HOBART AND WILLIAM SMITH COLLEGES

FINGER LAKES INSTITUTE

FINGER LAKES PRISM
Partnership for Regional Invasive Species Management

Water Chestnut Management Plan

Control, Monitoring and Resources Guide

Finger Lakes-PRISM | Finger Lakes Institute at Hobart and William Smith Colleges, 300 Pulteney Street, Geneva, NY 14456

www.fingerlakesinvasives.org

Water Chestnut Management Plan

EXECUTIVE SUMMARY

Water chestnut (*Trapa natans*) is a highly invasive annual floating-leaved aquatic plant. This species grows in mucky sediment and calm waters at relatively shallow depths (up to three or four meters) to form impenetrable mats that cover water surfaces and can have detrimental ecological and economical effects for the Finger Lakes region. Dense mats crowd out native aquatic vegetation and negatively affect water quality. Control of this invasive species can be costly, so it is essential that infestations are identified and managed while they are still small. There are several ways to manage water chestnut, including prevention, physical control, mechanical control, chemical control, biological control, and drawdown. Removing or chemically treating plants before they produce viable seeds must be the goal of any management and it is imperative that such activities continue until the seedbank is depleted to ensure successful infestation removal. Monitoring water chestnut populations is essential in detecting new populations early and gauging control method effectiveness.

Established in 2004, the Finger Lakes Institute at Hobart and William Smith Colleges is dedicated to the promotion of environmental research and education about the Finger Lakes and surrounding environments. In collaboration with regional environmental partners and state and local government offices, the Institute fosters environmentally-sound development practices throughout the region, and disseminates accumulated knowledge to the public.

Hobart and William Smith are nationally recognized liberal arts colleges defined by a longstanding focus on educating across academic disciplines and an intellectual environment that cultivates faculty and student connections. With a strong commitment to inclusive excellence, the Colleges have a distinguished history of interdisciplinary teaching and scholarship, curricular innovation and exceptional outcomes. Hobart and William Smith provide robust programs in career development, study abroad, service, leadership and athletics. There are 45 majors and 68 minors. With an enrollment of 2,061, more than 60 percent of students study abroad through one of the top global education programs in the country and all participate in community service. Located in the heart of the Finger Lakes region, Hobart and William Smith enjoy a lakeside campus on the shore of Seneca Lake. Originally founded as two separate colleges (Hobart for men in 1822 and William Smith for women in 1908), Hobart and William Smith students share the same campus, faculty, administration and curriculum.

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INTRODUCTION

Water chestnut (*Trapa natans)* was introduced to North America as an ornamental for garden ponds from Europe and Asia. By 1884, this highly successful invasive had become established in New York State. Water chestnut is an exceptionally hardy aquatic invasive species with traits that give it a competitive edge over native counterparts. The plant grows quickly to form dense, floating mats that become menacing for swimmers and impede boaters and other recreationists. The thickness of the mats severely limits sunlight within the water column, and can reduce or prohibit the growth of other aquatic plants. The lack of plant growth, combined with organic decomposition, reduces dissolved oxygen concentrations in the water column that then further affects aquatic organisms and degrades the integrity of surface waters in the Finger Lakes. The water chestnut may even create breeding grounds for mosquitos.

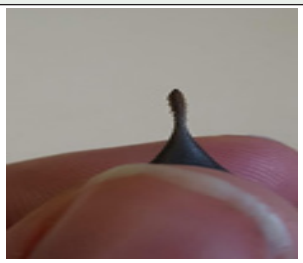
Biology

Water chestnut (*Trapa natans*) is a floating annual with rosettes of serrated triangular leaves that float on top of the water. It grows from a nutlet typically in shallow, slow-moving or still freshwaters to depths of four meters, although it is often found in two to three meters. The seeds are 4-spined nutlets that overwinter in mucky sediment, where they can remain viable for up to 12 years. Tiny recurved barbs are present at the end of each spine; these help the nutlet to cling to various materials, including fur and feathers.

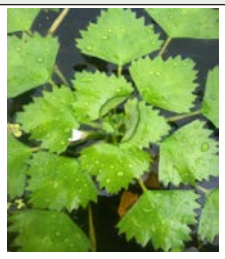
In the spring when water temperatures reach 12° C, (typically May through June), the nutlets sprout and grow quickly to form a floating rosette of toothed, triangular leaves with spongy, inflated petioles. The submersed leaves are fine and feathery in appearance. Small white flowers bloom throughout the summer, late-June through August. Each flower produces a seed, which, when mature, will fall off the rosette and sink. The rosettes are killed by a hard frost in the fall after the nutlets have dropped ensuring next year's population.

Water chestnut seed with four spines.

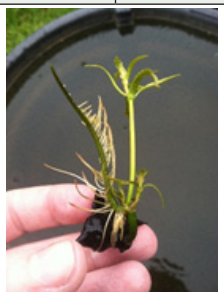
Floating water chestnut rosettes with toothed, triangular leaves.



Tiny recurved barbs at the end of a seed's spine.



Water chestnut rosette with small white flower.



Water chestnut seed and sprout.

Multiple stems, usually three or four, can sprout from a single seed and each stem can branch into several rosettes. Each rosette has the potential to produce up to 20 seeds, which allows for incredible reproductive success. Prevention of seed maturation is essential in managing water chestnut infestations. This is commonly done through physical control, or hand-pulling. Rosettes and the top of the stem should be removed from the water column prior to seed maturation. Seeds/nutlets turn black and drop in mid-late August so pulling beforehand is vital to successful management. The pulled water chestnut plants must be disposed of in a way that prevents them from re-entering the water and allows them to dry, after which, they are no longer viable. Often, they are disposed of using garbage bags. The disposal method and site may vary depending on the quantity of plants being removed.

Water chestnut rosettes with feathery submersed leaves and long stem.

Potential Impacts

Biological/Ecological

The profuse growth potential of each water chestnut plant gives this species the ability to completely cover the water surface with floating rosettes. Dense water chestnut mats outcompete and take the place of native aquatic vegetation that would normally be valuable wildlife food sources and provide habitat for fish and invertebrates. These mats also disrupt and slow water movement and may increase sedimentation. Once the plant covers the water surface, the water temperature and dissolved oxygen content of the darkened water column are reduced, resulting in degraded water quality. These altered ecological conditions negatively affect aquatic communities.

A dense water chestnut population in Red Creek. It can be observed here how the floating mat obstructs water flow.

Economic

It is estimated that the cost of damages, losses, and control of invasive species total nearly $120 billion annually in the United States and $5.7 billion annually alone in the Great Lakes basin (Pimental *et al.* 2005). Regarding water chestnut specifically, nationally, the cost of damages and losses from water chestnut infestations are estimated at $200 million annually (Pimental 2005). Over $13 million have been expended over 36 years (over $3 million/year on average) to manage water chestnut in Lake Champlain. Although there were noticeable decreases in water chestnut populations, control is ongoing (Vermont Department of Environmental Conservation 2018, https://dec.vermont.gov/sites/dec/files/wsm/lakes/ans/docs/2017%20VT%20WC%20hand%20harvesting%20report.pdf).

