Comprehensive Lake Management Plan

for

Explosion Lake, Horn Lake, Little Horn Lake, Reservoir Pond, McCaslin Brook and Townsend Flowage, Oconto County, Wisconsin

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Introduction

Project Area

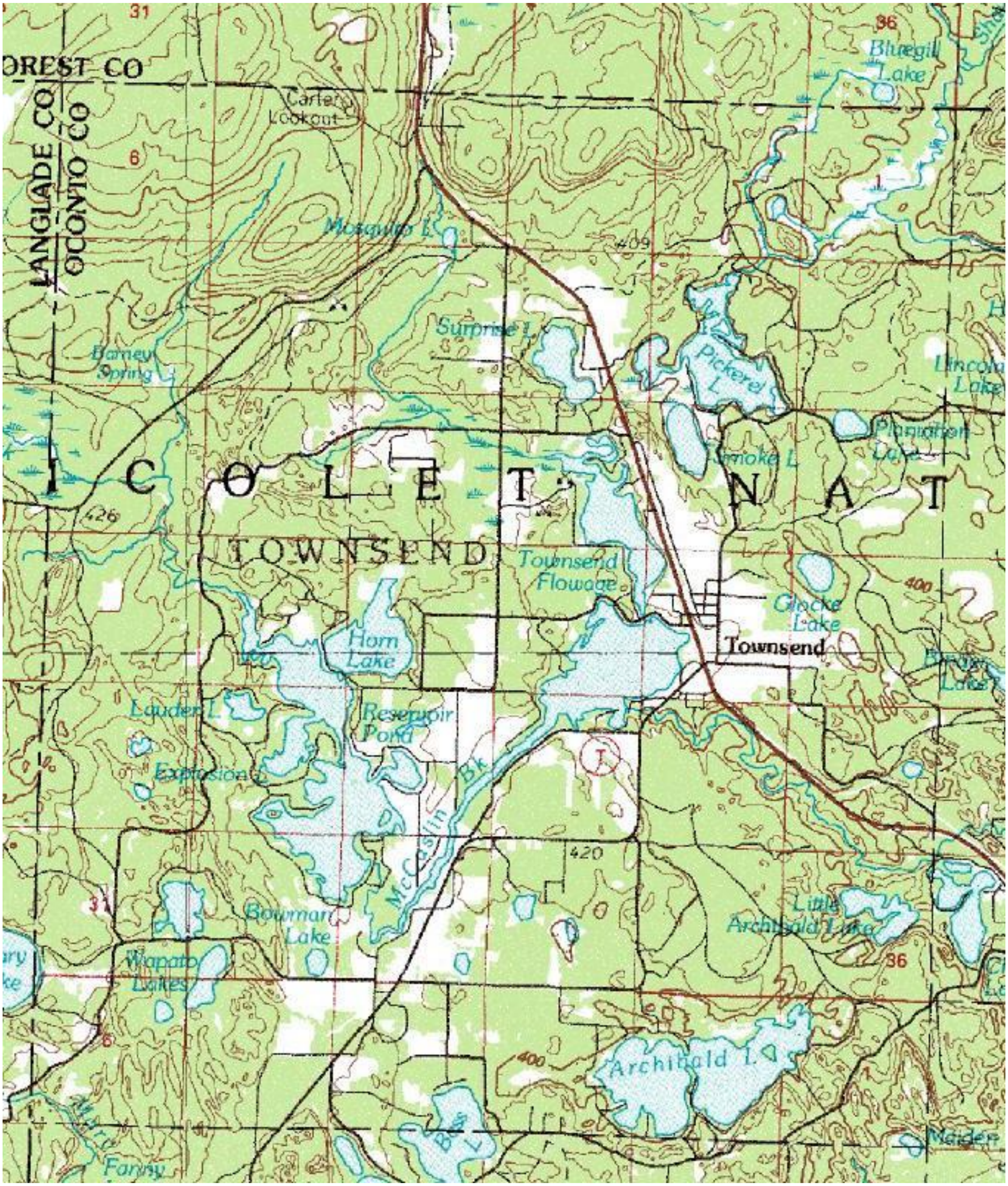
The Inland Lakes Protection and Rehabilitation District No. 1 (ILPRD) and the Townsend Flowage Protection District (TFPD) (formerly the Townsend Flowage Association) are located within the Nicolet National Forest, near the Village of Townsend (**Figure 1**). The ILPRD boundary includes four lakes: Reservoir Pond, Explosion Lake, Horn Lake, and Little Horn Lake as well as a portion of the McCaslin Brook above Reservoir Pond and below the dam leading to Townsend Flowage (**Figure 2**). Reservoir Pond was created in 1888 when the Holt Lumber Company dammed McCaslin Brook. Explosion, Horn and Little Horn Lakes are natural lake basins that are directly connected to Reservoir Pond through surface water. The TFPD includes the north and south basins of the Townsend Flowage and a section of McCaslin Brook upstream of the flowage (**Figure 3**). Here after these waterbodies will be collectively referred to as the *Townsend-are lakes*. They encompass more than 1,130 surface acres and support a fishery of, northern pike (*Esox lucius*), largemouth bass (*Micropterus salmoides*), and panfish (WNDR 2001). **Table 1** presents the physical characteristics of the waterbodies within the ILPRD and TFPD.

Table 1. Characteristics of lakes within the Inland Lakes Protection and Rehabilitation District and Townsend Flowage Protection District, Townsend, Wisconsin.

Waterbody	Size (acre)	Maximum depth (ft)	Mean depth (ft)
Explosion Lake	44	18.3	5.2
Horn Lake	131.4	13.9	6.7
Little Horn Lake	25.3	20.1	10.2
Reservoir Pond	428	15.2	5.4
McCaslin Brook	58.8	11	4.4
Townsend Flowage	445	23.5	8.3

The ILPRD and TFPD represent the interests of lakeshore property owners and other lake users. A majority of the riparian property owners are long-term, seasonal residents. Recreation (primarily fishing and boating) and relaxation are very important to the residents. In general, the public feels the water quality in the Townsend-area lakes is good. They are concerned about possible declines to the fishery, excessive weed growth and other impacts from aquatic invasive species (AIS). Excessive weed growth has been a major issue for a number of years.

Figure 1. Area surrounding the Inland Lakes Protection and Rehabilitation District No. 1 and the Townsend Flowage Protection District, Townsend, Wisconsin.



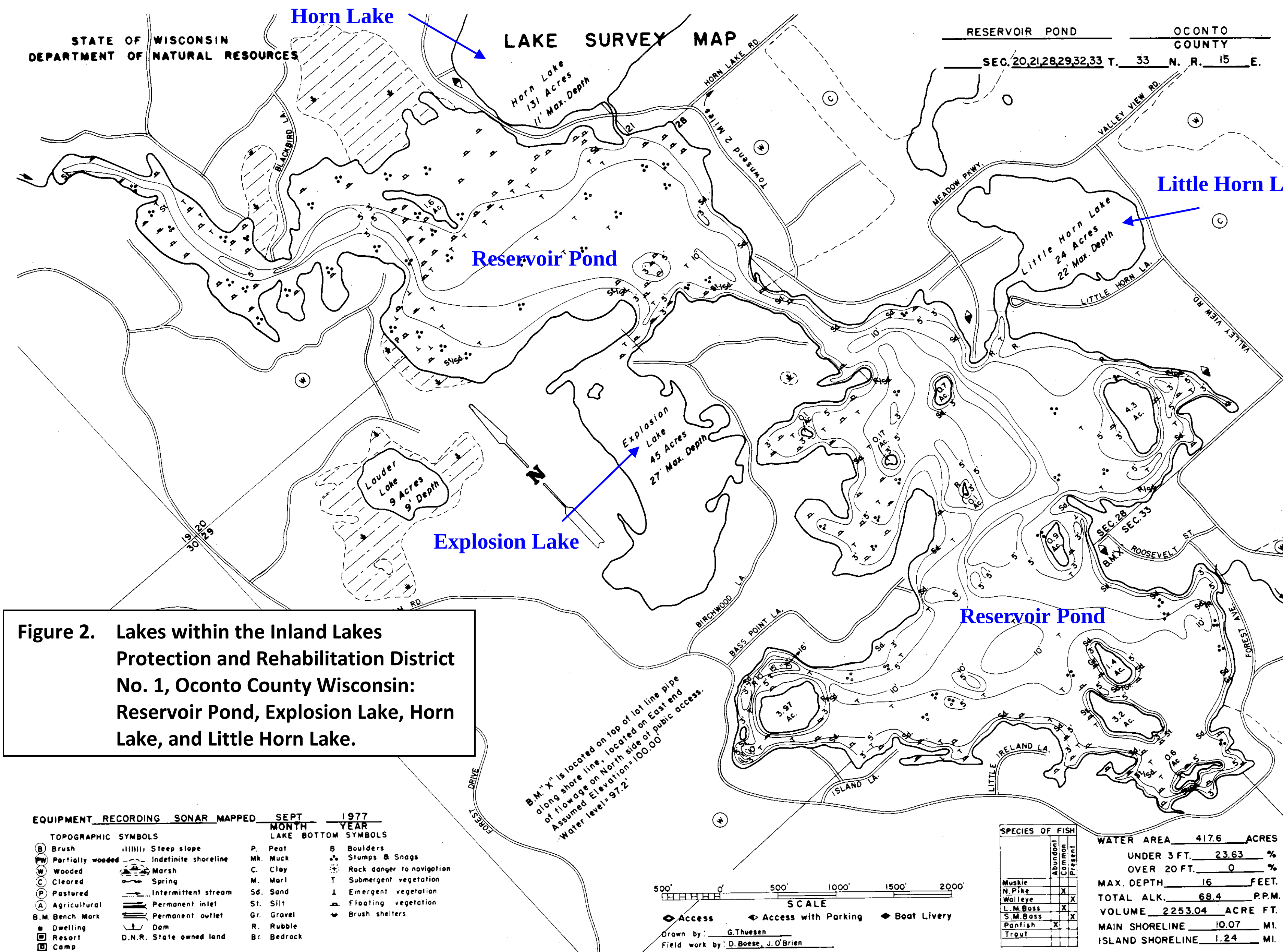
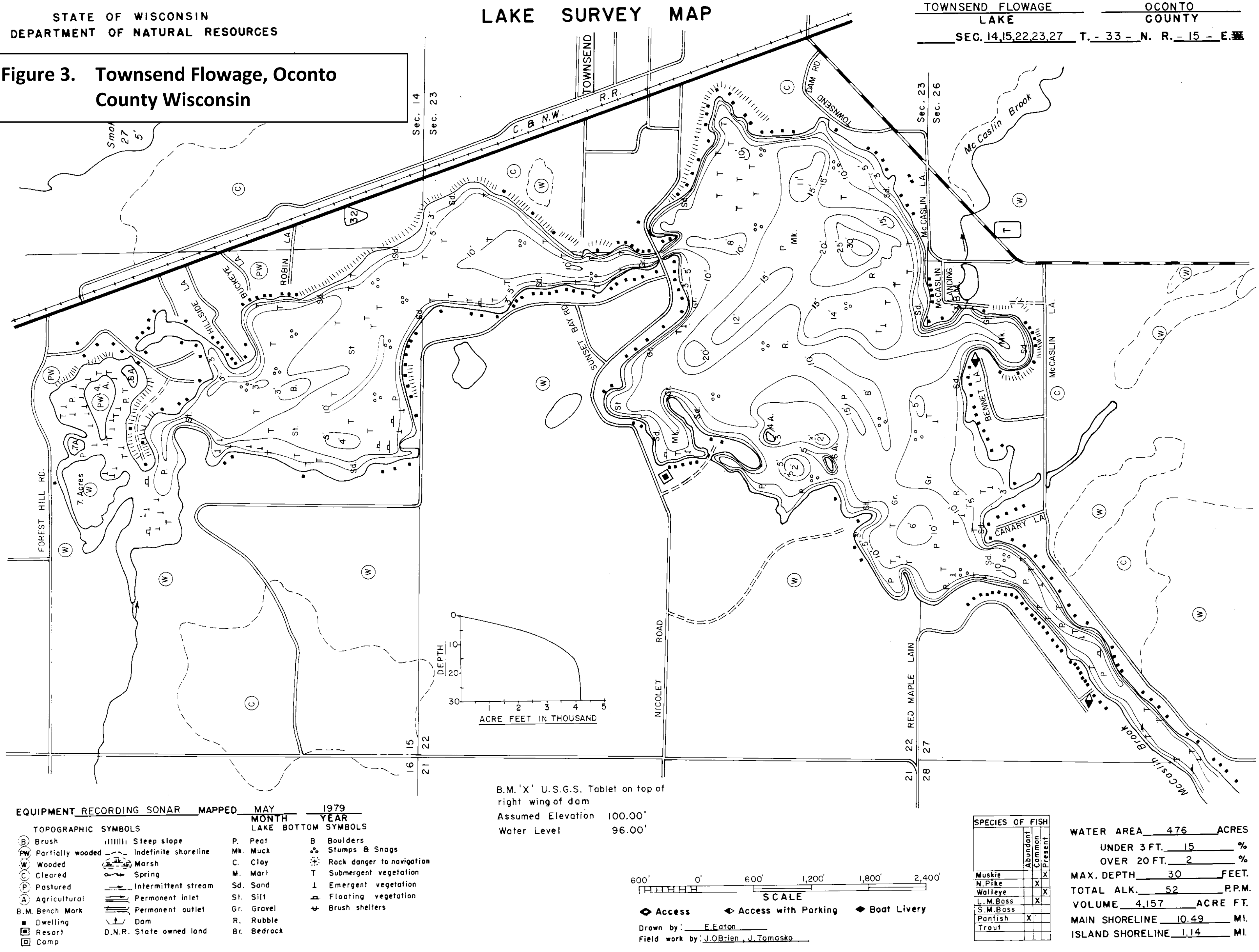


Figure 2. Lakes within the Inland Lakes Protection and Rehabilitation District No. 1, Oconto County Wisconsin: Reservoir Pond, Explosion Lake, Horn Lake, and Little Horn Lake.

Figure 3. Townsend Flowage, Oconto County Wisconsin



Traditionally, nuisance aquatic plant growth has been managed with mechanical weed harvesting and herbicide applications. Although harvesting occurs in all waterbodies, it is most intensive in Reservoir Pond, McCaslin Brook and Townsend Flowage. Harvesting focuses on maintaining navigation lanes through the densest areas of aquatic plant growth as well as picking up mats of uprooted vegetation. In addition, the ILPRD and TFPD have managed aquatic invasive species, namely Eurasian watermilfoil (EWM), for the past decade through herbicide treatments utilizing 2,4-D. The Districts have been fortunate to have received two multi-year, cost-share grants from the WDNR to monitor and manage aquatic invasive species.

This study has been intended to enhance the ability of the ILPRD and TFPD to develop, promote, and implement an effective long-range plan to protect the water quality and plant and animal communities within the lakes. Both organizations have previously sponsored studies leading to the development of lake management plans. In order to continue certain management practices (e.g. herbicide applications, mechanical harvesting, etc.) and to qualify for State-funded grants, the members of the ILPRD and TFPD chose to combine efforts and develop a single plan that encompasses the waters within the boundaries of both organizations. To this end, data has been collected for the past two years, using the same protocols on all of the waterbodies. The purpose of this study was to address the Districts' concerns regarding invasive species proliferation and spread, as well as water quality, fishery quality, scenic beauty and recreation. The results of this study are presented in this report. It also includes interpretation and implications of these results, as well as an analysis of management options.

Recent Management Activities

From 2005 to 2010, annual EWM treatments and AIS surveys were conducted. This started in 2005 when EWM was first confirmed in the north basin of Reservoir Pond and in Horn Lake during the August 2005 survey. Previous management plans for the ILPRD and the TFPD contain specific details regarding the management of EWM in the Townsend-area lakes. The following details cover the EWM management activities from 2010 through 2014

Spring AIS survey results in 2010 found approximately 12.2 acres of EWM growth. Areas of more localized EWM growth (i.e. delineated beds) were targeted for treatment. More isolated, individual plants were left untreated. In total, 10 acres within Reservoir Pond, Little Horn Lake and Townsend Flowage were treated with Navigate® at a rate of 150 lbs/acre.

A change was made in the treatment approach in McCaslin Brook. Previous attempts to control EWM in the brook using granular 2,4-D showed limited success. Some die-off was observed following treatment, but later surveys showed abundant growth in the treatment areas. It was theorized that as the granules slowly released the herbicide, the inflowing water quickly diluted the product, leading to decreased efficacy. As an alternative, in 2010, liquid 2,4-D was applied to the upstream portion of the brook at a rate of 1.0 ppm. This provided high concentrations of the product immediately upon application. However, the effect of dilution remained and again long-term control was not achieved.

During the 2010 post treatment surveys of Reservoir Pond, an area in the northern basin posed difficulties to the survey crew. Abundant plant and algae growth was noted offshore in this basin. The growth was largely milfoil species and native pondweeds. Harvesters did not cut in this area because EWM was known to be present. Navigation in this area was nearly impossible at the time of this survey, as was the ability to properly identify the extent of EWM present. In the more navigable portions, scattered EWM were identified along with what appeared to be northern watermilfoil (NWM). The final survey for the year took place on September 25, 2010. This area still contained densely growing aquatic plants. EWM was again noted growing at low densities in this area.

In the years to follow, the growth of EWM and NWM noticeably increased within the lakes, particularly Reservoir Pond and Little Horn Lakes. In some areas, NWM also superficially appeared to share some characteristics of EWM. These two species are known to hybridize. The resulting hybrid shares characteristics in common with both parent species including the ability to become a nuisance, similar to EWM. The ILPRD wished to determine if hybridization was occurring. In early September 2010, EWM samples were collected from Explosion Lake by the Wisconsin Department of Natural Resources (WDNR). Soon after, additional samples were collected from Reservoir Pond by Cason & Associates staff and lake volunteers. Samples were sent to Dr. Ryan Thum at the Annis Water Resources Institute in Muskegon, Michigan for DNA Analysis. Results of the analyses indicated that the sample from Explosion Lake was northern watermilfoil and the two samples from Reservoir Pond were EWM and northern watermilfoil. This suggested hybridization had not occurred at that time.

Results of the liquid 2,4-D treatment in McCaslin Brook initially showed promise in 2010; reducing the distribution of downstream EWM. The effects of water flow are apparent. The least successfully treated areas in the brook are upstream closer to Reservoir Pond. By September 2010 some regrowth had occurred. However, the regrowth was noticeably less than what had been documented following treatments with granular 2,4-D. Previous annual reports from this time period contain distribution maps of EWM.

From 2011 through 2013, AIS surveys were conducted by Onterra, LLC from DePere, Wisconsin. Survey reports by Onterra from this time period were sent to the ILPRD and TFPD. These reports included the results of the surveys as well as treatment recommendations. Treatments which took place during this time period were conducted by Cason & Associates, LLC.

Approximately 20 acres of EWM were treated with granular 2, 4-D within the ILPRD and TFPD during the spring of 2011. Treatment included 0.5 acre in Townsend Flowage, 7.8 acres in McCaslin Brook, 0.6 acre in Little Horn Lake and 11.1 acres in Reservoir Pond. All treatments were conducted at a dose of 150 lbs of Navigate per acre, except one bed was treated at 200 lbs per acre. This resulted in calculated concentrations of 2,4-D ranging from 2.1 to 3.5 ppm depending on application rate and depth of treatment site. On September 12, 2011, two field crews from Onterra conducted an assessment of the 2011 treatment areas, as well as a system-wide EWM peak-biomass survey. A total of 11.7 acres and 8.3 acres of EWM were identified within the ILPRD and the TFPD, respectively. Many of these areas were locations of previous EWM growth.

On April 24 and 25, 2012, a total of 22.8 acres of EWM were treated within the ILPRD and the TFPD. Spot treatments were utilized in Reservoir Pond and Townsend Flowage, where 7.7 acres of EWM were treated with granular 2, 4-D at a rate of 3.0 ppm. Again within the McCaslin Brook, liquid 2, 4-D was utilized for the spring 2012 treatment. A total of 15.1 acres of EWM were treated at a total rate of 4.0 ppm.

On August 13 and 14, 2012, Onterra conducted a survey of the lakes. Based on the Onterra's per- and post-treatment maps, the small spot treatments appeared to have been moderately effective, as many areas exhibited a reduction in the density of EWM; however, the majority of these sites still contained EWM following the treatment. The treatment in the McCaslin Brook was more effective. Prior to treatment, a majority of the area contained moderate to high densities of EWM, whereas only a few isolated plants were located post treatment. These were promising results since past treatments in the McCaslin Brook were ineffective.

Starting in the first week of September 2012, both the ILPRD and the TFPD underwent a drawdown of six feet to coincide with required dam repairs. Once dam repairs were completed, the water levels were raised again with the lakes. This process took longer than expected, particularly within Townsend Flowage which did not reach full water height until the summer of 2013. Because of the drawdown, there were no treatments in 2013.

On September 18, 2013, a mapping survey of EWM was conducted by Onterra on the Townsend-area lakes. EWM was found to be widespread throughout the system; largely as scattered or highly scattered beds. The total acreage decreased in Reservoir Pond and the Townsend Flowage. The drawdown may have impacted EWM. Drawdowns have been used as a management tool for EWM on other lakes. Density of EWM declined from highly dense in 2012 to highly scattered in 2013. Densities and acreages of EWM within Horn Lake were relatively similar from 2012 to 2013, while acreage increased in McCaslin Brook. EWM was not observed in Explosion Lake during the survey. During this time period, point-intercept surveys were not conducted. Therefore statistical analysis of the impact of the drawdown cannot be performed. However, the 2013 report from Onterra includes side-by-side comparison of pre- and post-drawdown survey results.

In 2014, no treatments were implemented and instead the EWM population was monitored through a fall mapping survey conducted by Onterra, which occurred on September 7 and 8, 2014. Survey methodologies are found in the year-end report provided by Onterra. The survey found EWM had either remained about the same or increased in most of the system. In Little Horn Lake, EWM deceased from 6.8 acres in 2013 to 2.9 acres in 2014; however, the density of EWM in Little Horn Lake increased from scattered to dense. Densities and acreages of EWM within Horn Lake were relatively similar from 2013 to 2014. The EWM in Reservoir Pond increased from 48.4 acres in 2013 to 66.4 acres in 2014. Within McCaslin Brook, EWM increased in acreage from 19.2 acres in 2013 to 44.7 acres in 2014. EWM remained low in density and acreage in the Townsend Flowage, where 1.1 acres of highly scattered plants were observed. No occurrences of EWM were found within Explosion Lake during the survey.

Volunteers from the ILPRD and the TFPD donate many hours each year toward management of their waterbodies. This includes participation in the State's Clean Boats, Clean Waters program and the Citizen Lake monitoring Network, as well as assisting with surveys for AIS. It is has been estimated the two organizations collectively donate over 2,000 hours of their time toward these and other efforts to support the lakes they live on.

Methods

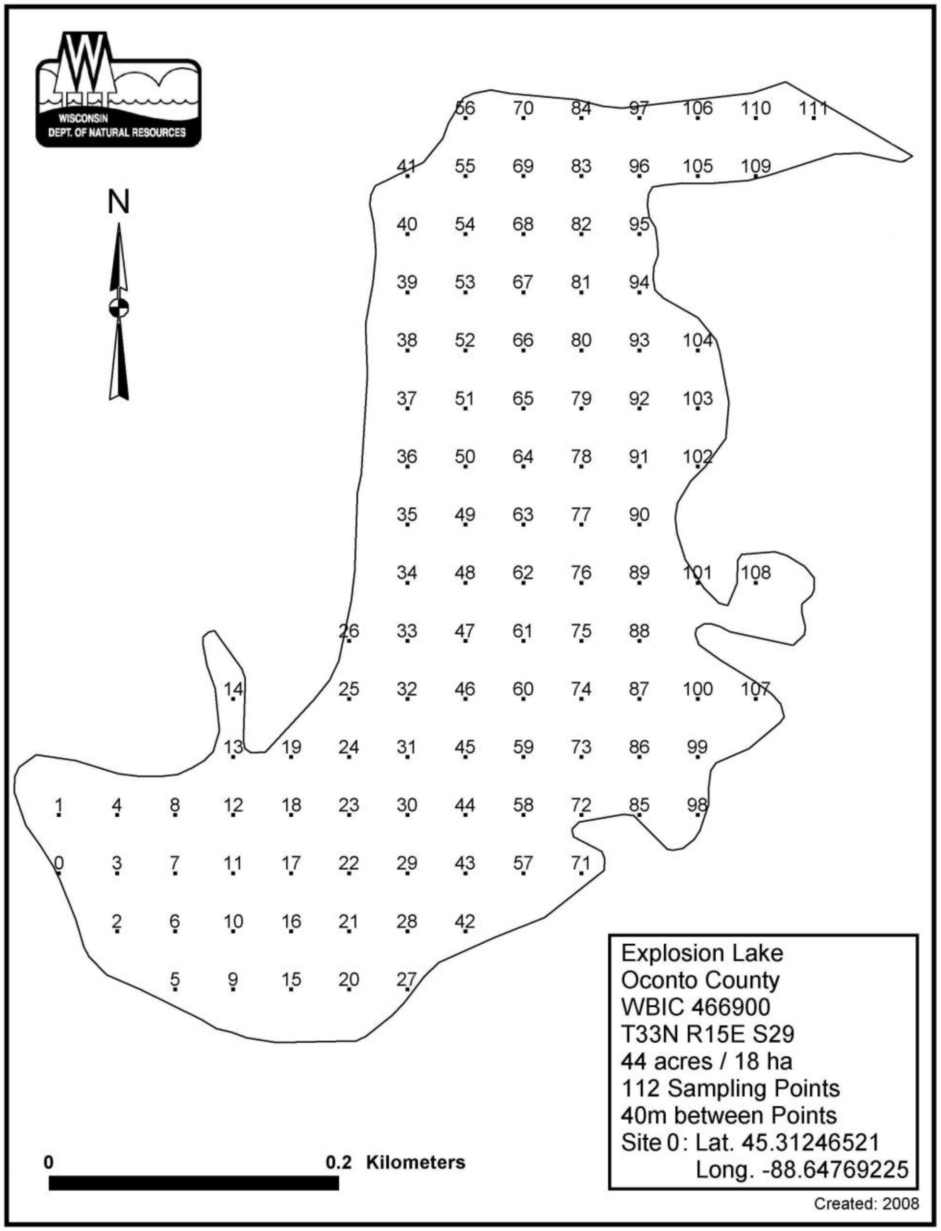
Aquatic Plant Assessment

From August 25th to 28th and on September 8th and 9th, 2014, a submergent aquatic plant survey was conducted utilizing methods developed by the WDNR. The Department's Bureau of Research developed plant survey maps for each of the waterbodies of Townsend. Within each waterbody, a series of grid points were mapped across the lake (**Figure 4, Table 2**). At each of these locations, aquatic plant samples were collected from a boat with a single rake tow. All plant samples collected were identified to *genus* and *species* whenever possible, and recorded. An abundance rating was given for each species collected using the criteria established by the WDNR (Hauxwell, et al., 2010) (**Figure 5)**. Data collected was used to determine species composition and diversity, percent frequency and floristic quality.

Table 2. Details of the point-intercept plant survey grids for Townsend-area lakes, Oconto county, Wisconsin.

Waterbody	Size (acre)	Number of sample points	Grid spacing (m)	Year map created
Explosion Lake	44	112	40	2008
Horn Lake	131.4	262	45	2006
Little Horn Lake	25.3	106	31	2009
Reservoir Pond	428	689	50	2007
McCaslin Brook	58.8	260	30	2014
Townsend Flowage	445	426	65	2005

Figure 4. Aquatic plant survey maps provided by the Wisconsin DNR for the Townsend-area lakes, Oconto County, Wisconsin.



