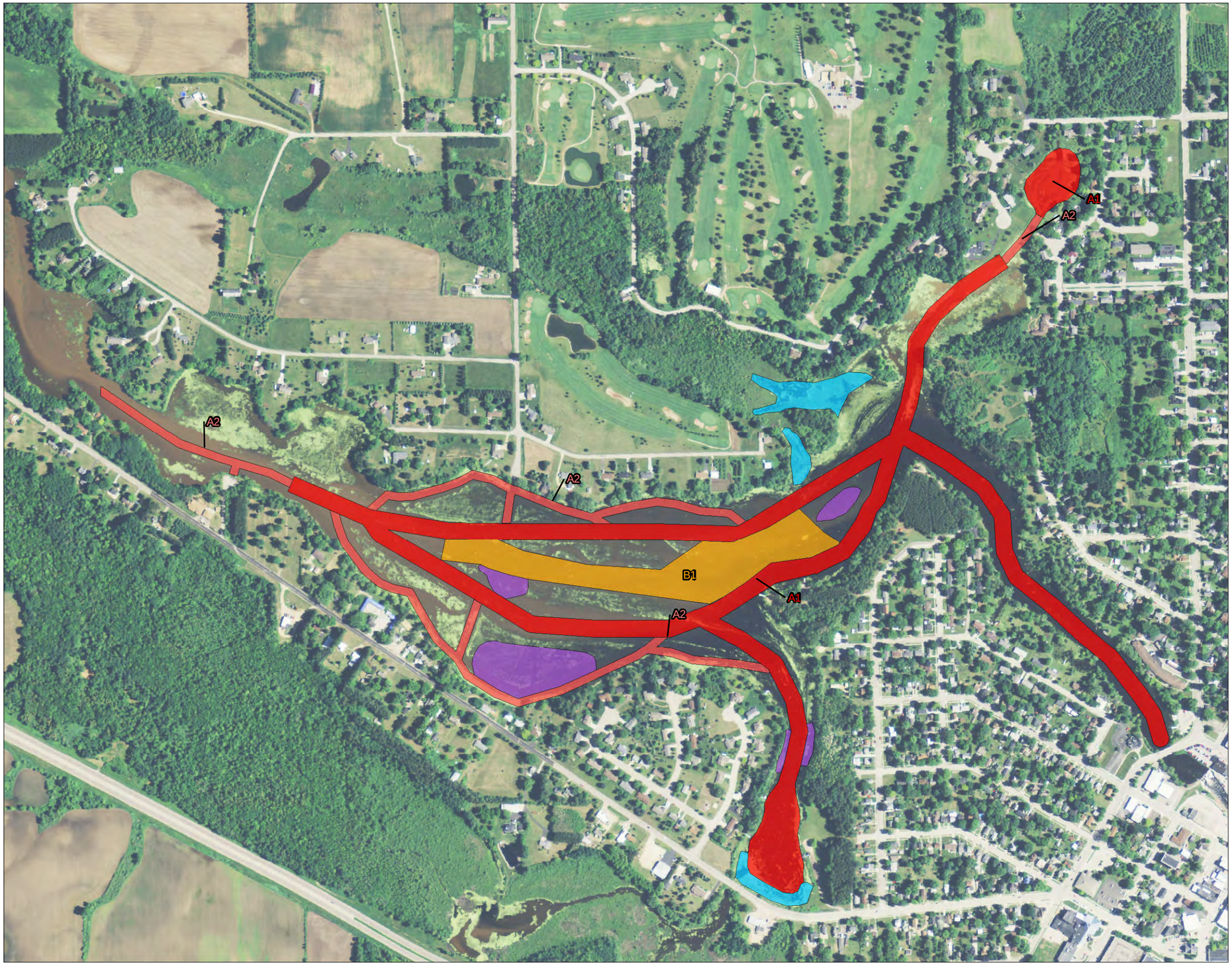


Figure No.
6

DRAFT

Title
Pigeon Lake
2015 Harvest Plan

Client/Project
Pigeon Lake Protection &
Rehabillitation District

Project Location
Waupaca Co., WI

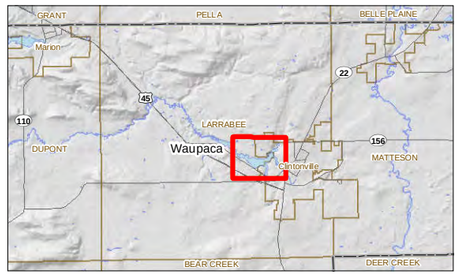
193702713
Prepared by KAS on 2015-03-10
Technical Review by MP on 2015-03-10
Independent Review by MK on 2015-03-11

0 300 600 Feet

1:7,200 (At original document size of 11x17)

N

Area	Instructions
NAVIGATIONAL ACCESS AREAS - 43.63 ac	
A_1	Cut a lane 75' wide - must leave 12" of plant growth on the bottom
A_2	Cut a lane 50' wide - must leave 12" of plant growth on the bottom
AIS MANAGEMENT AREAS - 10.78	
B_1	Top cut 2' to control surface matting of AIS and promote native species growth - prior to May 31 only.
DO NOT HARVEST	
	Floating Leaf Vegetation
	High Value Vegetation



Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet
2. Data Sources Include: Stantec, WDNR, and WisDOT
3. Orthophotography: 2013 NAIP

Stantec

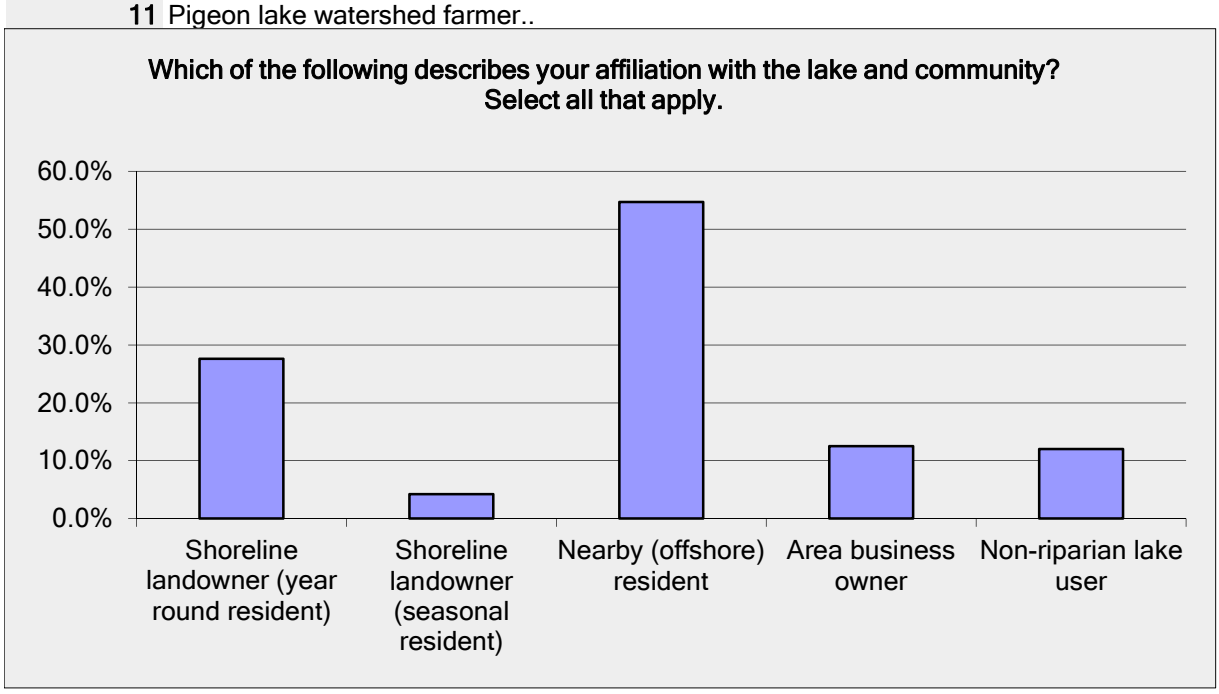
APPENDIX A

Pigeon Lake Comprehensive Lake Management Plan Update

Which of the following describes your affiliation with the lake and community? Select all that apply.

Answer Options	Response Percent	Response Count
Shoreline landowner (year round resident)	27.6%	53
Shoreline landowner (seasonal resident)	4.2%	8
Nearby (offshore) resident	54.7%	105
Area business owner	12.5%	24
Non-riparian lake user	12.0%	23
Other (please specify)		11
answered question		192
skipped question		0

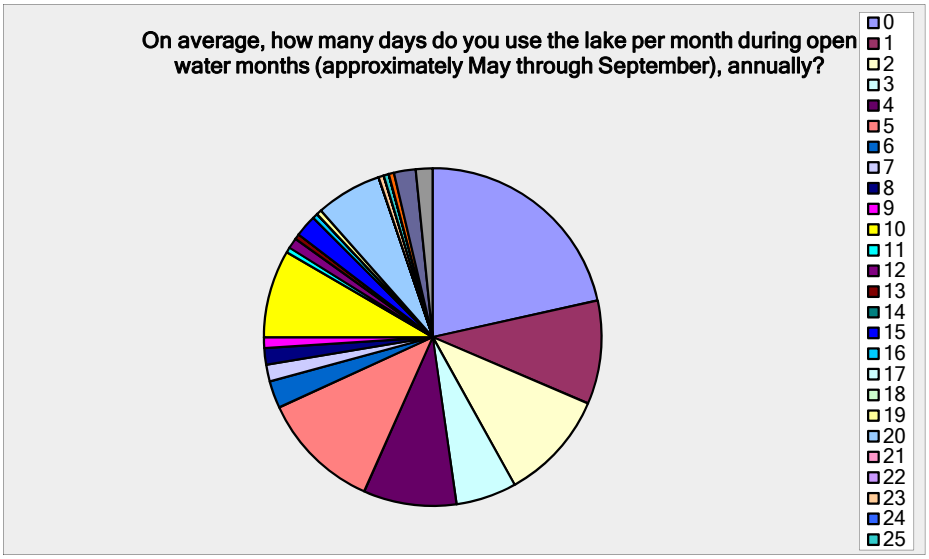
Number	Other (please specify)
1	Area business executive
2	land-owner in drainage area
3	Live on Pigeon River upstream from lake
4	shoreline landowner - vacant lot
5	Own the property but are not there often
6	South branch of the pigeon
7	Surrounding Area Landowner
8	pay the tax for this lake
9	Landowner in the watershed area
10	Pigeon river runs past my property
11	Pigeon lake watershed farmer..



Question 2

On average, how many days do you use the lake per month during open water months (approximately May through September), annually?

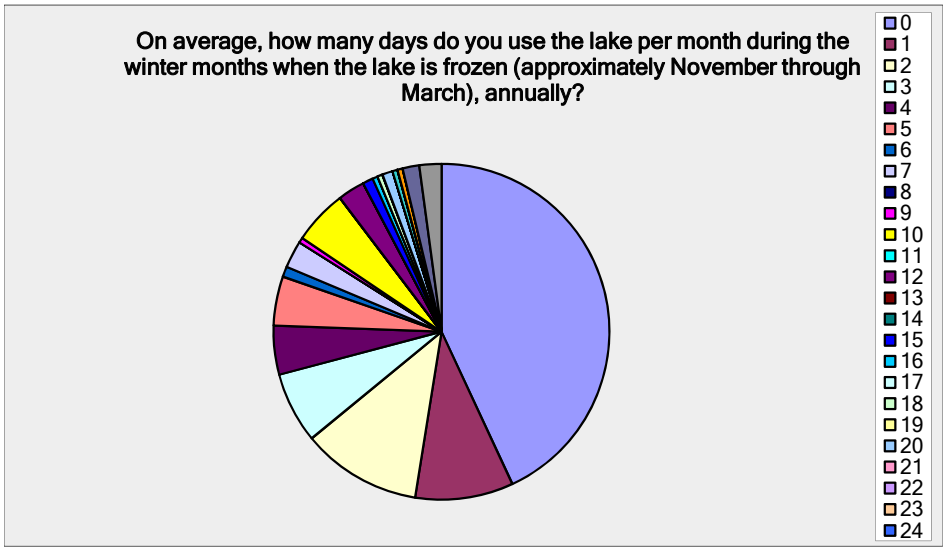
Answer Options	Response Percent	Response Count
0	21.5%	41
1	9.9%	19
2	10.5%	20
3	5.8%	11
4	8.9%	17
5	11.5%	22
6	2.6%	5
7	1.6%	3
8	1.6%	3
9	1.0%	2
10	8.4%	16
11	0.5%	1
12	1.0%	2
13	0.5%	1
14	0.0%	0
15	2.1%	4
16	0.5%	1
17	0.0%	0
18	0.0%	0
19	0.5%	1
20	6.3%	12
21	0.0%	0
22	0.0%	0
23	0.5%	1
24	0.0%	0
25	0.5%	1
26	0.0%	0
27	0.0%	0
28	0.0%	0
29	0.5%	1
30	2.1%	4
31	1.6%	3
answered question		191
skipped question		1



Question 3

On average, how many days do you use the lake per month during the winter months when the lake is frozen (approximately November through March), annually?

