LEWIS CREEK, BRISTOL POND, AND MONKTON POND
Addison County and Chittenden County, Vermont

INVASIVE PLANT MANAGEMENT PLAN

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PREPARED BY Matthew Gorton

For Lewis Creek Association

LEWIS CREEK ASSOCIATION

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INTRODUCTION

Aquatic invasive species (AIS) are expensive to control, costing town, State, and Federal governments millions of dollars annually. AIS species are easily spread between waterbodies via (but not limited to) fishing equipment, recreational equipment, and the transport of watercraft and their trailers. The spread of AIS is effectively minimized through education and outreach, equipment inspections, watercraft decontaminations, and community involvement. Without community involvement and volunteer support, the long-term management of AIS in the Lewis Creek watershed would be financially unsustainable. Therefore, Lewis Creek Association's (LCA) goal is to get the communities in the Lewis Creek watershed involved in early detection and rapid response, in order to prevent and control AIS within the watershed.

Description of the Sites

Lewis Creek

The Lewis Creek watershed provides important habitat for many fish, bird, amphibian, reptile, mammal, and invertebrate species. It also provides countless recreational opportunities for the people who inhabit the catchment area. Therefore, the conservation and continued protection of Lewis Creek and its surrounding land should be a high priority for the towns within the watershed.

Lewis Creek is located in the Champlain Valley and northern Green Mountain biophysical region in northern Addison County and southern Chittenden County Vermont. Lewis Creek is 33 miles long, with a catchment area of 81 square miles (LCA 2013; VTDECa undated). The headwaters of Lewis Creek originate in the forested mountains of Starksboro south of Ireland Road. The creek primarily flows through agricultural lands after it crosses Route 116 and drains into Lake Champlain at Hawkins Bay in Ferrisburgh.

Lewis Creek, despite its small watershed size compared to other major rivers entering Lake Champlain, has a high diversity in stream natural community assemblage types (6 of 7 fish and 9 of 10 macroinvertebrate aquatic natural stream community types found in Vermont) (Fiske and Langdon 2012). Three State priority natural communities and multiple class two wetlands exist within and around Lewis Creek (VTANR 2020). These natural communities are Hemlock-Balsam Fir-Black Ash Seepage Swamps (S3), Wet Clayplain Forests (S2), and Deep Bulrush Marshes (S4). Hemlock-Balsam Fir-Black Ash Seepage Swamps are characterized by yellow birch (*Betula alleghaniensis*), red maple (*Acer rubrum*), eastern hemlock (*Tsuga canadensis*), balsam fir (*Abies balsamea*), black ash (*Fraxinus nigra*), cinnamon fern (*Osmunda cinnamomea*), sphagnum moss (*Sphagnum* spp.), common fern moss (*Thuidium delicatulum*), Schreber's moss (*Pleurozium schreberi*), and liverwort (*Bazzania trilobata*). Wet Clayplain Forests are characterized by swamp white oak (*Quercus bicolor*), American elm (*Ulmus americana*), bur oak (*Quercus macrocarpa*), winterberry holly (*Ilex verticillata*), northern arrowwood (*Viburnum dentatum* var. *lucidulum*), lakeshore sedge (*Carex lacustris*), slender sedge (*Carex tenera*), swollen sedge (*Carex intumescens*), blunt broom sedge (*Carex tribuloides*), marsh fern (*Thelypteris palustris*), and Bailey's sedge (*Carex baileyi*). Deep Bulrush Marshes are characterized by soft-stem bulrush (*Scirpus validus*), hard-stem bulrush (*Scirpus acutus*), river bulrush (*Scirpus fluviatilis*), marsh spikerush (*Eleocharis palustris*), three-square bulrush (*Scirpus americanus*), slender bulrush (*Scirpus heterochaetus*), pickerelweed (*Pontederia cordata*), broad-leaved arrowhead (*Sagittaria latifolia*), bur-reed (*Sparganium* spp.), pondweeds (*Potamogeton* spp.), common coontail (*Ceratophyllum demersum*), and elodea (*Elodea canadensis*) (Thompson and Sorenson 2005).

Lewis Creek is known to support 44 species of fish, 153 species of bird, 15 species of amphibians, 11 species of reptiles, and many species of mammals and mussels (Andrews 2020; Fiske and Langdon 2012; Langdon *et al.* 2006; Sullivan *et al.* 2009). Two fish species are listed as high priority species of greatest conservation need (SGCN) and 3 fish species are listed as medium SGCN priority in Vermont. 15 bird species that use Lewis Creek are listed as high priority SGCN and 12 bird species are listed as medium priority SGCN (VTFWb 2015). Four endangered bird species, Bald Eagles (*Haliaeetus leucocephalus*), Black Terns (*Chlidonias niger*), Common Nighthawks (*Chordeiles minor*), and Rusty Blackbirds (*Euphagus carolinus*), are known to use Lewis Creek (VTFWa 2015). Four endangered mussel species, pocketbooks (*Lampsilis ovata*), fluted shells (*Lasmigona costata*), pink heelsplitters (*Potamilus alatus*), and fragile papershells (*Leptodea fragilis*), are found in Lewis Creek (Fiske and Langdon 2012). There are multiple rare, threatened, endangered and uncommon vascular plants, invertebrate animals, and vertebrate animals in and around Lewis Creek (VTANR 2020).

Bristol Pond and Monkton Pond

Bristol Pond (also known as Winona Lake) and Monkton Pond (also known as Cedar Lake) are located in northern Addison County. Bristol Pond drains into Lewis Creek via Pond Brook to the east of Silver Street in Hinesburg. Pond Brook's catchment area is 18.3 square miles and accounts for 23% of Lewis Creek's 81 square mile watershed (LCA 2013). Monkton Pond drains into Lewis Creek via Cedar Brook between Baldwin Road in Hinesburg and Roscoe Road in Charlotte. Cedar Brook has a catchment area of 5.4 square miles, accounting for 7% of Lewis Creek's watershed.

Bristol Pond forms a large biodiverse wetland complex that contains three State priority natural communities and is surrounded by class two wetlands (VTANR 2020). The natural communities within the Bristol Pond wetland complex are Black Spruce Woodland Bogs (S2), Dwarf Shrub Bogs (S2), Poor Fens (S2), and Intermediate Fens (S2). Black Spruce Woodland Bogs are typically characterized by black spruce (*Picea mariana*), bog labrador tea (*Rhododendron groeniandicum*), three-seeded sedge (*Carex trisperma*), sphagnum moss, highbush blueberry (*Vaccinium corymbosum*), and black huckleberry (*Gaylussacia baccata*). Dwarf Shrub Bogs are typically characterized by sheep laurel (*Kalmia angustifolia*), leatherleaf (*Chamaedaphne calyculata*), black spruce (*Picea mariana*), cup lichens (*Cladina* spp.), and Canada rosebay (*Rhododendron canadense*). Poor Fens are characterized by leatherleaf (*Chamaedaphne calyculata*), cottongrass (*Eriophorum virginicum*), sphagnum moss, few-seeded sedge (*Carex* oligosperma), coastal sedge (*Carex exilis*), bog-sedge (*Carex limosa*), white beak-sedge (*Rhyncospora alba*), liverwort (*Odontoschisma* spp.), cranberry (*Vaccinium macrocarpon*), and bog cranberry (*Vaccinium oxycoccos*). Intermediate Fens are typically characterized by sweetgale (*Myrica gale*), leatherleaf (*Chamaedaphne calyculata*), wiregrass Sedge (*Carex lasiocarpa*), common beaked sedge (*Carex utriculata*), bladderwort (*Utricularia* spp.), shrubby cinquefoil (*Dasiphora fruticosa*), and smooth sawgrass (*Cladium mariscoides*) (Thompson and Sorenson 2005).

Monkton Pond is not known to have any State priority natural communities. However, the pond is surrounded by class two wetlands and contains pondweeds, elodea, spatterdock (*Nuphar advena*), and white water-lily (*Nymphaea odorata*) (VTANR 2020).

Bristol Pond is known to support seven species of fish, 142 species of bird, nine species of amphibians, five species of reptiles, and many species of mammals (Andrews 2020; Langdon *et al.* 2006; Sullivan *et al.* 2009). Nine bird species that use Bristol Pond are listed as high priority species of greatest conservation need (SGCN) and six bird species are listed as medium priority SGCN in Vermont (VTFWb 2015). Two endangered bird species, Bald Eagles and Rusty Black Birds, are known to use Bristol Pond (VTFWa 2015). There are multiple rare and uncommon vascular plants, invertebrate animals, and vertebrate animals in and around Bristol Pond (VTANR 2020).

Monkton Pond is known to support 13 species of fish, 76 species of bird, three species of amphibians, four species of reptiles, and many species of mammals (Andrews 2020; Langdon *et al.* 2006; Sullivan *et al.* 2009). Four bird species that use Monkton Pond are listed as high priority SGCN and three bird species are listed as medium priority SGCN in Vermont (VTFWb 2015). Two endangered bird species, Bald Eagles and Rusty Black Birds, are known to use Monkton Pond (VTFWa 2015). There are rare and uncommon vascular plants, invertebrate animals, and vertebrate animals in and around Monkton Pond (VTANR 2020).