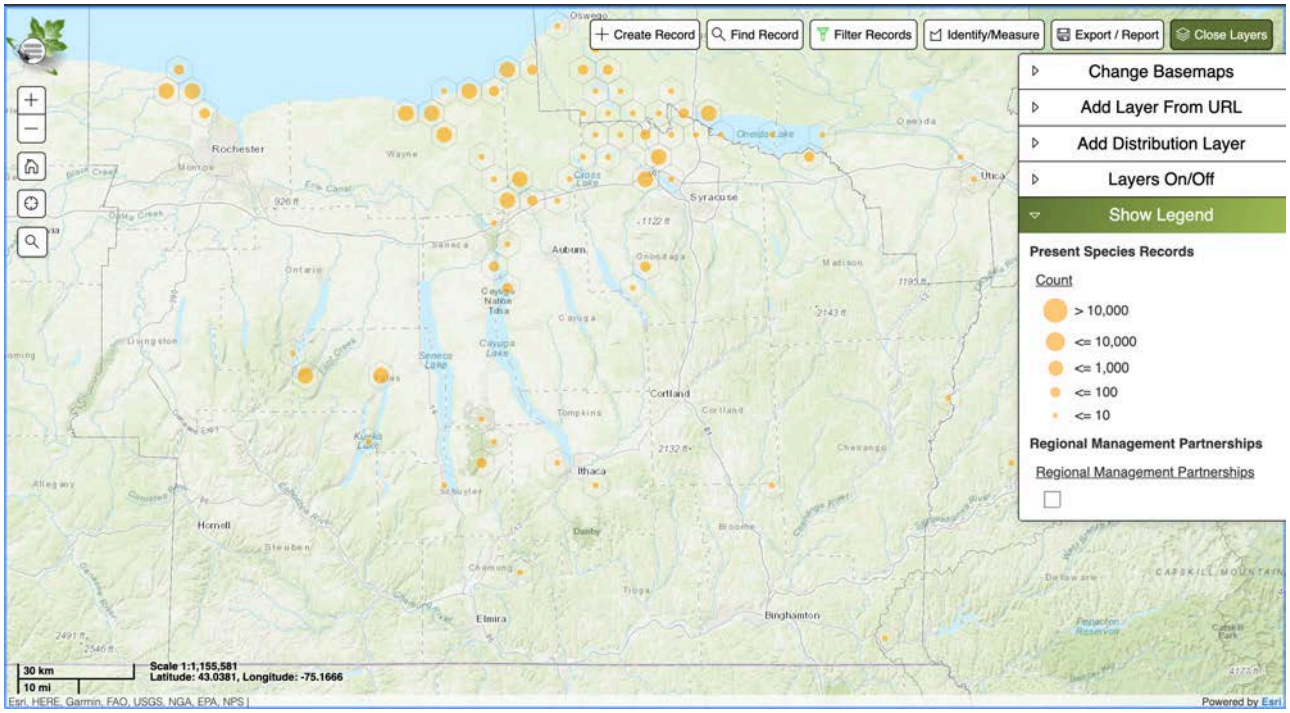
Tourism is a major economic driver in the Finger Lakes region due to abundance of beautiful lakes and waterways. Infestations of aquatic invasive species, such as, water chestnut, have the potential to severely affect dollars coming to the region. Degraded water quality and aquatic habitat negatively affect fisheries and associated recreational activities. The sheer mass and density of water chestnut infestations can significantly restrict boating and swimming and can lower the value of waterfront property.

A dense population of water chestnut in Sodus Bay. This illustrates how an infestation can form an impenetrable mat that impedes native aquatic vegetation as well as navigation and recreational activities.

A water chestnut infestation in a marina in the Finger Lakes region. Businesses like this can be hurt by impeded navigation and recreational activities.

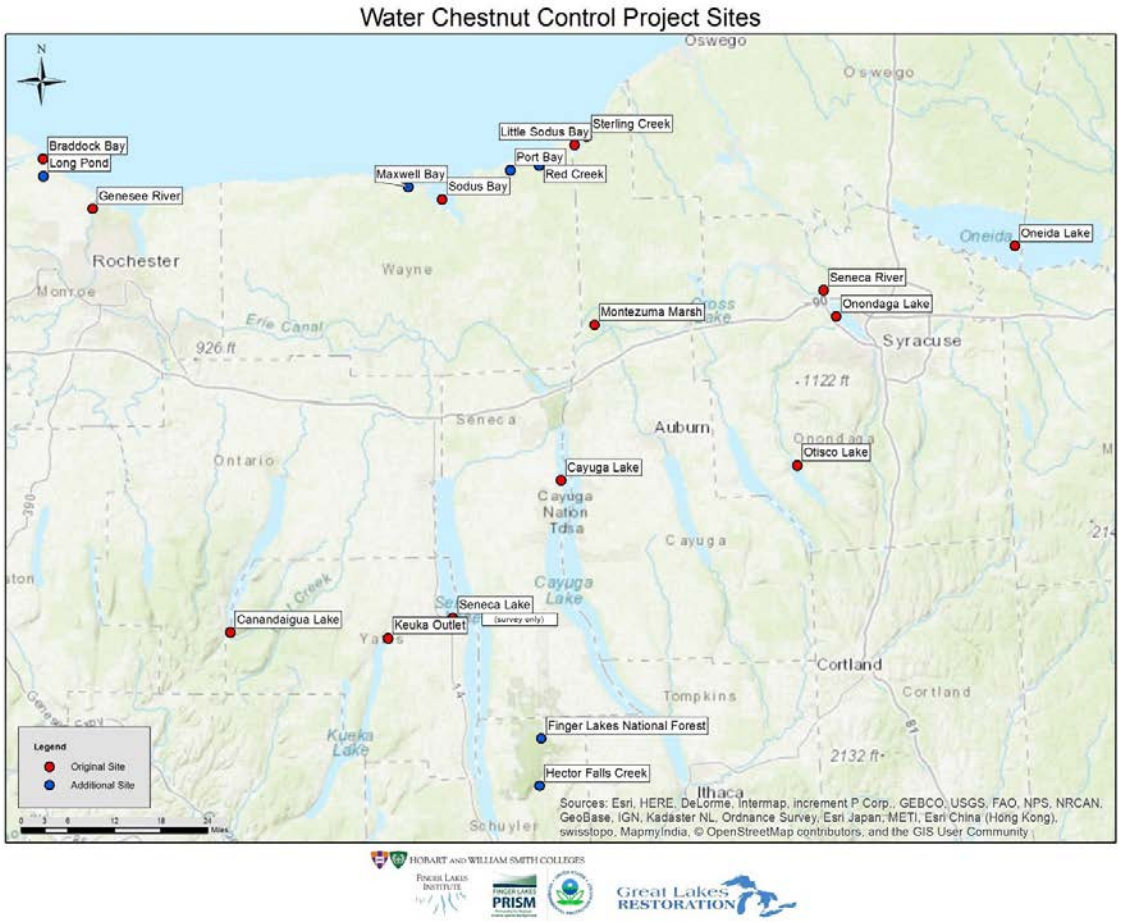
Distribution

Water chestnut was first recorded in the United States in the mid-1800's in Massachusetts. Likely, an ornamental plant that escaped to other waters in the 1870's, it had spread to Central New York waters by the early 1900's.



