INTRODUCTION

Photo 1. Deer Lake, Lincoln County.

Deer Lake, Lincoln County, is a 156-acre headwater spring-fed lake with a max depth of 62 feet. The outlet from Deer Lake flows through a channel into the remaining Rice River Reservoir via Bridge Lake. In early July 2008, Onterra ecologists located a small bed of Eurasian water milfoil near the Deer Lake outlet while completing a survey as a part of a management planning project. The WDNR awarded the Deer Lake District an AIS Rapid Response Grant to aid in the costs associated with the newly discovered aquatic invasive species. After completing a lake management plan, the Deer Lake District (DLD) was awarded AIS-Early Detection and Response funds to address a pioneer population of EWM, which expired in 2014. The DLD was awarded a WDNR Aquatic Invasive Species Education, Prevention & Planning (AIS-EPP) grant in December 2015 which provides funding for three years (2016-2018) of EWM monitoring and control planning. This report discusses the monitoring and control activities conducted during the second year (2017) of this three year grant funded project.

MONITORING METHODOLOGIES

A set of EWM mapping surveys were used within this project to coordinate and qualitatively monitor the hand-harvesting efforts (Figure 1). The first monitoring event on Deer Lake in 2017 was the ESAIS Survey. This late-spring/early-summer survey provides an early look at the lake to help guide the hand-harvesting management to occur on the system. Following the hand-harvesting, Onterra ecologists completed the Late-Summer EWM Peak-Biomass Survey, the results of which serve as a post-treatment assessment of the hand-harvesting. The hand-removal program would be considered successful if the density of EWM within the hand-removal areas was found to have decreased from the ESAIS Survey to the Late-Summer Peak-Biomass Survey.

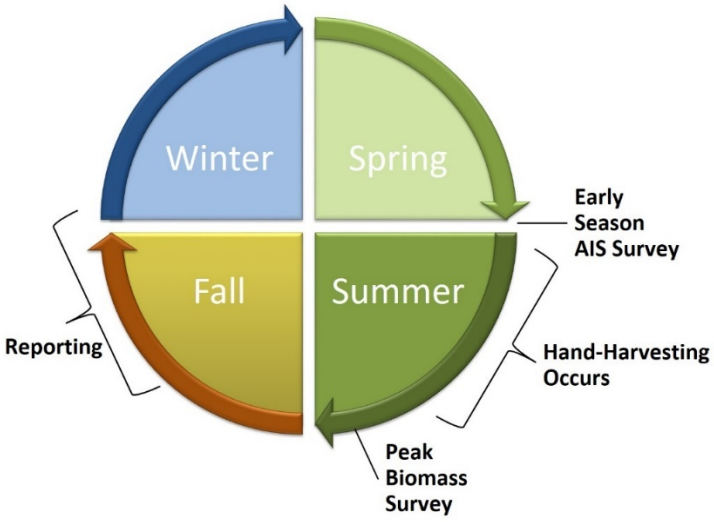


Figure 1. Project timeline diagram.

EARLY SEASON AIS SURVEY RESULTS (PRE-HAND-HARVESTING)

On June 7, 2017, Onterra ecologists conducted the ESAIS Survey on Deer Lake. During the survey, the EWM population was mapped using sub-meter GPS technology by using either 1) point-based or 2) area-based methodologies. Large colonies >40 feet in diameter are mapped using polygons (areas) and were qualitatively attributed a density rating based upon a five-tiered scale from *Highly Scattered* to *Surface Matting*. Point-based techniques were applied to EWM locations that were considered as *Small Plant Colonies* (<40 feet in diameter), *Clumps of Plants*, or *Single or Few Plants*.

During the survey, the field crew noted excellent viewing conditions with clear water, full sun and light winds. The EWM plants were found to be growing up to near the surface of the water in most instances. A similar amount of EWM was mapped as compared to the previous survey conducted in 2016, with several colonies requiring mapping with area-based methodologies (Map 1). From this survey, the highest concentrations of EWM were identified and prioritized for hand removal. Sites C-17, D-17, E-17 and F-17 contained the densest colonies of EWM known to be in the lake and were given first priority for control efforts with three additional sites with less dense EWM colonies given second priority (Map 1). Onterra provided the spatial data from this survey to the DLD and the professional hand harvesting firm to aid the control efforts.

