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September 29, 2021

Leverett Conservation Commission
Town Hall
9 Montague Road
Leverett, MA 01054
Via email: concom@leverett.ma.us

Re: Management Plan for Leverett Pond
Additional Information and Reports
DEP File: 200-0196

Dear Commission Members:

The attached report and appendices provide the Conservation Commission with the additional information requested, and the information recommended by MADEP in their comment letter from November 2020.

The Friends of Leverett Pond take the stewardship of Leverett Pond seriously and are seeking long-term solutions to provide excellent water quality, and wildlife and fisheries habitat improvements, while fighting an onslaught of invasive plant species invading the Pond. We are making a series of recommendations for the long-term management and restoration of Leverett Pond. We are seeking a five-year Order of Conditions as an Ecological Restoration Limited Project, to be in full compliance with the Final Generic Environmental Impact Report (Eutrophication and Aquatic Plant Management in Massachusetts, 2004), and the DEP issued The Practical Guide to Lake Management in Massachusetts (2004).

The following management techniques are recommended in our report, which includes non-chemical and chemical methods to reduce invasive plant species. Not all methods will be implemented in a single year, and we make specific recommendations for annual reporting to the Conservation Commission with the work completed during the year, and the work proposed for the following year. We have additionally provided the Conservation Commission with Draft Special Conditions for your consideration. These are similar to those issued recently by other Conservation Commissions, and provide a annual review of work completed and proposed for review by the Leverett Conservation Commission.

Hydro-raking: This method was described in the NOI, but it is not recommended at this time. Should the Town of Leverett Fire Department choose to use a hydro-rake or dredge to increase the sump at the fire hydrant on Depot Road, a new Notice of Intent will be required for this activity.

Weed Harvesting: Weed harvesting is an appropriate non-chemical method to remove excess floating and aquatic vegetation. This method of vegetation control is not a long-term management solution, particularly for the Eurasian Milfoil, but it may provide short-term benefits in controlling excessive vegetation or when a non-chemical solution is warranted.

Drawdown: The installation of the new outlet control structure allows for a pond drawdown. The GEIR allows up to three feet of drawdown; additional drawdown is permitted with the approval of Mass Fish & Wildlife. Within the first five years of the Orders of Conditions, we provide recommendations for a winter drawdown of 3 feet to reduce the invasive species along the shallow edges of the Pond.

Herbicides: We understand the reluctance to apply aquatic herbicides, yet this method has been successful in the past in reducing invasive species in Leverett Pond, and this method needs to be part of the overall toolbox for keeping the invasive plant species in check. It is not realistic to try to eradicate the invasive plant species. The goal will be to reduce the growth of the invasive species to promote the growth of native aquatic plant species, and to slowly improve the fisheries habitat.

Raking: A non-chemical technique we recommend will be hand-raking along the shoreline. This may be particularly beneficial at the public boat-launch area which appears to be a primary source of invasive species introductions. This method may also be used along the shoreline by residents, or public service groups. Following the issuance of the Orders of Conditions permitting this hand removal technique, the Friends of Leverett Pond will withdraw the Request for a Determination of Applicability for hand-raking.

Water Quality: There were several comments made by MassDEP regarding water quality information, and watershed management. To address these comments water testing was conducted during 2021 within the Pond, and at the inlet. Additionally significant effort was made in 2021 to document the level of Dissolved Oxygen (DO). These data are included in the report. Dissolved oxygen is a key indicator of fish habitat value. The data collected by the Friends of Leverett Pond illustrate that dense vegetation causes low oxygen levels during late summer due to nocturnal plant respiration consumption of oxygen exceeding diurnal photosynthesis oxygen production. The GEIR recommends removal of excess aquatic vegetation when DO levels are below 5ppm (5 mg/L), which has been measured within the pond (Table 5 of the attached report). Decreased dissolved oxygen lowers fish vitality and can lead to mortality. The ecological benefits of Pond Management will be to improve the fisheries in Leverett Pond, in part by removing dense areas of invasive aquatic species.

Overall, the water quality in open water within Leverett Pond is good, with the primary source of pollutants coming from the Depot Road inlet. The areas with the lowest levels of dissolved oxygen are those where there are dense invasive species growth.

Wildlife and Fisheries Habitat: Although the GEIR does not require wildlife habitat and fisheries studies, the Leverett Conservation Commission requested additional data, and these have been provided. An assessment of wildlife habitat within the Pond, and the adjacent wetlands was conducted in June 2021 by SWCA, and a Fisheries survey was conducted by Massachusetts Fish and Wildlife in May 2021. A review of the fisheries data from 1994 to the present is not conclusive in findings given the different techniques used, but it does show a reduction in the size of fish such as small mouth bass within the pond since the first surveys were conducted in 1994. Furthermore, we have presented data from four other freshwater ponds in Massachusetts, the analysis of which indicates that the fish within Leverett Pond are robust and generally larger than the other ponds.

We have provided the Conservation Commission with factual data, laboratory reports, updated figures, and documentation, along with our recommendations for a long-term management plan for Leverett Pond. We have also provided a draft set of Conditions taken from Mass DEP “guidance for Aquatic Plant Management in Lakes and Ponds, as it relates to the Wetlands Protection Act” and extracted Conditions from other Towns.

I look forward to discussing these findings with the Commission.

Sincerely,

Mickey Marcus
Massachusetts Aquatic Applicator License #30027
Professional Wetland Scientist # 1635
Certified Ecological Restoration Practitioner #0001

Enc. Leverett Pond Assessment Report w/attachments
Draft Orders of Conditions

Cc: DEP, Western Regional Office
Mitch Mulholland, Tom Hankinson, Friends of Leverett Pond

LEVERETT POND WILDLIFE HABITAT ASSESSMENT REPORT

SEPTEMBER 2021

PREPARED FOR

Friends of Leverett Pond

PREPARED BY

SWCA Environmental Consultants

Project 64784

LEVERETT POND ASSESSMENT REPORT

Prepared for

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1 INTRODUCTION

The Friends of Leverett Pond (the Friends) is an organization committed to the preservation of the approximately 102-acre Leverett Pond (the pond), which is open to the public for boating, fishing, ice skating, and wildlife viewing. Overgrowth of invasive aquatic vegetation has been the primary threat to the health of the pond for over 50 years. The Friends have performed vegetation management since 1994; however, vegetation management was only performed when needed for ecological improvement and to eliminate invasive aquatic plant species within the waterbody. Past efforts have been successful, but continued expansion by invasive plant species, and the unchecked growth of aggressive nuisance floating aquatic plants have begun to degrade the fisheries habitat and water quality of the pond. Therefore, further vegetation management action, and long-term management is proposed.

The Friends have submitted a Notice of Intent to the Leverett Conservation Commission (DEP File No. 200-0196) and the Massachusetts Department of Environmental Protection (MassDEP) for the management of nuisance aquatic vegetation. Activities proposed (and their target species) include herbicide and non- herbicide techniques. In this report we describe the different methods available for management of the invasive plant species including herbicide application (invasive plant species); mechanical weed and root removal (invasive and nuisance vegetation), hand removal (invasive and nuisance vegetation), benthic barrier placement (invasive aquatic vegetation), drawdown, hand-raking, and SCUBA (invasive and nuisance aquatic vegetation). This scope of work was submitted as a 5-year management plan. SWCA Environmental Consultants (SWCA), on behalf of the Friends of Leverett Pond, has collected additional data and compiled many years of data to assist with this management plan and to provide recommendations for invasive and nuisance aquatic vegetation management and overall fisheries and water quality improvements.

The intention of this report and associated recommendations is to describe current conditions within and surrounding the pond, postulate potential shortcomings/areas for improvement, and propose restorative improvement projects that would have the most positive impact on wildlife and water quality. The focus throughout this assessment is quality, diversity, continuity, and connectivity of fish and wildlife habitat and plant communities throughout the pond. A large factor for habitat quality (for reptiles, amphibians, invertebrates, and select bird species) is water quality and water temperature. In improving these qualities, species diversity may increase and long-term survivability of all wildlife that use the pond may improve.

Furthermore, the recommendations presented in this report focus on adaptive management with integrative methods of pond management. While this report presents past and current conditions within the pond, ponds are dynamic systems and a variety of management techniques may be needed to appropriately respond to changes in invasive plant species distribution and density, wildlife habitat needs, as well as recreational use of the pond.

2 SITE DESCRIPTION

The pond is approximately 102 acres in surface area and was classified as a “Great Pond” in 1994. The reported maximum depth within the pond is 21 feet and the average depth was recorded as 5 feet by the Massachusetts Division of Fisheries & Wildlife (2016). Clarity is often up to 9 feet deep throughout the pond (Mass Fish & Wildlife, 2016). Most of the pond is a warm water lacustrine system, a littoral subsystem, and an aquatic bed class (Cowardin et al., 1979). The margins of the pond include palustrine forested wetland, palustrine shrub wetland, and palustrine emergent wetland classes (both persistent and non-persistent communities were observed). The pond substrate consists of muck and sand; however, aquatic vegetation covers more than 40% of the bottom of the pond and submergent vegetation covers

nearly 100% of the bottom. Aside from the vegetative buffers to the pond, it is surrounded by low-density residential land use and forest.

A public right-of-way (ROW) paved boat ramp with limited parking is located at the southern end of the pond at 190 Depot Road in Leverett. Small streams drain into the southern end of the pond by Depot Road and the margins of the pond near the boat ramp are densely vegetated with broad-leaf cattails (*Typha latifolia*) and other emergent plants. The pond flows to the north into a diverse swamp and outlets through a dam on the northeast corner of the pond.

Two historic mills were located downstream of the northern end of the pond in 1794 (Acorn Botanical Associates, 1999). A dam located at the northeastern end of the pond was originally constructed in 1938 and repaired in 1952, 1979, and completely replaced 2020. The pond water level has been manipulated by past drawdowns, such as the drawdowns performed in the 1950's (Acorn Botanical Associates 1999). Additionally, the pond level was 24 inches below its normal level in 2018 and 2019 due to dam leaks, which have since been repaired.

Soils within the vicinity of the pond include Scituate (stony and very stony fine sandy loam), Shapleigh (extremely rocky fine sandy loam), Essex (very stony fine sandy loam), Ridgebury (very stony and extremely stony fine sandy loams), and to some extent Merrimac (fine sandy loam). The northern extent of the pond contains high organic histic (peat) content.

3 MANAGEMENT HISTORY

The Friends have been actively engaged in the ecological management and maintenance of the pond since 1994, when Eurasian milfoil was discovered within the pond. The goal of management has always been the elimination of invasive plant species, fisheries and wildlife habitat improvement, and the continued ability of the Public to access the pond. This work has been permitted through MassDEP since that time through two different Orders of Conditions (OOCs). The OOC that permitted management within the pond from 1994 to 2000 is MassDEP File No. 200-104 and in 2001 work was performed under MassDEP File No. 100-129.

Following management in 2001, vegetation was sufficiently reduced and remained at lower densities until the invasive plant variable-leaf watermilfoil (*Myriophyllum heterophyllum*) was discovered in the central east portion of the pond in 2007. In 2010, the Friends pursued a new OOC, under MassDEP File No. 100-166 and continued vegetation management under this permit through 2020, when the OOC expired.

