Aquatic Restoration Consulting, LLC

December 2, 2020

Dudley Pond Association
P.O. BOX 5114
Wayland, MA

Dear Dudley Pond Association,

Thank you for choosing Aquatic Restoration Consulting, LLC (ARC) to perform an aquatic macrophyte survey at Dudley Pond. The attached report provides a summary of the macrophyte conditions encountered on September 18, 2020 and a recommended path forward based on the Dudley Pond Association's goal to implement a long-term management strategy reducing reliance on herbicides. In the attached report, we utilize the results of our macrophyte survey and limited review of prior reports to conceptualize possible pilot studies to assess non-herbicide control of target species (milfoil and tapegrass).

Please let me know if you have any questions or comments regarding this report. Thank you for the opportunity to assist with plant management in Dudley Pond.

Sincerely,

Wendy C. Gendron, CLM
Aquatic Ecologist

Report For:
Dudley Pond Association
Wayland, Massachusetts

Dudley Pond
Aquatic Macrophyte Survey - 2020

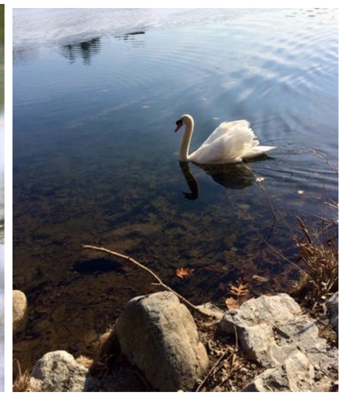

Photo source: Living on Dudley Pond, By Judy Currier Apr 11, 2018
https://patch.com/massachusetts/wayland/living-dudley-pond

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November 2020

Table of Contents

Tables

Figures

Introduction

Aquatic Restoration Consulting, LLC (ARC) performed an in-lake aquatic macrophyte survey of Dudley Pond on September 18, 2020. The intent of the survey was to document the aquatic plant community and relative abundance of plants. The nuisance invasive species known to inhabit the pond are Eurasian watermilfoil (*Myriophyllum spicatum*) and curly leaf pondweed (*Potamogeton crispus*). The Dudley Pond Association (Association) reports that tapegrass (*Vallisneria americana*) has become a nuisance and its abundance has greatly increased since first observed in 2010.

The Association and the Town of Wayland have employed several management strategies to control rooted aquatic plant growth dating back to 1968. Most of the early strategies employed the application of aquatic herbicides. In recent times, a combination of hand pulling and herbicides were used. Herbicide treatments began targeting tapegrass as well as Eurasian watermilfoil (EWM) in 2016. SOLitude Lake Management recently treated the pond in August 2019 using ProcellaCOR, a selective systemic herbicide efficacious on Eurasian watermilfoil (EWM) but not shown to be effective on tapegrass.

This report provides a summary of findings of the macrophyte survey and provides a recommended plan to assess the efficacy on non-chemical treatment strategies that could be used as part of long-term EWM and tapegrass management.

In-Lake Plant Survey

Methods

ARC conducted a plant survey on September 18, 2020. ARC scientists observed submerged aquatic plants using an Aqua-Vu® underwater camera and recorded data based on a modified semi-quantitative point interception method (Madsen and Wersal, 2017)[1]. This systematic design establishes predefined observation points based on a grid system. This methodology is best used for an overall assessment of the waterbody plant community. It is ideal for this application because the observer is more likely to encounter most of the species that exist within the lake. We established a grid with approximate 200-250 foot spacing between points. The point grid resulted in 104 observation points (Figure 1). By employing this method, observation points can be revisited in subsequent years to assess changes over time. At each point, we recorded:

- water depth using a graduated metal conduit for depths <10 feet (using the conduit reduces the depth interference by plants) and sonar in waters >10 ft
- estimated percent cover of all plants as measured by the areal extent of plants within an approximate two square meter visual area;
- estimated percent biovolume as measured by the height of the water column occupied by plants within the two square meter area.
- both cover and biovolume are estimated using a semi-quantitative (0-4) ranking system as follows:

0 = 0%	1 = to 1 - 25%,
2 = 26 - 50%,	3 = 51 - 75%, and
4 = 76 – 100%	

[1] Madsen, JD and RM Wersal. 2017. A review of aquatic plant monitoring and assessment methods. *Journal of Aquatic Plant Management*. 55:1–5