History of Activity and Description of How Aquatic Invasive Plants Interfere with Conservation Goals

LCA hired Matthew Gorton, a conservation biologist, to survey Lewis Creek, Bristol Pond, and Monkton Pond for AIS during the summer of 2020. Along with this exotic plant management plan, an ArcGIS web map showing the location of AIS in Lewis Creek, Bristol Pond, and Monkton Pond was produced.

Aquatic invasive species harm ecosystems, local economies, and human health in the Lake Champlain Basin. Aquatic invasive plant species have been present in the Lewis Creek watershed for decades and can outcompete native plants by forming dense mats of vegetation. These dense mats impede recreational boaters, swimmers, and anglers, and degrade ecosystems and wildlife habitats (MDEP 2020). Aquatic invasive plants are spread via seeds, roots, fragments, animals, and by humans. Documenting where aquatic invasive plants occur within the watershed will help towns, private watershed groups, and State and Federal agencies monitor their distribution and may help focus management efforts in the future.

The presence of AIS in the Lewis Creek watershed threatens the biological health and equilibrium of the watershed. If aquatic invasive plants are allowed to spread throughout the watershed, biodiversity may be reduced; the productivity, nutrient cycling, and microorganisms could be negatively impacted; and the food web may be detrimentally modified (Zedler and Kercher 2004). Currently, very few aquatic invasive plant species occur within the Lewis Creek watershed. If control efforts of the aquatic invasive plants that already exist in the watershed occur, the likelihood of them spreading to other uninfested areas of the watershed are relatively low.

Inventory of Plant Species and Weed Management Plan Goals

The following invasive plant species were found at Lewis Creek: curly-leaf pondweed (*Potamogeton crispus*), Eurasian watermilfoil (*Myriophyllum spicatum*), flowering rush (*Butomus umbellatus*), Japanese knotweed (*Polygonum cuspidatum*), orange daylily (*Hemerocallis fulva*), poison parsnip (*Pastinaca sativa L.*), and yellow iris (*Iris pseudacorus*). Eurasian watermilfoil and European frogbit (*Hydrocharis morsus-ranae*) were found at Bristol Pond. Eurasian watermilfoil and curly-leaf pondweed were found at Monkton Pond.

Additionally, banded mystery snails (*Viviparus georgianus*) were found at Monkton Pond. This plan will outline all the invasive plant species currently found within Bristol Pond, Monkton Pond, and Lewis Creek and explore potential control efforts that could be implemented. Actual management decisions will be dependent on secured funding for some efforts and the amount of time and man-hour resources that LCA, town officials, and residents deem appropriate.

AQUATIC INVASIVE PLANT SPECIES SURVEY

Sampling Process Design

The survey design was adapted from British Columbia's Inter-Ministry Invasive Species Working Group's (IMISWG) Aquatic Invasive Species Survey Methods (2015). Sample points were systematically distributed on Lewis Creek, Bristol Pond, and Monkton Pond (Figure 1). 115 sampling points were established at Bristol Pond, while 55 sampling points were established at Monkton Pond (Figure 2 and 3). Each sampling point was 100 meters apart from each other. Sampling points were established every 100 meters on navigable portions of Lewis Creek. If aquatic invasive plants were encountered in Lewis Creek, additional sampling points were assigned in 5 meter increments up and downstream of the sampling point, until the aquatic invasive plant was no longer encountered. This was done to try and map the extent of the infestation. IMISWG recommended tossing a sampling rake twice at each sampling point to obtain a representative sample of aquatic invasive species, and this was the protocol followed for this survey as well. All aquatic plants found were documented by genus and species and the density was estimated. Density was based on a rating of 0-4 and a percentage of coverage by species (see sampling methodology below). In addition, plants visible on the shore of Lewis Creek were noted.

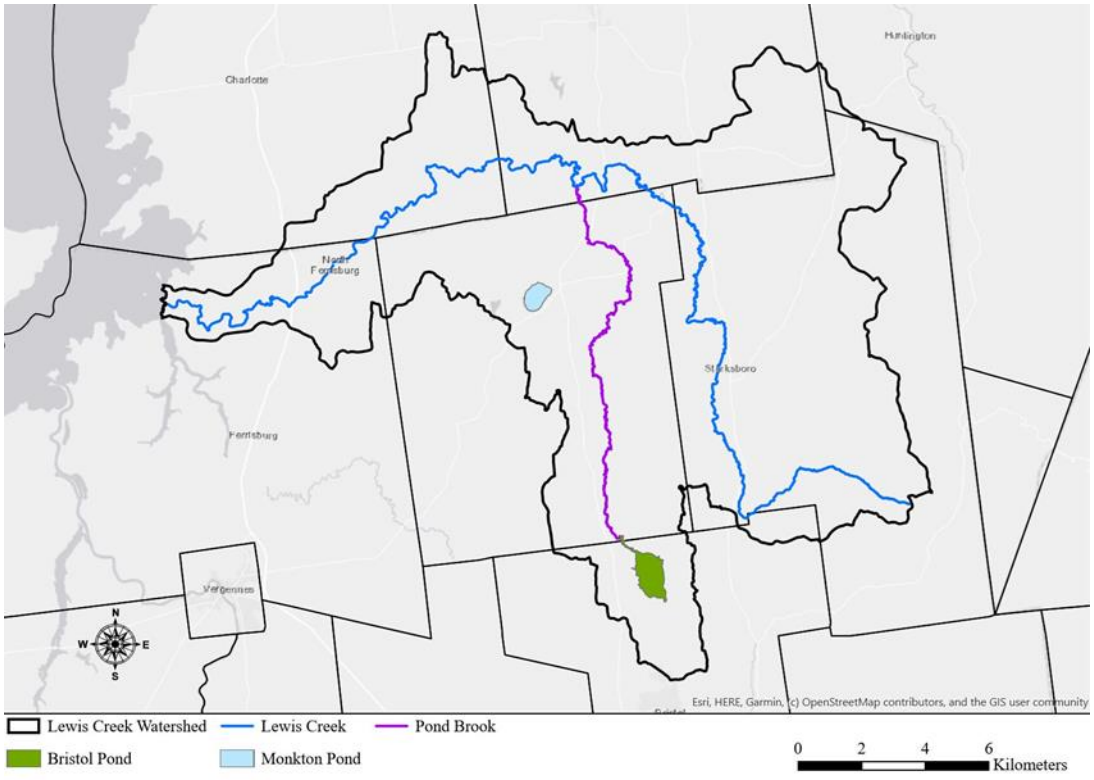

Figure 1. Location of Bristol Pond, Monkton Pond, Lewis Creek, and Pond Brook within the Lewis Creek watershed, Vermont.

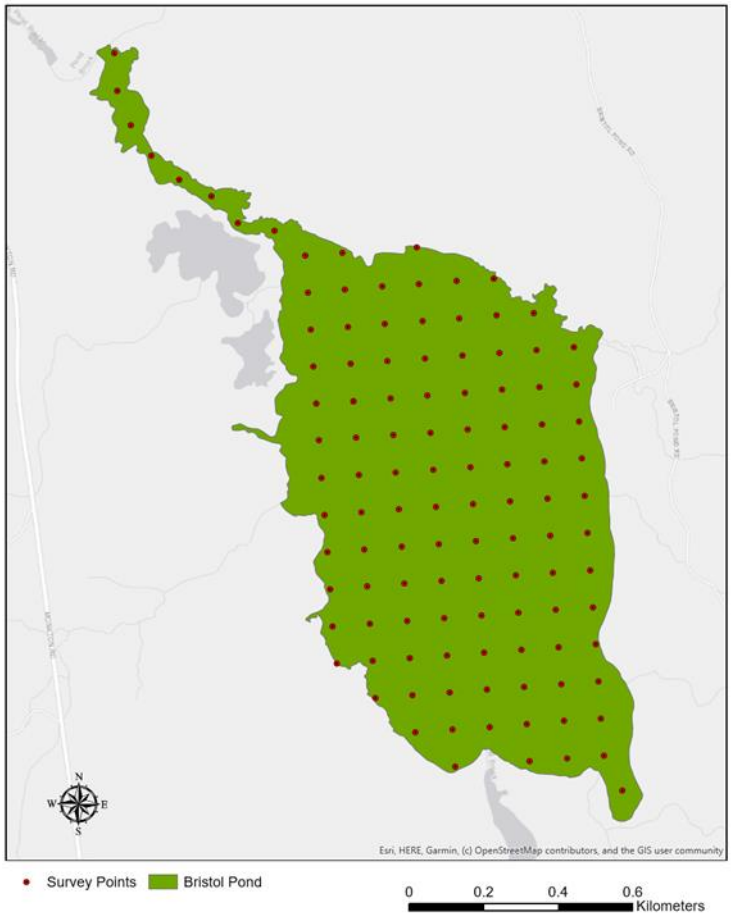

Figure 2. Aquatic invasive plant survey locations at Bristol Pond, Vermont.