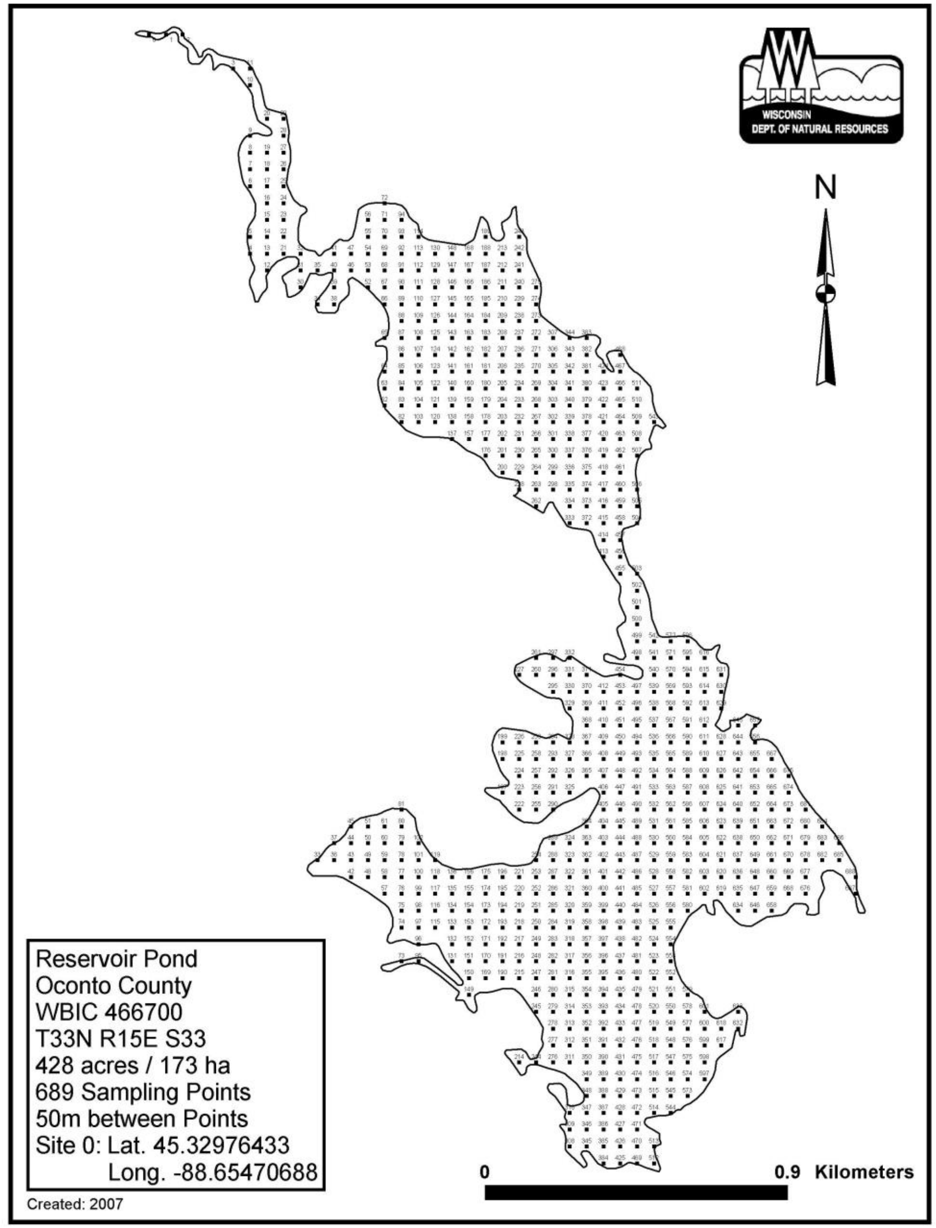
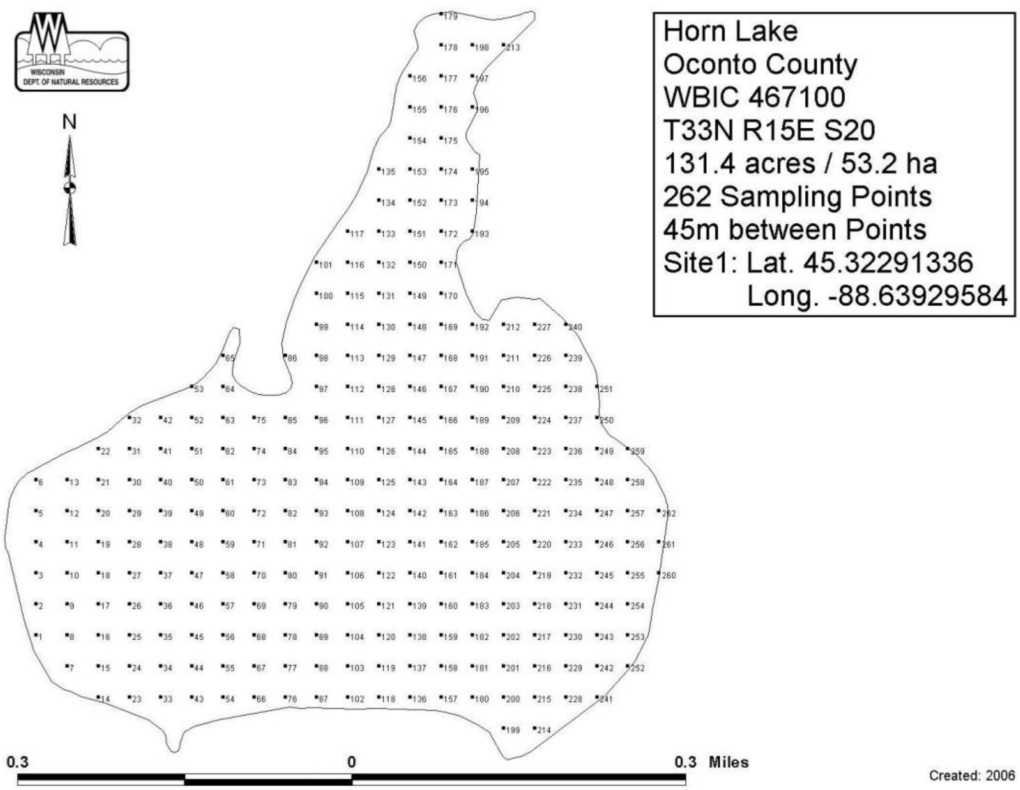
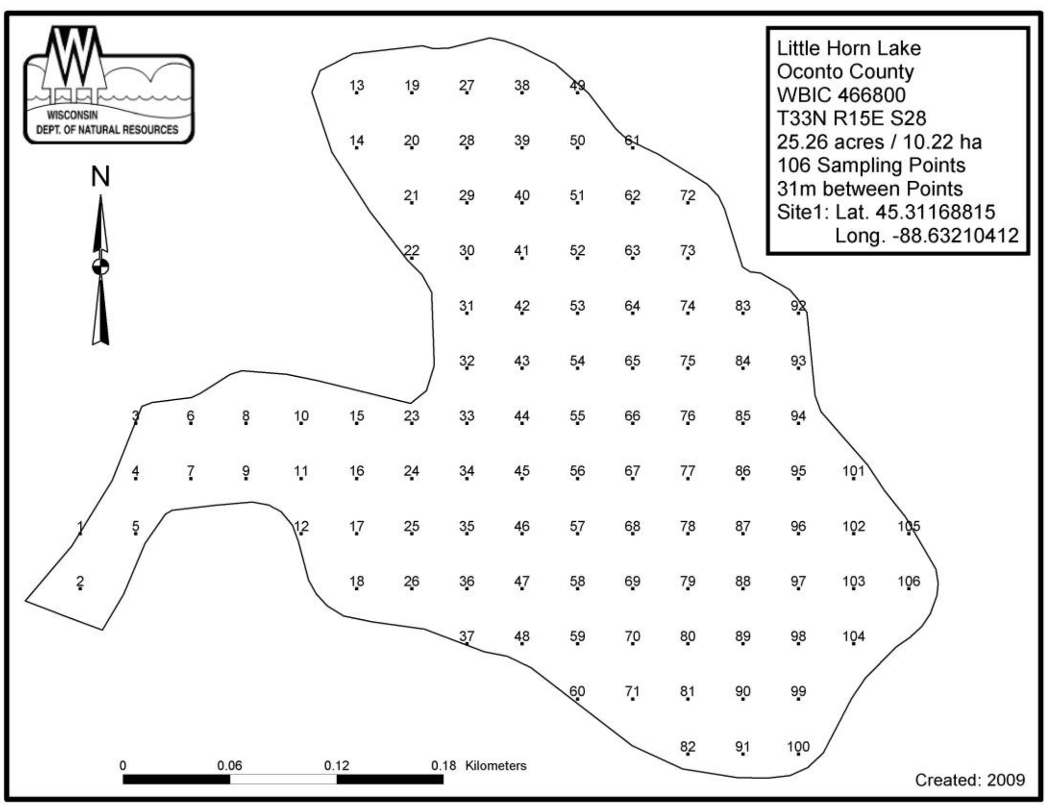


Figure 4 (continued). Aquatic plant survey maps provided by the Wisconsin DNR for the Townsend-area lakes, Oconto County, Wisconsin.





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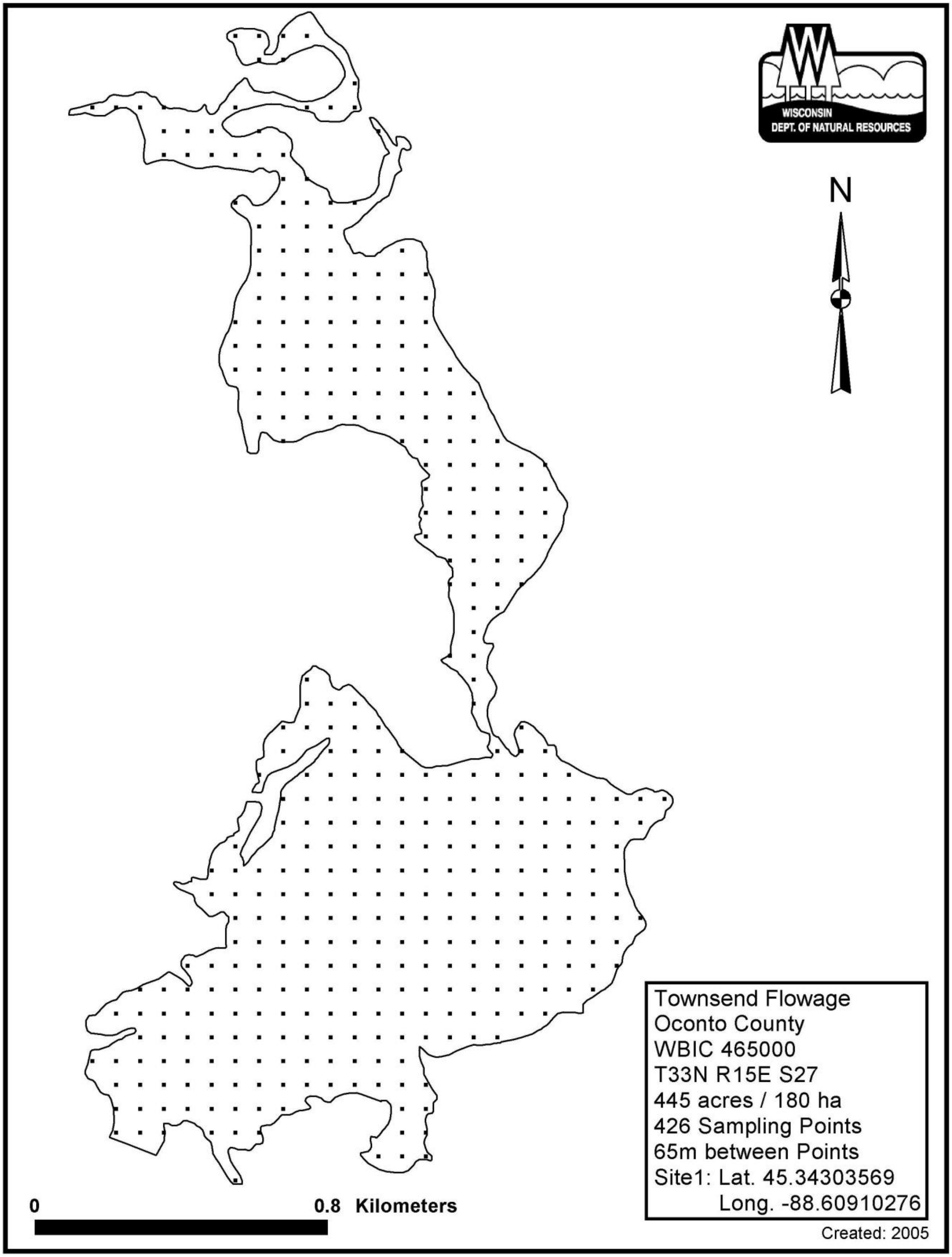

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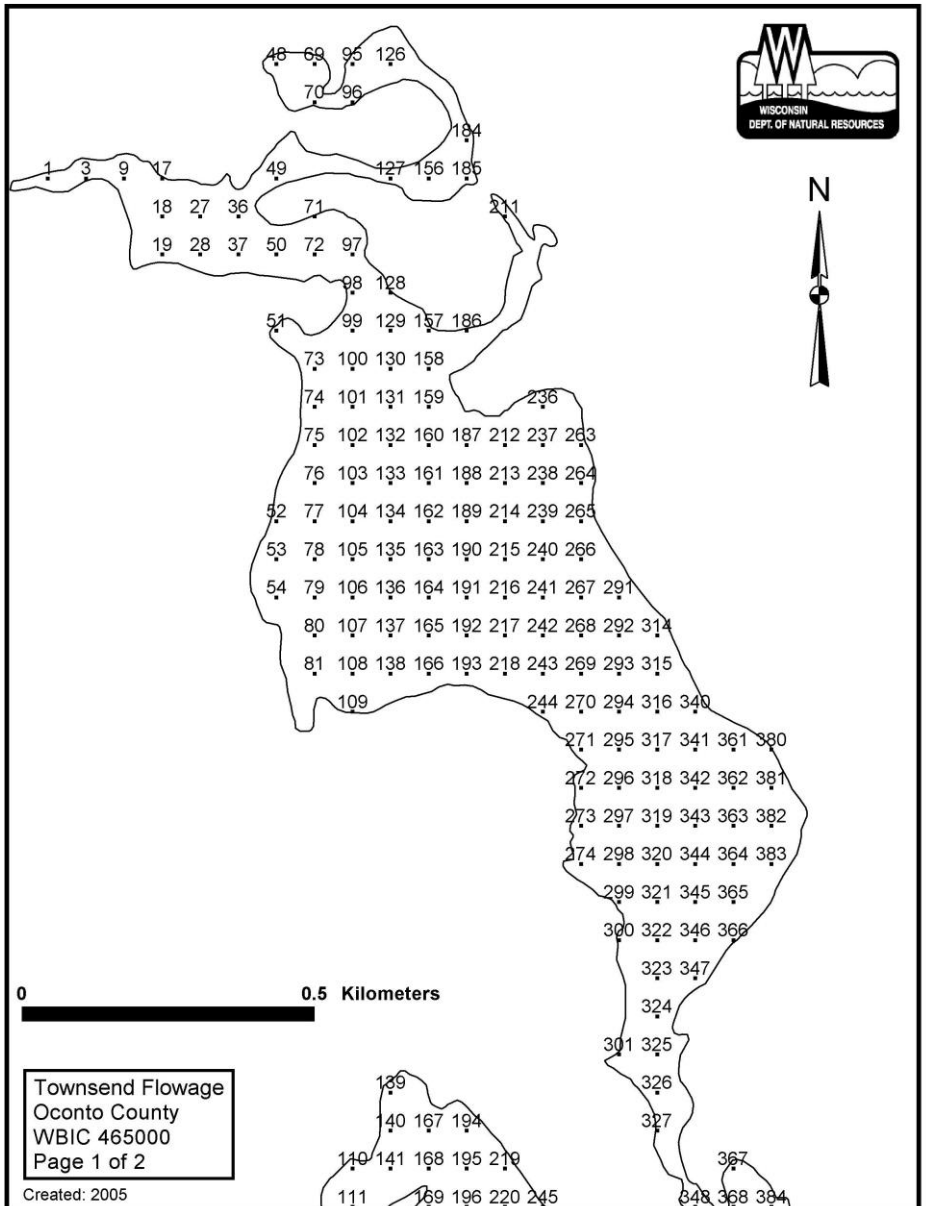

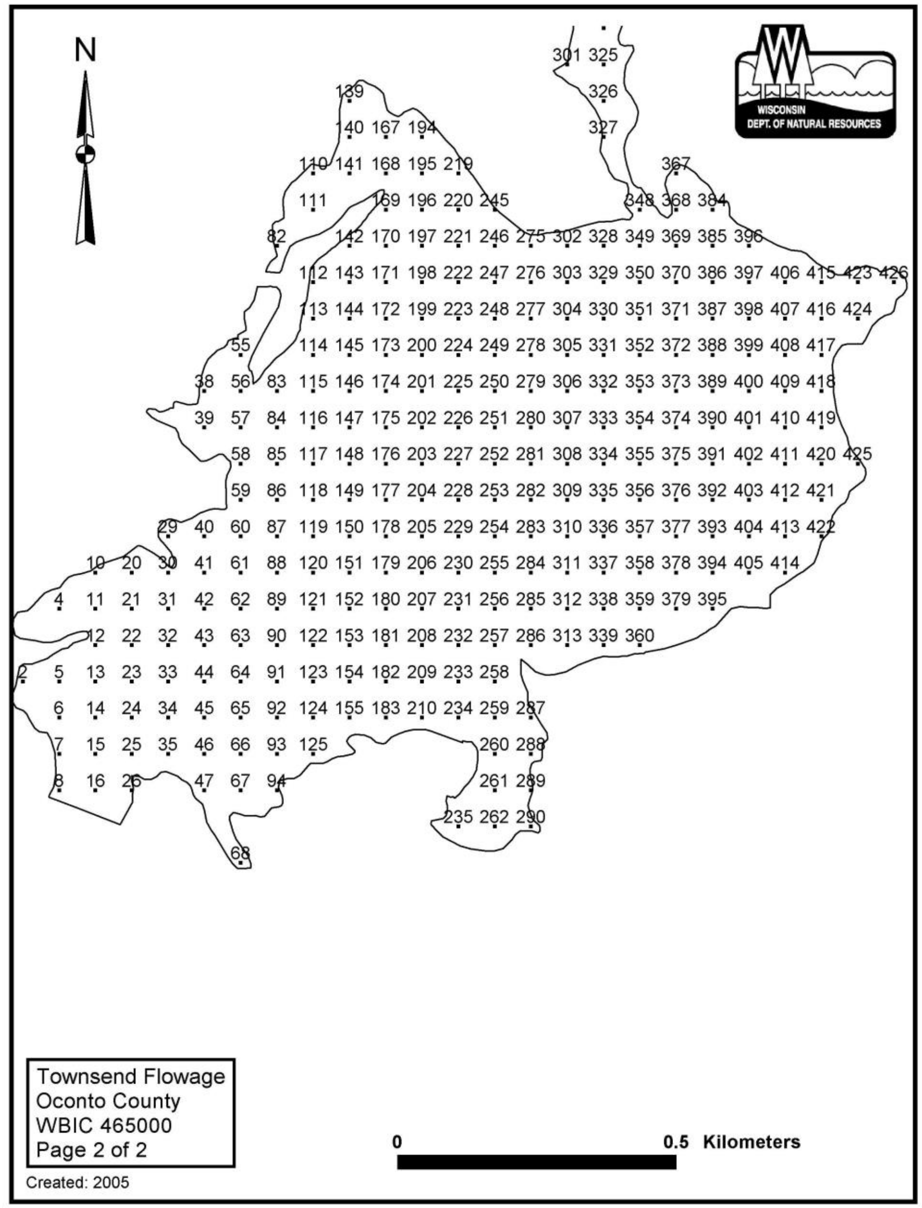

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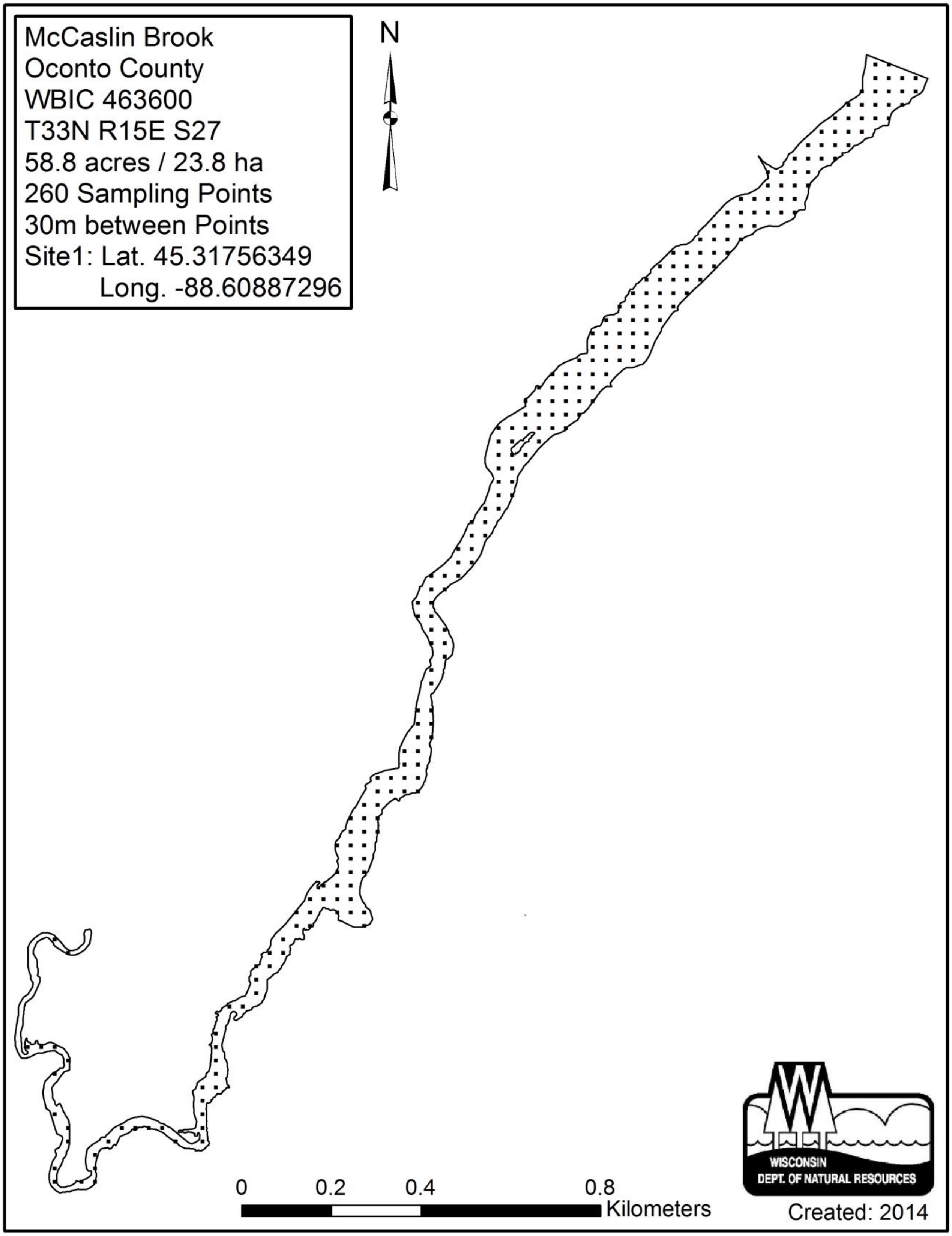

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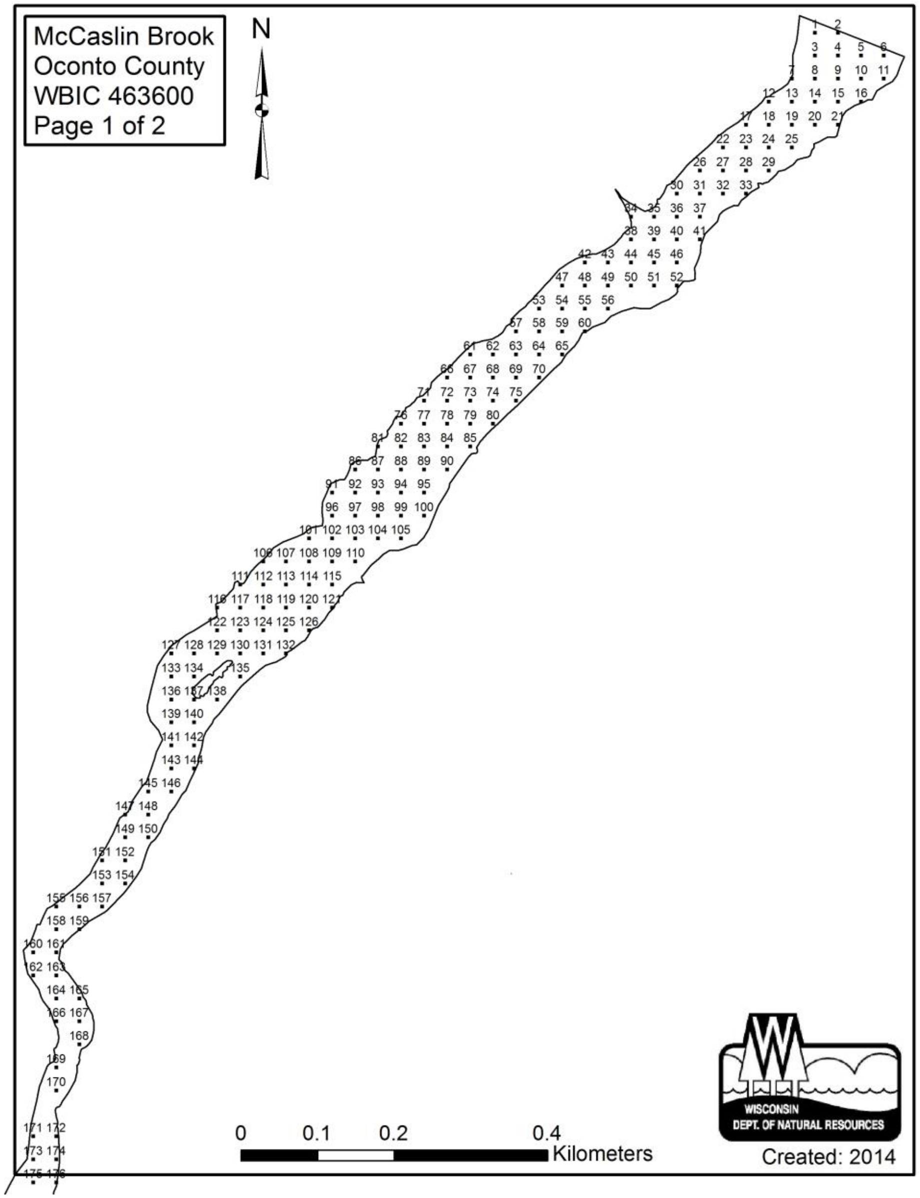


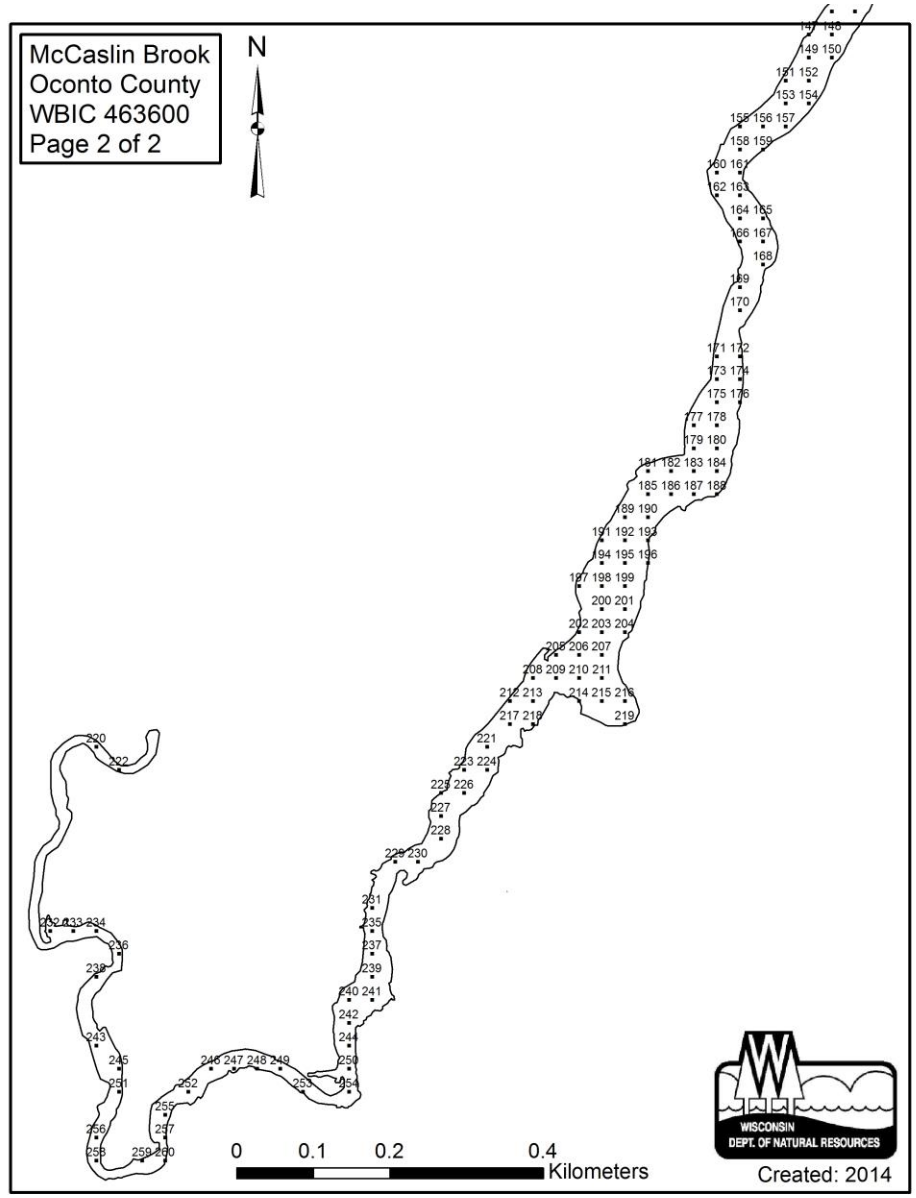


Figure 5. Plant abundance rating criteria used in submergent aquatic plant surveys.

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.

Aquatic Invasive Species Distribution Mapping

In order to best manage AIS in the Townsend-area lakes, detailed mapping surveys were conducted on September 23-27, 2015 and September 26-28, 2016 by Cason & Associates staff and members of the ILPRD and TFPD. The purpose of these surveys was to determine the distribution and abundance of EWM. Care was taken to accurately document the distribution and density of this species during each survey. The survey was performed using surface observations, sonar and rake tows to verify locations of EWM. The locations of the beds were drawn on a lake map. GPS coordinates were recorded at each bed to accurately map their locations and size using ArcMap mapping software.

Water Quality Assessment

Since 2006, regular water quality sampling has taken place on the waterbodies within the ILPRD annually from June to September. Sampling has included multiple monthly collections of water clarity data (Secchi depth) as well as three sampling events focused on chlorophyll *a,* total phosphorus, dissolved oxygen and temperature. Sampling on Townsend Flowage prior to 2014 was less consistent. Water quality sampling took place at the deep point of each lake. District volunteers conducted the water quality sampling as part of this study. Water samples were sent to the State Lab of Hygiene for analysis through the WDNR's Citizen Lake Monitoring Program. All data was gathered from the WDNR's Surface Water Integrated Monitoring System (SWIMS).

Chlorophyll, total phosphorus and Secchi depth data have been used to quantify the productivity of the lakes (Trophic State Index). Software available from the WDNR entitled, Wisconsin Lake Modeling Suite (WiLMS), was used to predict the trophic state of the lakes given their size, watershed area, mean depth and eco-region. Comparisons were made between the predicted TSI values and those calculated from the phosphorus, chlorophyll and Secchi data collected in 2015 and 2016. In addition, this software was used to predict the average total phosphorus concentration in these lakes. Comparisons were made between the predicted phosphorus and TSI values and those calculated from the phosphorus, chlorophyll and Secchi data collected during the study.

Watershed Assessment

Because much of what happens in the watershed surrounding a lake can impact the overall water quality and health of a lake, it is important to investigate and document aspects of the watershed which can have such an impact.

Since the Townsend Flowage is downstream of the lakes within the ILPRD, the Flowage's watershed encompasses all the lakes within the study area. The boundary of the watershed of the TFPD was delineated using topographic maps. During the previous management plans for both organizations, data from the WDNR's Bureau of Technology Services was used to determine land-use patterns and vegetative cover within the watersheds. The percent cover for each of these categories was determined. A ground survey of the watershed was conducted in an effort to identify potential nutrient loading sources and environmentally sensitive areas. The WiLMS software was used to estimate external and internal loading of phosphorus by assessing point and non-point sources of nutrients. The WiLMS software was also used to estimate the external loading of runoff pollutants, namely phosphorus, into the Townsed-area lakes. The software uses export coefficients for various land-use and cover types as well as precipitation, point sources and septic systems to represent phosphorus loading into the lake from external sources. This software also takes in account lake morphology, watershed drainage area and net precipitation. Export coefficients were not applied to the shoreland development specifically to each water body.