Water chestnut distribution in the Finger Lakes region according to iMapInvasives.org as of 5/15/20.

The Finger Lakes Institute at Hobart and William Smith Colleges, which hosts the Finger Lakes Partnership for Invasive Species Management (Finger Lakes PRISM), received a grant from the Environmental Protection Agency's Great Lakes Restoration Initiative (EPA's GLRI) for water chestnut survey and control in the Great Lakes basin in the Finger Lakes PRISM region. Twelve infestations and one survey site were targeted, although additional sites were managed as time and resources allowed. Recommended actions for these sites are provided in Table 2.



Water chestnut infestations in the Great Lakes basin of the Finger Lakes PRISM region. Targeted sites are red and additional sites are blue. There are more water chestnut populations that were not able to be addressed and were not included on this map.

Reporting an observation

If water chestnut is detected, it is imperative that the observer report the location. GPS coordinates and photos clearly indicating the species and identifying features should be submitted to iMapInvasives.org for identification confirmation, which can be completed using a free user account. Water chestnut populations grow quickly, so it is important to locate them in their early stages so they are easier to control and require fewer resources for management. Eradication of invasive species populations is much more feasible when caught as soon as possible after introduction.

CONTROL METHODS

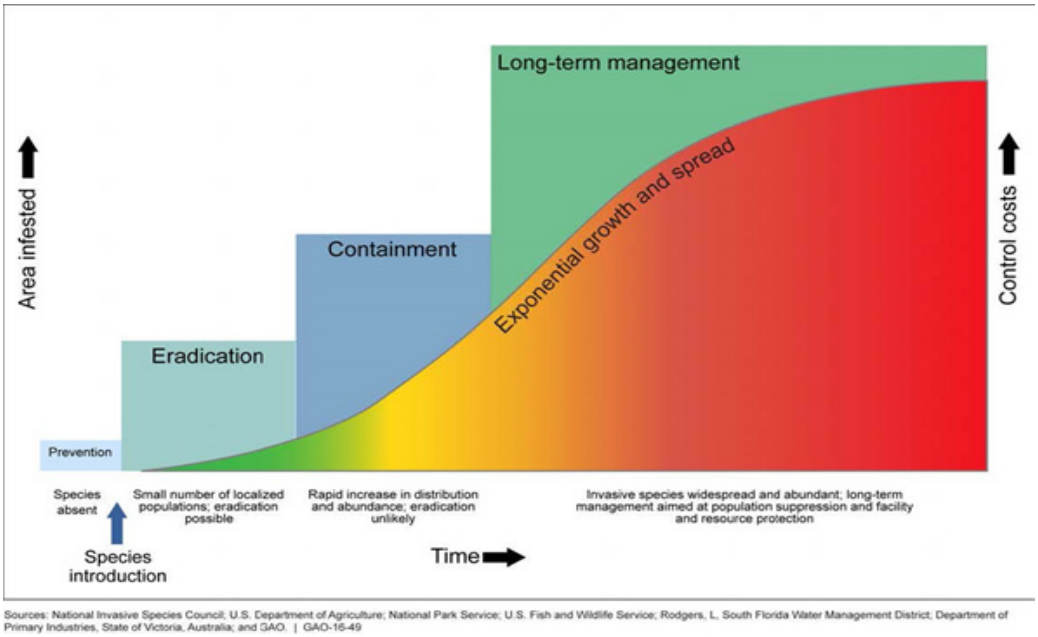
There are several strategies for managing water chestnut. The following methods are centered on preventing mature seed production. Control activities should occur each year until no viable seeds remain.

Table 1. Control methods for managing water chestnut.

Method	*Description*	*Advantages*	*Disadvantages*	*Best suited for*	*Relative Cost*
Prevention	Raise awareness, stop infestations before they even start	Long-term strategy, lower relative cost	Does not manage established infestations	Non-infested waterways and waterbodies susceptible to water chestnut spread	$
Physical Control	Remove water chestnut plants by hand before seeds mature	Effective, little impact to other species, affordable	Labor intensive	Small, localized infestations	$$
Mechanical Control	Remove water chestnut plants using an aquatic vegetation harvester	Can remove dense infestations effectively	Slow, expensive, limited by water depth and site access, may impact non-targeted species	Areas with concentrated water chestnut populations or mats that are too large to physically control, with access for large boats	$$$
Chemical Control	Apply pesticide to exterminate plants before they produce mature seeds	Effective when applied under the appropriate conditions and time of season, quicker than other methods	Expensive, regulatory restrictions, may impact non-targeted species	Large infestations	$$$
Biological control	Introduce an herbivore to control plant growth and prevent seed production	Long-term control	Not yet available, still under research	Not yet available, still under research	Not yet available, still under research
Drawdown	Lower water levels to expose and dry seedbank	Theoretically effective	Reported as ineffective, not feasible for most situations	Waterbodies where water levels may be manipulated and completely emptied	Not feasible for most situations

Prevention

The best management strategy for controlling invasive species is to prevent them from establishing in the first place. Prevention is cost-effective and precludes the negative effects associated with invasive species infestations. Ideally, known water chestnut populations would be contained to their current distribution by preventing new infestations through education and regulatory practices.



Invasive Species Curve illustrating infestation size and associated resource requirements.

Education

According to the New York State Invasive Species Comprehensive Management Plan (https://www.dec.ny.gov/docs/lands_forests_pdf/iscmpfinal.pdf), "[t]he introduction, spread, and management of invasive species is heavily influenced by the actions of citizens who live, work, and recreate on public and private lands and waterways in New York." Education and outreach efforts are intended to raise the public knowledge and awareness of invasive species and decrease the chances of an inadvertent introduction. In the Finger Lakes region, outreach events are held every year to inform people identification of invasive species and vectors of spread to new locations. Additionally, watercraft steward programs are in place at boat launches across the region to inspect incoming and outgoing watercraft for the presence of aquatic invasive species and to communicate to the public information concerning identification and the negative consequences of invasive species.

Regulations

Prevention is also supported by state laws and regulations. Although it not federally regulated, water chestnut is listed under New York State's 6 NYCRR Part 575 Invasive Species prohibited plants list. It is illegal to possess with the intent to sell, import, purchase, transport, or introduce water chestnut in New York State.

Physical Control

Physical control is a common and effective management strategy, so long as populations are not too large. This involves hand-pulling water chestnut rosettes from the water column once they have grown up to the water surface but prior to seed maturation. Usually this occurs at the end of June to about mid-August, depending on weather conditions. Whether an infestation may be physically controlled is largely determined by the density and area of the population, as well as the number of people and amount of time available for control activities. Water chestnut is easily identifiable and weakly rooted, making hand-pull events well-suited for volunteers. Hand-pulling water chestnut can be messy and tiring, but it is extremely effective in controlling infestations.

