A Summary of Findings from LakeScan™
Guided Surveys and Analysis of:

Upper Straits Lake

Oakland County, MI

2019 DATA AND ANALYSIS SUMMARY REPORT

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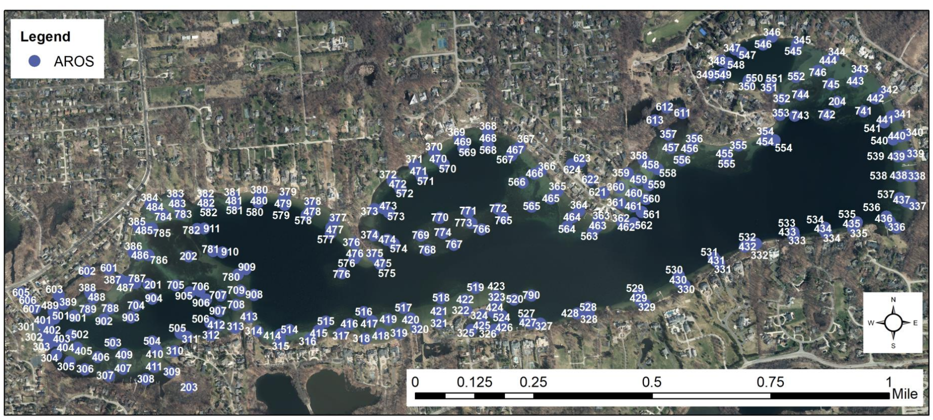

LakeScan™

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Introduction

Preface: Lakes are complicated systems. There is no simple way to consider all of the interacting systems within a lake and the impact of watersheds and invasive species invasions on these precious resources. LakeScan™ is a comprehensive system of analysis that is necessary to properly consider conditions in a lake and make reasonable, scientific and empirically based recommendations for management and improvement of lake ecosystems. This report is only the “tip of the iceberg”. All recommendations are based on the comprehensive record of the data.

Background: The LakeScan™ program provides an analysis of lake conditions as well as management recommendations based on data and observations collected over multiple lake surveys. Each survey includes a comprehensive mapping of aquatic vegetation present in the lake. Surveys may also collect additional data such as water quality samples, dissolved oxygen profiles, and temperature profiles. A LakeScan™ analysis takes the data collected during these surveys and calculates a series of metrics representative of the health of the lake ecosystem, as well as the nuisance threat presented by invasive and weedy species. In addition to providing a snapshot of lake health, these metrics allow for a comparison of lake conditions on a year-to-year basis as well as a comparison with other lakes. Survey data and the maps generated from it are used to provide treatment and intervention recommendations, when necessary. Recommendations are made keeping in mind that they should always result in improvements and ensure no further degradation of the lake ecosystem.

Data Collection Methods: A LakeScan™ analysis involves collecting data over two vegetation surveys. These surveys are based on a system where the lake is first divided into biological tiers (Table 1 and Figure 2) and then further subdivided into Aquatic Resource Observation Sites (AROS; Figure 1). For each survey, field personnel record the density, distribution, and position in the water column of each aquatic plant species in each AROS, as well as noting any present nuisance conditions. Aquatic plant communities change over the course of a year, so the surveys are split into early and late season observations. Early season surveys are scheduled with the goal of taking place within 10 days of early summer treatments to best observe treatment-targeted and non-targeted vegetation. However, this scheduling is subject to weather and times of increased boat activity.

Table 1 - Biological Tier Descriptions

Tier	Description
2	Emergent Wetland
3	Near Shore
4	Off Shore
5	Off Shore, Drop-Off
6	Canals
7	Around Islands and Sandbars
9	Off Shore Island Drop-Off

Vegetation Survey Observations: The primary goal of aquatic plant management in Upper Straits Lake, Oakland County, MI, is to preserve, protect, and if possible, improve the biodiversity of the flora and fauna of the lake. Key findings from the June 28th and August 22nd, 2019 intensive LakeScan™ vegetation surveys of Upper Straits Lake include:

- Overall, Upper Straits exhibited relatively good species diversity with invasive species showing significant recreational nuisance levels mainly in the northern and western shorelines and channels.
- Dominant native aquatic plant species detected at non-nuisance levels during both surveys include Chara (*Chara sp.)*, Variable pondweed (*Potamogeton graminius*), Wild celery (*Vallisneria americana*) and Waterlily (*Nymphaea sp*.).
- Ecological nuisance species included: Ebrid milfoil (*Myriophyllum spicatum x sibiricum*), starry stonewort (*Nitellopsis obtusa*) and curly leaf pondweed (*Potamogeton crispus*), all detected in both the June and August surveys. Curly leaf pondweed presented mild recreational nuisance levels in the June survey predominantly in Tiers 3, 4 and 6 AROS of the western shoreline and, as typical for this species, had significantly reduced in density and distribution by the August survey. Ebrid milfoil, found in Tiers 3, 4, 5, 6, 7, and 9 AROS throughout the lake, decreased in density from June to August, but remained a recreational nuisance in the western lobe. Distribution for this species remained relatively the same throughout the lake. Starry stonewort, found mainly in Tiers 4, 5, 6, 7, and 9 AROS throughout the lake, increased in density and distribution from the early-season to the late-season survey.

The following sections describe the lake and watershed characteristics, field water quality measurements, results of the aquatic vegetation surveys and aquatic vegetation management activities and recommendations.

Category 100 – Lake and Watershed Characteristics

This section provides an overview of physical and geopolitical characteristics of the lake and its watershed, as well as illustrations of AROS (Figure 1) and tier layouts (Figure 2) used for vegetation surveys. A summary of watershed land-use composition is included in Figure 3.

Location

County: Oakland

Township: West Bloomfield

Township/Range/Section(s): T2N, R9E

GPS Coordinates: N 42.591, W -83.338

Morphometry

Total Area: 323 acres

Shoreline Length: 23510 feet

Maximum Depth: 95 feet

Watershed Factors

Outlet type: Covered Weir

Administrative Management

Management Authority: Upper Straits Lake Association

Years in LakeScan™ Program: 6

First Year of Monitoring Program: 2014

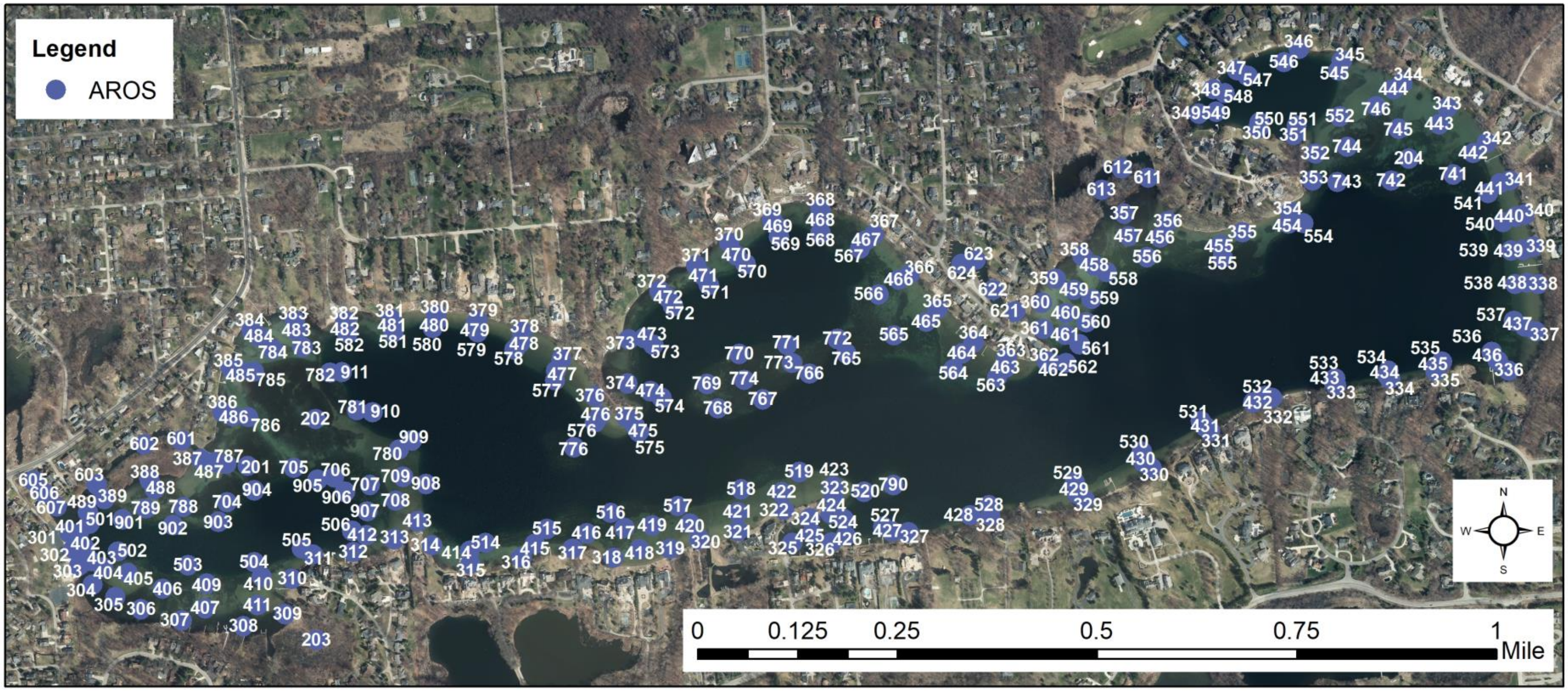

Figure 1 - Map of Aquatic Resource Observation Sites (AROS)

