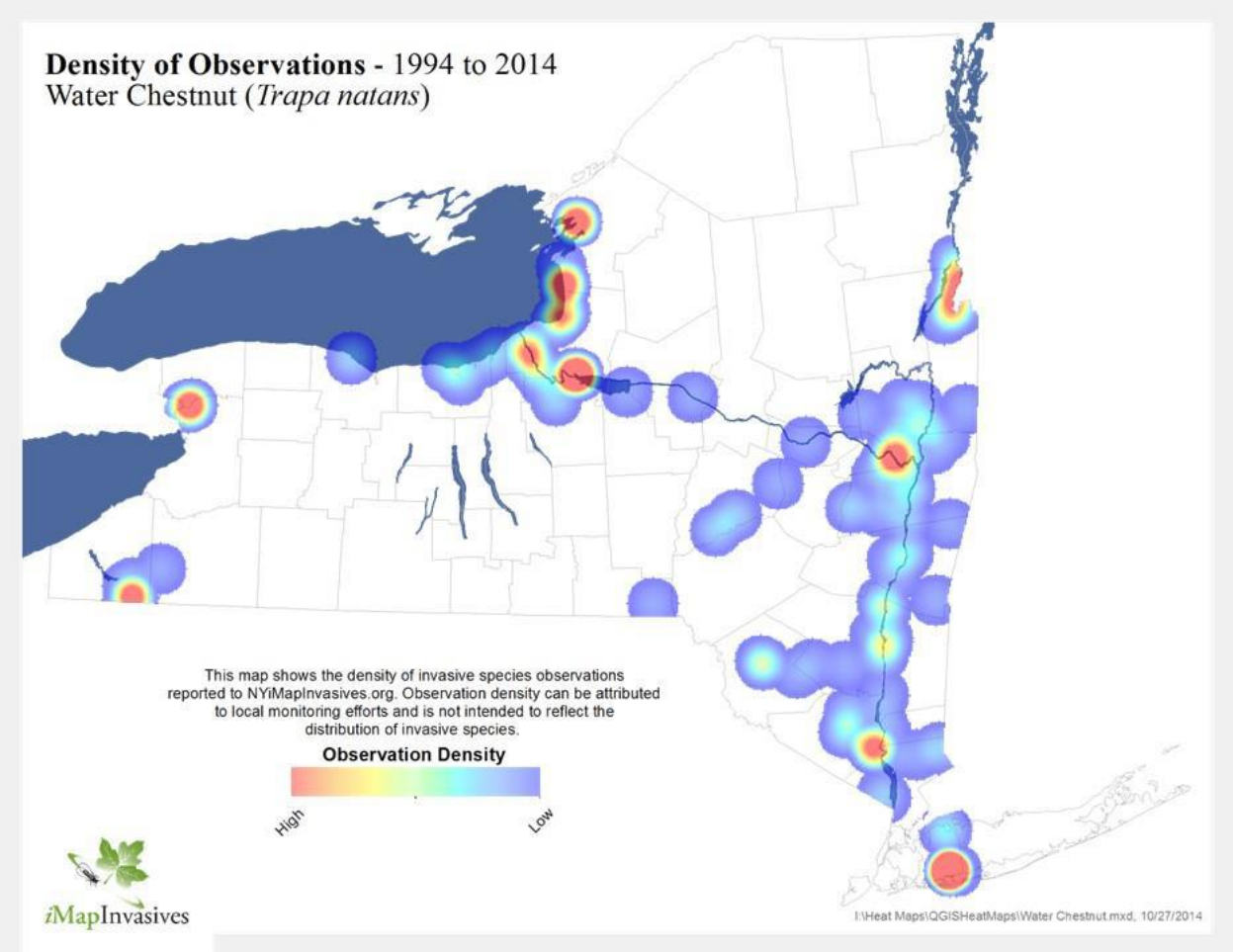
WATER CHESTNUT:
A MANAGEMENT PLAN FOR ONONDAGA COUNTY

I. Background



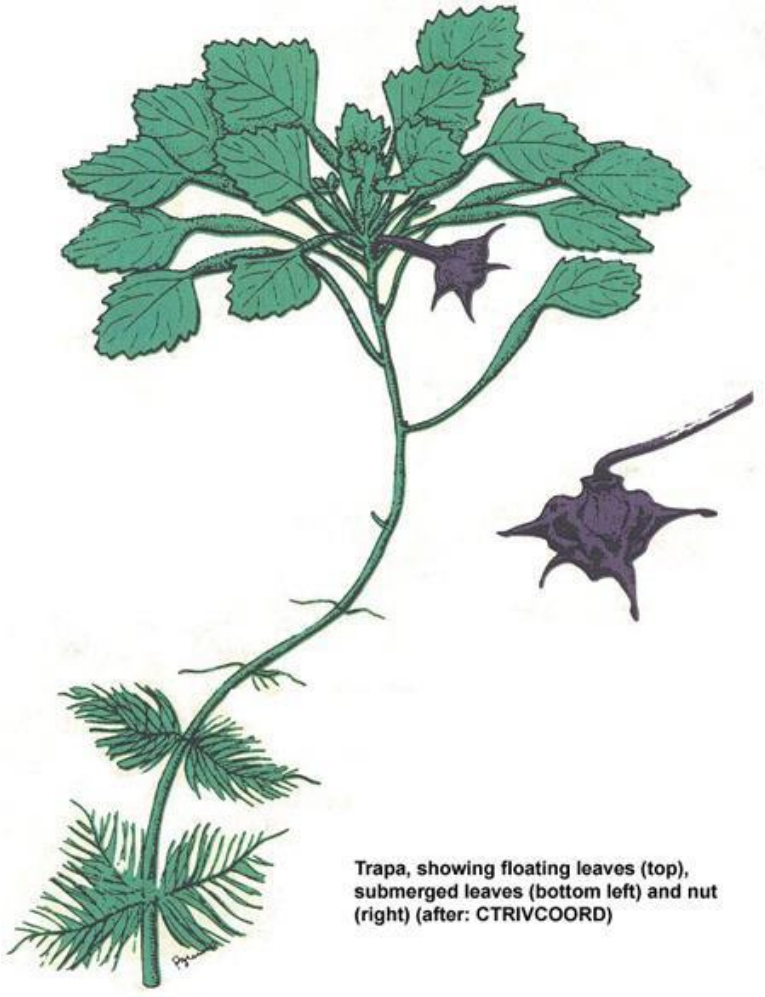
A. History

Over the course of the last several decades, Onondaga County has experienced a gradual but steady increase in its waterways of an aquatic invasive species known as *Trapa natans*, or water chestnut. Believed to have been brought to New England from outside the country in the 1870s, it spread to upstate New York over time, becoming a nuisance to transportation and recreation on lakes and rivers throughout central New York and a threat to the local aquatic wildlife.

Water chestnut is an aquatic plant that floats on the water's surface in the shallower parts of water bodies around two to five meters deep. It is anchored by a long, dark stem that reaches down into the sediment on the floor of the water body. The leaves of rosettes at the

top shield a nut that bears four sharp barbs which can cause injury if stepped on barefoot and can even breach footwear. The leaves themselves account for the most significant nuisance of the water chestnut. The plant can reproduce at an overwhelming rate which creates a dense and extensive mat made up of individual plants that float in close proximity to one another on the top of the water. This prohibits boaters, swimmers, and other recreational users from being able to enjoy the water body. It can also prevent over 95% of the sun's rays from reaching other aquatic plants and can inhibit the concentration of dissolved oxygen in the water, which negatively affects both plants and fish.