Management has historically consisted of hand pulling, hydro-raking, and herbicide application. The Friends have adapted their management strategy depending on the target species and their relative density in past management years.

4 WATERBODY ASSESSMENT

SWCA conducted water quality testing and documented aquatic plant species within the pond on June 7, 2021. The assessment of overall water quality is extremely important when assessing habitat quality of a waterbody. The identification of each pollutant source and type of waterbody impairment is also important for management planning. These impairments can include an overabundance of aquatic vegetation. The presence of invasive aquatic vegetation is certainly an impairment, as it stresses native vegetative communities and overtakes their habitat. The below methods, results, and water quality discussion presents current conditions of the pond. Visual references for the data presented below can be found in the Figures 1 and 2.

4.1 Aquatic plant Assessment

A SWCA lake and pond specialist completed a surface vegetation inventory in June 2021, survey. The survey was conducted from a kayak. Both floating and submerged vegetation populations were identified and geolocated using Collector for ArcGIS on a tablet and a sub-meter-accurate Geode remote antenna. Table 1 summarizes the vegetation located within the pond by vegetative community.

The dominant species identified within the pond included both invasive and native species, with the majority of invasive species consisting of milfoil. Species include: Eurasian watermilfoil (*Myriophyllum spicatum*), curly-leaf pondweed (*Potamogeton crispus*), large-leaf pondweed (*Potamogeton amplifolius*), watershield (*Brasenia schreberi*), common waterweed (*Elodea canadensis*), yellow pond lily (*Nuphar variegata*), white water lily (*Nymphaea odorata*), longleaf pondweed (*Potamogeton nodosus*), purple bladderwort (*Utricularia purpurea*), swollen bladderwort (*U. inflata*), and common bladderwort (*Utricularia vulgaris*). Other plant species that have been identified in the pond include fanwort *(Cabomba caroliniana*), variable-leaf watermilfoil (*Myriophyllum heterophyllum*), and ribbon-leaf pondweed (*Potamogeton epihydrus*). Other species present include free-flowered waterweed (*Elodea nuttalli*), Common Cattail (*Typha latifolia*), brittle naiad (*Najas minor*), and Robbins' pondweed (*Potamogeton robbinsii).*

Table 1. Leverett Pond Aquatic Vegetation Survey

Poly(s)	Population Size	Percent Cover	Vegetation Present	Location Notes
1, 3, 4, 6, 8, 10, 12-15, 20, 21	187 sf	50%	Eurasian milfoil	Small patches scattered throughout littoral zone of pond. These particular localized areas are denser than the larger polygons.
2, 16, 19, 29, 33	231 sf	50%	Curly-leaf pondweed	Small patches scattered throughout littoral zone of pond. These particular localized areas are denser than the larger polygons.
5, 9, 27	2,407 sf	98%	Longleaf pondweed	Small patches scattered throughout littoral zone of pond. These particular localized areas are denser than the larger polygons.
11, 22, 24, 25, 26, 30, 31	2,350 sf	50%	Curly-leaf pondweed and Eurasian milfoil	Smaller patches of this mix of vegetation throughout the littoral zone. The include areas of higher density within larger polygons or isolated populations (as of the survey date)
17	2,486 sf	3%	Eurasian milfoil	South to central-western portion of pond
18	56,391 sf	50%	Eurasian milfoil	South to central-western portion of pond
23	212,355 sf	85%	Cattail	Southern-most section of pond
28	1,048 sf	25%	Eurasian milfoil and longleaf pondweed	South to central-eastern portion of pond
32	1,4112 sf	50%	Eurasian milfoil	Central eastern portion of pond
34	111,144 sf	50%	Common waterweed and Eurasian milfoil	Southeastern portion of pond
35	40.6 acres	98%	Watershield, yellow pond and white water lily, longleaf pondweed	Large population of vegetation in south-central portion of pond
36	2.3 acres	15%	Curly-leaf pondweed and Eurasian milfoil	Southwestern edge of pond
37	3.7 acres	50%	Longleaf pondweed, watershield, yellow and white water lily	Central eastern narrow strip of vegetation

Poly(s)	Population Size	Percent Cover	Vegetation Present	Location Notes
38	31,653 sf	50%	Longleaf pondweed	Central eastern porion of pond
39	29,243 sf	98%	Curly-leaf pondweed, longleaf pondweed, watershield	Central western cove north of large polygon no. 35
40, 49	10 acres	98%	Watershield and yellow lily	Northern section of pond – stretching across the waterbody from west to east
41	70,012 sf	98%	Watershield, yellow pond lily, large-leaf pondweed, Eurasian watermilfoil, curly-leaf pondweed, bladderwort	Northeastern portion of pond; south of outfall/dam
45	8.5 acres	50%	Floating vegetation, floating islands; including bladderwort	Southern-most portion of pond above cattail population
46	40,306 sf	98%	Cattail	Southeastern-most portion of pond
47	4 acres	3%	Eurasian milfoil	Northern section of pond
48	22,702 sf	85%	Eurasian milfoil	Central-western portion of pond in cove
51	50,000 sf	98%	Watershield, yellow pond lily, large-leaf pondweed, Eurasian watermilfoil, curly-leaf pondweed, bladderwort	Northeastern portion of pond; south of outfall/dam

Note: sf = square feet. Polygons are represented in Figure 1. These data include aquatic vegetation only; no emergent or other vegetation types are included.

The most dominant plants in the pond are floating aquatic species: water lilies and watershield. The next most dominant are various pondweeds, followed by milfoil species, bladderwort, and curly-leaf pondweed. Section 5 describes the implication of dense vegetation cover in terms of wildlife habitat and water quality.

4.2 Water Quality Analysis Results

SWCA collected a sample from the pond on June 7, 2021, in order to better understand the current state of nutrient level, habitability, and overall health within the pond. The sample was taken 1.5 feet below the surface of the pond in the deepest section of the waterbody (the center of the pond), as seen in Figure 1 (Appendix A). The parameters measured, results, and implications to the overall health of the pond are outlined below in Table 2. Please see Appendix C for the official lab results from the water quality testing.

In order to capture an average of water quality within the pond, SWCA collected the grab sample in the center, deepest portion of the pond. This section of the pond is also not dominated by invasive and nuisance aquatic vegetation and better represents the best water clarity and open water habitat within the pond. This sample location was chosen to understand the baseline water quality conditions within the pond. Sampling within dense vegetative matts, in shallow water, or directly adjacent to inlets provide different results (see lab reports with generally poor water quality in Appendix C). However, data from the center of the pond provide the best generalized quality of the pond as a whole and indicate most accurately the pond's stage of eutrophication.

The water sample contained below recordable levels of total phosphorus, which defines the pond as oligotrophic. This indicates a healthy level of nutrients within the pond. The level of total nitrogen was also low within the collected sample; displaying levels of nitrogen that are healthy and typical for freshwater ponds. Furthermore, chlorophyll a levels, which are a proxy for algal concentration within the water column, were found to be low; at levels typical for oligotrophic freshwater ponds.

Results for conductivity, turbidity, dissolved oxygen (DO), and pH readings were all recorded within acceptable levels for freshwater ponds. Overall, it appears that past pond management efforts have maintained healthy water quality within the pond. The density of vegetation present currently has not altered these key water quality indicators within the pond, nor have recreational use or residential property maintenance. However, if management is not continued the pond's ecosystem will become stressed and water quality will begin to decline as less and less water flow and mixing becomes possible, temperatures increase, and oxygen stress increases. See Section 5 for further description on how these changes occur and their impact on habitat quality.

Table 2. Leverett Pond Water Analysis Results

Parameter	Results	Notes
Turbidity (NTU)	1.3	Drinking water standard level and typical for trout waters
Conductivity (µS/cm)	121.2	Typical for freshwater
Dissolved O_2 (mg/L)	8.6	Good – anything over 5 mg/L will support fish and invertebrates
Chlorophyll a (µg/L)	<10	Below recordable level – oligotrophic
Total Kjeldahl Nitrogen (mg/L)	0.2	Typical for freshwater (readily available N up to 1 mg/L)
Total hardness (mg/L as CaCO3)	34.8	Soft
pH (SU)	7.4	Standard for freshwater
Total Phosphorus (µg/L)	<10	Oligotrophic – below recordable levels

Note: mg/L = milligrams per liter; CaCO3 = calcium carbonate; µg/L = micrograms per liter; µS/cm = microSiemens per centimeter; SU = standard unit; NTU = Nephelometric Turbidity Units.

5 HABITAT ASSESSMENT

SWCA's Certified Wildlife Biologist completed a wildlife habitat evaluation and thorough vegetative inventory of major vegetation cover types at the pond in June 2021. Observations and details on significant habitat features are presented below, including details on major vegetation community types and habitat features surveyed, the wildlife which might utilize each area or feature, and the potential value of each habitat area. A visual depiction of all surveyed plant communities can be found in Figure 1 of this report. Photographs illustrating significant habitat features and habitat classes are included in the attached photographs (Appendix B).

5.1 Existing Plant Communities

Vegetation communities within the pond and along the margins of the pond can be classified into six categories, including:

1. Rooted vascular aquatic (within pond)
2. Floating vascular aquatic (within pond)
3. Palustrine persistent/non-persistent emergent wetland (within pond/islands and pond margins)
4. Palustrine broad-leaved deciduous shrub wetland (within pond/islands and pond margins)
5. Palustrine broad-leaved deciduous forested wetland (pond margins)

6. Deciduous and coniferous forested upland (pond margins)

Palustrine emergent islands, including floating islands, and wetlands along the pond margins include broad-leaf cattail (*Typha latifolia*), soft rush (*Juncus effusus*), and mixed sedges (*Carex stricta*, *C. crinita, C. vulpinoidea, Scirpus cyperinus*) pickerelweed (*Pontederia cordata*), bur-reed *(Sparganium eurycarpum),* and cattail. Broad-leaved deciduous shrubs are common along the shoreline and among islands (including floating islands) and are vegetated with swamp loosestrife (*Decodon verticillatus*), buttonbush (*Cephalanthus occidentalis*), maleberry (*Lyonia ligustrina*), speckled alder (*Alnus incana*), and red maple (*Acer rubrum*) saplings.

Forested wetlands and forested uplands are located along the pond margins. Dominant vegetation in the canopy includes red maple (*Acer rubrum*), eastern hemlock (*Tsuga canadensis*), eastern white pine (*Pinus strobus*), mixed oak (*Quercus rubra, Q. alba*), with sheep laurel (*Kalmia angustifolia*), mountain laurel (*Kalmia latifolia*), and maleberry in the understory.

Nearly the entire pond bank is well vegetated, including much of the residential shoreline areas. Each of these community types provides unique wildlife habitat features and functions. Many shrubs and trees overhang the pond shoreline and/or open water, providing shade and cover for various taxa, perch sites, nesting sites, and fishing overlook locations, for example. The following is a description of significant habitat features of documented vegetative communities at the pond. The various vegetated habitat features can be observed in Figure 1; where islands, floating vegetation, and submerged vegetation have been identified (along with Table 1)..