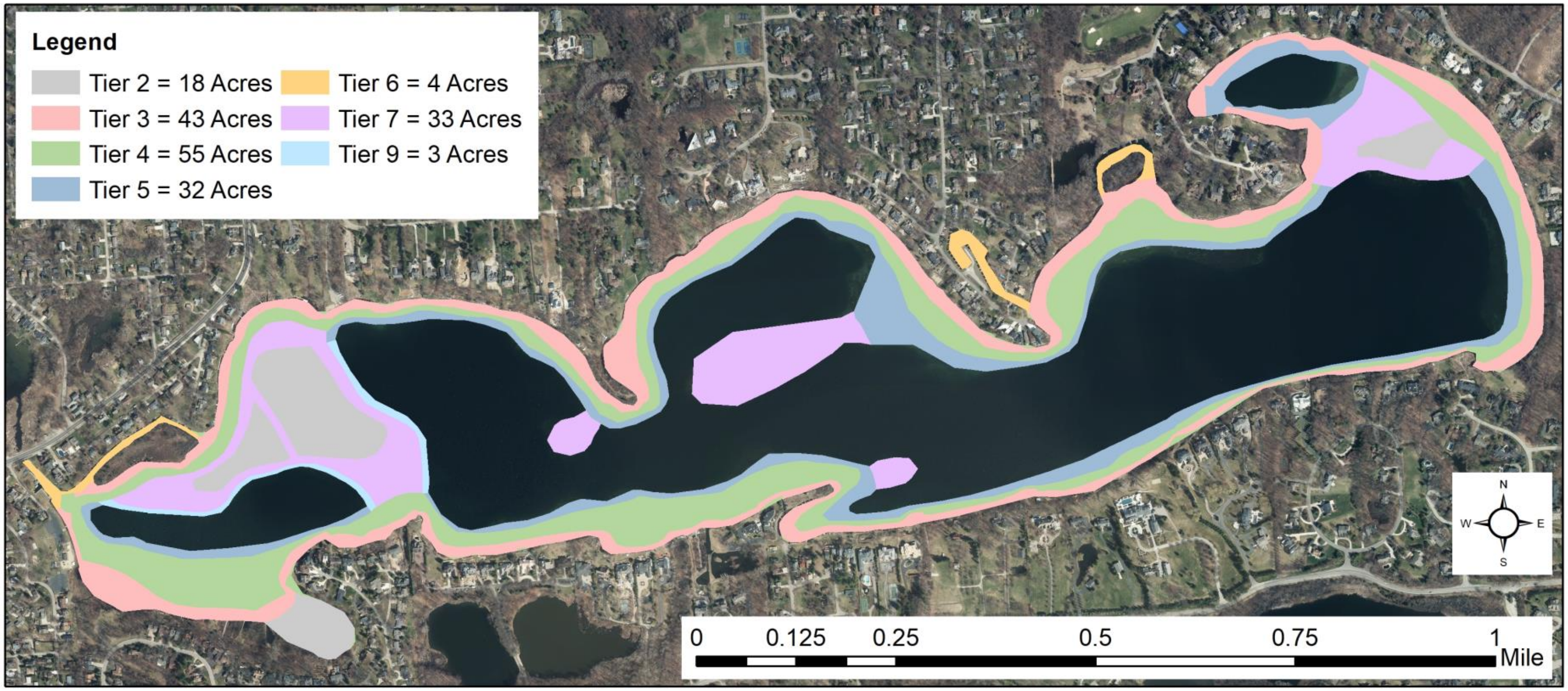

Figure 2 - Map of biological Tiers

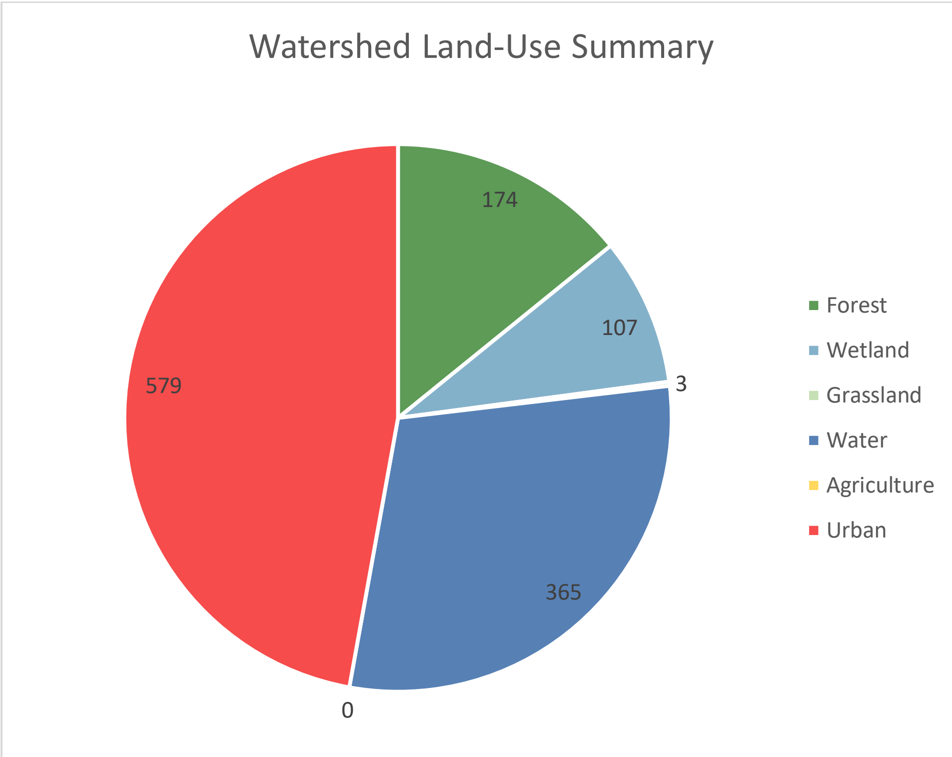

Figure 3 - Lake watershed land-use composition (acres), according to the Michigan Glacial Lakes Partnership Conservation Planner, available online at: http://midwestglaciallakes.org/resources/conservationplanner/.

Category 200 – Water Quality

Secchi depth, dissolved oxygen and temperature data were collected at the deepest point in the lake during each vegetation survey (Figures 4 and 5). Secchi disk transparency is the depth at which a Secchi disk (a flat white or black and white platter, approximately 20 centimeters in diameter) suspended into a lake disappears from the investigator's sight. In general, the greater depth at which the Secchi disk can be viewed, the lower the productivity of the water body. Secchi depth readings of greater than 15 feet can be indicative of low productivity or oligotrophic conditions (USGS, 2012). It is important to note that established populations of zebra mussels in a lake can significantly increase water clarity, thus resulting in greater Secchi disk readings.

A sufficient supply of dissolved oxygen (DO) in lake water is necessary for most forms of desirable aquatic life. Colder waters contain more dissolved oxygen than warmer waters. Oxygen depletion can occur in deeper, unmixed bottom waters during warmer summer months in highly productive lakes. Increased algal growth associated with additional nutrients in the lake can lead to severe decreases in DO in lake bottom waters. This decrease in oxygen is due, in part, to dead algae and other organic matter, such as rooted plant material broken away from shoreline areas and leaves, grass and other plant debris washed in from shoreline lawns and storm drains settling to the bottom of the lake and decaying. This decay process is performed by organisms that consume oxygen and by chemical reactions in the sediment. The DO impacts are most often observed in bottom waters during periods of temperature stratification in warmer summer months and, to a lesser degree, under winter ice cover conditions.

Dissolved oxygen levels and temperature were measured using a YSI ProODO dissolved oxygen meter, calibrated prior to use. Michigan water quality standards for surface waters designated for warm water fish and aquatic life call for a DO of at least 5 mg/L (MDEQ, 2006).

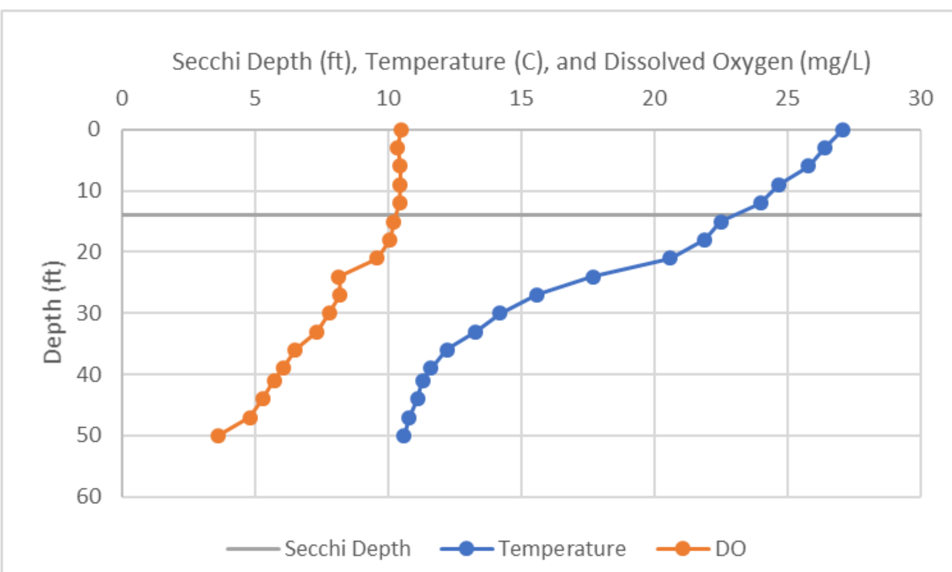

Figure 4 - Early season survey (June28) dissolved oxygen and temperature profiles with Secchi depth, taken at the deepest point in the lake.

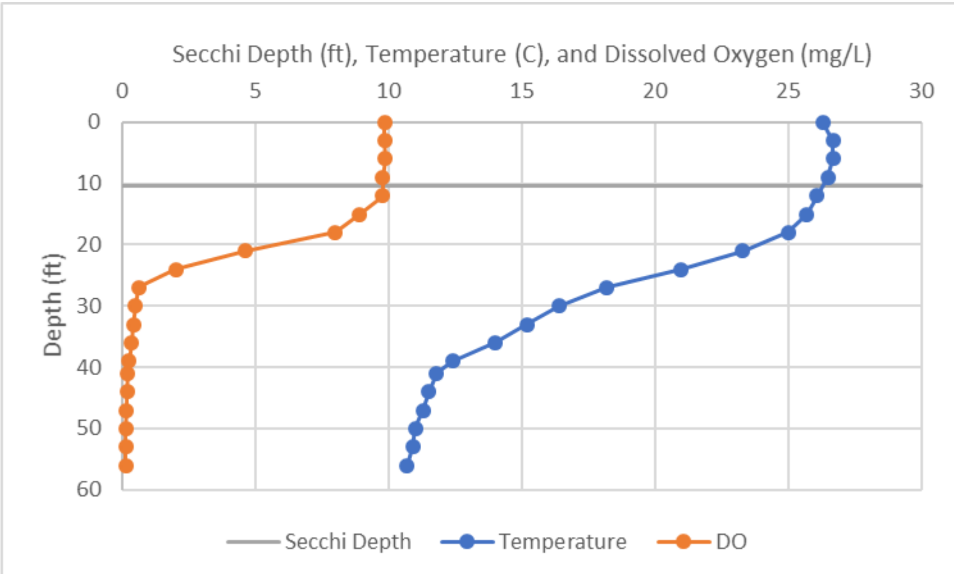

Figure 5 - Late season survey (August 22) dissolved oxygen and temperature profiles with Secchi depth, taken at the deepest point in the lake.

Category 700 – Aquatic Vegetation

This section details findings from the two vegetation surveys that were conducted on the lake. This includes observations, aquatic vegetation mapping, and LakeScan™ analysis metrics as discussed below and presented in Tables 2-5 and Figures 6-15. Maps in Figures 6 and 7 show results from early and late season surveys, respectively, combining results for all species. Figures 10-15 show maps of key nuisance plant species.

Early-Season Survey:

The early-season LakeScan™ vegetation survey of Upper Straits Lake, Oakland County, MI was conducted on June 28th, 2019. Weather conditions were mostly sunny with a chance of thunderstorms and 88°F, providing good visibility through the water column.

Overall, Upper Straits exhibited abundant vegetation growth and great species diversity (Figure 6). Native aquatic plant species observed include large areas of Chara along the western half of the lake, waterlily in Tiers 3 and 4 AROS, and various native pondweeds were observed in most AROS Tiers and ranged from depths of 2-11'.

Ecological nuisance species detected in this early-season survey include Ebrid watermilfoil, starry stonewort, and curly leaf pondweed. Ebrid watermilfoil density and distribution was consistently moderate throughout the lake, with higher density in the western-most lobe, along the western shoreline, creating a recreational nuisance in Tier 3, 4, and 5 AROS and near the ski lane in Tier 7 AROS (Figure 10). Starry stonewort was detected predominantly in Tier 6 of the western and the northeastern channels, and in Tier 4 and 5 of the north shore of the middle lobe (Figure 12). Curly leaf pondweed was found at low densities in Tier 3, 4, and 6 AROS of the western shore (Figure 14).