Water chestnut has been declared an invasive species throughout the northeastern US as far south as Virginia and also in some parts of Canada. Various local and regional governmental bodies have attempted to develop plans and strategies to combat this invasive species, with varying results. In Onondaga County, the struggle to limit water chestnut in our local waterways has largely been overseen by the Onondaga County Soil and Water Conservation District (OCSWCD), but its increased proliferation in recent years has called for a greater and more sustained effort to limit and extinguish it in local waters.



Trapa, showing floating leaves (top), submerged leaves (bottom left) and nut (right) (after: CTRIVCOORD)

B. Biology

Water chestnut is a difficult plant to eradicate entirely in any given area however. *Trapa natans* is an annual, growing from a seed, or nut, each spring. Once pollination has occurred, a new nut forms below water where, once mature, it falls off and either sinks to the bottom of the water body where it becomes embedded in the soft sediment or is carried by currents and eddies to a new location in which it can take root. Each plant may produce as many as ten to fifteen nuts before in autumn, when temperatures become cold enough, it dies off. The volume of decaying plants in the water body contributes to what is called nutrient loading, which adds large amounts of nutrients to the water and makes conditions for the species' continued presence in the water body that much more favorable. The dense, decaying mats of water chestnut have also been known to produce unpleasant odors, further adding to its undesirability.

The nuts that each plant produces embed themselves in the soft sediment along the bottom of the water body before a number of them sprout anew each spring and renew the cycle. The nuts that do not sprout the following spring however remain embedded in the sediment and create a seed bank for water chestnut to rely on each year. Each new nut that is produced can remain viable for ten to fifteen years, adding to the difficulty of completely eradicating water chestnut from a particular water body.

II. Management Options

A number of different options exist to attempt to keep water chestnut at bay, but to have any hope of someday completely eradicating it, a comprehensive, multi-pronged management plan must be put into place. In order to formulate such a plan, a number of the strategies that have been adopted by other localities have been examined and weighed based on a number of different factors including their rate of success in their respective regions, their likely rate of success in affected Onondaga County water bodies, their estimated costs, and their feasibility. The pros and cons of these strategies are outlined below and a conclusion is drawn as to which are the most likely to have success in alleviating the problem.

A. Mechanical Harvester/Hydrorake

The first and most widely effective method of ridding water bodies of water chestnut is using a mechanical harvester or a hydrorake to drive through the mats and harvest the plants right onto the boat and that way remove them from the water. Each type of harvesting boat can manage to harvest 1.5 acres of water chestnut per day, or approximately 0.2-0.6 acres per hour. Their slow pace is due in part to the need to periodically drive the boat to a designated

location where the harvested plants may be offloaded to make room for further harvests. The offloaded plants will then need to be taken to a predetermined location and either composted (for use at area farms) or incinerated.

The mechanical harvester's method of removal of the plants from the water is by cutting through the stems and loading the leaves onto the boat, thus removing the most troublesome aspect of the plants. This method, though effective, may necessitate the harvester making multiple cuttings at the same locations at different times of the year if the cut stems regrow their leaves. The harvesters are only operable in depths of six feet or greater, so if no point of access with the necessary depth exists where it can be loaded into the water body, a crane may be necessary to insert the harvester into a point of appropriate depth. Hydrorakes, on the other hand, require less depth - as little as one foot – in which to operate. Furthermore, hydrorakes pull the entire plant up, including the stem and the roots, so that the plant may not regrow its leaves and re-establish itself.

Based on the above reasons, the hydrorake may seem the more attractive of the two options. Once costs are taken into account however, the choice becomes a more difficult one. In its Invasive Water Chestnut Control Study commissioned by the City of Watervliet, NY in October of 2018, SOLitude Lake Management gave an estimated cost of $10,000/acre for the use of a hydrorake, while the cost of the use of a mechanical harvester was given as a one-time

mobilization fee of $3,500 and $ 1,233/acre thereafter, as well as a further disposal fee of $1,233/acre (Weston&Sampson, 2018). Several permits may also be required prior to commencement of harvesting activities, as well as a plan put into place to limit or avoid the disturbance of any non-invasive plant or animal species in the target areas.