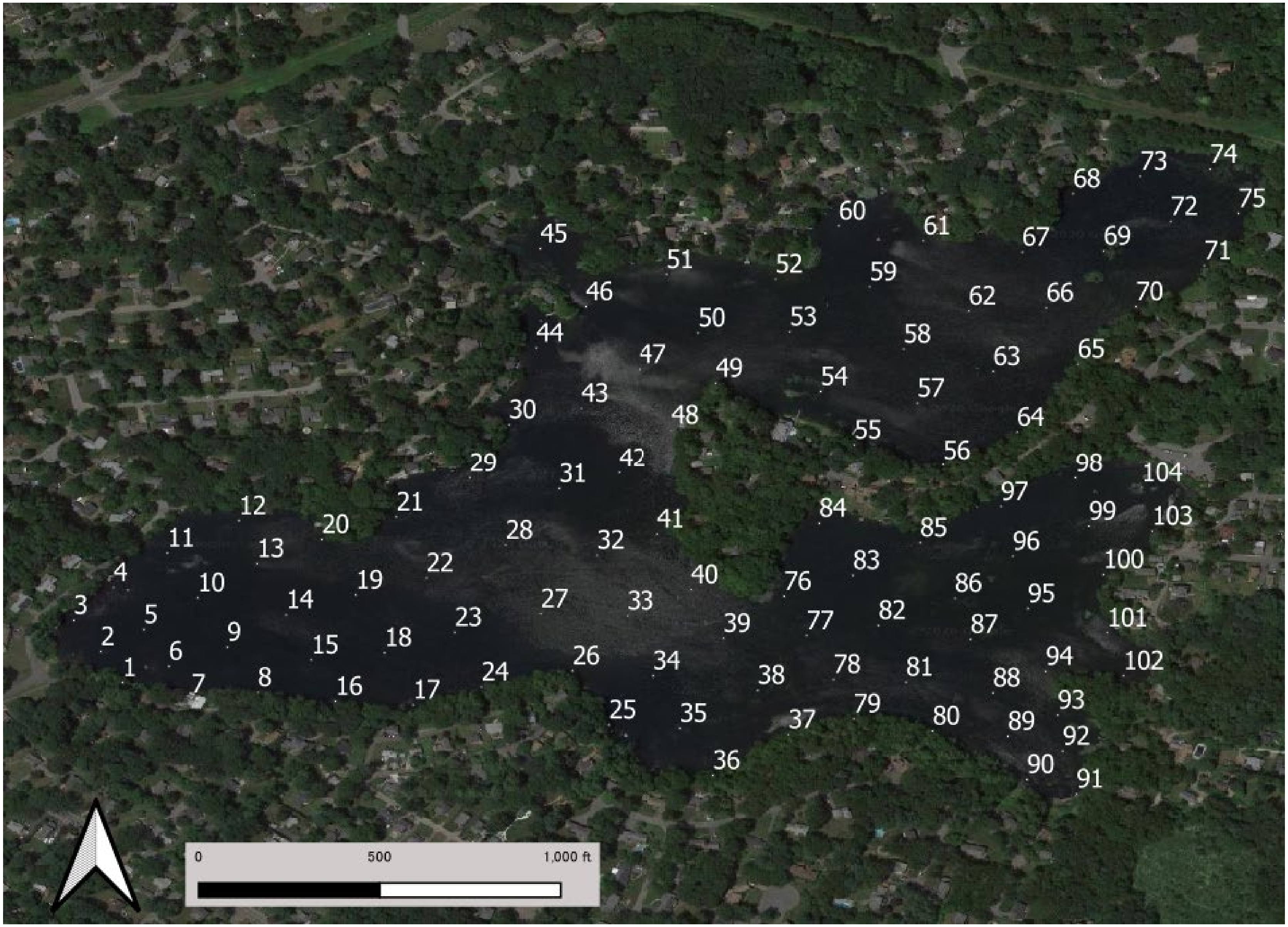

Figure 1. Dudley Pond Aquatic Plant Observation Points

- identified plants to the species level or to genus level for those that were not readily identifiable in the field. We estimated the density of all species present using categories of: Trace, Sparse, Moderate and Dense. We used a rake toss to verify the visual identification of plants and density observed with the Aqua-Vu®.

ARC utilized QGIS software to produce maps depicting plant cover, biovolume and species density maps for EWM and tapegrass. There are inherent error/precision limitations associated with biological surveys and data are an estimation of conditions at the time of the survey.

Results

Table 1 provides a listing of data collected at each observation point. Plants were observed at 77% of the observation points (80 out of 104). No plants were observed in water depths greater than 10 feet. Where observed, plant cover was greater than 50% (cover ranks 3 & 4) at 65 observation points, representing 63% of the total observation points containing plants (Figure 2). Biovolume, a representation of the portion of the water column occupied by plants, was high (rank 4) indicating that plants reached the water surface at about one quarter of the locations (23%, or 18 of the 80 points; Figure 3).

Plant species richness (number of species encountered) was low, especially at any given point. On average, each location contained just two different species. Slender naiad (also known as nodding waternymph; *Najas flexilis*), was the most frequently encountered plant during the September 2020 survey (90% of the survey points with plants), followed by tapegrass (71%). When present, tapegrass was typically dense (54% of locations Figure 4). Slender naiad and tapegrass were commonly encountered together. Filamentous green algae were also widely distributed but the overall density was relatively low. EWM was encountered at only four locations and at low densities (Figure 5).

Both tapegrass and slender naiad are common native species and are important sources of food and shelter for aquatic biota. Slender naiad rarely becomes problematic but tapegrass can become a nuisance when dense monocultures are formed. Tapegrass can grow up to six feet under ample light and sediment conditions. The long ribbon-like leaves extending from a rosette (Figure 6) and the female reproductive structure, a long flower stalk (peduncle), often binds up boat motors and entangle swimmers. The plant is prolific and can spread rapidly. It can reproduce by seeds and runners (rhizomes) and can form winter buds (turions) allowing the plant to overwinter more successfully than other native plants. These multiple forms of reproduction and climate resiliency make controlling plant growth exceedingly difficult.

Table 1. Dudley Pond Macrophyte Survey Data (Sept. 2020).

Point	Water Depth (ft)	Cover	Bio-volume	Benthic Mat	Cha	Eleo	FG	Lm	Mh	Ms	Nf	No	Nv	Pc	Pp	Usp	Va	Species Richness
1	8.0	4	4								S						D	2
2	7.0	4	1								D			T			S	3
3	5.2	4	4								S						D	2
4	7.5	3	2								D						D	2
5	7.7	4	2								D						S	2
6	8.1	3	1								D							1
7	8.0	4	4								S						D	2
8	6.6	0	0															0
9	9.5	4	1		M						D							2
10	11.0	0	0															0
11	9.5	4	1				S				D						S	3
12	8.6	4	1		M						D							2
13	16.0	0	0															0
14	23.0	0	0															0
15	22.5	0	0															0
16	17.8	0	0															0
17	18.0	0	0															0
18	22.7	0	0															0
19	23.4	0	0															0
20	12.0	0	0															0
21	11.2	0	0															0
22	22.9	0	0															0
23	23.4	0	0															0
24	22.4	0	0															0
25	9.5	0	0															0
26	12.0	0	0															0
27	25.0	0	0															0
28	23.6	0	0															0
29	22.0	0	0															0
30	8.3	4	1				M				D					D		3
31	10.7	0	0															0
32	13.0	0	0															0
33	9.2	1	1								S						S	2
34	19.0	1	1	M														1
35	10.2	0	0															0
36	8.2	2	1								S						S	2
37	6.5	1	1								S							1
38	7.5	3	1								D						D	2
39	8.0	4	2								M						D	2
40	8.2	4	2								D						D	2
41	5.3	3	1								D						M	2
42	9.0	0	0															0
43	8.4	1	1								T						T	2
44	8.0	1	1		S						S			T				3
45	5.0	4	2		D						D	M					D	4
46	8.0	4	3								S						D	2
47	8.5	3	1		D						D							2
48	5.1	2	1							T	M						T	3
49	5.0	1	1				S				S							2
50	8.2	1	1								S							1
51	7.8	1	1				S				M					T	S	4
52	3.0	2	2														S	1
53	6.9	3	1		S						D						T	3
54	6.8	4	3		T						M	S					D	4
55	6.1	4	2		S						D							2
56	7.5	4	2				S				D							2
57	6.9	4	4								S						D	2
58	7.2	2	1								S						S	2
59	7.3	4	2		S						D						M	3
60	6.5	4	3								M						D	2
61	4.5	3	2				T				M						D	3
62	7.4	4	2		M						D						S	3
63	7.2	4	2		M						D						S	3
64	7.2	4	2		M						D							2
65	7.0	4	2		M		S				D					T		4
66	6.9	4	3		T		S				D					S	D	5
67	6.5	4	4		M						D					T	D	4
68	5.2	4	1		M						D					S		3
69	6.3	4	2		S		S				D			T		S	M	6
70	4.1	4	3				M				D	S						3