Answer Options	Response Percent	Response Count
0	42.9%	82
1	9.4%	18
2	11.5%	22
3	6.8%	13
4	4.7%	9
5	4.7%	9
6	1.0%	2
7	2.6%	5
8	0.0%	0
9	0.5%	1
10	5.2%	10
11	0.0%	0
12	2.6%	5
13	0.0%	0
14	0.0%	0
15	1.0%	2
16	0.5%	1
17	0.0%	0
18	0.5%	1
19	0.0%	0
20	1.0%	2
21	0.0%	0
22	0.0%	0
23	0.0%	0
24	0.0%	0
25	0.5%	1
26	0.0%	0
27	0.0%	0
28	0.5%	1
29	0.0%	0
30	1.6%	3
31	2.1%	4
answered question		191
skipped question		1

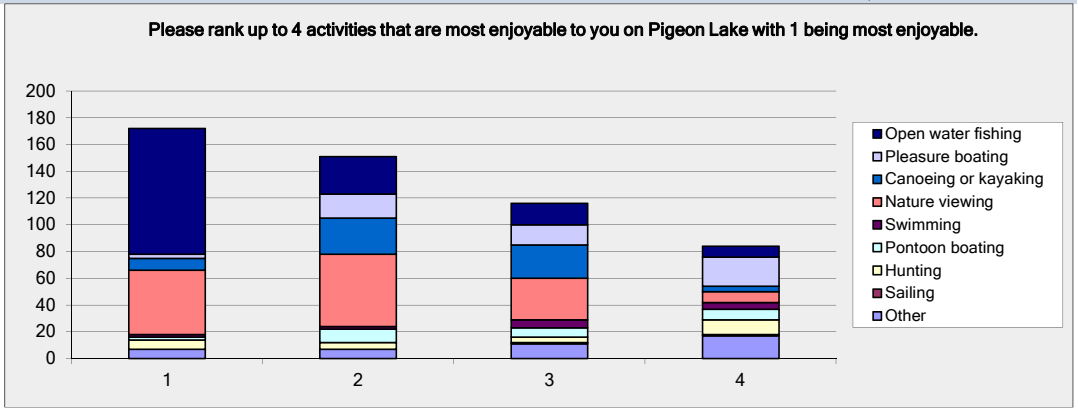


Question 4

Please rank up to 4 activities that are most enjoyable to you on Pigeon Lake with 1 being most enjoyable.

Answer Options	Open water fishing	Pleasure boating	Canoeing or kayaking	Nature viewing	Swimming	Pontoon boating	Hunting	Sailing	Other	Response Count
1	94	3	9	48	2	2	7	0	7	172
2	28	18	27	54	2	10	5	0	7	151
3	16	15	25	31	6	7	4	1	11	116
4	8	22	4	8	5	8	11	1	17	84
Average Ranking	**1.58**	2.97	**2.37**	**1.99**	2.93	2.78	2.70	3.50	2.90	
									Answered Question	**175**

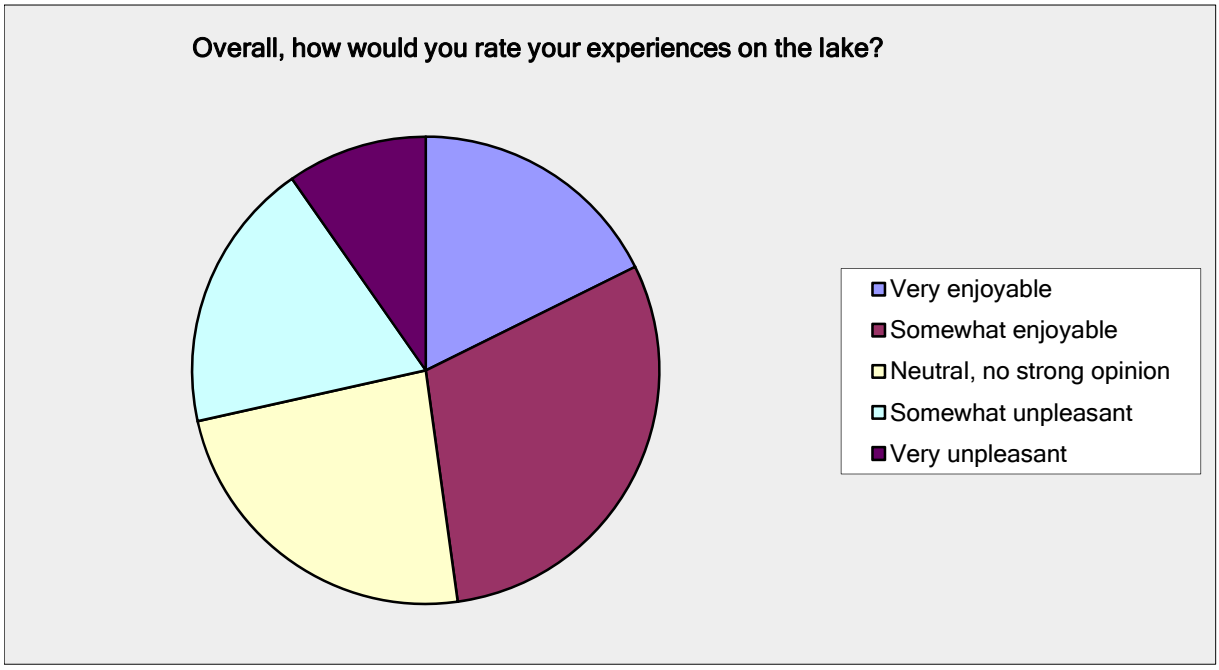
Number	Other (please specify)
1	ice fishing
2	Ice fishing
3	walking the trail
4	ice walking
5	ice fishing
6	Ice fishing
7	walking the nature trail along the lake
8	we are on the river and our activities also involvbe the lake
9	Ice Skating or Snow shoe hiking
10	Encouraging ducks and geese during migration
11	walking/hiking adjacent trails
12	none
13	you cant enjoy any of these activities on the pond...to weedy, shallow etc.
14	snowmobiling
15	Snowmobiling
16	Trapping
17	letting dog run
18	Sorry, I grew up on Lake Michigan Pigeon Lake is really a pond and not large enough for recreation.
19	ice fishing
20	I do not use the pond at all
21	none
22	Do not use the lake
23	Ice fishing
24	Strictly business owner, do not use the lake
25	no activities
26	ICE FISHING
27	Ice fishing
28	Ice Fishing
29	walking
30	Showshoeing
31	ice fishing/ walking on ice during winter
32	ice fishing
33	Jet ski
34	ice fishing



Question 5

Overall, how would you rate your experiences on the lake?

Answer Options	Response Percent	Response Count
Very enjoyable	17.7%	33
Somewhat enjoyable	30.1%	56
Neutral, no strong opinion	23.7%	44
Somewhat unpleasant	18.8%	35
Very unpleasant	9.7%	18
answered question		186
skipped question		6

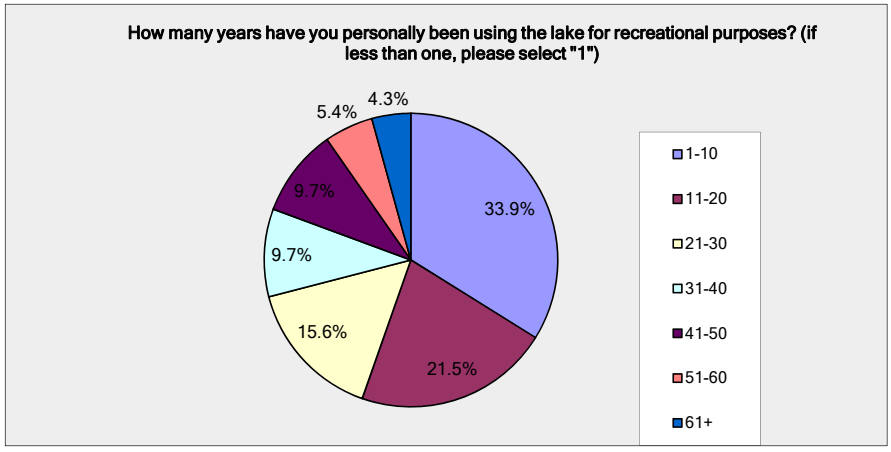


Question 6

How many years have you personally been using the lake for recreational purposes? (if less than one, please select "1")

Answer Options	Response Percent	Response Count
1	16.1%	30
2	1.6%	3
3	2.7%	5
4	3.2%	6
5	1.6%	3
6	1.1%	2
7	1.1%	2
8	0.5%	1
9	0.5%	1
10	5.4%	10
11	0.5%	1
12	2.7%	5
13	1.6%	3
14	2.7%	5
15	5.4%	10
16	1.1%	2
17	1.1%	2
18	0.5%	1
19	0.5%	1
20	5.4%	10
21	0.0%	0
22	1.1%	2
23	0.0%	0
24	0.5%	1
25	5.9%	11
26	0.5%	1
27	0.0%	0
28	1.1%	2
29	1.1%	2
30	5.4%	10
31	1.1%	2
32	0.5%	1
33	0.5%	1
34	0.0%	0
35	2.7%	5
36	0.5%	1
37	0.0%	0
38	1.1%	2
39	0.5%	1
40	2.7%	5
41	0.0%	0
42	1.1%	2
43	1.1%	2
44	0.0%	0
45	1.6%	3