B. Hand-pulling

Another method that has proven relatively successful at the removal of water chestnut is that of hand-pulling. This is carried out by workers in kayaks or canoes who paddle out into the affected area, don gloves, and pull the water chestnut up out of the water with their hands. As with the hydrorake, the goal is to remove both the leaves floating on top of the water as well as the stem, the roots, and the barbed nut so the plant is unable to regrow its leaves or reproduce by releasing its seeds to settle into the sediment below. When they cannot carry any more of the harvested water chestnut in their boats, the workers must then likewise return to shore to offload their cargo to be allowed to dry and then removed and disposed of.

Because the speed at which the water chestnut are collected is much slower and the harvest much less voluminous than those with a mechanical harvester or hydrorake, the

method of hand-pulling is better suited to areas where the water level is more shallow and the sprawl of water chestnut less dense. The more selective nature of this method is also better suited to areas in which the avoidance of disturbances to non-invasive species is desired. In the Watervliet Invasive Water Chestnut Control Study, SOLitude Lake Management anticipated the cost of hand-pulling with a crew of two people to be $1,000/acre (Weston&Sampson, 2018). Some permits may be required in wetland areas and some shorelines where threatened or endangered species may have habitats.

C. Herbicides

A third method that has met with various levels of success is that of herbicide treatment. Several different brands of herbicide have been registered with the Environmental Protection Agency (EPA) and approved for use by New York State in its waterways. Some of these pesticides have demonstrated great promise in decreasing the acreage occupied by water chestnut. In 2012, the Oswego County Soil and Water Conservation District used an herbicide called Clearcast to treat over 220 acres of water chestnut in the Oswego and Seneca Rivers. With regular treatment over the following years, the water chestnut were reduced to approximately 20 acres by 2016 (OARS, 2017).

Unlike hand-pulling or even mechanical harvesting, permission to apply a particular pesticide in any water body in New York State requires a series of permits. Pesticides are not

particularly selective, and so must be applied carefully or avoided altogether in places in which other plants exist which are specifically not being targeted. Also, once it has been approved and the pesticide applied over a vast area, the water chestnut in that area may begin to emit a foul-smelling odor as they decay, similar to that emitted when they die en masse at the end of their growing season in the fall. At that point, the only option is to remove them from the water by harvesting them with a mechanical harvester or a hydrorake and hand-pulling (which would avert the odor and prevent nutrient loading). If left unharvested, there is the chance they could break up naturally, but their gradual decomposition would add significant amounts of nutrients to the habitat that would encourage the re-establishment of water chestnut in the water body. Based on the Watervliet Invasive Water Chestnut Control Study, SOLitude Lake Management gives an anticipated cost of $800/acre (Weston&Sampson, 2017).

D. Drawdowns

Another method that has been considered for eradicating water chestnut is that of drawdowns. This requires the level of the water body to be lowered, or “drawn down,” by

artificial means so that it is low enough for the sediment to dry out and kill the plants living within the water body. Although this method has met with some limited amounts of success, it is considered a very disruptive option. Drawdowns would need to be carried out once the water chestnut have begun to sprout in late May/early June, but not so late that pollination has begun to take place and they have begun to drop their seeds (late July/early August). This would restrict normal recreational opportunities in the water body at a time of year when they are greatly desired by the public. Furthermore, it would create a great disturbance to other species within the ecosystem – one it may or may not be able to absorb. Accurate costs associated with drawdowns are difficult to anticipate, as labor, fuel and monitoring costs vary, as do those of the pumps, siphons, and other materials requisite in drawing down the levels of water bodies. Due to the disruptive nature to both the public and the ecosystem and the variable, possibly heavy costs associated with the process, drawdowns are not feasible and not recommended at this time.