Late-Season Survey:

The late-season LakeScan™ vegetation survey of Upper Straits Lake was conducted on August 22nd, 2019. Weather conditions were mostly sunny and 75°F, with a chance of precipitation. Visibility throughout the water column was good.

Species diversity remained high for the late-season survey of Upper Straits Lake. Chara densities decreased in the western half of the lake, however, various pondweeds and wild celery increased in density and distribution throughout the entire lake. Wild celery flowers presented a recreational nuisance throughout many areas of the lake.

Curly leaf pondweed density significantly decreased, with very few individual plants detected in the northwestern Tier 6 AROS (Figure 15). Starry stonewort density and distribution significantly increased throughout much of the areas it was previously detected in during the early-season survey and was detected at higher density and distribution in the northern Tiers during the late-season survey than the early-season survey (Figure 13). Starry stonewort was observed topping out and close-to topping out in Tier 6 of the western-most channel, creating a nuisance for boat access. Ebrid watermilfoil density decreased in much of the lake, primarily throughout the Tier 6 AROS, but still posed a recreational nuisance in Tier 3 and 4 of the western lobe, near the beach and boat docks (Figure 11).

The maps below (Figures 6 and 7) depict results of the vegetation surveys. Data on all combined species are represented using three-dimensional density, which reflects a combination of vegetation density, distribution and height observations.

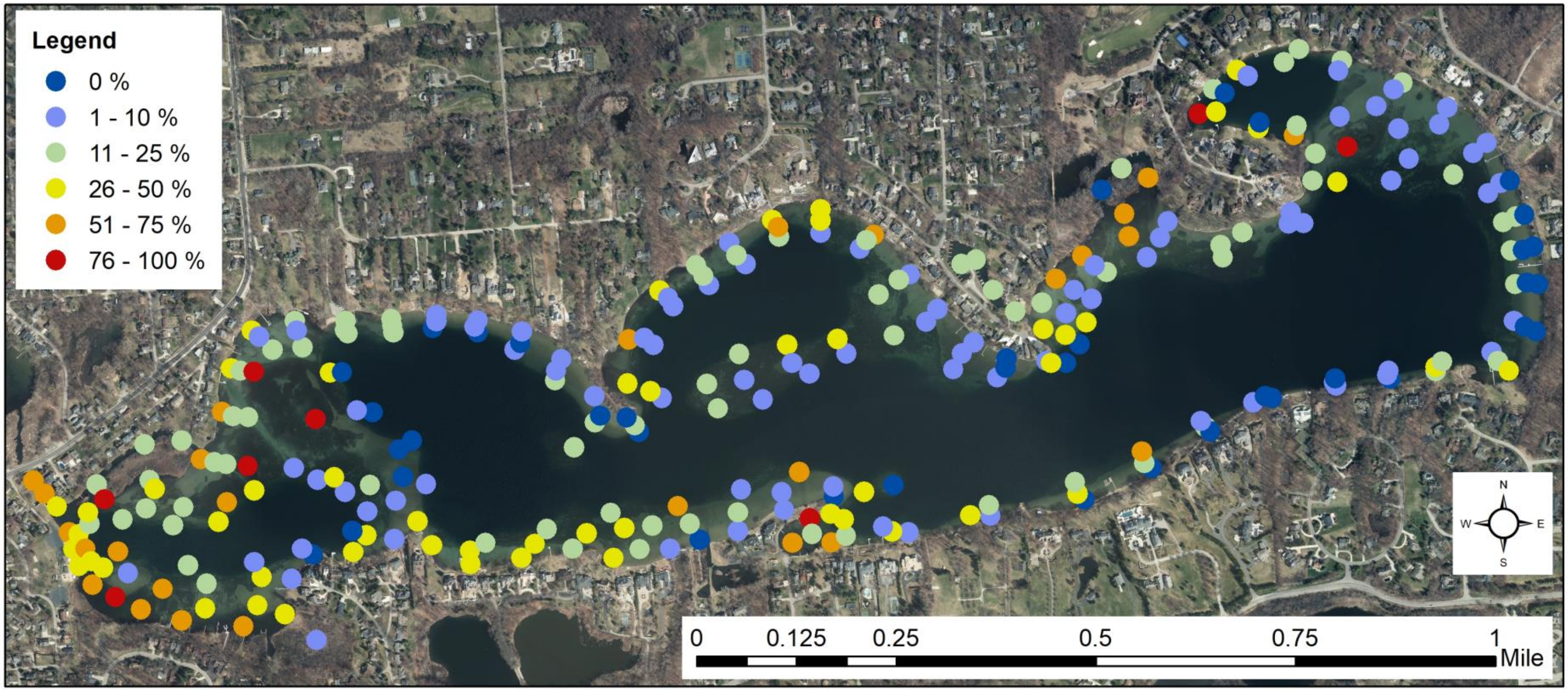

Figure 6 - Early season survey (June 28) vegetation 3D Density (a function of observed vegetation coverage, and height of all vegetation species)

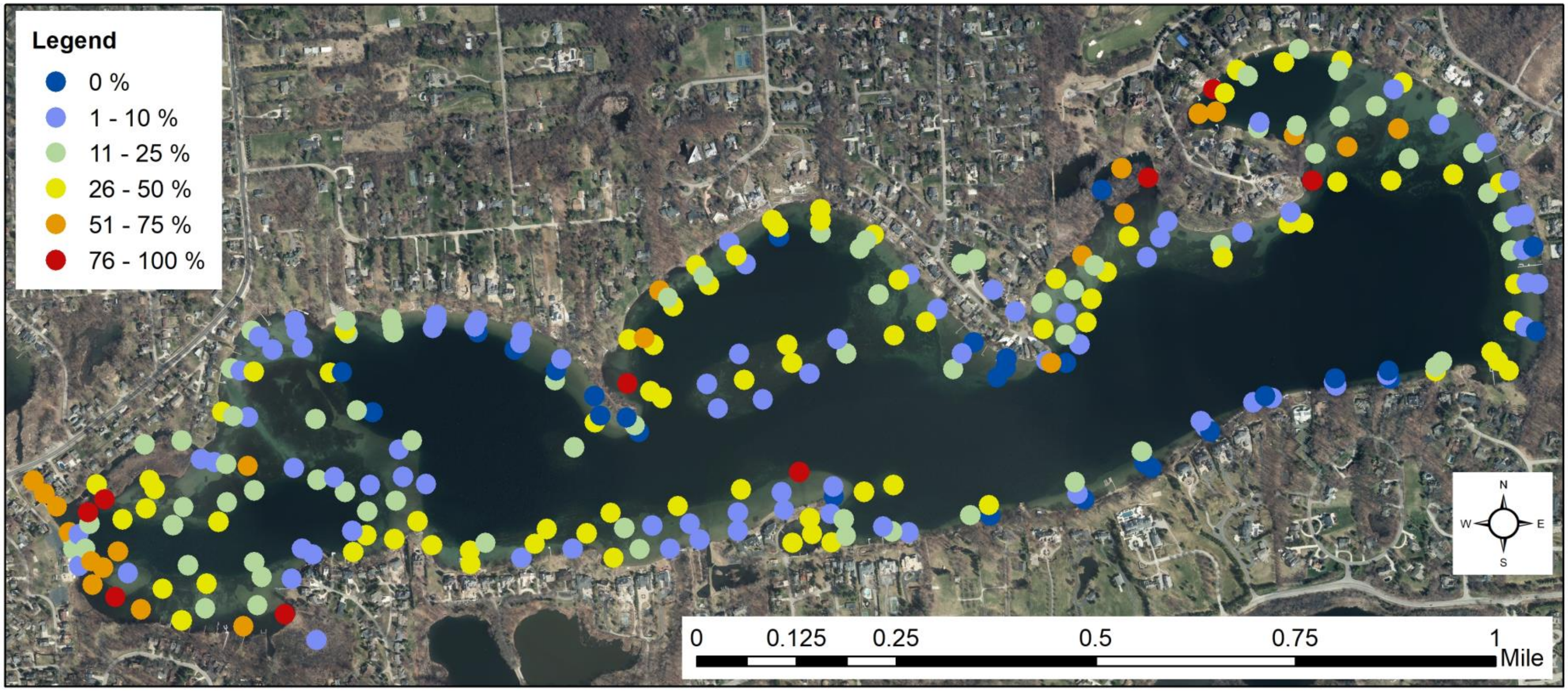

Figure 7 - Late season survey (August 22) vegetation 3D Density (a function of observed vegetation coverage, and height of all vegetation species)

Six important lake characteristics for defining aquatic plant conditions are presented here for the 2019 annual findings on the lake health (Table 2). 'Richness' metrics are counts of either species or morphology (plant structure) types that were observed in the lake. 'Index' metrics are scores indicative of different aspects of lake health. The range of possible index scores is 1 to 100 with a higher score indicating better conditions in relation to management goals assigned for your lake. Annual metrics are also compared here to last year's metrics and include:

- Species Richness – the number of species present in the lake
- BioD60 T2+ Index – a measure of the health of the plant community in your lake
- Morphological Richness – the number of morphology (plant structure) types present in the lake
- MorphoD26 Index – reflects the habitat value of vegetation for fish and other aquatic animals
- Vegetation Quality Index – examines the lake coverage of desirable versus undesirable species
- PNL Index2 – provides a value depicting the density and distribution of nuisance vegetation in your lake

Table 2 - 2019 LakeScan™ Metric Results

LakeScan™ Metric	Score Category	Useful in Describing Conditions For:	2019 Score	2018 Score	Management Goal
Species Richness	Biodiversity	Ecosystem Health	27	17	-
BioD60 T2+ Index	Biodiversity	Ecosystem Health	76	36	50
Morphological Richness	Structural Diversity	Fish Habitat	16	14	-
MorphoD26 Index	Structural Diversity	Fish Habitat	83	70	50
Vegetation Quality Index	Nuisance Condition	Ecosystem Health	46	42	50
PNL Index2	Nuisance Condition	Recreation	33	61	50

(Red scores indicate improvements are needed; yellow indicate marginal conditions; green are desirable)

Table 3, below, shows how the same six metrics have changed over previous years.

Table 3 - LakeScan™ Metrics Results History

Year	Species Richness	BioD60 T2+	Morpho. Richness	MorphoD26	Veg. Quality Index	PNL Index2
2019	27	76	16	83	46	33
2018	17	36	14	70	42	61
2017	19	49	13	70	52	30
2016	19	48	12	51	41	97
2015	17	43	11	58	42	N/A

(Red scores indicate improvements are needed; yellow indicate marginal conditions; green are desirable)

Species present in the lake are shown in Table 4. 'T Value' is a value ranging from 1 to 4 that is assigned to each species, where 1 represents a species highly likely to require treatment and 4 represents a species highly unlikely to require treatment. ‘Morpho. Type’ is the category of plant shape describing the species. 'Frequency' represents the percentage of survey sites (AROS) where a given species was found. 'Dominance' represents the degree to which a species is more numerous than its competitors. ‘PNL’ is a value that ranges from 0 to 3 that incorporates plant species and plant height in the water column with in-field observations of species location within the lake and in-lake structures.