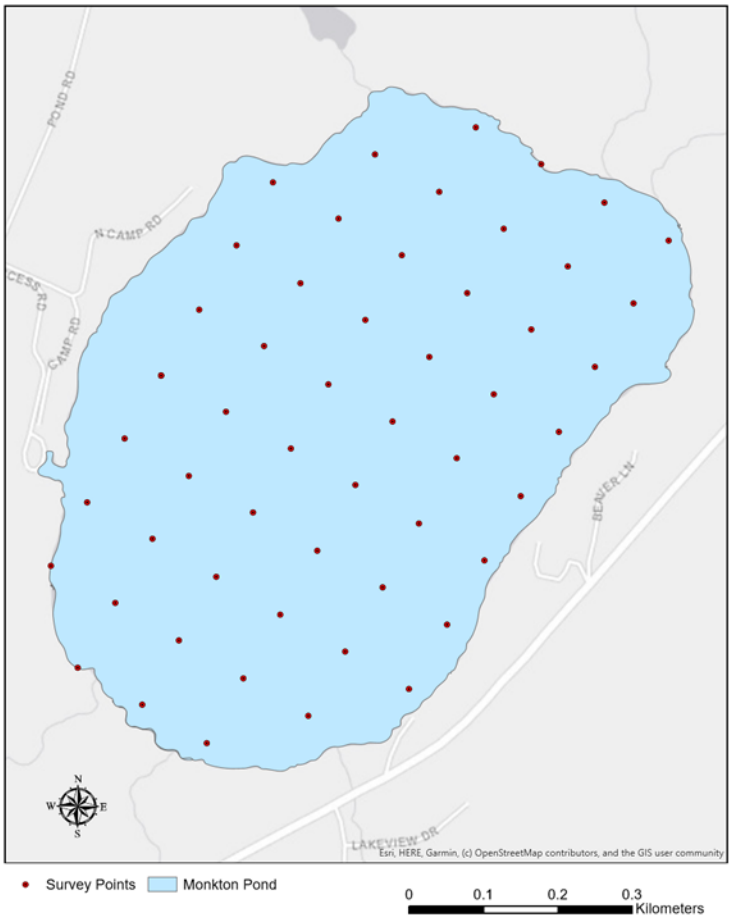

Figure 3. Aquatic invasive plant survey locations at Monkton Pond, Vermont.

Sampling Methods

Surveys were conducted on foot and from a canoe using a sampling rake and an underwater viewer. The surveyors utilized a Garmin GPS Map 64s to navigate to the proper sampling location. At each sampling point the surveyors tossed a sampling rake 2 times to collect vegetation. Collected vegetation was placed into a white tub, where plants were identified after each rake toss. The amount of aquatic vegetation collected on the rake tosses were quantified using a scale of 0-4 (0 = no plants, 1 = sparse, 2 = half full, 3 = full, 4 = overflowing/clogged) for each toss and the percent of each type of plant from both of the rake tosses was recorded by separating the plants by species in the white tub.

Decontamination measures were followed to prevent the unintentional spread of AIS between the waterbodies being sampled and the individual sampling sites. Between each sampling location the surveyors removed the aquatic vegetation from the rake, returned native species to the water, and kept all AIS to properly dispose of. Any AIS that was collected was composted away from any water source. The surveyors removed any visible plant material, mud, and water from their equipment, clothing, and watercraft before leaving the sampled waterbody each sampling day. The sampling rake and attached rope, white tub, anchors, and any rope that came into contact with water were soaked in a solution of 5% acetic acid for a minimum of 4 hours, were rinsed thoroughly with water, and were then allowed to dry as long as possible.

Analytical Methods

Frequencies of occurrence of aquatic invasive plant species were calculated for Lewis Creek, Bristol Pond, and Monkton Pond. Frequency of occurrence was calculated by dividing the number of survey points where the species was observed by the total number of points surveyed on the waterbody, then multiplying that number by 100 to achieve a percent.

$$F = \frac{sp}{p} \times 100$$

Whereas sp represents survey points where the species were observed, and p represents the total number of points surveyed.

Survey Results

Lewis Creek

Lewis Creek had the most sampling sites and was subject to the most sampling rake tosses (Table 1). Yet, no AIS were pulled up during the survey. However, Eurasian watermilfoil and curly-leaf pondweed were observed close to the mouth of Lewis Creek (Figure 4). Flowering rush and yellow iris were found on the banks of Lewis Creek near its mouth (Figure 4). Orange daylilies and poison parsnip were found on the banks of the creek primarily between Greenbush Road in Ferrisburgh and Silver Street in Hinesburg (Figure 5). Japanese knotweed was primarily found between Tyler Bridge Road in Monkton and Meadowlark Lane in Starksboro, with the heaviest concentration being north of State's Prison Hollow Road in Starksboro (Figure 6). Three native species of pondweed (*Potamogeton sp.*) were pulled up during the survey (Table 2).

Bristol Pond

Eurasian watermilfoil was the only AIS that was pulled up during the survey at Bristol Pond (Table 3). However, European frogbit was observed along the margins of the pond and interspersed in the wetlands. Including Eurasian watermilfoil, 11 aquatic plant species were pulled up with the sampling rake during the survey of the pond, with big-leaf pondweed (*Potamogeton amplifolius*) occurring the most frequently (Table 3). Even though Eurasian watermilfoil didn't occur the most frequently, it had the highest average coverage of the sampling rake for the species that occurred more than once (Table 4). Furthermore, Eurasian watermilfoil was widespread throughout the pond and often outcompeted most plants where it occurred. However, in some places it didn't completely choke out other vegetation. Big-leaf pondweed and bladderwort (*Utricularia macrorhiza*) dominated the areas where Eurasian watermilfoil wasn't present.

Monkton Pond

Eurasian watermilfoil and curly-leaf pondweed were pulled up with the sampling rake during the survey at Monkton Pond (Tables 4 and 5). Banded mystery snails were also observed floating in the water during the survey. A total of 12 aquatic plant species were pulled up with the sampling rake during the survey of Monkton Pond, with Eurasian watermilfoil occurring the most frequently (Table 5). Eurasian watermilfoil was clearly dominant throughout the pond. Curly-leaf pondweed was most prominent along the eastern shore of the pond and was the most dominant plant where it occurred. Muskgrass (*Chara sp.* or *Nitella sp.*) was the most frequently occurring native plant and thrived when Eurasian watermilfoil and curly-leaf pondweed weren't present.

Table 1. Number (N) of rake tosses thrown at Bristol Pond, Lewis Creek, and Monkton Pond, VT during the summer of 2020.

	N Rake Tosses	Avg. Rake Toss	St.dev
Bristol Pond	218	1.66	1.12
Lewis Creek	1046	0.01	0.10
Monkton Pond	102	1.75	1.37

Table 2. Frequency of occurrence of sampled plant species at Lewis Creek, VT during the summer of 2020.

Species	Frequency of Occurrence
Big-leaf pondweed (*Potamogeton amplifolius*)	0.2
Ribbon-leaf pondweed (*Potamogeton epihydrus*)	0.2
Flat-stem pondweed (*Potamogeton zosteriformis*)	0.2

Table 3. Frequency of occurrence of sampled plant species at Bristol Pond, VT during the summer of 2020.

Species	Frequency of Occurrence
Big-leaf pondweed (*Potamogeton amplifolius*)	57.8
Common bladderwort (*Utricularia macrorhiza*)	51.4
Eurasian watermilfoil (*Myriophyllum spicatum*)	44.0
Water stargrass (*Zosterella dubia*)	37.6
Eel grass (*Vallisneria americana*)	26.6
Common waterweed (*Elodea canadensis*)	14.7
Flat-stem pondweed (*Potamogeton zosteriformis*)	8.3
White water lily (*Nymphaea odorata*)	2.8
Watershield (*Brasenia schreberi*)	1.8
Coontail (*Ceratophyllum demersum*)	0.9
Water lilies (*Nuphar sp.*)	0.9

*Red text denotes invasive species.

Table 4. Average percent of sampling rake coverage at Bristol Pond and Monkton Pond, VT during the summer of 2020.

	Bristol Pond			Monkton Pond		
Species	N of Sites Found	Avg. Percent of Rake	St.dev	N of Sites Found	Avg. Percent of Rake	St.dev
Watershield (*Brasenia schreberi*)	2	0.30	0.20	NA	NA	NA
Coontail (*Ceratophyllum demersum*)	1	1.00	0.00	1	0.20	0.00
Muskgrass (*Chara sp. or Nitella sp.*)	NA	NA	NA	25	0.56	0.38
Common waterweed (*Elodea canadensis*)	16	0.29	0.29	8	0.30	0.29
Eurasian watermilfoil (*Myriophyllum spicatum*)	48	0.49	0.32	28	0.56	0.38
Water lilies (*Nuphar sp.*)	1	0.50	0.00	4	0.11	0.05
White water lily (*Nymphaea odorata*)	3	0.18	0.09	3	0.38	0.24
Big-leaf pondweed (*Potamogeton amplifolius*)	63	0.41	0.27	8	0.18	0.31
Curly-leaf pondweed (*Potamogeton crispus*)	NA	NA	NA	9	0.34	0.19
Flat-stem pondweed (*Potamogeton zosteriformis*)	9	0.15	0.12	7	0.27	0.29
Common bladderwort (*Utricularia macrorhiza*)	56	0.37	0.29	2	0.15	0.10
Eel grass (*Vallisneria americana*)	29	0.29	0.23	6	0.20	0.36
Water stargrass (*Zosterella dubia*)	41	0.42	0.36	1	0.10	0.00

*Red text denotes invasive species.

Table 5. Frequency of occurrence of sampled plant species at Monkton Pond, VT during the summer of 2020.