E. Dredging

Hydraulic dredging is another option that has been used elsewhere to control the growth of water chestnut. It aims to reduce the seed bank lying dormant in the soft sediment on the bottom of the water body which sustains water chestnut in that area from year to year. Hydraulic dredging works by agitating the sediment with the dredge head, thus creating a slurry made up of the sediment and the various aquatic plants growing out of it, which is then suctioned through a tube or pipe to a handling location. Once the slurry is suctioned off the floor, it would lengthen the depth of the water body. This method is considered feasible only for water bodies which do not see a regular re-accumulation of sediment at a rapid pace. Furthermore, it is not selective, meaning non-target plant species living in the sediment would be suctioned up along with the target one. SOLitude Lake Management anticipates the cost of hydraulic dredging to be approximately $121,005/acre based on an assumed average depth of five feet and $15 cubic yard and not including potential mobilization and startup fees (Weston&Sampson, 2017). Despite its reported successes, because the process does not distinguish between invasive and non-invasive aquatic plant life and due to the prohibitive cost involved, dredging is not recommended at this time.

F. Benthic Barriers

Benthic barriers are anything that can be placed along the bottom of a water body to prevent aquatic vegetation from taking root and proliferating. These can include silt, sand, clay, gravel, or artificial materials such as sheets of polyethylene. Benthic barriers have met with great success in limiting and in some places eliminating water chestnut altogether, but they would also eliminate any other native vegetation that grows in the vicinity. Though this management option can be effective in small areas, benthic barriers are not recommended for

larger areas where there are significant water currents or waves due to difficult and costly installation and maintenance. Anticipated costs by SOLitude Lake Management place them at $45,000-$65,000/acre installed (Weston&Sampson, 2017). Due to the extensive cover of water chestnut in the county's water bodies and what would be a prohibitively expensive undertaking, benthic barriers are not recommended at this time.

G. Biological Control

A final method to arrest the spread of water chestnut is that of biological control. It involves introducing a species that is known to feed on water chestnut into the area and allowing the predator species to consume it and in that way keep it from proliferating in great numbers and becoming a nuisance. While this would be a very cost effective option, and several promising species have been suggested, including a beetle called *Galerucella birmanica*, there are still issues with this control measure at this time. It would involve introducing a non-native species to a foreign environment, therefore further research is needed to evaluate what the species' effect on the wider ecosystem would be. In particular, Dr. Bernd Blossey of Cornell University has been doing some very promising research with leaf beetles and their effect on water chestnut and should be nearing the end of his research program. If one day these leaf beetles are approved for release into the environment, or a more suitable species is identified and approved, biological control may become a more feasible option in the future, but since no biological control for the eradication of water chestnut currently exists, this option is not feasible at this time.

Table 1 - Summary of the Anticipated Cost and Feasibility of Management Options

Method	Cost/Acre	Feasibility
Harvester	$1,233/acre, $1,233/acre disposal fee, $3,500 startup fee	Yes
Hydrorake	$10,000/acre	No
Hand-pulling	$1,000/acre	Yes
Herbicides	$800/acre	Yes
Drawdowns	Variable	No
Dredging	$121,005/acre (not including mobilization and startup fees)	No
Benthic Barriers	$45,000-65,000/acre	No
Biological Controls	Unknown	Not at this time

III. Recommendations

The problem posed by the infestation of water chestnut in the county's waterways is not one with a simple solution. The heavy volume and persistent proliferation of the species presents an issue that must be confronted on several levels. After evaluating some of the management plans adopted by other localities in the region facing similar conditions, specifically those in Watervliet and in the Sudbury, Assabet, and Concord River Watershed in Massachusetts, the following recommendations are proposed as part of a management plan which will keep water chestnut at bay and possibly begin to eradicate it.