Canoes, kayaks, waders, and ice fishing sleds, which serve as a floating platform, have proven useful in conducting hand-pulls by allowing people to get within close reach of water chestnut and float the pulled plants to the shoreline for disposal. Larger boats, such as jon boats or air boats, and rakes are applicable when hand-pulling a dense mat that does not require much maneuvering. They are also well suited for ferrying water chestnut between canoers and kayakers and the shoreline or boat launch in the event that boats or floating sleds become full. If the water depth is shallow and the sediment is hard, waders may also be appropriate for hand-pulling water chestnut. Pulled water chestnut may be placed in containers for ease of transporting. In addition to floating ice fishing sleds, these may include small boats, leaf/lawn bags, laundry bags, laundry baskets, and garbage bags. Nitrile-covered work gloves may be appropriate for protecting hands when water chestnut seeds are forming or pulled up with the rest of the plant.

A jon boat being used to collect and ferry water chestnut from paddlers pulling water chestnut.

A floating ice fishing sled being used to collect and float pulled water chestnut to the shoreline.

Canoers with a floating ice fishing sled paddling to a water chestnut infestation.

An airboat being used to collect water chestnut. The boat operator has a rake for pulling water chestnut onto the boat.

Regulations
Hand removal of invasive species may require a General Permit for the Management of Invasive Species (https://www.dec.ny.gov/permits/106121.html). Such activities are regulated if they occur within or adjacent to a freshwater wetland, within the beds or banks of Protected Streams, within Navigable Waters, or in a designated Wild, Scenic and Recreational River area. A Temporary Revocable Permit may be required if hand-pulling is organized as a group event on state land (https://www.dec.ny.gov/regulations/51387.html).

Environmental Permit Office Information

Region 7:
615 Erie Boulevard West, Room 206
Syracuse, NY 13204-2400
Phone: 315-426-7438
Fax: 315-426-7425
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The Syracuse office serves the following counties: Cayuga, Onondaga, and Oswego.

Sub-Office
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Fax: 607-753-8532
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The Cortland office serves the following counties: Broome, Chenango, Cortland, Madison, Tioga, and Tompkins.

Region 8:
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The Region 8 office serves the following counties: Chemung, Genesee, Livingston, Monroe, Ontario, Orleans, Schuyler, Seneca, Steuben, Wayne, and Yates.

Case Study: Braddock Bay

Braddock Bay is part of the Braddock Bay Wildlife Management Area (WMA), owned by New York State, and operated by the Town of Greece in Monroe County. The WMA consists of 2,125 acres of bay-marsh complex, 300 acres of which form Braddock Bay. This site is largely open water bordered by cattail marsh. Water chestnut was observed in 2013 in the inland cove formed by the sand spit located southeast of the mouth of the bay. Control efforts have removed plants from this location via hand-pulls since it was first observed. From 2014-2018, several joint physical control efforts have resulted in an overall 98% population reduction. Large volunteer efforts were organized in 2014 and 2015, involving the Finger Lakes PRISM, the Genesee Audubon Society, N.Y. B.A.S.S. Nation, and others to manage this water chestnut population. In 2014, volunteers spent five days removing nine tons of water chestnut. In 2015, nearly 7 tons were pulled. The water chestnut was transported to a town composting facility using garbage trucks in collaboration with the Town of Greece.

In 2016, 2017, and 2018, a strike team funded by the EPA's GLRI as part of the aforementioned grant participated in the joint volunteer pulls and control efforts in Braddock Bay. About 3,000 pounds of water chestnut were removed in 2016 and disposed of via garbage truck. The main infestation was markedly smaller than in previous years. In 2017, 217 pounds of water chestnut were pulled, a 93% population reduction from the previous year. In 2018, the strike team and volunteers pulled 1,209 pounds of water chestnut. The initial infestation in the cove remained distinctly smaller than previous years, measuring 273 pounds- about a 91% population reduction from 2016 and 98% reduction overall. However, populations that likely spread from the initial infestation grew, particularly on the northwest side of Braddock Bay and in Salmon Creek, up to three miles away from the original infestation. It appears that much of the seedbank from the original water chestnut infestation has been depleted, although continued control efforts are needed to completely eradicate the infestation.

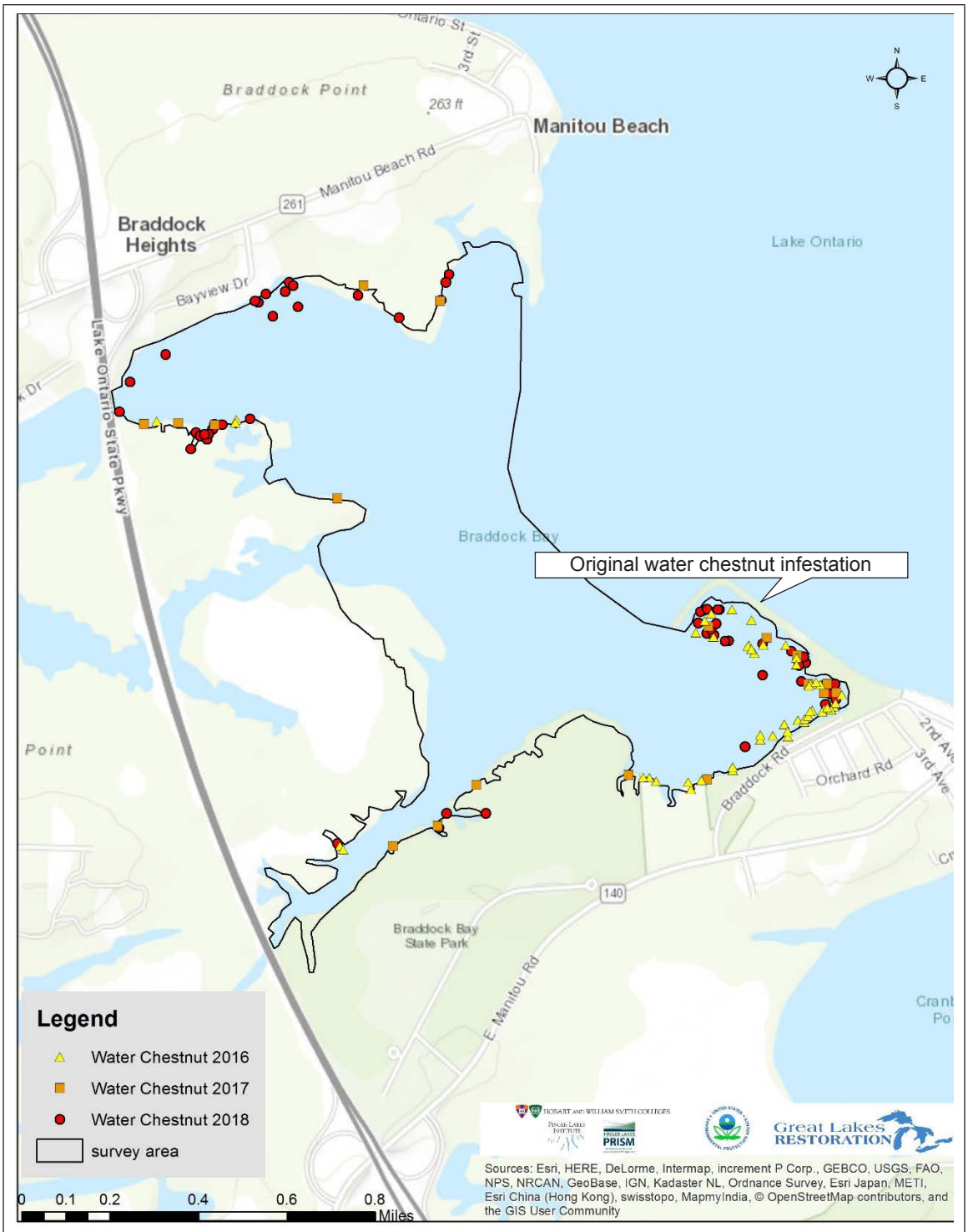
In 2014, about 9 tons of water chestnut were removed from Braddock Bay via hand-pulling. A garbage truck was necessary for disposal of the pulled plants.