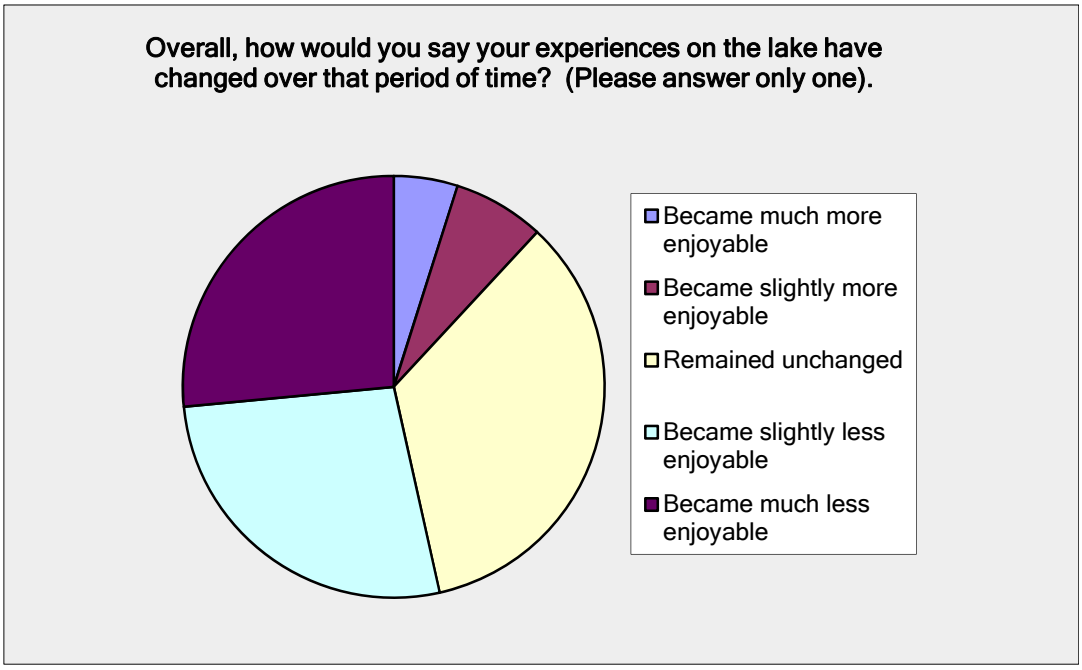
46	1.1%	2
47	0.5%	1
48	0.0%	0
49	0.0%	0
50	4.3%	8
51	0.5%	1
52	1.1%	2
53	0.0%	0
54	0.0%	0
55	2.2%	4
56	0.0%	0
57	0.0%	0
58	0.5%	1
59	0.0%	0
60	1.1%	2
61	0.0%	0
62	0.0%	0
63	0.0%	0
64	0.0%	0
65	1.6%	3
66	0.0%	0
67	0.5%	1
68	0.0%	0
69	0.0%	0
70	1.6%	3
71	0.0%	0
72	0.0%	0
73	0.0%	0
74	0.0%	0
75	0.5%	1
76	0.0%	0
77	0.0%	0
78	0.0%	0
79	0.0%	0
80	0.0%	0
81	0.0%	0
82	0.0%	0
83	0.0%	0
84	0.0%	0
85	0.0%	0
86	0.0%	0
87	0.0%	0
88	0.0%	0
89	0.0%	0
90	0.0%	0
91	0.0%	0
92	0.0%	0
93	0.0%	0
94	0.0%	0
95	0.0%	0
96	0.0%	0
97	0.0%	0
98	0.0%	0
99	0.0%	0
100	0.0%	0
	answered question	**186**
	skipped question	**6**



Question 7

Overall, how would you say your experiences on the lake have changed over that period of time? (Please answer only one).

Answer Options	Response Percent	Response Count
Became much more enjoyable	4.9%	9
Became slightly more enjoyable	7.0%	13
Remained unchanged	34.6%	64
Became slightly less enjoyable	27.0%	50
Became much less enjoyable	26.5%	49
answered question		185
skipped question		7

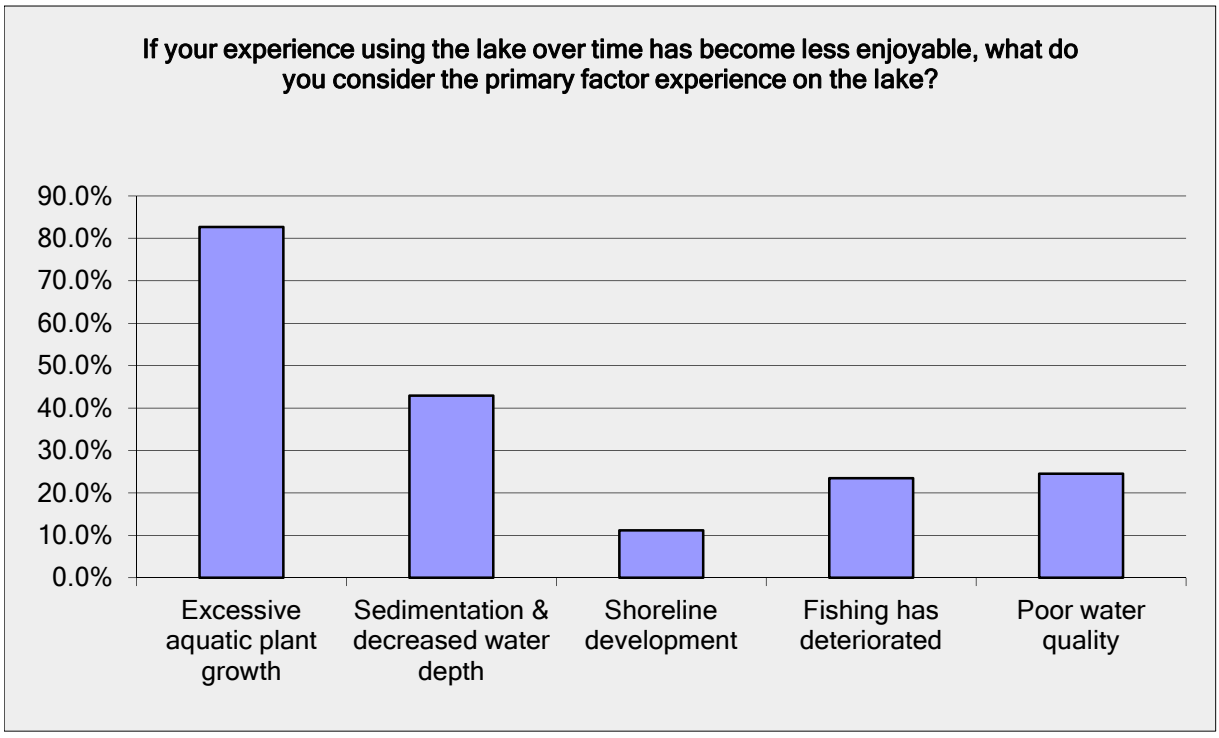


Question 8

If your experience using the lake over time has become less enjoyable, what do you consider the primary factor experience on the lake?

Answer Options	Response Percent	Response Count
Excessive aquatic plant growth	82.7%	81
Sedimentation & decreased water depth	42.9%	42
Shoreline development	11.2%	11
Fishing has deteriorated	23.5%	23
Poor water quality	24.5%	24
Other (please specify)		8
answered question		98
skipped question		94

Number	Other (please specify)
1	weeds
2	ice vehicle traffic
3	Loss of clean firm bottom for spawning beds.
4	less water to fish because of the plants in the lake.!!!!
5	all of the above
6	putting rip rap along the point shore has ruined the fishing and trapping there
7	More fishing dock's also for the disabled and elderly (Maybe like gaurd rails)
8	The green slime that floats on the top of the lake....I believe it may be duck weed????

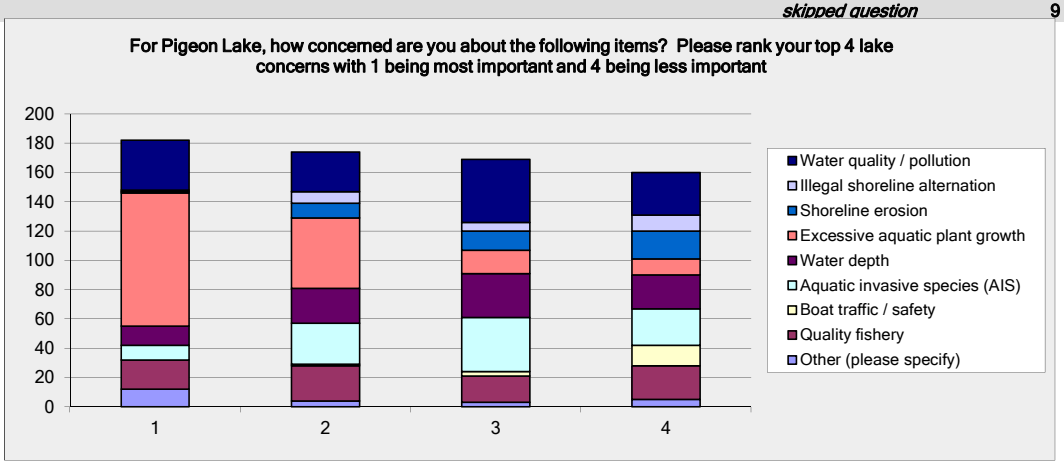


Question 9

For Pigeon Lake, how concerned are you about the following items? Please rank your top 4 lake concerns with 1 being most important and 4 being less important

Answer Options	Water quality / pollution	Illegal shoreline alternation	Shoreline erosion	Excessive aquatic plant growth	Water depth	Aquatic invasive species (AIS)	Boat traffic / safety	Quality fishery	Other (please specify)	Response Count
1	34	1	1	91	13	10	0	20	12	182
2	27	8	10	48	24	28	1	24	4	174
3	43	6	13	16	30	37	3	18	3	169
4	29	11	19	11	23	25	14	23	5	160
AVERAGE RANK	**1.85**	2.46	2.07	**1.59**	2.00	2.06	2.22	**1.78**	2.42	
									answered question	183
									skipped question	9

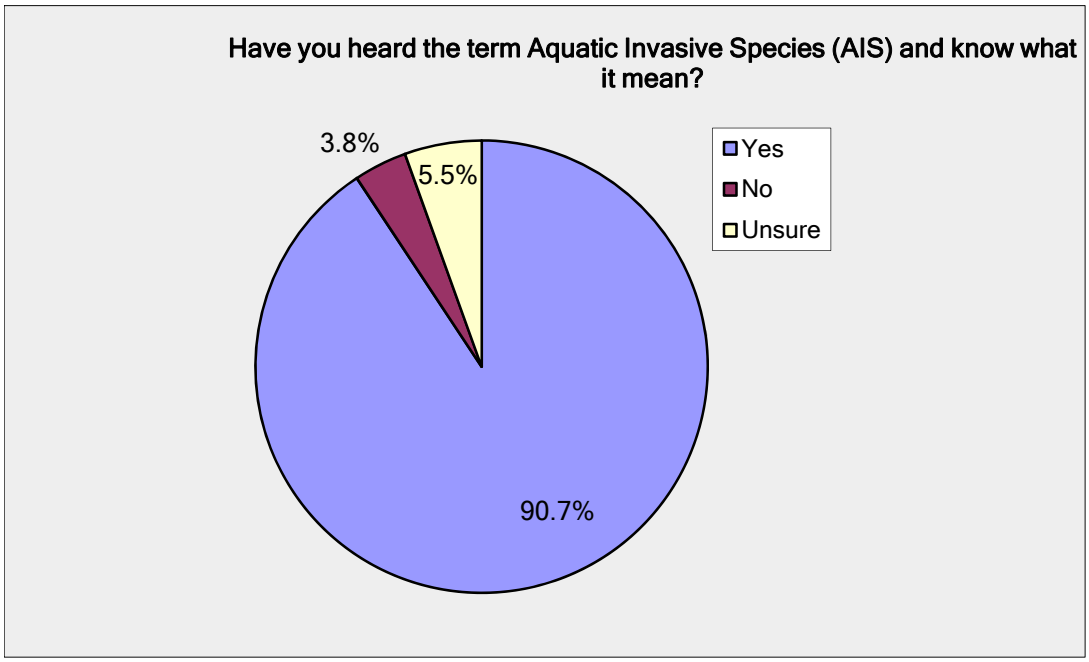
Number	Other (please specify)
1	sedimentation
2	sedimentation
3	sedimentation
4	sedimentation
5	shorelinwe developement
6	sedimentation
7	sedimentsation
8	SEDIMENTATION
9	SEDIMENTATION
10	SEDIMENTATION
11	sedimentation
12	sedimentation
13	sedimentstion
14	high speed traffic boat-water--race cars-ice
15	Hunting ducks and geese. Very dangerous. Bullet holes through my garage.
16	Upstream erosian filling the lake
17	time lost studying and NOT taking action!!
18	the cutter isnt out early enough
19	I dont think it helps, that people living on the lake using fertilizer on their yards(run off into lake)
20	fishing
21	The shoreline should have been left alone, natural and undisturbed. PLD ruined the shoreline.
22	waste of money on a pond that does not need to exist
23	Draw down lake to help reduce sediment .increase depth of lake add rip rap to shore line.
24	Sediment
25	Open hunting area's
26	Loon shit (muck)