A. Proposed Management Plan

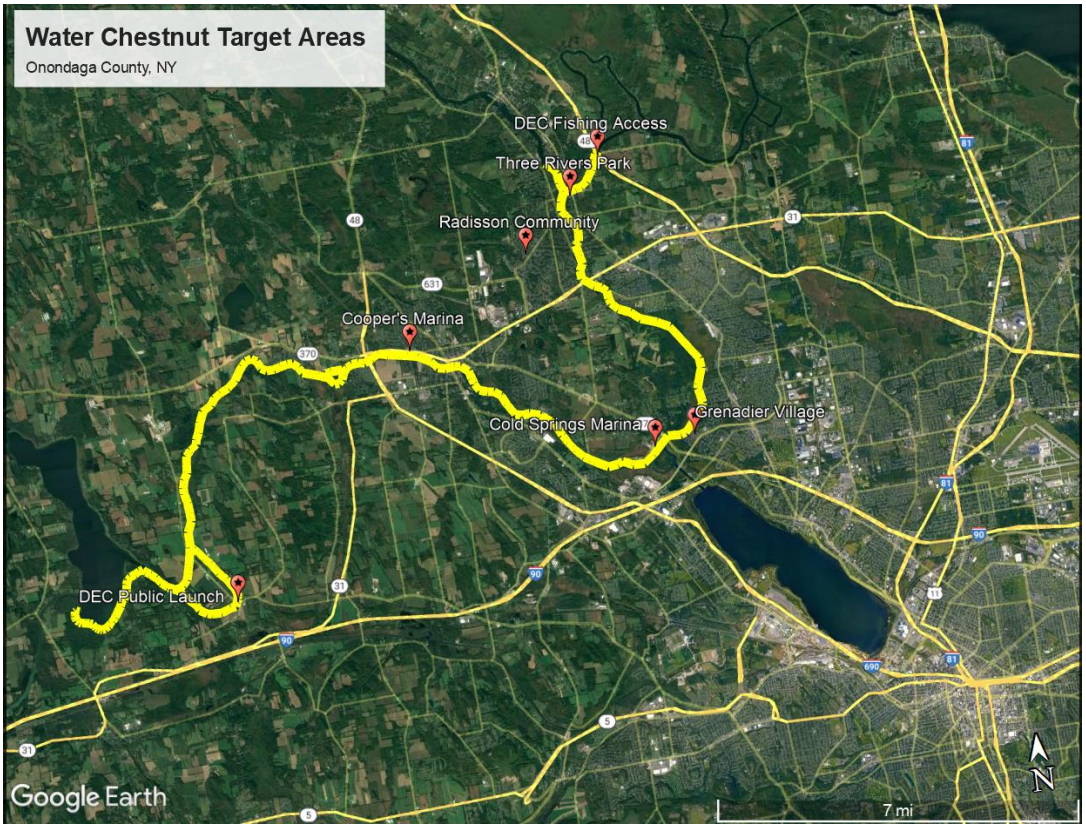
Water chestnut must first be targeted for physical removal in the spring once it has begun to appear on the water (usually in June) before it is given the chance to become pollinated and its seeds start to mature and break off. This will allow for the clearance of water bodies and their continued use throughout the summer for boating, fishing, swimming, and other forms of recreation. This can be carried out through each of two ways: in denser and more widespread areas, a mechanical harvester is recommended, as it can be commissioned at a relatively low cost for the amount of work it does; in shallower areas where the harvester cannot reach and where other considerations must be taken into account such as disturbing specific plants or wildlife, hand-pulling is recommended. Though it is the slower of the two, hand-pulling can in

some places be sped up by seeking the assistance of such groups as lake organizations or a general call for volunteers.