5.2 Fish and Wildlife

The pond provides a diverse ecosystem and a matrix of habitat types, including open water, dense aquatic beds, persistent emergent and non-persistent emergent marsh habitats, shrub wetlands and floating islands, and adjacent forested wetlands and forested uplands on islands within the pond and along the pond margins.

The pond provides a highly productive fisheries resource dominated by bluegill sunfish (*Lepomis macrochirus*); however, pumpkinseed (*Lepomis gibbosus*), golden shiner (*Notemigonus crysoleucas*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), and chain pickerel (*Esox niger*) have also been documented in low numbers (NEE, 1994; Acorn Botanical, 1999). The dense aquatic vegetation provides suitable cover and food for sunfish and largemouth bass. Sunfishes are ideally suited to the dense aquatic vegetation and shallow, warmer water temperatures. The Friends and SWCA also received fisheries data from the Massachusetts Division of Fisheries & Wildlife (Mass Fish & Wildlife) that indicate healthy fish populations within the pond. These data and an analysis of their results is included in Section 5.2.1.

Mammal surveys completed at Leverett Pond (NEE 1994; Acorn Botanical Associates 1999) have documented whitetail deer (*Odocoileus virginianus*), mink (*Mustela lutreola*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), cottontail rabbit (*Sylvilagus floridanus*), eastern chipmunk (*Tamias striatus*), little brown bat (*Myotis lucifugus*), gray squirrel (*Sciuridae carolinensis*), and red squirrel (*Tamiasciurus hudsonicus*). In addition, river otter (*Lontra canadensis*), weasel (*Mustela sp*.), northern flying squirrel (*Glaucomys sabrinus*), white footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), porcupine (*Erethizon dorsatum*), coyote (*Canis latrans*), and red fox (*Vulpes vulpes*) inhabit the watershed. In addition to these previously documented mammals, SWCA additionally observed muskrat (*Ondatra zibethicus*) at the dam, and beaver (*Castor canadensis*) evidence (three lodges and numerous chews) during the June 2021, assessment. Additional large and small mammals are likely to use the pond and adjacent wetlands.

Reptile and amphibian evidence has similarly been well-documented at the pond, including northern leopard frogs (*Rana pipiens*), pickerel frog (*Rana palustris*), spring peeper (*Pseudacris crucifer*), and spotted salamander (*Ambystoma maculatum*) (NEE 1994; Acorn Botanical Assessments 1999). SWCA additionally observed eastern painted turtles (*Chrysemys picta*), snapping turtles (*Chelydra serpentina*), water snakes (*Nerodia sipedon*), garter snakes (*Thamnophis sirtalis*), red spotted newts (*Notophthalmus v. viridescens)*, gray treefrogs (*Hyla versicolor*), American toads (*Bufo americanus*), bullfrogs (*Rana catesbeiana*), and green frogs (*Rana clamitans*) within the pond during the June 2021, assessment.

The pond provides excellent birding opportunities, as a large number of breeding, neotropical migrating, waterfowl, and winter native bird species inhabit the pond throughout the year. The pond is an important stopover site for migrant birds to stop, rest, and feed during their migration. Of note, SWCA observed green heron (*Butorides virescens*), great blue heron (*Ardea herodias*), belted kingfisher (*Megaceryle alcyon*), Canada geese (*Branta canadensis*), barred owl (*Strix varia*), red-winged black bird (*Agelaius phoeniceus*), eastern phoebe (*Sayornis phoebe*), tree swallow (*Tachycineta bicolor*), gray catbird (*Dumetella carolinensis*), and pileated woodpecker (*Dryocopus pileatus*) during the June 2021, assessment. Other birds of note that have been observed utilizing the pond include golden and bald eagles (*Aquila chrysaetos* and *Haliaeetus leucocephalus*), snowy egret (*Egretta thula*), and swan (*Cygnus olor*). There are too many species to list here; however, additional species are listed in the Acorn Botanical Survey report (1999).

Invertebrates, such as dragonflies and damselflies, were also noted in abundance during the 2021 wildlife habitat assessment. Over 100 species were documented in previous studies (NEE, 1994; Acorn Botanical Associates, 1999).

5.2.1 Fisheries Data

Mass Fish & Wildlife has conducted multiple electrofishing surveys in Leverett Pond over the years. Data from two of these electrofishing surveys (1994 and 2021) were presented to the Friends. SWCA has analyzed these data sets and compiled the following assessment of each data set and a rough comparison of the two using catch-per-unit-effort (CPUE) and condition (K) of the fish.

Electrofishing effort during the 1994 survey was 4355 seconds and it appears that only one run was conducted. The 2021 sample was separated into four different runs efforts of 900, 900, 819, and 1564 seconds. The total effort was 4183 seconds. These four separate runs occurred in different sections of the lake.

The 1994 fish survey grouped bluegills, sunfish, and pumpkinseeds together (all in family *Centrarchidae)* (n= 63). In the 2021 survey, bluegills and pumpkinseeds were separated; their totals included in Table 3.

Also observed in the 1994 electrofishing data is Tiger Muskellunge (or Tiger Musky), a hybrid between Northern Pike (*Esox Lucius*) and Muskellunge (*Esox masquinongy*). They are sterile hybrids which are used throughout the United States and Canada to control populations of smaller prey fish species without establishing a population. Tiger Musky are stocked periodically in Massachusetts, which began in the 1980s (Staff, 2015). Tiger Musky were stocked in Leverett Pond in the 1960s by Mass Fish & Wildlife. Tiger Musky are no longer found in Leverett Pond.

Overall, it is difficult to compare these two data sets (see Table 4 for comparison), but when looking at presence/absence differences between the two, the following conclusions can be drawn. In 1994, there were no Golden Shiners or Yellow Perch observed. Six tiger muskies may have been observed in 1994, but no tiger muskies were observed in Leverett Pond in 2021. In 1994, CPUE was 1.32 fish/minute (96 fish/4355 seconds), while in 2021 total CPUE was 3.72 fish/minute (259 fish/4183 seconds). However,

without additional information about the electrofishing methods used in 1994 it is difficult to claim anything about changes in fish densities.

Table 3. 2021 Electrofishing Survey Results

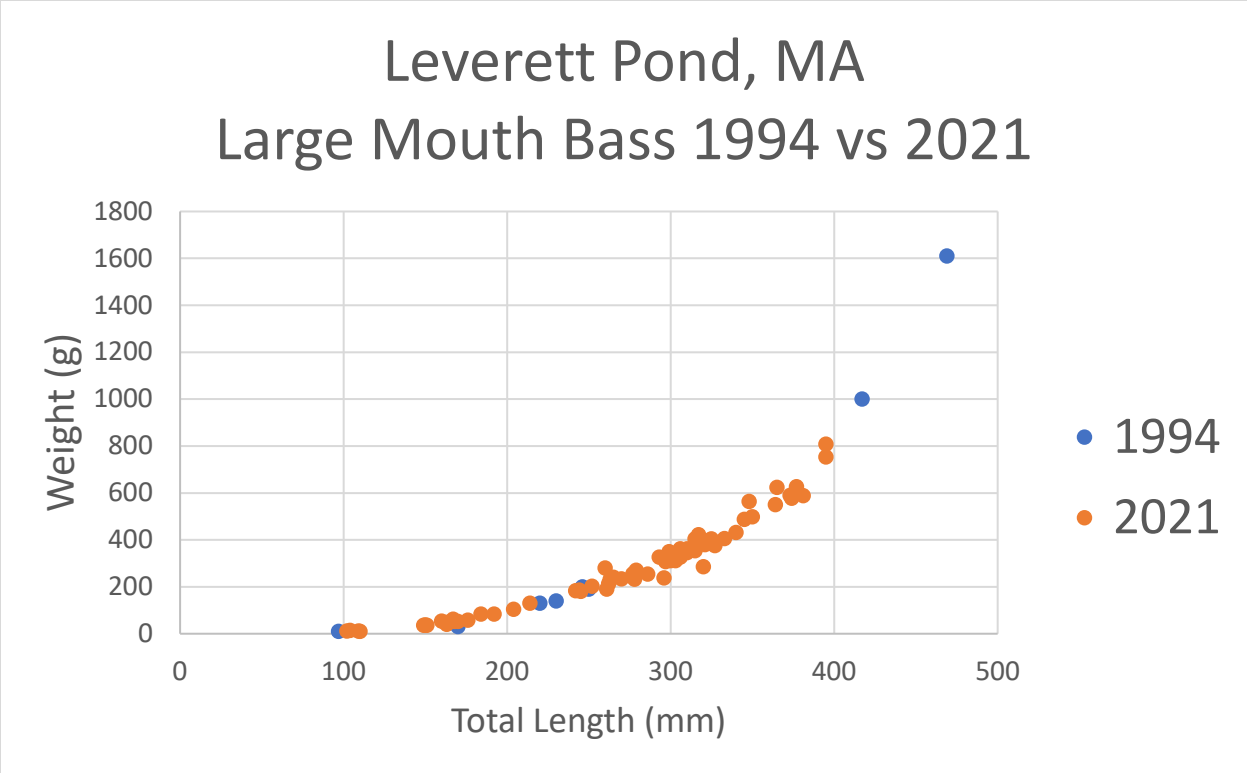
Species	Total Run 1 (900 sec.)	Total Run 2 (900 sec.)	Total Run 3 (819 sec.)	Total Run 4 (1,564 sec.)	TOTAL (4,183 sec.)
Largemouth Bass	14	11	18	27	70
Bluegill	21	15	14	18	68
Chain Pickerel	4	13	4	10	31
Golden Shiner	5	10	4	6	25
Pumpkinseed	5	4	8	6	23
Yellow Perch	1	6	5	8	20
Black Crappie	4	0	3	11	18
Brown Bullhead	1	1	1	1	4
Total:	55	60	57	87	259
CPUE (fish/min):	3.67	4.00	4.17	3.34	3.72

Table 4. 1994 and 2021 electrofishing data

Species	1994 (4,355 sec.)	2021 (4,183 sec.)
Largemouth Bass	14	70
Chain Pickerel	9	31
Golden Shiner	0	25
Yellow Perch	0	20
Black Crappie	1	18
Brown Bullhead	3	4
Grouped Centarchids (pumpkinseed, bluegill, sunfish)	63	91
Tiger Musky	6	0
TOTAL FISH	96	259
CPUE (fish/minute)	1.32	3.71

A fish condition (K) analysis is also difficult to conduct, as more data are needed from multiple years to determine an expected weight-to-length ratio of fish of a particular size. Even comparing a Large Mouth Bass, which were found in relative abundance in both sampling years, is not recommended, as (1) there is insufficient data to create a robust trendline from 2021, and (2) several of the fish from 1994 were larger than the 2021 fish. Graph 1 depicts these data to display the difficulty in comparison.

Regardless of the difficulty in data analysis based on the information available and comparison between data sets, one thing that is apparent when assessing the electrofishing data is this: there is a robust fish population within Leverett Pond. Proper and healthy habitat for these fish needs to be maintained to ensure the survival and future health of the fish population itself.