Citizen Participation

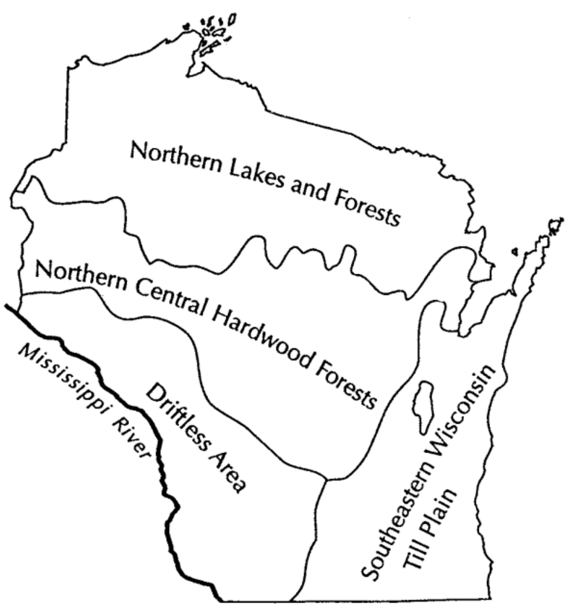
The WDNR wants assurance that the project elements and management recommendations fit the concerns of the lake residents. Therefore, a survey of members of the ILPRD and TFPD was conducted by the District Boards and lake volunteers. This survey evaluated the health and usage of the lake and helped identify issues to be addressed as part of the larger project. Jordan Petchenik, a Resource Sociologist with the WDNR provided extensive guidance in the development of the questions and survey. Copies of the survey were sent to all members of the ILPRD and the TFPD. Volunteers tabulated the results. Volunteers analyzed the results and produced the summaries found in **Appendix A.** Results of this survey will continue to be used to direct future management of the study's waterbodies.

Results and Discussion

Aquatic Plant Communities

Results of the data for the point-intercept aquatic plant surveys conducted on the waters within the ILPRD in 2009 and 2014 and the waters within the TFPD in 2006 and 2014 are found in **Tables 3-9**. In 2014, the number of native plant species identified during the point-intercept surveys on each lake ranged from 21 in Horn Lake to 39 in McCaslin Brook (**Table 3**). Overall, this is well above the state-wide average of 13 species (Nichols, 1999). The Districts' waters lie within the Northern Lakes and Forests ecoregion of Wisconsin (**Figure 6**). Natural lakes in this region also have an average of 13 species. The average number of species found in flowages in this region is 23.5 species (Nichols, 1999). The abundance of plant growth and individual species varied within the waterbodies being studied. **Table 3** includes additional summary data for the plant surveys in 2006, 2009 and 2014

Figure 6. Ecoregions of Wisconsin (after Omernick and Gallant, 1988).



Tables 4-9 include summary tables showing the frequency of occurrence for plant species in each basin. Percent frequency values reflect the relationship between the number of locations where a particular species was found versus the total number of locations sample. In each table, the previous data summaries from either 2006 or 2009 are included. Chi-square statistical analysis has been conducted for each plant species in each lake basin to determine if statically significant changes in species abundance have occurred between the two surveys. The summary tables identify which species experienced significant change, the extent of the change and whether the change represents an increase or decrease in a species' abundance. The plants identified as Eurasian watermilfoil in Explosion and Little Horn Lakes have not yet been genetically confirmed to be this non-native species. The Eurasian watermilfoil in the remaining waterbodies are confirmed.

Simpson Diversity Index

The plant data collected were used to calculate Simpson Diversity Index (**Table 3**). In order to estimate the diversity of the aquatic plant community, this index takes in account both the number of species identified (richness) and the distribution or relative abundance of each species.

Table 3. Summary of aquatic plant survey data collected on the waters of the Inland Lakes P & R District #1 in 2009 and 2014 and on the waters of the Townsend Flowage Protection District in 2006 and 2014, Oconto County, WI.

Waterbody	Number points sampled		Number points w/ veg.		Max depth of plants		Number of species		Simpson Diversity Index		Mean Coefficient of Conservatism		Floristic Quality Index	
	2009	2014	2009	2014	2009	2014	2009	2014	2009	2014	2009	2014	2009	2014
Explosion Lake	95	110	77	93	18.2	18.3	25	31	0.89	0.89	6.28	6.34	31.4	32.4
Horn Lake	260	262	154	131	12.5	13.9	16	21	0.93	0.87	6.13	6.16	24.5	26.8
Little Horn Lake	104	106	89	97	20.1	19.0	23	25	0.93	0.92	6.43	6.15	30.9	27.5
Reservoir Pond	547	596	544	582	11.8	15.2	35	35	0.91	0.93	6.29	6.29	37.2	35.0
McCaslin Brook	75	106	71	97	5.5	11.0	18	39	0.87	0.93	6.00	6.18	25.5	36.0
	2006	2014	2006	2014	2006	2014	2006	2014	2006	2014	2006	2014	2006	2014
Townsend Flowage	399	398	378	364	20.5	20.0	24	32	0.91	0.93	5.96	6.19	28.6	35.0

Table 4. Results of aquatic plant surveys conducted in 2009 and 2014 on Explosion Lake, Oconto County, Wisconsin.

Common Name	Scientific Name	Aug. 2009 Percent Frequency	Sept. 2014 Percent Frequency	Significant Change	Increase (I) or Decrease (D)
Eurasian watermilfoil [x]	*Myriophyllum spicatum*	--	0.92		
Chara	*Chara* spp.	40.86	55.96	*	I
Slender +southern naiad	*Najas flexilis/guadalupensis*[+]	39.78	53.21	*	I
Leafy pondweed	*Potamogeton foliosus*	20.43	21.10		
Aquatic moss	--	6.45	11.93		
Illinois pondweed	*Potamogeton illinoensis*	7.53	7.34		
Small bladderwort	*Utricularia minor*	4.3	7.34		
Common bladderwort	*Utricularia vulgaris*	2.15	7.34		
White water lily	*Nymphaea odorata*	11.83	6.42		
Coontail	*Ceratophyllum demersum*	5.38	6.42		
Common waterweed	*Elodea canadensis*	5.38	6.42		
Small pondweed	*Potamogeton pusillus*	--	6.42	*	I
Floating-leaf pondweed	*Potamogeton natans*	4.30	5.50		
Filamentous algae	--	3.23	5.5		
Spatterdock	*Nuphar variegata*	11.83	4.59		
Northern watermilfoil	*Myriophyllum sibiricum*	7.53	4.59		
Creeping bladderwort	*Utricularia gibba*	2.15	4.59		
Wild celery	*Vallisneria americana*	1.08	4.59		
Various-leaved watermilfoil	*Myriophyllum heterophyllum*	--	3.67		
Needle spikerush	*Eleocharis acicularis*	4.3	3.67		
Flat-stem pondweed	*Potamogeton zosteriformis*	6.45	2.75		
Common burreed	*Sparganium eurycarpum*	2.15	2.75		
Fries' pondweed	*Potamogeton friesii*	1.08	2.75		
Flat-leaf bladderwort	*Utricularia intermedia*	1.08	2.75		
Star duckweed	*Lemna trisulca*	1.08	1.83		
Water star-grass	*Heteranthera dubia*	3.23	0.92		
Variable pondweed	*Potamogeton gramineus*	2.15	0.92		
Hardstem bulrush	*Schoenoplectus acutus*	--	0.92		
Watershield	*Brasenia schreberi*	1.08	--		

* significant change ($p \leq 0.05$), ** more significant change ($p \leq 0.01$), *** most significant change ($p \leq 0.001$)

[+] Slender naiad (*Najas flexilis) and southern naiad (Najas guadalupensis) lumped together due to uncertainty in 2009 identification.*

[x] *Not yet genetically confirmed to be Eurasian watermilfoil*

Table 5. Results of aquatic plant surveys conducted in 2009 and 2014 on Horn Lake, Oconto County, Wisconsin.

Common Name	Scientific Name	Aug. 2009 Percent Frequency	Sept. 2014 Percent Frequency	Significant Change	Increase (I) or Decrease (D)
Eurasian watermilfoil	*Myriophyllum spicatum*	1.54	0.76		
Slender +southern naiad	*Najas flexilis/guadalupensis*+	38.08	36.64		
Wild celery	*Vallisneria americana*	7.31	9.54		
Fern pondweed	*Potamogeton robbinsii*	8.46	9.16		
Leafy pondweed	*Potamogeton foliosus*	11.54	8.78		
Muskgrasses	*Chara* spp.	9.62	5.73		
Common waterweed	*Elodea canadensis*	3.85	3.05		
Flat-stem pondweed	*Potamogeton zosteriformis*	0.38	3.05	*	I
White water lily	*Nymphaea odorata*	2.31	2.67		
Small pondweed	*Potamogeton pusillus*	0.38	1.91		
Watershield	*Brasenia schreberi*	--	1.15		
Illinois pondweed	*Potamogeton illinoensis*	13.08	1.15	***	D
Floating leaf pondweed	*Potamogeton natans*	0.77	1.15		
Spatterdock	*Nuphar variegata*	0.38	1.15		
Water star-grass	*Heteranthera dubia*	--	0.76		
Northern watermilfoil	*Myriophyllum sibiricum*	0.77	0.76		
White stem pondweed	*Potamogeton praelongus*	--	0.38		
Aquatic moss	--	--	0.38		
Large-leaf pondweed	*Potamogeton amplifolius*	1.54	0.38		
Coontail	*Ceratophyllum demersum*	0.38	0.38		

* significant change ($p \leq 0.05$), ** more significant change ($p \leq 0.01$), *** most significant change ($p \leq 0.001$)

+ Slender naiad (*Najas flexilis) and southern naiad (Najas guadalupensis) lumped together due to uncertainty in 2009 identification.*

Table 6. Results of aquatic plant surveys conducted in 2009 and 2014 on Little Horn Lake, Oconto County, Wisconsin.

Common Name	Scientific Name	Aug. 2009 Percent Frequency	Sept. 2014 Percent Frequency	Significant Change	Increase (I) or Decrease (D)
Eurasian watermilfoil [x]	*Myriophyllum spicatum*	7.69	11.88		
Common waterweed	*Elodea canadensis*	32.69	48.65	*	I
Northern watermilfoil	*Myriophyllum sibiricum*	50.00	41.58		
Nitella	*Nitella* spp.	7.69	39.60	***	I
Aquatic moss	--	23.08	38.61	*	I
Slender +southern naiad	*Najas flexilis/guadalupensis*[+]	46.15	33.66	*	D
Fern pondweed	*Potamogeton robbinsii*	3.85	20.79	***	I
Coontail	*Ceratophyllum demersum*	14.42	18.81		
Chara	*Chara* spp.	19.23	15.84		
Leafy pondweed	*Potamogeton foliosus*	42.31	15.84	**	D
Wild celery	*Vallisneria americana*	10.58	12.87		
Flat-stem pondweed	*Potamogeton zosteriformis*	15.38	10.89		
Large-leaf pondweed	*Potamogeton amplifolius*	7.69	10.89		
Small pondweed	*Potamogeton pusillus*	9.62	9.90		
Illinois pondweed	*Potamogeton illinoensis*	33.65	7.92	***	D
Water star-grass	*Heteranthera dubia*	0.96	5.94		
Spatterdock	*Nuphar variegata*	11.54	4.95		
Filamentous algae	--	12.5	2.97	**	D
Variable pondweed	*Potamogeton gramineus*	5.77	1.98		
Star duckweed	*Lemna trisulca*	2.88	0.99		
Floating-leaf pondweed	*Potamogeton natans*	2.88	0.99		
Fries' pondweed	*Potamogeton friesii*	--	0.99		
Clasping-leaf pondweed	*Potamogeton richardsonii*	--	0.99		
Bushy pondweed	*Najas flexilis*	46.15	--	***	D
Creeping bladderwort	*Utricularia gibba*	9.62	--		
Watershield	*Brasenia schreberi*	2.88	--		
Flat-leaf bladderwort	*Utricularia intermedia*	2.88	--		
Common bladderwort	*Utricularia vulgaris*	2.88	--		
Needle spikerush	*Eleocharis acicularis*	0.96	--		

* significant change ($p \leq 0.05$), ** more significant change ($p \leq 0.01$), *** most significant change ($p \leq 0.001$)

[+] Slender naiad (*Najas flexilis) and southern naiad (Najas guadalupensis) lumped together due to uncertainty in 2009 identification.*

[x] *Not yet genetically confirmed to be Eurasian watermilfoil*

Table 7. Results of aquatic plant surveys conducted in 2009 and 2014 on Reservoir Pond, Oconto County, Wisconsin.

Common Name	Scientific Name	Aug. 2009 Percent Frequency	Sept. 2014 Percent Frequency	Significant Change	Increase (I) or Decrease (D)
Eurasian watermilfoil	*Myriophyllum spicatum*	3.01	15.12	***	I
Slender +southern naiad	*Najas flexilis/guadalupensis*+	72.37	57.05	**	D
Coontail	*Ceratophyllum demersum*	56.20	55.33		
Muskgrasses	*Chara* spp.	14.29	35.91	***	I
Northern watermilfoil	*Myriophyllum sibiricum*	59.96	35.05	***	D
Fern pondweed	*Potamogeton robbinsii*	12.41	34.71	***	I
Common waterweed	*Elodea canadensis*	59.21	32.82	***	D
Small pondweed	*Potamogeton pusillus*	16.54	31.27	***	I
Wild celery	*Vallisneria americana*	19.92	20.79		
Flat-stem pondweed	*Potamogeton zosteriformis*	26.69	19.76	**	D
Leafy pondweed	*Potamogeton foliosus*	21.62	19.42		
Star duckweed	*Lemna trisulca*	14.47	14.78		
Nitella	*Nitella* spp.	4.14	11	***	I
Water star-grass	*Heteranthera dubia*	4.51	9.11	**	I
Spatterdock	*Nuphar variegata*	4.51	8.76	**	I
Aquatic moss	--	1.13	7.73	***	I
Large-leaved pondweed	*Potamogeton amplifolius*	5.45	7.39		
White water lily	*Nymphaea odorata*	1.88	5.67	**	I
Filamentous algae	--	35.15	5.15	***	D
White water crowfoot	*Ranunculus aquatilis*	1.50	3.61	*	I
Common duckweed	*Lemna minor*	1.69	3.09		
Floating-leaf pondweed	*Potamogeton natans*	4.70	3.09		
Fries' pondweed	*Potamogeton friesii*	0.38	2.92	**	I
Common bladderwort	*Utricularia vulgaris*	3.57	1.55	*	D
Illinois pondweed	*Potamogeton illinoensis*	21.39	0.86	***	D
Variable pondweed	*Potamogeton gramineus*	0.38	0.69		
Small bladderwort	*Utricularia minor*	1.32	0.52		
Flat-leaf bladderwort	*Utricularia intermedia*	1.13	0.52		
Sago pondweed	*Stuckenia pectinata*	0.19	0.52		
Long-leaf pondweed	*Potamogeton nodosus*	0.19	0.34		
Various-leaved watermilfoil	*Myriophyllum heterophyllum*	0.75	0.17		
Clasping-leaf pondweed	*Potamogeton richardsonii*	--	0.17		

* significant change ($p \le 0.05$), ** more significant change ($p \le 0.01$), *** most significant change ($p \le 0.001$)

+ Slender naiad (*Najas flexilis) and southern naiad (Najas guadalupensis) lumped together due to uncertainty in 2009 identification.*

Table 7 (continued). Results of aquatic plant surveys conducted in 2009 and 2014 on Reservoir Pond, Oconto County, Wisconsin.

		Aug. 2009	Sept. 2014		
Common Name	***Scientific Name***	**Percent Frequency**	**Percent Frequency**	**Significant Change**	**Increase (I) or Decrease (D)**
Common bur-reed	*Sparganium eurycarpum*	--	0.17		
Creeping bladderwort	*Utricularia gibba*	2.07	--	***	D
Watershield	*Brasenia schreberi*	0.75	--	*	D
White-stem pondweed	*Potamogeton praelongus*	0.38	--		
Common watermeal	*Wolffia columbiana*	0.19	--		

* significant change ($p \leq 0.05$), ** more significant change ($p \leq 0.01$), *** most significant change ($p \leq 0.001$)

Table 8. Results of aquatic plant surveys conducted in 2009 and 2014 on McCaslin Brook, Oconto County, Wisconsin.

Common Name	Scientific Name	Sept. 2009 Percent Frequency	Sept. 2014 Percent Frequency	Significant Change	Increase (I) or Decrease (D)
Eurasian watermilfoil	*Myriophyllum spicatum*	12.50	34.70	***	I
Common waterweed	*Elodea canadensis*	94.44	79.45	**	D
Coontail	*Ceratophyllum demersum*	30.56	57.08	***	I
Nitella	*Nitella* sp.	--	40.64	***	I
Filamentous algae	--	61.11	32.42	***	D
Slender +southern naiad	*Najas flexilis/guadalupensis*+	16.67	21.92	*	I
Liverwort	*Riccia* sp.	--	21.46	***	I
Northern watermilfoil	*Myriophyllum sibiricum*	29.17	21.00		
Water star-grass	*Heteranthera dubia*	2.78	18.72	***	I
Wild celery	*Vallisneria americana*	5.56	16.44	*	I
Common duckweed	*Lemna minor*	--	14.61	***	I
Aquatic moss	--	1.39	14.61	**	I
Flat-stem pondweed	*Potamogeton zosteriformis*	4.17	13.70	*	D
Spatterdock	*Nuphar variegata*	--	12.33	**	I
Common bladderwort	*Utricularia vulgaris*	9.72	12.33		
Large leaf pondweed	*Potamogeton amplifolius*	5.56	11.42		
White water crowfoot	*Ranunculus aquatilis*	13.89	9.59		
Muskgrasses	*Chara* sp.	81.94	7.76	***	D
White water lily	*Nymphaea odorata*	1.39	7.76		
Clasping-leaf pondweed	*Potamogeton richardsonii*	12.5	7.76		
Star duckweed	*Lemna trisulca*	22.22	5.94	***	D
Clasping-leaf pondweed	*Myriophyllum heterophyllum*	--	5.48	*	I
Long-leaf pondweed	*Potamogeton nodosus*	--	5.48	*	I
Fern pondweed	*Potamogeton robbinsii*	--	5.48	*	I
Small pondweed	*Potamogeton pusillus*	1.39	5.02		
Floating-leaf pondweed	*Potamogeton natans*	--	4.11		
Illinois pondweed	*Potamogeton illinoensis*	9.72	3.20	*	D
Softstem bulrush	*Schoenoplectus tabernaemontani*	--	2.74		
Common bur-reed	*Sparganium eurycarpum*	--	2.74		
Sago pondweed	*Stuckenia pectinata*	--	2.28		

* significant change ($p \le 0.05$), ** more significant change ($p \le 0.01$), *** most significant change ($p \le 0.001$)

+ Slender naiad (*Najas flexilis) and southern naiad (Najas guadalupensis) lumped together due to uncertainty in 2009 identification.*

Table 8 (continued). Results of aquatic plant surveys conducted in 2009 and 2014 on McCaslin Brook, Oconto County, Wisconsin.

		Sept. 2009	Sept. 2014		
Common Name	**Scientific Name**	**Percent Frequency**	**Percent Frequency**	**Significant Change**	**Increase (I) or Decrease (D)**
Leafy pondweed	*Potamogeton foliosus*	--	1.37		
Variable pondweed	*Potamogeton gramineus*	--	1.37		
Small bladderwort	*Utricularia minor*	--	0.91		
Water smartweed	*Persicaria amphibia*	--	0.46		
Fries' pondweed	*Potamogeton friesii*	--	0.46		
White-stem pondweed	*Potamogeton praelongus*	1.39	--		

* significant change ($p \leq 0.05$), ** more significant change ($p \leq 0.01$), *** most significant change ($p \leq 0.001$)

Table 9. Results of aquatic plant surveys conducted in 2009 and 2014 on Townsend Flowage, Oconto County, Wisconsin.

		July 2006	Aug. 2014		
Common Name	**Scientific Name**	**Percent Frequency**	**Percent Frequency**	**Significant Change**	**Increase (I) or Decrease (D)**
Eurasian watermilfoil	*Myriophyllum spicatum*	--	3.33	***	I
Slender +southern naiad	*Najas flexilis/guadalupensis*+	61.50	49.23	***	D
Coontail	*Ceratophyllum demersum*	53.80	48.97		
Leafy pondweed	*Potamogeton foliosus*	46.70	46.41		
Common waterweed	*Elodea canadensis*	56.70	43.85	***	D
Northern watermilfoil	*Myriophyllum sibiricum*	39.00	39.49		
Flat-stem pondweed	*Potamogeton zosteriformis*	20.30	30.51	***	I
Nitella	*Nitella* sp.	12.60	23.85	***	I
Wild celery	*Vallisneria americana*	16.70	19.49		
Clasping-leaf pondweed	*Potamogeton richardsonii*	28.50	17.44	***	D
White-stem pondweed	*Potamogeton praelongus*	8.20	15.13	**	I
Muskgrasses	*Chara* sp.	11.30	14.36		
Large leaf pondweed	*Potamogeton amplifolius*	9.00	13.85	*	I
Illinois pondweed	*Potamogeton illinoensis*	5.10	7.95		
Spatterdock	*Nuphar variegata*	11.30	5.64	**	D
Sago pondweed	*Stuckenia pectinata*	1.30	5.64	***	I
Aquatic moss	--	--	4.87	***	I
Star duckweed	*Lemna trisulca*	10.50	4.62	**	D
Water star-grass	*Heteranthera dubia*	--	4.36	***	I
Variable pondweed	*Potamogeton gramineus*	3.60	4.10		
White water lily	*Nymphea odorata*	4.10	3.85		
Floating-leaf pondweed	*Potamogeton natans*	4.90	3.08		
Filamentous algae	--	1.50	2.31		
Flat-leaf pondweed	*Utricularia intermedia*	--	2.31	**	I
Small bladderwort	*Utricularia minor*	--	2.31	**	I
Fern pondweed	*Potamogeton robbinsii*	--	2.05	**	I
Needle spikerush	*Eleocharis acicularis*	--	1.79	**	I
White water crowfoot	*Ranunculus aquatilis*	0.80	1.54		
Watershield	*Brasenia schreberi*	4.90	0.77	***	D
Common bladderwort	*Utricularia vulgaris*	2.80	0.77	*	D
Common duckweed	*Lemna minor*	--	0.77		
Common bur-reed	*Sparganium eurycarpum*	--	0.77		
Water smartweed	*Persicaria amphibia*	--	0.51		
Stiff water crowfoot	*Ranunculus aquatilis*	0.80	--		

* significant change ($p \leq 0.05$), ** more significant change ($p \leq 0.01$), *** most significant change ($p \leq 0.001$)

+ Slender naiad (*Najas flexilis) and southern naiad (Najas guadalupensis) lumped together due to uncertainty in 2009 identification.*

As these parameters increase, so does the overall diversity. With the Simpson Diversity Index (D), 1 represents infinite diversity and 0, no diversity. That is, the bigger the value of D, the higher the diversity. The value of D calculated for this study's waterbodies ranged from 0.89 to 0.93 representing above average diversity. The value of D increased in three waterbodies, decreased in two and remained the same in Explosion Lake. Overall, it appears there has been little change in the diversity of plants in these waters in the five to eight years between surveys.

Assessment of Floristic Quality

These plant data were also used to assess the "floristic quality" of each water body (**Table 3**). The method used assigns a value to each *native* plant species called a Coefficient of Conservatism (C). It does not take in account the presence of exotic species, mosses, sponges, or filamentous algae. Coefficient values range from 0 - 10 and reflect a particular species' likelihood of occurring in a relatively undisturbed landscape. Species with low coefficient values, such as coontail (C = 3), are likely to be found in a variety of habitat types and can tolerate high levels of human disturbance. On the other hand, species with higher coefficient values, such as small bladderwort (*Utricularia minor*) (C = 10), are much more likely to be restricted to high quality, natural areas. By averaging the coefficient values available for the submergent and emergent species found in 2014, values ranging from 6.15 to 6.34 (**Table 3**) were calculated. The average value for lakes in Wisconsin is 6.0. The average for lakes in the Northern Lakes and Forests ecoregion is 6.7, while the average for flowages in this region is 6.2 (Nichols, 1999).

By utilizing the Coefficients of Conservatism for the plant species for each water body within the District, further assessment of floristic quality can be made. By multiplying the average coefficient values by the square root of the number of plant species found, a Floristic Quality Index (FQI) was calculated (**Table 3).** Values from 2014 ranged from 26.8 to 36.0. In general, higher FQI values reflect higher lake quality. The average for Wisconsin lakes is 22.2. The average for lakes in the Northern Lakes and Forests ecoregion is 24.3. The average for flowages in this region is 28.3 (Nichols, 1999). Both Coefficient of Conservatism and the Floristic Quality Index values suggest the quality of the waterbodies near Townsend, specifically in terms of the plant community, is above average for the region.

Aquatic plants serve an important purpose in the aquatic environment. They play an instrumental role in maintaining ecological balance in ponds, lakes, wetlands, rivers, and streams. Native aquatic plants have many values. They serve as buffers against nutrient loading and toxic chemicals, act as filters that capture runoff-borne sediments, stabilize lakebed sediments, protect shorelines from erosion, and provide critical fish and wildlife habitat. Therefore, it is essential that the native aquatic plant community within the Townsend-area lakes. **Appendix B** provides a list of the more abundant native aquatic plant species that were found during the 2014 surveys. Ecological values and a description are given for each species

Aquatic Invasive Species Management

EWM has been the main aquatic invasive species of concern in the Townsend area over the past ten years. In the introduction of this report, a detailed account of exotic species management since 2005 is given. Although its presence has been suspected, hybrid watermilfoil has not been identified in these lakes. In early September 2010, milfoil samples were collected from Explosion Lake and Reservoir Pond for genetic testing. Results of the analysis indicated that the sample from Explosion Lake was northern watermilfoil and the two samples from Reservoir Pond were Eurasian watermilfoil and northern watermilfoil. Hybrid watermilfoil was not found. In addition, curly-leaf pondweed (*Potamogeton crispus*), another fairly common aquatic invasive species in Wisconsin, is listed as "observed" in 2014. This species was not identified during any of the 2014 point-intercept surveys. The website also lists the banded mystery snail (*Viviparus georgianus*) and the Chinese mystery snail (*Cipangopaludina chinensis*) as being present in the Districts' lakes. One shoreline invasive plant purple loosestrife (*Lythrum salicaria*) was identified along the shore of McCaslin Brook a few years ago. Soon after it was removed.

Data from the 2014 point-intercept surveys was used to develop the maps shown in **Figures 7-12**. In addition, results of the September 23-27, 2015 aquatic invasive species survey are found in **Table 10** and **Figures 12-18**. In total, approximately 137 acres of EWM were found in the seven waterbodies. A majority of this (72%) was determined to be 'highly scattered'. Only 6% was identified as 'dense'.

Table 10. Acreage of Eurasian watermilfoil identified on September 23-27, 2015 on the waterbodies within the Inland Lakes Protection and Rehabilitation District No. 1 and the Townsend Flowage Protection District, Oconto County, WI.

Basin	EWM/HWM acreage	Lake acreage	% cover	FOO* Sept 2014
Explosion Lake	0.5	44	1.23%	0.92%
Horn Lake	2.2	131.4	1.66%	0.76%
Little Horn Lake	3.2	25.26	12.67%	11.88%
Reservoir Pond	91.2	428	21.31%	15.12%
McCaslin Brook	24.0	58.8	40.81%	34.70%
Townsend Flowage	15.7	446	3.52%	3.33%
Total	136.8	1,133		

Plant density	EWM/HWM acreage
Highly scattered	98.7
Scattered	14.0
Moderately dense	15.7
Dense	8.5
Total	136.8

* FOO = frequency of occurrence calculated from 2014 point-intercept survey data.

Figure 7. Locations of Eurasian watermilfoil (*Myriophyllum spicatum*) identified during the 2014 point-intercept survey of Explosion Lake, Oconto County, Wisconsin.

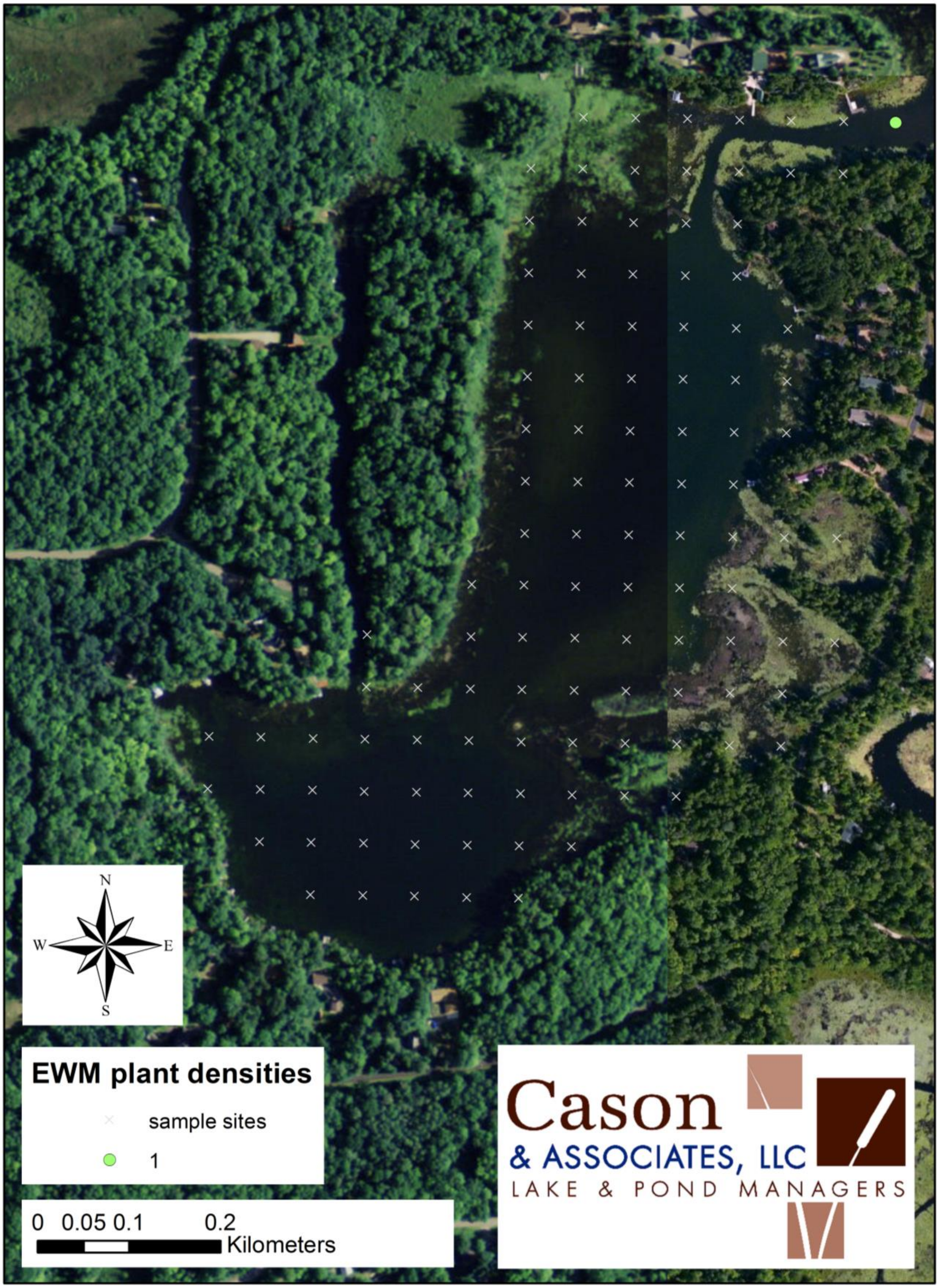


Figure 8. Locations of Eurasian watermilfoil (*Myriophyllum spicatum*) identified during the 2014 point-intercept survey of Horn Lake, Oconto County, Wisconsin.