In 2015, about 7 tons of water chestnut were removed from Braddock Bay via hand-pulling.
A garbage truck was necessary for the disposal of the pulled plants.

In 2016, about 3 tons of water chestnut were hand-pulled from Braddock Bay.

In 2017, about 217 pounds of water chestnut were hand-pulled from Braddock Bay.

In 2018, about 273 pounds of water chestnut were hand-pulled from this population in Braddock Bay. This illustrates an overall 98% population reduction in water chestnut using physical control.



Water chestnut in Braddock Bay, Monroe County, NY. Points indicate water chestnut presence only, not quantity or density. The original infestation was mostly located in the southeast cove of the bay, although any points close to those from 2016 are considered to have been part of the original infestation.

Running a Volunteer Hand-pull Event

Once physical control is decided upon as an appropriate control method for a water chestnut infestation *and* relevant permitting processes related to freshwater wetlands and/or state land have been completed, it can be efficient to have many people helping pull water chestnut. A volunteer event can serve this purpose.

Location

The site may be suitable for a volunteer event if there is access fairly close to the infestation, with enough area to stage people, boats, and pulled plants. This may require property owner permission.

Pick a date.

The ideal time to pull water chestnut is late June through early August, after the plants have grown to the water surface but before the seeds mature. A back-up date should also be chosen in case of inclement weather. The volunteer base may influence the best day to have a hand-pulling event. People who work may be more available on evenings and weekends, while retired persons may have weekday availability.

Disposal

A disposal method should be arranged in advance of the volunteer event. This can involve composting the pulled plants well away from the shoreline with property owner permission, in an invasive species disposal box (provided at some boat launches), or disposing of them in garbage bags. If there is a very large amount of pulled water chestnut that needs to be taken offsite, it may be necessary to contact local waste management.

Advertise

Once a date is decided, it should be shared widely to recruit volunteers. This can be done using community fliers, social media, newspapers, etc. Important information to communicate includes

- Date and time
- Meeting location and map
- Supplies to bring
- Contact information of the person coordinating the event, for sign-up purposes and if volunteers have questions
- It is recommended that the volunteer event date be advertised at least one month prior to the event.

Example fliers advertising a list of pull dates and a specific pull.

Supplies

An assortment of supplies recommended for water chestnut pulls: boat, paddle, boat towel, life jacket, nylon-coated work gloves, leaf/lawn bag, garbage bags, floating sled, tarp, pitchfork or rake, water chestnut ID, permit (if applicable), site map, water, first aid kit, sun lotion, bug repellant, camera, scale, GPS unit, tablet, dry bags.

The following items have been found to be useful when coordinating volunteer hand-pulls.

Water chestnut identification: Provide water chestnut photos so volunteers understand which plant they are looking to remove. A live plant is especially helpful, which may be collected from the pull site. A fact sheet available for printing is on the Finger Lakes PRISM webpage: http://fingerlakesinvasives.org/invasive_species/water-chestnut/.

Map: A site map may be provided for volunteers to see, with the meeting location, water access point, and pulling area clearly marked. This helps volunteers understand where they will be working and help keep the group together if the pull site is not visible from the water access or meeting area.

Example site map of Braddock Bay

Safety:

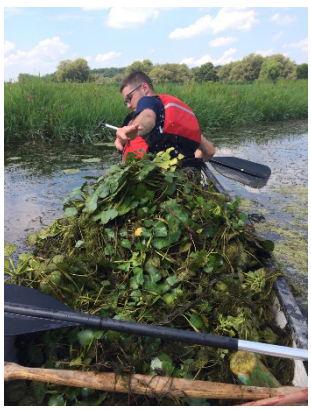
- First aid kit
- Nitrile coated work gloves are useful in protecting volunteers' hands from sharp seeds that may be pulled up with the plant.
- Extra personal floatation devices (PFD's)

Containers for collecting water chestnut:

- Garbage bags

- Leaf/lawn bags

- Or just pile whatever will fit on the boat!



Ways to document the event: It is useful to have a way to measure how much water chestnut is removed from the site. This can be done using body weight scales, fish hanging scales, or luggage scales (see Monitoring section).

- Camera

Personal supplies that volunteers may bring:

- Boat, if they are not supplied or rented by the event coordinator
- Sunscreen
- Hat
- Water
- Snacks
- Clothes and shoes for getting dirty and/or wet- Dress for the weather!

Have fun!

Mechanical Control

Mechanical control of water chestnut involves the use of an aquatic vegetation harvester, which cuts the plants at a set water depth and removes the cut plants utilizing a conveyor system. This method is suitable for infestations that are too large or dense to hand-pull, though it can be an expensive and time-intensive process. Locations with appropriate launching and retrieving access for the harvesters and parking for the conveyor are required, as well as calm waters at levels deep enough to support a loaded harvester. Although mechanical harvesting offers immediate relief from the effects of a water chestnut monoculture, fragmentation of the plants may occur, making it difficult to fully collect and control the infestation. Other plant species may also be affected due to this method's lack of species specificity, so it is ideal to utilize mechanical control in areas where water chestnut is the only species present or is very dominant.

The expense associated with mechanical control can range widely depending on the cost of the harvester (purchase, rental, maintenance), density of the water chestnut infestation, and distance to the offloading site. Rental costs may range between $1500 and $3500 per cut or per day.

Regulations
Mechanical harvesting is regulated if the activity occurs within or adjacent to freshwater wetlands. It is recommended that the regional DEC permitting office be contacted for further information.