Graph 1: Large Mouth Bass Length X Weight in 1994 (blue) and 2021 (orange)

Additional comparison was drawn comparing the 2021 data in Leverett Pond and 2021 data from each of four other Massachusetts ponds (Appendix E). These include 20 total length and weight comparisons. Twelve out of those 20 comparisons show that Leveret Pond Fish are arithmetically larger than other ponds' fish. Of those 12 data points that are larger, 10 are significantly larger. These data indicate that the fish in Leverett Pond are flourishing (as compared to other waterbodies). However, the DO concentrations within much of the pond are at or nearing dangerously low levels and continued unchecked growth of aquatic vegetation will worsen these conditions. Vegetation within the pond will need to be managed prior to fish population stress. This will be critical in the maintenance of the existing healthy fish population.

See Section 5.4.1 for more detail on the DO conditions within the pond and its implications on fish health.

5.2.2 Vegetation Foraging Habitat and Cover Habitat

Submergent vegetation is ubiquitous throughout the pond. These aquatic beds provide cover and forage habitat for aquatic invertebrates, fish, reptiles, and amphibians. Sunfishes are ideally suited to the dense aquatic vegetation and shallow, warmer water temperatures. Dense submergent vegetation provides cover for fish from aerial predators such as kingfishers, or from diving ducks. Pondweeds are an important food source utilized by waterfowl such as mallard (*Anas platyrhynchos*), black duck (*Anas rubripes*), pintail (*Anas acuta*), and Canada geese. Diving ducks such as ringneck (*Aythya collaris*) and merganser (*Mergus merganser*) forage among this vegetation in search of small fish, particularly sunfish. Pied-billed grebe (*Podilymbus podiceps*) are also very common on the pond in the spring and are often seen foraging.

Dense persistent emergent vegetation, such as broad-leaved cattail along the southern margin of the pond, provide excellent nesting habitat for several species of birds, including red-winged black birds. Larval

dragonflies use non-persistent emergent and persistent emergent vegetation to climb from their aquatic habitats and eclose as flying adults. Adult dragonflies will then utilize these stems as perch sites on which to hunt prey. These emergent wetlands are densely vegetated and provide excellent cover and refuge habitat for amphibians, snakes, small mammals, and birds; and emergent plants, in addition to sheltered basking habitat for reptiles such as painted turtles. Dense rushes and sedges furnish important nesting cover for waterfowl as well as for marsh wrens (*Cistothorus palustris*) and red-winged blackbirds, and give concealing protection to muskrats, raccoons, and other small mammals. The hard seeds (or achenes) of rushes and sedges are one of the more important and most commonly used foods of ducks and of certain marsh birds. The stems and rootstocks are an important food source for muskrats and geese. Aquatic beds with rooted vascular plants, such as arrowhead (*Sagittaria latifolia*), can also provide sheltered areas along the margins of the pond where amphibians such as green frogs can lay eggs with less predatory pressure from fish.

Shrubs such as swamp loosestrife, buttonbush, maleberry, and alder colonize the bank and many islands throughout the pond. Swamp loosestrife, in particular, provides excellent cover habitat for numerous taxa and basking habitat for reptiles since the stems bend and form dense tangles at the water surface. Buttonbush has exceptional wildlife benefits, attracting many types of pollinators, waterfowl, birds, and mammals. Buttonbush and maleberry flowers provide nectar to pollinators, attracting hummingbirds, butterflies, and bees. Songbirds and waterfowl eat buttonbush seeds. Small mammals and birds will consume maleberry fruit. The exposed roots of shoreline shrubs provide fish with shelter from predators, waterfowl with refuge, foraging and nesting habitat, and reptiles with basking habitat. The leaves provide food for invertebrates, such as caterpillars of several species of moth, caddisflies, stoneflies, and water beetles. These, in turn, are preyed upon by fish. The wood of alder does not rot under water, and alder seeds are eaten by siskin (*Carduelis pinus*), redpoll (*Acanthis flammea*), and goldfinch (*Spinus tristis*). Portions of the pond bank contain overhanging roots or branches above the water's surface, which provide shade, cover, fishing/hunting perch sites, and basking sites.

Dead snags were observed along the pond shoreline and surrounding natural communities (see Appendix B). Standing dead trees often provide hollow areas and cavities used by mammals and birds for nesting, roosting, foraging, and perching and are considered significant habitat features to wildlife. Perches such as these are often utilized by kingfishers if they overlook open water, or dead snags can be used as foraging habitat by woodpeckers.

Tree canopy surrounding the pond includes a mix of deciduous and coniferous trees, including red maple, mixed oaks, eastern hemlock, and eastern white pine. Oaks provide mast, which is an important food source to wildlife species such squirrels, chipmunks, and white-tailed deer. Winter evergreens such as azalea and rhododendron provide excellent winter cover habitat along the shoreline margin.

Coarse woody debris is important as it may provide cover and basking habitat for small mammals, amphibians, reptiles, and fish. Coarse woody debris is common throughout the pond. SWCA observed several painted turtles and one garter snake utilizing coarse woody debris as basking habitat on the day of the June 7, 2021, assessment (see Appendix B).

5.2.3 Nesting and Breeding Habitat

Standing water can be an important habitat feature as it can provide rehydration, foraging, and breeding habitat for amphibians, reptiles, wading birds and waterfowl. Amphibian breeding was observed in June 2021 along the margins of the pond, and several amphibians have been documented utilizing the pond as breeding habitat (NEE 1994; Acorn Botanical Assessment 1999). Dense aquatic vegetation provides important breeding habitat for fish. Bass, chain pickerel, sunfish, and golden shiners all utilize dense growths of aquatic vegetation as part of the mating and nesting process. The submergent vegetation is

also important source of shelter and food for the newly hatched young of these different fish species. For example, newly hatched chain pickerel attach themselves to plants by an adhesive gland on the snout for about a week, during which time they subsist on the yolk. After they develop a complete mouth, they release themselves from the vegetation and are capable of feeding on small organisms.

The dense emergent vegetation provides suitable nesting habitat for, birds, waterfowl, and mammals (see photographs in Appendix B). Cattails provide nesting material and food for muskrats and geese. Standing dead trees often provide hollow cavities used by mammals and birds for nesting, roosting, foraging, and perching and are considered significant habitat features to wildlife, if present. SWCA observed several dead snags along the pond margins. Perches such as these are often utilized by kingfishers if they overlook open water, or dead snags can be used as foraging habitat by woodpeckers.

5.3 Landscape Context

The pond is surrounded by low-residential development and large blocks of interior forest (Department of Fisheries and Wildlife 2009). For example, approximately 314 acres of interior forest abuts the northern end of the pond and 1,044 acres of interior forest are located less than 1 kilometer east of the pond. The Long Hill Natural Area, consisting of approximately 35.3 acres, abuts the northwestern end of the pond and municipal lands consisting of approximately 10 acres abut the southern end of the pond plus an additional 0.7 acre associated with the dam at the northeastern end of the pond. Large areas of Priority and Estimated Habitats of rare species are located around the pond, but do not include the pond itself (NHESP 2020).

Habitat continuity is an important factor when determining impacts and overall habitat quality. Because of these large interior forested areas and protected open space areas, in addition to the locally low residential population, habitat continuity is excellent. Perennial and intermittent streams, large, vegetated wetland complexes and open water associated with the pond, and contiguous forested areas, provide contiguous habitat for a number of wildlife including turtles, frogs, waterfowl, and riparian animals such as mink.

5.4 Habitat Degradation

The primary threat to habitat quality at the pond is overgrowth of aquatic vegetation, decreased biodiversity, decreased oxygen levels within the pond, and thermal loading within the pond. Eurasian milfoil and variable-leaf milfoil are aggressive plant species that create a monoculture, outcompeting other plants and decreasing habitat value. It is an invasive plant species that if left untreated can lead to reduced native plant diversity and reduced habitat quality. Dense submergent vegetation may provide excellent cover habitat for prey, but it decreases predator habitat. Interspersion of open water and aquatic beds is optimal for a balanced predator-prey habitat matrix.

Dense aquatic vegetation, including Eurasian and variable-leaf milfoil but also water-shield and water lilies, lead to an increase in water temperature. Water lilies and water-shield cover approximately 40% of the pond surface, creating a biodome, trapping heat and increasing aquatic temperatures, which can lead to algal blooms. Populations of bladderwort have been shown to greatly decrease DO in the water column as well. Specific data collected by established and accomplished citizen scientists from the Friends is included in Section 5.4.1 to better illustrate the impact that these vegetation populations have.

Dense milfoil and bladderwort may cause low oxygen levels during late summer due to nocturnal plant respiration consumption of oxygen exceeding diurnal photosynthesis oxygen production. The GEIR recommends removal of excess aquatic vegetation when DO levels are below 5ppm (5 mg/L), which has

been measured within the pond (Table 5). Decreased dissolved oxygen lowers fish vitality and can lead to mortality. The ecological benefits of Pond Management will be to improve the fisheries in Leverett Pond, in part by removing dense areas of invasive aquatic species.

5.4.1 Dissolved Oxygen Results

Dissolved oxygen profiles were taken in 13 discrete locations within the pond (Profiles A-N). These were collected to discover what effect dense vegetation within the pond may have on DO, at what depths DO starts to decline, and how this compares to open water areas. Table 5 presents these data with a description of each Profile's location and relevant vegetation community.

These data suggest that there is a strong correlation between dense vegetation (either dense submerged, floating, or dead vegetation) and lower DO levels within the water column. Furthermore, there is a strong correlation between a rapid decrease in DO in these areas as water depth increases. Graphs 2 through 4 display various comparisons of these data.