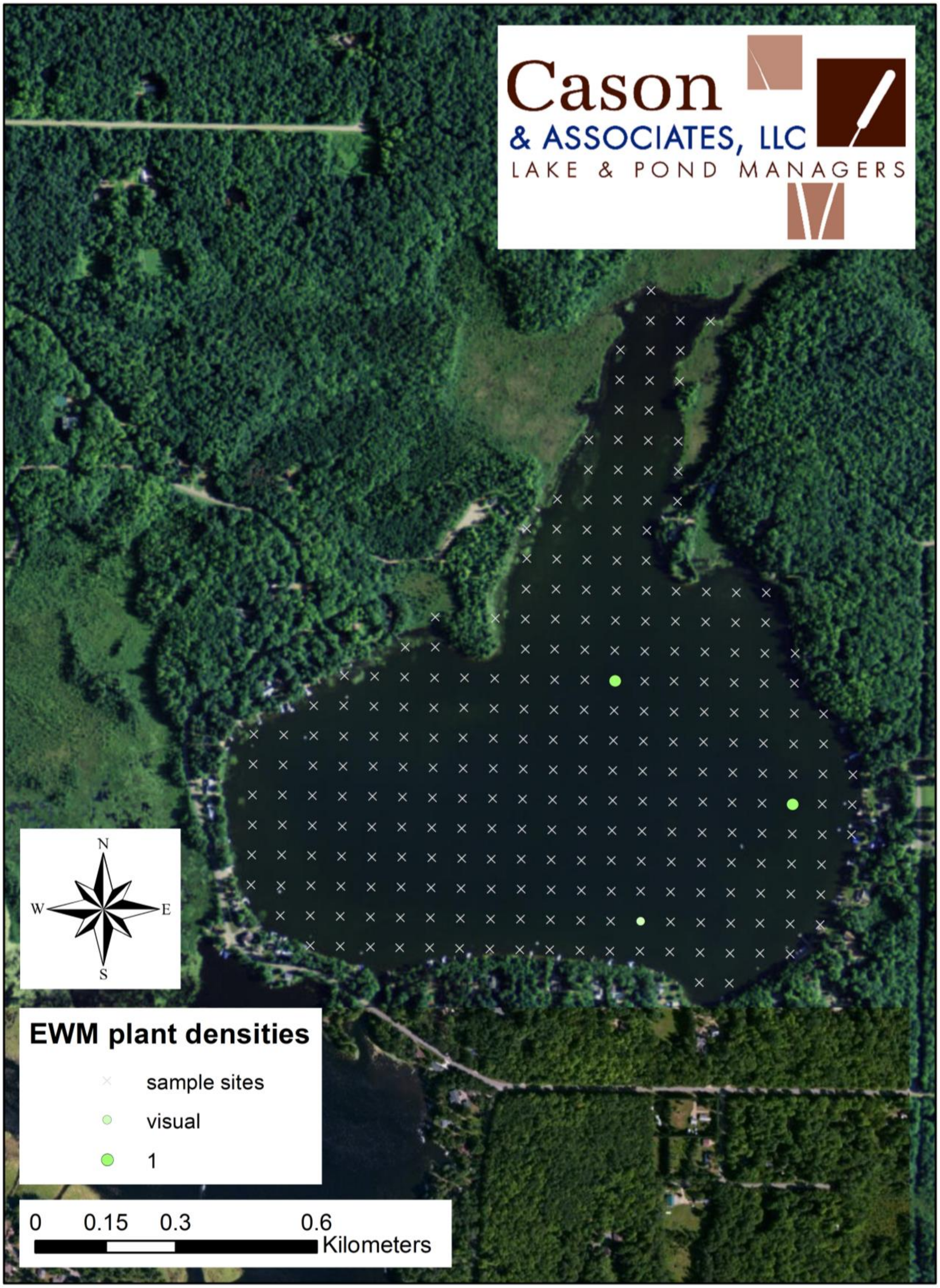


Figure 9. Locations of Eurasian watermilfoil (*Myriophyllum spicatum*) identified during the 2014 point-intercept survey of Little Horn Lake, Oconto County, Wisconsin.

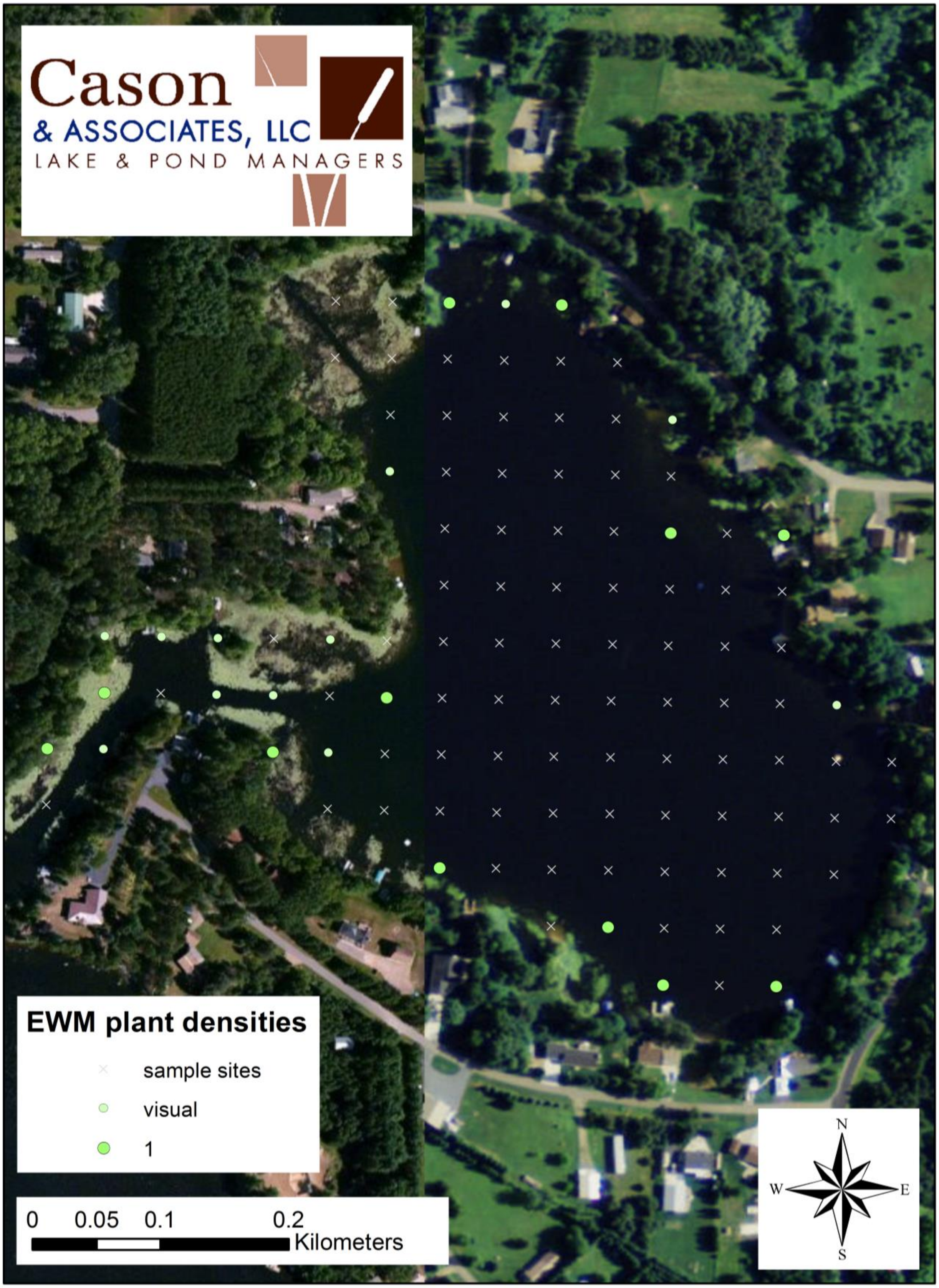


Figure 10. Locations of Eurasian watermilfoil (*Myriophyllum spicatum*) identified during the 2014 point-intercept survey of Reservoir Pond, Oconto County, Wisconsin.

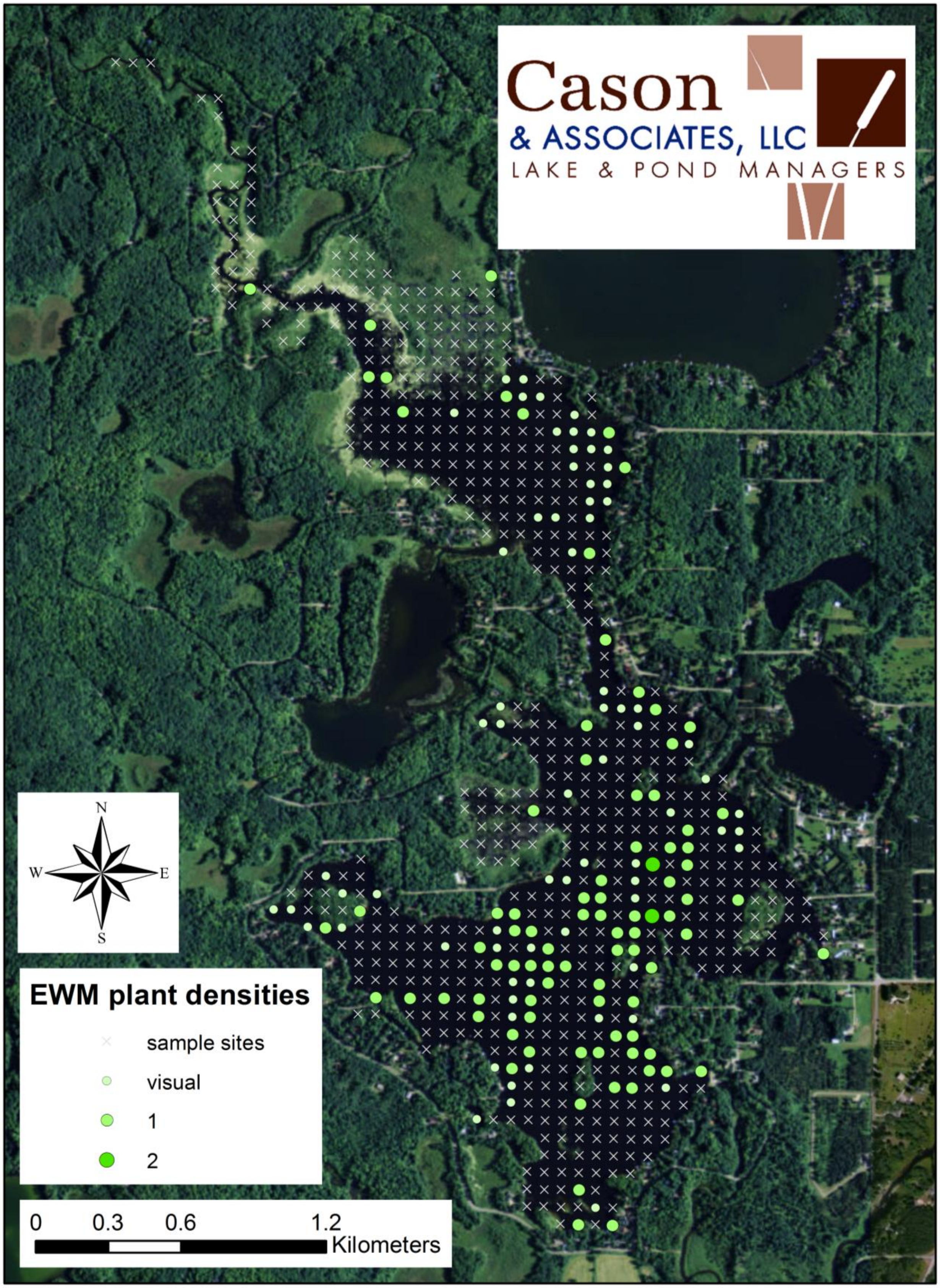


Figure 11. Locations of Eurasian watermilfoil (*Myriophyllum spicatum*) identified during the 2014 point-intercept survey of McCaslin Brook, Oconto County, Wisconsin.

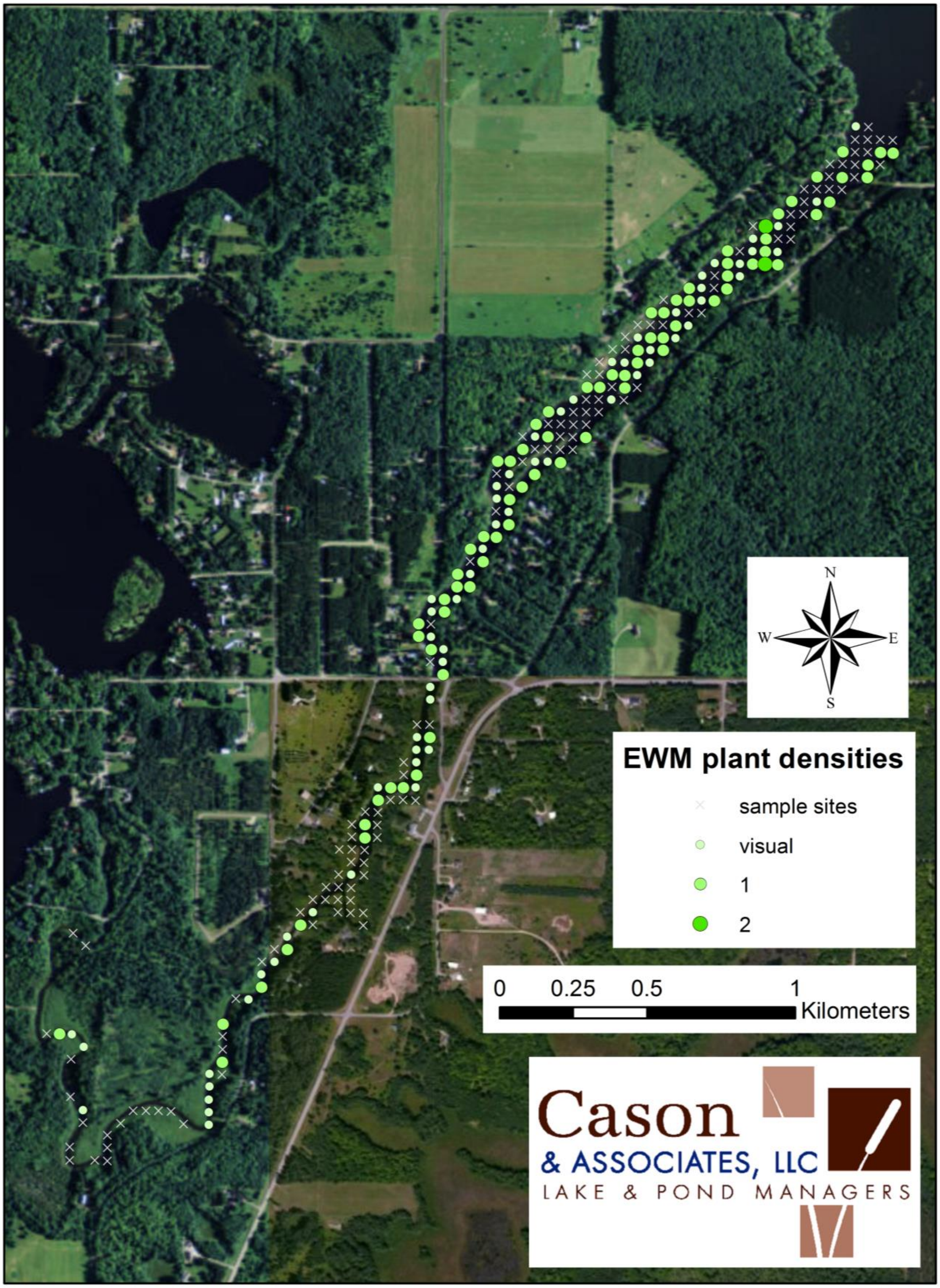


Figure 12. Locations of Eurasian watermilfoil (*Myriophyllum spicatum*) identified during the 2014 point-intercept survey of Townsend Flowage, Oconto County, Wisconsin.

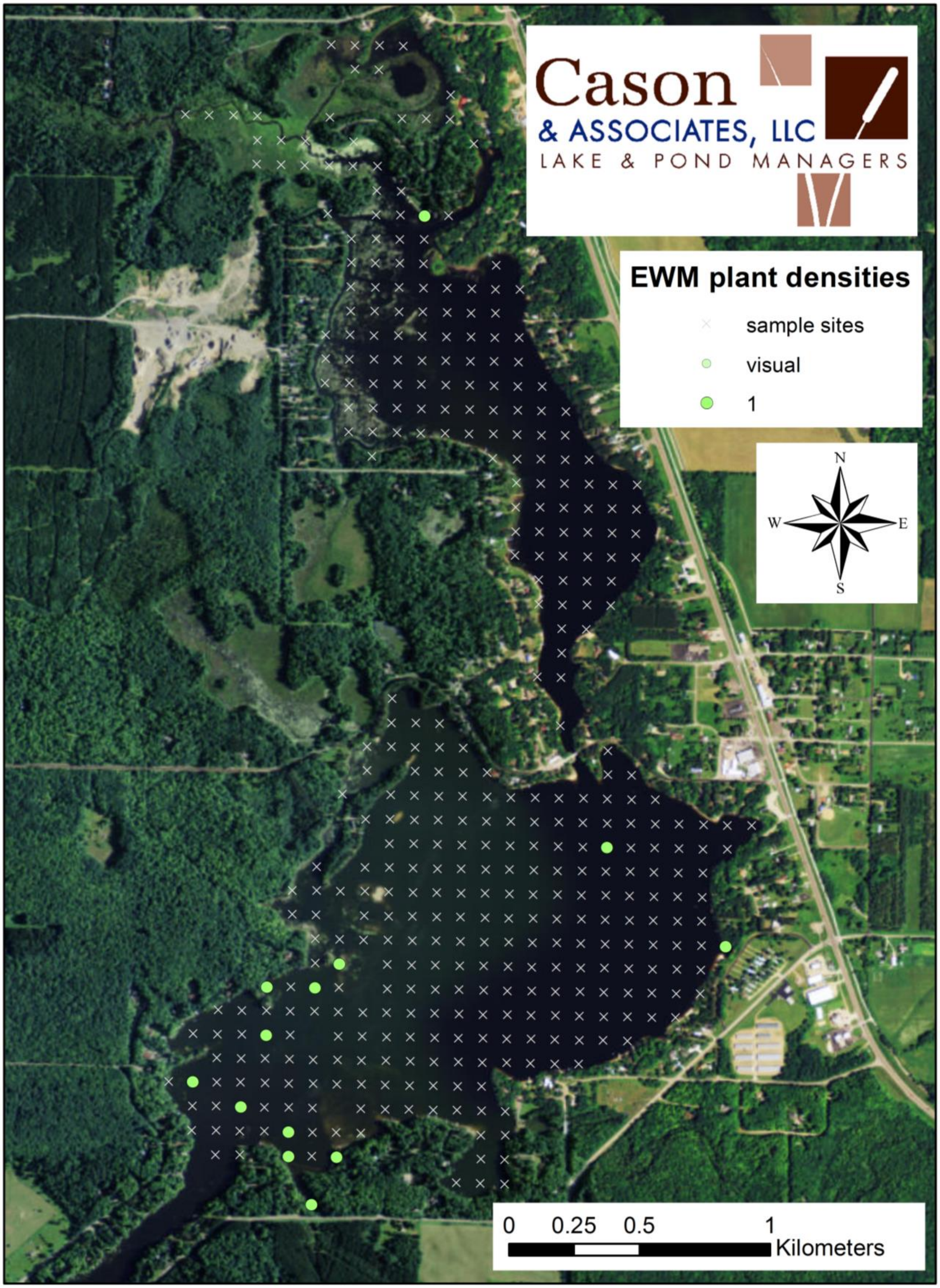


Figure 13. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 23-27, 2015 on Explosion Lake, Oconto County, Wisconsin.

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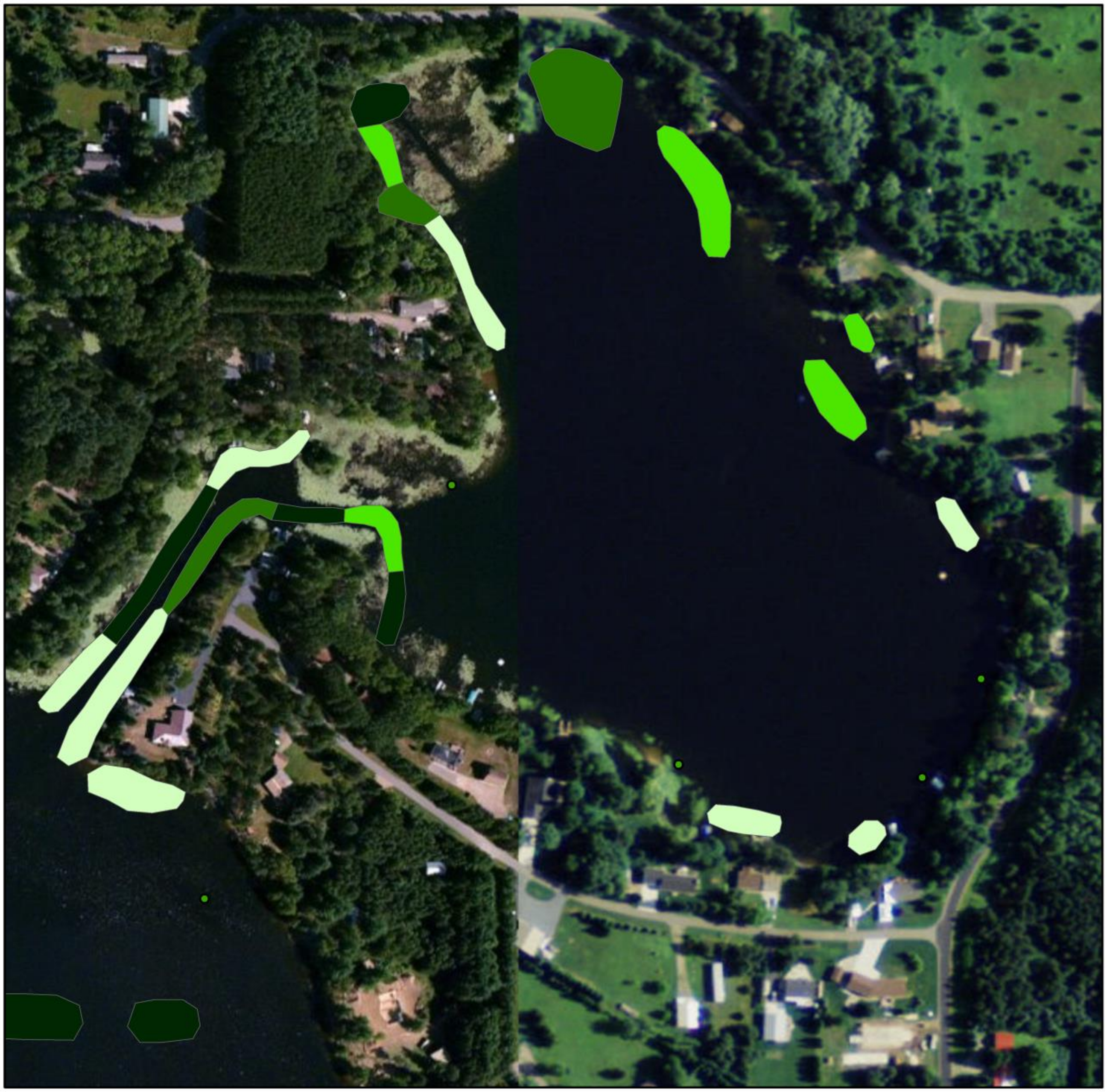
Figure 14. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 23-27, 2015 on Horn Lake, Oconto County, Wisconsin.

Figure 15. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 23-27, 2015 on Little Horn Lake, Oconto County, Wisconsin.



EWM plant densities

- Individual plants, small groups of plants
- High Scattered EWM
- Scattered EWM
- Moderately Dense EWM
- Dense EWM

N W E S

0 0.045 0.09 0.18 Kilometers

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Figure 16. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 23-27, 2015 on Reservoir Pond, Oconto County, Wisconsin.

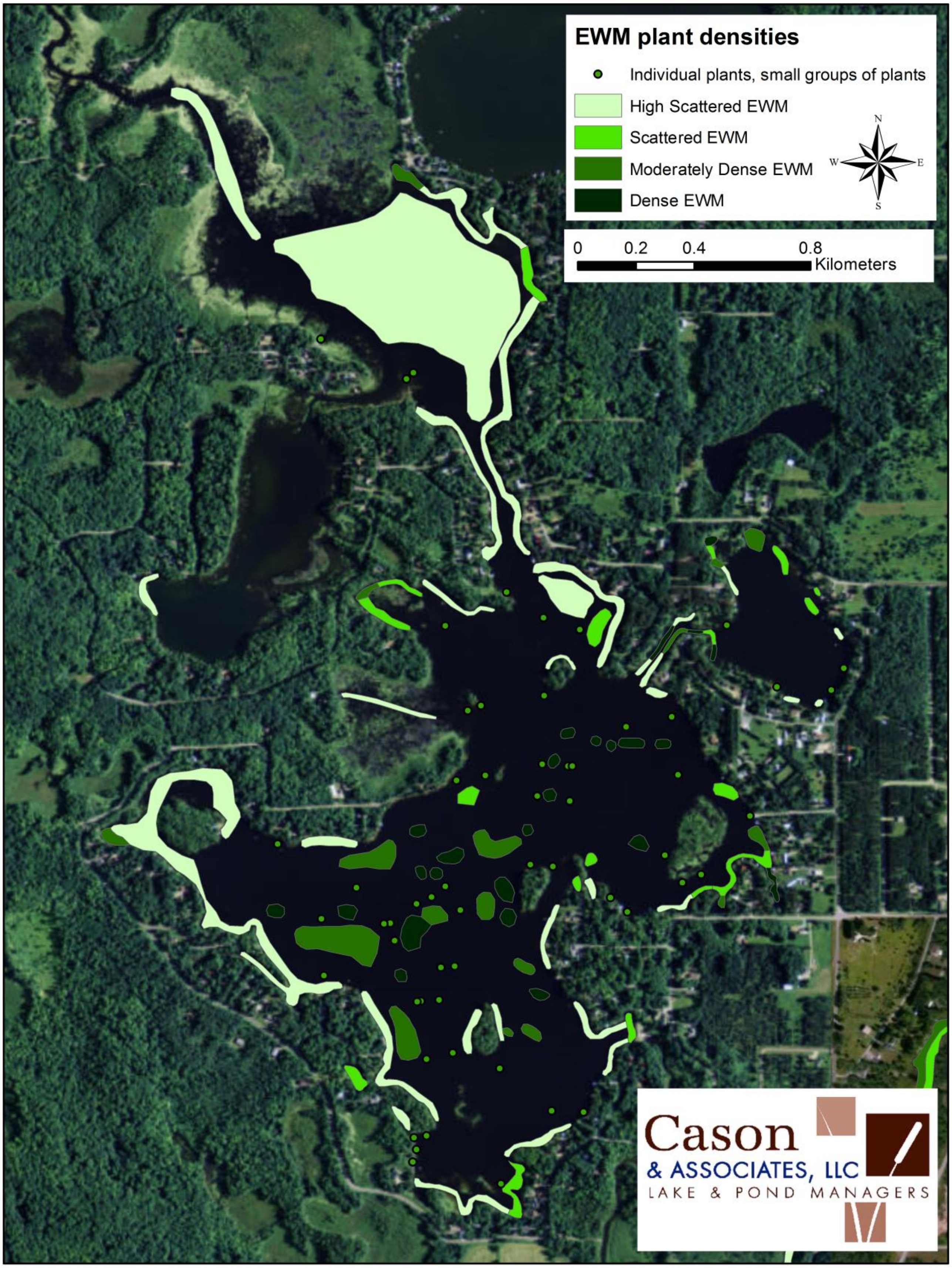


Figure 17. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 23-27, 2015 on McCaslin Brook, Oconto County, Wisconsin.