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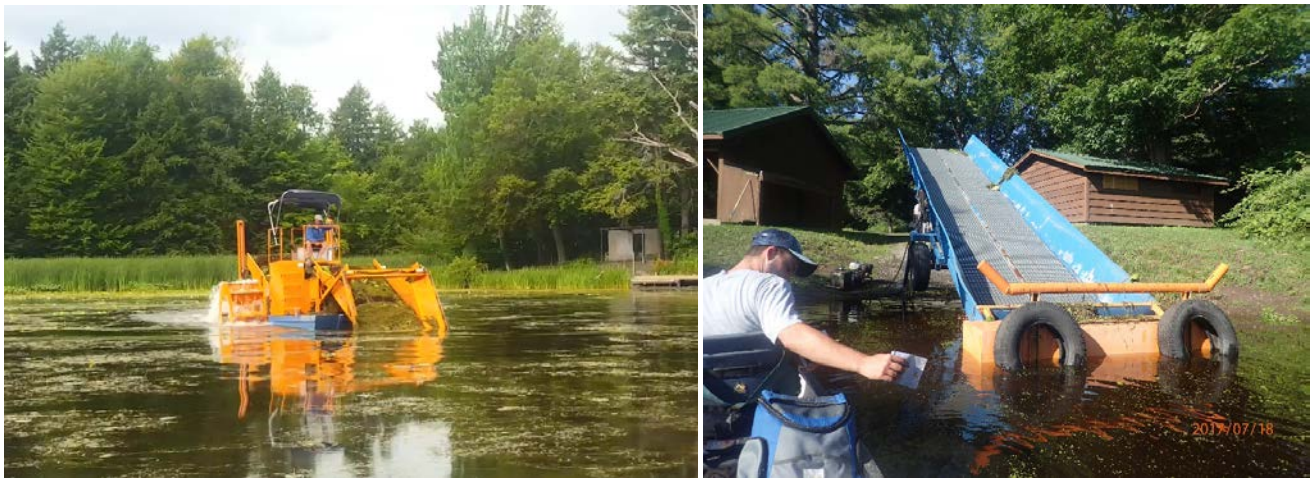
The Region 8 office serves the following counties: Chemung, Genesee, Livingston, Monroe, Ontario, Orleans, Schuyler, Seneca, Steuben, Wayne, and Yates.

Case Study: Sodus Bay

The Wayne County Soil & Water Conservation District runs an aquatic vegetation harvesting program for Lake Ontario embayments to manage submersed plant material. Harvest locations include Sodus Bay and Maxwell Bay, where the harvesters are used to contain and control large, dense areas of water chestnut. Water chestnut has been in Sodus Bay since the late-1900's, so these are long-standing populations that are being managed.



An aquatic vegetation harvester in operation and conveyor awaiting a load of harvested plants for removal into a dump truck for disposal in Wayne County.

Part of a dense water chestnut population in Sodus Bay in 2016, prior to any harvesting activities. This particular population has been mechanically controlled since 2017.

A harvested lane in Sodus Bay, 2017.

Case Study: Cayuga Lake

Water chestnut was discovered in Cayuga Lake in 2015, approximately two miles south of Cayuga Lake State Park. This infestation measured about two acres in size, including a heavily concentrated area of one half-acre, and was harvested by the Seneca County Soil and Water Conservation District. In 2016, this area was harvested once again, then the water chestnut strike team hand-pulled any remaining rosettes that may have been missed by the harvester, totaling 271 pounds. In 2017 and 2018, this area was primarily physically controlled. There was a 68% population reduction based on physical control, after a successful rapid response to the infestation via mechanical control. This site is a model example of early detection and rapid response.

Sparse water chestnut population in Cayuga Lake, 2018,
wo years after being harvested.

Chemical Control

Chemical treatment is a management option appropriate for expansive and dense water chestnut infestations. This involves the application of chemicals approved for aquatic use in New York State performed by a New York State-approved pesticide applicator, which should occur when the rosettes reach the water surface, but prior to leaf overlapping or seed production. Usually, this transpires toward the end of June or beginning of July in the Finger Lakes region. Chemical treatment can be costly depending on the area of the infestation, chemical used, and site access, but may range between $300 and $1,000 per acre. New York State has authorized the use of diquat and 2,4-dichlorophenoxyacetic acid (2,4-d) for use on submerged and emergent vegetation, although other chemicals may be allowed for use provided they are registered with the state and not in conflict with other regulations. Glyphosate and imazamox have also been used to treat water chestnut in the Finger Lakes region. Glyphosate, imazamox, and 2,4-d are systemic herbicides, which means they are translocated throughout the plant and cause a complete die-off at a sufficient dosage. There may be unintended impacts to non-target species, as these chemicals are not species-specific. The resulting water chestnut die-off can cause low dissolved oxygen concentrations. However, it is less labor intensive than physical control and is convenient when infestations are located a distance away from waterway access, which would otherwise make the process of physically removing the plant material difficult.

Regulations
Chemical treatment requires a permit from the DEC regional environmental permits office in most cases: Article 15 Pesticide Permit (https://www.dec.ny.gov/chemical/8530.html). An additional permit may be required if the treatment area is located within regulated freshwater wetlands or their buffer zone: Article 24 Freshwater Wetland Permit (https://www.dec.ny.gov/permits/6058.html). A State Pollutant Elimination System (SPDES) General Permit and Notice of Intent is also required (https://www.dec.ny.gov/chemical/70489.html). Public notice of the scheduled chemical treatment and water quality sampling are often included in the permitting process. A site-specific Environmental Impact Statement may also be required. A Generic Environmental Impact Statement on Aquatic Vegetation Management (GEIS) was completed in 1981 for all the aquatic herbicides registered for use at the time, endothall, diquat, copper sulfate, and 2,4-D. A Supplemental Environmental Impact Statement (SEIS) was completed for herbicides registered after 1981.

For current information regarding the permitting process, the regional DEC office may be contacted for more information. It is recommended that the DEC is consulted with early in the process to determine permitting requirements.

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The Syracuse office serves the following counties: Cayuga, Onondaga, and Oswego.

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The Cortland office serves the following counties: Broome, Chenango, Cortland, Madison, Tioga, and Tompkins.

Region 8:
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The Region 8 office serves the following counties: Chemung, Genesee, Livingston, Monroe, Ontario, Orleans, Schuyler, Seneca, Steuben, Wayne, and Yates.

Case Study: Red Creek

A dense seven-acre population of water chestnut is located in Red Creek, Wolcott, NY. It was determined that it could not be physically controlled and there is not appropriate access for aquatic vegetation harvesters. This infestation was, instead, chemically treated with 2,4-d early August of 2018. The treatment appeared to have been effective as the water chestnut browned and died off within a couple weeks. The treatment occurred prior to seed maturation, although effects will not be recorded until at least the following growing season. This infestation is several years old, so control will need to continue to deplete to the seedbank for successful management.

The dense population of water chestnut in Red Creek in 2016, two years prior to chemical treatment.

Chemical treatment of water chestnut in Red Creek occurred in 2018. An airboat was used to navigate in the infestation.

Biological Control

Biological controls are not typically used for controlling water chestnut in NYS.

Grass Carp

Grass Carp (*Ctenopharyngodon idella*) consume vegetation from aquatic habitats. Since this species is considered non-native, only triploid Grass Carp, which have been sterilized, may be used for aquatic vegetation control (http://www.dec.ny.gov/outdoor/7973.html). Grass Carp can consume a great amount of plant material and live for more than 10 years, so these qualities must be taken into account when considering this management method. Water chestnut has been documented in the digestive tract of Grass Carp, showing that the carp will feed on it, although their food preferences are unpredictable, and they will consume non-target species. This method may be effective in situations where the fish are able to be contained and water chestnut is their only food source. The stocking of this fish requires a permit and the stocked waterbody must meet several conditions related to size, connectivity, use, and habitat.

Grass Carp (*Ctenopharyngodon idella*)
Photo credit: Eric Engbretson, US Fish and Wildlife Service, Bugwood.org

For current information regarding the permitting process, the regional DEC office may be contacted for more information.