HAND-HARVESTING MANAGEMENT ACTIONS

The DLD contracted with DASH, LLC to conduct professional hand-harvesting of EWM in 2017. Professional divers conducted hand-harvesting activities on July 16-18, 2017 spending a combined total of 21.95 diver hours on the lake. Hand-harvesting efforts were undertaken at five sites in the lake and resulted in approximately 1,032 pounds of EWM harvested (Table 1). Additional details of the hand harvesting efforts as reported by DASH, LLC are included as an appendix to this report (Appendix A).

Table 1. Deer Lake, 2017 professional hand-harvesting activities. Adapted from DASH, LLC Final Report (Appendix A). Site locations shown on Map 1.

Site	Pounds harvested	Time (hours)
C-17	158	4.5
D-17	423	6.7
F-17	169	4
E-17	246	5.25
G-17	36	1.5
Total	**1032**	**21.95**

The Deer Lake District has a well-organized group of trained volunteers capable of conducting hand-harvesting and monitoring of EWM in Deer Lake. Volunteer diving efforts have typically been directed at known EWM occurrences around the lake with a focus on areas mapped as a *small plant colony* or smaller. On five occasions during the summer of 2017, volunteers performed visual surveys from a watercraft in search of EWM occurrences not previously marked during professional surveys. Survey crews are able to record any newly located EWM occurrences on a district owned Garmin GPS unit that was loaded with the spatial data of the EWM population mapped during the June ESAIS

survey conducted by Onterra. Volunteer members conducted SCUBA or snorkeling dives on two occasions during the 2017 season to hand-harvest EWM in the lake and removed approximately 15 pounds of EWM during each dive. Volunteer harvesting occurred within known areas along the western side of the lake including within a *highly scattered* colony that was mapped in June south of Site D-17. Two divers harvested EWM while other volunteers supported the dive team from additional watercraft and collected any floating EWM fragments that could be found.

LATE-SUMMER PEAK-BIOMASS SURVEY RESULTS (POST HAND-HARVESTING)

The Late-Summer EWM Peak-Biomass Survey was conducted on September 14, 2017 to qualitatively assess the hand harvesting efforts as well as to understand the peak growth (peak-biomass) of the EWM population throughout lake. The field crews noted good conditions during the survey with some clouds and modest winds. At the time of the survey, water levels in Deer Lake were approximately 1.5 feet lower than the level that was maintained for much of the summer. Figure 2 compares the hand-harvesting sites before and after the hand removal efforts.

Site A-17 contained a *scattered* colony of EWM as well as point-based EWM occurrences including *single or few plants, clumps of plants and a small plant colony* during the June survey. This site was given a lower priority for hand harvesting actions in 2017 in order to focus on sites that had an EWM population that was smaller or denser. The late-summer survey found the EWM population in Site A-17 to be approximately the same with the portion of the lake previously mapped with point-based methods having expanded slightly and merged with the larger *scattered* colony (Figure 2).

Site B-17 contained a *scattered* colony of EWM during the June survey. This site was also given a lower priority for control efforts in 2017 compared to other sites. Professional harvesting was not reported to have taken place within site B-17 during 2017. Native aquatic plants dominated site B-17 at the time of the late-summer survey. A reduction of EWM was observed in 2017 in site B-17 such that only *single or few plants* or *clumps of plants* were observed (Figure 2).

Site C-17 contained a colony consisting of *dominant* EWM during the June survey and was designated as a first priority harvesting site. Professional hand-harvesting efforts yielded 158 pounds of vegetation removed from the site over the course of 4.5 hours (Table 1). Following the removal efforts, no EWM was located in the site during the late-summer survey. A large population of native milfoil was observed within the site at the time of the late-summer survey. The removal efforts in 2017 at site C-17 were highly successful in controlling the EWM population within the site.

Site D-17 contained a *highly dominant* colony of EWM during the June survey and was designated as a first priority site for control actions. Professional hand-harvesting efforts yielded 423 pounds of EWM removed from the site over the course of 6.7 hours (Table 1). After the hand-removal efforts, a *highly scattered* colony of EWM was located in the site. Native aquatic vegetation including northern watermilfoil was dominant within the site at the time of the survey. With the reduction in EWM density observed in site D-17, control expectations were met within the site in 2017.