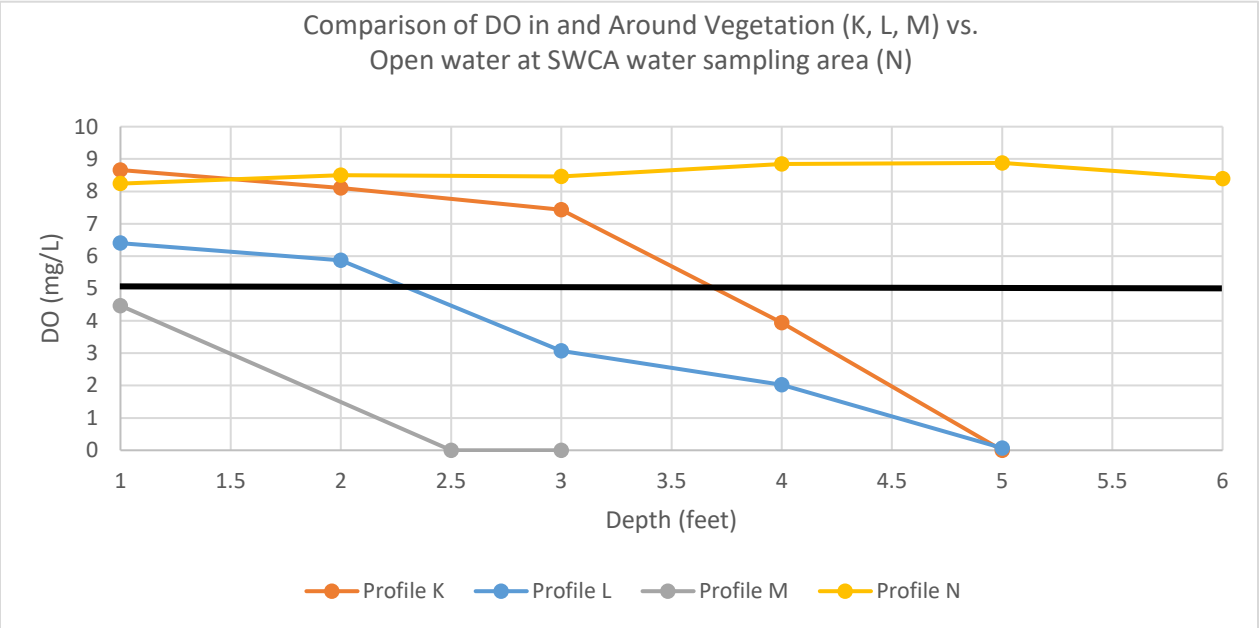
Table 5. Dissolved Oxygen Profiles A – N

Profile	Description	DO (mg/L) across the following depths (feet) from the surface									
		1	2	3	4	4.5	5	6	7	8	9
A	Open water between Hopley and Hankinson	8.50	7.91	6.51	6.48		6.08	4.94	0.81	1.00	0.45
B	Deep submerged milfoil between Hopley and Hankinson	5.98	5.96	5.93	5.96		5.73	4.76	4.36	0.01	0.07
C	Dense milfoil before channel opening (1) - milfoil present at 2 ft	6.38	5.83	5.44	1.21		0.00	0.00			
D	Dense milfoil before channel opening (2) - milfoil present at 2 ft	7.29	7.01	5.73	0.19		0.00	0.00			
E	Dense milfoil before channel opening (3) - milfoil present at 2 ft	7.44	6.60	5.76	1.16		0.00	0.00			
F	Open water 200 feet off J. Roberts Shore	6.62	6.71	6.60	6.51		6.49	6.57	6.52	6.28	6.05
G	Open water 400 feet off M. Dover Shore	6.92	7.06	7.03	6.98		6.96	6.92	7.04	7.01	7.03
H	Watershield Monolayer south of Jack and Claire	4.88	4.67	3.75	0.91						
I	Heavy mixed watershield, bladderwort, pond lilies	4.25	5.03	4.37	1.63		0.23				
J	Open water 100 feet off Hankinson, near islands & dead plant matter	7.93	7.71	7.83	4.06	0.05					
K	Open water 100 feet off Mulholland, near dense large leaf pondweed	8.66	8.10	7.43	3.94		0.00				
L	350 feet northeast of Chamberlain property, in dense watershield	6.40	5.87	3.07	2.02		0.07				
M	100 Feet north of public boat launch, middle of channel	4.47	0.00	0							
N	SWCA water sample location	8.24	8.50	8.46	8.85		8.88	8.39			

As discussed in Section 4.2, SWCA collected a water sample during the June 7, 2021 visit. This sample was collected at the center of the pond in a location that was free of vegeation to display average

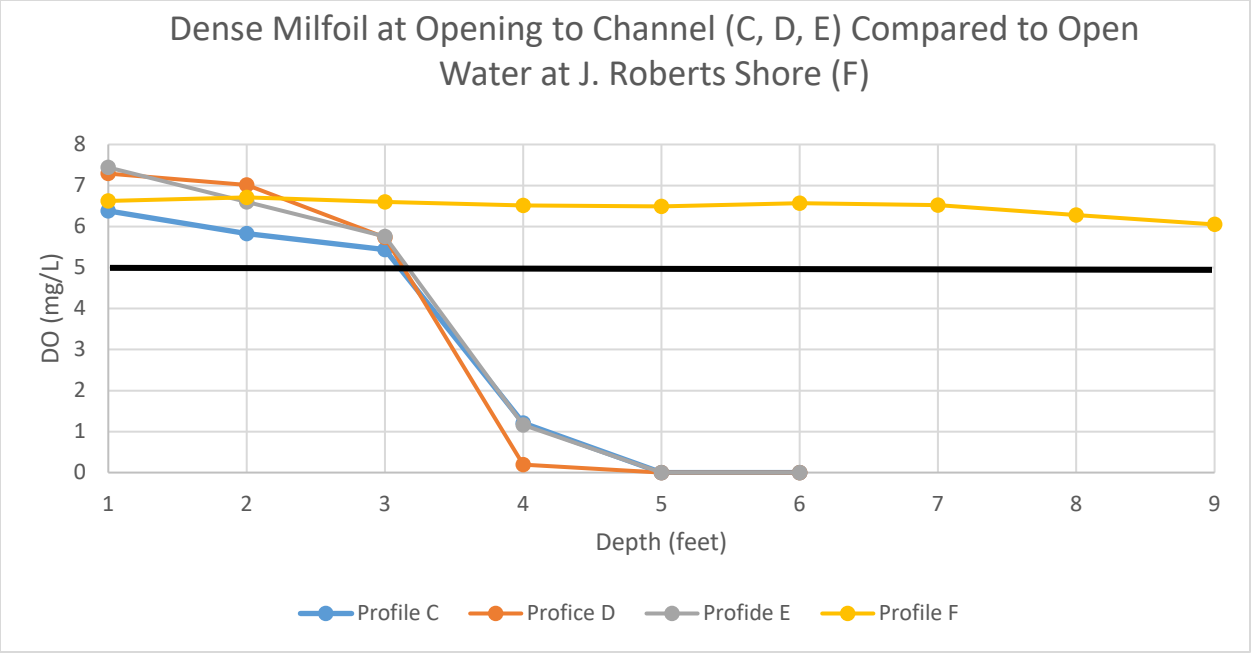
conditions wtihin the pond where there is not an overgrowth of vegetation. The primary metric of healthy fish habitat that is effected by dense vegeation is DO. Therefore, the Friends collected DO Profile N at this same location.

Graph 2 plots these data against other locations within or adjacent to dense vegetation. It is clear to see a trend of decreasing DO and, therefore, fisheries quality. Furthermore, while the open water area maintains DO concentrations of approxmiately 8.5 mg/L, the other profiles significantly decrease in DO concentrations around 2 to 3 feet below the surface. Furthermore, each of the samples from within or near dense vegeation drop below the GEIR-set 5 mg/L DO concentration at most 3.75 feet below the surface. Profile L, which is located in an area of dense watershield, shows DO concentrations below 5 mg/L approxmiately 2.25 feet below the surface and the sample near the public boat launch (Profile M) is below that management level at the surface.

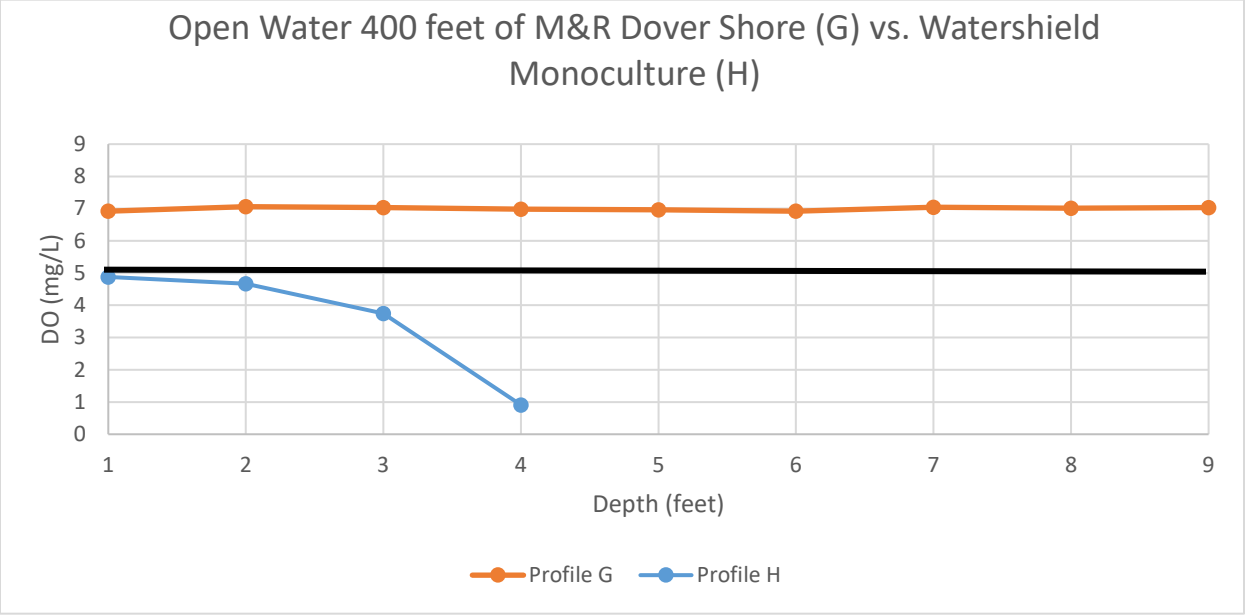


Graph 2. Dissolved Oxygen in open water vs. vegetated and near vegetated areas

Two more examples of this stark difference between open water and vegetated areas are displayed in Graphs 3 and 4. In each of these comparisons, the open water or areas without dense vegetation appear to contain healthy DO concentrations throughout the water column, whereas the densely vegetated areas reach a concentration below 5 mg/L, which again is the concentration at which vegetation management is recommended in the GEIR.



Graph 3. Dissolved Oxygen at Profiles C, D (channel), and E compared to Profile F (open water)



Graph 4. Dissolved Oxygen at Profile G (open water) and Profile H (watershield monoculture)

6 MANAGEMENT RECOMMENDATIONS

Considering all abovementioned data and analysis of existing and missing habitat features, including water quality, within the pond, SWCA developed a list of potential implications related to the proposed nuisance vegetation treatment methods.

The following recommendations include methods of reducing plant biomass within the pond. SWCA understands that the Friends are not interested in removing all vegetation, but rather to reach a healthier

density of aquatic vegetation within the pond. Reducing the biomass within the pond may increase DO, increase circulation and flow, and lower aquatic temperatures, which will improve fish and wildlife habitat. Additionally, the specific reduction of watershield and water lilies will reduce the temperature of the water, which would increase the quality of fisheries habitat. Decreased temperature will have a positive effect on DO as well, because colder water has a higher capacity for DO, as does increased circulation, which would also be a byproduct of thinning floating aquatic vegetation.

Furthermore, the vegetation present in the pond (at their current densities) utilize more oxygen for photosynthesis during their peak growth and throughout the growing season than they produce through respiration. Then, when the plants senesce in the fall, they utilize an exorbitant amount of oxygen during decomposition in the fall. The entire life cycle of these plants is a large stress to fisheries and other aquatic habitats.