Question 10

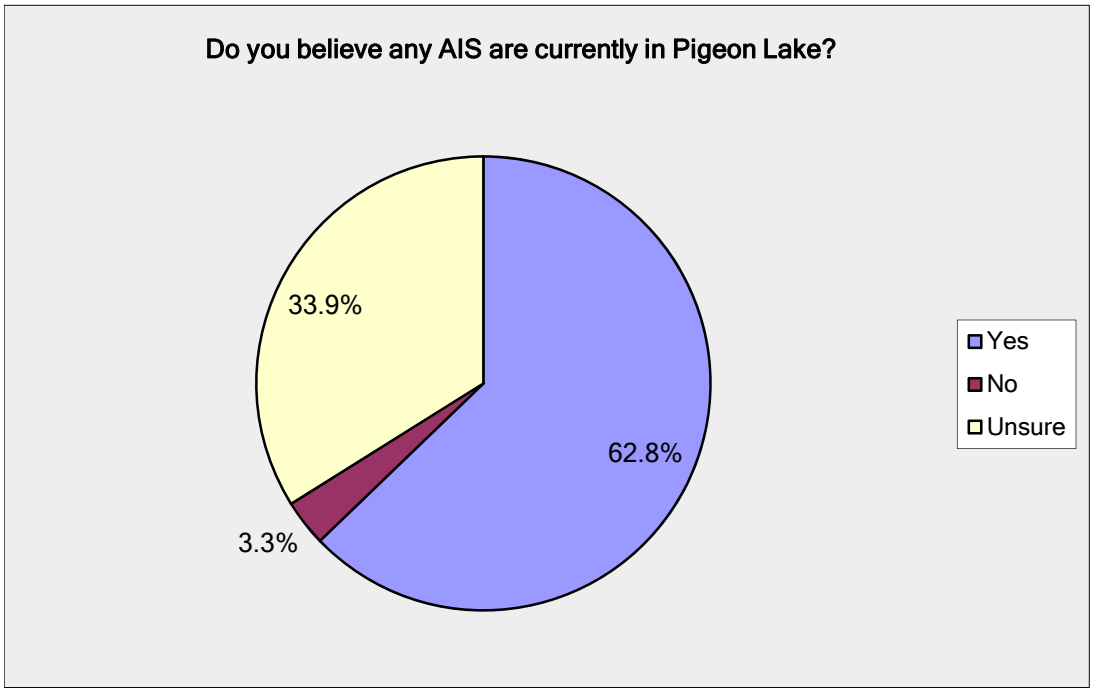
Aquatic Invasive Species (AIS) are non-native plants or animals that can out-compete their native counterparts and potentially cause a myriad of problems within the lake and/or ecosystem. Prior to this survey, have you heard the term Aquatic Invasive Species and did you know what it meant?

Answer Options	Response Percent	Response Count
Yes	90.7%	166
No	3.8%	7
Unsure	5.5%	10
answered question		183
skipped question		9



Question 11

Do you believe any AIS are currently in Pigeon Lake?		
Answer Options	**Response Percent**	**Response Count**
Yes	62.8%	115
No	3.3%	6
Unsure	33.9%	62
answered question		**183**
skipped question		**9**

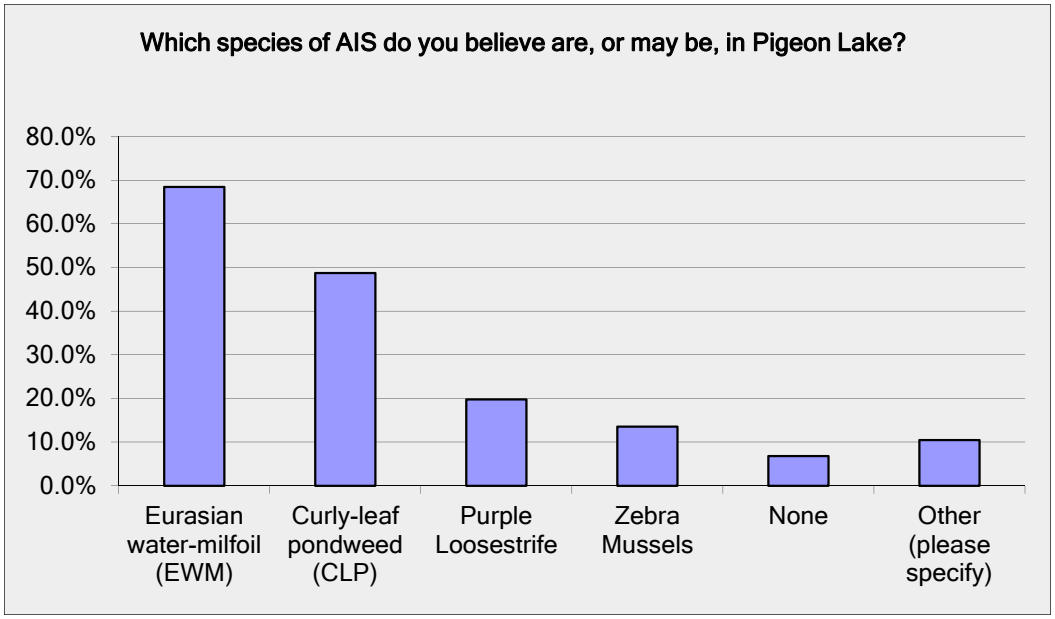


Question 12

Which species of AIS do you believe are, or may be, in Pigeon Lake?

Answer Options	Response Percent	Response Count
Eurasian water-milfoil (EWM)	68.5%	111
Curly-leaf pondweed (CLP)	48.8%	79
Purple Loosestrife	19.8%	32
Zebra Mussels	13.6%	22
None	6.8%	11
Other (please specify)	10.5%	17
	answered question	162
	skipped question	30

Number	Other (please specify)
1	do't know
2	unsure
3	I must be one of the few residents that did not graduate with a degree in Marine Science or Biology. I would just be guessing....
4	blue-green algae
5	Don't know
6	I have no knowledge of any, but believe any are possible with some more likely than others.
7	Don't know
8	I don't know.
9	I honestly don't know
10	don't know
11	Unsure
12	unsure
13	not sure what is in the pond
14	Not sure
15	No clue
16	unknown
17	do not know

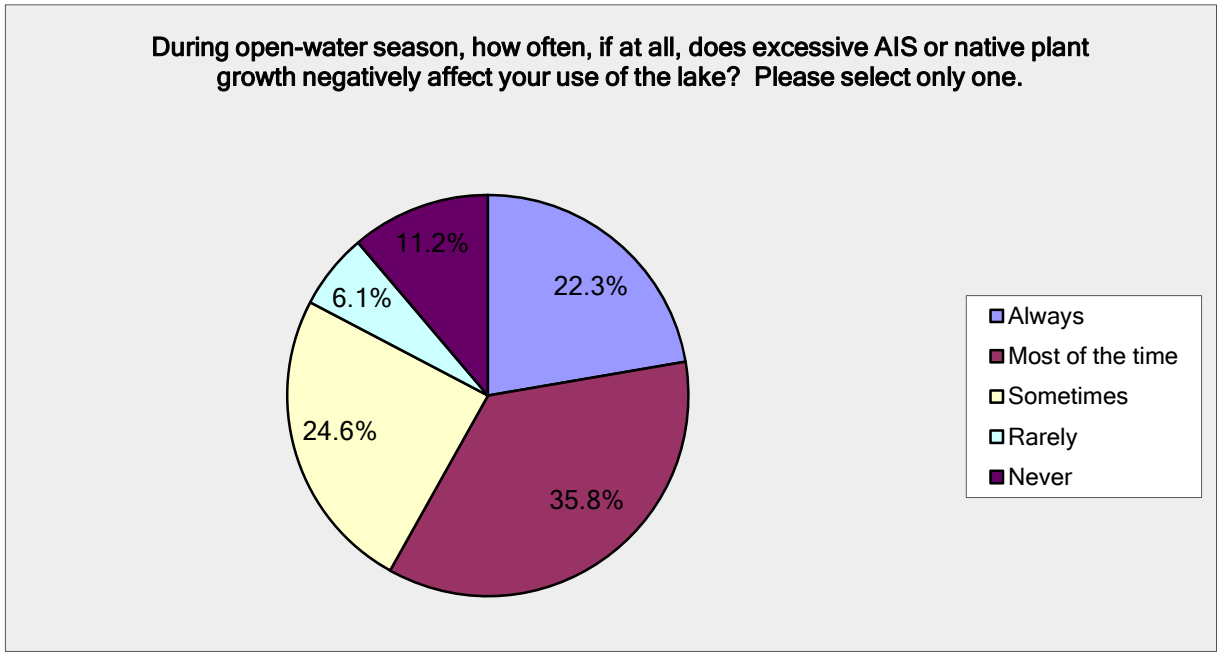


Question 13

During open-water season, how often, if at all, does excessive AIS or native plant growth negatively affect your use of the lake? Please select only one.

Answer Options	Response Percent	Response Count
Always	22.3%	40
Most of the time	35.8%	64
Sometimes	24.6%	44
Rarely	6.1%	11
Never	11.2%	20
Comments		9
	answered question	179
	skipped question	13

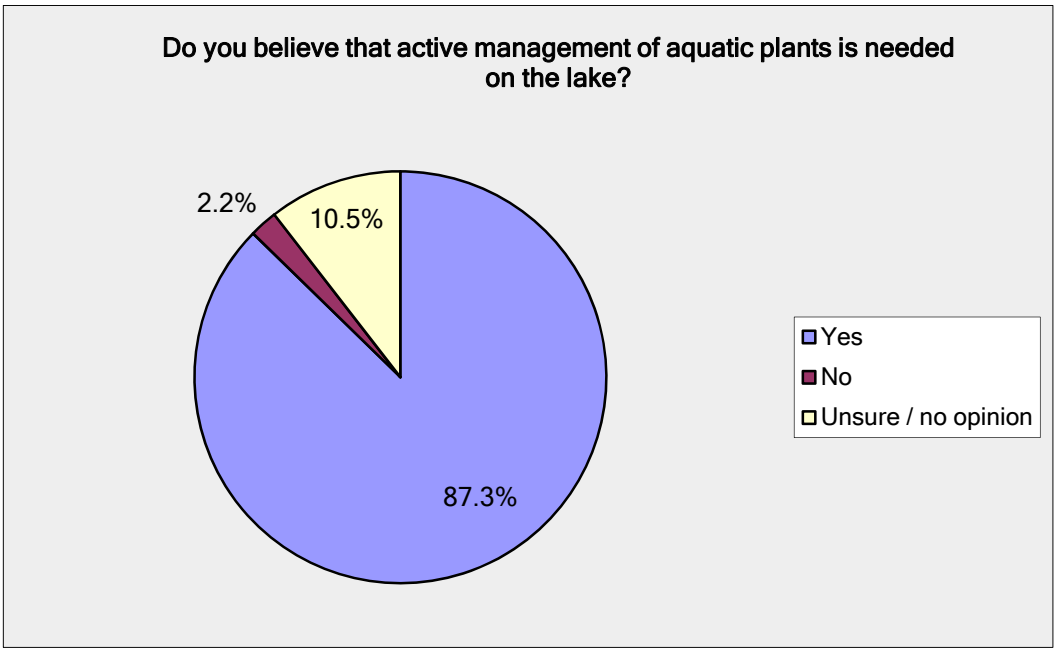
Number	Comments
1	I have used the lake for 38 years for nature viewing and boating and have lived on the Pigeon River for 30 years. The plant growth is worse now than 30 years ago. It used to "green up" so we could not use our boat the first part of June. Now it is too weedy already the first part of May. It seems to be getting worse each year. We have to go to another body of water if we want to use our boat.
2	green algae/weeds on top of water makes fishing difficult from docks
3	WEfish the river and open water
4	Hard to fish with hook and line
5	The pond needs to be drained, dredged down 8-12 feet and refilled and re-stocked.
6	I don't use Pigeon Lake, a few times a year I will walk by Pigeon lake.
7	I do not use the pond
8	Boat landing full of floating weeds.
9	quality of fishing



Question 14

Do you believe that active management of aquatic plants is needed on the lake?