Site E-17 contained a *scattered* and *dominant* EWM colony during the June survey and was given first priority for control actions in 2017. Professional hand-harvesting efforts yielded 246 pounds of EWM removed from the site over the course of 2.25 hours (Table 1). The late-summer survey indicated the

EWM population within site E-17 was reduced to a *clump of plants* as well as a few *single or few plant* occurrences. The EWM removal efforts conducted in site E-17 resulted in successful control during 2017.

Site F-17 was designated as a first priority harvest site after a *dominant* EWM colony was mapped in the site during the June 2017 survey. Professional hand-harvesting efforts totaled four hours with a yield of 169 pounds of vegetation removed from the site (Table 1). The late-summer survey found the EWM population to have decreased in the site such that point-based mapping methods were used rather than area based mapping. The EWM population consisted of two small plant colonies, a clump of plants and numerous single or few plants occurrences (Figure 3). Successful control of EWM was achieved in site F-17 during 2017.

G-17 was designated as a lower priority site after the June mapping survey during which a *scattered* EWM colony as well as some *clumps of plants* and *single or few plants* was observed in the site. After visiting each of the higher priority harvesting sites, professional divers were able to spend 1.5 hours at site G-17 and harvested 36 pounds of vegetation (Table 1). The late-summer survey showed a reduction of EWM in site G-17 such that no colonized areas were mapped within the site with only *clumps of plants* or *single or few plant* occurrences being present (Figure 3). Successful control of EWM was achieved in site G-17 during 2017.

During the peak-biomass survey, water levels were high enough such that the survey boat was able to access some portions of the shallow bays along behind the sandbars in the lake. A relatively low amount of EWM occurrences were located in these shallow bays and often consisted of point-based occurrences in which the plants were growing up to the surface of the water. The largest colonized area of EWM located in the lake was a *scattered* colony approximately 0.8 acres in size located on the northern end of the lake in the hand-harvest site A-17. One other low density (*highly scattered*) colony was located on the west side of the lake within and south of site D-17. Additional point-based occurrences consisting of *small plant colonies, clumps of plants* or *single or few plants* were located in sparsely within other areas of the lake (Map 2).