Table 4 - Aquatic Plant Species Observed in 2019

Common Name	Scientific Name	T Value	Morpho. Type	Frequency	Dominance	PNL*
Eurasian Watermilfoil Hybrid	*Myriophyllum spicatum x sibiricum*	1	1	58.6%	13.3%	1 or 3
Green/Variable Watermilfoil	*Myriophyllum verticillatum L. or Myriophyllum heterophyllum Michaux*	2	1	1.7%	0.0%	0 or 2
Common Bladderwort	*Utricularia vulgaris L.*	3	3	3.7%	0.6%	0 or 2
Coontail	*Ceratophyllum sp.*	2	4	8.1%	0.3%	0 or 2
Elodea	*Elodea sp.*	2	5	6.4%	0.4%	0 or 2
Naiad	*Najas sp.*	2	7	12.9%	0.5%	0 or 2
Chara	*Chara sp.*	4	8	79.3%	43.3%	0 or 2
Bird's Nest Stonewort	*Tolypella intricata*	4	8	3.1%	0.1%	0 or 2
Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	1	8	41.7%	8.1%	1 or 3
Curly Leaf Pondweed	*Potamogeton crispus L.*	1	10	10.2%	0.4%	1 or 3
Water Star Grass	*Zosterella dubia (Jacq.) Small*	2	10	0.7%	0.0%	0 or 2
Purple Loosestrife (sub)	*Lythrum salicaria L.*	3	10	6.8%	0.8%	1 or 3
Swamp Loosestrife	*Decodon verticillatus*	4	10	4.1%	0.3%	0 or 2
Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	2	11	1.7%	0.3%	0 or 2
American Pondweed	*Potamogeton nodosus Poiret*	3	12	1.4%	0.2%	0 or 2
Variable Pondweed	*Potamogeton graminius L.*	3	13	67.1%	5.2%	0 or 2
Illinois Pondweed	*Potamogetion illinoensis Morong*	3	13	0.3%	0.0%	0 or 2
White Stem Pondweed	*Potamogeton praelongus Wulfen*	3	13	2.7%	0.0%	0 or 2

Common Name	Scientific Name	T Value	Morpho. Type	Frequency	Dominance	PNL*
Sago Pondweed	*Stuckenia sp.*	2	16	22.4%	0.9%	0 or 2
Thin Leaf Pondweed	*Potamogeton sp.*	4	16	3.1%	0.1%	0 or 2
Wild Celery	*Vallisneria americana Michaux*	2	17	58.3%	5.4%	0 or 2
Sparganium	*Sparganium sp.*	4	17	11.9%	0.9%	0 or 2
Flowering Rush	*Butomus umbellatus L.*	4	18	1.0%	0.0%	0 or 2
Rush	*Juncus pelocarpus Meyer [f. submersus Fassett]*	4	19	11.9%	5.0%	0 or 2
Waterlily	*Nymphaea sp.*	2	21	34.6%	13.3%	0 or 2
Spadderdock	*Nuphar sp.*	2	21	3.7%	0.5%	0 or 2
Thin and Floating Leaf Pondweed	*Potamogeton sp.*	3	15	0.7%	0.1%	0 or 2

**PNL can either be one number or the other for each species in each survey site (AROS) and this value depends on plant height in the water column and location within the waterbody*

Figure 8 shows the distribution of aquatic plant coverage by T Value over different surveys. The Combined Annual (VS S) analysis represents a combination of the seasonal surveys, both the early season survey (VS 3) and the late season survey (VS 5). T - 1 species are usually very weedy and create the greatest nuisance conditions and are therefore most likely to be targeted for suppression by a variety of means. T - 2 species are occasional nuisance species and may be targeted for control or suppression in some circumstances. T - 3 species are not targeted for control but occasionally require treatment for some growth management. T - 4 species are protected from impact from any management activity.

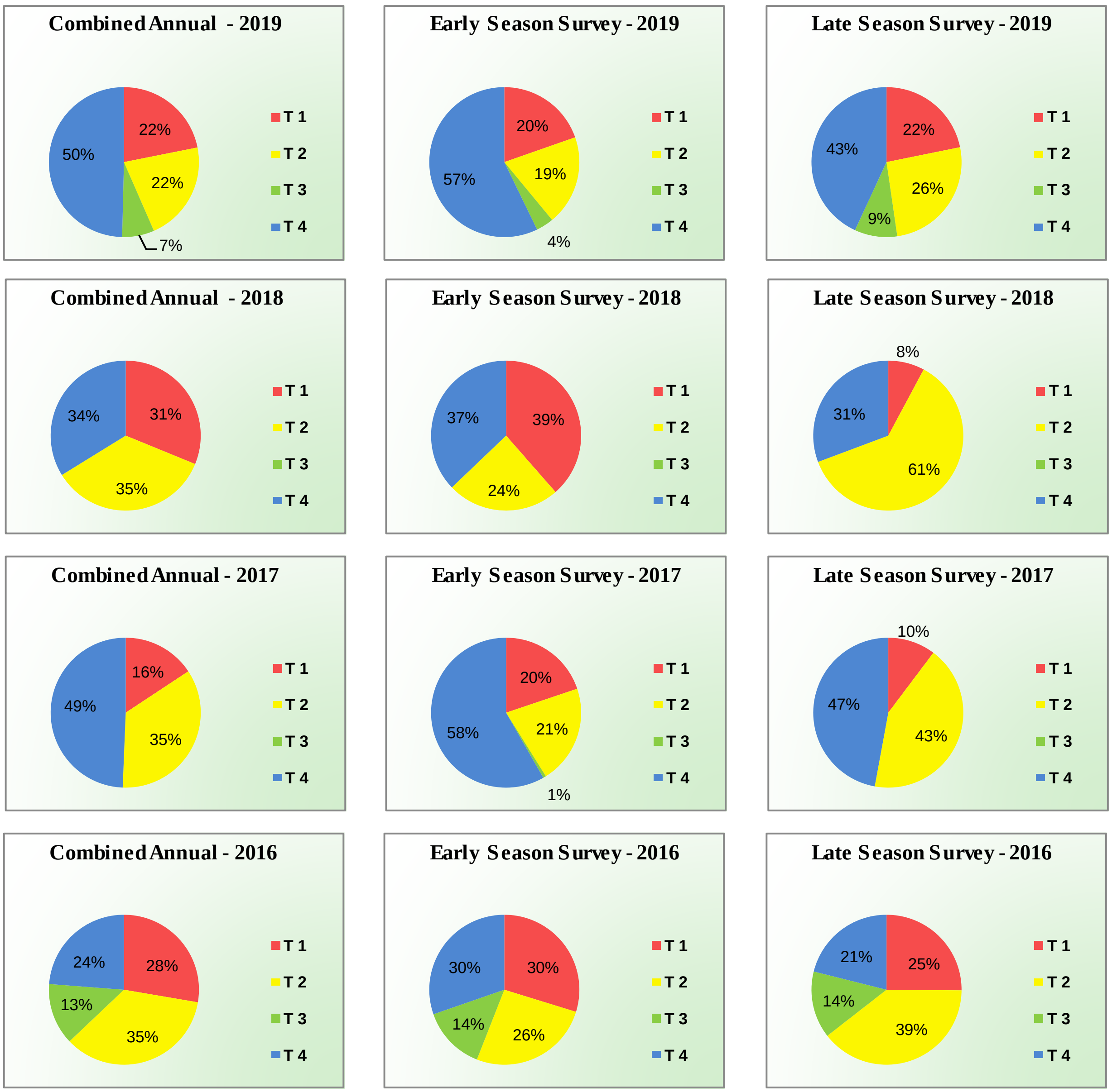

Figure 8 - Distribution of aquatic plant coverage by T Value comparing combined, early-season, and late-season surveys from 2016 – 2019.

Category 750 – Lake Management

There are several species that typically become a nuisance in Michigan's inland lakes (See Appendix B). These species are usually targeted for very selective control to prevent them from becoming an aesthetic or recreational nuisance and to protect desirable plants that are part of lake floras. This section includes an analysis on nuisance conditions in the lake, as well as a description of any management actions that were taken. Information on the extent and locations of nuisance species are included in Figures 9 – 15.

Upper Straits Lake is currently host to all three of the most notorious aquatic weeds species found in many of the inland lakes in the Great Lakes region. All of these invasive species are <u>not</u> native to Michigan inland lakes but have been present at nuisance levels in many lakes for decades. A watermilfoil hybrid, referred to as ebrid watermilfoil, has been a dominant nuisance in Upper Straits lake for decades. Nuisance levels are particularly acute in some of the bays and channels that adjoin the lake. Another of the notorious three species, curly leaf pondweed, has been a minor co-dominant weed with ebrid watermilfoil in some years. Starry stonewort is the most recent of the three exotic invasive species to invade the lake and is found in many AROS (~ ½) throughout most parts of the lake. It has typically been observed at nuisance levels in the canals, small bays and along the southwestern shoreline of the lake. Flowering rush is another non-native, or exotic species that is found in Upper Straits Lake. It is a notorious weed in some other States but does not seem to grow to extreme nuisance levels in most Michigan lakes. It is conspicuously present in many AROS but does not currently grow to unequivocal nuisance levels. Some native pondweeds grow to nuisance levels in some of the shoreline areas where they can obstruct boat traffic and interfere with swimming. New State regulatory policies will greatly limit what can be done to manage nuisance native pondweed populations beginning in 2020.

Ebrid Watermilfoil: The ebrid watermilfoil in Upper Straits Lake only grows to extreme nuisance levels in some AROS, while it may be present at sub-nuisance levels in other AROS. Unfortunately, it was found at high AROS frequency level during a September review of lake conditions. It is not clear if it may expand to create greater nuisance conditions in the lake in 2020, or if this was merely temporary occurrence. However, given the mild winter of 2019/2020, a larger-scale treatment should be anticipated to be needed earlier than most years. Most of the lake should be selectively treated for milfoil and curly leaf pondweed control by mid-June. The total number of acres that require treatment could be more than has been required in recent years and costs could increase by 15%. Starry stonewort could also emerge early, because of the mild winter conditions. If this were to occur, starry stonewort could potentially suppress some of the nuisance milfoil production. Because of this uncertainty, a "pre-season" review of conditions will be conducted in late May to provide a determination of final treatment plans.

Curly Leaf Pondweed: Curly leaf pondweed production has been highly variable and unpredictable in Upper Straits Lake. A late May review of conditions will be necessary to understand the scope of nuisance conditions that might be caused by curly leaf pondweed in 2020. The same combination of herbicides and algaecides can be used to simultaneously control both ebrid watermilfoil and curly leaf pondweed, if the curly leaf pondweed emerges as a significant nuisance. It is extraordinarily easy to kill with a variety of aquatic herbicides.

Starry Stonewort: Starry stonewort has been present in nearby lakes for at least a decade. The bays and channels along the northern shore of the lake could quickly produce nuisance conditions in 2020.

Resident volunteers will be needed to make frequent observations in these areas since it is impossible to predict when nuisance conditions might suddenly appear. As soon as active and rapid growth is observed, plans should be made to treat the starry stonewort before biomass reaches untenable levels. Blooms can grow to extreme nuisance levels in less than 10 days.

Prescriptives: The species present in the lake in 2019 were tallied in a manner that was different from previous years. However, when the data is reconsidered, conditions in 2019 were still better than those tallied in 2018. The primary goal of the management program is to increase key lake quality metrics, such as biodiversity, because as these metric values improve, conditions in the lake will improve for all forms of recreation. Continued selective nuisance plant management is necessary to support good metric numbers and conditions for recreation and the aesthetic enjoyment of Upper Straits Lake.