Answer Options	Response Percent	Response Count
Yes	87.3%	158
No	2.2%	4
Unsure / no opinion	10.5%	19
answered question		181
skipped question		11



Question 15

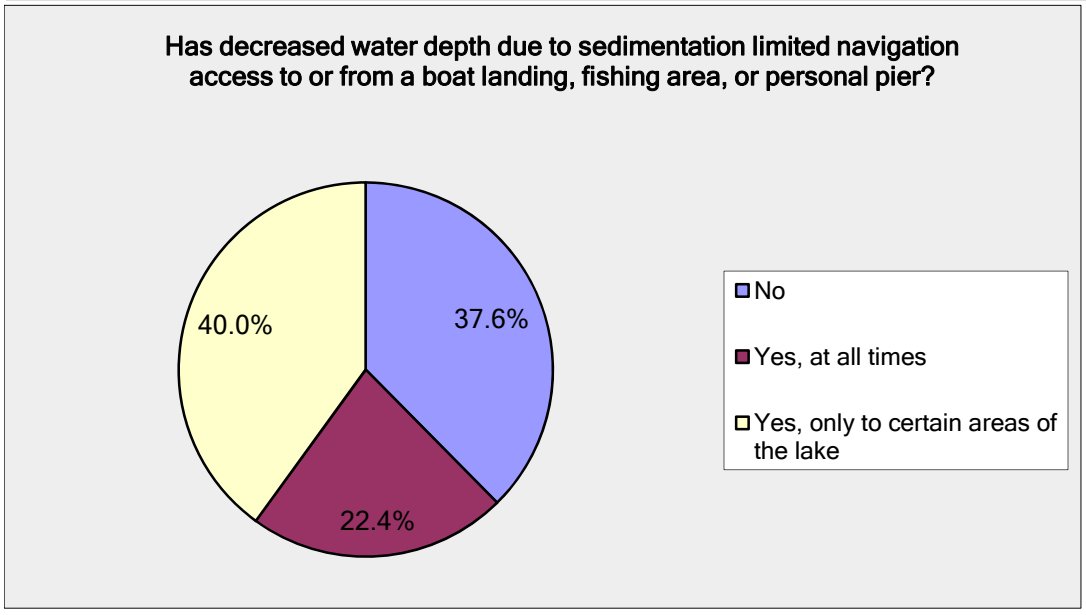
Which of the following aquatic plant management options would you support? Please rank your top 4 preferences with 1 being the most preferred and 4 being the least preferred option.

Answer Options	Manual removal or hand pulling	Mechanical harvesting or cutting	Herbicide control	Hydraulic or mechanical dredging	Over winter water level drawdown	Continue to monitor the size of infestation through annual AIS surveys	No action; wait and see what happens over the long term	Not sure; would rely on a professional consulting firm	Not sure; would rely on the WDNR guidance	Response Count
1	6	60	22	41	8	4	2	14	11	168
2	21	34	29	27	17	8	3	12	13	164
3	17	22	23	29	11	11	5	15	13	146
4	10	7	13	14	16	7	3	17	20	107
AVERAGE RANK	2.57	**1.80**	**2.31**	**2.14**	2.67	2.70	2.69	2.60	2.74	
										Question Totals
									answered question	**169**
									skipped question	**23**

Question 16

Has decreased water depth due to sedimentation limited navigation access to or from a boat landing, fishing area, or personal pier?

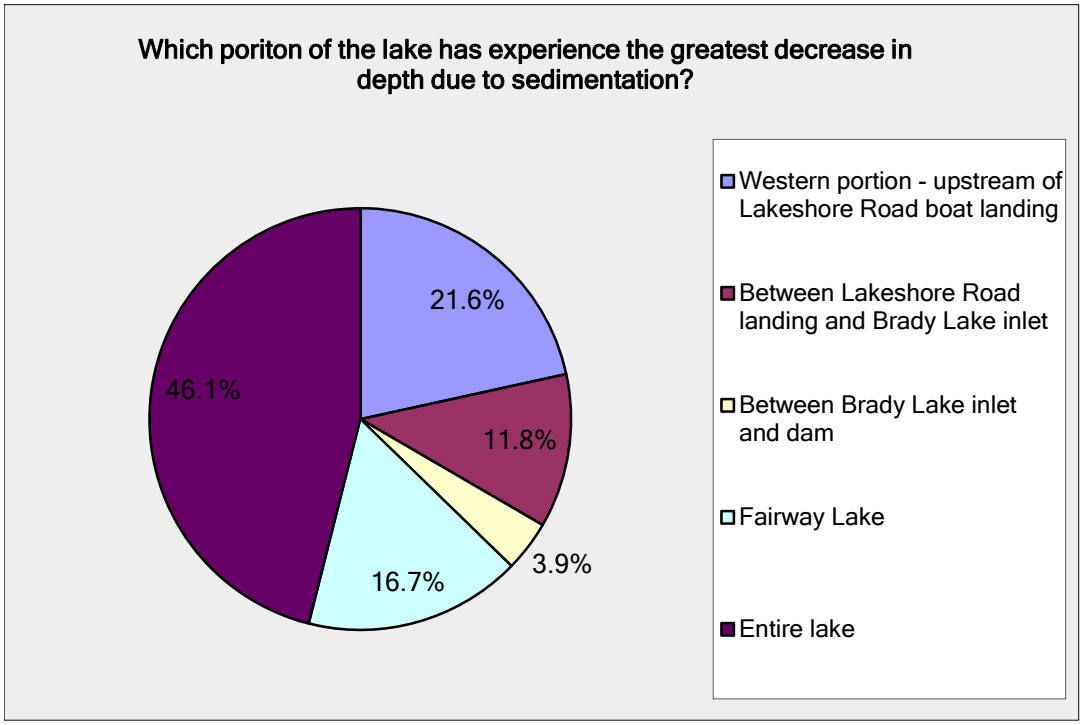
Answer Options	Response Percent	Response Count
No	37.6%	64
Yes, at all times	22.4%	38
Yes, only to certain areas of the lake	40.0%	68
answered question		170
skipped question		22



Question 17

Which poriton of the lake has experience the greatest decrease in depth due to sedimentation?

Answer Options	Response Percent	Response Count
Western portion - upstream of Lakeshore Road boat	21.6%	22
Between Lakeshore Road landing and Brady Lake inlet	11.8%	12
Between Brady Lake inlet and dam	3.9%	4
Fairway Lake	16.7%	17
Entire lake	46.1%	47
answered question		102
skipped question		90



Question 18

Which of the following sedimentation management/reduction options would you support? Please rank your top 4 preferences with 1 being the most preferred and 4 being the lesser preferred option

Answer Options	Focus on agricultural runoff / sedimentation	Dredging	Extended or over winter drawdown	Remove dam and return to natural river	Review and potentially alter how the dam is operated	No action: wait and see what happens over the long term	Not sure; would rely on a professional consulting firm	Not sure; would rely on WDNR guidance	Response Count
1	25	45	3	8	3	0	16	5	105
2	26	23	10	3	17	0	7	9	95
3	14	10	14	3	15	1	16	9	82
4	9	7	8	5	10	2	17	12	70
AVERAGE RANKING	**2.09**	**1.75**	2.77	**2.26**	2.71	3.67	2.61	2.80	
									Question Totals
								answered question	105
								skipped question	87

Question 19

Please rank up the importance of the following elements of the Comprehensive Lake Management Plan update with 1 being most important and 4 being less important.

Answer Options	Study and understand current aquatic plant problems	Protect native plant species	Reduce extent and density of existing AIS infestations	Identify ways to reduce sediment input (loads) into the lake	Explore ways to remove or reduce current sediments from the lake	Prevent the introduction of new AIS	Identify and explore new aquatic plant management strategies	Seek grant funding for management efforts	Review dam operational guidelines for water level management	Ability to obtain a large scale an/or harvesting permits	Other	Response Count
1	22	8	25	17	46	4	11	13	4	8	2	160
2	15	17	22	30	22	8	7	22	4	8	1	156
3	19	11	19	17	24	10	18	12	8	11	1	150
4	7	7	7	23	6	13	14	23	12	12	0	124
AVERAGE	**2.17**	2.40	**2.11**	2.53	**1.90**	2.91	2.70	2.64	3.00	2.69	1.75	6
											answered question	**161**
											skipped question	**31**

Number	Other (please specify)
1	identify, publicly shame, and resolve any chronic "bad actor" landowners upstream
2	you have studied the problem for 45 years now it is time for action
3	stop the politics and get some action going in a positive direction
4	The pigeon lake is discusting to look at and smell. There is a geat recreational potential here and nothing is done to clean it up. I personally wouldn't let my dog swim in that lake. It is an eyesore in Clintonville and an embarrassment to the area. The DNR dam study that was done in the past clearly stated the dam is to be kept at 5.0 to the max of 5.2.. The dam is always above 5.2 and has been for years. Why put this survey out, no one listens to the public any way. .
5	Unless someone is an expert in this area, we should not abide by these comments. Opinions from those who are not experts are not going be the the best course of action to follow
6	Why not just drain the lake and quit wasting our money?

Question 20

Any additional comments or concerns?

Answer Options	Response Count
	60
answered question	60
skipped question	132

Number	Response
1	will have more time to use lake, live in marion and know of your problems like marions
2	need to cut weeds deeper and need to remove sediments
3	sediment needs to be removed and weeds will alweays need to be harvested, we have learned from other lakes
4	hunting on the lake, spring and fall don't have weeds, it's beutiful
5	It is always difficult to make a lake from a pond. Too much runoff feeding the river from farm;and and no deep holes for water turnover
6	Don't drain the lake, where this was done on other lakes it didn't help
7	I WOULD LIKE TO THANK THIS COMMITTEE AND YOPUR CONTINUED STRIVING TO BEKNOWLEDGEABLE ABOUT THIS LAKE
8	MY NEIGHBOR HAS A HUGE TREE FALLEN DOWN CREATING BACKUP OF WEEDS WHAT CAN BE DONE ABOUT THAT?
9	Would like to see the lake become an attraction to both citizens and outsiders. Fishing, recreational boating, swimming.
10	I like what lola and weyauwega did. Deeper with reduced plants.
11	yes please put more portable potty in the park that stop the litter in park
12	talk is cheap we all know the flipside
13	Lake Needs help/clean up is needed
14	I am AGAINST making any permanent alterations to the dam or its operation. A winter or temporary drawdown could have benefits. Perhaps the experiences of the Marion Millpond up river could assist in future planning. I have lived on the river for 30 years, paid many taxes and seen many plans brought forward to manage the river, however the thick plants deny me the use of the river for recreational boating. On some summer days the plants are so thick that it seems you could walk across them to get to the other side of the river. The harvesting machine gives temporary relief. On a positive note, the shoreline plants, fish, birds and animals that inhabit the river seem to be healthy and thriving. It is my one reason for owning property here.
15	publicize the root causes, and responsible parties, for the Marion dam fiasco
16	Excess nutrient load from, application of fertilizers, manure pits or excessive manure application to fields which ends up in the Marion or Clintonville pond.
17	Need to get rid of Green Slime on Pond
18	Please find a way to get rid of some of the plant life in the lake so people can be able to go out in a boat and fish, Thank You!!!
19	Bottom adacent to my property has been changing from sand to muck over the last 7 years. I've noticed that fish spawning activity is greatly reduced.
20	enjoying the lake with grandchildren. would like less "green slime" if possible
21	We need to save this Lake for future generations! Do what needs to be done to make this a nice recreational spot for everyone to enjoy! This would help our local economy if this lake was in decent shape.
22	no
23	Since when is it called Pigeon "Lake"? Thought it was the Pigeon "Pond".
24	we understand this is an old water system and we would like to enjoy it as much as we can!!!!
25	There are many issues that many of us are not well enough educated on to pass judgement upon, so we must trust in the stewardship and common sense of those who are educated enough to make decisions regarding the future health and well being of the Pigeon pond.
26	The aquatic plant growth in this body of water is out of control. However I would rather deal with the weeds than to have the body of water drained. Draining the water out does not work, take a look at the Marion pond, no fish & lots of weeds only a year or two after the lake was drained.