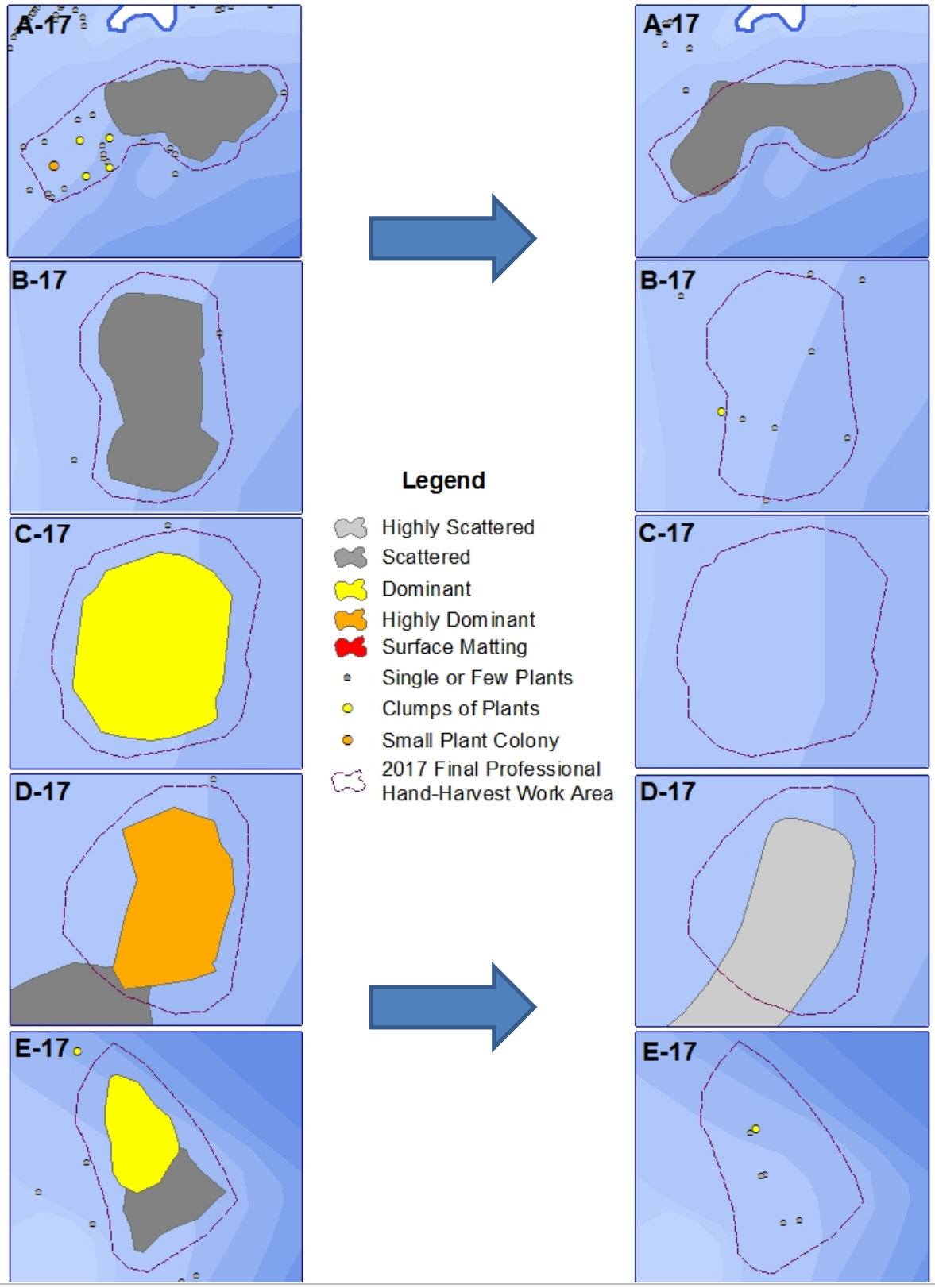


Figure 2. June 2017 pre- and September 2017 post-hand-harvesting EWM survey results in Deer Lake.

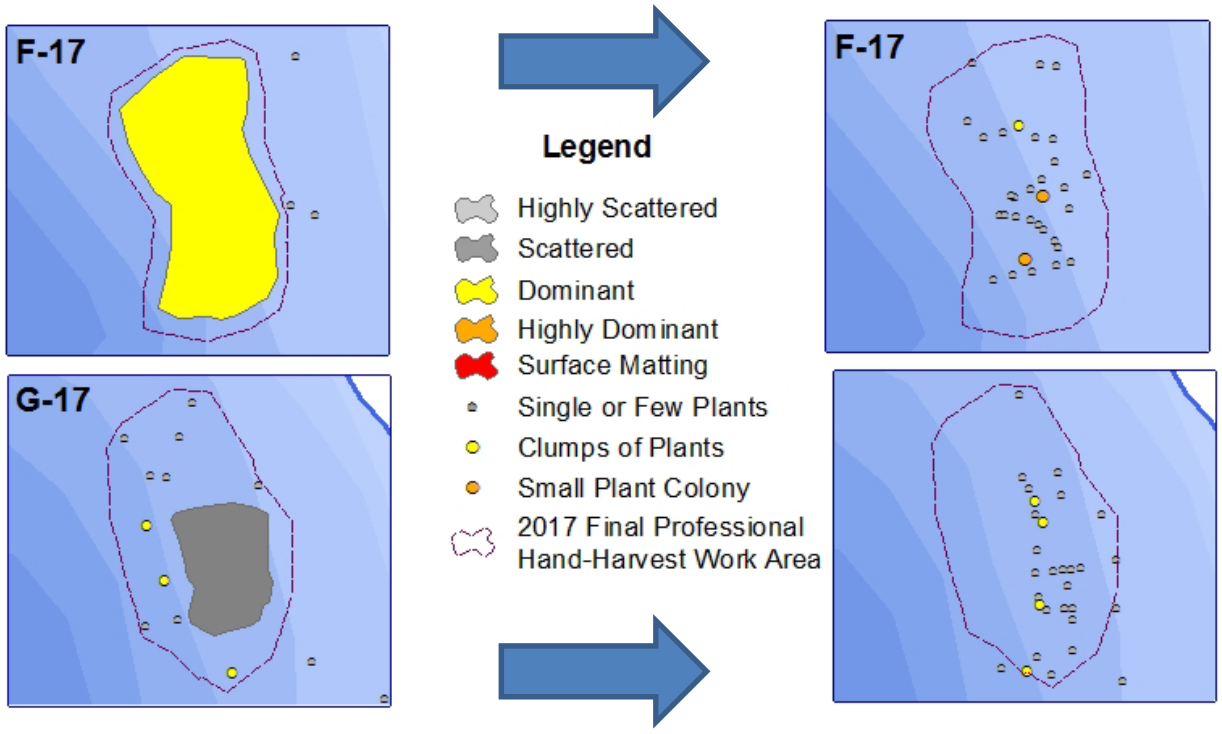


Figure 2- continued. June 2017 pre- and September 2017 post-hand-harvesting EWM survey results in Deer Lake.