Table 1. Continued

Point	Water Depth (ft)	Cover	Bio-volume	Benthic Mat	Cha	Eleo	FG	Lm	Mh	Ms	Nf	No	Nv	Pc	Pp	Usp	Va	Species Richness
71	5.0	4	3				S				D						S	3
72	6.6	4	2				D				D					T		3
73	5.6	4	3		S		D				D					M	S	5
74	4.5	3	2			T	M				S	D				D		5
75	3.5	4	3			T	D				M	D				D		5
76	5.0	4	3		T		T				S	M					D	5
77	7.5	4	3								S					T	D	3
78	7.0	4	2								D						M	2
79	7.0	0	0															0
80	7.5	4	1				M				D							2
81	7.5	4	3				T				D						M	3
82	6.8	4	4				T				S						D	3
83	6.4	4	4				S				S	T					D	4
84	5.5	4	4				M				S						D	3
85	5.2	4	4				M					S					D	3
86	6.4	4	4				T				M				S		D	4
87	6.9	4	4								S						D	2
88	7.7	1	1							T							T	2
89	7.7	3	1		D						D							2
90	3.7	3	2								S	M					M	3
91	2.7	2	1				S				S	S	S				T	5
92	5.0	4	4		S		S					M					D	4
93	5.5	4	3								M	M					T	3
94	2.7	1	1				S		S		S						T	4
95	5.5	4	2		T						D						M	3
96	6.2	4	4				S								S		D	4
97	6.4	4	4							S	M						D	3
98	4.5	4	4							T		M				S	D	4
99	6.0	4	2		T		S				D					S		4
100	6.0	4	4				S				S						D	3
101	4.7	4	2				T				T						D	3
102	3.1	4	4		M						S					S	D	4
103	3.8	4	4				T	T				S	M			T	D	6
104	2.7	4	2			S	M				D							3
Frequency of Occurrence				1	24	3	32	1	1	4	72	14	2	3	2	17	57	
Frequency of Occurrence (%)[1]				1%	30%	4%	40%	1%	1%	5%	90%	18%	3%	4%	3%	21%	71%	
Density When Present (%)																		
			Dense	0%	13%	0%	9%	0%	0%	0%	50%	14%	0%	0%	0%	18%	54%	
			Moderate	100%	38%	0%	22%	0%	0%	0%	14%	43%	50%	0%	0%	6%	12%	
			Sparse	0%	29%	33%	47%	0%	100%	25%	33%	36%	50%	0%	100%	35%	21%	
			Trace	0%	21%	67%	22%	100%	0%	75%	3%	7%	0%	100%	0%	35%	12%	

[1] – Percent Frequency of Occurrence is the number of times the species was present when plants were observed(# time species observed/80 total observations with plants).

Plant species identification key

Cha - *Chara* (stonewort; macroalga)	Nf - *Najas flexilis* (slender naiad; nodding waternymph)
Eleo - *Eleocharis sp*. (spikerush)	No - *Nymphaea odorata* (yellow pond-lily)
FG - Filamentous green algae	Nv - *Nuphar variegata* (white pond-lily)
Lm - *Lemna minor* (common duckweed)	Pc - *Potamogeton crispus* (curly leaf pondweed)
Ms - *Myriophyllum spicatum* (Eurasian watermilfoil)	Pp - Potamogeton perfoliatus (clasping leaf pondweed)
Ms - *Myriophyllum humile* (low watermilfoil)	Usp - Utricularia species (bladderwort)
	Va - *Vallisneria americana* (tapegrass)

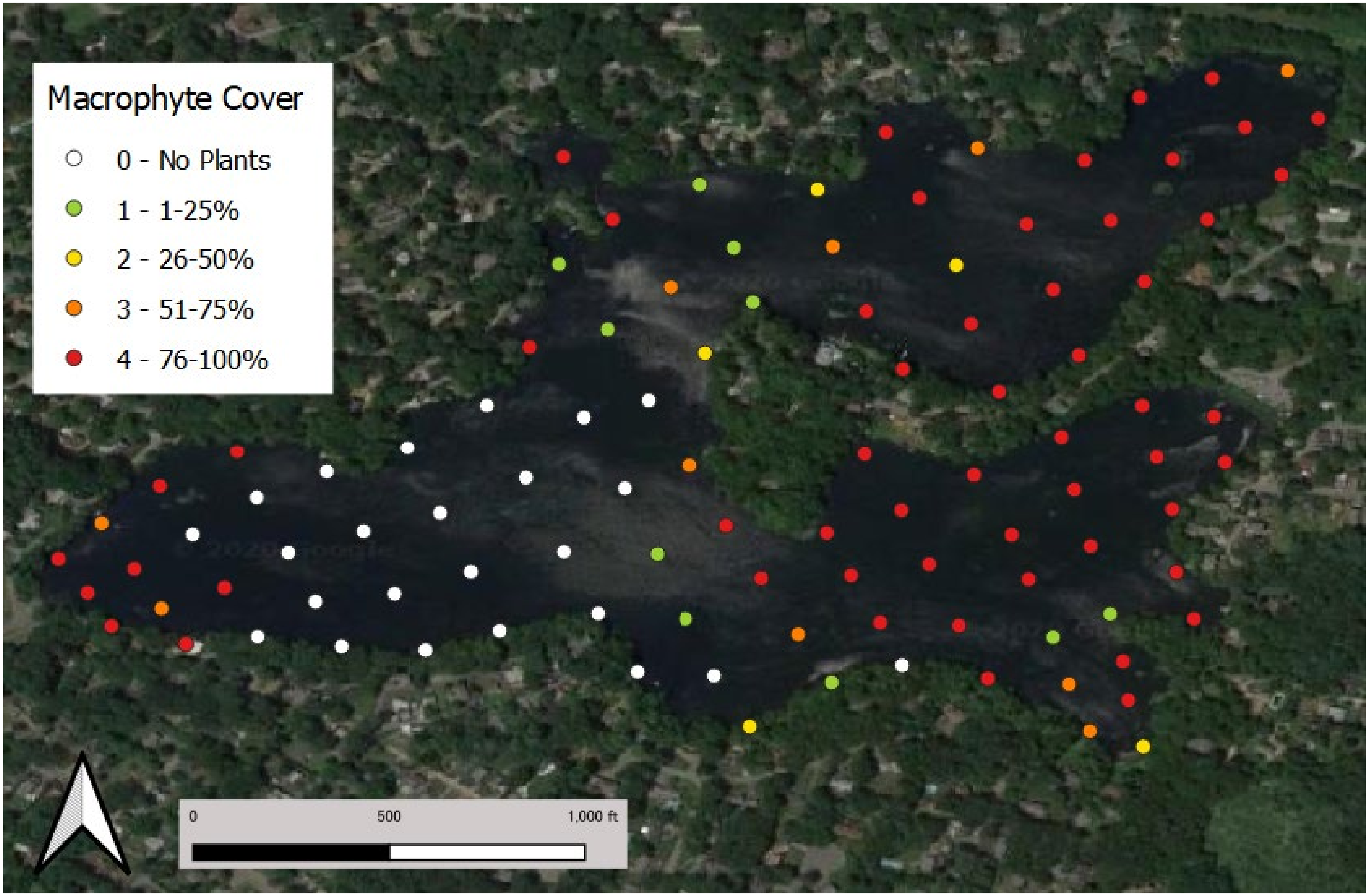

Figure 2. Dudley Pond Macrophyte Cover (Sept. 2020)