The ability of water chestnut to re-establish itself year after year due to the seed banks it has built up in the sediment of the various water bodies it inhabits calls for a sustained effort over the ensuing years and perhaps even decades, as its nuts can remain viable for up to fifteen years. For this reason, the permitted use of pesticide is recommended in conjunction with that of mechanical harvesting. It is essential to kill the plants before they are allowed to pollinate and thus replenish themselves by releasing their seeds to mature and become embedded in the sediment for re-emergence the following year or at a later date. Mechanical harvesters, though effective, move fairly slowly, as do hand-pullers. If there is only a single mechanical harvester in use and many acres of thick mats of water chestnut at various locations for it to harvest, it may not be possible for the harvester to reach all of those locations before the seeds begin to mature and fall off to add to the seed bank. The application of pesticide is the more time-sensitive method for preventing water chestnut from forming seeds, and once they have been exterminated they can then be harvested by the mechanical harvesters at a later date. However the application of herbicide would prevent water chestnut from being picked by hand-pullers and from being composted. It would therefore need to be harvested by mechanical harvesters only and then disposed of as solid waste.

In addition to the management plan proposed herein, greater communication and cooperation on the issue with surrounding counties is needed. While a plan may be enacted to eliminate water chestnut in local waters, Onondaga County can do nothing about water chestnut that arrives in its waters from surrounding counties borne by the currents and tides

that feed into its rivers and lakes. For this reason, OCSWCD has formed a relationship with Oswego County to work together on water chestnut management in water bodies that share a confluence between the two counties, to great success. (Conversation with Mark Burger and Megan Vanderwarker, 2021)



B. Anticipated Financial Considerations

Based on figures submitted by OCSWCD for the 2021 water chestnut management season and the number of pounds of water chestnut removed at each of the targeted management areas throughout the county, the below figures reflect an estimated cost for the first year of the management plan:

Table 2 – OCSWCD Water Chestnut Management 2021

Location	Method	Amount (lbs.)	Cost
All Locations	Hand-pulling	45,740	
Three Rivers	Herbicide		
Belgium Bridge	Mechanical Harvester		
Cooper's Marina	Mechanical Harvester	616,000	
Jack's Reef	Mechanical Harvester	112,000	
South Bay	Mechanical Harvester	860,000	
Forey Path	Mechanical Harvester		
Eno Point		5,000	
Totals	**All**	**1,638,740**	**$64,546.45**

(*courtesy Onondaga County Soil and Water Conservation District)*

C. Implementation Goals and Evaluation

The proposed management plan will be a path toward successfully ridding local waters of the nuisance that is *Trapa natans* and freeing them up for hassle-free transportation and recreation, as well as allowing for safer and more beneficial waters for its aqueous flora and fauna. However, a successful resolution should not be expected to occur overnight. This management plan will require a commitment to practicing these methods year after year for several years before any noticeable difference may be observed due to water chestnut's ability to build up a seed bank in the sediment and remain dormant for a time before spontaneously springing back to life. Once the management plan is in place, a gradual reduction in the density and sprawl of water chestnut can be expected.

Based on similar plans in the region, a five-year goal of reducing water chestnut cover in the county's water bodies by half is feasible. The responsibility for implementing the management plan will be that of OCSWCD through funding from Onondaga County. OCSWCD has extensive experience with carrying out all three facets of the management plan and agreements in place with local farms to compost the harvested water chestnut and will continue to carry them out. The County will monitor and evaluate the progress being made based on the amount of water chestnut that has been cleared at each location. As this occurs and the amount to be harvested, hand-pulled, and treated with pesticide at each location

decreases, the required financial commitment will decrease also. Under the above management plan, we may begin to see a noticeable reduction in the nuisance posed by water chestnut in the county's waterways.

V. References

Conversation with Mark Burger and Megan Vanderwarker. (2021, October, 26). Onondaga County Soil and Water Conservation District.

OARS. (2017). Water Chestnut Management Guidance & Five-Year Management Plan for the Sudbury, Assabet, and Concord River Watershed. https://www.oars3rivers.org/sites/default/files/Water%20Chestnut%20Guidance%20and%20Management%20Plan.pdf

Weston & Sampson PE, LS, LA, PC. (2018). City of Watervliet Normanskill Relicensing – Water Chestnut Control Study. https://www.townofguilderland.org/planning-department/files/water-chestnut-control-study

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