



Hydrilla Management Plan for New Croton Reservoir



2018 - 2023

Prepared March 2018

EXECUTIVE SUMMARY

This management plan serves as an outline of the steps that the New York City Department of Environmental Protection (DEP) is taking to control Hydrilla, a federally listed noxious weed, in New Croton Reservoir as well as to provide documentation of the analysis that went into the decisions to pursue treatment. Control of Hydrilla in New Croton Reservoir will support a broader regional program to minimize the establishment and spread of Hydrilla as initiated by New York State Department of Environmental Conservation (NYSDEC) in the Croton River and elsewhere across the state. The strategy presented here is adaptive and DEP may revise it annually, or as needed, based on the lessons learned from management efforts each year.

Based on an alternatives analysis and an expert panel review conducted by the Water Research Foundation, DEP proposes to pilot a treatment program in 2018 to assess the efficacy of a granular fluridone (Sonar H4C) application in New Croton Reservoir. The control program will be scaled up to a reservoir-wide treatment program in 2019 and incorporate lessons learned from the pilot, particularly regarding fluridone dispersal. Water quality monitoring, and plant and tuber survey work in the reservoir will be integral in evaluating the success of the project and adapting the strategy as necessary.

INTRODUCTION AND BACKGROUND

The New York City Department of Environmental Protection (DEP), in collaboration with New York State Department of Environmental Conservation (NYSDEC), proposes to manage an infestation of Hydrilla (*Hydrilla verticillata*) in New Croton Reservoir in concert with ongoing management efforts in the lower Croton River (NYSDEC 2016). Hydrilla is a federally listed noxious weed that can reproduce from plant fragments, underground tubers, and turions or wintering buds. It has the potential to cause negative impacts to the New York City Water Supply System as well as downstream ecosystems in the Croton and Hudson Rivers, and throughout the region.

The first detection of Hydrilla in New York State was in 2008 in a small pond in Orange County. Since then it has been found in 11 counties across the state, although the majority of these infestations are isolated and do not pose a large threat of spread. NYSDEC is supporting control programs for those populations that have higher potential for becoming widespread, which include Cayuga Inlet/Lake in Ithaca, NY and the Tonawanda Creek/Erie Canal in Buffalo, NY in addition to the Croton River System (McGlynn and Eyres 2017).

In fall 2013, a botanist conducting a rare plant survey discovered Hydrilla in the Croton Bay. Follow-up surveys in 2014 revealed that the infestation extended through much of the Croton River below the Cornell Dam and above into the New Croton Reservoir. Preliminary surveys conducted by SUNY Oneonta Biological Field Station ecologists in the reservoir revealed that the infestation extended from the boat launch to the dam but was restricted to several patches throughout the western portion of the reservoir.



*New Croton Reservoir looking west over the Cornell Dam
NYC DEP*

New Croton Reservoir, located in Westchester County, New York, is the terminal reservoir in the Croton System of eleven reservoirs operated by DEP. Its 2,100 acres and 19 billion gallon capacity supplies approximately 10% of the water to customers in an average year but can provide more during periods of high demand and any lack of availability of water elsewhere in the system. Water leaves the reservoir and goes through Croton Water Filtration Plant (WFP) where it runs through an anthracite/sand dual media filter and is disinfected with UV and chlorine before going into distribution in the City. Just seven miles south of the New Croton Reservoir, Kensico Reservoir is the terminal reservoir for the unfiltered Catskill-

Delaware System (Wright, Landis, and Nelson 2018).

This management plan serves as an outline of the steps that DEP is taking to control Hydrilla in New Croton Reservoir as well as to provide documentation of the analysis that went into the decisions to pursue treatment. A team of DEP staff from across the Bureau of Water Supply in consultation with NYSDEC and national experts have developed the strategy with the intention of protecting the water

supply and the region from this aquatic invasive species. DEP will provide updates to this document and the project website based on further research, the outcomes of other case studies and the pilot project.

Problem Statement

The goal of this project is to control Hydrilla in New Croton Reservoir to support a broader regional program to minimize the establishment and spread of Hydrilla and to keep it out of the unfiltered Catskill-Delaware System and throughout the watersheds of the northeastern US. The project will aim toward eradicating Hydrilla from the reservoir with the understanding that this will be a long-term effort requiring regional collaboration. Eradication would involve depletion of the tuber bank, which can take a long time since some tubers remain dormant and are resistant to treatment for several years. Thorough surveys would be necessary to ensure that all parts of the infestation are treated and a single missed area could infest the reservoir again. Suppressing the growth of Hydrilla in the short-term will have the benefit of a significant decrease in its negative impacts and potential for continued spread. Successful implementation of this project will also provide regional benefits to all aquatic resources and their ecological and economic contributions.