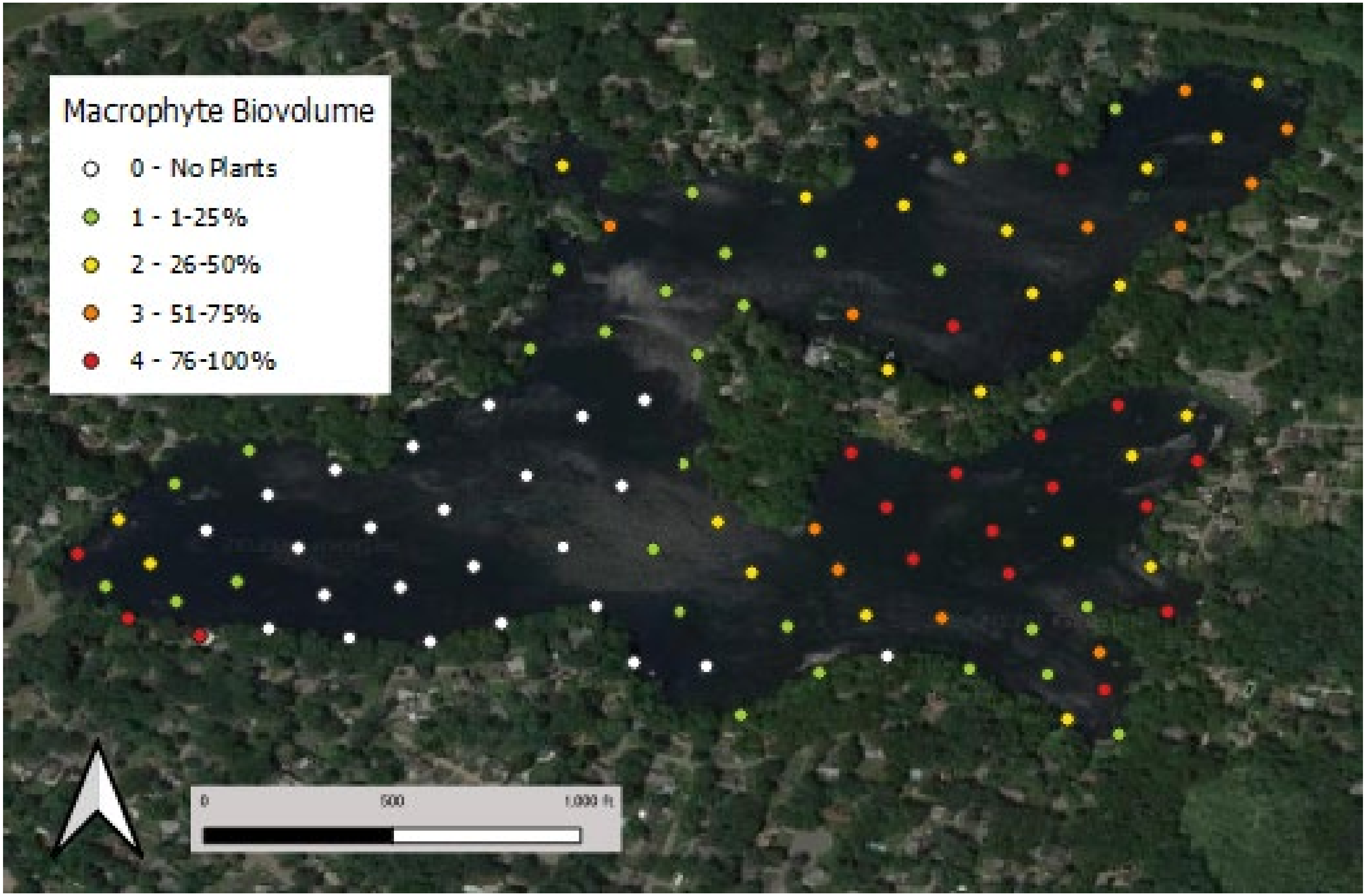

Figure 3. Dudley Pond Macrophyte Biovolume (Sept. 2020).

Figure 4. Dudley Pond Tapegrass Density (Sept. 2020)