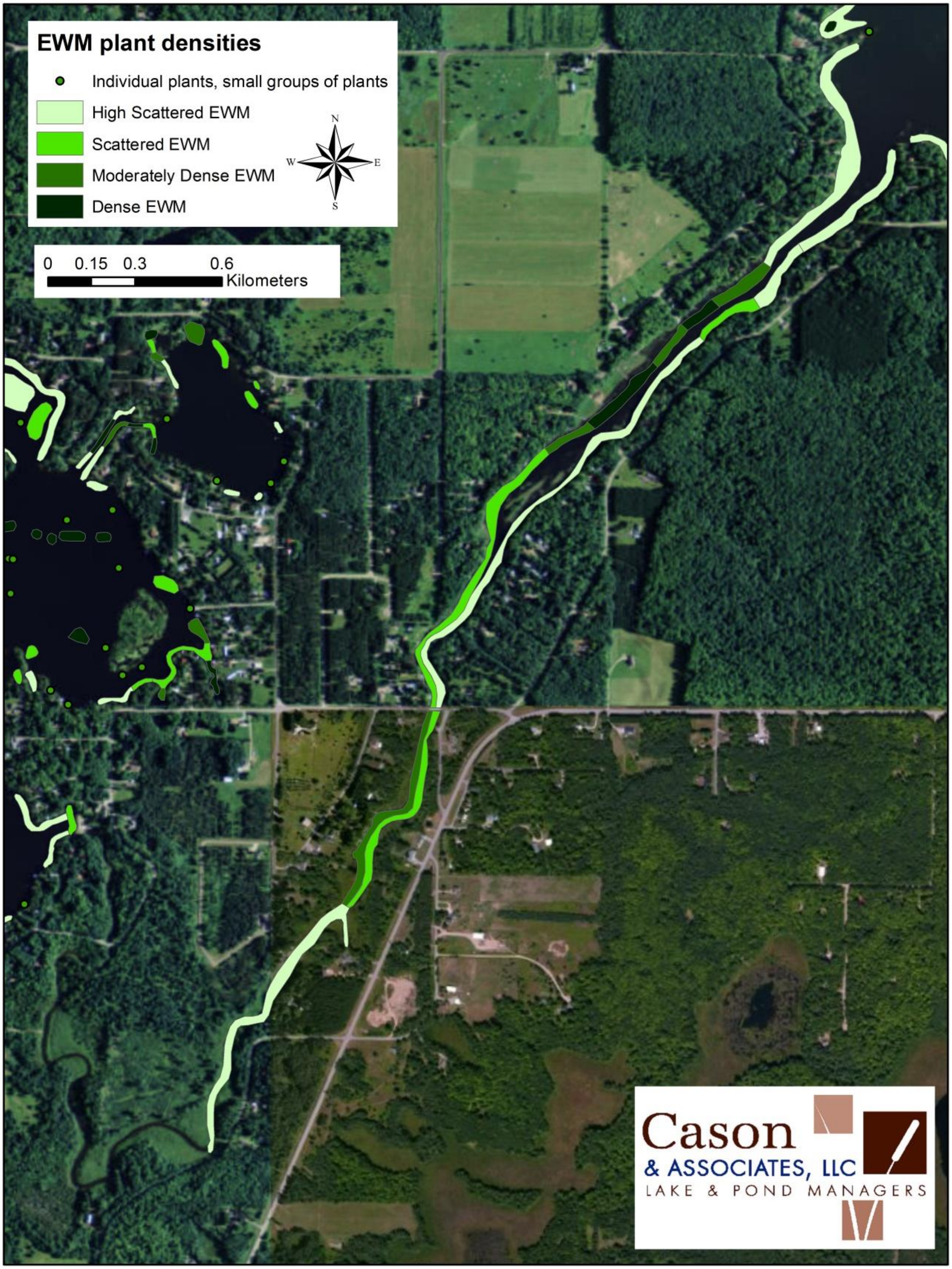
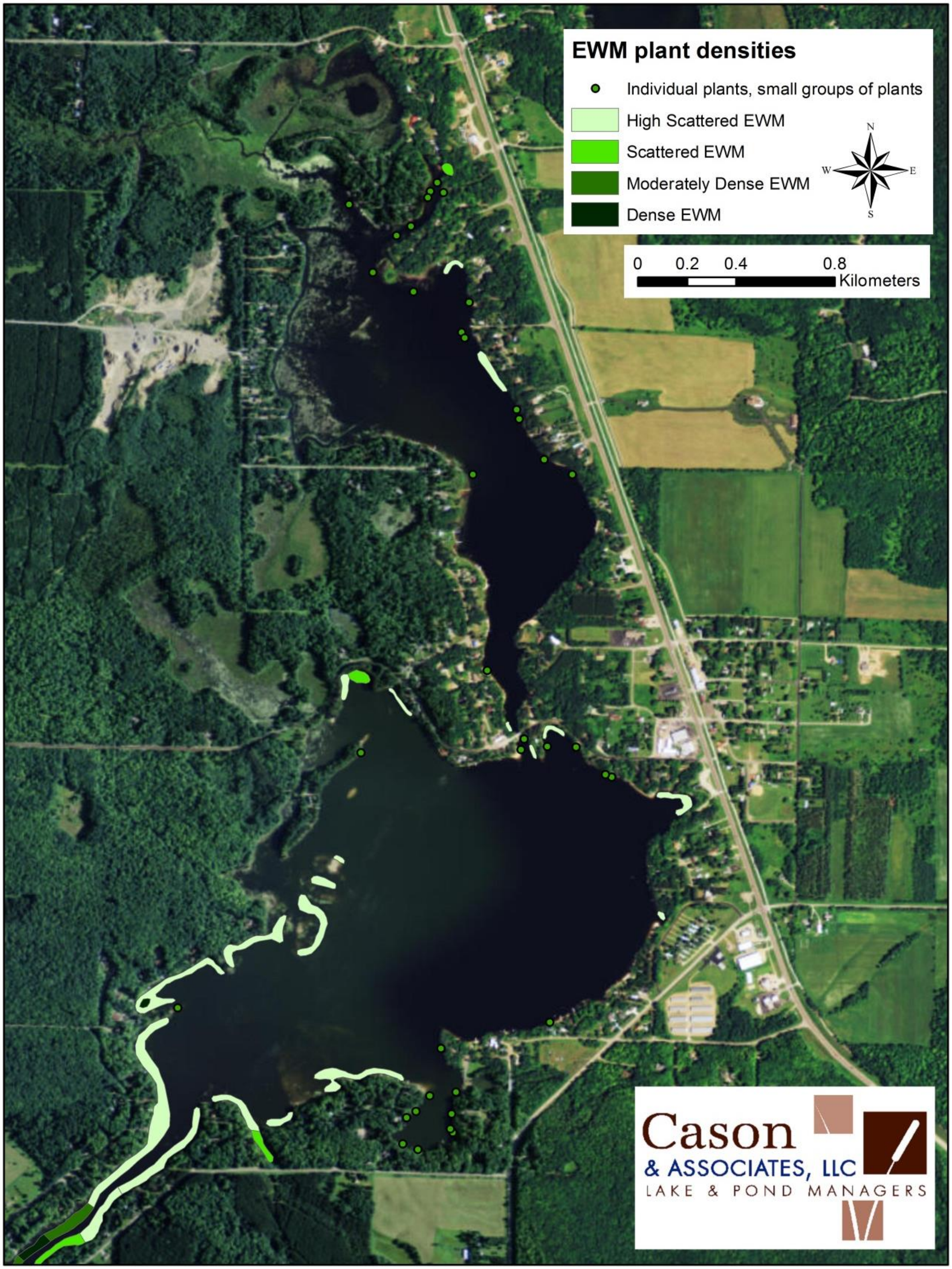


Figure 18. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 23-27, 2015 on Townsend Flowage, Oconto County, Wisconsin.



Results of the September 26-28, 2016 aquatic invasive species survey are found in **Table 11** and **Figures 19-24**. In total, approximately 280 acres of EWM were found in the seven waterbodies; 57% of which was categorized as either 'moderately dense' or 'dense'. The distribution of EWM increased from 13.8% to 146.9% in these waterbodies. The overall increase in distribution is just over 100%. In other words, the total acreage of EWM has doubled in the past year.

Table 11. Acreage of Eurasian watermilfoil identified on September 23-27, 2015 on the waterbodies within the Inland Lakes Protection and Rehabilitation District No. 1 and the Townsend Flowage Protection District, Oconto County, WI.

Basin	EWM/HWM acreage	Lake acreage	% cover	% increase since 2015
Explosion Lake	0.6	44	1.41%	14.7%
Horn Lake	2.5	131.4	1.89%	13.8%
Little Horn Lake	4.9	25.26	19.55%	54.3%
Reservoir Pond	225.2	428	52.62%	146.9%
McCaslin Brook	28.3	58.8	48.13%	17.9%
Townsend Flowage	18.4	446	4.13%	17.3%
Total	280.0	1,133		104.6%

Plant density	EWM/HWM acreage	& of EWM/EWM acreage	% increase since 2015
Highly scattered	37.8	13.5%	-61.7%
Scattered	82.6	29.5%	491.5%
Moderately dense	136.8	48.9%	770.1%
Dense	22.8	8.1%	168.9%
Total	280.0		104.6%

Figure 19. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 26-28, 2016 on Explosion Lake, Oconto County, Wisconsin.

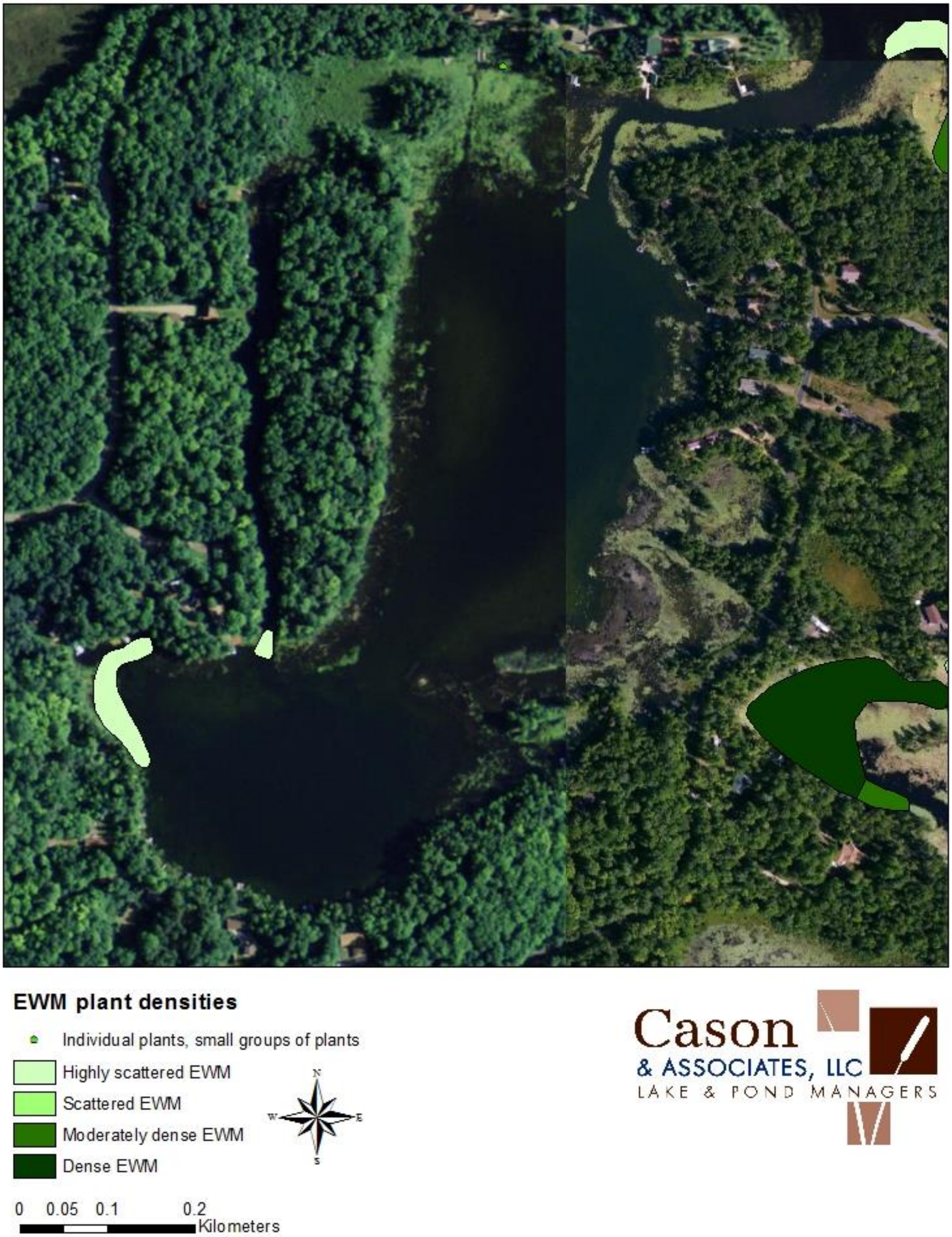


Figure 20. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 26-28, 2016 on Horn Lake, Oconto County, Wisconsin.

Figure 21. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 26-28, 2016 on Little Horn Lake, Oconto County, Wisconsin.

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Figure 22. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 26-28, 2016 on Reservoir Pond, Oconto County, Wisconsin.

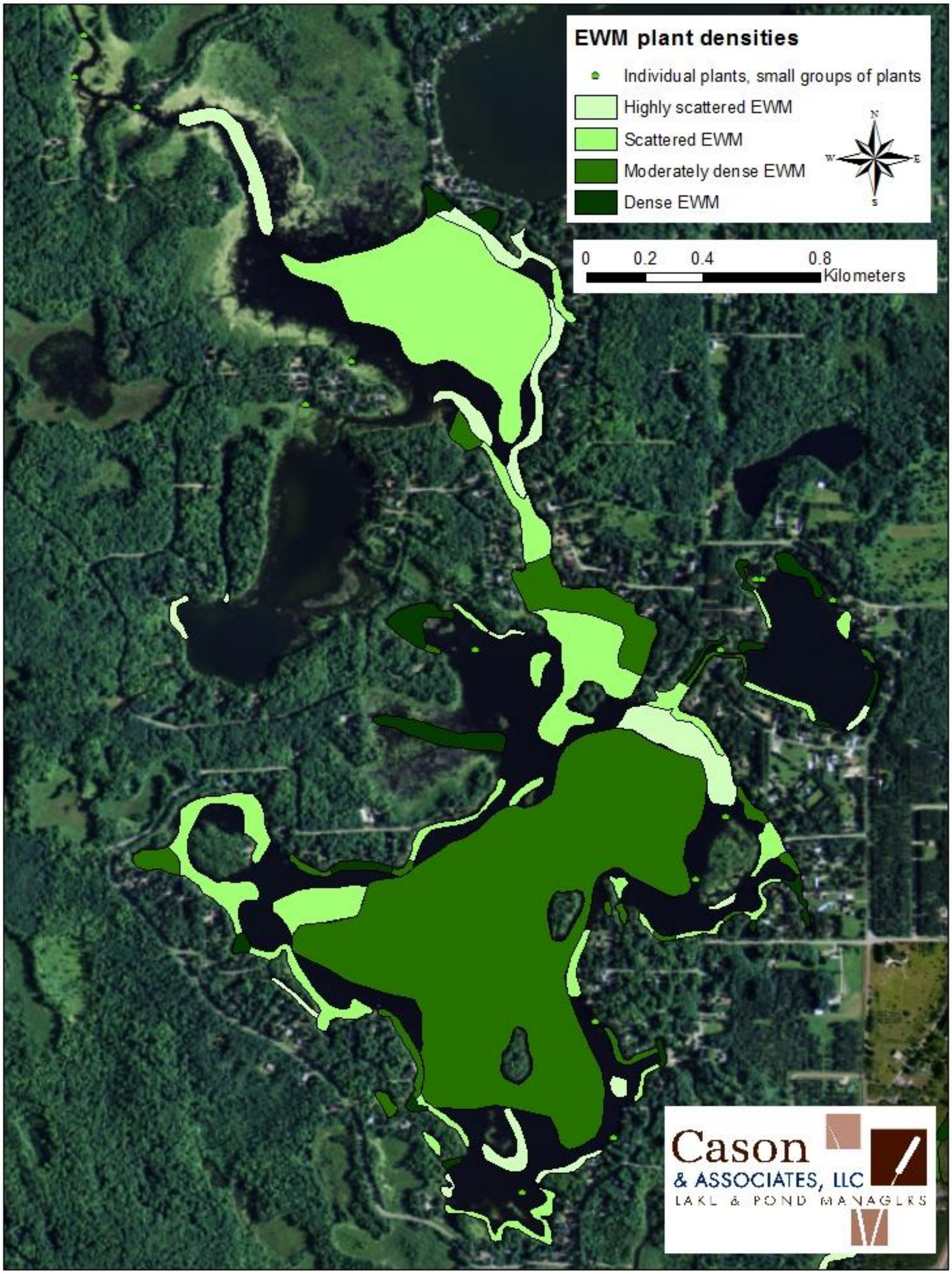
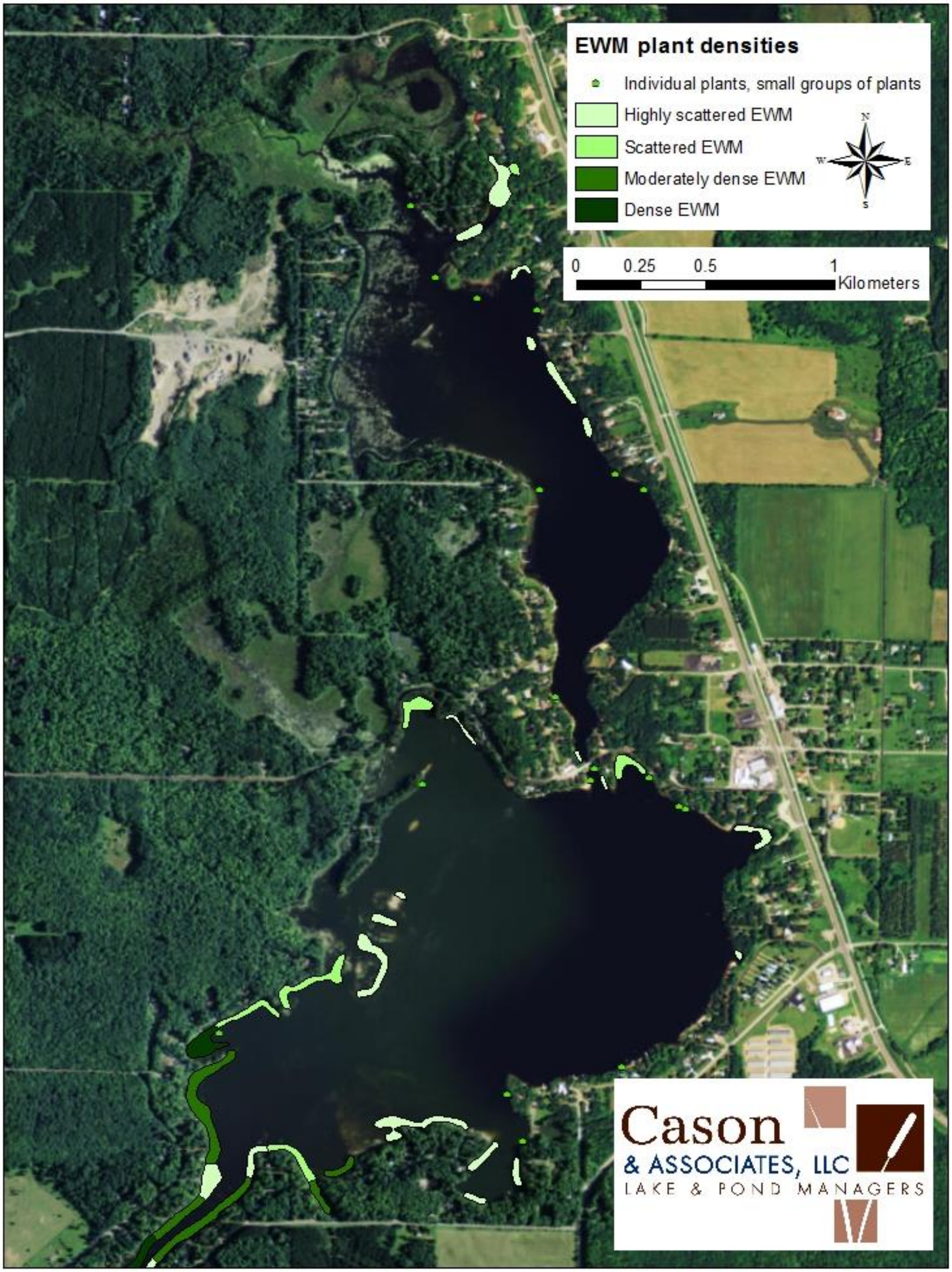


Figure 23. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 26-28, 2016 on McCaslin Brook, Oconto County, Wisconsin.

Figure 24. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) identified on September 26-28, 2016 on Townsend Flowage, Oconto County, Wisconsin.



Water Quality Analysis

Water quality data available from 2003 to 2016 for the lakes within the ILPRD and the TFPD were collected and compiled below and in the appendices.

Dissolved oxygen and temperature

The threshold level of oxygen needed for fish such as largemouth bass, yellow perch, and sunfish to grow and thrive is 5 mg/L. Dissolved oxygen data show that surface levels of dissolved oxygen have consistently remained high in the Townsend area lakes. Even at the warmest times of the year, sufficient levels of oxygen were present to depths of 9-12 (depending on the basin). The compiled dissolved oxygen and temperature data for these lakes can be found in **Appendix C**.

Phosphorus

Phosphorus is one of the most important water quality indicators. Phosphorus levels can determine the amount of algae growth in a lake. Phosphorus can come from external sources within the watershed (fertilizers, livestock, septic systems) or to a lesser extent, from groundwater. Phosphorus can also come from within the lake through a process called internal loading. Internal loading occurs when plants and chemical reactions release phosphorus from the lake sediments into the water column.

The average phosphorus concentration for natural lakes in Wisconsin is 0.025 mg/L or 25 ppb (Shaw, et al, 2004). Wisconsin Administrative Code NR 102.06 establishes total phosphorus criteria for lakes and rivers based on a number of criteria. For lakes that are both drainage and stratified, the criterion is 0.030 mg/L. For lakes that are drainage lakes, but are not stratified, the criterion is 0.040 mg/L. The lakes in question include include both some that stratify and some that don't. Values at or below these levels are preferred. A large majority of data available for the Townsend area lakes from 2003 to present are below this level (**Figure 25**). In general, these data indicate very good water quality within these lakes.

Chlorophyll

Chlorophyll is the pigment found in all green plants, including algae, that give them their green color. It is the site in plants where photosynthesis occurs. Chlorophyll absorbs sunlight to convert carbon dioxide and water to oxygen and sugars. Chlorophyll data is collected to estimate how much phytoplankton (algae) there is in a lake. Generally, the more nutrients there are in the water and the warmer the water, the higher the production of algae and consequently chlorophyll.

Chlorophyll concentrations below 10 µg/L are most desirable for lakes. All available chlorophyll data for the Townsend lakes is found in **Figure 26**. Nearly all the data fall below this level with a large majority of the chlorophyll concentrations measured since 2003 have been below 5 µg/L. Again these data indicate very good water quality within these lakes.

Figure 25. Total phosphorus data from 2003 to present for the waters of Townsend, Oconto County, Wisconsin.

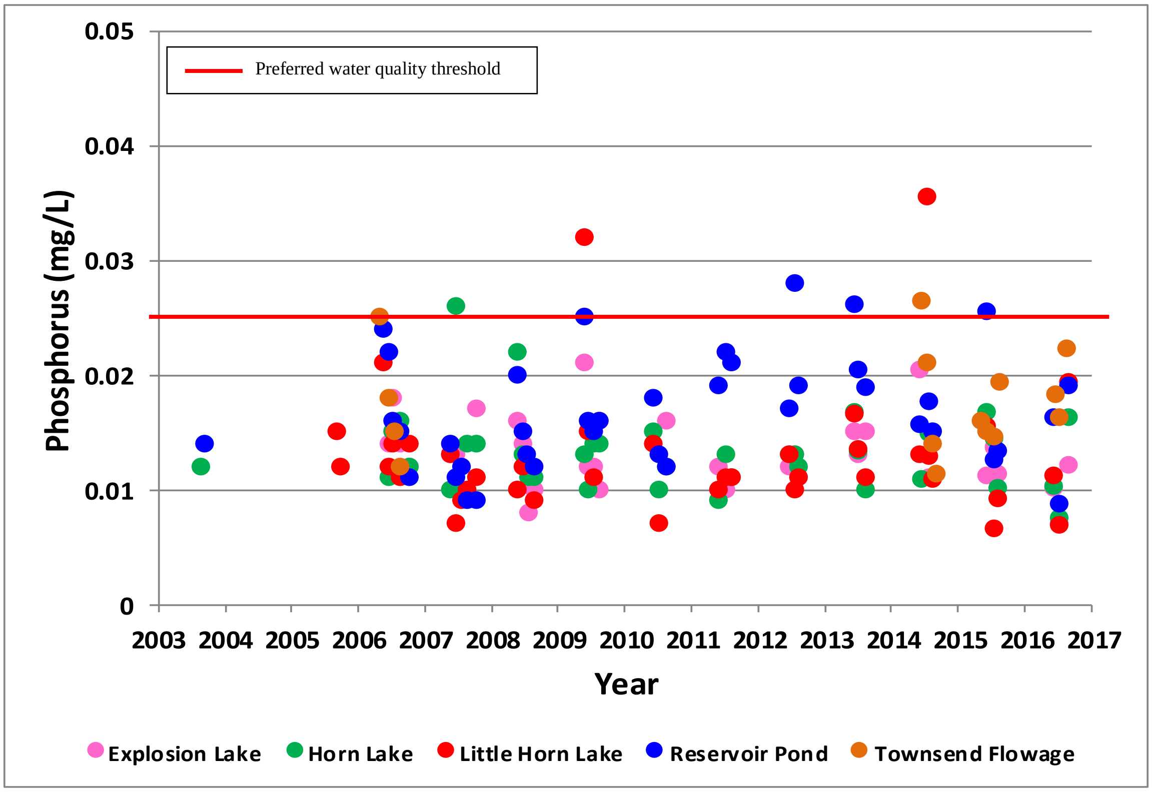
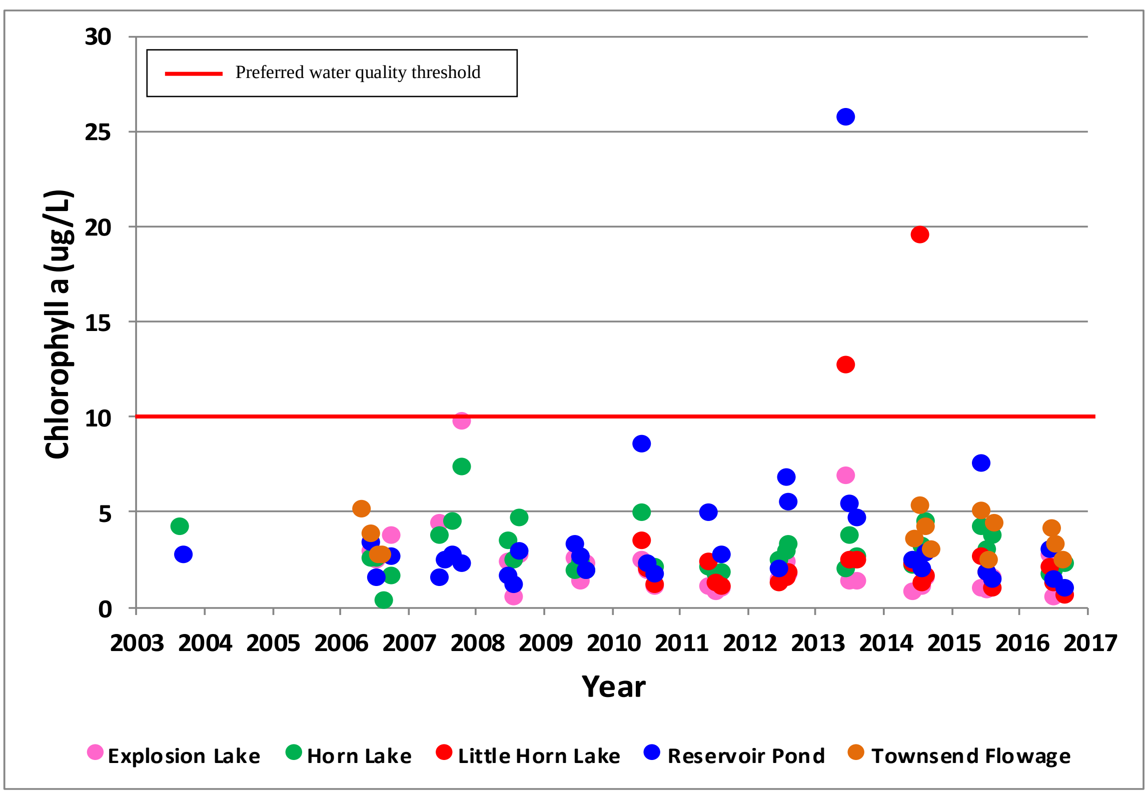


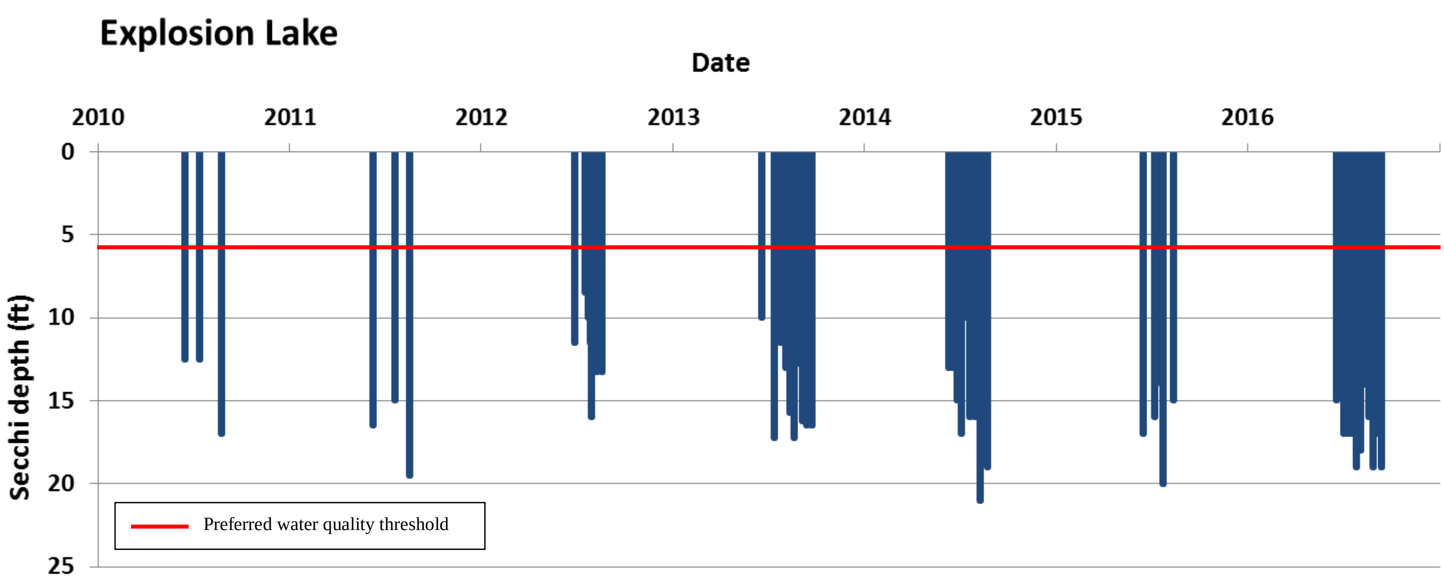
Figure 26. Chlorophyll a data from 2003 to present for the waters of Townsend, Oconto County, Wisconsin.



Secchi Transparency

Water clarity is often used as a quick and easy test for a lake's overall water quality, especially in relation to the amount of algae present. There is an inverse relationship between Secchi depth and the amount of suspended matter, including algae, in the water column. The less suspended matter, the deeper the Secchi disc is visible and the higher water quality present. Secchi depths greater than six feet are generally indicative of good water quality. Water clarity readings collected for the Townsend-area lakes since 2010 have largely been greater than six feet (**Figure 27**). The variation in the data from lake to lake is not due to differences in clarity, but rather the depth of the lakes themselves. **Table 1** includes the maximum depths of each lake. As with the previous water quality parameters, the water clarity data as a whole indicate very good to excellent water quality in these lakes.

Figure 27. Secchi transparency values from 2010 to 2016 for the Townsend-area lakes , Oconto, Wisconsin.