Environmental Permit Office Information

Region 7:
615 Erie Boulevard West, Room 206
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Leaf Beetle

The beetle *Galerucella birmanica* has been identified as a potential biological control agent for water chestnut (http://fingerlakesinvasives.org/wp-content/uploads/2014/01/bIOcONTROLWatChest.pdf). These beetles feed on water chestnut leaves. At high enough densities, the herbivory can cause reduced plant biomass, reduced reproduction rates, and plant mortality. This biocontrol is not yet available and is still being studied, but may be a management option in the future.

Galerucella birmanica beetles on a water chestnut plant. Photo provided by Wade Simmons.

Drawdown

Drawdown consist of manipulating the water levels to expose previously submerged plants or seeds to adverse conditions. Theoretically, once water chestnut plants and seed are thoroughly dried, they become unviable and will not be able to grow or sprout. If water levels are able to be manipulated, a complete drawdown of an infested area could be effective if the seedbank becomes dry. However, this management option is not available in many of the infested waterways in the Finger Lakes region due to their connectivity to other waterways and lakes and lack of appropriate water control structures. According to *A Primer on Aquatic Plant Management in NYS* (http://www.dec.ny.gov/animals/7137.html), no effects of a winter drawdown are observed on water chestnut.

Regulations
Reservoir releases are regulated in terms of volume, timing, and rate of change. Drawdown activities may also fall under freshwater wetland regulation and require permits.

For current information regarding the permitting process, the regional DEC office may be contacted for more information.

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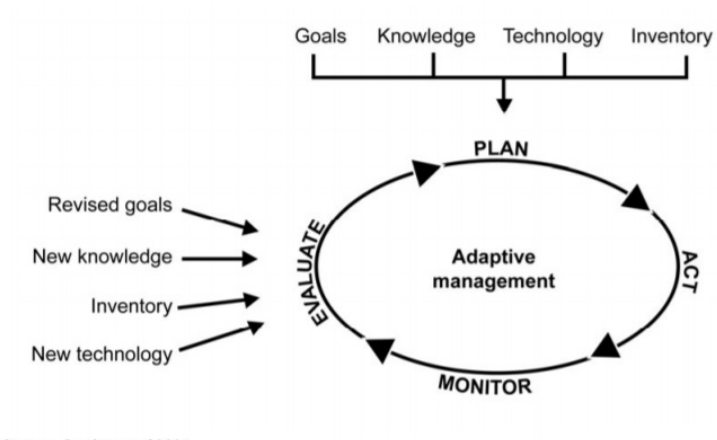
MONITORING

It is essential to track water chestnut infestations throughout the duration of management, even after populations are thought to have been completely removed. Quantifying the extent and density of populations each growing season allows managers to assess the effectiveness of their chosen control activities. Monitoring populations provides an opportunity for managers to adjust their management strategy in an iterative process as a part of adaptive management, which is an approach recommended by the New York State Invasive Species Comprehensive Management Plan (https://www.dec.ny.gov/docs/lands_forests_pdf/iscmpfinal.pdf). However monitoring is accomplished, it is important to be consistent, so observations from each year are comparable, i.e. weights, photos facing a certain direction, etc.

Adaptive Management: A structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.



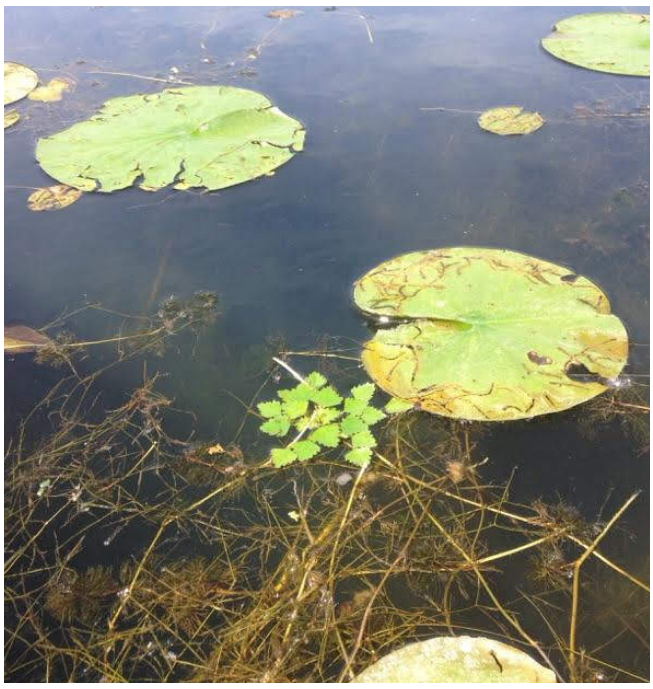
Source: Stankey *et al* 2005.
Figure 1-1 Adaptive Management Cycle

http://nyis.info/wp-content/uploads/2017/12/NYS-IS-Mant-Strategy-2011.pdf

Water chestnut infestations can be measured as an area (for example, in acres) using handheld GPS units or mobile devices including cell phones or tablets with programs such as Google Earth or ArcGIS.

Mobile devices may be used to record and map water chestnut locations to determine the infestation area.

Water chestnut populations may also be measured by density, or how close together rosettes grow. Density may be quantified using a scale modified from the point-intercept rake-toss method for sampling aquatic plants (Madsen 1999 https://emrrp.el.erdc.dren.mil/elpubs/pdf/apcmi-02.pdf), where the following rankings apply: 0-Zero, 1-Trace, 2-Sparse, 3-Medium, 4-Dense. Visually, a "Zero" ranking would indicate no water chestnut, "Trace" would indicate an individual plant or a few rosettes, "Sparse" may be considered a "hand-full" of plants, "Medium" would indicate a patch of water chestnut, and "Dense" would indicate a patch or mat of water chestnut plants growing thickly, in a way where rosettes may even be stacking on top one another.



"Trace" Density: an individual rosette or plant.

"Sparse" Density: a few or "hand-full" of plants

“Medium” Density: a patch of water chestnut

“Dense” Density: a mat of water chestnut with interlocking or stacking rosettes

Water chestnut can also be quantified as it is removed from the control site, by weight. Water chestnut may be placed in containers such as garbage bags or lawn/garden bags and allowed to drain of excess water. The weight may be measured using body weight scales or digital hanging scales, such as those used for fish or luggage. It is recommended that scales with at least a 50- or 100-pound capacity are used. The weight may also be estimated by taking the average weight of several filled containers and multiplying that by the number of filled containers. For large amounts of water chestnut being taken to disposal using trucks, truck scales may be an option, provided the empty truck weight is also known.

Water chestnut in a laundry bag and lawn bag weighed using a digital hanging scale. It is recommended that scales with at least a 50 or 100 pound capacity are used.

When there are several filled containers of water chestnut that need to be quantified, an average weight may be multiplied by the number of similarly filled containers for an estimate. Containers may include garbage bags, floating sleds, etc.

RESOURCES

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Pimental, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics, 52: 273-288.

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Vermont Department of Environmental Conservation. 2018. Water Chestnut Hand Harvest Program 2017. Montpelier, Vermont. Available at: https://dec.vermont.gov/sites/dec/files/wsm/lakes/ans/docs/2017%20VT%20WC%20hand%20harvesting%20report.pdf.