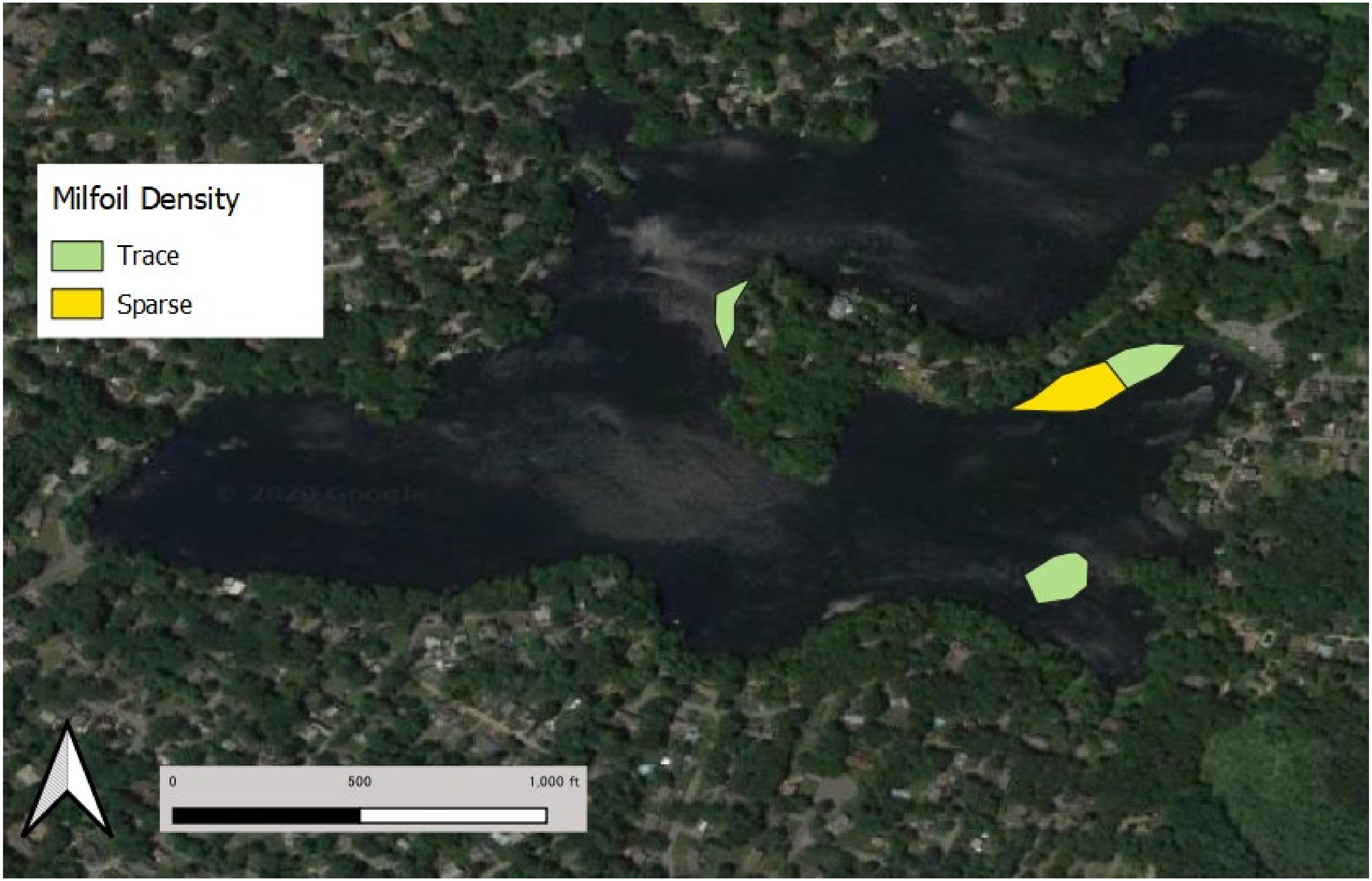

Figure 5. Dudley Pond Eurasian Milfoil Density (Sept. 2020)

Figure 6. Tapegrass Sexual Reproductive Structures.[2]

a) Tapegrass (*Vallisneria americana*) staminate flower on the male plant on the left, and seedpod on the female plant on the right. b) Seedpods carry hundreds of tiny seeds, which are about 1.6 mm or 1/16 of an inch in size.[2]

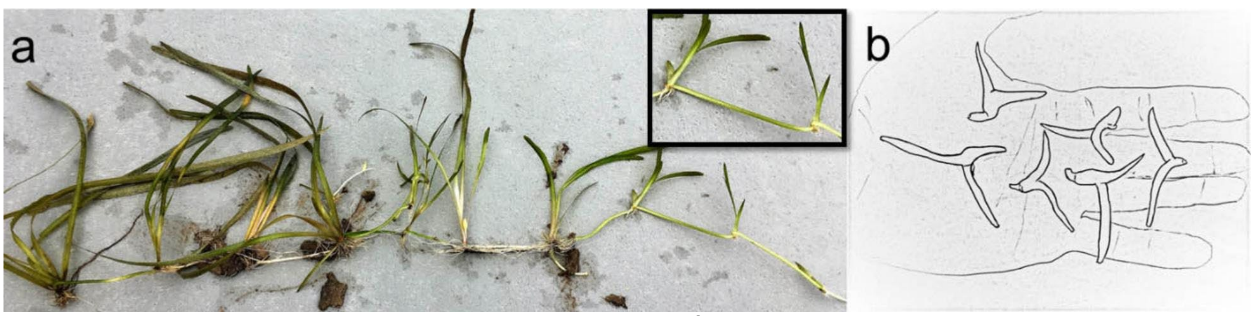

Figure 7. Tapegrass Rhizomes (a) and Turions (b)[2]

Management Options

Dudley Pond provides an ideal environment for rooted plant growth. The water quality monitoring program continues to show desirable water clarity (6.8-10.8 feet Secchi disk transparency 2011-2016) allowing much of the sunlight to reach the sediment. This explains the current observations of plant growth up to ten feet. The 1983 IEP Diagnostic Feasibility Study noted that the pond has substantial nutrient rich organic sediment (muck and silty/sand) capable of supporting dense plant growth. Sediment thickness varies but generally increased with water depth. Sediment in the pond is thickest, generally 2-14 feet, in the northeast cove and main basin (Figure 8). It is highly likely that the sediment thickness in all areas of the pond have increased in the past 40 years, especially with the continued layering of decayed plant material and watershed inputs. Given ample light and rich nutrient sediment, dense plant cover is unavoidable without management.

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[2] Mohsen Tootoonchi, Lyn A. Gettys, and Jehangir H. Bhadha 2019. Tapegrass, Eelgrass, or Wild Celery (*Vallisneria americana* Michaux): A Native Aquatic and Wetland Plant. Agronomy Department, UF/IFAS Extension document number SS-AGR-437.