Species	Frequency of Occurrence
Eurasian watermilfoil (*Myriophyllum spicatum*)	54.9
Muskgrass (*Chara sp. Or Nitella sp.*)	49.0
Curly-leaf pondweed (*Potamogeton crispus*)	17.6
Common waterweed (*Elodea canadensis*)	15.7
Big-leaf pondweed (*Potamogeton amplifolius*)	15.7
Flat-stem pondweed (*Potamogeton zosteriformis*)	13.7
Eel grass (*Vallisneria americana*)	11.8
Water lilies (*Nuphar sp.*)	7.8
White water lily (*Nymphaea odorata*)	5.9
Common bladderwort (*Utricularia macrorhiza*)	3.9
Coontail (*Ceratophyllum demersum*)	2.0
Water stargrass (*Zosterella dubia*)	2.0

*Red text denotes invasive species.

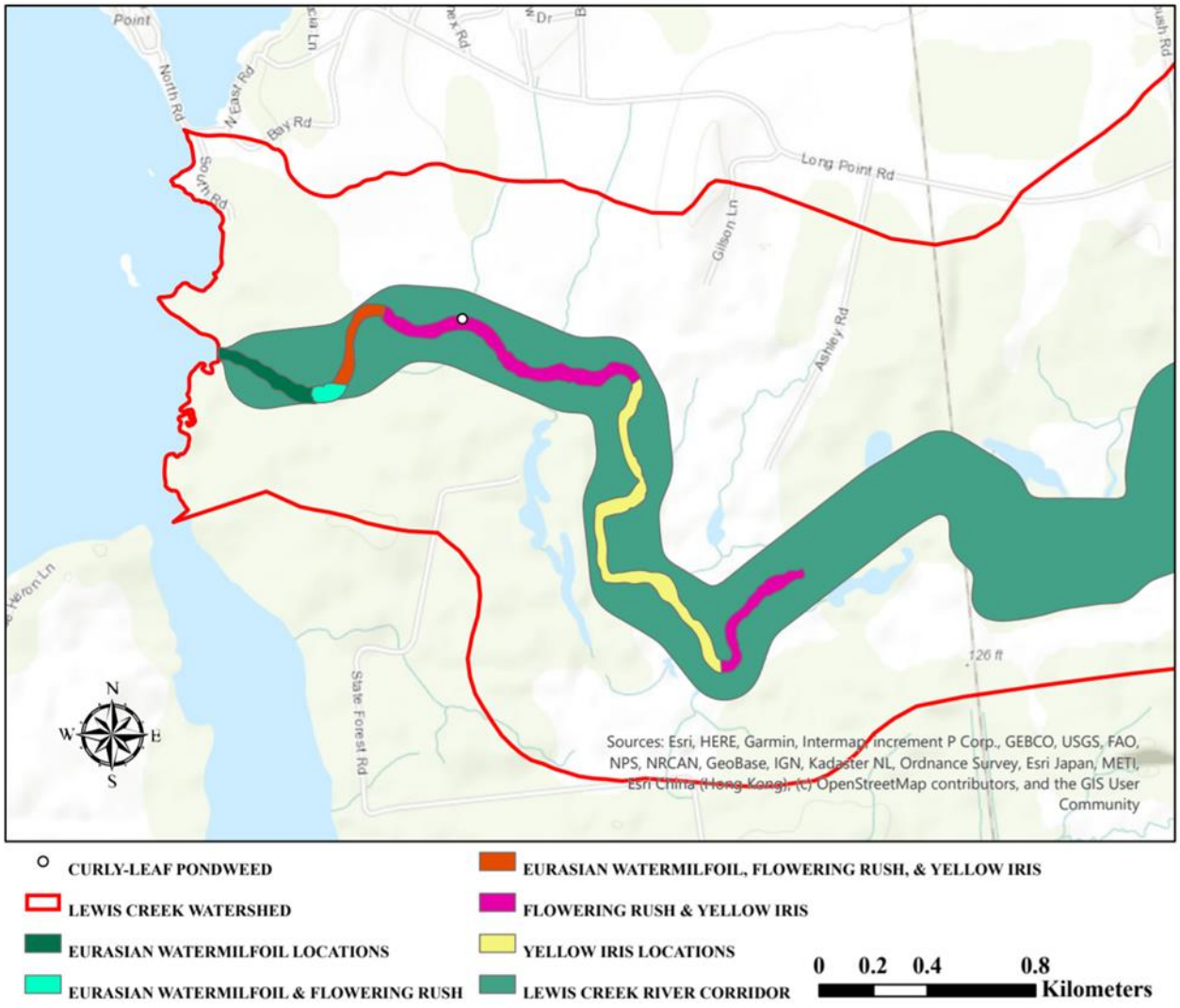

Figure 4. Invasive plant species present at the mouth of Lewis Creek, VT.

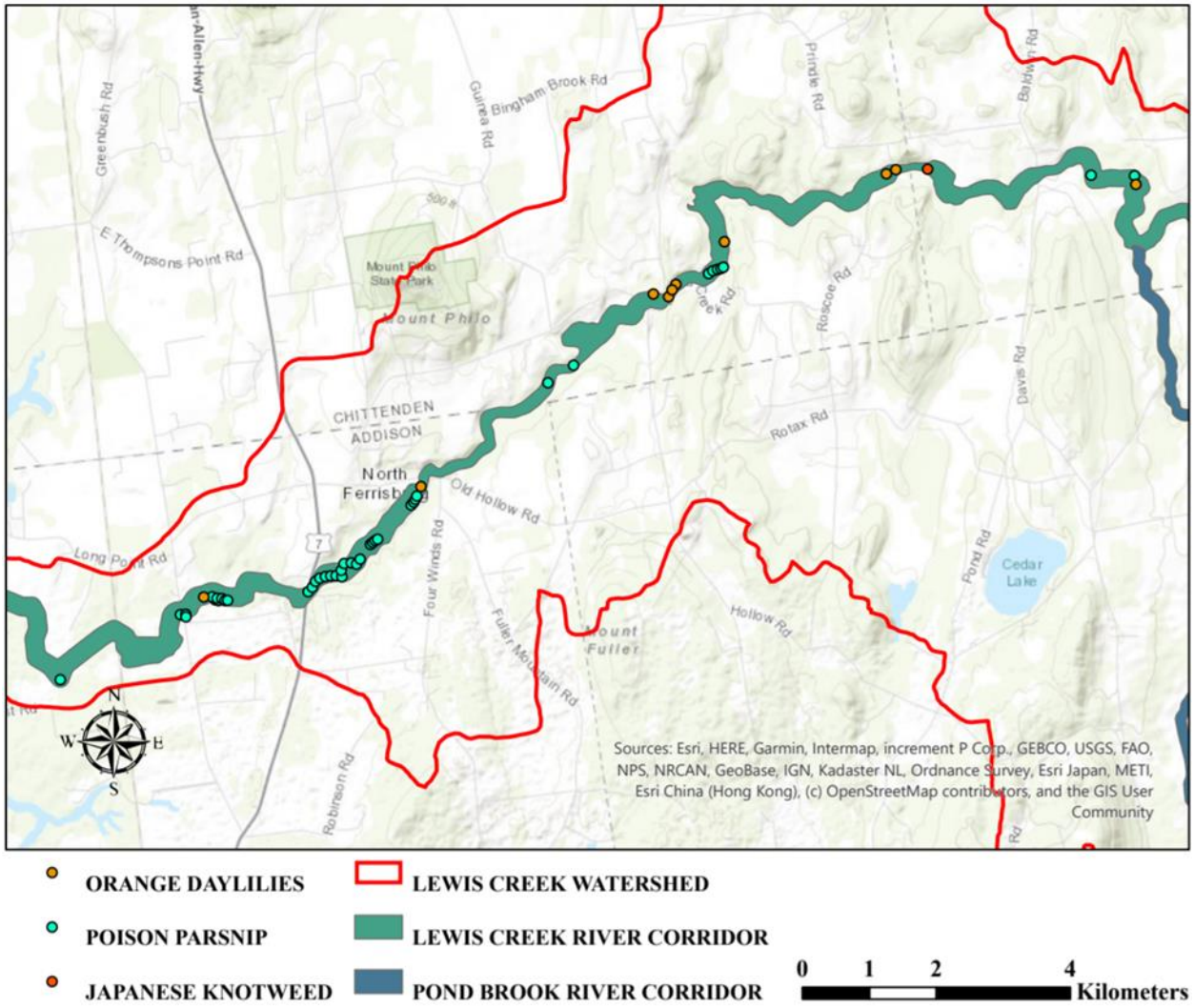

Figure 5. Invasive plant species present at Lewis Creek between Greenbush Road in Ferrisburgh, VT and Silver Street in Hinesburg, VT.