MANAGEMENT PROCESS

1. **Confirm and describe water chestnut presence**

- Is the species identified correctly?
- How big is the area in need of control? (small or large?)
- How dense is the water chestnut population (scattered or thick?)
- How will you be able to access to population (public or private property, distance away from water access)?

2. **Choose and employ the method of control for your site (more than one method may be applicable and may be used in combination): physical, mechanical, chemical, biological, drawdown**

- Are any permits needed for the chosen control method(s)? You will want to contact the DEC to be sure. Permits may be necessary if your site contains
    - A Freshwater Wetland, or
    - State Land

  Or if you plan to use
    - Chemical treatment
    - Grass carp stocking

- What type of water access is available? The size and condition of the boat ramp may limit the type of boat you can use.
- Is there a cost to launch, such as at a marina?
- What is the distance between the boat launch and infestation? This may influence the type of boat you will use. This may also influence the control method as it pertains to water chestnut removal.
- What is the distance to disposal site (depending on control method)?
- What type and quantity of boat is available for use? (canoe, kayak, motorboat, airboat, harvester, etc.)
- If relevant (physical or mechanical control), how will the water chestnut be disposed of?
    - How much water chestnut needs to be disposed of- a lot or a little?
    - What is the distance between disposal location and control site? This may contribute to a cost of transporting the plants.
    - Is there a cost to use the disposal location?

2. **Monitoring**

- Important for gauging management method success and detection of new populations
- The water chestnut population area, density, and biomass/weight of water chestnut removed are all useful ways of measuring water chestnut infestations. Comparisons of these measures across years of management will provide an indication of whether control efforts are effective.

RECOMMENDED ACTIONS FOR WATER CHESTNUT SITES PREVIOUSLY MANAGED

Table 2. Recommended control of known sites in the Finger Lakes region

Site	County	DEC Region	Access	Recommended Control Method	Reasoning	Equipment	Permit	Disposal
Braddock Bay	Monroe	8	Boat launch	Monitor, Physical control	Infestation is small and dispersed enough to physically control	Paddle boats, jon boat, airboat	Freshwater wetland, State land	Compost, garbage
Canandaigua Lake: West River	Yates	8	Boat launch	Monitor, Physical control	Infestation is small and dispersed enough to physically control	Paddle boats, jon boat, airboat	Freshwater wetland, State land	Invasive species disposal box
Cayuga Lake: Canoga Marsh	Seneca	8	hand launch with permission	Monitor, Physical control	Infestation is small and dispersed enough to physically control	Paddle boats, jon boat, airboat	Freshwater wetland, State land	Compost
Finger Lakes National Forest	Schuyler	8	Hand launch	Monitor, Physical control, Biocontrol?	Access restricts boats. Few trace populations. One dense population in an isolated pond may be a candidate for grass carp biocontrol	Kayak, floating sleds, chest waders, grass carp?	Grass carp stocking	Compost
Genesee River	Monroe	8	Boat launch	Monitor, Physical control	Small population dispersed close to docks.	Paddle boats	Freshwater wetland	Dispose offsite
Hector Falls Creek	Schuyler	8	Hand launch	Monitor, Physical control	Waterbody access restricted. Small population.	Paddle boats	Freshwater wetland	Compost
Keuka Outlet	Yates	8	Boat launch	Monitor, Physical control	Submersed plants and water depth restricts boat access. Small population.	Paddle boats	Freshwater wetland	Invasive species disposal box
Little Sodus Bay	Cayuga	7	Boat launch	Monitor, Physical control	Very small population, if present. Submersed plants may restrict boat access.	Paddle boat or motor boat.	Freshwater wetland	Dispose offsite
Long Pond	Monroe	8	Hand launch	Monitor, Physical control	Waterbody access restricts boats.	Paddle boats	Freshwater wetland, State land	Compost
Maxwell Bay	Wayne	8	Boat launch	Monitor, Physical control, Mechanical control, Chemical control	Large, dense, accessible population. Currently mechanically controlled. Physical control should be utilized where harvesters may not reach.	Paddle boats, aquatic vegetation harvester	Confirm with DEC	Dispose offsite

Site	County	DEC Region	Access	Recommended Control Method	Reasoning	Equipment	Permit	Disposal
Montezuma Marsh	Cayuga	7	Hand launch, boat launch	Monitor, Physical control, Mechanical control, Chemical control	Large dense population and smaller, sparser populations. Dense population must be mechanically or chemically controlled. Remainder of infestation can be physically controlled. Boats may be restricted by water depth.	Paddle boats, jon boat, airboat, floating sleds	Freshwater wetland, State land	Dispose offsite
Oneida Lake	Onondaga, Madison	7	Hand launch, boat launch	Monitor, Physical control	Populations in Big Bay, Lewis Point, and Oneida Lake Marina are either small in area or sparse enough that physical control is most efficient.	Paddle boats, chest waders, motor boat, floating sleds	Confirm with DEC	Compost
Onondaga Lake	Onondaga	7	Hand launch	Monitor, Physical control	Small population, if present.	Paddle boats	Confirm with DEC	Dispose offsite
Otisco Lake	Onondaga	7	Hand launch with permission	Monitor, Physical control	Waterbody access and water depth restricts boats. Small, manageable population.	Paddle boats, chest waders	Confirm with DEC	Compost
Port Bay	Wayne	8	Boat launch	Monitor, Physical control	Populations are small and dispersed enough that physical is most efficient. Submersed plants may restrict boat access in areas	Paddle boats, floating sleds	Freshwater wetlands in areas, State land in areas	Invasive species disposal box, dispose offsite
Red Creek	Wayne	8	Hand launch, boat launch	Monitor, Physical control, Chemical control	Dense population is too large to physically control. Bridges restrict boat access in areas. Sparser populations distributed throughout waterway may be physically controlled.	Paddle boats, floating sleds airboat	Freshwater wetlands, State land	Dispose offsite

Site	County	DEC Region	Access	Recommended Control Method	Reasoning	Equipment	Permit	Disposal
Seneca River	Cayuga, Onondaga	7	Boat launch	Monitor, Physical control, Mechanical control, Chemical control	Dense mats dispersed throughout waterway. Small patches may be physically controlled. Access may restrict aquatic vegetation harvesters.	Paddle boats, motor boats, airboats	Freshwater wetlands	Dispose offsite
Sodus Bay	Wayne	8	Hand launch, boat launch	Monitor, Physical control, Mechanical control	Small populations dispersed throughout the bay may be hand-pulled. Water depth may restrict access in these areas. The large dense population in the south end should continue to be mechanically controlled.	Paddle boats, motor boats, aquatic vegetation harvester	Freshwater wetlands, State land	Dispose offsite
Sterling Creek	Cayuga	7	Hand launch, boat launch	Monitor, Physical control	Small patches are dispersed throughout waterway and are small enough to be hand-pulled.	Paddle boats, floating sleds	Freshwater wetlands	Dispose offsite, invasive species disposal box?

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FINGER LAKES PRISM
Partnership for Regional Invasive Species Management

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