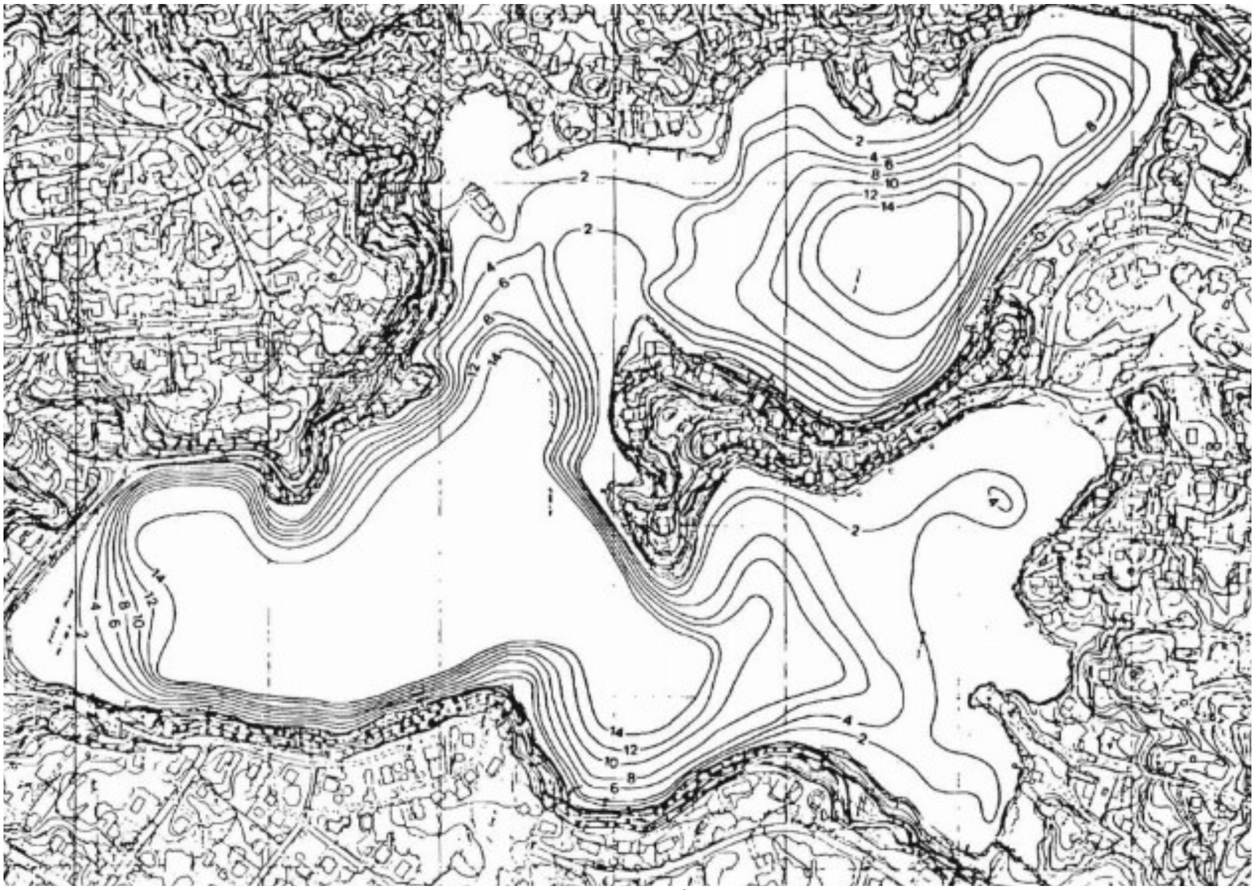

Figure 8. Dudley Pond Sediment Thickness 1981[3].

The management of EWM has been an on-going challenge. However, the limited observances of EWM in September 2020 suggests that the ProcellaCOR treatment last year was successful, although no quantitative data were available as of the writing of this report to document results. A review of historic data suggests that tapegrass density has increased substantially over the years to the point that the nuisance level of this native species has exceeded that of EWM. Herbicides used in the past, such as fluridone, have had only marginal impact on tapegrass and the high density this year suggests that the recent treatment with ProcellaCOR had little to no effect on tapegrass.

Although dated, much of the discussion in the 1983 Diagnostic Feasibility Study is still valid today. While the report did not recommend herbicide treatments to control nuisance plant growth because of funding and the belief that treating a large portion of the lake would likely result in increasing algal blooms (without also applying a algaecide), water clarity data following fluridone treatments have not indicated an increase in algal blooms. However, no data other than clarity are available to verify this statement.

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[3] IEP 1983. Diagnostic Feasibility Study of Dudley Pond. Available at https://issuu.com/wswqc/docs/1983_iep_diagnostic-feasibility_study_dudley_pond

Mechanical Harvesting

IEP discussed the pros and cons of mechanical harvesting back in 1983. Mechanical harvesting equipment generally focuses on cutting the vegetation and off-loading the material to a landside location. The limiting factor at the time of the IEP report was capital cost of equipment and operation and maintenance. If the Association or Town can support the required labor and direct costs (including disposal of the plant material), this option is still viable. Mechanical harvesting would reduce the contact recreation impact of the aquatic vegetation, but it would not control the growth, overall cover is likely to remain the same.

A relatively new harvesting machine (not available at the time of the IEP evaluation) is gaining traction among lake associations. This “Eco harvester”, sold by Weeders Digest, uses a rolling drum that grabs the vegetative portion of plants and theoretically rips the plant out of the sediment capturing the roots. If this machine is successful, this would help control the growth by removing the root system and rhizomes that support growth and expansion of tapegrass. In preparation of this report, ARC reviewed professional accepted peer reviewed literature sources to find scientifically based studies evaluating the claims of the manufacturer. While no peer reviewed literature was discovered specific to the Eco harvester, there are several anecdotal stories that support such claims on the internet. However, there are also reports that contradict the manufacturers claims. These conflicting reports highlight the need for a repeatable quantitative study. An example of a Lake Association’s experience notes the inability of the Eco harvester to pull plants (specifically milfoil) out by the roots and achieve the manufacturer productivity rates[4]. Again, neither the positive nor negative statements on the internet are peer reviewed, repeatable studies. In addition, ARC was unable to find reports (anecdotal or otherwise) on the use of the Eco harvester for tapegrass. What is consistent in the documentation reviewed, however, is the ability of the machine to “skim” dense mats of floating weeds effectively.

If the Association wishes to purchase an Eco harvester, ARC strongly recommends performing a pilot study to ensure that the product is tested for the specific use (tapegrass and root/rhizome removal) and expected results are achieved on a consistent basis. A study design would include staking out several test plots where a traditional cutting harvester would remove vegetation and separate plots would be harvested using the Eco harvester. Control plots where no action is employed would also be staked. All test plots would be monitored before harvesting, immediately after and 30 days, 120 days (or end of growing season) and one year following harvesting to assess efficacy of each technique. Ideally, this study, with repeated harvesting would continue for three years to evaluate if any cumulative benefits are achieved over time. At a minimum, the Association should consider a year long test before investing in the purchase of equipment. Complete evaluation of capital cost, labor for operation, maintenance and plant disposal are beyond the scope of this macrophyte survey and review of management strategies but these should also have equal weight in the decision-making process. It should also be noted that IEP’s statement about harvesting is still valid “…Dudley Pond sediments, although not excessively rich in phosphorus, will probably support vigorous weed growth for many years to come despite repetitive annual mechanical harvesting.”

Hydro-raking

Hydro-raking is another form of physical plant removal. A backhoe is essentially mounted on a barge and uses a rake like attachment on the arm to remove plant material along with the root mass. The downside of this technique is that it generates a lot of turbidity and the effective depth

[4] https://static1.squarespace.com/static/5711749107eaa0c2d05636ca/t/57d350829f7456b185c4f472/1473466499624/10-15newsletter.pdf

is limited by the reach of the arm (can reach up to 10 feet depending on equipment). The plant material still needs to be off-loaded which is a bit more complicated because the equipment picks up roots and sediment along with the vegetative plant material. Application of this technique is typically employed to remove water lilies, *Phragmites* and cattails but has been used on native submerged aquatic vegetation as well. Since tapegrass is known to spread via rhizomes, this technique could be evaluated in a test plot as described above in one of the harvesting section plots. It is not recommended that the Association purchase this equipment, rather a contractor could be hired to systematically remove sections along the shoreline incrementally over several years to combat tapegrass. While this technique is not recommended pond-wide it would be highly effective in areas immediately in front of homes along the shore. This has the potential to provide multiple years (3-5 years) of relief if performed well. It is more expensive than mechanical harvesting (averaging $1,500-$2,000 per day, plus mobilization and disposal).