CONCLUSIONS AND DISCUSSION

The 2017 EWM professional and volunteer based EWM hand-harvesting control program on Deer Lake met control objectives in each site in which efforts were undertaken. These sites will be revisited in 2018 to determine if re-growth or re-colonization of EWM is occurring. In many lakes, a coordinated hand-harvesting effort is able to slow the spread and population increase of EWM throughout the lake. Whether from control efforts or environmental factors or a combination of each, the EWM population was effectively controlled during 2017. Many Wisconsin lakes showed declines in aquatic vegetation during 2017 likely resulting from the record precipitation observed in the first half of the year. As reported by the Milwaukee Journal Sentinel, January 1 through July 31 was Wisconsin's wettest year on record (records date back 123 years). These climactic conditions can impact water clarity, water levels and flow, nutrient levels, etc. that need to be included as factors that impacted the aquatic plant population of Deer Lake.

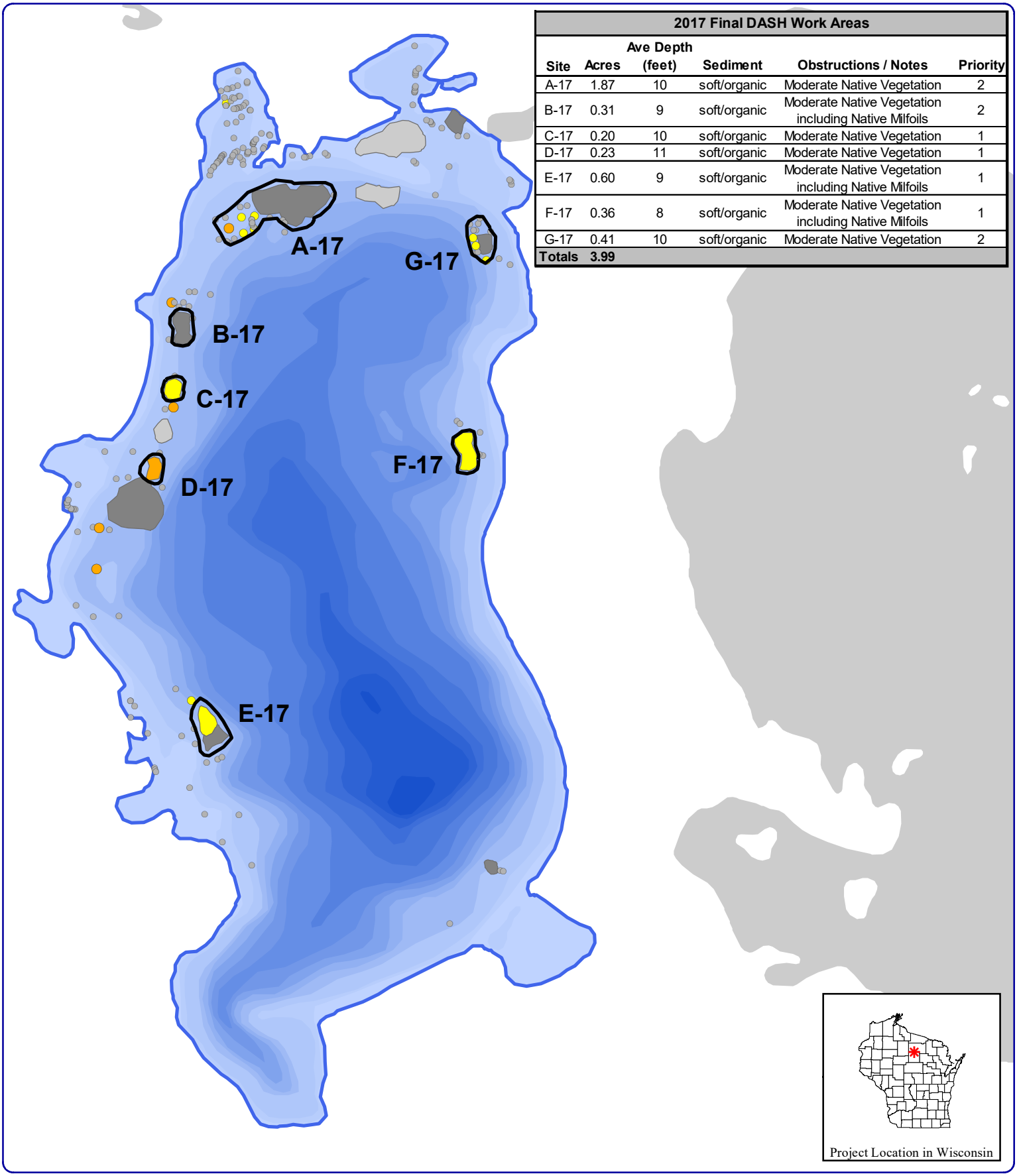
With the current known population of EWM in Deer Lake, the proposed 2018 control strategy does not include an herbicide treatment. Building on the successful hand removal efforts in recent years, it is recommended that a control strategy that focuses on utilizing hand-harvesting methods continue in 2018. The DLD owns a Garmin GPSMAP 78 capable of being supplied with basemaps created by Onterra. Onterra will conduct an EWM mapping survey during June 2018 and provide the DLD with a basemap containing the survey findings which will help guide the harvesting activities.