6.1 Invasive and Nuisance Plant Management

There are various mechanical and chemical means of invasive and aggressive native vegetation management and the best pond management plans include an integrative and adaptive approach. SWCA understands that the Friends have implemented a variety of these methods in the past.

6.1.1 Chemical Management

Prior to any chemical application in a given year, a License to Apply must be obtained from MassDEP by a licensed aquatic applicator listing the specific chemicals and application rates proposed. We recommend that a copy of the annual license be provided to the Leverett Conservation Commission.

While a variety of herbicides have been utilized to manage vegetation within the pond in the past, recent innovations in herbicide development have resulted in more targeted and high effective species-specific management approaches. In particular, the invasive milfoil species within the pond should be managed using ProcellaCOR. ProcellaCOR was utilized in the last year of pond management (2019) with high efficacy. This systemic herbicide specifically targets these plants by direct chemical uptake by the plant and into the root system. This systemic uptake results in high success rates for plant control, requiring infrequent repeat applications.

Curly-leaf and other pondweeds will not be affected by ProcellaCOR and therefore would require a different management approach. Diquat (Reward, Tribune, or equivalent) is very effective on pondweed species as well as Elodia species. Furthermore, when applied at label-recommended rates, diquat has a relatively short half-life in natural (non-laboratory) environments, high sorption rates, and low toxicity to humans and wildlife. Diquat should be applied directly to target vegetation early in the season, before milfoil species start to flourish. Diquat is a contact herbicide and does not manage vegetation systemically, therefore it will only manage the above-root plant material and does not have a dramatic effect on future regrowth. It does, however, allow for effective reduction of dense invasive vegetation and can prevent its spread to other portions of a waterbody as well as between waterbodies.

There are not many effective means of chemically managing floating aquatic vegetation, as most herbicides that are effective require direct foliage contact. This is difficult to achieve with floating vegetation because direct application of herbicides is easily washed off by flowing water and the entire leaf structure does not make full contact with the waterbody. Diquat and other contact herbicides will have an effect on the floating aquatic species found within the pond (watershield and water lilies); however, flumioxazin (Clipper or equivalent) has much higher efficacy. Flumioxazin, however, needs to remain in the water column (with no over-dam flow) for 30 to 45 days in order to be effective. Holding back water within Leverett Pond for that amount of time is not feasible. Therefore, the best approach to

managing floating vegetation is with a combination of contact herbicide application and manual/mechanical methods of removal.

There is also a section of problematic cattail growth near the ROW boat launch and around an adjacent fire hydrant. SWCA suggests that this be managed using Clearcast if mechanical means are not permitted. If mechanical removal of cattail cannot be performed on the cattail in this area, the Friends should conduct herbicide application followed by cutting and revegetation to discourage the regrowth of cattail in this area.

Each of the proposed herbicide application methods is permitted for use in waterbodies of the Commonwealth and have been recommended for use in the General Environmental Impact Report (GEIR) for lakes and ponds for the Commonwealth of Massachusetts. When used at label-recommended rates, these herbicides are not toxic to aquatic life and will be applied in a sensitive manner, with care for non-target vegetation as well as aquatic wildlife. The proposed methods will also not have an effect on any mammal species, as uptake of herbicide is rapid enough to not require any use restrictions (including recreation) following applications at label-mandated rates. See Appendix D for a complete summary of the environmental fate, toxicology, and application rate information for each proposed herbicide.

6.1.2 Manual/Mechanical Management

The three methods describe in this section include hydroraking, use of a harvester, and hand-raking. Hydroraking is an efficient tool that can be used for the selective removal of nuisance or aquatic vegetation removal. A hydro-rake is a floating pontoon outfitted with a rake attachment at the end of a mechanical arm. The hydro-rake is launched from the bank and mobilizes across waterbodies, propelled by paddlewheels, which allow it to mobilize across very shallow water.

Hydroraking has been implemented in the pond in the past; however, SWCA does not recommend hydroraking or harvesting to manage the current vegetation assemblage within the pond. This is due to the requirements for additional permits from MassDEP, and the relatively small area that may cleared by hydroraking. Should the Town of Leverett require the excavation of the hydrant off Depot Road, we suggest a NOI for this area should be submitted as a new application.

A weed harvester is a technique that may be effectively used to reduce the volume of aquatic vegetation, particularly adjacent to the public boat launch, but this is not a long-term management solution to manage the large populations of floating aquatic vegetation (watershields and water lilies, primarily). However, includes the same permitting restrictions as hydroraking within great ponds. This mechanical cutting could provide additional open water habitat, increase DO, decrease water temperature, increase fish mobility routes, and provide recreational access to more portions of the pond.

Another recommended technique for reducing aquatic vegetation is by hand-raking. This technique is permitted by the GEIR and is an effective means of reducing dense stands of invasive and nuisance vegetation at the Public boat launch, and abutting private or public properties along the pond.

6.1.3 Drawdown

Another management option is implementing a drawdown of water in the pond, by using the newly installed outlet control structure. As permitted in the GEIR, data from Massachusetts have shown that there is no long-term impact to fisheries and wildlife in a pond if the drawdown is 3 feet or less. The water needs to be released slowly over time, to allow wildlife to find shelter in deeper areas and to not overwhelm downstream systems. Drawdowns are commonly performed in late fall or winter and the

exposed section of the littoral zone are exposed over the winter months. The dam can be closed in December to allow water to naturally raise to original bank-full water depths within the pond.

In consultation with MassWildlife and the Conservation Commission, SWCA recommends at least one drawdown during the five-year Order of Conditions to reduce dense stands of aquatic vegetation along the shoreline. The goal of this is to significantly reduce the density of vegetation and therefore reduce the frequency and amount of herbicide applications.

6.2 Long-Term Management Strategies

While it is likely that some level of vegetation management (particularly milfoil species, swollen bladderwort, curly-leaf pondweed, watershield, and water lily management) will need to continue on a regular basis, there are strategies that the Friends can take to reduce the continued need for invasive and aggressive native aquatic vegetation management. The first of these is educating pond users on means of reducing the spread of invasive plant species. The Friends have noticed that users of the ROW boat launch often have invasive plant species attached to their boat and/or boat trailer. The Friends should utilize relevant State educational brochures to lake users at the boat launch area and consider installing washing stations in upland areas around the pond. This could decrease the frequency of invasive plant reestablishment from recreational use in the pond.

7 SUMMARY

Leverett Pond contains good water quality and hosts a number of fish and other wildlife species. However, the growing density of submerged and floating invasive and nuisance aquatic vegetation is threatening the health of the waterbody. The Friends have successfully maintained the health and ecological integrity of the pond over the years. But in order to maintain high water quality and wildlife habitat value, continued pond management is needed. Management strategies include a mix of mechanical/manual and chemical approaches and will be performed as needed, adapting management strategies as best suits current conditions. Adaptive management is key to successful lake and pond management and the Friends have done a highly credible job with this approach in past years.

We are providing the Leverett Conservation Commission with draft Special Conditions recommended by MassDEP, and those used by other towns regulating Lake and Pond management. These Conditions include significant reporting on work proposed during each year, and an annual reporting to the Conservation Commission.

Each of the management approaches described within this report have been submitted to the local Conservation Commission and MassDEP. Each method aligns with the suggestions of the GEIR for the Commonwealth of Massachusetts as well as other state and local pond management guides. The Friends should continue to collect water quality, vegetation, and other observational notes throughout the growing seasons to continue to adapt and monitor the health of the waterbody.

8 LITERATURE CITED

Acorn Botanical Services. 1999. Leverett Pond Management Plan. Prepared for and submitted to the Friends of Leverett Pond. 28 pp. Available at: http://people.umass.edu/~jmfield/POND_1.html.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior Fish and Wildlife Service Office of Biological Services. Washington D.C., USA.

Friends of Leverett Pond. Leverett Pond Weed Management Proposal. Accessed July 2021. Available at: https://leverett.ma.us/files/Leverett_Pond_Weed_Management_Proposal.pdf

Martin, Alexander, C., H. S. Zim and A. L. Nelson. 1951. American Wildlife and Plants A Guide To Wildlife Food Habits. Dover Publications, Inc., USA.

Massachusetts Paddler Association. 2020. Leverett Pond. Accessed July 2021. Available at: https://massachusettspaddler.com/leverett-pond-leverett-franklin-county.

New England Environmental, Inc. (NEE) 1994. Leverett Pond Land Under Waterbody Wildlife Habitat Evaluation. Prepared for and submitted to the Friends of Leverett Pond. 24 pp.

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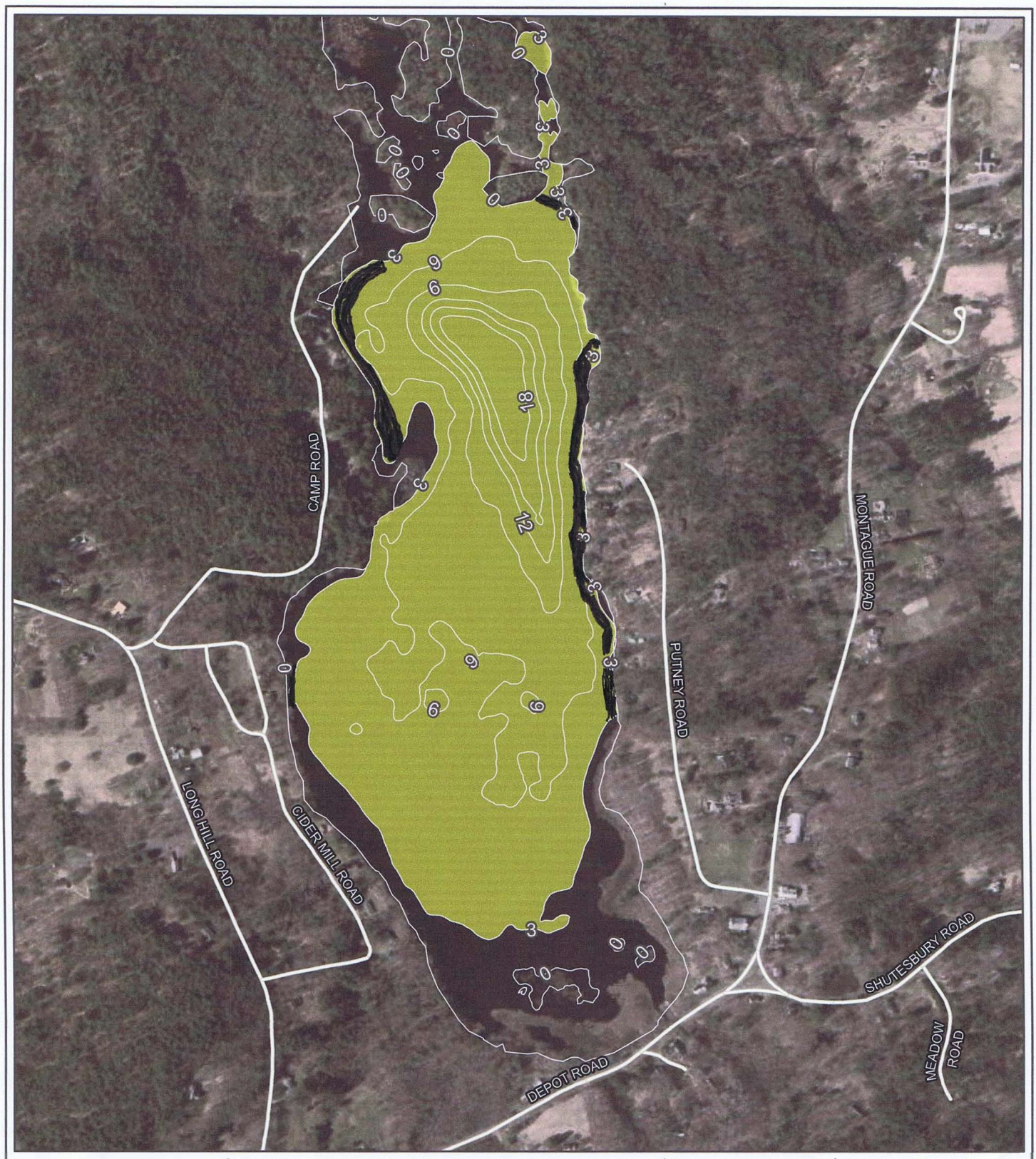
APPENDIX A

Figures



LEVERETT POND INVASIVE SPECIES CONTROL

Figure 3 Safe Zone 2 - Drawdown

Water Depth (ft)

Drawdown Safe Zone

MassDOT Roads

Area of winter drawdown of 3 feet pond-wide. Green area is wildlife safe zone during drawdown.