The impact of the mild winter conditions of 2019/2020 will be significant. Ebrid watermilfoil is likely to become an extreme nuisance in earlier 2020 and is likely to emerge at nuisance levels in the bays and channels long before water temperatures will reach 65˚ at the sediment interface. This temperature minimum is necessary to have any reasonable expectation that a herbicide treatment outcome will be satisfactory by any measure. Even though ebrid watermilfoil is expected to emerge earlier in 2020 than most years, treatment should be held off until at least early June or later in the month. Starry stonewort is also likely to have benefited from these mild conditions and is also expected to appear at greater levels in 2020. Treatment areas and costs could rise by as much a 15% over the previous year levels. If the emergence of ebrid watermilfoil and starry stonewort would follow the same time-table as observed in most years, a mid-June treatment should be anticipated for both nuisance weeds. A late August treatment may be necessary to control the nuisance ebrid watermilfoil regrowth in shallow areas of the lake, and especially the bays and canals. Starry stonewort production may also constitute a nuisance in late July and require mitigation. Pondweed control is virtually prohibited by Michigan Department of Environment, Great Lakes, and Energy (EGLE) permitting policies, but given winter conditions, it is not likely to grow to nuisance level in 2020. If it should grow to nuisance levels, MI EGLE permit policies only allow treatment of native pondweeds that are no further than 100's from developed shorelines or in water depths less than 5' or the smaller of the two areas.

Perceived nuisance level (PNL) is determined at each AROS during vegetation surveys and is summarized in Table 5. PNL is a value that ranges from 0 to 3 that incorporates plant species and plant height in the water column with in-field observations of species location within the lake and in-lake structures (i.e. surrounds a dock, within the ski lane, in front of the public boat launch). Before a PNL is assigned, a species is determined to be either an ecological nuisance, a recreational nuisance, or both. An ecological nuisance is identified as a species that is invasive or non-native to Michigan that seriously threatens the biodiversity of the plant community, ecosystem functions, and overall stability of the lake ecosystem. Recreational nuisance is assigned to species that may impair or inhibit boat traffic or swimming ability at the time of the survey. Recreational nuisance can be assigned to both native and invasive/non-native species. PNL 0 is assigned to plant species that are native and do not create a recreational nuisance. PNL 1 indicates ecological nuisance species that do not pose a recreational nuisance. PNL 2 describes native plant species that are a recreational nuisance. PNL 3 indicates ecological nuisance species that also create a recreational nuisance. The maximum PNL value that is found at each AROS during all seasonal LakeScan™ surveys is used for this analysis. The total number of AROS acres is summed for each of the 3 PNL levels and the "no nuisance" AROS (PNL 0). The first column is the percentage of the total AROS acres that are assigned each PNL value. The total and species specific PNL summaries are presented in Figure 9 below.

Table 5 - AROS Perceived Nuisance Level Summary.

% Total AROS Acres	PNL Level	Perceived Nuisance Level Description	Total AROS Acres
27%	PNL 0	No Nuisance	29
33%	PNL 1	Ecological Nuisance	35
19%	PNL 2	Equivocal Nuisance	20
21%	PNL 3	Obvious Nuisance	22

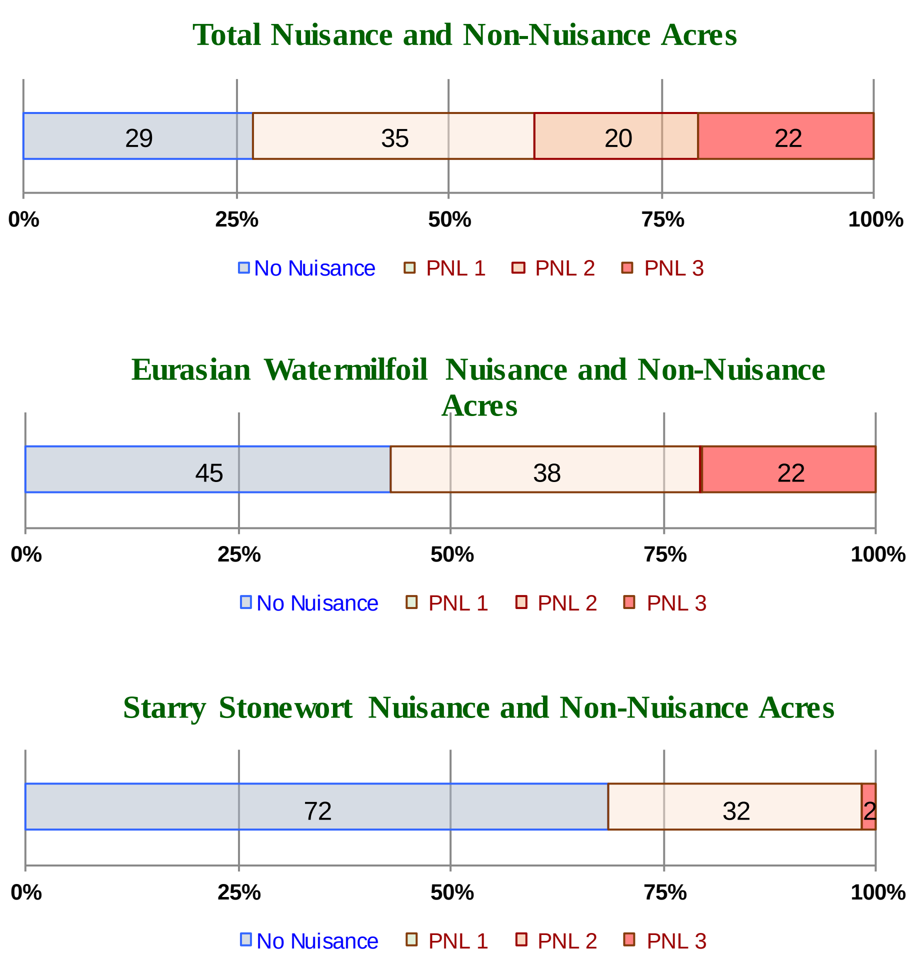

Figure 9 - Total and Species-specific Perceived Nuisance Levels.

Mapped data on nuisance species are reported individually below in Figures 10-15 using coverage, a combination of density and distribution observations from the vegetation surveys.

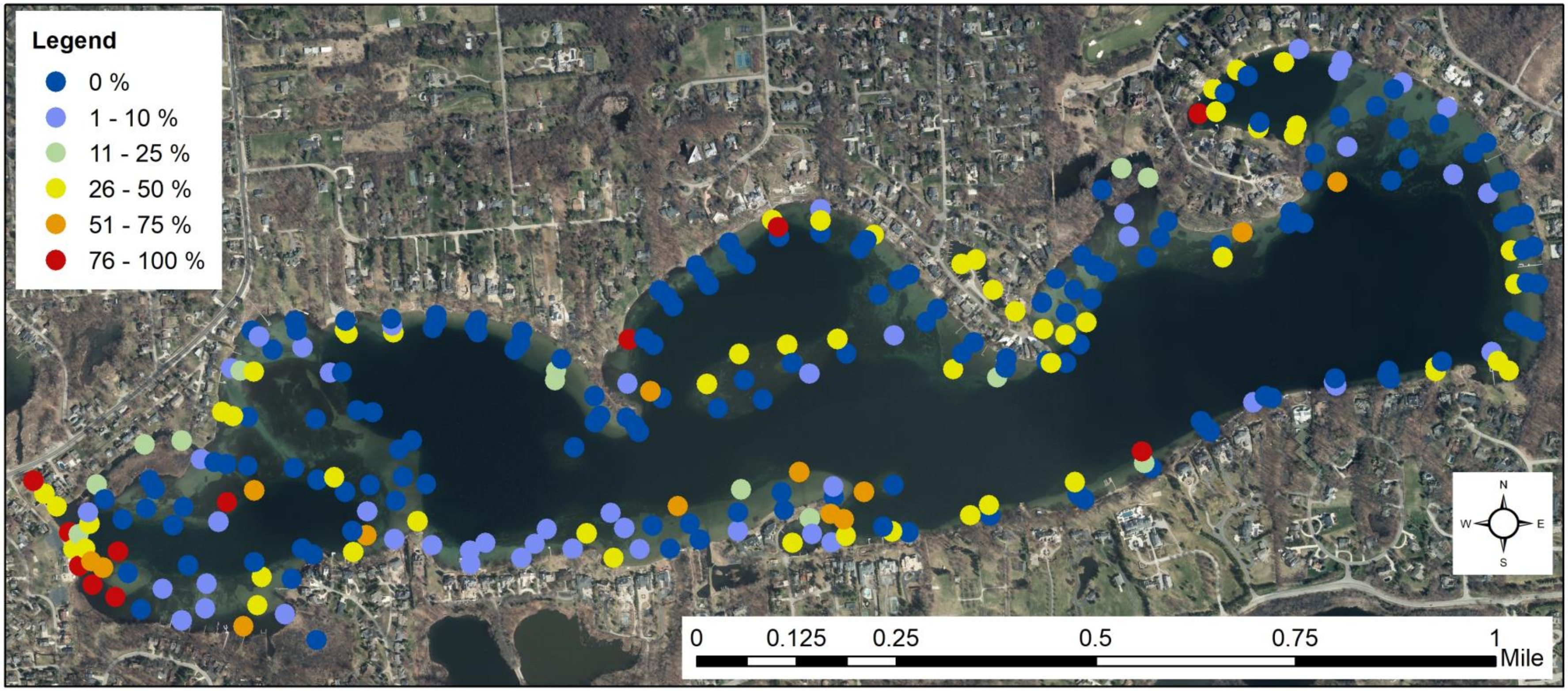

Figure 10 - Early season (June 28) Eurasian Watermilfoil and Hybrids coverage (a combination of the LakeScan™ density and distribution observations)