Dredging

While dredging is likely the most effective technique to achieve immediate and the most long-lasting results, it is also the most expensive and environmentally impactful to non-target biota. There is a thorough discussion of this in the IEP report and in the Eutrophication and Aquatic Plant Management in Massachusetts Final Generic Environmental Impact Report[5] (GEIR). The general discussion in the IEP report is still valid, although cost, sediment quality and quantity are outdated and needs to be re-examined, dredging of the coves would provide relief from excessive rooted plants if sufficient light limiting depth or removal of nutrient rich sediment is achieved. A dredging feasibility study is beyond the scope of this study but could be performed if the Association wishes to explore this option further. Using the high end cost per cubic yard in the GEIR and the quantity stated in the IEP report, actual dredging construction is estimates at $264,000, which is a low estimate considering it does not include design and permitting. But annualized over several years it becomes more economical. Permitting a dredging project can be lengthy and a dredging feasibility study should be conducted if this is of interest. Components of a feasibility study would include an evaluation of the sediment quantity and quality, evaluation of disposal alternatives, and provide the impact assessment for permitting and will update cost estimates.

Benthic Barriers

Benthic barriers are essentially lake sediment covers. Cover material can be natural substances like clay, sand, gravel or manufactured sheets made from nylon, plastic, fiberglass, or other non-toxic materials. Natural materials change the composition of sediment to prevent plant growth whereas manufactured sheets prevent root access to underlying sediment and can be moved around. Both techniques can be applied over existing plant materials, but efficacy is reduced. It is recommended, if possible, that areas be cleared or partially cleared of plants prior to deployment. Over time, natural processes will deposit silts and organics allowing plants to take root once again.

This technique is usually applied to small areas like beaches and around docks and access ramps. Manufactured barriers were successful in controlling milfoil in Lake George in three acres for about three years. Recolonization of the area with native species was rapid, but milfoil returned within two years. It would be next to impossible to deploy over the entire littoral area of Dudley Pond. However, the Association could implement this in select areas where residents are having

[5] Available at https://www.mass.gov/files/documents/2016/08/sd/eutrophication-and-aquatic-plant-management-in-massachusetts-final-generic-environmental-impact-report-mattson.pdf (GEIR 2004)

difficulty accessing open water. It is unlikely that the State and/or the Conservation Commission will allow the lake to be "filled" with materials, but manufactured barriers have been permitted throughout Massachusetts relatively frequently.

The barriers can be difficult to deploy and require maintenance. Once the barriers are removed, the treatment area could be planted with *Chara* harvested from other areas of the lake to encourage native plant growth and competition. Professionally installed, costs are about $15,000 per acre, but materials could be purchased and installed by volunteers which would significantly reduce costs. The GEIR provides an expanded discussion, including expectations of maintenance and costs of this technique.

Biological Control

Biological control is the introduction of another species to control plant growth. Herbivorous fish (such as grass carp) and invertebrates (such as weevils and beetles) are common biota used for biological control. It has variable success and has had more undesirable effects than anticipated in many cases. Grass carp are not approved for introduction in the State of Massachusetts. It is unknown if any specific invertebrate targets tapegrass. For these reasons biological control using fish and invertebrates is not recommended for Dudley Pond.

Plant Replacement

Plant replacement is another form of biological control. It is the direct alteration of the plant community through select removal and planting/seeding. Plant replacement could be tested in Dudley Pond, but this would require the removal of tapegrass (via harvesting, herbicides, barriers, etc.) before another plant (like *Chara*) could be planted to prevent the regrowth of tapegrass. This is labor intensive, and success of plant replacement projects has varied.

This is a solid theory, but attempts have not been as successful as hoped. The State of New Hampshire attempted to replace two acres of invasive, non-native variable milfoil (*Myriophyllum heterophyllum*) in Lake Massasecum located in Bradford, NH (under a research grant) by suction harvesting milfoil and planting the exposed area with a native species mix. Early monitoring showed desirable progress but required substantial follow up suction and hand harvesting. After a couple years of follow up, the State eventually resorted to herbicides. Two experimental plant replacement projects were undertaken in Massachusetts: Island Creek in Duxbury and Lake Buel in Monterey. In Island Creek, the goal was to replace variable watermilfoil and fanwort (*Cabomba caroliniana*), both aggressive non-native species, with Robbins pondweed (*Potamogeton Robbinsii*), a desirable high habitat value species that generally does not become a nuisance to boating and swimming. Both planting of adult plants and seeding was attempted. The plants grew where planted but did not readily expand from the planting footprint and were unable to outcompete the aggressive milfoil and fanwort. In Lake Buel, EWM was removed and mats of *Chara* and *Najas* were harvested using a mechanical harvester and relocated to areas cleared of EWM. *Chara* and *Najas* maintained dominance in the planted areas for about a year and a half. It is unknown whether the Town continued to monitor and if the project achieved long term success. ARC reached out to the current consultant, but no data are available at this time to comment on current conditions.

Plant replacement is still experimental and if the Association wishes to take on a pilot replacement project, a pilot study could be designed and implemented. Data from the September 2020 survey indicate that Robbins pondweed is not present (or present in sufficient density to be picked up in the 104-point survey) and therefore could not be used as a suitable replacement species. However, a moderate sized mat of *Chara* proximal to survey point 45, in the small cove around

68-76 Lakeshore Drive was observed and a portion of this mat could be relocated to a section of the pond that contains dense tapegrass. Monitoring the relocated area will reveal if *Chara* could expand and outcompete tapegrass on a larger scale. While *Najas* was a promising co-dominant replacement species in the Lake Buel project, *Najas* is dense in Dudley Pond and is co-dominant with tapegrass in many areas. Because it is co-dominant it does not appear to compete well against tapegrass. These species are thriving well together; therefore, there is low probability of success for *Najas* to outcompete tapegrass given its current density.

There are several other physical and chemical alternatives to herbicides that are not discussed above. They are not mentioned herein because they either have limited applicability, not desirable to the public (e.g. dyes) or not feasible due to physical constraints (e.g. winter water level drawdown is not applicable due to a lack of physical outlet control and unknow ability to successfully refill). A comprehensive evaluation of all alternatives detailing both short- and long-term advantages and disadvantages with economic analysis is beyond the scope of this effort. However, plant management alternatives have not changed much since the development of the GEIR other than additional herbicides are available. The Association can review the complete list in the GEIR, or at least the companion document that provides a condensed version of the GEIR management[6].

Recommendations

Dudley Pond has ample light and desirable sediment to support rooted plant growth and therefore something will grow. The pond will not sustain a plant-free littoral zone without dredging (and even that is limited) or excessive chemical application. The best achievable goal is to strike a balance of valuable aquatic habitat and human use by selecting a desirable native plant that will cover the pond bottom but that does not have a growth morphometry that allows the plant to reach the water surface impairing boating and swimming uses. Herbicides have become more selective over the years for control of non-native species, but none are known to effectively control tapegrass.