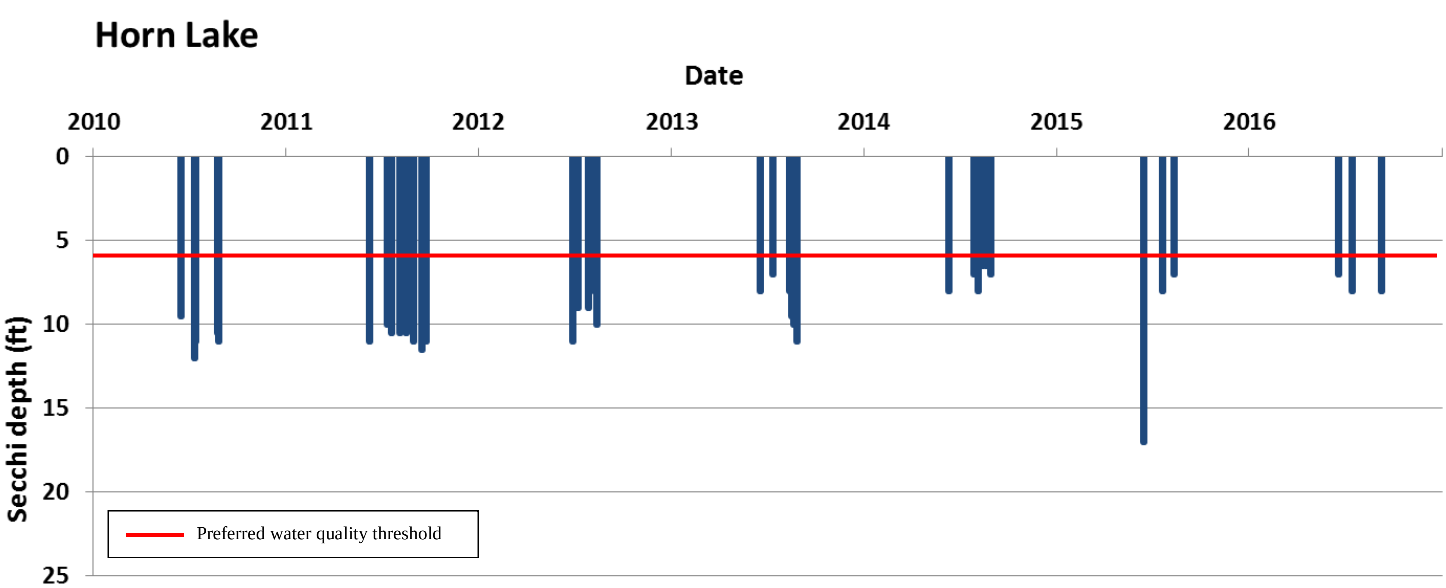
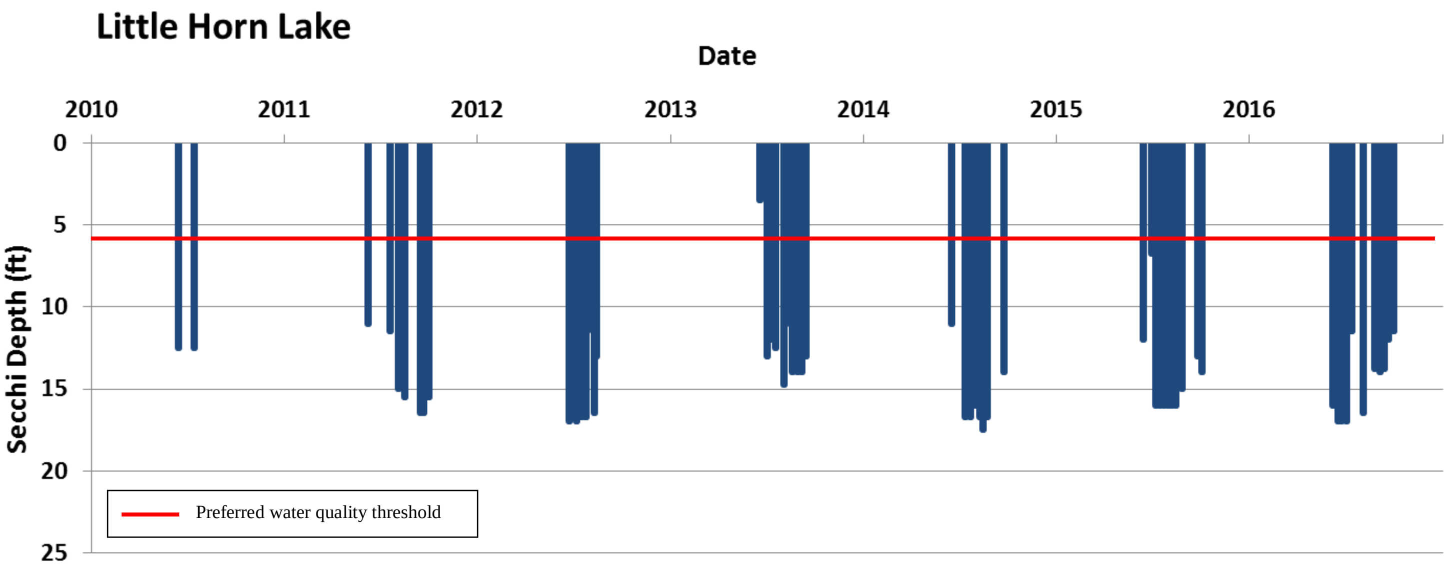
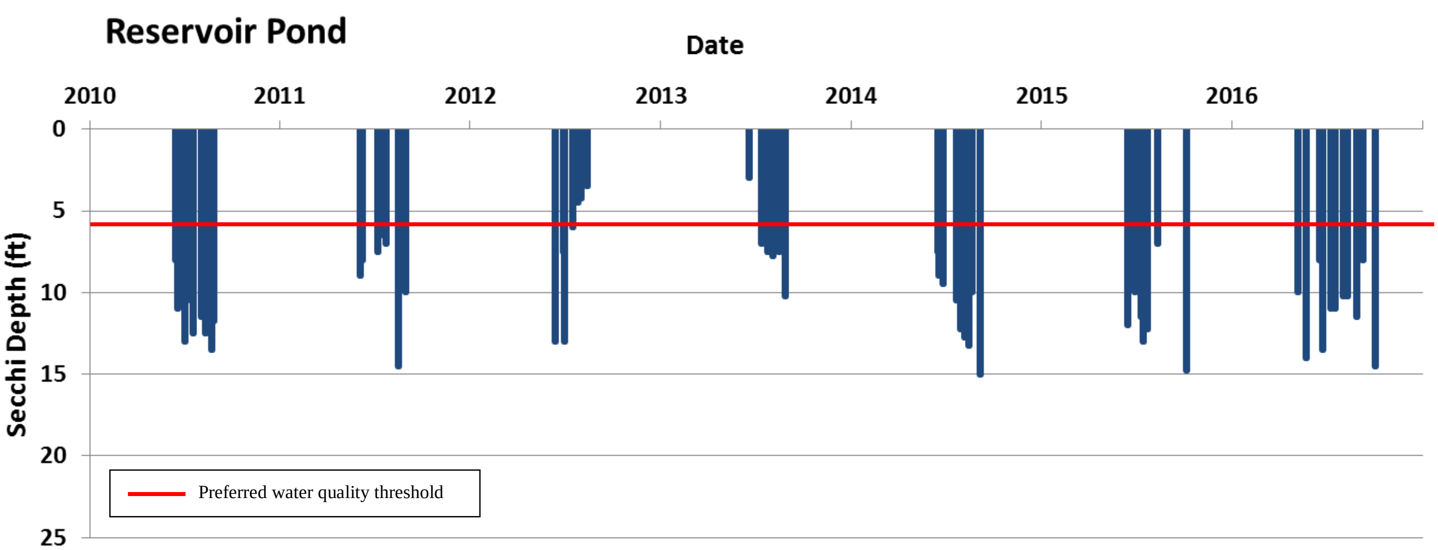
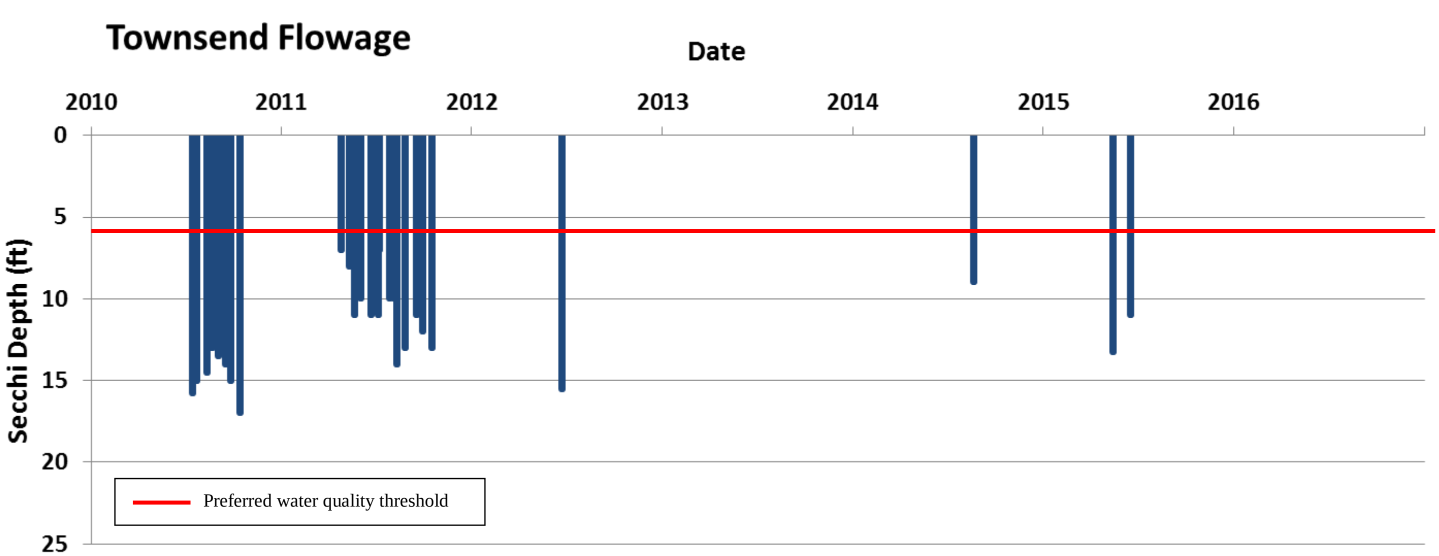


Figure 27 (continued). Secchi transparency values from 2010 to 2016 for the Townsend-area lakes, Oconto, Wisconsin.







Trophic State

There is a strong relationship between levels of phosphorus, chlorophyll and water clarity in lakes. As a response to rising levels of phosphorus, chlorophyll levels increase and transparency values often decrease. The effect of this is viewed as an increase in the productivity of a lake.

Lakes can be categorized by their productivity or trophic state. When productivity is discussed, it is normally a reflection of the amount of plant and animal biomass a lake produces or has the potential to produce. The most significant and often detrimental result is elevated levels of algae and nuisance aquatic plants. Lakes can be categorized into three trophic levels:

- oligotrophic - low productivity, high water quality
- mesotrophic - medium productivity and water quality
- eutrophic - high productivity, low water quality

These trophic levels form a spectrum of water quality conditions. Oligotrophic lakes are typically deep and clear with exposed rock bottoms and limited plant growth. Eutrophic lakes are often shallow and marsh-like, typically having heavy layers of organic silt and abundant plant growth. Mesotrophic lakes are typically deeper than eutrophic lakes with significant plant growth, and areas of exposed sand, gravel or cobble-bottom substrates.

Lakes can naturally become more eutrophic with time, however the trophic state of a lake is more influenced by nutrient inputs than by time. When humans negatively influence the trophic state of a lake the process is called *cultural eutrophication*. A sudden influx of available nutrients may cause a rapid change in a lake's ecology. Opportunistic plants such as algae and nuisance plant species are able to out-compete other more desirable species of macrophytes. The results is often poorer water quality.

Total phosphorus, chlorophyll and Secchi depth are often used as indicators of the water quality and productivity (trophic state) in lakes. Values measured for these parameters can be used to calculate Trophic State Index (TSI) values (Carlson 1977). The formulas for calculating the TSI values for Secchi disk, chlorophyll, and total phosphorus are as follows:

- TSI = 60 - 14.41 ln Secchi disk (meters)
- TSI = 9.81 ln Chlorophyll (µg/L) + 30.6
- TSI = 14.42 ln Total phosphorus (µg/L) + 4.15

The higher the TSI calculated for a lake, the more eutrophic it is (**Figure 28**). Classic eutrophic lakes have TSI values starting around 50. Most of the TSI values calculated from the Townsend-area lakes' water quality data were between 40 and 50 (**Figure 29**). Occasionally TSI values above 50 were calculated. TSI values indicate the Townsend-area lakes in terms of water quality exhibit characteristics near the boundary between mesotrophic and eutrophic waters.

Figure 28. Relationship between trophic state in lakes and parameters including Secchi transparency, chlorophyll, and total phosphorus.

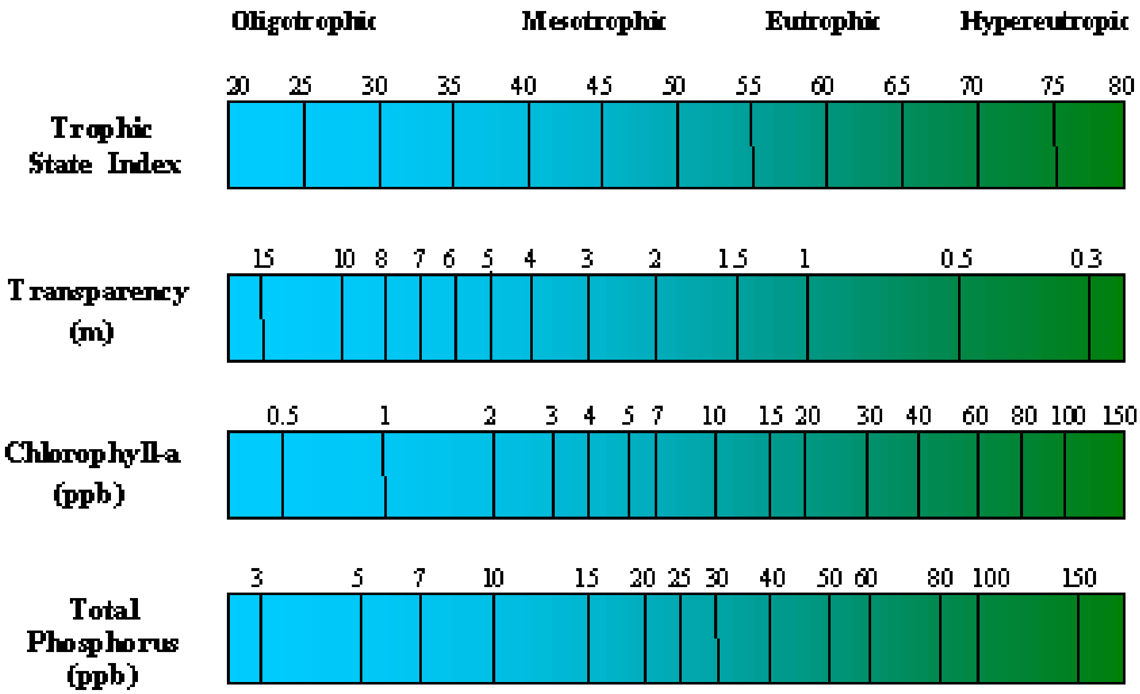
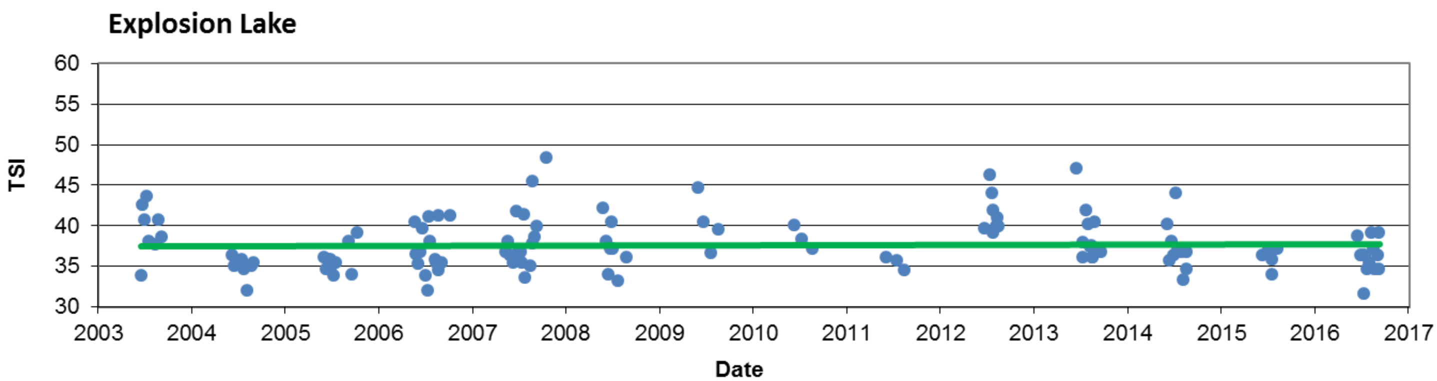
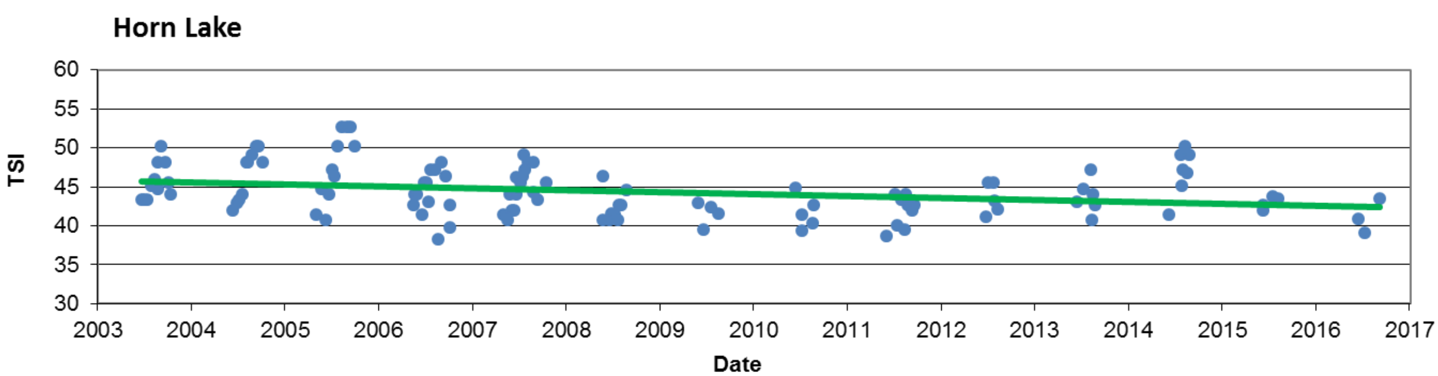
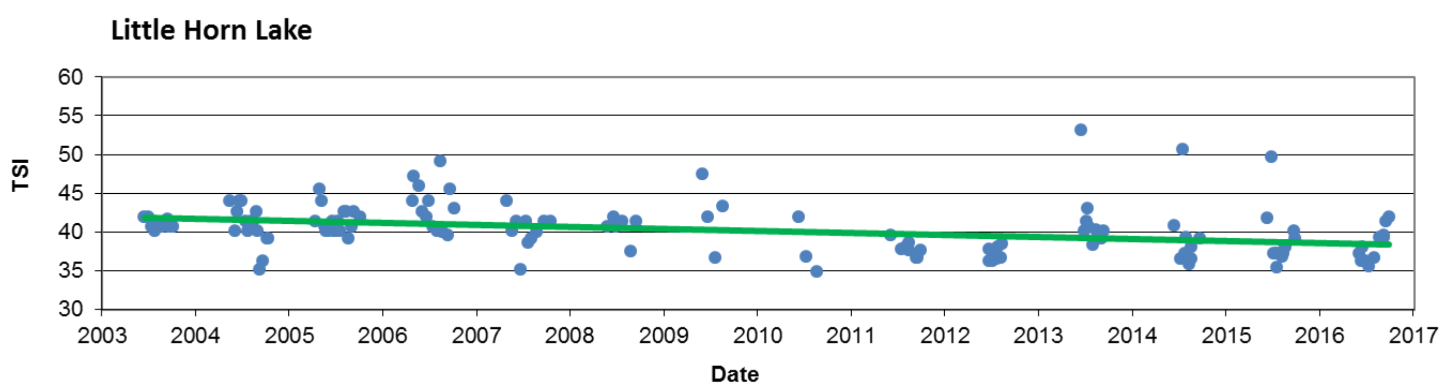


Figure 29. Trophic State Index values from 2003 to 2016 for the Townsend-area lakes, Oconto, Wisconsin.







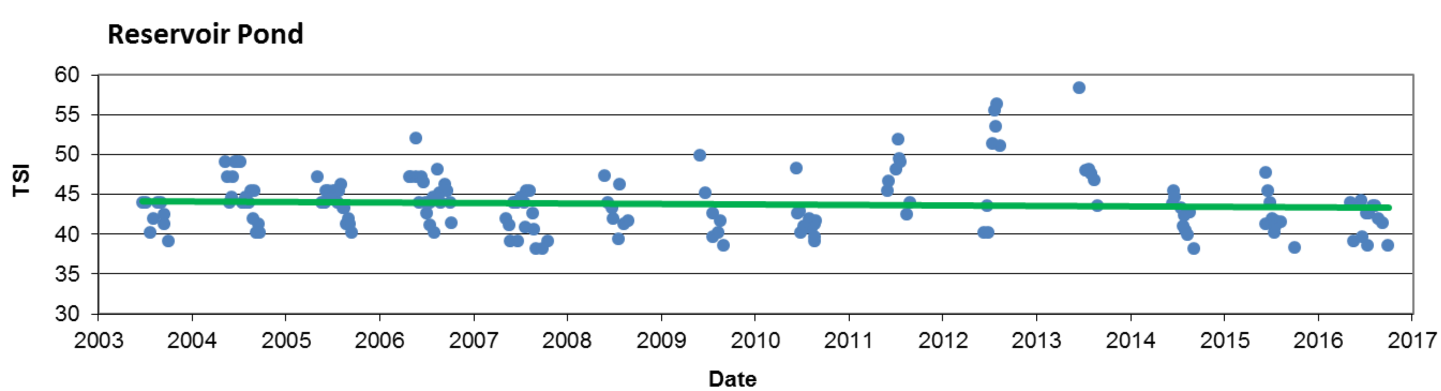
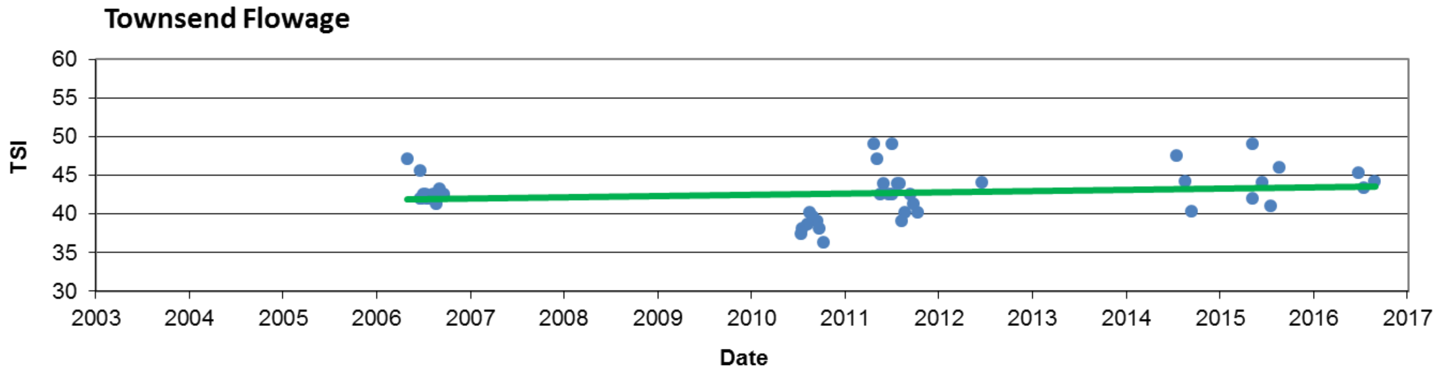


Figure 29 (continued). Trophic State Index values from 2003 to 2016 for the Townsend-area lakes, Oconto, Wisconsin.



Watershed Analysis

The lakes within the ILPRD form a flowage that empties into McCaslin Brook. This section of the brook then flows to Townsend Flowage. Therefore, the ILPRD lakes lie within the watershed of Townsend Flowage. **Figures 30 and 31** show the delineation of the Townsend Flowage watershed and the land use types present. The data for the land use map (**Figure 31**) was provided by the WDNR's Bureau of Technology Services.

A survey and resulting analysis found that the watershed of Townsend Flowage is approximately 22.5 square miles. This includes approximately 16.4 square miles of watershed attributed to the lakes of the ILPRD. In addition to waters of the ILPRD, the watershed of Townsend Flowage includes Mosquito Creek (enters from the north), much of the Town of Townsend as well as surrounding forests and wetlands within the Nicolet National Forest.

Table 12 contains a breakdown of land use and cover types within the watershed of Townsend Flowage. Not surprisingly, the watershed as a whole is dominated (nearly three quarters) by coniferous and deciduous forests. The agricultural areas of the watershed are concentrated between Reservoir Pond and Townsend Flowage near Valley View Road and are primarily hay, alfalfa, and fallow fields. The fallow areas appear to have been in crop production at some point in the past but now make up a significant portion of the areas identified as agricultural lands. It is possible some of these areas have been placed under the Conservation Reserve Program (CRP). By taking land out of production, farmers help reduce soil erosion, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters.

Figure 30. Watershed of the waters of Townsend, Oconto County, Wisconsin.

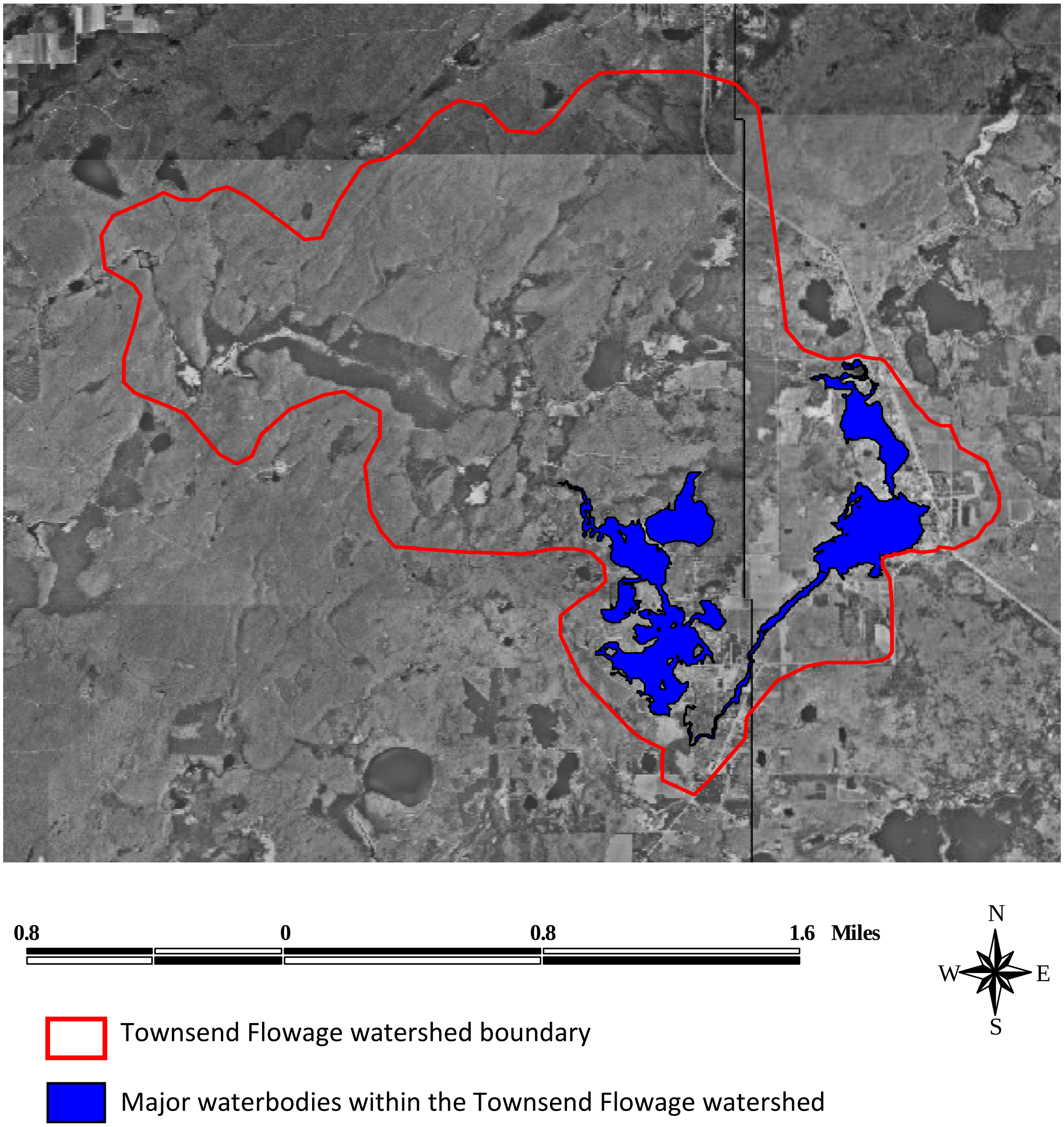


Figure 31. Land cover types and watershed delineation for the waters of Townsend, Oconto County, Wisconsin.

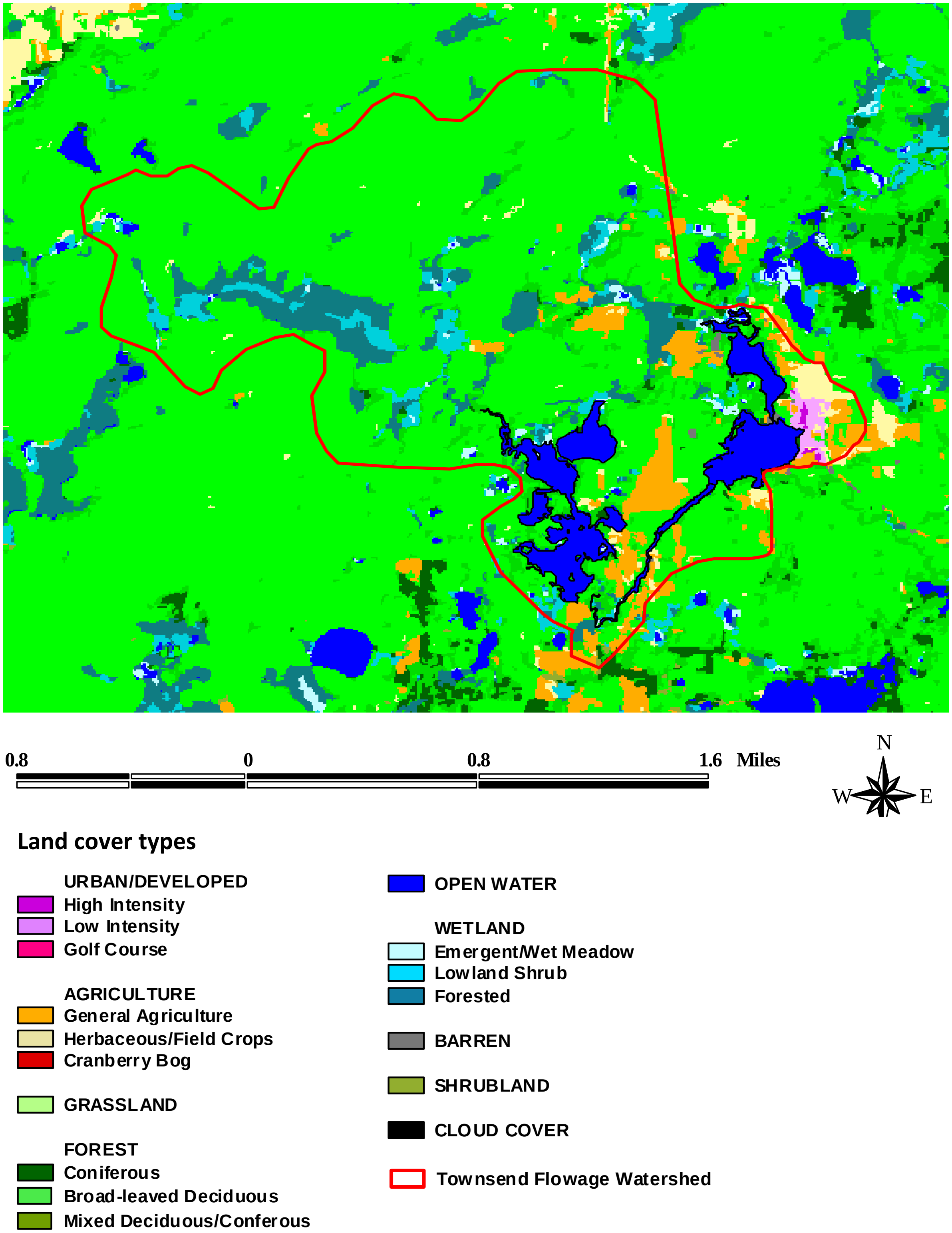


Table 12. Land use and cover types found within the watershed of the waters of Townsend, Oconto County, WI.