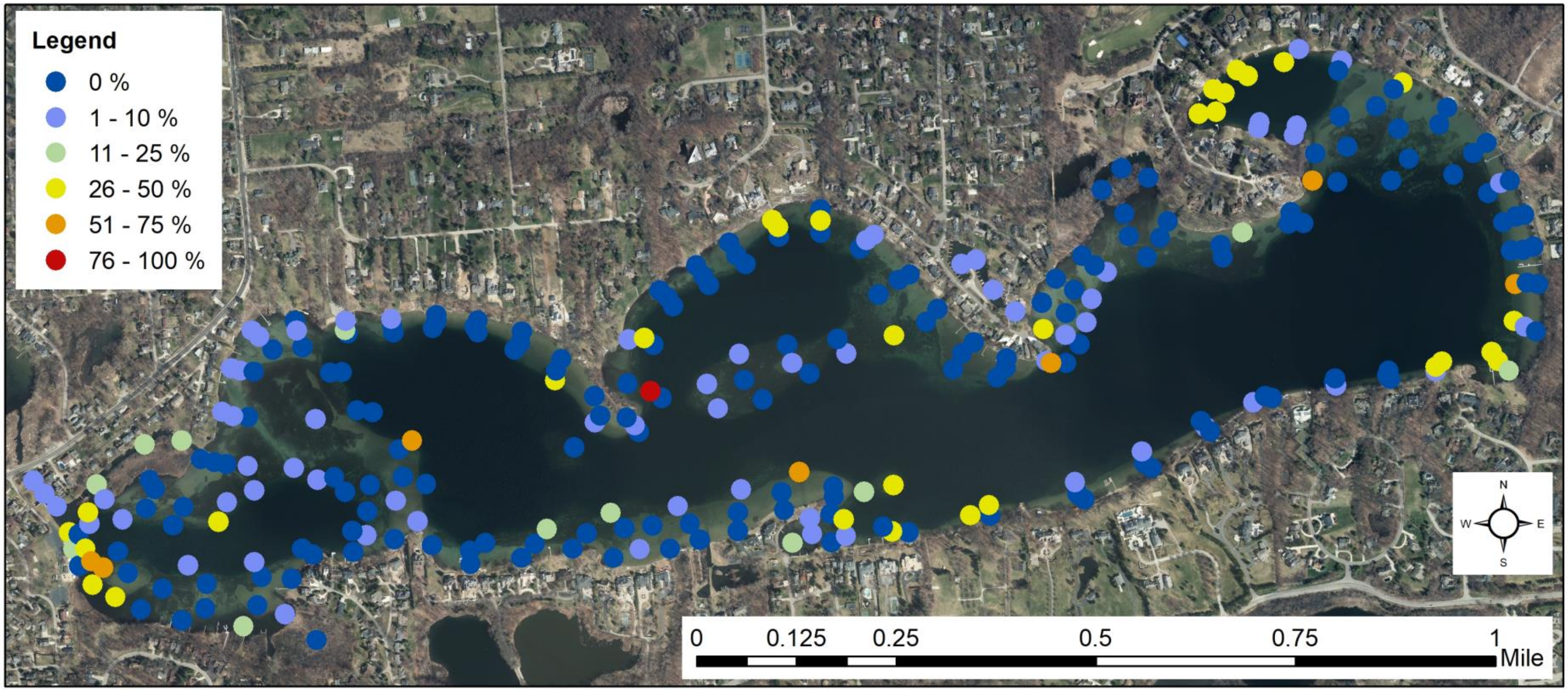

Figure 11 - Late season (August 22) Eurasian Watermilfoil and Hybrids coverage

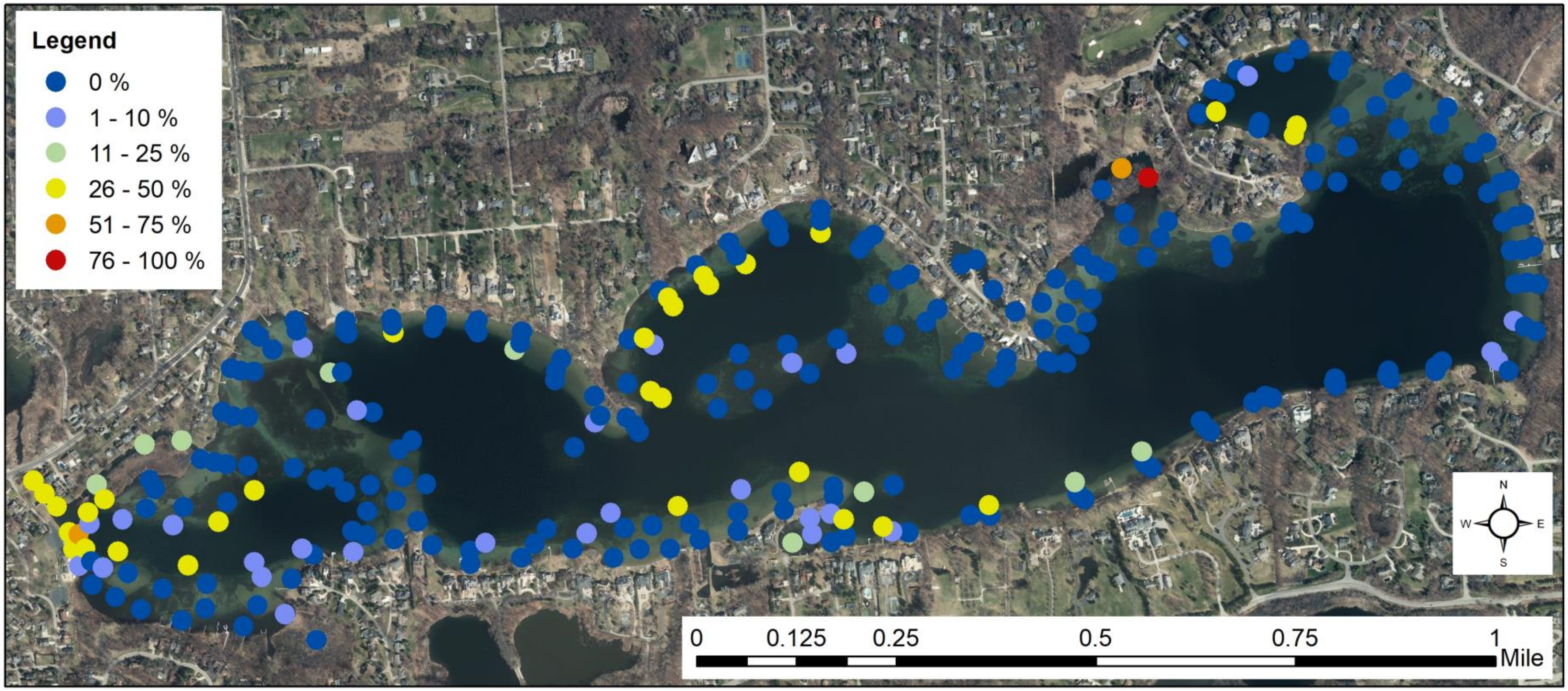

Figure 12 - Early season (June 28) Starry Stonewort coverage

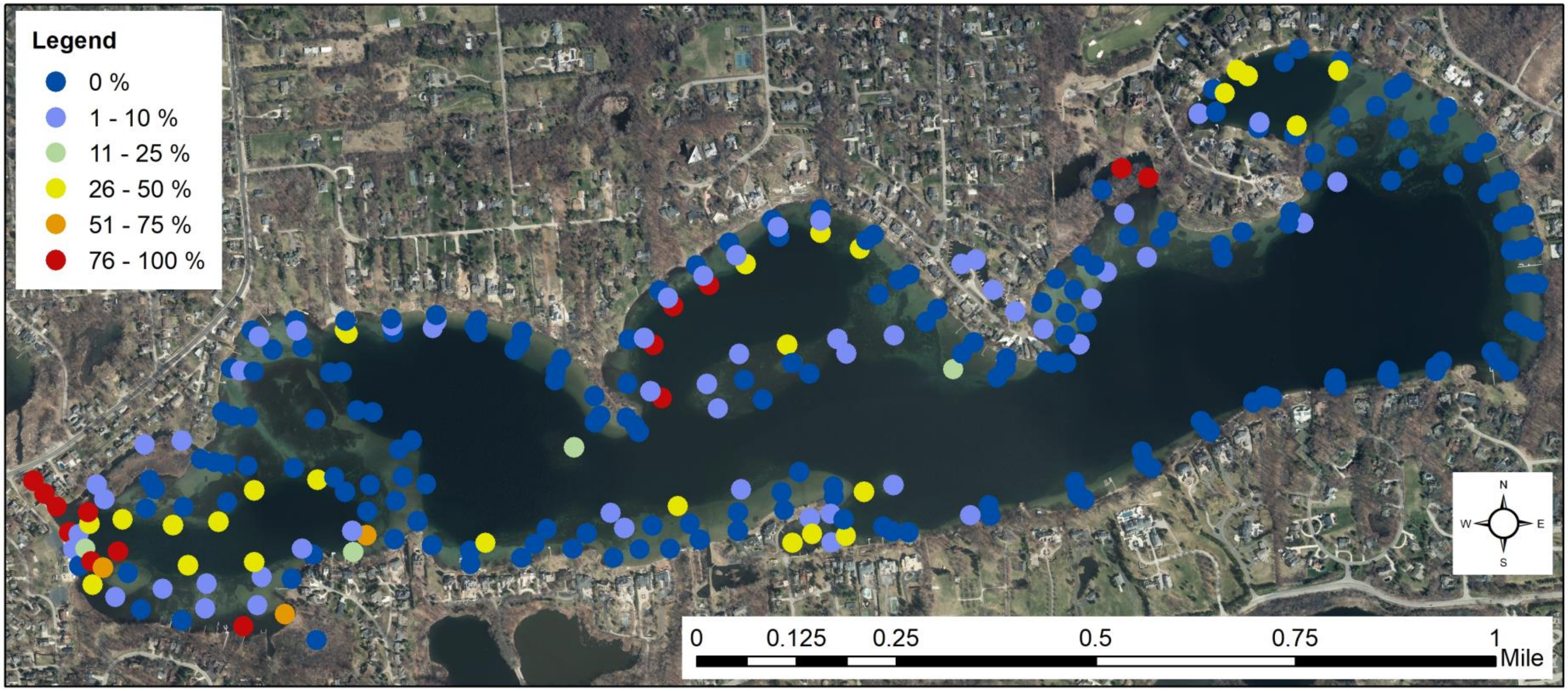

Figure 13 - Late season (August 22) Starry Stonewort coverage

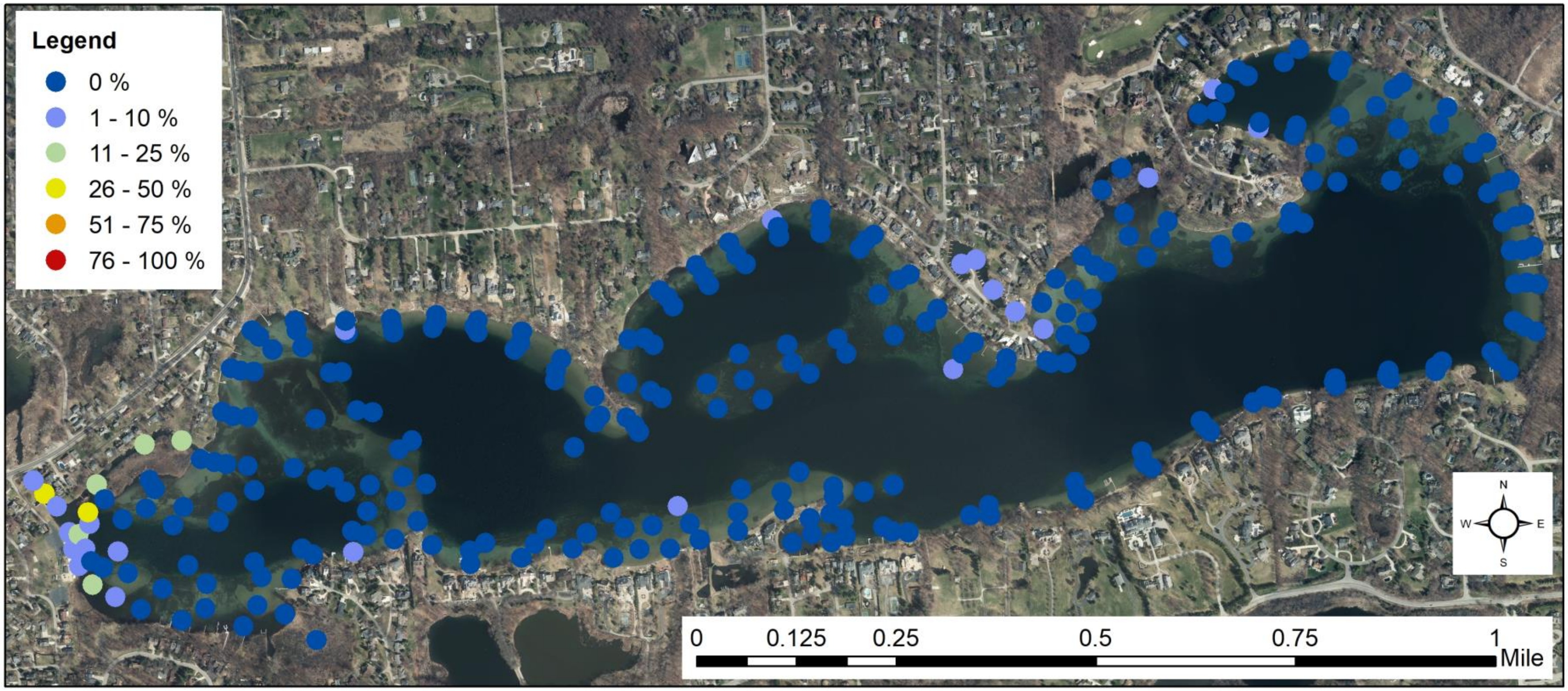

Figure 14 - Early season (June 28) Curly Leaf Pondweed coverage

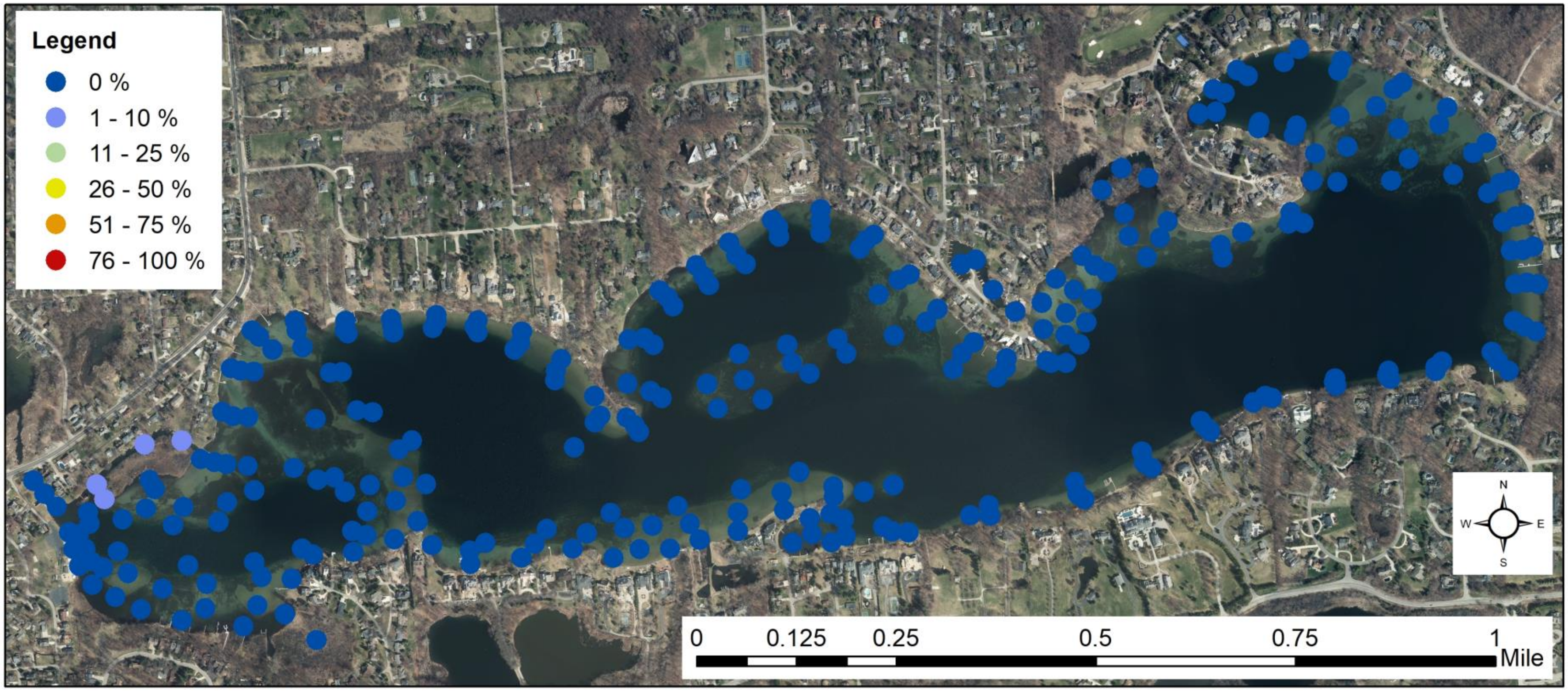

Figure 15 - Late season (August 22) Curly Leaf Pondweed coverage

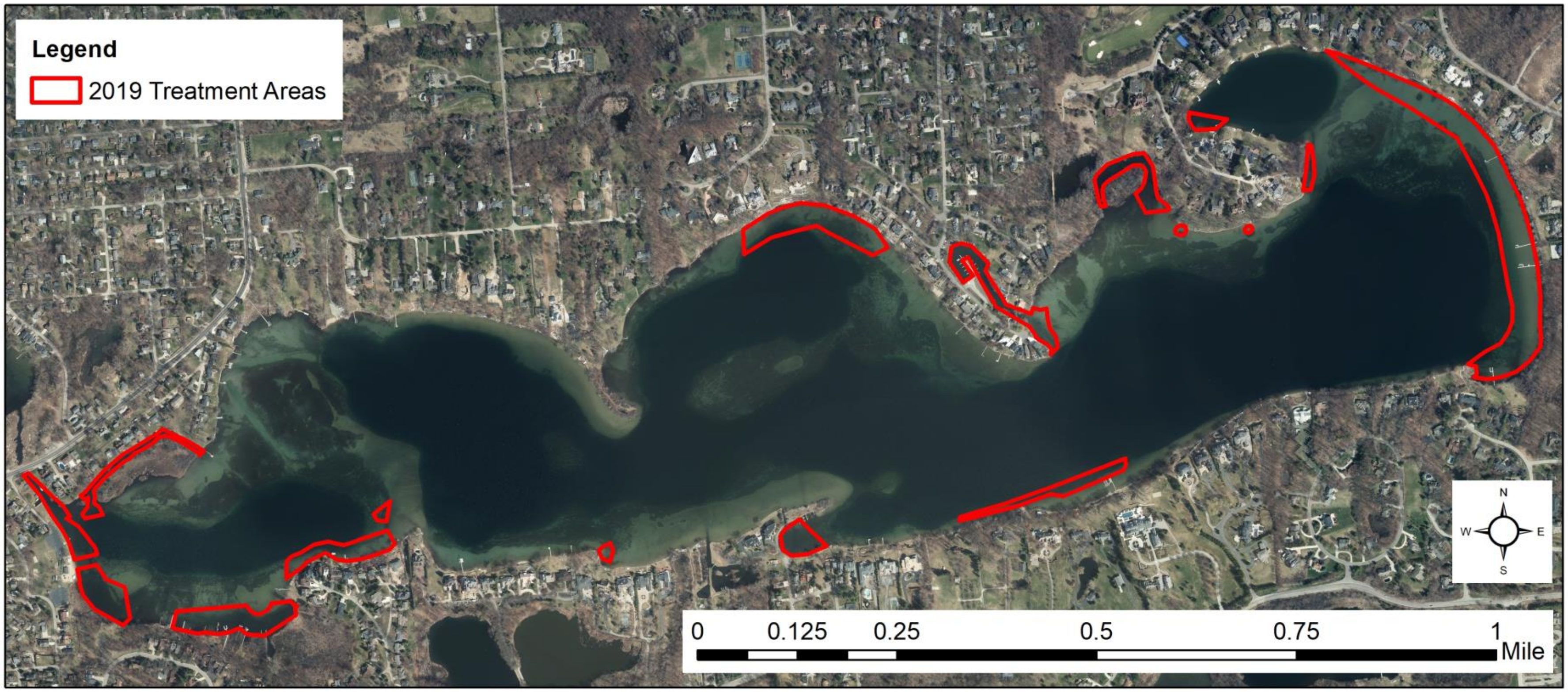

Figure 16 - 2019 Treatment Map

References

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Appendices

Appendix A: Blue Green Algae

Blue green algae blooms are becoming increasingly common in Michigan. Blooms can appear as though green latex paint has been spilled on the water, or resemble an oil slick in enclosed bays or along leeward shores (Figure A1). Blue green algae blooms are usually temporal events and may disappear as rapidly as they appear. Blue green algae blooms are becoming more common for a variety of reasons; however, the spread and impact of zebra mussels has been closely associated with blooms of blue green algae.

Figure A1: Example blue green algae images from the 2019 LakeScan™ field crew.

Blue green algae are really a form of bacteria known as cyanobacteria. They are becoming an important issue for lake managers, riparian property owners and lake users because studies have revealed that substances made and released into the water by some of these nuisance algae can be toxic or carcinogenic. They are known to have negative impacts on aquatic ecosystems and can potentially poison and sicken pets, livestock, and wildlife. Blue green algae can have both direct and indirect negative impacts on fisheries. Persons can be exposed to the phytotoxins by ingestion or dermal absorption (through the skin). They can also be exposed to toxins by inhalation of aerosols created by overhead irrigation, strong winds, and boating activity.