It should be reiterated that tapegrass is a resilient plant that has multiple mechanisms for reproduction and expansion. Generally, tapegrass is considered a desirable species and is not often a target plant for management. For these reasons there is not a lot of information on plant control remedies and very few tested solutions other than winter water level drawdown (not applicable for Dudley Pond), mechanical removal and herbicides, which have shown only fair results.

Harvesting Pilot Testing

Based on the stated goal during the survey site visit, a desire to explore long-term management of EWM and tapegrass while reducing dependency on herbicides, and the Associations current focus on exploring the purchase and operation of an Eco harvester, the following is recommended:

- Establish a study design that compares the efficacy of an Eco harvester against a traditional cutter and control plots (and hand pulling/hydro-raking plots if desired). A sample layout is provided in Figure 9 using approximately 150'x50' test plots.
- Monitor plots with a quantitative assessment at least five times: before, within a day or two after, 30 days, 120 days (or end of growing season) and one year following mechanical removal. Perform qualitative monitoring using video and general observations over the entire plot area. Conduct quantitative monitoring of plant stems

[6] The Practical Guide to Lake Management in Massachusetts. Available at https://www.mass.gov/doc/the-practical-guide-to-lake-management-in-massachusetts/download

within multiple 6’x6’ subplots randomly placed within study plots. Monitoring could be conducted by trained volunteer divers or by a consultant who could use video to save on cost rather than diving.

- Quantify the volume of biomass removed from each plot.
- Observe the plants removed and estimate the percentage of plants that retained roots/rhizomes. Specifically note what species were harvested.
- At the end of the study, compare efficacy and manufacturer claims regarding production and root mass removal. Evaluate if results met expectations and use these data to make an informed decision on whether to purchase the equipment.

Plant Replacement

If the Association is still willing to investigate plant replacement given the uncertainty of success, the Association could take on a small-scale plant replacement project with a similar study design as the harvester assessment described above. *Chara* is the only suitable low-growing plant currently in the pond that has the potential to outcompete tapegrass. A small area currently colonized by dense tapegrass could be cleared (hand harvesting or benthic barrier) and a portion of a *Chara* mat could be transplanted into the newly exposed area. This replacement area would be monitored to assess the growth and expansion of *Chara* over the course of two growing seasons. If successful, the test project could be expanded over time.

Continued Use of Herbicide

While ARC understands the desire to reduce the use of herbicides, the Association should continue to monitor the effectiveness of ProcellaCOR and supplement removal of small EWM patches with hand pulling as done in previous years. Long term effectiveness of ProcellaCOR is yet to be determined but given the lack of milfoil in the September 2020 compared with verbal pre-treatment reports, the recent application appears highly successful. If density rebounds, another treatment could be considered. Over time, future treatments may not be necessary and hand pulling density of milfoil should decrease substantially. Unfortunately, eradication is rarely achieved, and continued employment of multiple strategies and adaptive management is needed.

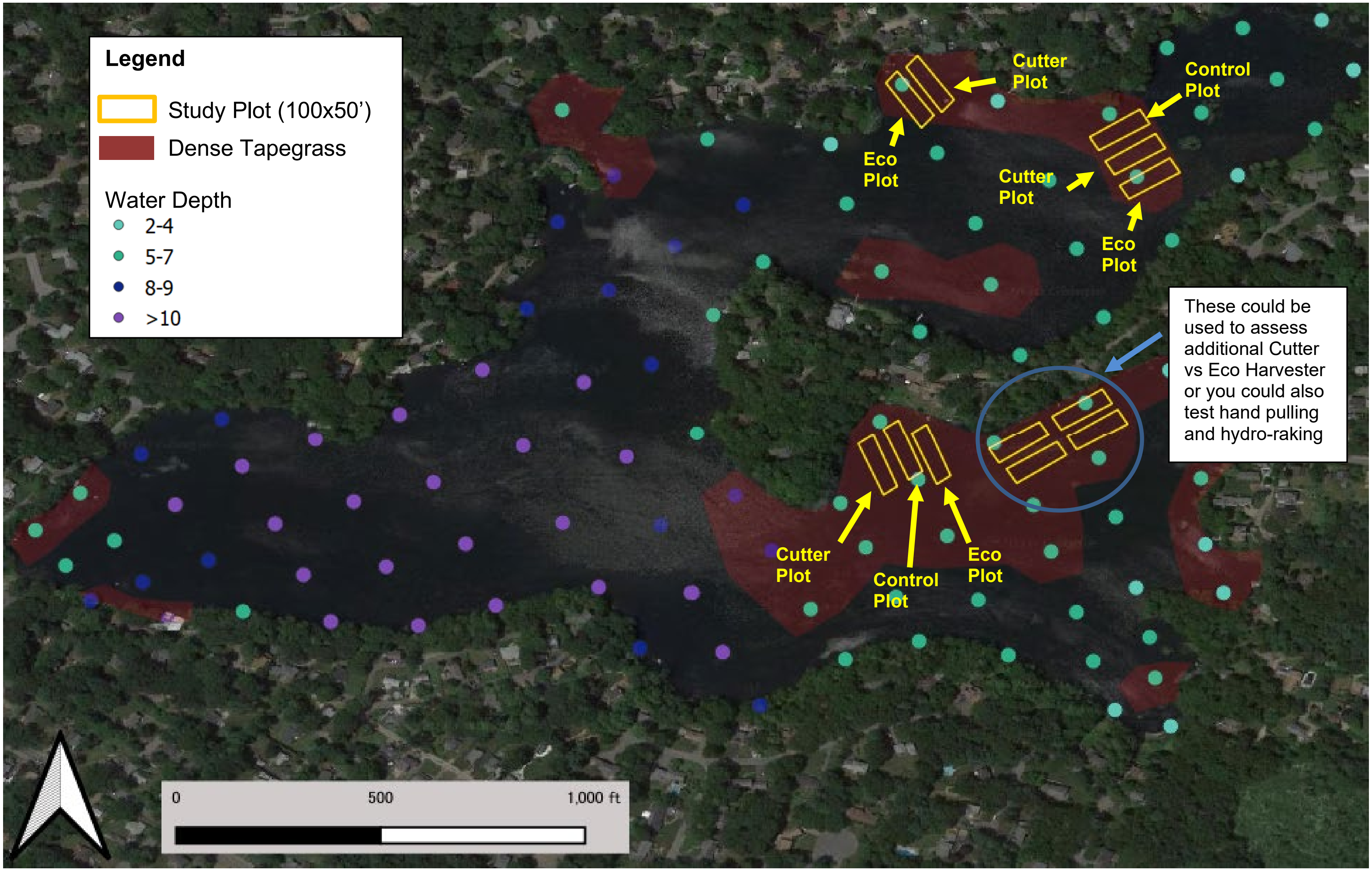

Figure 9. Sample Eco Harvester Test Design