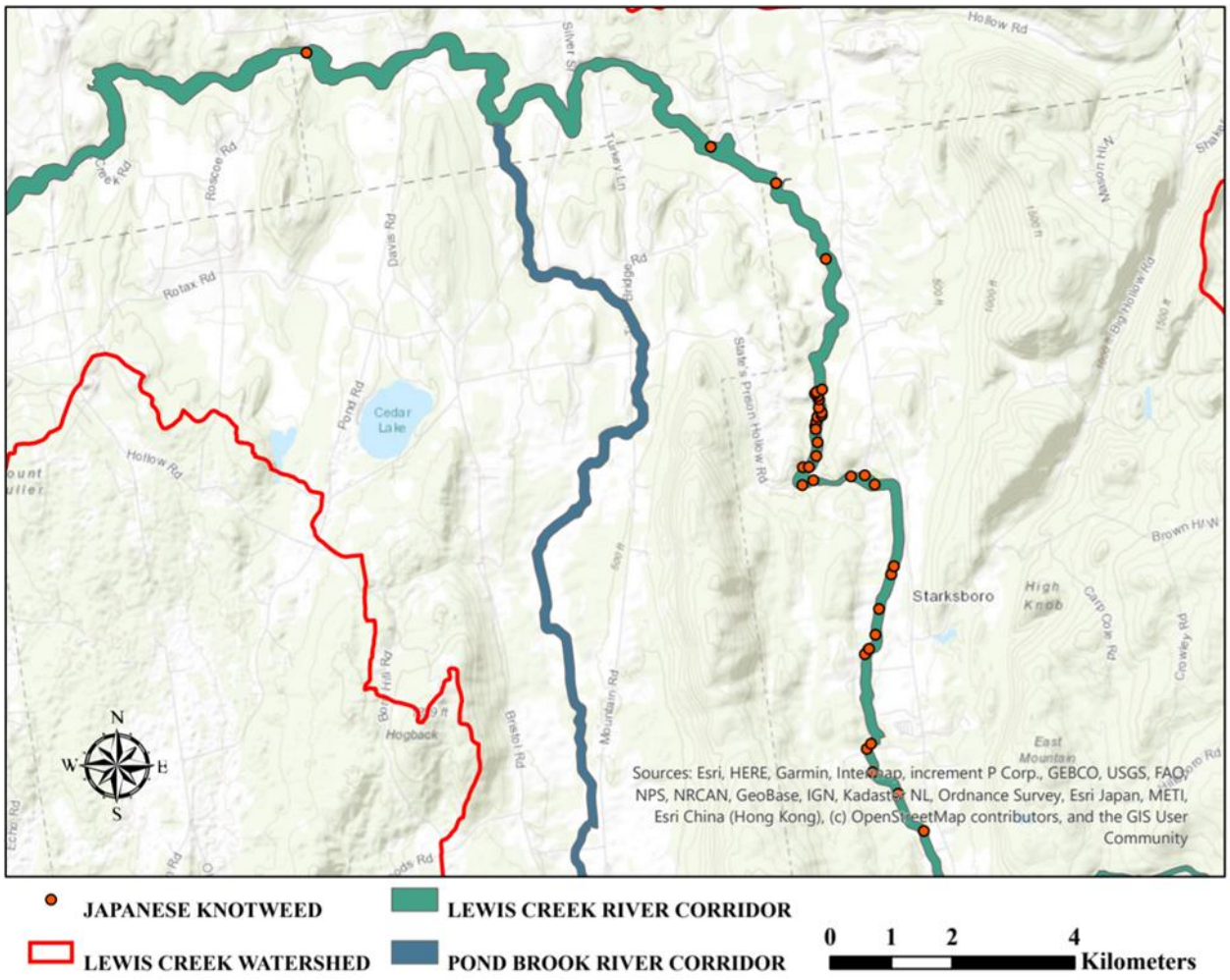

Figure 6. Invasive plant species present at Lewis Creek between Roscoe Road in Charlotte, VT and Meadowlark Lane in Starksboro, VT.

OVERVIEW OF WEED MANAGEMENT PLAN

Management Philosophy & Setting Priorities (Using Adaptive Strategies)

Invasive plant control is part of the overall site management and restoration program. We typically focus on the species and communities that we want in place of the invasive species, rather than on eliminating plants. Preventative programs have been implemented to keep the sites free of species that are not yet established, but which are known to be pests elsewhere in the region. Priorities have been set for the control or elimination of invasive exotic species that have already established themselves on the sites, according to their actual and potential impacts on native species and communities. Action is taken only when careful consideration indicates that leaving invasive species unchecked will result in more damage than controlling it with available methods.

We use an adaptive management strategy by establishing and recording the goals for the sites. Then we identify species that block us from reaching these goals and assign them priorities based on their impacts. One shortcoming of this step is that the monitoring and observations are arbitrary, and are affected by the observer, water levels, and seasonality. We also consider methods for controlling AIS or otherwise diminishing their impacts and, if necessary, re-order priorities based on likely impacts to target and nontarget species. Then we develop control plans based on this information and implement the plan, and the results of our management actions will be monitored. Lastly, we will evaluate the effectiveness of our methods in light of the goals of the sites, and use this information to modify and improve control priorities, methods, and plans. Finally, we will start the cycle over again by establishing new/modified goals.

We set priorities in the hope of minimizing the total, long-term workload. Therefore, we act to prevent new infestations and assign highest priority to existing infestations that are the fastest growing, most disruptive, and affect the most highly valued area(s) of the site. We also consider the difficulty of control, giving higher priority to infestations we think we are most likely to be controlled with available technology and resources.

Summary of Specific Actions Planned

In the summer of 2020, biologists surveyed Lewis Creek, Bristol Pond, and Monkton Pond for AIS. During these surveys six AIS were found in Lewis Creek: curly-leaf pondweed, Eurasian watermilfoil, flowering rush, Japanese knotweed, orange daylily, and yellow iris. Previous to this survey, Japanese knotweed and orange daylily hadn’t been documented in Lewis Creek. Two AIS were found at Bristol Pond: Eurasian watermilfoil and European frogbit. Three AIS were found at Monkton Pond: Eurasian watermilfoil, curly-leaf pondweed, and banded mystery snails. Prior to this survey, curly-leaf pondweed and banded mystery snails hadn’t been documented in Monkton Pond. The goal of this management plan is to provide recommendations of controlling AIS to LCA and the towns within the Lewis Creek watershed.

SPECIFIC WEED CONTROL PLANS

Eurasian watermilfoil (*Myriophyllum spicatum*)
Priority – Low

Description
Eurasian watermilfoil is an aquatic invasive plant found in freshwater or brackish ponds, lakes, slow-moving streams, or shallow water bodies. The plant typically roots in muddy substrate and grows stems that range from 3 to 33 feet in length towards the water's surface. Leaves are olive green in color and found in whorls of four around the stem. Eurasian watermilfoil may be distinguished from native milfoils by the number of leaflets on each leaf (12 to 16) and its soft, feather like textures. Plants may reproduce from any node along the stem or from small yellow flowers that emerge from the water's surface. Native Milfoils have less than 12 leaflets per leaf. Eurasian watermilfoil also has a much longer internodal spacing along the stem between whorls than native milfoils. Eurasian watermilfoil stems and leaf tips may also be reddish in color. Eurasian watermilfoil and native milfoils can hybridize.

Current Distribution at Survey Sites
On Lewis Creek, Eurasian watermilfoil was found from the Vermont Fish and Wildlife boat access to the mouth of the creek (~0.6 km of stream). Eurasian watermilfoil was found in most places in Bristol Pond, but wasn't found in the channel that leads from the boat access to the main body of the pond, or in the deeper portions of the eastern portion of the pond. In Monkton Pond, Eurasian watermilfoil was found throughout most of the pond. However, no milfoil was observed in the deeper portions of the center and northern part of the pond.

Damage and Threats
Eurasian watermilfoil is extremely tolerant of a wide range of water and soil conditions and will form dense mats in waters up to 20 feet deep. These mats have been noted as affecting the temperature, light, and oxygen levels within a water body and because of their density are poor spawning areas for fish. Furthermore, the non-native Milfoil is rarely used by waterfowl, fish, or aquatic insects as a food source and can impede recreational traffic when dense. Because Milfoil may sprout from any plant fragment, it is easily spread to new areas by wind and wave action, boat traffic, and water currents.

Goals
Educate boaters and recreational users of Lewis Creek, Bristol Pond, and Monkton Pond to prevent the spread of Eurasian watermilfoil by encouraging them to clean, drain, and dry their boats, anchors, and associated equipment before and after visiting the waterbodies and avoiding navigation through dense patches of aquatic vegetation.

Objectives
Continue to monitor known populations of Eurasian watermilfoil in the waterbodies, continue the boat launch steward program at Bristol Pond, expand the boat launch steward program to Monkton Pond, and consider limited hand harvests if populations grow.

Management Options

a) **No Treatment**

b) Mechanical

i. Hand Pulling

For small, new Milfoil populations, divers may hand pull plants at their base, ensuring to remove all parts of the root and stem of the plant. All plant parts should be removed from the waterbody and allowed to dry or compost in a non-wetland area. If no Milfoil fragments are left, this can be a highly successful control method. A number of years of concerted diver effort would be necessary to manage small stands. Typically, it is a very labor and cost intensive control method for large milfoil populations.