Approximately one half of blue green algae blooms contain phytotoxins, and this is determined through lab testing. It is recommended that persons not swim in waters where blue green algae blooms are conspicuously present. Specifically, persons should avoid contact with water where blooms appear as though green latex paint has been spilled on the water, or where the water in enclosed bays appears to be covered by an “oil slick”. Pets should be prevented from drinking from tainted water. Since blue green algae toxins can enter the human body through the lungs as aerosols, it is suggested that water containing obvious blue green algae blooms not be used for irrigation in areas where persons may be exposed to it.

Blue green algae are not very good competitors with other, more desirable forms of algae. They typically bloom and become a nuisance when resources are limiting or when biotic conditions reach certain extremes. Some of the reasons that blue green algae can bloom and become noxious are listed below:

TP and TN: The total phosphorus (TP) concentration in a water resource is usually positively correlated with the production of suspended algae (but not rooted plants, i.e. seaweed). Very small amounts of phosphorus may result in large algae blooms. If the ratio of total nitrogen (TN) to total phosphorus is low (<20), suspended algae production may become nitrogen limited and noxious blue green algae may dominate a system because they are able to "fix" their own nitrogen from atmospheric sources. Other common and desirable algae are not able to do this.

Free Carbon Dioxide: All plants, including algae, use carbon dioxide in photosynthesis. Alkalinity, pH, temperature, and the availability of free carbon dioxide are all closely related and inter-regulated in what can be referred to as a lake water buffering system. Concentrations of these key water constituents will shift to keep pH relatively constant. Carbon dioxide is not very soluble (think about the bubbles of carbon dioxide that escape soda pop). The availability of this essential substance can be in short supply in lake water. Many blue green algae contain gas "bubbles" that allow them to float upward in the water column toward the water surface where they can access carbon dioxide from the atmosphere. Consequently, blue green algae that can float have a competitive advantage in lakes where carbon dioxide is in low supply in the water. This is also why blooms form near the surface of the water.