Leverett, MA
72.5051°W 42.4561°N

N

1:7,000

0 200 400 Feet

0 100 200 Meters

Updated: 9/8/2021
Project No. 64784

SWCA ENVIRONMENTAL CONSULTANTS

Photo 7: SWCA observed several painted turtles, such as this one, basking on woody debris. *Photo taken June 7, 2021*

Photo 10: Dead snags such as this one provide important nesting, foraging, and hunting perch habitat. *Photo taken June 7, 2021*

Photo 8: View of a shrub-dominated island with one of several beaver lodges within the Pond. This lodge is among several islands and 'floating' islands near the northern end of the Pond. *Photo taken June 7, 2021*

Photo 11: View facing west in between two islands near the northern end of the Pond. Emergent vegetation such as this provides dragonfly habitat. *Photo taken June 7, 2021*

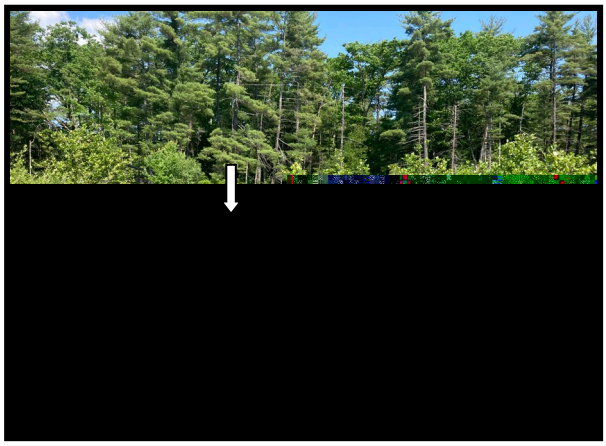


Photo 9: View of dense aquatic vegetation and Pond margins. A painted turtle is basking on woody debris in the distance (arrow). *Photo taken June 7, 2021*

Photo 12: View of the eastern Pond shoreline showing dense shrub growth. Swamp loosestrife grows in arching tangles at and below the water's surface, providing cover and refuge habitat. *Photo taken June 7, 2021*

Photo 13: View facing east showing the dam located along the northeastern Pond shoreline. *Photo taken June 7, 2021*

Photo 16: View of a birds nest among the cattails and shrubs along the Pond shoreline. *Photo taken June 7, 2021*

Photo 14: View one of the several beaver lodges in the Pond. This lodge is among several islands and 'floating' islands at the southern end of the Pond. *Photo taken June 7, 2021*

Photo 17: View facing north showing vegetated islands within the Pond and dense aquatic vegetation within the Pond. *Photo taken June 7, 2021*

Photo 15: Dense colonies of cattails grow along the margins of the Pond. *Photo taken June 7, 2021*

Photo 18: View of largeleaf pondweed, which grows in dense colonies throughout the Pond. *Photo taken June 7, 2021*

APPENDIX C

Water Chemistry Lab Analysis

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SePRO Research & Technology Campus SeSCRIPT*

16013 Watson Seed Farm Road, Whitakers, NC 27891

Chain of Custody: COC9979 **LABORATORY REPORT**

Customer Company **Customer Contact**

Company Name: SWCA Inc	Contact Person: Naomi Valentine
Address: 3033 North Central Ave Phonix AZ 85012	E-mail Address: nvalentine@swca.com
	Phone: 4136582012

Waterbody Information

Waterbody:	Leverett Pond - Center of Pond Sample
Waterbody size:	102
Depth Average:	4

Sample ID	Sample Location	Test	Method	Results	Sampling Date / Time
CTM28129-1	Leverett	Turbidity (NTU)	EPA 180.1	1.3	06/07/2021
		Conductivity (uS/cm)	EPA 120.1	121.2	
		Dissolved Oxygen (mg/L)	EPA 360.1	8.6	
		Chlorophyll a (ug/L)	EPA 445	<10	
		Total Phosphorus (ug/L)	EPA 365.3	<10	
		Total Hardness (mg/L as CaCO3)	EPA 130.2	34.8	
		Total Kjeldahl Nitrogen (mg/L)	EPA 351.2	0.2	
		pH	EPA 150.1	7.8	

ANALYSIS STATEMENTS:
SAMPLE RECEIPT /HOLDING TIMES: All samples arrived in an acceptable condition and were analyzed within prescribed holding times in accordance with the SRTC Laboratory Sample Receipt Policy unless otherwise noted in the report.
PRESERVATION: Samples requiring preservation were verified prior to sample analysis and any qualifiers will be noted
in the report.
QA/QC CRITERIA: All analyses met method criteria, except as noted in the report with data qualifiers.
COMMENTS: No significant observations were made unless noted in the report.
MEASUREMENT UNCERTAINTY: Uncertainty of measurement has been determined and is available upon request.

Laboratory Information
Date / Time Received: 06/18/21 11:00 AM
Date Results Sent: Friday, June 25, 2021

Disclaimer: The results listed within this Laboratory Report relate only to the samples tested in the laboratory. The analyses contained in this report were performed in accordance with the applicable certifications as noted. All soil samples are reported on a dry weight basis unless otherwise noted in the report. This Laboratory Report is confidential and is intended for the exclusive use of SRTC Laboratory and its client. This report shall not be reproduced, except in full, without written permission from SRTC Laboratory. The Chain of Custody is included and is an essential component of this report.

This entire report was reviewed and approved for release.

Reviewed By: Laboratory Supervisor

SePRO Research & Technology Campus SeSCRIPT*

16013 Watson Seed Farm Road, Whitakers, NC 27891

Chain of Custody: COC10784 **LABORATORY REPORT**

Customer Company **Customer Contact**

Company Name: Friends of Leverett Pond, INC	Contact Person: Mitchell Mulholland
Address: 35 Cider Mill Rd Leverett, MA 01054-0209	E-mail Address: mulholland@anthro.umass.edu
	Phone: 413-548-9161

Waterbody Information

Waterbody:	Leverett Pond - Public Access Sample
Waterbody size:	102
Depth Average:	4

Sample ID	Sample Location	Test	Method	Results	Sampling Date / Time
CTM30486-1	LPPA-1	Turbidity (NTU)	EPA 180.1	4.2	08/19/2021
		Conductivity (uS/cm)	EPA 120.1	253.0	
		Salinity (ppT)	EPA 120.1	<1	
		Free Reactive Phosphorus (ug/L)	EPA 365.3	42	
		Dissolved Oxygen (mg/L)	EPA 360.1	6.7	
		Total Phosphorus (ug/L)	EPA 365.3	111.4	
		Alkalinity (mg/L as CaCO3)	EPA 310.2	54.2	
		Total Hardness (mg/L as CaCO3)	EPA 130.2	57.3	
		Total Nitrate (mg/L) and Nitrite (mg/L)	Campbell et al 2004	0.1	
		Nitrite (mg/L)	Campbell et al 2004	<0.02	
		Nitrate (mg/L)	calculated	0.1	
		Total Kjeldahl Nitrogen (mg/L)	EPA 351.2	0.6	
		Total Nitrogen (mg/L)	calculated	0.7	
		pH	EPA 150.1	6.9	

ANALYSIS STATEMENTS:
SAMPLE RECEIPT /HOLDING TIMES: All samples arrived in an acceptable condition and were analyzed within prescribed holding times in accordance with the SRTC Laboratory Sample Receipt Policy unless otherwise noted in the report.
PRESERVATION: Samples requiring preservation were verified prior to sample analysis and any qualifiers will be noted
in the report.
QA/QC CRITERIA: All analyses met method criteria, except as noted in the report with data qualifiers.

COMMENTS: No significant observations were made unless noted in the report.
MEASUREMENT UNCERTAINTY: Uncertainty of measurement has been determined and is available upon request.

Laboratory Information
Date / Time Received: 08/20/21 11:15 AM
Date Results Sent: Wednesday, August 25, 2021

This entire report was reviewed and approved for release.

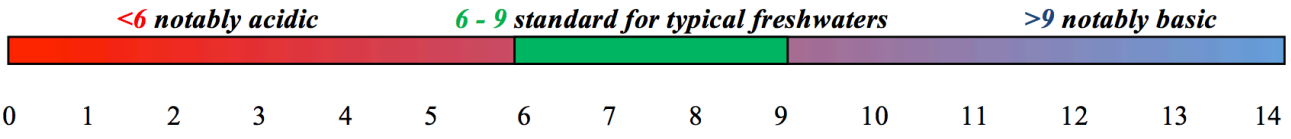
Reviewed By: Laboratory Supervisor

SRTC SePRO Research & Technology Campus SePRO

Water Quality Analysis Explanation

These water quality parameters are essential to document the condition of a water body and design custom treatment prescriptions to achieve desired management objective

pH: Measure of how acidic or basic the water is (pH 7 is considered neutral).



Hardness: Measure of the concentration of divalent cations, primarily consisting of calcium and magnesium in typical freshwaters. *0-60 mg/L as CaCO3 soft; 61-120 moderately hard; 121-180 hard; > 181 very hard*

Alkalinity- Measure of the buffering capacity of water, primarily consisting of carbonate, bicarbonate and hydroxide in typical freshwaters. Waters with lower levels are more susceptible to pH shifts.
<= 50 mg/L as CaCO3 low buffered; 51-100 moderately buffered; 101-200 buffered; > 200 high buffered

Conductivity- Measure of the waters ability to transfer an electrical current, increases with more dissolved ions.
< 50 uS/cm relatively low concentration may not provide sufficient dissolved ions for ecosystem health; 50-1500 typical freshwaters; > 1500 may be stressful to some freshwater organisms, though not uncommon in many areas

Dissolved Oxygen- amount of diatomic oxygen dissolved in the water.
< 2 mg/L likely toxicity with sufficient exposure duration; < 5 stressful to many aquatic organisms; >= 5 able to support most fish and invertebrates

Phosphorus: Essential nutrient often correlating to growth of algae in freshwaters.