Land Type	% cover
Forest (coniferous/deciduous)	73.8
Wetland (forested/wet meadow)	13.8
Agriculture (general/row crops)	8.0
Surface Water (not including Flowage)	3.2
Urban (Town of Townsend)	1.1

During the watershed assessment, no obvious signs of runoff or erosion were found in the outlying areas. This was also the case when watershed assessments were conducted during the development of previous management plans. This is not surprising, given that less than 10 percent of the watershed is either agriculture or urban areas. Much of the shorelines of the Townsend-area lakes have a high concentration of homes with rip rap, sea walls, or undeveloped waterfronts. There are also a number of homes with native shoreline vegetation.

Occasionally new lots are developed or new construction takes place on existing lots. An increase in development translates to increases in the number of lawns, driveways and other hard surfaces which are known to contribute nutrients and sediments to a lake. In addition, there are a number of areas along the shoreline of these lakes with steep slopes, particularly on Townsend Flowage. For these reasons, it is those areas closest to the lakes which can have the greatest influence on water quality.

Nutrient loading

The external loading of runoff pollutants, namely phosphorus, into the Townsend-area lakes can be approximated by utilizing general export coefficients and the WiLMS predictive modeling software. Export coefficients are available for a number of land use types as kilograms of pollutant per hectare per year. Coefficients for total phosphorus used in the WiLMS model are given in **Table 13**. WiLMS also takes into account a number of other factors including lake morphology, watershed drainage area, net precipitation, oxygen stratification, measured phosphorus concentrations during turnover and the growing season, and estimated area of anoxia. By inputting data for a number of these factors, the WiLMS software was able to predict the total annual phosphorus load into the lakes.

Table 13. General Export Coefficients for total phosphorus for the Eastern U.S.

Land Use	Export Coefficients* (kg/ha/yr)
	TP
Urban	0.5
Rural/Agriculture	0.8
Forest	0.09

*From Rast and Lee (1978).

By utilizing the data available for land use types in the Townsend Flowage watershed and the above coefficients, it was estimated that the total input of phosphorus from direct runoff annually is approximately 896 kg (1,975 lbs). This includes an estimated 612 kg (1,350 lbs) of phosphorus enter the ILPRD lakes annually. The fact that a significant portion of the agricultural areas within the watershed are fallow or out of production suggests that the actual phosphorus input levels estimated by the WiLMS may be less than predicted.

In addition, the internal loading of phosphorus in the Districts' lakes is minimal because only small areas of Little Horn Lake, Explosion Lake and Townsend Flowage become anoxic in the summer. It is under anoxic conditions that nutrients, namely phosphorus are released from the sediments in lakes.

Comparisons were made between the predicted TSI values and those calculated from the phosphorus, chlorophyll and Secchi data for the summer sampling events. In each category, the observed or measured values for these parameters were found to at or below those predicted by the WiLMS software. In other words, water quality of these lakes is greater than expected.

Fish and Wildlife Assessment

The Townsend-area lakes are a well-known fishing destination in Oconto County. Some of the most commonly found species in these lakes include northern pike, largemouth bass and panfish. In addition, walleye (*Sander vitreus)* and muskellunge (*Esox masquinongy*) are present, but less abundant. Fish stocking in these lakes by the WDNR has taken place on an irregular basis since the early 1970s. **Table 14** contains the current stocking data available through the WDNR with a majority of stocking focused on walleye and muskellunge. In addition, a 2015 Fish Management Report for the ILPRD lakes by the WDNR can be found in **Appendix D**. In this report, it states more than 4,000 fish representing 13 fish species were identified during the 2015 survey.

Table 14. Fish stocking data from 1972 to 2015 for the Townsend-area lakes, Oconto County, Wisconsin.

Year	Waterbody Name	Location	Species	Strain (Stock)	Age Class	Number Stocked	Avg Length (in)
2015	HORN LAKE	33N-15E-20	WALLEYE	LAKE MICHIGAN	LARGE FINGERLING	1,341	7
2013	HORN LAKE	33N-15E-20	WALLEYE	LAKE MICHIGAN	LARGE FINGERLING	1,340	7.8
2011	HORN LAKE	33N-15E-20	WALLEYE	LAKE MICHIGAN	SMALL FINGERLING	5,008	1.8
2009	HORN LAKE	33N-15E-20	WALLEYE	LAKE MICHIGAN	SMALL FINGERLING	4,594	1.7
2005	HORN LAKE	33N-15E-20	WALLEYE	LAKE MICHIGAN	SMALL FINGERLING	6,600	1.5
2003	HORN LAKE	33N-15E-20	WALLEYE	LAKE MICHIGAN	SMALL FINGERLING	6,000	1.3
1972	LITTLE HORN LAKE	33N-15E-28	WALLEYE	UNSPECIFIED	FINGERLING	1,200	3
2015	RESERVOIR POND	33N-15E-33	WALLEYE	MISSISSIPPI HEADWATERS	LARGE FINGERLING	4,126	8.1
2013	RESERVOIR POND	33N-15E-33	WALLEYE	LAKE MICHIGAN	LARGE FINGERLING	492	7.8
1974	RESERVOIR POND	33N-15E-33	WALLEYE	UNSPECIFIED	FINGERLING	11,000	4
1972	RESERVOIR POND	33N-15E-33	WALLEYE	UNSPECIFIED	FINGERLING	8,720	3
2014	RESERVOIR POND	33N-15E-33	NORTHERN PIKE	MUD LAKE - MADISON CHAIN OF LAKES	SMALL FINGERLING	7,490	2.52
2013	RESERVOIR POND	33N-15E-33	NORTHERN PIKE	MUD LAKE - MADISON CHAIN OF LAKES	SMALL FINGERLING	29,535	4.8
1973	RESERVOIR POND	33N-15E-33	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,200	11
2014	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	LAKE MICHIGAN	LARGE FINGERLING	6,667	6.8
2012	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	LAKE MICHIGAN	SMALL FINGERLING	10,000	1.5
2010	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	LAKE MICHIGAN	SMALL FINGERLING	10,000	1.4
2008	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	10,044	1.4
2005	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	LAKE MICHIGAN	LARGE FINGERLING	4,760	7.4

Table 14 (continued). Fish stocking data from 1972 to 2015 for the Townsend-area lakes, Oconto County, Wisconsin.

Year	Waterbody Name	Location	Species	Strain (Stock)	Age Class	Number Stocked	Avg Length (in)
2003	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	10,000	2.1
2000	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	UNSPECIFIED	SMALL FINGERLING	10,000	1.7
1998	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	UNSPECIFIED	SMALL FINGERLING	10,000	1.2
1976	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	UNSPECIFIED	FINGERLING	34,000	3
1974	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	UNSPECIFIED	FINGERLING	18,000	3.67
1972	TOWNSEND FLOWAGE	33N-15E-27	WALLEYE	UNSPECIFIED	FINGERLING	14,080	3
2015	TOWNSEND FLOWAGE	33N-15E-27	MUSKELLUNGE	UPPER WISCONSIN RIVER	LARGE FINGERLING	400	11.4
2014	TOWNSEND FLOWAGE	33N-15E-27	MUSKELLUNGE	UPPER WISCONSIN RIVER	LARGE FINGERLING	400	9.8
2013	TOWNSEND FLOWAGE	33N-15E-27	MUSKELLUNGE	UPPER WISCONSIN RIVER	LARGE FINGERLING	476	9.7
2012	TOWNSEND FLOWAGE	33N-15E-27	MUSKELLUNGE	UPPER WISCONSIN RIVER	LARGE FINGERLING	400	10.2
2011	TOWNSEND FLOWAGE	33N-15E-27	MUSKELLUNGE	UPPER WISCONSIN RIVER	LARGE FINGERLING	400	9.3
2009	TOWNSEND FLOWAGE	33N-15E-27	MUSKELLUNGE	UPPER WISCONSIN RIVER	LARGE FINGERLING	200	10.5
1977	TOWNSEND FLOWAGE	33N-15E-27	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,200	9
1975	TOWNSEND FLOWAGE	33N-15E-27	MUSKELLUNGE	UNSPECIFIED	FINGERLING	640	11
1973	TOWNSEND FLOWAGE	33N-15E-27	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,800	11

The six most abundant species collected were bluegill, black crappie (*Pomoxis nigromaculatus*), pumpkinseed (*Lepomis gibbosus*), rock bass (*Ambloplites rupestris*), yellow bullhead (*Ameiurus natalis*) and northern pike.

Results of the fish and wildlife habitat survey are found in **Figures 32-40**. These maps identify areas of woody debris and tree falls, emergent and floating-leaf plant locations and areas of sand or gravel substrates near shore. Collectively, a large portion of the Townsend-area lakes is littoral and supports healthy submergent aquatic plant growth. **Table 15** includes habitat requirements and improvements information regarding fish species commonly found in these waters. This information was gathered from George C. Becker's *Fishes of Wisconsin*.

Figure 32. Fish and wildlife habitats in and around Explosion Lake, Oconto County, Wisconsin.

Figure 33. Fish and wildlife habitats in and around Horn Lake, Oconto County, Wisconsin.

Figure 34. Fish and wildlife habitats in and around Little Horn Lake, Oconto County, Wisconsin.

Figure 36. Fish and wildlife habitats in and around the northern basin of Reservoir Pond, Oconto County, Wisconsin.

Figure 37. Fish and wildlife habitats in and around the southern basin of Reservoir Pond, Oconto County, Wisconsin.

Figure 38. Fish and wildlife habitats in and around McCaslin Brook, Oconto County, Wisconsin.

Figure 39. Fish and wildlife habitats in and around the northern basin of Townsend Flowage, Oconto County, Wisconsin.

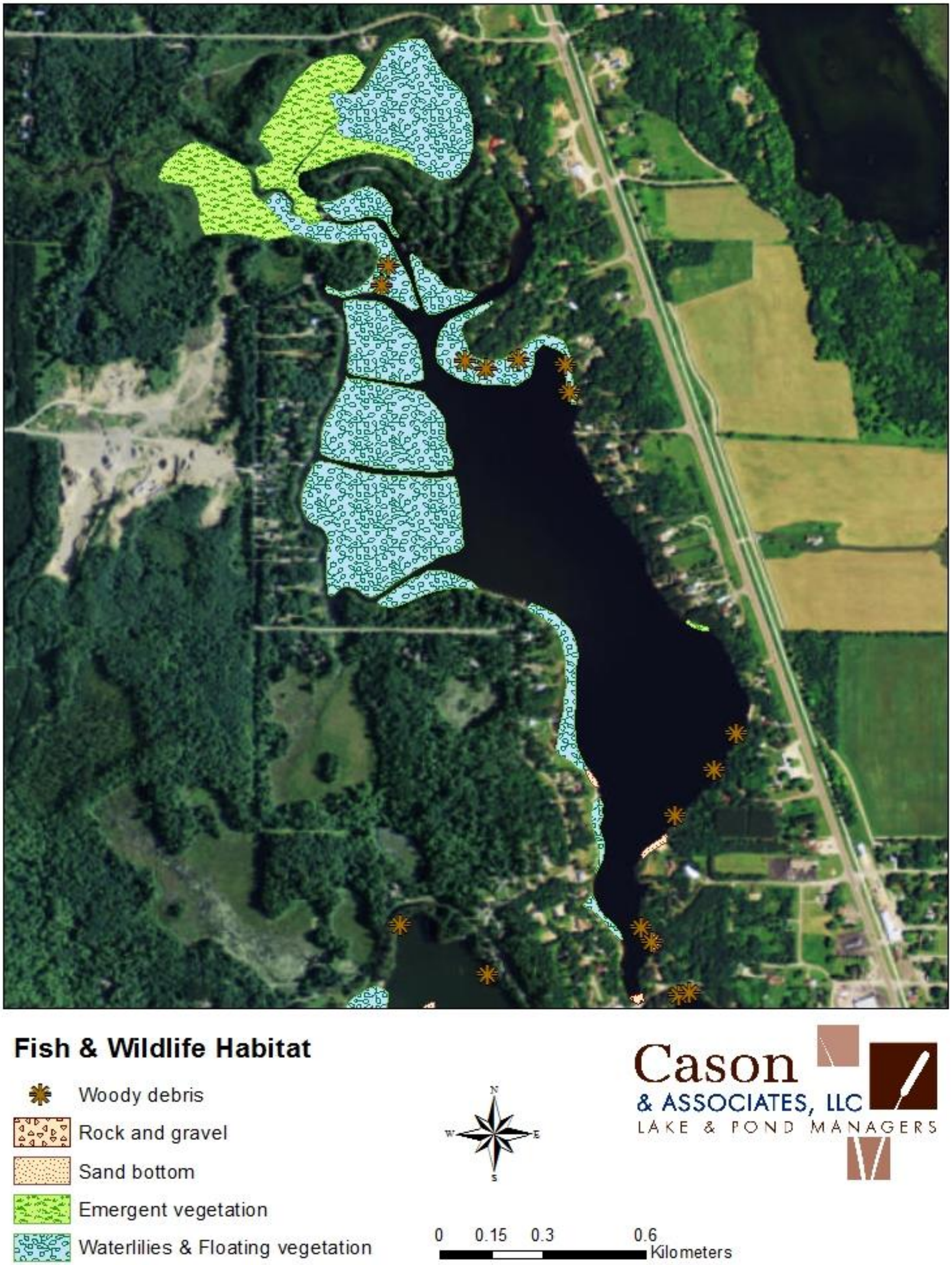


Figure 40. Fish and wildlife habitats in and around the southern basin of Townsend Flowage, Oconto County, Wisconsin.

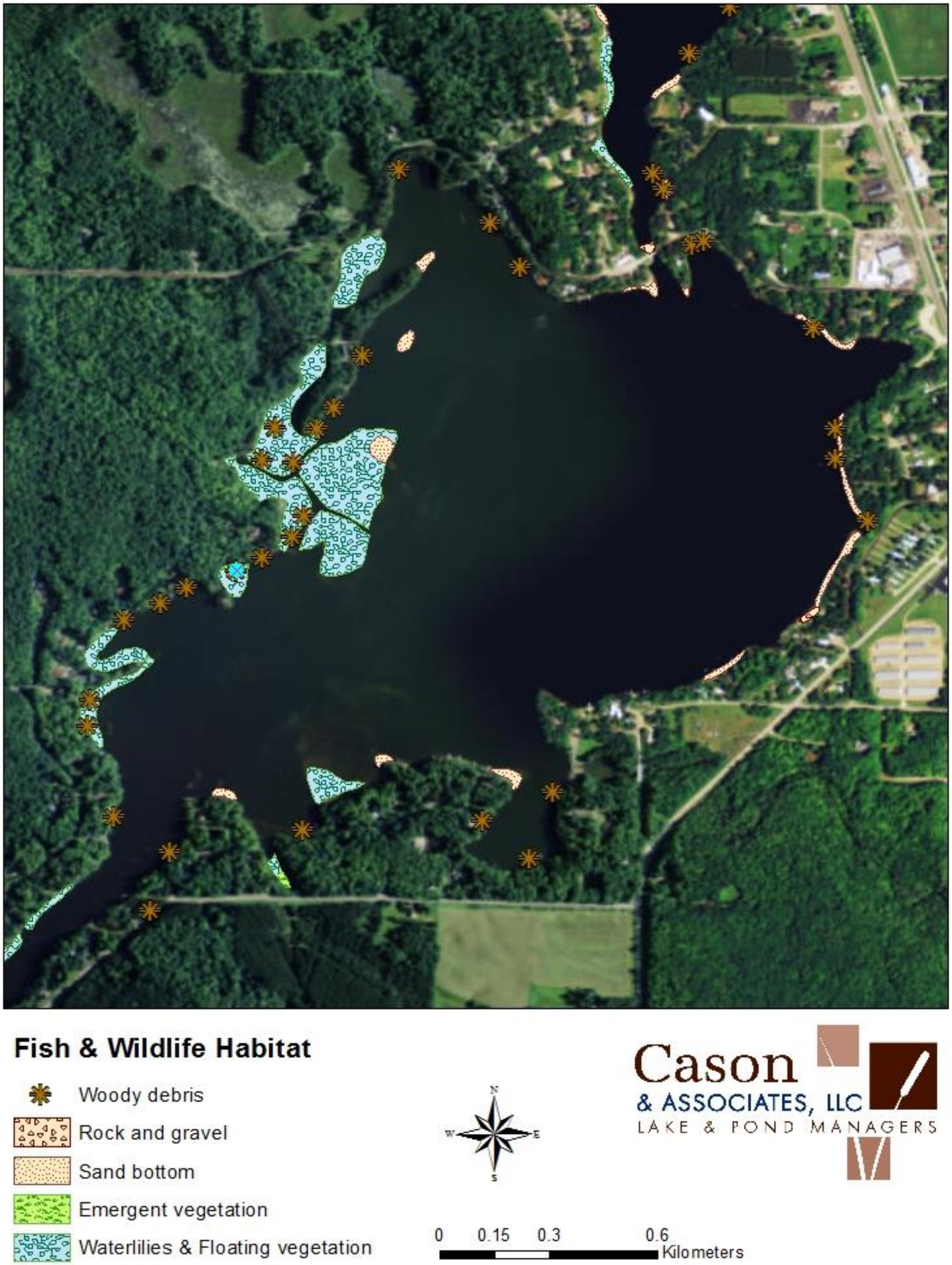


Table 15. Description of fish habitat requirements and improvements for fish species commonly found in the Townsend-area lakes, Oconto County, Wisconsin.

Species	Habitat Requirements: Spawning	Habitat Requirements: Rearing	Habitat Requirements: Foraging	Habitat Improvements	Important Water Quality Parameters
Large-Mouth Bass (*Micropterus salmoides*)	***** Shallow protected areas containing emergent vegetation with sandy to gravely substrate ***** Soft bottoms with woody debris present	* Shallow edges	* Waters less than 18 ft. deep containing aquatic macrophytes * Shallow open areas	* Leave woody debris in lake including small limbs *Control dense stands of nuisance vegetation to improve foraging efforts	* Water temperature is a very important factor * L-M Bass prefer warm water (27-30°C)
Northern Pike *(Esox lucius)*	* Shallow flooded marshes associated with a lake or any flooded area containing emergent vegetation	* Shallow spawning areas with vegetation	* Site feeders, prefer vegetation for camouflage which allows them to ambush their prey	* Control dense stands of nuisance vegetation * Plant native macrophytes	* Do best in cool to moderately warm water temperatures. (21-27°C)
Walleye *(Sander vitreus)*	* Rocky Shorelines with wave washed shallows * Areas where inlet streams enter lake and contain a gravel substrate	* After hatching migrate out to open waters of lake * After 1-2 months return to inshore habitats	* Utilize hard bottom areas including bars, shoals, and emergent vegetation	* Construction of artificial spawning areas (rocks, gravel) * Addition of woody debris (logs) for habitat/foraging	* Do well in both clear and turbid waters
Black Crappie *(Pomoxis nigromaculatus)*	* Shallows containing sand or fine gravel substrate * Spawn near chara and other submerged vegetation	* Young live in shallow protected areas	* Midwater feeders associated to abundant stands of aquatic vegetation and open areas * School around large submerged trees	* Plant chara which is associated with spawning sites * Submerge woody structures	* Prefer clear, warm waters

Table 15 (continued). Description of fish habitat requirements and improvements for fish species commonly found in the Townsend-area lakes, Oconto County, Wisconsin.

Species	Habitat Requirements: Spawning	Rearing	Foraging	Habitat Improvements	Important Water Quality Parameters
Bluegill *(Lepomis macrochirus)*	* Shallows consisting of sand or gravel substrate	* Young stick to shallow cover (emergent and submerged vegetation)	* Tend to remain in or near cover during the day and at night enter the shallows * Utilize all sources of vegetation	* Control dense stands of exotic vegetation *Add woody cover if habitat is limited	* Found more frequently in clear water verses turbid * Very susceptible to winter kill due to low oxygen levels
Pumpkinseed *(Lepomis gibbosus)*	* Spawn in shallow warm bays with sand or gravel substrates	* Young tend to live on or near shallow water spawning areas in emergent vegetation	* Feed in deeper waters with rocky or plant covered substrates	* Control dense stands of exotic macrophytes * Restore native emergents	* Most frequently found in cool to moderately warm waters * Prefer clear to moderately turbid water
Yellow Perch *(Perca flavescens)*	* Spawn in slow-moving or static waters where emergent and submerged vegetation is present * Also spawn on submerged brush	* Shallows among vegetation	* Feed mainly near the bottom in offshore open water habitats lacking dense vegetation	* Control dense stands of nuisance vegetation * Protect native macrophytes	* Do well in turbid, nutrient rich waters
Bullhead *(Ictalurus spp.)*	* Nest constructed in mud or sand beneath matted vegetation, woody debris, muskrat burrows, and overhanging banks	* Move in compact swirling schools in deep open water near the surface * As young grow older they move to shallow waters	* Opportunistic feeders, eat whatever is available * Remain in cover during the day and at night move into shallow open waters	* Provide any type of cover (logs, brush, rocks) * Protect native aquatic plants	* Very tolerant to siltation and low oxygen levels
Rock Bass *(Ambloplites rupestris)*	* Shallows consisting of sand or gravel substrate	* Shallow gravel and rock	* Shallow clear waters, usually rocky containing macrophytes and crayfish	* Prevent siltation of gravel and add large rock substrates if habitat type is limited. *Allow for some vegetation, but not dense	* Prefer clear cool to warming waters *Populations decline in enriched waters

District members' survey

Volunteers with the ILPRD and the TFPD tabulated the results of the public opinion poll sent to their members in 2015. A total of 191 surveys were returned to the ILPRD and the TFPD. A total of 81 surveys were returned to the ILPRD representing 13.5% of the 600 that were sent out. The TFPD received 110 or 36.8% of the surveys back. Volunteers produced the results found in **Appendix A.** Results of this survey have been used and will continue to be used to direct future management of the Townsend-area lakes.

A majority of respondents are long-time, seasonal property owners in Townsend. Recreation and relaxation are very important. Fishing is very important with most residents practicing catch and release of bluegill, bass and northern pike. Most feel the quality of fishery is fair, but are concerned the quality of fishing has changed for the worse over the years. They feel there is good water quality in the lakes, and feel the water quality has remained the same or somewhat declined; for many possible reasons. Their top concerns include aquatic plant growth, AIS and loss of fish habitat. They feel knowledgeable about AIS and believe aquatic plants often affect enjoyment of the lakes. They feel an integrated management approach is needed including chemical applications, manual removal and mechanical harvesting.

Lake Management Alternatives

Aquatic Invasive Species Management

EWM continues to be one of the primary lake management concerns for the ILPRD and the TFPD. As of 2016, the distribution of EWM in the Townsend-area lakes is the highest is has ever been with 280 acres spread across the lakes. These lakes are high-use recreational lakes. Many property owners and local businesses rely on these lakes for summer recreation and economic stability.

Control options for this species should be revisited. EWM has interfered with recreational activities including swimming, boating and fishing in numerous lakes throughout Wisconsin including the Townsend-area lakes. Communities of native aquatic plants, as well as fish and wildlife, have also suffered as a result of this aquatic invader.

Herbicide treatment of invasives

Herbicides have been the most widely used and often most successful tools for controlling EWM in the State. The most commonly employed herbicide used to manage EWM in hundreds of Wisconsin lakes is 2,4-D (e.g. Navigate®, DMA4®, Sculpin®). When applied at labeled rates, 2,4-D has been shown to be an effective tool at managing EWM. There are other aquatic plant species that are sensitive to 2,4-D applications as well. As a result, some non-target species may experience statistically significant declines following a herbicide treatment. Based on published concentration, exposure time data (Green and Westerdahl 1990) a 2,4-D concentration of 2.0

mg/L is required for good control at an exposure time of 24 hours after treatment (HAT). In addition, 1.0 mg/L is required for good control at 48 HAT and 0.5 mg/L is required for 72 HAT. When large-scale (whole-lake) treatments take place, often a low-dose of herbicide is applied with a target concentration often between 0.3 and 0.4 mg/L.

2,4-D is a herbicides which break down microbially and does not persist in the environment. When applied at the labeled rates, herbicides are an effective management tool for control of many aquatic plant species. While no control method could be considered cheap, herbicide treatments are among the least costly of methods. This is in part due to the relatively low labor costs in comparison to measures such as hand-pulling, mechanical harvesting, etc. When properly executed, herbicide treatments have produced long-term control of invasive species (below nuisance levels). The greatest disadvantage of herbicide treatments is that they rarely produce 100% control. In order to effectively manage an exotic species with herbicides, the chemical has to be present at a high enough concentration for a long enough period of time to cause plant mortality. A number of factors can influence this. All herbicides in an aquatic environment will become diluted by the surrounding water. This makes it particularly difficult to achieve success in smaller, spot treatments. Flowing systems have increased risk of lowered exposure time. Microbes break down the chemicals at varying rates. Certain plants are more resilient than others. Factors such as plant maturity may also reduce treatment efficacy. Several follow-up management activities (e.g. treatments, mechanical harvesting, manual removal, etc.) whether in-season or in subsequent years, may be needed to reduce AIS to target levels.

Due to high dilution rates of this herbicide, the WDNR discourages the use of 2,4-D on small spot treatments where the appropriate contact/exposure time cannot be achieved. The contact/exposure time is the time required for a herbicide to be in contact with a plant to be effective. There are some areas where small treatment areas can be considered if the contact/exposure time can be achieved such as protected bays.

By targeting a whole-lake low-dose concentration of herbicide, the exposure time can be extended since dilution is generally mitigated. This is not the case in flowing systems, however. In addition, not only are the known locations of invasive species targeted with whole-lake treatments, the unknown locations are as well.

As with any herbicide treatment, collateral damage is always a concern. The *desired* result of herbicide treatment of exotic species is to effectively eliminate the target species while minimizing the impact to non-target species and to water quality. This can be difficult in situations where native species sensitive to herbicide treatments are present or where large amounts of plant biomass may remain after treatment. To offset this risk, early-season treatments with semi-selective herbicides and low concentrations target exotic species when the plants are small and when cooler temperatures slow the microbial decomposition of herbicides.

With large-scale treatments, It will also be important to include monitoring of the residual herbicide concentrations after treatment. For greatest success, it is important the target concentrations are reached. If the concentrations are not achieved, then the treatment can be ineffective and could add to plant tolerance of the chemical. Collecting this information is the only way to assure dosage and contact/exposure time is achieved. It is recommended the Districts work with the WDNR and the applicator to develop a monitoring plan with a schedule of sampling frequency and locations as well as instructions for the preservation and submission of the water samples.

Biological control - milfoil weevils

There has been considerable research on biological vectors, such as insects, and their ability to affect a decline in Eurasian watermilfoil populations. Of these, the milfoil weevil (*Euhrychiopsis lecontei*) has received the most attention. Native milfoil weevil populations have been associated with declines in Eurasian watermilfoil in natural lakes in Vermont (Creed and Sheldon, 1995), New York (Johnson et al., 2000) and Wisconsin (Lilie, 2000). While numerous lakes have attempted stocking milfoil weevils in hopes of controlling milfoil in a more natural manner, this method has not proven successful in Wisconsin. A twelve-lake study called "The Wisconsin Milfoil Weevil Project" (Jester et al. 1999) conducted by the University of Wisconsin, Stevens Point in conjunction with the WDNR researched the efficacy of weevil stocking. This report concluded that milfoil weevil densities were not elevated, and that Eurasian watermilfoil was unaffected by weevil stocking in any of the study lakes. Recently, however, work carried out on a number of Portage County lakes has shown some promise at enhancing milfoil weevil populations. In order for weevils to be successful in reducing the extent of Eurasian watermilfoil, a number of environmental criteria are needed, including the availability of proper year-round habitat. This study did not include an assessment of shoreline habitat specifically in terms of weevil survival.

Lake Drawdowns

Lake drawdowns have been used as a means to manage both exotic and native aquatic plants in flowages and millponds. Drawdowns for management of AIS were more heavily promoted by the WDNR in years past, but less so in recent years. The benefits of an effective drawdown can include reductions in both exotic and native plant densities, short-term increases in native plant diversity, and compaction and decomposition of organic sediments. If done properly, a drawdown can result in a number of positive changes to a lake.

The financial cost of conducting a drawdown is often minimal in a situation where a dam can be adjusted to let water out of the lake at no cost. There would, however, be costs associated with the permitting process and likely outreach efforts. Other costs of a drawdown include short-term loss of recreational use, impacts to local economies and loss of wildlife including fish, mollusks and other invertebrates as well as a loss of angling opportunities

Drawdowns can be conducted over the growing season, over the winter, or both. Growing season drawdowns allow for a more prolonged period of time when the lake bed is exposed and desiccation and decomposition rates are highest. Growing season drawdowns can also stimulate emergent plan habitat in exposed areas. The effectiveness of a winter drawdown is a result of freezing conditions (depends on frost killing plant roots) and is therefore dependent upon weather and snowfall amounts.

The most recent drawdowns on Reservoir Pond and Townsend Flowage lasted through the winter and into the growing season. Unfortunately, they resulted in only short-term declines in EWM and native vegetation. Within a short period of time, the distribution of EWM returned to pre-drawdown levels.

Manual removal of vegetation

Manual removal options include raking or hand-pulling aquatic plants and diver-assisted suction harvesting (DASH). Individuals can remove aquatic vegetation in front of their homes, however, there are limitations as to where plants can be hand-pulled and how much can be removed. In most instances, control of native aquatic plants is discouraged and is limited to areas next to piers and docks. When aquatic vegetation is manually removed it is restricted to an area that is 30 feet or less in width along the shore. Invasive species (EWM, curly-leaf pondweed, etc.) may be manually removed beyond 30 feet without a permit, as long as native plants are not harmed. Manual removal of native plants beyond the 30 foot area would require an NR 109 permit. Benefits of manual removal include low cost compared to other control methods. However, raking or hand-pulling aquatic plants can be labor intensive.