If this method is to be used in Lewis Creek, the divers must start at the upstream part of the infestation and need to ensure that no fragments get washed downstream, where the plants can re-establish themselves. This method would only be effective on Bristol and Monkton Pond to clear areas around the boat accesses and around camp beaches, and would not be a long-term eradication solution.

ii. Mechanical Harvesting

The State of Vermont and other lake and bay associations operate large mechanical aquatic plant harvesters that mow all aquatic vegetation stems from the water's surface to allow users access. These harvesters are not species selective and do not remove Milfoil roots and thus do not control the populations. This would need to be an annual operation of "mowing" which can be costly, and can lead to species fragmentation and spread. This method is not feasible for Lewis Creek or either pond due to water levels and the size of the harvester. Also, due to the non-selective nature of the harvesters, this control method is not recommended. This method requires a permit from VT ANR.

iii. Bottom Barriers

Bottom barriers are mats that block light penetration and are typically made of rubber or fabric that have been used to successfully prevent Eurasian watermilfoil growth in lakes and ponds around docks and along boat lanes. These barriers are anchored to the bottom and prevent light from reaching the substrate, preventing the growth of all plant species. Depending on the type of barrier, it may be expensive to deploy, maintain, and remove after treatment, but are highly successful at controlling dense populations of Eurasian watermilfoil. Benthic barriers could effectively be used to control Eurasian watermilfoil around boat launch accesses and around camp beaches on Lewis Creek, Bristol Pond, and Monkton Pond (WCSWCD undated). This method requires a permit from VT ANR, and should not be used in broad areas of a waterbody, due to its non-target impact on all aquatic plants (and likely animals) in the area where the mat is located.

c) Chemical

Some herbicides that are federally registered for use in aquatic ecosystems can be effective to control large watermilfoil infestations. However, long-term eradication of large infestations may be unlikely and extremely expensive. Herbicides, such as 2,4-D (trade names AquaKleen® and Navigate®) and triclopyr (trade name Renovate3®) can be relatively selective for Eurasian watermilfoil when used appropriately. However, native plant mortality will still probably occur. 2,4-D is most effective when it is applied during the spring or fall. However, 2,4-D is selective for dicots and will cause some damage to other dicots, like Coontail (*Ceratophyllum demersum*). Other herbicides such as fluridone (trade names Sonar® and Avast!®) are less selective and may negatively affect other plants in the waterbody. The most selective herbicide with active ingredient florpyrauxifen-benzyl (trade name ProcellaCOR) is quite selective, but can still damage some non-target species. These herbicides come in a variety of forms (i.e., pellets, liquid, spray) and typically require multiple applications followed by selective hand pulling to be effective.

Chemicals are not recommended for controlling Eurasian watermilfoil in Lewis Creek, because they probably will not be effective in a riverine environment, and this river is connected to Lake Champlain which is already infested. Furthermore, Lewis Creek contains Mudpuppies (*Necturus maculosus*), which are a S2 species, which are already stressed (and possibly extirpated) by sea lamprey treatments being conducted by USFWS and the State of Vermont. Added stress may extirpate Mudpuppies from Lewis Creek. The implementation of herbicide treatments in Bristol Pond are not recommended due to the natural communities surrounding Bristol Pond, the high quality of the wetlands surrounding the pond, and the high cost of herbicide treatments. Limited, spot treatment of Eurasian watermilfoil could potentially limit the growth of milfoil in Monkton Pond. However, this option would be expensive and could be high-risk and more damaging to other plant species than helpful. Largescale die-offs of plants (regardless of control method) can lead to oxygen depletion within the waterbody, which can cause largescale fish kills. It often requires repeating and a number of times to achieve the target goal and step down to a maintenance level of control (DASH, hand pulling, limited benthic barrier matting). If a large area is being treated, the applicator should treat the pond in sections (depending on the selectivity of the herbicide) and allow each section to decompose for about two weeks before treating another section (Texas A&Ma 2020). Therefore, we don't recommend using herbicides in Monkton Pond. *Herbicide treatment may be considered an allowed use under VWE 6.18, upon approval of a written plan from the Wetlands Program. Herbicide treatment within / near waters also requires an Aquatic Nuisance Control Permit from the Lakes Program, which would limit the percentage of the littoral zone that can be treated at any one time*.

d) Biological

Many forms of biological control agents have been investigated in the United States to control Eurasian watermilfoil. Many insects, bacteria, and fungi are currently in

experimental stages and are not close to receiving approval for release. Some states have introduced a plant-eating fish, the Chinese Grass Carp (*Ctenopharyngodon idella*) to combat Watermilfoil. Grass Carp that are used for biological control are sterile, triploid individuals, meaning that they should not be able to reproduce. However, triploid Grass Carp have been able to successfully breed with diploid Grass Carp which has contributed to them becoming invasive in some bodies of water (UF IFAS 2020). Introducing Grass Carp is illegal in Vermont waters. The Vermont Department of Environmental Conservation (VTDEC) has been working with a native aquatic insect, the Watermilfoil Weevil (*Euhrychiopsis lecontei*), since 1989 as a possible biological control agent. The Watermilfoil Weevil was successful in decreasing Eurasian watermilfoil in Brownington Pond and other selective ponds. However, Weevil populations have proved to be unpredictable and unreliable as control agents. It is difficult to produce enough weevils to successfully control a large infestation. VTDEC and other scientists continue to research the use of Watermilfoil Weevils as a potential bio-control agent in the future. However, at this time, it's not a recommended effective control method (VTDECb undated). *USDA APHIS reviews biological controls for permitted use in the United States.*

European frogbit (*Hydrocharis morsus-ranae*)
Priority – High

Description
European frogbit is a free-floating aquatic plant that resembles Water Lilies. Frogbit leaves are leathery, round, heart-shaped and range in size from 0.5 – 2.5 inches (typically smaller than aquatic lily leaves). It reproduces sexually by its small, three-petal white flowers with a yellow spot in the center or asexually by the production of stolons. Frogbit survives the winter by producing turions, small buds that break off of the plant and sink to the substrate, which rise in the spring to form new plants.

Current Distribution at Survey Sites
European frogbit was only found at Bristol Pond. Because it is free-floating, frogbit wasn't found in any open channels with faster moving water and it wasn't observed in the open water of the pond. It was typically found along the margins of the pond and at the boat access interspersed with bulrush (*Scirpus spp.*), sedges (*Carex spp.*), pickerelweed (*Pontederia cordata*), and other emergent vegetation.

Damage and Threats
The ability of frogbit to form long stolons allows it to spread rapidly and cover a large area. The formation of dense mats will decrease light penetration to a wetland's benthic layer and negatively affect aquatic life. In shallow water areas, decomposition of frogbit mats decrease dissolved oxygen levels and further disrupt native vegetation and animals. Dense patches of frogbit will also inhibit boat traffic and waterfowl use.

Goals
Reduce dense growths of European frogbit to annual hand harvest maintenance levels (<10% coverage).

Objectives
Annually monitor and control the frogbit population.

Management Options

a) **No Treatment**

b) **Mechanical**
   i. **Hand Pulling**
      Currently, the only control option for frogbit control is hand harvesting the plant during the growing season. This has been reported as only providing temporary and limited relief for small populations. If new frogbit populations are caught during their first year of infestation, before over-wintering turions are formed, frogbit may be eliminated from an area. All parts of harvested plants should be removed from the waterbody and should be dried or composted at a site away from wetland areas.

ii. Shading

Shading has proven to be an effective management tool in reducing European frogbit populations. Percent shade coverage of 70-100% has the greatest results at reducing or eliminating European frogbit growth (Zhu et al. 2014). Although this method might work in a small pond, it is not feasible for a larger body of water.

c) Chemical

European frogbit has been successfully managed using endothall or diquat herbicides. This method **IS NOT** species selective and non-target impacts are possible. Furthermore, herbicides have primarily been shown to only be effective against European frogbit as a single season control (State of Michigan 2018). *Herbicide treatment may be considered an allowed use under VWE 6.18, upon approval of a written plan from the Wetlands Program. Herbicide treatment within / near waters also requires an Aquatic Nuisance Control Permit from the Lakes Program.*

Curly-leaf pondweed (*Potamogeton crispus*)
Priority – Medium

Description
Curly-leaf pondweed is a submersed aquatic perennial plant found in 0.3 to 4 meter-deep brackish or freshwater wetlands. Its leaves are long, waxy, and reddish-green in color with a slightly toothed margin. The plant produces small, inconspicuous flowers and fruits, but the seed viability in the United States is questionable. Reproduction is primarily through turion production, similar to European frogbit. Turions are produced mid-summer and fall to the wetland substrate. In late fall the turions germinate and adult plants persist through the winter, even under the ice. This unusual life cycle allows this pondweed to be the first plant in the spring to begin growing.

Current Distribution at Survey Sites
Curly-leaf pondweed was only found at one location on Lewis Creek, just upstream of the Vermont Fish and Wildlife boat access. At Monkton Pond, curly-leaf pondweed was primarily found on the southeastern margin of the pond, dominating the sites where it occurred.

Damage and Threats
Like many other aquatic invasive plants, curly-leaf pondweed can create dense vegetative mats that outcompete native vegetation and impede recreational use of waterways. Because these plants are the first to emerge in the spring, this pondweed has a competitive edge over native vegetation that begins to grow later in the year.

Goals
Educate boaters and recreational users of Lewis Creek, Bristol Pond, and Monkton Pond to prevent the spread of curly-leaf pondweed by encouraging them to clean, drain, and dry their boats, anchors, and associated equipment before and after visiting the waterbodies and avoiding navigation through dense patches of aquatic vegetation.

Objectives
Continue to monitor known populations of curly-leaf pondweed in the waterbodies, continue the boat launch steward program at Bristol Pond, and expand the boat launch steward program to Monkton Pond.