27	no
28	do something to return the lake to an acceptable state for swimming, shoreline beaches,remove sedament and weeds
29	Please don't drain the pond like Marion do, it will not work. The pond needs to be dredged out from 10 to 20 feet deep. That would make a nice pond.
30	Get the process going before there is no lake.
31	Was unable to answer several questions in this survey due to lack of knowledge - should have been an option answer stating "do not know"
32	you have studied the problem fo,r 45 years now it is time for action
33	None
34	it has jurrasically improved the last year compared to the following for ais
35	control the boats ripping up the weeds
36	would be a shame to see this lake go to waste,had lots of good times fishing withmy dad on the pond
37	Do not drane the pond for the fish poplasn is grate
38	I would strongly oppose a draw down of the lake. It has proven unsuccessful in area lakes and only harms all the living things that call it home.
39	Tell Scott Walker to get the money from his slush fund
40	With a golf course upstream at Marion and one in Clintonville, both on the lake fronts...their fertilizer is feeding the weeds...in my opinion.
41	Someting needs to be done with the current condition of this lake. It is unuseable most of the summer months and smells bad when it is hot. That in itself cannot be healthy. Thank You
42	Once again the Pond is a eyesore and detriment to the community. We could have a wonderful lake with sand swimming areas, but instead we have a green smelly slime hole. better to drain it and turn it into a river, at least it won't look so bad nor smell.
43	Purchase Canadian carp to eat the weeds (they are sterilized)
44	I think we should gather expert advice -- consulting firm and/or WDNR. I also think we should talk to the people who oversaw the management of the Marion pond. What are their thoughts on the results of the draining? We should listen to the opinions of those who are familiar with the pond by living by it and/or using it, but we need to balance that with expert opinion. People who professionally manage ponds are the ones who will have the most important opinion.
45	remove the sediment and weeds, and control there reentery to the Lake
46	You can't change the fact that an artificial lake will always confront the same problems sooner or later. Why not stop wasting my money on a body of water that is doomed from the outset?
47	smell
48	mid summer you cant even fish anymore, too many weeds
49	Not sure...
50	1997 put in pier 4.5 feet deep today's depth is maybe 2inches
51	Limit weed cutting to main body. Not in no wake areas.
52	scheduled cutting by map layout
53	Look for new methods and try new things to help control the AIS and not things that have been proven ineffective, Thanks for the survey!
54	I would like to see some emplasis given to the clean up on Fairway Lake
55	get rid of the green lake!
56	get rid og the sediment
57	I think the properrty values of homes on Pigeon will sart declining and the city tax base will suffer unless something is done to turn this into a usable lake again
58	As someone who has been on the pond most falls hunting over the last 30 yrs, it is sad to see how bad it has gotten.
59	Get rid of the muck, weeds and dnr.
60	I think that last years water quality was a lot better then past years. Whatever the lake district did in the 2013 season worked. It could use a little more work but it is a great start. I personally dont think we should get rid of all the invasive weeds completely, but find a wayto maintain them. I am very much against putting in a chemical to kills the weeds. If that is done it will kill everything in the lake and make enjoying the lake a huge disappointment. Thanks

APPENDIX B

Appendix B – Supporting Aquatic Plant Documentation

The point intercept method was used to evaluate the existing emergent, submergent, floating-leaf and free-floating aquatic plants. If a species was not collected at a specific point, the space on the datasheet was left blank. For the survey, the data for each sample point was entered into the WDNR "Worksheets" (i.e., a data-processing spreadsheet) to calculate the following statistics:

Taxonomic richness (the total number of taxa detected)

- **Maximum depth of plant growth**
- **Community frequency of occurrence** (number of intercept points where aquatic plants were detected divided by the number of intercept points shallower than the maximum depth of plant growth)
- **Mean intercept point taxonomic richness** (the average number of taxa per intercept point)
- **Mean intercept point native taxonomic richness** (the average number of native taxa per intercept point)
- **Taxonomic frequency of occurrence within vegetated areas** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points where vegetation was present)
- **Taxonomic frequency of occurrence at sites within the photic zone** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points which are equal to or shallower than the maximum depth of plant growth)
- **Relative taxonomic frequency of occurrence** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the sum of all species' occurrences)
- **Mean density** (the sum of the density values for a particular species divided by the number of sampling sites)
- **Simpson Diversity Index (SDI)** is an indicator of aquatic plant community diversity. SDI is calculated by taking one minus the sum of the relative frequencies squared for each species present. Based upon the index of community diversity, the closer the SDI is to one, the greater the diversity within the population.

Floristic Quality Index (FQI) (This method uses a predetermined Coefficient of Conservatism (C), that has been assigned to each native plant species in Wisconsin, based on that species' tolerance for disturbance. Non-native plants are not assigned conservatism coefficients. The aggregate conservatism of all the plants inhabiting a site determines its floristic quality. The mean C value for a given lake is the arithmetic mean of the coefficients of all native vascular plant species occurring on the entire site, without regard to dominance or frequency. The FQI value is the mean C times the square root of the total number of native species. This formula combines the conservatism of the species present with a measure of the species richness of the site.

Table 1: Taxa Detected During 2014 Aquatic Plant Survey, Pigeon Lake, Waupaca County, WI

Genus	Species	Common Name	Category
Ceratophyllum	*demersum*	Coontail	Submersed
Chara	*sp.*	Muskgrass	Submersed [algal]
Elodea	*canadensis*	Common waterweed	Submersed
Heteranthera	*dubia*	Water star-grass	Submersed
Lemna	*minor*	Small duckweed	Free-floating
Lemna	*trisulca*	Forked duckweed	Free-floating
Myriophyllum	*spicatum*	Eurasian water-milfoil	Submersed AIS
Najas	*flexilis*	Slender naiad	Submersed
Nuphar	*variegata*	Spatterdock	Floating-leaf
Nymphaea	*odorata*	White water lily	Floating-leaf
Potamogeton	*crispus*	Curly-leaf pondweed	Submersed AIS
Potamogeton	*praelongus*	White-stem pondweed	Submersed
Potamogeton	*zosteriformis*	Flat-stem pondweed	Submersed
Ranunculus	*aquatilis*	Stiff water crowfoot	Submersed
Sparganium	*sp.*	Bur-reed species	Emergent
Spirodela	*polyrhiza*	Large duckweed	Free-floating
Stuckenia	*pectinata*	Sago pondweed	Submersed
Vallisneria	*americana*	Wild celery	Submersed
Wolffia	*columbiana*	Common watermeal	Free-floating

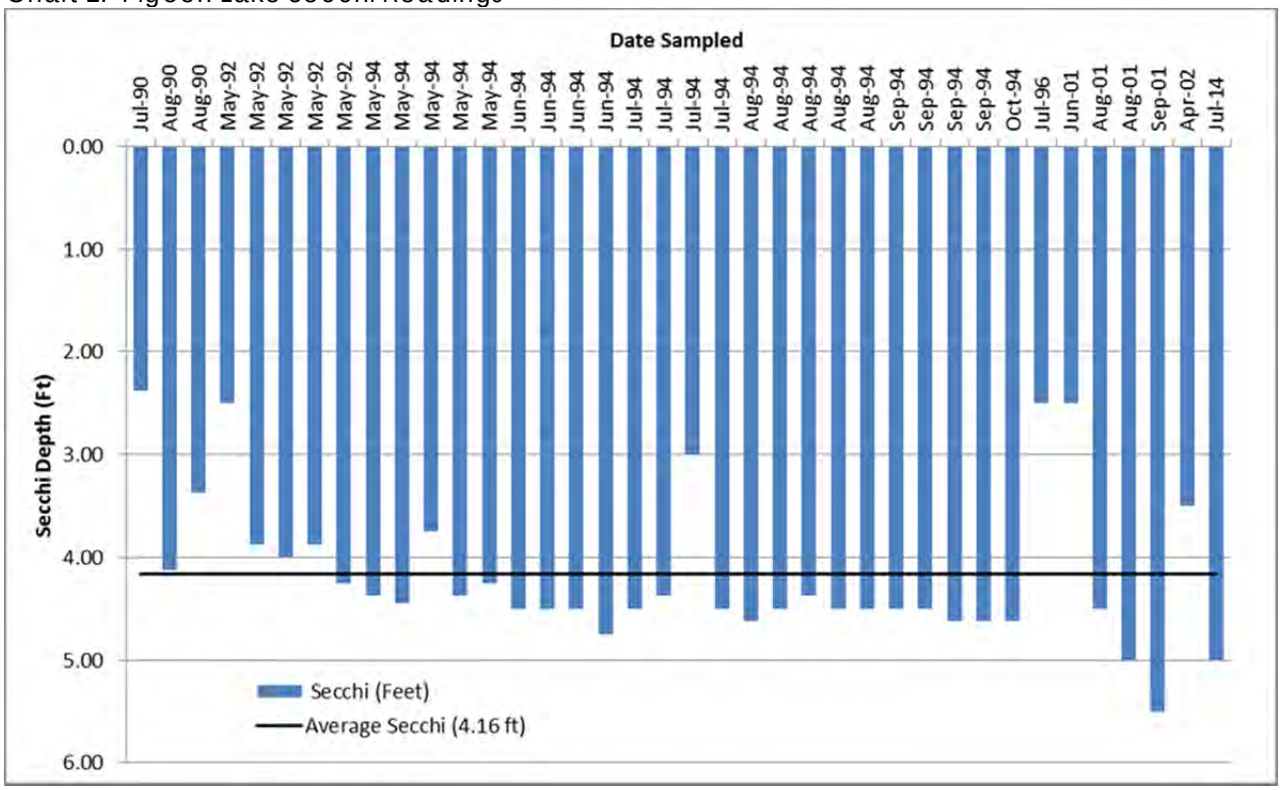
Table 3: 2014 Aquatic Plant Taxa-Specific Statistics, Pigeon Lake, Waupaca County, WI

Common Name	Percent Frequency of Occurrence within vegetated areas	Percent Frequency of Occurrence at sites shallower than max depth of plants	Percent Relative Frequency of Occurrence	Number of Intercept Points Where Detected	Average Density
Coontail	74.63	71.60	24.67	300	1.17
Common watermeal	44.53	42.72	14.72	179	1.00
Muskgrass	43.28	41.53	14.31	174	1.05
Eurasian water-milfoil	38.31	36.75	12.66	154	1.02
Slender naiad	22.64	21.72	7.48	91	1.00
Wild celery	21.39	20.53	7.07	86	1.00
Small duckweed	16.92	16.23	5.59	68	1.00
Common waterweed	13.93	13.37	4.61	56	1.11
White-stem pondweed	7.21	6.92	2.38	29	1.00
Curly-leaf pondweed	4.98	4.77	1.64	20	1.00
Water star-grass	4.23	4.06	1.40	17	1.00
White water lily	3.98	3.82	1.32	16	1.00
Stiff water crowfoot	1.74	1.67	0.58	7	1.00
Flat-stem pondweed	1.49	1.43	0.49	6	1.00
Bur-reed species	1.24	1.19	0.41	5	1.00
Forked duckweed	1.00	0.95	0.33	4	1.00
Spatterdock	0.50	0.48	0.16	2	1.00
Large duckweed	0.25	0.24	0.08	1	1.00
Sago pondweed	0.25	0.24	0.08	1	1.00

APPENDIX C

Appendix C – Supporting Water Quality Documentation

Chart 1: Pigeon Lake Secchi Readings



Category	TSI	Lake Characteristics	Total P *(ug/l)*	Chlorophyll a *(ug/l)*	Water Clarity *(feet)*
Oligotrophic	1-40	Clear water; oxygen rich at all depths, except if close to mesotrophic border; then may have low or no oxygen; cold-water fish likely in deeper lakes.	< 12	<2.6	>13
Mesotrophic	41-50	Moderately clear; increasing probability of low to no oxygen in bottom waters.	12 to 24	2.6 to 7.3	13 to 6.5
Eutrophic	51-70	Decreased water clarity; probably no oxygen in bottom waters during summer; warm-water fisheries only; blue-green algae likely in summer in upper range; plants also excessive.	> 24	>7.3	<6.5
Pigeon Lake	**58.2**	**Eutrophic**	**67.9**	**19.4**	**4.16**

Adopted from Carlson 1977, Lillie and Mason, 1983, and Shaw 1994 et al

APPENDIX D

Appendix D – Supporting Watershed Documentation

Watershed and land use evaluation is a necessary component of a management plan. The land use within the watershed is the primary sources of nutrient into the ecosystem. Slight changes in land use watershed can create major impacts on the receiving water body. For instance, if a large land area is disturbed runoff will have a greater sediment and nutrient load. The opposite can occur if major areas that were disturbed are now vegetated with trees or native plants. Land use within the watershed is from WISCLAND – WI DNR data.