Croton System Infestation

Solitude Lake Management conducted extensive surveys in the Croton River and the Hudson River from 2014 through 2017 in order to establish that the extent of the infestation was limited to the Croton system. These surveys also documented the increase in density of the infestation prior to treatment in 2017 (McGlynn and Eyres 2017). NYSDEC and the Lower Hudson Partnership for Regional Invasive Species Management funded this work.

In 2016 and 2017, DEP retained Solitude Lake Management to survey New Croton Reservoir for Hydrilla in greater detail. The survey targeted the known infested areas at the boat launch and to the west near the dam in order to assess density in addition to surveying surrounding sections of shoreline to delimit the extent. The 2016 survey included detailed acoustic scanning of the aquatic plant community throughout the entire littoral zone of the reservoir to identify “hot spots” of plant growth that were then mapped in detail. The results indicated that there were patches of Hydrilla along the south shore and extensive infestations along the northern shore of the reservoir west of the boat launch in Hunter Brook Creek cove but the Hydrilla was restricted to a narrow swath of shallow shoreline except for a few places. The 2017 survey indicates that the density and extent are both increasing gradually (Doyle 2017). Survey results are included here for Hydrilla in Appendix A and B.

IMPACTS

If left to grow unchecked, the Hydrilla infestation in New Croton Reservoir will have a number of impacts on the reservoir and the region. Because Hydrilla effectively outcompetes native vegetation, the species can colonize all viable portions of a waterbody and negatively impact reservoir operations, ecology and recreation. Its ability to survive well in low light conditions enables Hydrilla to extend beyond the areas that other aquatic plants can inhabit. It forms dense mats of vegetation that can have a negative impact on water quality, reducing dissolved oxygen, and raising pH (Washington Invasive Species Council 2016).

Reservoir Operational Impacts

- A) *Clogging of shallow intakes* – After storm events, or as large mats dislodge in mid to late autumn, there is a possibility that plant material could enter and clog intakes, particularly the shallower intakes.
- B) *Disinfection byproducts* - The decomposition of Hydrilla at the end of the growing season may cause elevated levels of natural organic matter (NOM), which can react with chlorine in water treatment to form carcinogenic disinfection byproducts (DBPs). This would be particularly problematic if Hydrilla were to spread into the unfiltered Catskill-Delaware System.
- C) *Restriction of access* - Large mats of Hydrilla could restrict transportation around the reservoir and make the completion of tasks such as water quality monitoring and emergency response difficult.
- D) *Spread to other water supplies* – All of these impacts could be more or less severe in other reservoirs in the NYC system, which supplies 9 million New Yorkers or half the population of the state, as well as nearby reservoirs in Connecticut. The shallower reservoirs would experience these impacts to a greater degree and they may see measurable losses to capacity.

Ecological Impacts

- A) *Altering the ecosystem* – As Hydrilla gains dominance and the plant community shifts, fish populations as well as the balance of other aquatic organisms will change in the reservoir. With spread unchecked, these impacts will quickly become regional.
- B) *Establishment of harmful cyanobacterium* – The cyanobacterium, *Aetokthonos hydrillicola*, grows on the leaves of Hydrilla in the southeastern United States and causes avian vacuolar myelinopathy (AVM), an often-fatal neurological disease of bald eagles, waterfowl, and wildlife that consume Hydrilla (Wilde et al. 2005). A broadly established population may increase the chances that this cyanobacterium will move into the Northeast.
- C) *Riverine Submerged Aquatic Vegetation* – Rare and other important native submerged aquatic vegetation in the Croton and Hudson Rivers would see a negative impact from the expansion of Hydrilla through the system. These plant communities serve an important function for fish and wildlife habitat.



Bald eagles can die from cyanobacteria that live on Hydrilla leaves.
NYC DEP

Recreational Impacts

- A) *Boating and Swimming* – A widespread regional infestation would disrupt recreational boating and swimming and the economic benefits associated with these activities. There are a number of marinas, charters, and boat rental companies along the Hudson River and its tributaries.

Swimming in the Croton River and the Hudson River could see negative effects from the establishment of large Hydrilla beds.

- B) Small-scale hydrilla infestations may temporarily benefit recreational fishing, but fish biomass decreases with large infestations (NEANS 2017). At peak growth each year, fishing boats may not be able to traverse some of the shallower coves in New Croton Reservoir and shallower reservoirs may become impassable each year.

RARE/ENDANGERED SPECIES

This project is not likely to impact any threatened or endangered species. There are two active bald eagle nests on the New Croton Reservoir and they are more than a quarter mile from both pilot project sites. A more detailed assessment of impacts to nesting bald eagles will be required for the full-scale treatment in 2019. Solitude Lake Management surveyed the plant species and did not detect any rare or endangered aquatic plants in New Croton Reservoir in 2016 or 2017.