Management Options

a) No Treatment

b) Mechanical

i. Hand Pulling

For small curly-leaf pondweed populations snorkelers/divers may hand pull plants at their base, ensuring to remove all parts of the root and stem of the plant. All plant parts should be removed from the waterbody and be allowed to dry or compost in a non-wetland area. If no plant fragments are left, this can be a highly successful control method. Typically, it is a very labor and cost intensive control method for large populations. Hand pulling could be extremely effective at reducing or eradicating the curly-leaf pondweed in Lewis Creek and could potentially be effective at reducing the curly-leaf pondweed at Monkton Pond.

ii. Mechanical Harvest

Curly-leaf pondweed can be hand cut in the early spring after plants begin emerging. This method will provide immediate relief to infestation levels and some evidence suggests that early cuts can prevent the production of turions and disrupt reproductive life cycles. Repeat cutting each spring may effectively control smaller populations of pondweed. However, plants may regrow from fragments and may be spread to other portions of the waterbody.

iii. Bottom Barriers

Bottom barriers are mats that block light penetration and are typically made of rubber or fabric that have been used to successfully prevent curly-leaf pondweed growth in lakes and ponds around docks and along boat lanes. These barriers are anchored to the bottom and prevent light from reaching the substrate, preventing the growth of all plant species. Depending on the type of the barrier, it may be expensive to deploy, maintain, and remove after treatment, but are highly successful at controlling dense populations of curly-leaf pondweed. Benthic barriers could effectively be used to control curly-leaf pondweed around boat launch accesses and around camp beaches on Lewis Creek, Bristol Pond, and Monkton Pond (WCSWCD undated). This method requires a permit from VT ANR, and should not be used in broad areas of a waterbody, due to its non-target impact on all aquatic plants (and likely animals) in the area where the mat is located.

c) Chemical

Because of curly-leaf pondweed's distinctive life cycle, chemical control of this plant could be a viable option in Monkton Pond. Treating waterbodies early in the spring, after curly-leaf pondweed emerges but prior to other aquatic plant growth, could allow for more selective herbicide use. Endothall based herbicides such as Aquathol or Hydrothol 191 are effective on pondweeds in waters with cooler temperatures. However, liquid formulations of Endothall have been shown to be lethal on fish species (WDNR 2012). Any decision to apply herbicides in water should follow strict label guidelines and effects of endothall herbicides on emerged wetland vegetation also need to be addressed. Largescale die offs of plants (regardless of control method) can lead to oxygen depletion within the waterbody, which can cause largescale fish kills. If a large area is being treated, the applicator should treat the pond in sections (depending on the selectivity of the herbicide) and allow each section to decompose for about two weeks before treating another section (Texas A&Mb 2020). However, we do not recommend treating Monkton Pond with chemicals due to the high-quality wetlands surrounding the pond and impacts to non-target species. *Herbicide treatment may be considered an allowed use under VWE 6.18, upon approval of a written plan from the Wetlands Program. Herbicide treatment within / near waters also requires an Aquatic Nuisance Control Permit from the Lakes Program.*

Japanese knotweed (*Polygonum cuspidatum*)
Priority – Medium

Description
Japanese knotweed is usually found in wet habitats along river and stream banks, and in disturbed areas such as roadsides and old fields. In Vermont, knotweed covers miles of shoreline on every major river in the State. It can grow up to 11 feet tall and resembles bamboo in appearance. Japanese knotweed has jointed, hollow stems that have many red or purple nodes where the leaves attach. It is also characterized by its many alternate, heart-shaped leaves and its white or pale green flowers that bloom in the late summer. Japanese knotweed is native to east Asia.

Current Distribution at Survey Sites
On Lewis Creek, Japanese knotweed was found sporadically from Meadowlark Lane in Starksboro to slightly upstream of Sequin's covered bridge on Roscoe Road in Charlotte. The knotweed was found in large, dense clumps near State Prison Hollow Extension in Starksboro.

Damage and Threats
Japanese knotweed displaces native species and large infestations on rivers and streams may lead to sedimentation, increased bank erosion, and the amplification of flooding. It also makes it difficult to access streams. Riverbanks dominated by Japanese knotweed provide poor quality habitat for wildlife. They can also shade out nesting areas that would otherwise be available for species of conservation concern, like Wood Turtles (*Glyptemys insculpta*). Japanese knotweed is able to spread vegetatively via rhizomes, which make it extremely hard to eradicate. When disturbed, the rhizomes may split into fragments that are capable of forming a clone of the parent plant. knotweed may also persist after the stems are cut. The cut portion and the portion that is still rooted are capable of regrowing into new plants if they are in contact with moist soil.

Goals
Continue to monitor Japanese knotweed on Lewis Creek and try to control it where possible.

Objectives
Limit the distribution of Japanese knotweed on Lewis Creek.

Management Options

a) **No Treatment**

b) **Mechanical**
   i. **Cutting**
   Japanese knotweed is not effectively controlled by cutting alone. However, cutting accompanied by follow-up herbicide application has shown to be effective at managing knotweed. On Lewis Creek, knotweed could be cut with motorized trimmers, stout sickles, and/or machetes. Properly timed cuttings will make follow-up operations much easier by eliminating the tall canopy. Penn State (undated), suggests targeting June 1st as a cutting date. After the cutting, herbicide application should be delayed at least six weeks. This technique could be effective at reducing or eradicating Japanese knotweed in Lewis Creek. Other mechanical options include multiple cutting events (every 2 weeks or so), combined with

digging of roots, and covering with hardware cloth for small patches. Repeated efforts over many years to mechanically control knotweed can be effective.

c) Limiting Spread

Japanese knotweed can be controlled indirectly by ensuring that no knotweed rhizomes are present in soil or on excavation equipment.

d) Chemical

In tandem with cutting, the foliar application of glyphosate is the most effective herbicide for controlling Japanese knotweed. Glyphosate is relatively cheap, can be used near water, and has no soil activity. However, glyphosate and the surfactant used (polyethoxylated tallow amine) can be fatal to amphibians (Govindarajulu 2008). Therefore, stem injections of glyphosate may help mitigate the risk posed to the amphibians near the treatment area. Stem injections can be effective, but may be extremely laborious for a large-scale infestation. Knotweed's first flush of growth is fueled by stored carbohydrates in the rhizomes. These carbohydrates move to the canopy during the first growth spurt. The foliar herbicides and stem injections move through the plant with the carbohydrates. Therefore, to control the rhizomes, the foliar application or stem injection needs to be made between July 1st to the first killing frost. If the knotweed is cut around June 1st, then the follow-up herbicide treatment should be delayed for at least six weeks. This will allow the knotweed to develop a new, smaller canopy, and begin to send carbohydrates back to the rhizomes (Penn State undated). *Herbicide treatment may be considered an allowed use under VWE 6.18, upon approval of a written plan from the Wetlands Program. Herbicide treatment within / near waters also requires an Aquatic Nuisance Control Permit from the Lakes Program.*

Yellow-flag iris (*Iris pseudacorus*)
Priority – High

Description
Yellow-flag iris is an obligate wetland herbaceous perennial that grows 3-4 feet in height. Specimens in Lewis Creek have exceeded 6-foot clumps and have been observed in floodplains covering 40 square feet. Its flower blooms yellow (sometimes a light cream variation appears) which distinguishes it from its native counterpart, Blue-flag Iris (*Iris versicolor*). Its flowers appear from April to June and form 6-angled fruit capsules that hang from a long stipe. Yellow-flag iris spreads primarily through rhizome growth and plants will easily contaminate a new area when bits of rhizome are moved in water or soil. Yellow-flag iris tends to form dense masses of plants, excluding typical native wetland plants like cattails (*Typha sp.*) from growing.

Current Distribution at Survey Sites
Yellow-flag iris was found primarily in large clumps in the floodplain forest of Lewis Creek upstream of the Vermont Fish and Wildlife boat access.

Damage and Threats
In large numbers, yellow-flag iris will form a dense colony that prevents the growth of other native wetland plants. As plants extend rhizomes and create denser mats of roots, local conditions become more favorable for Iris, further increasing its population size and decreasing regeneration of native plants. The dense mats formed by yellow-flag iris have been documented at preventing waterfowl from breeding.

Goals
Obtain permission from neighboring landowners to remove yellow-flag iris and remove or treat small populations before they spread and become problematic.

Objectives
Remove all yellow-flag iris from Lewis Creek's edge and monitor the area annually to ensure new plants do not arise.

Management Options

a) **No Treatment**

b) **Mechanical**
   i. **Hand Digging**
   Single plants and small clumps (<~10 plants) may be removed from an area by hand digging out all roots and rhizomes. The use of a "parsnip predator" is recommended for easy digging. Rhizomes, seed pods, and flowers must be removed from the area and be allowed to decompose thoroughly before disposal. Plant parts should not be composted. Any digging or excavating will cause soil disturbance to the area and may promote growth of Iris root fragments or seeds found in the soil. Replanting an area after Iris removal with wetland grass or fast-growing Cattails (*Typha spp.*) may prevent the regrowth of Iris.

ii. Dead-heading

For areas that cannot be dug, Iris flowers may be "dead-headed" by cutting blooms before fruit appears. Cut flower heads should be bagged and allowed to decompose thoroughly before disposal. This method will prevent the spread of Iris through seed production but will not contain or decrease a population's size as Iris will continue to spread through rhizome growth.

c) Chemical

Herbicide may be selectively used for plants in small patches or numbers. Leaves should be wiped using a sponge with a 17.9% glyphosate solution during the plant's growing season, post-bloom. Rodeo, a glyphosate product manufactured by Dow Chemical, is labeled as safe for use in aquatic environments. A fall (late September – early October) foliar application of 2.5% Rodeo with LI700 surfactant has proven very effective at eliminating Iris clumps, but ideally should only be applied to large clumps that are not diggable. *Herbicide treatment may be considered an allowed use under VWE 6.18, upon approval of a written plan from the Wetlands Program. Herbicide treatment within / near waters also requires an Aquatic Nuisance Control Permit from the Lakes Program.*

Orange day-lily (*Hemerocallis fulva*)
Priority – Medium

Description
Orange daylilies form beautiful orange flowers that can be as tall as 6 feet. Orange daylilies have become an invasive species because they spread rapidly into fields and along roadsides when dumped. They can form dense patches that displace native plants. Orange daylilies are native to Asia. They are a popular ornamental plant that many people plant in their gardens.