Total Phosphorus (TP) is the measure of all phosphorus in a sample as measured by persulfate strong digestion and includes: inorganic, oxidizable organic and polyphosphates. This includes what is readily available, potential to become available and stable forms. *<12 µg/L oligotrophic; 12-24 µg/L mesotrophic; 25-96 µg/L eutrophic; > 96 µg/L hypereutrophic*
Free Reactive Phosphorus (FRP) is the measure of inorganic dissolved reactive phosphorus (PO4-3, HPO4-2, etc). This
form is readily available in the water column for algae growth.

Nitrogen: Essential nutrient that can enhance growth of algae.

Total N is all nitrogen in the sample (organic N+ and Ammonia) determined by the sum of the measurements for Total Kjeldahl Nitrogen (TKN) and ionic forms.
Nitrites and Nitrates are the sum of total oxidized nitrogen, often readily free for algae uptake.
< 1 mg/L typical freshwater; 1-10 potentially harmful; >10 possible toxicity, above many regulated guidelines

Chlorophyll a: primary light-harvesting pigment found in algae and a measure of the algal productivity and water quality in a system.
0-2.6µg/L oligotrophic; 2.7-20 µg/L mesotrophic; 21-56 µg/L eutrophic; > 56 µg/L hypereutrophic

Turbidity- Measurement of water clarity. Suspended particulates (algae, clay, silt, dead organic matter) are the common constituents impacting turbidity.
< 10 NTU drinking water standards and typical trout waters; 10-50 NTU moderate; > 50 NTU potential impact to aquatic life.

APPENDIX D

Supplemental Herbicide Information

1. PROPOSED PRODUCT REVIEW

Neither of the proposed herbicides are on the Massachusetts Groundwater Protection List, which means that the state does not consider these pesticides in danger of potentially impacting groundwater. This is determined based on chemical characteristics and toxicological profile.

The following product review includes information on specific label requirements, general chemical process, and toxicology. The label requirements mandate how each pesticide may be applied (application rate, restrictions on application size, and frequency) and post-application water use restrictions. These are mandated by the state and federal government and are the primary guidelines for any application. The next level of research includes how the chemicals themselves react in the environment – how mobile they are, how long they may persist, and ultimately how likely it is that they will reach groundwater.

1.1. Pertinent Label Information

The information detailed below has been collected from each of the proposed pesticide's labels. Some restriction information has been omitted due to a lack of relevance to the proposed work. For example, there are some agricultural restrictions that are not relevant to this project, but they are likely included in most herbicide and algaecide labels.

Table 1. Proposed Pesticide Label Information

Chemical Name	Active Ingredient	Aquatic Application Rate	Restrictions
ProcellaCOR	Florphyrauxifen-benzyl	1 to 5 PDU	Irrigation – 6 hours to 7 days Max application rate of 25 PDU per acre-foot and three applications per year No restrictions for recreation, including swimming and fishing
Diquat	Diquat dibromide [6,7-dihydrodipyrido (1,2-a:2',1'-c)pyrazinediium dibromide]	2 ppm	Domestic water restriction of 3 days Irrigation restrictions of 3 days No swimming, fishing, or recreation restrictions

Notes: µg/L = micrograms per liter; ppb = parts per billion; ppm = parts per million; PDU = Product Dose Unit (1 PDU ProcellaCOR = 0.0052 pounds active ingredient).

*From Mass Drinking Water Standard - adopted from Maximum Contaminant Levels (MCLs) published by the EPA as part of the Phase V rule (57 Federal Register [FR] 31776: 7-17-92)

1.2. Chemical Process

Understanding the way in which each pesticide reacts with vegetation, water, and sediment is integral to determining how water quality may be affected by each application. Overall, the proposed pesticides are on the low end of persistence, mobility and potential to reach groundwater and are therefore unlikely to cause any disturbance to water quality, vegetation or wildlife/fisheries.

Table 2. Proposed Pesticide Chemical Processes

Chemical Name	Pesticide Type	Half Life	Soil Persistence/ Mobility	Water Persistence/ Mobility	Potential to Reach Groundwater
ProcellaCOR	Systemic Herbicide; Selective	1-2 Days	Low to no persistence and/or mobility	Miscible with water – rapidly degrades – Low mobility and persistence	Very Low/None
Diquat	Contact Herbicide Broad Spectrum	< 48 hours	Binds to soil rapidly – becomes biologically unavailable/ Very low	Very low	Very Low

1.3. Toxicology

The EPA has established concentrations at which pesticides would be potentially harmful to human health. These are called Maximum Contaminant Level Goals (MCLG), Maximum Contaminant Levels (MCL), and Human Health Benchmarks for Pesticides (HHBP). The MCLG and MCL levels were established prior to the HHBP by the EPA. These were established under the National Primary Drinking Water Regulations (NPDWR), which are legally enforceable primary standards and treatment techniques that apply to public water systems. The HHBP were updated in 2017 for any contaminants that the EPA determined would require additional testing and reevaluation. These levels all represent the concentration (parts per million [ppm]) at which human health effects could potentially be observed both for low (one-day) and chronic (long-term or lifetime) exposure. The EPA does not advise concern nor remedial action for any positive water testing readings below these levels.

Table 3. Pesticide Toxicology Information

Chemical Name	Species – toxicity level	Human Toxicity Info	Byproduct Toxicity	HHBP, MCLG & MCL
ProcellaCOR	Fish – low Aquatic inverts. – low Humans – low	Low impact on human health – no drinking water or recreational use restrictions – minimal PPE	N/A	None – no significant human health risk
Diquat	Fish – Low Honey Bee – Low Humans – acute toxicity	Toxicity related to direct consumption or contact (e.g. applicators) – acute and low	N/A	MCLG & MCL 0.02 ppm

2. SUMMARY OF DATA

The following section draws conclusions on potential human health risks and recommendations on the use of each proposed pesticide.

2.1. ProcellaCOR

ProcellaCOR is one of the most environmentally sensitive herbicides on the market. Its very low impact allowed it to qualify for a special expedited approval process, which means that the results of rigorous

testing were so conclusive, that the approval process was able to be shortened at the Federal level. However, this does not mean that there was less testing or less thorough analysis of impacts, toxicology, or environmental fate. Additionally, the Commonwealth of Massachusetts conducted its own analysis and approval of ProcellaCOR through MassDEP and MassWildlife.

ProcellaCOR is a systemic aquatic herbicide that is selective to milfoil species and select other aquatic vegetation (*Azolla, sp., Eichhornia sp., Alternanthera philoxeroides, Nelumbo lutea, Nyphoides sp., Hydrocotyle umbellata, Ludwigia sp., Brasenia schreberi, Bacopa sp., Ceratophyllum demersum, Hydrilla verticillata,* and *Trapa sp.*).

There are no MCLGs or MCLs for ProcellaCOR because of its extremely low impact to human health. There are no recordable impacts and personal protective equipment required for ProcellaCOR treatment is very limited because of that.

ProcellaCOR is the preferred herbicide for treatment within Leverett Pond because of its selectivity and extremely low impact to human and environmental health. If ProcellaCOR cannot be used for treatment, the next option proposed is the use of diquat (Reward, Tribune, or equivalent). See Section 2.2 for details on diquat.

2.2. Diquat

Diquat is a broad-spectrum contact herbicide registered for aquatic use. The trade name to be used during this pond management program is Reward, Tribune, or equivalent. Diquat has a short half-life of 48 hours or less in the environment (outside of sterile lab settings). This is because diquat reacts with water and plant material rapidly and bonds very stably to sediment. This results in very low mobility in water and soil of both its active ingredients and by-products, and results in very low leaching to groundwater. There would be a very low chance of diquat reaching and/or remaining within any drinking water source.

The MCLG and MCL for diquat is 0.02 ppm. The ECA will apply no higher than an application rate of 0.5 gallons per surface acre to a maximum of half of the pond at one time, which computes to a concentration of 0.09 ppm immediately upon application. However, the high sorption rates and quick half-life of diquat in water would reduce this concentration by more than half following application. Moreover, diquat will not mobilize to drinking water and the MCLG for diquat is calculated by consumption of 0.22 milligrams of diquat per kilogram (consumer's weight) per day. There is no chance this quantity if diquat would be consumed per day by any recreational users, let along nearby homeowners. The EPA lists the development of cataracts as the potential health effect from long-term exposure at levels greater than the MCL. This risk is primarily associated with applicator health and not a threat to the health of Leverett Pond or its surrounding area.

APPENDIX E

Supplemental Comparative Fish Data

Comparative Analysis of Average Length and Weight of Five Species of Fish Commonly Found in Northeast Freshwater Waterbodies

Table 1. Comparative Analysis of Fish Species in Leverett Pond vs. Other Waterbodies

Fish Species	Length (mm)			Weight (g)		
	Comparative Pond	Leverett Pond		Comparative Pond	Leverett Pond	
(A) Largemouth Bass						
Lake Warner	300.81	267.49			286.73	
Lake Wyola	351.25	267.49		794.00	286.73	*
Cranberry Pond	**108.25**	**267.49**	*		286.73	
Lake Rohunta	**128.53**	**267.49**	*	**160.44**	**286.73**	
(B) Bluegill						
Lake Warner	150.42	122.63	*		93.05	
Lake Wyola	129.83	122.63		**73.40**	**93.05**	
Cranberry Pond	**115.63**	**122.63**		**36.28**	**93.05**	*
Lake Rohunta	**115.31**	**122.63**		**67.23**	**93.05**	
(C) Chain Pickerel						
Lake Warner	418.50	352.45			233.68	
Lake Wyola	**176.57**	**352.45**	*	**47.14**	**233.68**	*
Cranberry Pond	**232.15**	**352.45**	*	**131.36**	**233.68**	*
Lake Rohunta	**247.73**	**352.45**	*	**122.57**	**233.68**	*
(D) Pumpkinseed						
Lake Warner	178.55	155.96			136.20	
Lake Wyola	197.00	155.96		192.50	136.20	
Cranberry Pond	**144.20**	**155.96**		**67.40**	**136.20**	*
Lake Rohunta	**79.00**	**155.96**	*	**79.00**	**136.20**	
(E) Yellow Perch						
Lake Warner	**235.83**	**260.75**	*		211.80	
Lake Wyola	**173.16**	**260.75**	*	**75.21**	**211.80**	*
Cranberry Pond	301.00†	260.75		269.00†	211.80	
Lake Rohunta	**210.33**	**260.75**	*	**131.33**	**211.80**	*

Note: **bolded text** = comparisons in which Leverett Pond samples are arithmetically larger; * = comparisons that are significantly different at the 0.05 level of significance by Student's t-Test; † = only one yellow perch was collected during the Cranberry Pond survey and this was not included in the statistical comparison.

Data Source: Massachusetts Division of Fisheries and Wildlife 2021 Fish Surveys