Watershed evaluation includes a presentation of the data gathered as part of this project and modeling programs used to predict land use changes and watershed impacts. The Wisconsin Lake Modeling Suite (WiLMS), a screening level and water quality evaluation toll, was used to model the lake's watershed. Using this model, estimates of nutrient and sediment runoff from various land cover types was analyzed for potential impact to the lake. In conjunction with WiLMS, the Lake Eutrophication Analysis Procedure (LEAP) was used to model internal phosphorus loading and eutrophication indices of Pigeon Lake based on watershed land cover, creating a nutrient budget.

Table 7: Phosphorus input by land use type. Pigeon Lake, Waupaca County, WI

		Phosphorus Loading	
Land Use	**Acres**	**kg/year**	**Average kg / acre / year**
Mixed Agricultural	18772.3	6078	0.32
Commercial / Industrial	42.8	26	0.61
Forest	21429.8	781	0.04
Pasture / Grassland	12615.3	1532	0.12
Lake Surface	162.7	20	0.12
High Density Residential	808.7	491	0.61
Rural Residential	2852.7	115	0.04
Wetlands	10816.2	438	0.04
Marion Wastewater Facility	---	703.2	---
TOTAL	**67500.5**	**10184.2**	**1.90**

Table 8: Percent phosphorus loading by source. Pigeon Lake, Waupaca County, WI

Land Use	**Acres**	**Percent of Watershed**	**Percent of Phosphorus Loading**
Mixed Agricultural	18772.3	27.81%	59.68%
Commercial / Industrial	42.8	0.06%	0.26%
Forest	21429.8	31.75%	7.67%
Pasture / Grassland	12615.3	18.69%	15.04%
Lake Surface	162.7	0.24%	0.20%
High Density Residential	808.7	1.20%	4.82%
Rural Residential	2852.7	4.23%	1.13%
Wetlands	10816.2	16.02%	4.30%
Marion Wastewater Facility	---	---	6.90%
TOTAL	**67500.5**	**100.00%**	**100.00%**

Table 9: Marion Wastewater Treatment Facility Point-Source Discharge Data

Marion Wastewater Treatment Facility

Year	Avg. Flow (MGD)	Avg. TP Concentration (mg/L)
1999	0.246	---
2000	0.222	---
2001	0.235	---
2002	0.26	---
2003	0.306	1.75
2004	0.36	1.75
2005	0.294	1.75
2006	0.236	1.75
2007	0.226	2.2
2008	0.244	2.2
2009	0.217	2.2
2010	0.279	2.2
2011	0.312	2.2
2012	0.209	2.45
2013	0.225	1.25
AVERAGE	**0.258**	**1.97**

Date: 11/17/2014 Scenario: 3

Lake Id: Pigeon Lake
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 67337.8 acre
Total Unit Runoff: 10.50 in.
Annual Runoff Volume: 58920.6 acre-ft
Lake Surface Area <As>: 162.7 acre
Lake Volume <V>: 688.0 acre-ft
Lake Mean Depth <z>: 4.2 ft
Precipitation - Evaporation: 3.8 in.
Hydraulic Loading: 59261.1 acre-ft/year
Areal Water Load <qs>: 364.2 ft/year
Lake Flushing Rate <p>: 86.14 1/year
Water Residence Time: 0.01 year
Observed spring overturn total phosphorus (SPO): 46.0 mg/m^3
Observed growing season mean phosphorus (GSM): 70.33 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low Loading (kg/ha-year)	Most Likely Loading (kg/ha-year)	High Loading (kg/ha-year)	Loading %	Low Loading (kg/year)	Most Likely Loading (kg/year)	High Loading (kg/year)
Row Crop AG	0.0	0.50	1.00	3.00	0.0	0	0	0
Mixed AG	18772.3	0.30	0.80	1.40	59.7	2279	6078	10636
Pasture/Grass	12615.3	0.10	0.30	0.50	15.0	511	1532	2553
HD Urban (1/8 Ac)	808.7	1.00	1.50	2.00	4.8	327	491	655
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	2852.7	0.05	0.10	0.25	1.1	58	115	289
Wetlands	10816.2	0.10	0.10	0.10	4.3	438	438	438
Forest	21429.8	0.05	0.09	0.18	7.7	434	781	1561
Commercial / Industrial	42.8	1.00	1.50	2.00	0.3	17	26	35
Lake Surface	162.7	0.10	0.30	1.00	0.2	7	20	66

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
Marion Wasterwater Facility	356471.1	445.6	703.2	873.4	6.9

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	
# capita-years	0.0			
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	9955.0	22449.3	37708.7	100.0
Total Loading (kg)	4515.6	10182.9	17104.5	100.0
Areal Loading (lb/ac-year)	61.19	137.98	231.77	
Areal Loading (mg/m^2-year)	6858.12	15465.63	25978.03	
Total PS Loading (lb)	982.3	1550.3	1925.4	6.9
Total PS Loading (kg)	445.6	703.2	873.4	6.9
Total NPS Loading (lb)	8958.1	20855.4	35638.1	93.1
Total NPS Loading (kg)	4063.4	9460.0	16165.3	93.1

LEAP - Lake Eutrophication Analysis Procedure

Lake Name:	Pigeon Lake	**Ecoregion:**	North Central Hardwood Forests
Watershed Area:	67337.8 Acres	**Surface Area:**	162.7 Acres
Mean Depth:	4.2 ft	**TP Load:**	5263 kg/yr
Lake Outflow:	35 AF/yr	**Avg TP Inflow:**	148 ug/L
Residence Time:	0.0 years		
Areal Water Load:	53.84 m/yr	**P Retention Coef:**	0.17

Variable	Observed	Predicted	Std Error	Residual	T-test
TP (ug/L)	68	123	25	-0.26	-2.28
Chlr a (ug/L)	19.4	74.0	34.0	-0.58	-2.52
Secchi (m)	1.3	0.6	0.2	0.32	2.04

Note: Residual = Log10(Observed/Predicted)

T-test for signifigant difference between observed & predicted

Chlrophyll A Interval Frequencies (%)

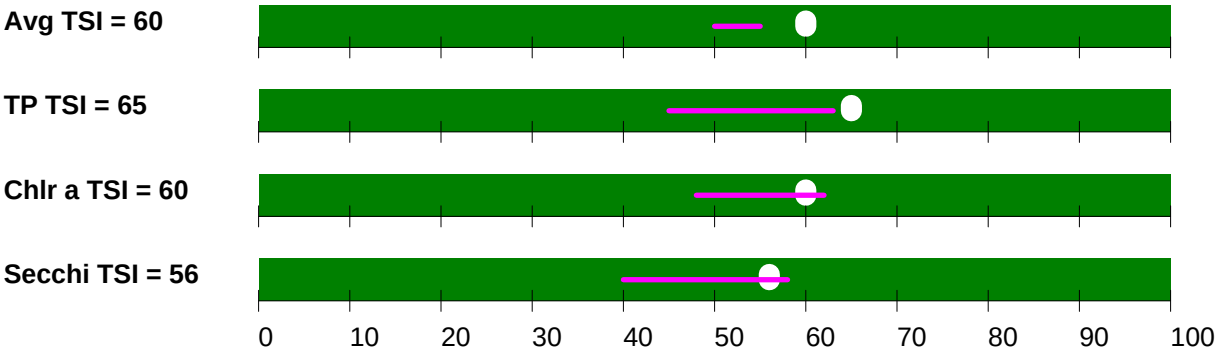
ppb	Observed	Case A	Case B	Case C
10	87%	100%	100%	100%
20	38%	99%	99%	96%
30	13%	95%	94%	87%
60	0%	58%	57%	55%

Case A = within year variation considered

Case B = within year + year-to-year variation

Case C = Case B + Model Error

Carlson's Trophic Status Index



APPENDIX E

Management Options for Aquatic Plants

Option	Permit Needed	How it Works	Pros	Cons
No Management	No	No active plant management	Possible protects native species that can enhance water quality and provide habitat for aquatic fauna: • No financial cost • No system disturbance • No harmful effects of chemicals • Permit not required	May allow small populations of invasive plants to become larger and more difficult to control later • Requires intensive monitoring
Mechanical Control	Required under NR 109	Plants reduced by mechanical means	Flexible control	Must be repeated, often more than once per season, sometimes weekly
		Wide range of techniques from manual to mechanized	Can balance habitat and recreational needs	Can suspend sediments and increase highly turbidity and nutrient release
a. Handpulling/ Manual raking	Yes/No	Scuba divers or snorkelers remove plants are removed with a rake	Little to no damage done to lake or to native plant species	Very labor intensive and costly by hand or plants
		Works best in soft sediments	Can be highly selective Can be done by shoreline property owners within an area <30 ft wide or removing EWM or CLP Can be very effective at removing problems particularly following early detection of an invasive specie	Needs to be carefully monitored Roots, runners and even fragments of some without permits species (including EWM) will start new where selectively planted, so all of plant must be removed Small scale control only plants Can be very costly if subcontracted
b. Harvesting	Yes	Plants are “mowed” at depths of 2-5 ft., collected with a conveyor and off loaded onto shore	Immediate results	Not selective in species removed
		Harvest invasives only if invasive is already present throughout the lake	Good for CLP management if cut prior to turion production and is then cut to be kept in check through its growth cycle Usually minimal impact to the lake Harvested lanes through dense weed beds can increase growth and forage ability of some fish Can remove some nutrients from the lake	Fragments of EWM can re-root Difficulty in finding disposal sites Can remove some small fish and reptiles from lake Initial cost of harvester expensive High transport, maintenance and operational costs Liability if owned
Biological Control	Yes	Living organisms (e.g. insects or fungi) eat or infect plants	Self sustaining organism will over winter resume eating its host the next year Lowers density of problem plant to allow growth of natives	Effectiveness will vary as control agent’s population fluctuates Provides moderate control – complete control unlikely Control response may be slow. Must have enough control agent to be effective

Management Options for Aquatic Plants

a. Weevils on EWM	Yes	Native weevil prefers EWM to other native water milfoil	Native to Wisconsin: Weevil cannot "escape" and become a problem Selective control of target species Longer term control with limited management	Excessive cost need to stock large numbers, even if some already present and are costly **$1.00/each** Need good habitat for over wintering on shore (leaf litter) associated with undeveloped shorelines High Panfish populations decrease densities through predation
b. Pathogens	Yes	Fungal/bacterial/viral pathogen introduced to target species to induce mortality	May be species specific May provide long term control Few dangers to humans or animals	Largely experimental; effectiveness and longevity unknown Possible side effects not understood
c. Allelopathy	Yes	Aquatic plants release chemical compounds that inhibit other plants from growing	May provide long term, maintenance free control Spikerushes (*Eleocharis* spp.) appear to inhibit Eurasian watermill foil growth	Initial transplanting slow and labor intensive Spikerushes native to Wisconsin and have not effectively limited EWM growth Wave action along shore makes it difficult to establish plants; plants will not grow in deep or turbid water
d. Restoration of native plants	Possibly, strongly recommend plan and consultation with DNR	Diverse native plant community established to help repel invasive species	Native plants provide food and habitat for aquatic fauna Diverse native community more repellant to invasive species Supplements removal techniques	Initial transplanting slow and labor intensive Nuisance invasive plants may outcompete plantings Largely experimental; few well documented successful cases and very costly
Physical Control	Required under Ch. 30/NR 107	Plants are reduced by altering variables that affect growth, such as water depth or light levels		
a. Drawdown	Yes, may require Environmental Assessment	Lake water lowered; plants killed when sediment dries, compacts or freezes	Can be effective for EWM, especially when done over winter, provided drying and freezing occur. Sediment compaction is possible over winter.	Plants with large seed bank or propagules that survive drawdown may become more abundant upon refilling
		Must have a water level control or device or siphon	Summer drawdown can restore large portions of shoreline and shallow areas as well as provide sediment compaction	Species growing in deep water (e.g. EWM) that survive may increase, particularly if desired native species are reduced
		Season or duration of drawdown can change effects	Emergent plant species often rebound near shore providing fish and wildlife habitat, sediment stabilization and increased water quality Successful for EWM	May impact attached wetlands and shallow wells near shore Not a good control measure for CLP