The DLD is in the process of building and developing a District owned and operated Diver Assisted Suction Harvesting (DASH) unit with a hookah breathing system similar to what some professional

hand-harvesting firms deploy. A DASH system involves divers removing plants and feeding them into a suction hose for delivery to the deck of the harvesting vessel. The DASH methodology is considered a form of mechanical harvesting and thus requires a WDNR-approved permit. DASH is thought to be more efficient in removing target plants than divers alone and is believed to limit fragmentation during the harvesting process. While the DASH system can be beneficial in some situations, it is often thought to be too cumbersome for use when EWM is loosely scattered over large areas. In this situation, the DASH boat needs to be continually repositioned and it may simply be easier for a non-tethered diver to remove these occurrences.

Having the option of deploying harvesting teams that can use traditional diving or suction harvesting methods will greatly aid the DLD in being capable of addressing a variety of work areas in Deer Lake ranging from isolated individual plants to larger, dense colonies of EWM. Based on the EWM population mapped in September 2017, hand harvesting utilizing DASH methodologies may be applicable to several areas in the lake including the largest known concentration of EWM mapped on the northern end of the lake. Depending on the operating status and diver availability of the DLD owned DASH system, the DLD may want to consider contracting with a professional harvesting firm in 2018 to increase the total amount of effort devoted to EWM control. Any hand-harvesting activities should be tracked where harvesters record where, when, and how much effort (time) that are spent conducting these activities.

A Late-Summer EWM Peak-Biomass Survey would be conducted towards the end of the growing season to evaluate any 2018 hand-harvesting efforts, as well as to propose a control strategy (hand-removal and/or herbicide treatment) for 2019.



2017 Final DASH Work Areas					
Site	Acres	Ave Depth (feet)	Sediment	Obstructions / Notes	Priority
A-17	1.87	10	soft/organic	Moderate Native Vegetation	2
B-17	0.31	9	soft/organic	Moderate Native Vegetation including Native Milfoils	2
C-17	0.20	10	soft/organic	Moderate Native Vegetation	1
D-17	0.23	11	soft/organic	Moderate Native Vegetation	1
E-17	0.60	9	soft/organic	Moderate Native Vegetation including Native Milfoils	1
F-17	0.36	8	soft/organic	Moderate Native Vegetation including Native Milfoils	1
G-17	0.41	10	soft/organic	Moderate Native Vegetation	2
Totals	**3.99**				