Similar to hand-pulling, suction harvesters physically remove plants from the lake bed. A diver or snorkeler is needed to remove the plants from the sediment and feed it into the harvester. As with other similar activities, removal of the entire plant, including the stems and roots is important to eliminate the possibility of further spread. This method should increase manual invasive species harvesting efficiency and reduce the amount of fragmentation during the harvesting operations. There are firms in the State that specialize in DASH. As an alternative, a number of lake organizations in the State have built their own DASH units and operate them throughout the season. There are a lot of variables to consider when it comes to planning DASH activities and selecting areas to harvest. These include plant bed size and density, water clarity, sediment type, native plant abundance, obstructions such as docks or fallen trees, financial resources and time restraints. These factors also determine the speed at which progress is made. DASH is a small-scale tool and should not be expected to greatly reduce EWM densities in areas of widespread growth. DASH operations should primarily focus on areas scattered Eurasian/hybrid watermilfoil locations not slated for chemical treatment. It would be wise to focus first on areas of high boat traffic including channels and public boat launches.

Aquatic plant harvesting

Mechanical harvesting involves the removal of aquatic plants from a lake using a machine that cuts and collects the plants for transport to an off-shore disposal site. Mechanical harvesting has been used as an aquatic plant management tool on the Townsend-area lakes many years. Generally, harvesting equipment can be adjusted to cut to a desired depth up to approximately five feet. Harvesting operations often include equipment, such as a barge, to transport plant materials from a harvester to the shore where a conveyor is used to transfer the materials to a waiting truck. Harvesting is often used for areas where dense, sometimes monotypic, aquatic plant growth significantly interferes with navigation. It is also used to collect floating mats of vegetation that interfere with recreational use of the lakes. Harvesting produces fast results on a small scale, and the removal of plant biomass from a lake. In recent years, a number of lodge and resort owners have reported a decline in business due to the increase in aquatic plant growth. In addition, the benefits of harvesting include nutrient removal, and few if any seasonal restrictions. However, this method is limited to water deep enough for navigation. In addition, harvesting is not generally used to restore aquatic plant communities. It is a maintenance approach used primarily for navigational issues. Harvesting over the long-term can have the ability to keep EWM populations in check, as well as promote native plant growth (Barton et al., 2013). Harvesting can complicate the management of exotic species, particularly Eurasian watermilfoil. Because milfoil spreads efficiently through fragmentation, and harvesting results in a large number of fragments, the two are generally considered incompatible. Harvesting also comes with high initial equipment costs, as well as relatively high maintenance, labor, and insurance costs, disposal site requirements, and a need for trained staff. Many of these issues are avoided with contract harvesting. Other negatives include impacts to fish, invertebrates and amphibians.

A WDNR permit is required by Chapter 109 (Wisconsin Administrative Code - NR 109). for aquatic plant harvesting. In the summer of 2012, the District’s harvesting permit was renewed. The previous harvesting permit of the ILPRD expired in 2015. An extension was given while this management plan was developed. The updated proposed harvesting map is shown in **Figure 41**. Similarly, the TFPD has an existing harvesting permit. It was renewed in 2013. **Figure 42** shows the harvesting map for Townsend Flowage included with the permit renewal.

Figure 41. Proposed locations for mechanical harvesting of aquatic plants within the waters of the Inland Lakes P & R District, Oconto County, Wisconsin.

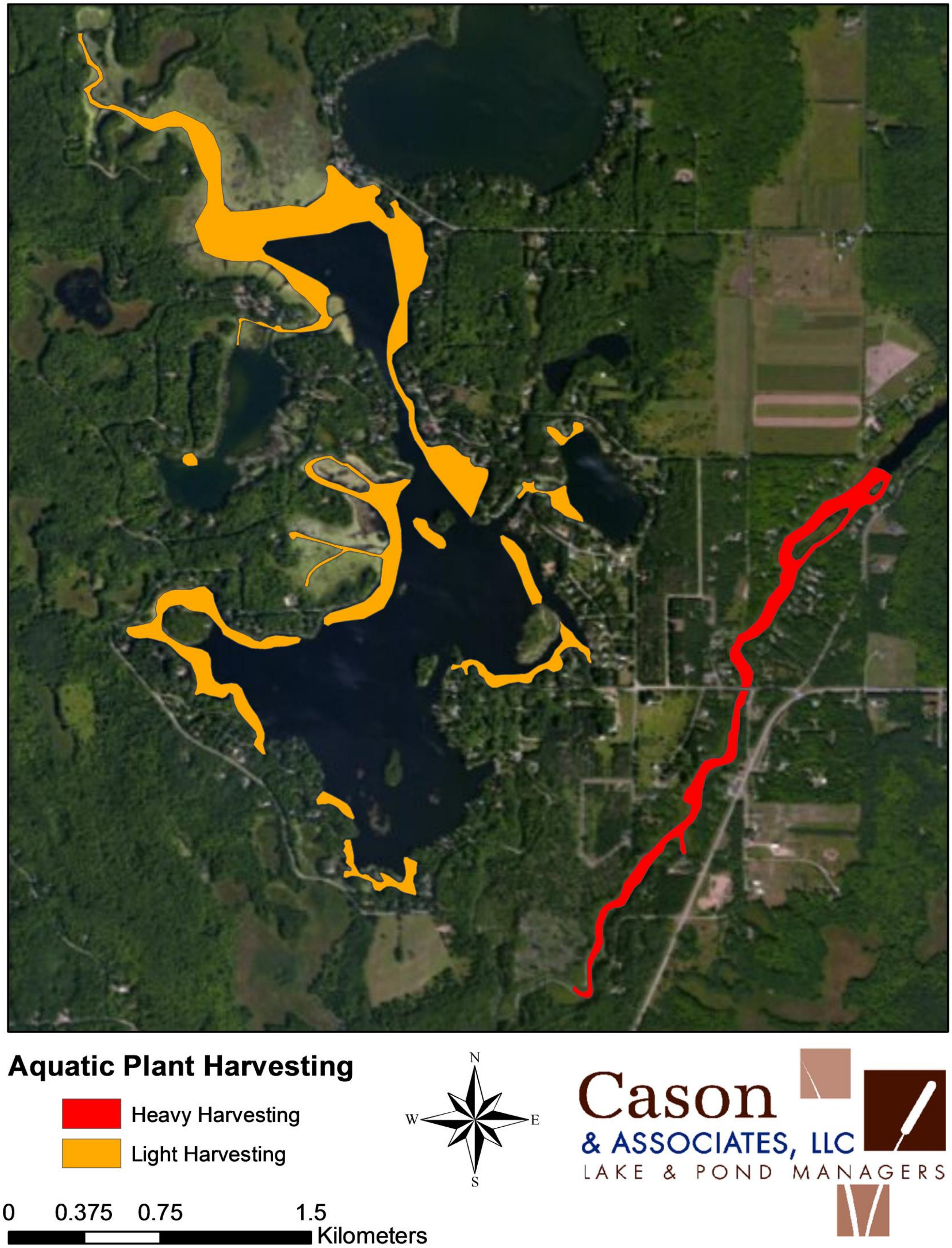
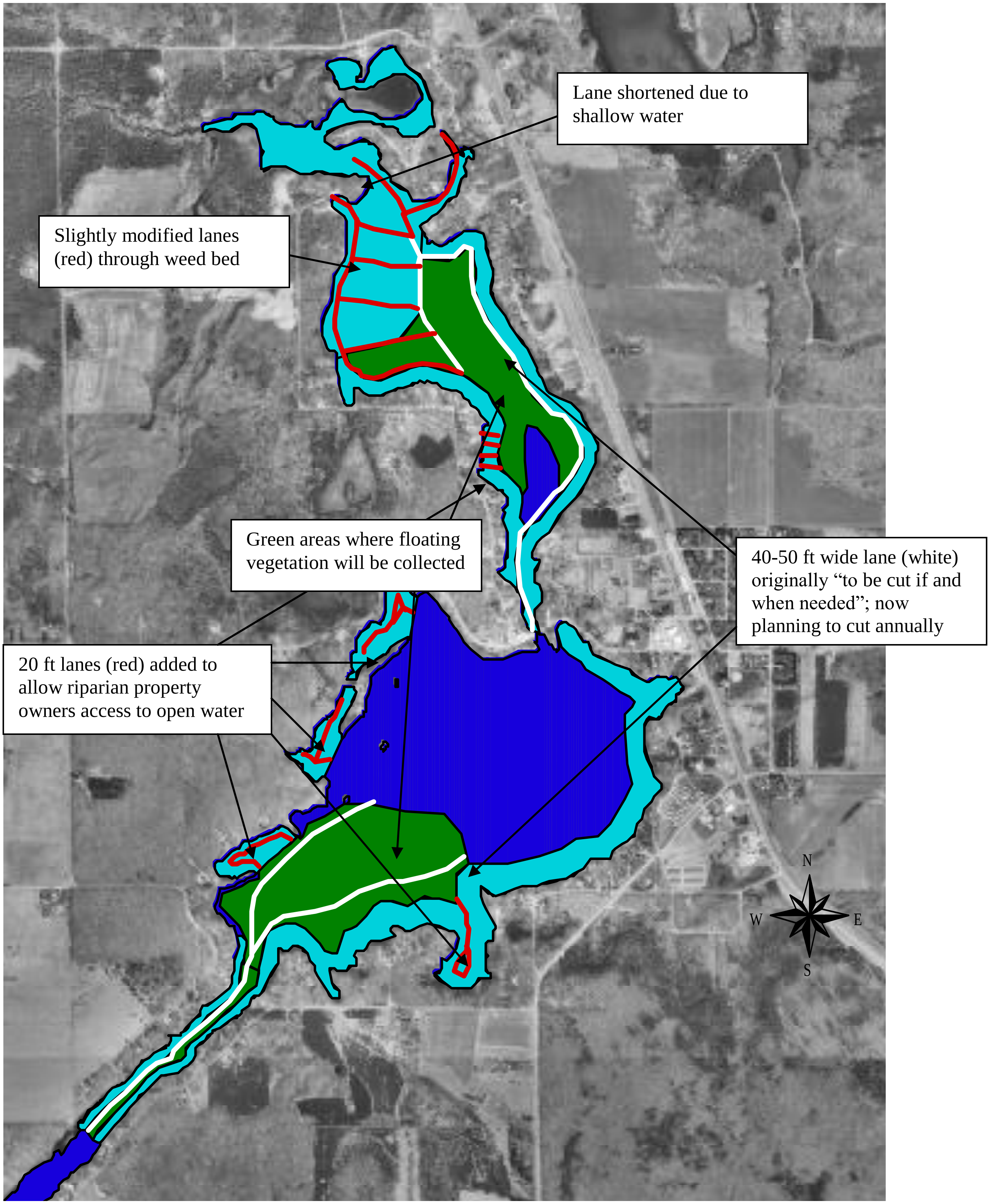


Figure 42. Aquatic plant harvesting map for the Townsend Flowage Protection District.



Conclusions and Recommendations

Results of the property owner survey indicated that the relaxation and recreational opportunities on the Townsend-area lakes are very important to residents and largely the reason for owning property on the lake. Results also indicate that the residents' top concerns are aquatic plant growth, AIS and loss of fish habitat. Future management of aquatic plants in these lakes will continue to be a challenge. The Districts will have to contend with nuisance levels of exotic and native aquatic plant species for the foreseeable future.

Eurasian Watermilfoil

After the initial introductions, Eurasian watermilfoil quickly colonized the Townsend-area lakes. In many ways the lakes have ideal conditions for the growth and spread of aquatic plants including the EWM which will continue to be a threat to the lake's ecosystem. The nature of many of these lakes will also continue to complicate control efforts which are more easily employed on other lakes. These lakes are mostly shallow, productive waterbodies which encourage abundant plant growth. High recreational use and harvesting efforts can promote EWM growth which can spread quickly through fragmentation. Numerous non-navigable areas (shallow, rocky or stump-laden) provide refuge for milfoil growth away from the effects of treatments. In addition, as a flow-through system, chemicals applied during a treatment can be diluted by inflowing water.

Currently, the Townsend-area lakes have an above average diversity of submergent aquatic plants. For a time, chemical treatments were providing seasonal relief of EWM. Unfortunately, late-season regrowth was observed and additional treatments were needed. With a lack of treatments for the past few years, EWM has spread unimpeded with significant populations in Little Horn Lake, Reservoir Pond, McCaslin Brook and the south basin of Townsend Flowage.

Several options are available for managing EWM in these lakes. An integrated approach utilizing multiple management techniques should be employed. EWM growth differs from one basin to the next. Depending upon the lake basin, different approaches can be utilized. For instance, given the low occurrence of EWM in Explosion Lake, manually removal (hand-pulling or DASH) should be effective. In Horn Lake, Little Horn Lake and Townsend Flowage, where relatively small, but manageable beds exist, spot treating with a fast-acting herbicide is recommended. In Reservoir Pond and McCaslin Brook (and possibly Little Horn Lake) the EWM growth is wide-spread and relatively dense in a number of locations. In these areas, large-scale, liquid 2,4-D treatments would be the most effectively both in terms of EWM control and costs. Based on available research from the WDNR, a lake-wide concentration of 0.3 to 0.4 ppm should be able to effectively manage EWM while minimizing impacts to native aquatic plant species. In addition, in order to most accurately determine the amount of herbicide needed to reach a target concentration, updated bathymetry (depth contours) of each basin is recommended.

The bathymetric maps on the DNR website are quite old and the landscape has changed considerably since they were created. Updated bathymetry is critical because accurate water volumes are needed in order to determine the amount of herbicide that is needed to meet a prescribed dosage and contact/exposure time. If the required dosage and contact/exposure time is not achieved, the treatment will not be effective.

Admittedly, aquatic plant management in a flow-through situation is challenging. Concerns have been raised over treating McCaslin Brook. In the past, it seems only seasonal or short-term control was gained with either granular or liquid 2,4-D. It is believed this primarily due to the rate of flow in the brook. However, if Reservoir Pond was treated just prior to and in the same manner as McCaslin Brook, any water leaving Reservoir Pond and entering the Brook would already contain herbicide theoretically at the target concentration. It is also recommended the flow of water into and out of Reservoir Pond be monitoring to calculate the hydraulic residence time and to make any adjustments to the treatment which are warranted due to flow.

Hydraulic retention time is the time it takes the volume of water in a reservoir to exit. This hydraulic retention time and flow variations within the reservoir are critical components for planning chemical treatments because they can affect the contact/exposure time of herbicides. If flow variation or hydraulic retention time is greater than the time needed for a herbicide to have contact with a plant, then the chemical will not stay on target long enough to kill the plant.

In other Wisconsin lakes during the past couple of years, more small-scale, spot treatments have taken place utilizing faster-acting contact herbicides. Diquat is a broad-spectrum herbicide that can effectively control aquatic plant growth with as little as six hours of contact time.

The Districts should understand that management of EWM will need to be adaptive. If the currently proposed approach is unable to provide continued progress in the coming years, a modified treatment approach or other non-chemical management approach should be considered. On a limited basis, harvesting can be used to supplement EWM management. It should be understood that this approach can encourage the spread of this species, as has been seen in McCaslin Brook and its movement downstream to Townsend Flowage.

The Districts can continue selective weed-cutting activities in the lakes while EWM management is ongoing. Postponing cutting entirely does not address the nuisance growth of native plants. A high rate of cutting will worsen the problem and accelerate the spread of EWM. As a compromise, the District should annually postpone cutting until four weeks after treatment. This will allow the treatments to take full effect. At that time, cutting for nuisance relief could take place. Operators should be made aware of the locations treated, how to properly identify EWM, and to avoid cutting in areas of active Eurasian watermilfoil growth as much is possible.

It is recommended that annual AIS surveys be performed for the foreseeable future. These surveys will serve to monitor the effects of previous management activities while preparing for additional efforts. With the wide-spread distribution of EWM in the lakes, it is recommended that monitoring utilizing current WDNR protocols be employed to accurately locate and map aquatic invasive species in the lakes. Specifically, a focused point-intercept approach would allow for qualitative mapping of the EWM beds as well as quantitative data collection that can be used in statistical analyses. It is recommended spring and fall invasive species surveys take place annually. This will allow for the monitoring of not only EWM but other invasive species, such as curly-leaf pondweed. This cold-water species is best identified in the spring.

It is also recommended that annual winter stakeholder meetings take place to assess the results of the previous year's AIS management activities. Attendees should include representatives from the WDNR, Army Corps of Engineers, District Board, Cason & Associates and the Oconto County AIS specialist. These meetings should provide consensus on annual invasive species management activities. It is recommended a goal of reducing EWM growth to 10% littoral frequency of occurrence based on point-intercept survey data goal be established. This approach provides a standardized, repeatable, and quantitative approach. If and when this goal is reached in any particular basin, management should integrate other pest management techniques such as spot treatments using a contact herbicide, hand pulling, DASH or mechanical harvesting. Stakeholders should collectively decide on how best to proceed when this initial goal is met. Management actions may vary from basin to basin and from year to year.

Genetic testing

The genetic analysis conducted in 2010 showed the milfoil species present within the ILPRD and the TFPD include both Eurasian watermilfoil and northern watermilfoil. Hybrid watermilfoil was not identified. It is generally recommended this type of analysis be repeated approximately everyone five years. Since both parent species are present and treatment has not taken place for some time, it is plausible that hybridization has occurred or that a hybrid strain has since been introduced. It would be wise to collect samples in 2017 prior to any chemical management from all basins to better determine what types of milfoil are found the lakes and where.

Aquatic Invasive Species grant

The Districts are eligible to apply for a grant through the WDNR help manage EWM and other invasive species in the lakes. The Aquatic Invasive Species – Established Population grant program provides funding on a cost-sharing basis to assist with planning, implementing and monitoring efforts related to, in this case, large-scale management of EWM. The most recent AIS grant was awarded to the ILPRD in 2010. It is recommended a new proposal be submitted to the WNDR (February 1st deadline) to cover three years of management activities from 2017 through 2019.

Clean Boats, Clean Waters

The ILPRD and the TFPD have existing Clean Boats, Clean Water (CBCW) programs. The WDNR in cooperation with the UW-Extension Lakes Program has developed this volunteer watercraft inspection program designed to educate motivated lake organizations in preventing the spread of exotic plant and animal species among Wisconsin lakes. This program is particularly useful to the Townsend-area lakes due to the large number of visitors to the lakes. Through the Clean Boats, Clean both Districts train volunteers to monitor and stop the spread of invasive plants and animals. Not only does this program help reduce the likelihood of new invasive species being introduced to the Districts' lakes, it also help prevent the spread of invasive species out of these lakes to other lakes in the region. More information can be found at the WDNR's website.

Education plays a big part in the Clean Boats, Clean Waters program. All individuals willing to participate should be taught to identify exotic species. The Districts should make it a priority to include such measures during all normally scheduled meetings whenever possible. In addition, special meetings should be sponsored to train volunteers for this program.

The native plant, northern watermilfoil, grows in the lakes. Because it superficially looks much like Eurasian watermilfoil, care should be taken to specifically learn to differentiate between the two species. In addition to Eurasian watermilfoil and curly-leaf pondweed, it would behoove members of the District to become familiar with the identification of other exotic species that pose a threat to Wisconsin lakes (see **Appendix E**). Additional information and education materials are available through the WDNR and the local UW-Extension office. **Appendix E** also contains information regarding management options for the exotic species previously mentioned. As always, education should be a key component of any exotic species management effort.

Water Quality Management

Data show during the warmest times of the year, the Townsend-area experience good to excellent water quality. For the most part, detailed data are available for the past decade or more. There are a number of practices that individual property owners can undertake to improve or maintain water quality in their lakes. It is recommended the Districts continue to encourage these activities through presentations at meeting and in newsletters.

Nutrient management options

Since the watershed is mainly forested, the shoreline development increases in importance as a potential nutrient source. Elevated nutrient inputs from human activities around a lake can adversely affect both water clarity and water quality. A number of practices can be carried out to improve water quality. Significant contributions of nutrients to the lake can come from direct runoff from areas closest to the lake. The following are options for water quality enhancement which both the District, as a whole, and individual lakefront property owners can undertake in an effort to maintain water quality.

The first step in managing nutrients in a lake is to control external sources of nutrients. These can include: encouraging proper lawn care, restoring vegetation buffers around waterways, encouraging beneficial agricultural practices, and reducing run-off.

Lawn care practices

Individuals can play a large part in reducing sedimentation from local sources. Mowed grass up to the water's edge is a poor choice for the well-being of a lake. Studies show that a mowed lawn can cause seven times the amount of phosphorus and 18 times the amount of sediment to enter a waterbody (Korth and Dudiak, 2003). Lawn grasses also tend to have shallow root systems that cannot protect the shoreline as well as deeper-rooted native vegetation (Henderson et al., 1998). Property owners should take care to keep leaves and grass clippings out of the lake whenever possible, as they contain nitrogen and phosphorus. The best disposal for organic matter, like leaves and grass clippings, is to compost them.

Fertilizers that enter the lake will encourage an increase in plant and algae biomass. Fertilizers contain nutrients that can wash directly into the lake. While elevated levels of phosphorus can cause unsightly algae blooms, nitrogen inputs have been shown to increase weed growth. Increases in plant biomass will lead to further sedimentation and navigational issues. Landowners are encouraged to perform a soil test before fertilizing. A soil test will help determine if a yard needs to be fertilized. For assistance in having soil tested, contact the local county UW-Extension office. Since April 1, 2010, fertilizers containing phosphorus cannot be applied to lawns or turf in Wisconsin. This change in the State's statutes is intended to provide protection to Wisconsin's lakes, rivers, streams and other water resources from phosphorus run-off. The fact is most lawns in Wisconsin don't need additional phosphorus. The numbers on a bag of fertilizer are the percentages of available nitrogen, phosphorus and potassium found in the bag. Phosphorus free fertilizers will have a 0 for the middle number (e.g. 10-0-3).

Vegetative buffer zones

There are beneficial alternatives to the traditional mowed lawn. It is best to leave the natural shoreline undisturbed. If clearing is necessary to access and view the lake, consider very selective removal of vegetation.

If the natural shoreline has been disturbed or removed it would be ideal to restore it. Restoring a vegetative buffer zone is an important alternative. Ideally, a buffer zone consists of native vegetation that may extend from 25 – 100 feet or more from the water's edge onto land, and 25 – 50 feet into the water. Often a buffer to this extent is not feasible, either physically or economically. In these cases, a smaller or narrower buffer can still provide the same benefits of a more extensive buffer, just on a smaller scale. A buffer should cover between 50% and 75% of the shoreline frontage (Henderson et al., 1998). In most cases this still allows plenty of room for a dock, swimming area, and lawn. Buffer zones are made up of a mixture of native trees, shrubs, and other upland and aquatic plants. Studies have also shown that providing complex habitats through shoreline features, such as plants and erosion control devices, can result in significant increases in fish diversity and numbers (Jennings et al., 1999).

Shoreline vegetation serves as an important filter against nutrient loading and traps loose sediment. A buffer provides excellent fish and wildlife habitat, including nesting sites for birds, and spawning habitat for fish. Properly vegetated shorelines also play a key role in bank stabilization. A number of resources are available to assist property owners in creating beneficial buffer zones. These include the WDNR, local UW-Extension office, and the County Land and Water Conservation Department. These organizations can provide descriptions of beneficial native plant species and listings of aquatic nurseries in the State. Oconto County and the WDNR have grant programs that can be utilized for funding sources.

Erosion control

Erosion is a natural process, but it's for the benefit of the landowner and health of the lake that erosion control practices be carried out to slow the process as much as possible. Sedimentation into the lake causes nutrient pollution, turbid water conditions, eliminates fish spawning habitat, and increases eutrophication. Shoreline owners are encouraged to leave existing vegetation undisturbed, as it is a great shore stabilizer. The placement of logs, brush mats, and rock riprap are also options against erosion. When riprap is used it is recommended that desirable shrubs and aquatic plants be planted within the riprap. The plantings serve as nutrient filters and habitat. Before any shoreline stabilization project is initiated, it is advised that property owners contact the local WDNR office for project approval and to obtain any necessary permits.

Reduced impacts from boating

Boat traffic can cause an increase in suspended solids, especially in shallow areas of lakes (Hill, 2004). Studies have shown that maximum increases in turbidity occur between two and 24 hours following boating activities. The full effects of heavy boating depend upon a number of factors including propeller size, boat speed, draft, and sediment characteristics (Asplund, 1996). Silty sediments tend to have the highest susceptibility to resuspension and the highest potential for the reintroduction of nutrients into the water column. Studies have also focused on algae (chlorophyll a) concentrations but found no significant changes following boating activity. This is due primarily to an indeterminate time lag which occurs between the release of nutrients and the subsequent increase in algal growth. It has also been suggested that disturbances to the native plant communities due to watercraft use can accelerate the spread of opportunistic exotic plant species such as Eurasian watermilfoil and curly leaf pondweed (Asplund and Cook, 1997).

Wisconsin statutes require boaters to maintain no-wake speeds within 100 feet of shorelines, other boats, or fixed structures, including boat docks and swimming platforms. However, it is difficult to enforce such regulations, and even slow boat traffic can have a negative impact on sediments and plant communities in shallow areas. This not only has a negative impact to the lake but shallow conditions can also damage boat propellers and motors. It is recommended that the Districts take the opportunity to educate members and lake users alike of the impacts boating can have on a lake.

Septic system maintenance

Septic systems are known to contribute nutrients to a lake. It is the responsibility of lakeshore property owners to ensure that septic systems are properly functioning. A failing septic system can contaminate both surface and ground water. Many Counties in Wisconsin are currently taking inventory of septic systems and enrolling them in a three-year maintenance program. Property owners should avoid flushing toxic chemicals into septic systems. This can harm important bacteria that live in the tank and naturally break down wastes. Owners should also avoid planting trees, compacting soil, or directing additional surface runoff on top of the drain field.

Wisconsin Citizen Lake Monitoring Network

A fair amount of historic water quality data is available for the lakes within the ILPRD. This is not the case for the TFPD. TFPD volunteers should consider increasing the frequency of data collection to match the ILPRD. This includes regular collection of water clarity (Secchi depth) data and three sampling events each summer where samples are collected for chlorophyll and phosphorus analysis as well as monitoring dissolved oxygen and temperature profiles. This should all still be available to both organizations through the Wisconsin Citizen Lake Monitoring Network. This program provides an opportunity for volunteers from lake organizations to assist in state-wide water quality monitoring. Through a database managed by the WDNR, information gathered is shared by volunteers and archived. The importance of long-term data is crucial in assessing changes to the lake environment. In addition, participating in projects of this type can help the Districts secure additional grant money from the WDNR. Funds are awarded to organizations that demonstrate a commitment to the health and wellbeing of their lakes.

Implementation Plan

Management Goal 1: Reduce aquatic invasive species growth.

Management Action: Annual monitoring and integrated management.
Timeframe: Annual surveys using the point-intercept method. Combination of chemical treatments, manual removal and mechanical harvesting to manage Eurasian watermilfoil.
Facilitators: District Boards, Cason & Associates, LLC

Description: Surveys for exotic species, namely Eurasian watermilfoil and curly-leaf pondweed will be conducted annually on the Townsend-area lakes. These will be focused point-intercept combined with visual, meandering-boat surveys which will be conducted by Cason & Associates staff and District volunteers. Surveys will be used to monitor the distribution of Eurasian watermilfoil. These surveys will qualitatively and quantitatively assess the efficacy of previous herbicide treatments and determine the need for additional treatments.

Annual spring treatments are anticipated to further reduce the distribution of Eurasian watermilfoil. Both whole-lake and small-scale treatments will be employed based on plant density, lake morphology and current research. Currently, a majority of Reservoir Pond and McCaslin Brook contain EWM at various densities. It is anticipated that multiple treatment approaches may be employed over the next five years as EWM distribution changes. Changes may be made to the herbicide type or formulation, the application rates or methodology, and/or combinations of herbicides.

As treatments take place, additional management tools will be encouraged by the Districts, particularly in basins where the EWM has been reduced to less than the 10% littoral frequency of occurrence. As small scattered locations of invasive species are identified, the Districts will shift to other means such as mechanical harvesting and manual removal. The Districts will also look into the option of hiring DASH operations in lake basins or areas of scattered EWM growth. In addition, property owners will be encouraged to hand-pull AIS around their docks and shorelines.

The Districts plan to apply for further funding through the WDNR's Aquatic Invasive Species grant program to offset treatment and monitoring costs.

Management Goal 2: Manage the health of the native plant community within the waters of Townsend.

Management Action: Selective harvesting of native plants according to WDNR permit conditions.
Timeframe: Annual summer harvesting.
Facilitator: District Boards
Description: In order to manage nuisance levels of native aquatic plants, the Districts plans to continue their annual harvesting programs. Harvesting for native aquatic plants is expected to be

delayed annually until at least four weeks following herbicide treatment of Eurasian watermilfoil. Once this period has passed, operators will be instructed to cut in areas specifically allowed through the permit. They will be made aware of all permit conditions. They will also be shown how to accurately identify invasive species be aware (via onboard maps) of the current distribution of EWM in each lake. For the time being, they will be instructed to avoid cutting in areas of Eurasian watermilfoil growth. As needed, the Districts will pursue renewal for their multi-year harvesting permits, making any needed changes or modifications during this process.

Management Goal 3: Encourage shoreline improvements on an individual riparian owner basis.

Management Action: Restore or improve near-shore plant community to improve water quality and fish and wildlife habitat. Educate District members regarding the reduction of nutrients and sediments from immediate watershed.
Timeframe: Ongoing
Facilitator: District Boards
The District boards plans to provide information to its membership regarding shoreline improvement options and other actions the District as a whole and individuals can take. Particular attention will be paid to the use of vegetative buffer strips and tree falls as a means to improve fish habitat in the lake. Recent changes to the State's shoreline zoning regulations will also be conveyed to the memberships. Resources included in this plan as well as those available from the WDNR, Oconto County and UW-Extension will be utilized. The Districts will also solicit appropriate speakers to address these issues at membership meetings. Shoreline improvement demonstrations may be planned at the Districts' discretion.

Management Goal 4: Continued participation in the Clean Boats, Clean Waters Citizen Lake Monitoring Network programs.

Management Action: Expand on Clean Boats, Clean Waters and Citizen Lake Monitoring Network programs.
Timeframe: Annual, continuous
Facilitator: District Boards

District volunteers are currently trained and participate in the monitoring of boat landings through the Clean Boats, Clean Waters program. There have been times when it has been challenging for the District Boards to recruit new volunteers for this program. Members of the Boards are dedicated to this program and will continue to encourage lake residents to become trained and volunteer through this program. The Districts will work with the WDNR and the County Aquatic Invasive Species Coordinator to expand this program and increase the number of volunteers and hours.

District volunteers currently participate in the WDNR's Citizen Lake Monitoring Network program. The level of involvement for the TFPD is lower than that of the ILPRD. The District Boards understand the benefit of participating in this program. The TFPD will investigate the options for increasing their involvement through the WDNR and will solicit new volunteers as needed to take on these roles. District members are expected to participate in a training session.

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