Current Distribution at Survey Sites
On Lewis Creek, orange daylilies were found sporadically from slightly upstream of Baldwin Road in Hinesburg to Greenbush Road in Ferrisburgh. Most of the orange daylilies were found near Sequin's covered bridge on Roscoe Road and Quinlan's covered bridge on Monkton Road in Charlotte.

Damage and Threats
Orange daylilies outcompete native plants by forming dense patches. They invade meadows, forests, floodplains, ditches, forest edges, and banks of rivers. Orange daylilies are hard to control due to their rhizomes which help them spread rapidly.

Goals
Educate the public about the threat of orange daylilies and monitor established populations.

Objectives
Control established orange daylily populations and educate the public on native alternatives for their gardens.

Management Options

a) **No Treatment**

b) **Mechanical**
   i. **Hand Digging**
      Small clumps of orange daylilies can be controlled by hand digging out all roots and rhizomes. After hand digging, the soil should be combed carefully to ensure that every piece of the roots, rhizomes, or any other part of the plant are removed. Plant parts should be removed from the area and be allowed to decompose thoroughly before disposal. Plant parts should not be composted. Hand digging, along with monitoring, may be effective at controlling orange daylilies on Lewis Creek.

c) **Chemical**
   Herbicide may be selectively used for plants in small patches or numbers. Plants should be sprayed with a glyphosate solution during the plant's growing season, post-bloom (Waterworth 2020). Rodeo, a glyphosate product manufactured by Dow Chemical, is labeled as safe for use in aquatic environments. Orange daylilies are hardy and may require multiple treatments. *Herbicide treatment may be considered an allowed use under VWE 6.18, upon approval of a written plan from the Wetlands Program. Herbicide treatment within / near waters also requires an Aquatic Nuisance Control Permit from the Lakes Program.*

Flowering rush (*Butomus umbellatus*)
Priority – High

Description
Flowering rush is an aquatic perennial that grows along freshwater shorelines and in wetland areas with water as deep as 3 feet. Its leaves are three-angled, a unique distinguishing feature. Flowering rush is most conspicuous in late summer and early fall when its large, umbellate pink flowers are visible on tall stalks that can reach over 3 feet in height. Flowers produce dark brown beaked fruit that split open to release many seeds.

Current Distribution at Survey Sites
Flowering rush was found on Lewis Creek from just downstream of the Vermont Fish and Wildlife boat access to the portion of the creek that borders the dairy farm at the end of Ashley Road in Ferrisburgh.

Damage and Threats
Flowering rush has been observed displacing native species and sometimes is found in populations so thick that boat access is limited. Furthermore, flowering rush spreads by seed and rhizome fragments (as well as bulbils) and has been noted to appear in floodplain forests. The flowering rush found at the mouth of Lewis Creek has the potential of being dispersed by seeds attached to mobile birds or mammals or by broken rhizome fragments floating along the water. However, a study by Bemidji State University and Queens University reports that some North American populations do not produce viable seeds; this suggests that flowering rush may likely spread by human activity or animals like Muskrats, that typically dig and disrupt wetland bottoms, dislodging and moving rhizomes. However, recent genetic analysis of the flowering rush plants in Charlotte (Town Farm Bay) show that those plants do have viable seeds, as they are diploid.

In well-established wetlands, flowering rush has not been observed as problematic. Changes in water level or minor disruptions, however, could change site conditions and allow for flowering rush to spread quickly in disturbed areas. If wind storms or disturbance events decrease native plant numbers or water levels fluctuate frequently, flowering rush could potentially spread throughout the floodplain forests in Lewis Creek.

Goals
The population of flowering rush should be monitored annually, especially in nearby forests and upstream of the mouth of Lewis Creek. If the population continues to expand or begins to displace current native flora, control efforts should be considered.

Objectives
Annual monitoring of the flowering rush population and management if the population spreads or becomes more dense.

Management Options

a) **No Treatment**

b) **Mechanical**
    i. **Stem Cutting**

Flowering rush has been successfully controlled when stems are cut, sometimes multiple times a season, below the water surface. This method will not kill the plant but will prevent seed production and decrease overall plant abundance. Plants should be cut while flowering and all cut reproductive parts should be bagged and removed from wetland areas.

ii. Hand Digging

Small patches of flowering rush in shallow water may be dug out. Extreme care must be taken to remove all parts of the root system – even small bits of roots or rhizomes can resprout and grow, especially in disturbed areas. This method is only recommended for small patches of plants in drier areas where root fragments are less likely to be spread by moving water.

c) Chemical

Herbicide is not a recommended technique for controlling flowering rush found in deep waters but can be selectively used for plants found on dry banks or shallow water. The narrow leaves and the sleek surface of flowering rush make it difficult to effectively "paint" the plant with herbicides and the typical location of the plant in wetland areas prohibits the use of herbicides with added surfactants that increase the herbicides' absorption into the plant's leaves. Currently, there are no herbicides that are selective for flowering rush. So, when treating with herbicides, extra care should be taken to prevent contact with other wetland plants. *Herbicide treatment may be considered an allowed use under VWE 6.18, upon approval of a written plan from the Wetlands Program. Herbicide treatment within / near waters also requires an Aquatic Nuisance Control Permit from the Lakes Program.*

SUGGESTED ACTIONS

Given the importance and diversity of natural communities in the Lewis Creek watershed, LCA plans to continue to invest to maintain the health of the area, and to use early detection, which allows rapid response, to minimize effects on this resource, ideally in conjunction with community volunteers.

Although no future plans have been finalized at the time of this writing, future work will include continuing the boat launch steward program at Bristol Pond (Figure 7), and expanding it to Monkton Pond. The peaks of the field season (June through July) are the highest priority for this program. Ideally, the boat launch stewardship would be funded by LCBP, State, and Federal grants. However, the aforementioned funds may not be available indefinitely. So, LCA will benefit from working with town Conservation Commissions to create a more sustainable volunteer boat launch steward program. Furthermore, future collaboration with local Conservation Commissions, towns, watershed groups, and non-profit organizations will be beneficial to educate the community and encourage better stewardship of our waterways.

Figure 7. LCA's boat launch steward inspects boats before they launch into Bristol Pond.

If LCA and other stakeholders intend to successfully prevent the spread of AIS, they need to ensure that early detection and rapid response occurs. This could be accomplished by organizing volunteers into invasive species patrol teams that are modeled after VTDEC's Invasive Patrollers Program (VTDEC 2020). These invasive species patrol teams would regularly monitor waterbodies in the Lewis Creek watershed for AIS and report them to LCA and VTDEC.

Future potential actions that have not been finalized include updating this plan with updated knowledge about flowering rush and yellow-flag iris control, following the completion of those

two ongoing grant-funded projects by LCA. Steps for control in the Lewis Creek watershed include delineating the extent of flowering rush, determining genetics of the Lewis Creek population (diploid or triploid), and beginning work to control dense populations using techniques learned in current LCBP-funded grant that explores appropriate control techniques in Town Farm Bay. For Yellow-flag iris, after the completion of research into appropriate control techniques (funded by VT Fish & Wildlife Department in Little Otter WMA), annual reconnaissance and digging up of new plants should be continued in Little Otter WMA. Additionally, upstream work with landowner permission to manage dense populations (then smaller populations) will allow minimization of seed dispersal to Little Otter WMA. This work will hopefully be a partnership between LCA, VT Fish & Wildlife Department, towns, and LCBP. Stewardship work like this will need to be ongoing, in order to maintain gains made so far with removal efforts. Additionally, the other high priority species from this plan, European frogbit, needs close attention. Bristol Pond should be monitored for frogbit once every year or two. Gathering community volunteers for European frogbit removal at Bristol Pond will be a worthwhile activity. Finally, while poison parsnip and banded mystery snail were discovered in the Lewis Creek watershed during this survey, they are not part of the AIS management plan at this time.

Public outreach including LCA Facebook posts and e-newsletters that mention these invasives should occur at least twice a year. Ideally, these outreach efforts will also tag, or be developed in conjunction with, various partners (towns, VT Fish & Wildlife Department, LCBP, etc.) in order to gain a wider reach and support. The control of AIS will have to occur for the foreseeable future. Therefore, LCA must continue to cultivate the community's love for the watershed.

Finally, AIS surveys should occur regularly. LCA should monitor the AIS already present in the watershed at least every 5 years. High priority AIS species should be monitored more frequently. This document is a living document that LCA will refer to every year and adapt as the environment changes. Much more work must occur if we are to continue the process of bringing our ecosystems closer to ecological equilibrium.

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