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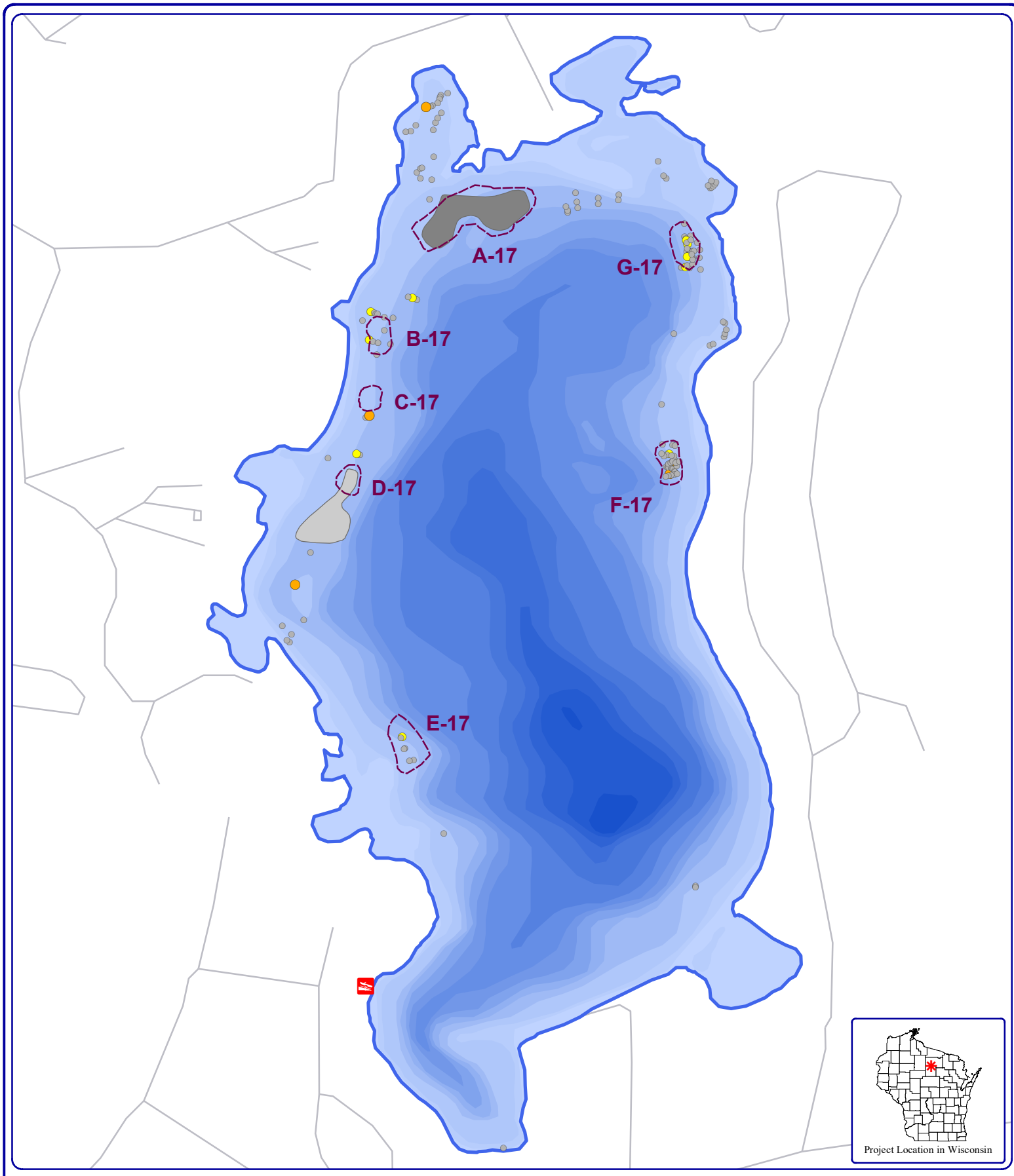
Sources:
Data: Roads and Hydro: WDNR
Aquatic Plant Survey: Onterra, 2017
Map Date: June 21, 2017
Filename: DeerLincoln_EWM_June17.mxd

Legend

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting *(None)*
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2017 Final Professional Hand-Harvest Work Area

Map 1
Deer Lake
Lincoln County, Wisconsin

June 2017 EWM Survey Results & Final Professional Hand-Removal Strategy



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Sources:
Roads and Hydro: WDNR
Aquatic Plant Survey: Onterra, 2017
Map Date: September 19, 2017
Filename: DeerLincoln_EWM_PB_Sept17.mxd

Legend

- Highly Scattered
- Scattered
- Dominant *(none)*
- Highly Dominant *(none)*
- Surface Matting *(none)*
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2017 Final Professional Hand-Harvest Work Area

Map 2
Deer Lake
Lincoln County, Wisconsin

September 2017 EWM Survey Results