Biotic Factors: Zebra mussels and zooplankton (microscopic, free-floating animals) are filter feeding organisms that strain algae and other substances out of the lake water for food. Studies have shown that filter-feeding organisms often reject blue green algae and feed selectively on more desirable algae. Over time, and given enough filter feeding organisms, a lake will experience a net loss in "good" algae and a gain in "bad" blue green algae as the "good" algae are consumed and the "bad" algae are rejected back into the water column. This is one of the most disturbing factors associated with the invasion and proliferation of zebra mussel. Lakes that are full of zebra mussel may not support the production of "good" algae and experience a partial collapse of the system of "good" algae that are necessary to support the fishery.

Appendix B: Common Species of Concern

Eurasian Watermilfoil and Hybrids (Ebrids):

Background: Anecdotal evidence suggests that hybrid milfoil has been found in Michigan inland lakes for a long time (since the late 1980's). University of Connecticut professor Dr. Don Les was the first to determine that there were indeed, Eurasian watermilfoil and northern watermilfoil hybrids in Michigan based on samples sent to his Connecticut lab by Dr. Douglas Pullman, Aquest Corp. in 2003. Experience has proven that it is usually not possible to determine whether the milfoil observed is either Eurasian or hybrid genotype (Figure B1). However, because they play such similar roles in lake ecology, they are simply "lumped together" and referred to collectively as ebrid milfoil. Ebrid milfoil is a very common nuisance in many Michigan inland lakes.

Management: Lake disturbance, such as weed control, unusual weather, and heavy lake use can destabilize the lake ecosystem and encourage the sudden nuisance bloom of weeds, like ebriid milfoil. Ebrid milfoil is an ever-present threat to the stable biological diversity of the lake ecosystem. Species selective, systemic herbicide combinations have been used to successfully suppress the nuisance production of ebrid milfoil and support the production of a more desirable flora. However, it is becoming much more resistant to all herbicidal treatment. This resistance can be easily defeated with the use of microbiological system treatments. This is done with only a minor increase in cost. Milfoil community genetics are dynamic, not static, and careful monitoring is needed to adapt to the expected changes in the dominance of distinct milfoil genotypes. Some of these genotypes may be more herbicide resistant than others and treatment strategies must be adjusted to remain effective in different parts of the lake.

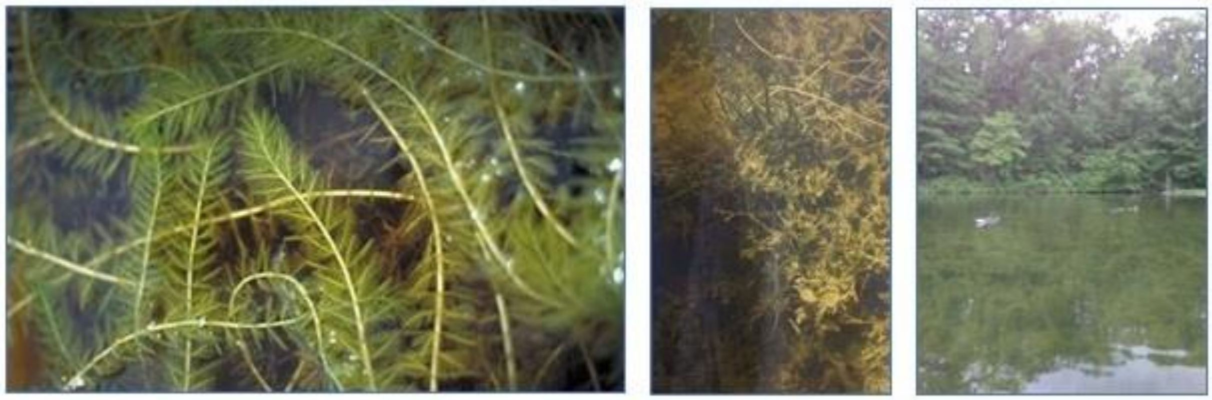

Figure B1: Example Eurasian Watermilfoil and Hybrids images from the 2019 LakeScan™ field crew.

Starry Stonewort

Background: Starry stonewort invaded North American inland lakes after becoming established in the St. Lawrence Seaway/Great Lakes system. It has probably been present in Michigan's inland lakes since the late 1990's but was not positively identified until 2006 by Aquest Corporation in Lobdell Lake, Genesee County, MI. Since then, it has been discovered in lakes all over Michigan. It is truly an opportunistic species that will bloom AND crash and impose a very significant and deleterious impact on many ecosystem functions. Bloom and crash events are unpredictable and can happen at any time of the year. In some years starry stonewort can become a horrendous nuisance while it can be inconspicuous in others. It can comingle with other similar species and be very difficult to find when it is not blooming (Figure B2).

Management: Starry stonewort is capable of growing to extreme nuisance levels. It is easy to kill, but very difficult to treat. It grows so rapidly that mechanical methods of control are strongly discouraged. First, starry stonewort can regrow so rapidly after cutting that it can be nearly impossible to keep up with the nuisance production of this fast-growing plant. Mechanical controls can also help to disperse and spread starry stonewort throughout inland lakes when the plant is fragmented. It is even more disturbing that desirable plant species are more susceptible to mechanical control strategies than starry stonewort and mechanical controls can thereby select for the dominance of starry stonewort over a much more desirable flora. Starry stonewort is susceptible to most selective algaecides, but the dense mats of vegetation are very difficult to penetrate and provide reasonable biocide exposure. Consequently, multiple algaecide applications may be required to "whittle down" dense starry stonewort growth if the mats reach sufficient height.

 

Figure B2: Example starry stonewort images from the 2019 LakeScan™ field crew.

Pondweeds

Background: The pondweeds are possibly the most common plant found in Michigan inland lakes. They are a very large and diverse group of aquatic plants (Figure B3). All but one of the common Michigan Pondweeds are native or endemic. Curly leaf pondweed is the only exception and is native to Europe and Asia and is thought to have arrived in North America near the turn of the 20th century. It can become an extreme nuisance in the early spring but generally declines on its own by mid-summer. Curly leaf pondweed can create problems such as recreational nuisances, ecological nuisances by outcompeting native species and reducing light availability to other plant species, and decreases fish spawning habitat. It seems to have been a more common nuisance in previous decades and has been less aggressive in recent years. However, it can still bloom near Memorial Day and become a terrible nuisance in some lakes – in some years.

More often than not, pondweeds are thought to be desirable because of the support they provide for a wide range of aquatic animals, including fish. Many of the most common species are considered to be promiscuous and hybrids, resulting from a variety of species crosses, abound in Michigan inland lakes. Although native pondweeds are generally considered to be desirable and rarely grow to nuisance levels, they have been observed to grow to increasingly nuisance levels during the past decade. There is no definitive answer or reason why the native pondweeds are emerging as increasingly weedy and problematic plants in inland lakes. However, it is not difficult to imagine that the pondweeds have evolved to become more aggressive after 40 years of competition with aggressive ebrid milfoils, curly leaf pondweed, and starry stonewort - and steadily increasing cultural disturbance in Michigan. Today, pondweed production must be carefully monitored. Management action may be required when particular pondweed biotype becomes invasive and threatens the diversity of large plant communities.

Management: Nuisance pondweed growth is very difficult to manage. However, it can become necessary to manage these native species when they interfere with reasonable navigation and compromise ecosystem stability. It is recommended that the production of various pondweeds be closely monitored before any specific management intervention strategy or technology (MIST) be considered for management. Most native pondweeds are much more resistant to herbicides than other plant species. Mechanical harvesting is generally recommended for nuisance pondweed management, despite the lack of selectivity. There are contact herbicides that can be used to suppress nuisance native pondweeds, but the use of these agents needs to be precisely prescribed and executed or worse problems can emerge.

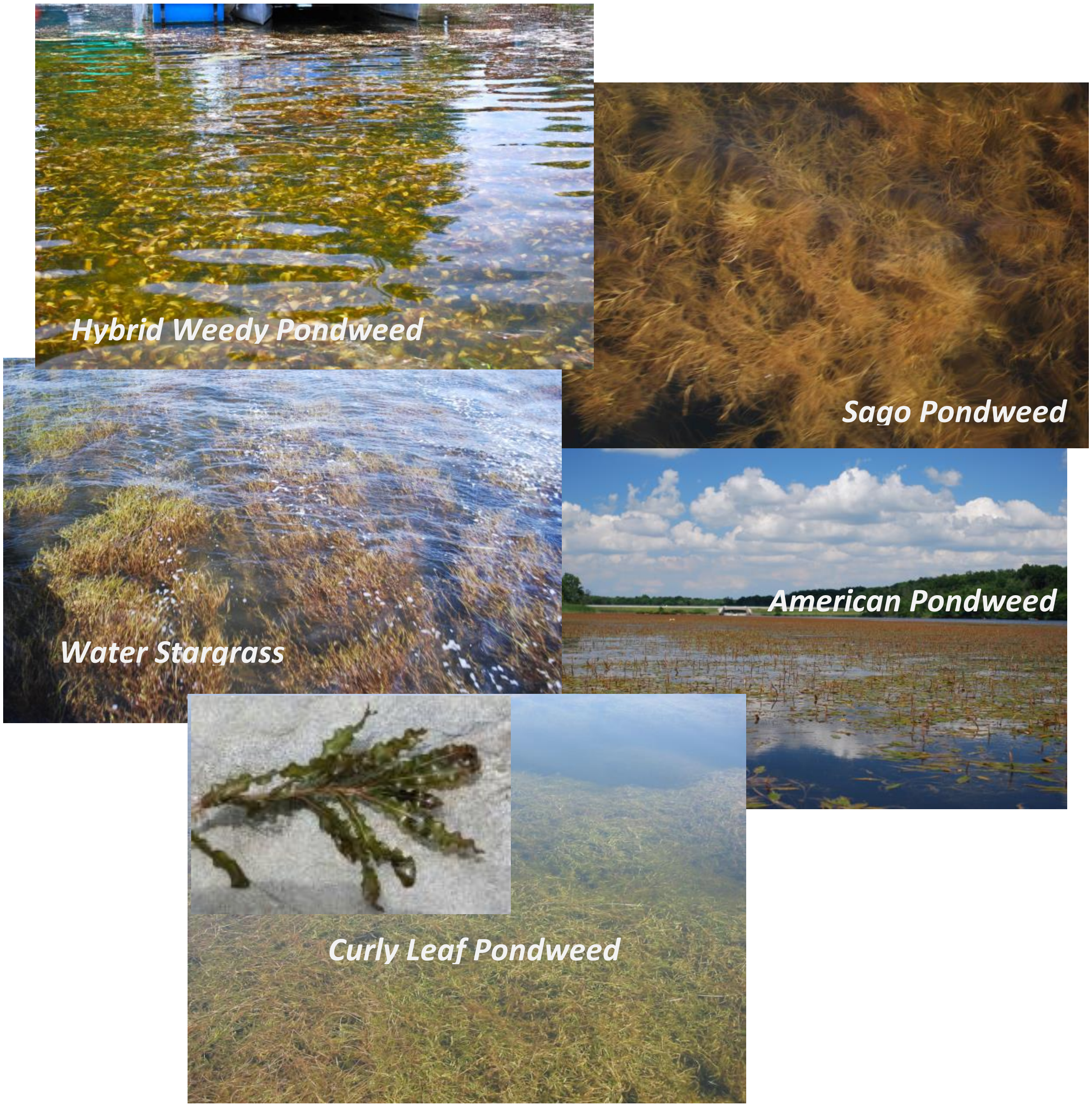

Figure B3: Example pondweed images from Dr. G. Douglas Pullman.