Management Options for Aquatic Plants

			Low cost if not a hydroelectric dam Restores natural water fluctuation important for all aquatic ecosystems	Can affect fish, particularly in shallow lakes if oxygen levels drop or if water levels are not restored before spring spawning Winter drawdown must start in early fall or will kill hibernating reptiles and amphibians Controversial
b. Dredging	Yes	Plants are removed along with sediment	Increases water depth	Expensive
		Most effective when soft sediments overlay harder substrate	Removes nutrient rich sediments	Increases turbidity and releases nutrients
		For extremely impacted systems	Removes soft bottom sediments that may have high oxygen demand	Exposed sediments may be recolonized by invasive species
		Extensive planning and permitting required		Sediment testing is expensive Removes benthic organisms Dredged materials must be disposed if Severe impact on lake ecosystem
c. Dyes	Yes	Colors water, reducing light and reducing plant and algal growth	Impairs plant growth without increasing turbidity Usually non-toxic, degrades naturally over a few weeks	Appropriate for very slam water bodies Should not be used in pond or lake with outflow Impairs aesthetics Affects to microscopic organisms unknown
d. Mechanical circulation (Solarbees)	Yes	Water is circulated and oxygenated	Reduces blue green algae	Method is experimental; no published studies have been done
		Oxygenation of water decreases ammonium-nitrogen, which is a preferred nutrient source of EWM, theoretically limiting EWM growth (has not been demonstrated scientifically)	May reduce levels of ammonium-nitrogen in the water and at the sediment interface, which could reduce EWM growth Oxygenated water may reduce phosphorus release from sediments if mixing is complete Reduces chance of fish kills by aerating water	Although EWM prefers ammonium-nitrogen to nitrate, it will uptake nitrate efficiently, so EWM growth may not be affected Units are aesthetically unpleasing Units could be a navigational hazard
e. Non-point source nutrient control	No	Runoff of nutrients from the watershed are reduced (e.g. by controlling construction erosion or reducing fertilizer use)	Attempts to correct source of problem, not treat symptoms Could improve water clarity and reduce occurrences of algal blooms	Results can take years to be evident due to internal recycling of already resent lake nutrients Expensive

Management Options for Aquatic Plants

			Native plants may be able to compete invasive species better in low nutrient conditions	Requires landowner cooperation and regulation Improved water clarity may increase plant growth
Chemical Control	Required under NR 107	Granules or liquid chemicals kill plants or cease plant growth; some chemicals used primarily for algae	Some flexibility for different situations	Possible toxicity to aquatic animals or humans, especially applicators
		Results usually within 10 days of treatment, but repeat treatments usually needed	Some can be selective if applied correctly Can be used for restoration activities	May kill desirable plant species, e.g. native water milfoil or native pondweeds Treatment set back requirements from potable water sources and/or drinking water use restrictions after application, usually based on concentration May cause severe drop in dissolved oxygen causing fish kill, depends on plant biomass killed, temperatures and lake size and shape Controversial
a. 2,4-D (DMA-4; Sculpin	Yes	Systemic[1] herbicide selective to broadleaf[2] plants that inhibit cell division in new tissue	Moderately to highly effective; especially on EWM	May cause oxygen depletion after plants die and decompose
		Applied as liquid or granules during early growth phase	Monocots, such as pondweeds (e.g. CLP) and many other native species not affected Can be used in synergy with endotholl for early season CLP and EWM treatments Widely used aquatic herbicides	Cannot be used in combination with copper herbicides (used for algae) Toxic to fish
b. Endothall (Aquathol)	Yes	Broad-spectrum[3], contact [4] herbicide that inhibits protein synthesis	Especially effective on CLP and also effective on EWM	Kills many native pondweeks
		Applied as liquid or granules	May be effective in reducing reestablishment of CLP if reapplied several years in a row in early spring Can be selective depending on concentration and seasonal timing Can be combined with 2,4-D for early season CLP and EWM treatments, or with copper compounds	Not as effective in dense plant beds Not to be used in water supplies Toxic to aquatic fauna (to varying degrees)
c. Diquat (Reward)	Yes	Broad-spectrum, contact herbicide that disrupts cellular functioning	Mostly used for water-milfoil and duckweed	May impact non-target plants, especially native pondweeds, coontail, elodea, naiads
		Applied as liquid, can be combined with copper treatment	Rapid action Limited direct toxicity on fish and other animals	Toxic to aquatic invertebrates Needs to be reapplied several years in a row

Management Options for Aquatic Plants

				Ineffective in muddy or cold water (<50°F)
d. Fluridone (Sonar)	Yes	Broad-spectrum, systemic pigment bleaching herbicide that inhibits photosynthesis, some reduction in non target effects can be achieved by lowering dosage	Effective on EWM for 2 to 4+ years Applied at very low concentration typically on lake wide basis of less than 8 PPB Specific granular formulation release over extended periods of time 30 – 60 days eliminating peaks and lessening impacts to non targets (natives)	Affects some non-target plants, particularly native milfoils, coontails, elodea and naiads, even at low concentrations. These plants are important to combat invasive species Requires long contact time: 60-90 + days Requires residual monitoring
			Slow decomposition of plants may limit decreases in dissolved oxygen Low toxicity to aquatic animals	Demonstrated herbicide resistance in hydrilla subjected to repeat treatments Unknown effect of repeat whole lake treatments on lake ecology
e. Glyphosate (Rodeo)	Yes	Broad spectrum, systemic herbicide that disrupts enzyme formation and function	Effective on floating and emergent plants such as purple loosestrife	Effective control for 1-5 years
		Usually used for purple loosestrife stems or cattails	Selective if carefully applied to individual plants	Ineffective in muddy water
		Applied as liquid spray or painted on loosestrife stems	Non-toxic to most aquatic animals at recommended dosages	Cannot be used near potable water intakes No control of submerged plants
f. Triclopyr (Renovate)	Yes	Systemic herbicide selective to broadleaf plants that disrupts enzyme function	Effective on many emergent and floating plants	Impacts may occur to some native plants at higher does (e.g. coontail)
		Applied as liquid spray or liquid	More effective on dicots, such as purple loosestrife; may be more effective than glyphosate Results in 3-5 weeks Low toxicity to aquatic animals No recreational use restrictions following treatment	May be toxic to sensitive invertebrates at higher concentrations Retreatment opportunities may be limited due to maximum seasonal rate (2.5 ppm) Sensitive to UV light; sunlight can break herbicide down prematurely Relatively new management option for aquatic plants (since 2003)
g. Copper compounds (Cutrine, Captain)	Yes	Broad-spectrum, systemic herbicide that prevents photosynthesis	Reduces algal growth and increases water clarity	Elemental copper accumulates and persists in sediments
		Used to control planktonic and filamentous algae	No recreational or agricultural restrictions on water use following treatment Herbicidal action on hydrilla, an invasive plant not yet present in Wisconsin	Short term results Small-scale control only, because algae are easily windblown

Management Options for Aquatic Plants

					Toxic to invertebrates, trout and other fish, depending on the hardness of the water Long-term effects of repeat treatments to benthic organism unknown Clear water may increase plant growth
h.	**Lime slurry**	Yes	Applications of lime temporarily raise water pH, which limits the availability of inorganic carbon to plants, preventing growth	Appears to be particularly effective against EWM and CLP Prevents release of sediment phosphorus, which reduces algal growth Increases growth of native plants beneficial as fish habitat	Relatively new technique, so effective dosage levels and exposure requirements are not yet known Short-term increase in turbidity due to suspended lime particles High pH detrimental to aquatic invertebrates May restrict growth of some native plants
i.	**Alum (aluminum sulfate)**	Yes	Remove phosphorus from water column and creates barrier on sediment to prevent internal loading of phosphorus	Most often used against algal problems Lasts up to 5 years	Most not eat fish for 30 days from treatment area
			Dosage must consider pH, hardness and water volume	Improves water clarity	Minimal effect on aquatic plants, or increased light penetration may increase aquatic plants Potential ecosystem toxicity issues for aquatic animals, including fish at some concentrations
j.	**Phoslock**	yes	Remove/sequesters phosphorus from water column and creates barrier on sediment to prevent internal loading of phosphorus	Most often used against algal problems/blooms Improves water quality	Higher cost than Alum
			Dosing based on water quality parameters and volumes	Lasts up to 5 years Made from natural materials/carriers and tends to be more environmentally friendly than alum	

***EWM** - Eurasian water-milfoil
***CLP** - Curly-leaf pondweed

[1]**Systemic herbicide -** Must be absorbed by the plant and moved to the site of action. Often slower-acting than contact herbicides.

[2]**Broadleaf herbicide -** Affects only dicots, one of two groups of plants. Aquatic dicots include waterlilies, bladderworts, watermilfoils, and coontails.

[3]**Broad-spectrum herbicide -** Affects both monocots and dicots.

[4]**Contact herbicide -** Unable to move within the plant; kills only plant tissue it contacts directly

Techniques for Aquatic Plant Control Not Allowed in Wisconsin

Option	How it Works	Pros	Cons
Biological Control			
a. Carp	Plants eaten by stocked carp	Effective at removing aquatic plants Involves species already present in Madison lakes	Illegal to transport or stock carp in Wisconsin Carp cause resuspension of sediments, increased water temperature, lower dissolved oxygen levels and reduction of light penetration Widespread plant removal deteriorates habitat for other fish and aquatic organisms Complete alteration of fish assemblage possible Dislodging of plants such as EWM or CLP turions can lead to accelerated spreading of plants
b. Crayfish	Plants eaten by stocked crayfish	Reduces macrophyte biomass	Illegal to transport or stock crayfish in Wisconsin Control not selective and may decimate plant community Not successful in productive, soft-bottom lakes with many fish predators Complete alteration of fish assemblage possible
Mechanical Control			
a. Cutting (no removal)	Plants are “mowed” with underwater cutter	Creates open water areas rapidly Works in water up to 25 ft	Root system remains for regrowth Fragments of vegetation can re-root and spread infestation throughout the lake Nutrient release can cause increased algae and bacteria and be a nuisance to riparian property owners Not selective in species removed small-scale control only
b. Rototilling	Sediment is tilled to uproot plant roots and stems	Decreases stem density, can affect entire plant	Creates turbidity
	Works in deep water (up to 17 ft)	Small scale control May provide long-term control	Not selective in species removed Fragments of vegetation can re-root Complete elimination of fish habitat

Techniques for Aquatic Plant Control Not Allowed in Wisconsin

			Releases nutrients Increased likelihood of invasive species recolonization
c. Hydroraking	Mechanical rake removes plants from lake Works in deep water (14 ft)	Creates open water areas rapidly	Fragments of vegetation can re-root May impact lake fauna Creates turbidity Plants regrown quickly Requires plant disposal
Physical Control			
a. Fabrics/Bottom Barriers	Prevents light from getting to lake bottom	Reduces turbidity in soft substrate areas Useful for small areas	Eliminates all plants, including native plants important for a healthy lake ecosystem May inhibit spawning by some fish Need maintenance or will become covered in sediment and ineffective Gas accumulation under blankets can cause them to dislodge from the bottom Affects benthic invertebrates Anaerobic environment forms that can release excessive nutrients from sediment