ALTERNATIVES ANALYSIS

DEP worked closely with the NYSDEC to assess the alternatives available to manage the Hydrilla infestations in the Croton River and New Croton Reservoir upon its discovery in 2014. Treatment methods used in other parts of the country, such as grass carp, were not suitable for use in this system. Experts from around the country repeatedly advised DEP and NYSDEC to consider herbicide treatment for the most effective management and fluridone and endothal quickly rose to the top of the list of chemical controls to consider.

The New Jersey Water Supply Authority summarized all of the alternatives for the Delaware and Raritan Canal in a summary table in 2017. DEP used this model as a template and modified the analysis to reflect the conditions specific to the New Croton Reservoir and the reasoning behind the DEP's treatment selection in Appendix C.

EXPERT PANEL REVIEW

On November 17, 2017, the Water Research Foundation (WRF), with support from DEP, put together an expert workshop to review Hydrilla management strategies for water suppliers. The consulting firm Hazen and Sawyer, under contract with WRF, facilitated the workshop in addition to putting together a research review on the topic of control of Hydrilla in water supplies and summarized this in the report, *Chemical Management of Hydrilla for Drinking Water Utilities*, by Wright, Landis and Nelson. The objectives of this project were to:

- Assess the state of knowledge of fluridone application for the management of Hydrilla in drinking water reservoirs and its impacts on treatability, water quality, and human and environmental health;
- Review lessons learned from prior Hydrilla management efforts;
- Provide an example of Hydrilla risk assessment to identify potential impacts from Hydrilla and management options;
- Provide recommendations for mitigation of impacts; and
- Develop a communications fact sheet and final report.

The following recommendations were included in the report:

- Endothall- and fluridone-based herbicides appear to be the best available options for chemical control of Hydrilla in New York for sources of drinking water
- Further, aquatic herbicide development is an active area of research, and additional information may become available over time that eases current restrictions or demonstrates increased effectiveness for available herbicides.
- Herbicide treatment is the only effective option available to DEP. Herbicide treatment of Hydrilla in New Croton Reservoir would likely be effective and feasible without resulting in adverse impacts to human or ecological health.
- While dilution and natural degradation will reduce the concentration of either herbicide, the application plan and monitoring should be coordinated with NYSDEC to ensure no adverse impacts on herbicide application in the Croton River downstream.
- Given the operational constraints on the reservoir, fluridone is the best available herbicide for treatment in proximity to the intakes given that it has no label restrictions on use around intake. Either fluridone or endothall could be used elsewhere in the reservoir. The thermocline should provide an effective barrier for either chemical since it prevents the mixing of deeper cold water with the shallower warm water that contains the herbicide.
- If DEP pursues herbicide treatment of New Croton Reservoir, it is recommended that DEP develop a comprehensive public outreach program to educate the public on the need for and risks of hydrilla to justify the use of herbicides in New Croton Reservoir. The public outreach program for herbicide treatment should address the potential for minor exposure, and put the level of incidental exposure in context with the USEPA-derived NOAEL.
(Wright, Landis, and Nelson)

DEP MANAGEMENT PLAN

To date, there has been limited work to control Hydrilla within the reservoir. DEP installed the benthic barrier, Aquascreen around the boat launch in 2015 and 2016 with the goal of suppressing growth around the launch to limit the spread from boat traffic moving through the area (see Appendix D). This project had limited success due to a number of challenges. DEP staff and interns engaged in some limited hand pulling in the boat launch as well in 2016. This proved to be very labor intensive and ineffective. Therefore, and in context with NYS's efforts in the Croton River, DEP has determined that the only viable alternative to achieve maximum control is chemical treatment in conjunction with education and outreach



*DEP staff attempting to remove Hydrilla around the boat launch
NYC DEP*

DEP will consult the Project Advisory Committee (PAC) that DEC formed to guide their project in the Croton River and request their feedback the management strategies and education and outreach. PAC

members include, NYSDEC, Riverkeeper, The Village of Croton-on-Hudson, Lower Hudson Partnership for Regional Invasive Species Management. Additionally, DEP will request feedback from the Town of Yorktown and an angler representative. The PAC will be available to DEP to help advise and guide the implementation of the strategy and the complicated task of communicating accurate information to interested stakeholders.

2018 Pilot

DEP is planning to pilot a treatment program for the 2018 growing season in order to assess the efficacy of treatment with a granular 2.7% fluridone solution (Sonar H4C) at two parts per billion (ppb) concentration in the New Croton Reservoir. The maximum contaminant level allowed by the United States Environmental Protection Agency in drinking water is 150 ppb and in New York State it is 50 ppb, while the label restricts applications to less than 20 ppb within a quarter mile of an intake. A certified applicator will treat two small areas that are located over a mile from the intakes. DEP anticipates that the fluridone will remain above the thermocline and will disperse to concentrations below detection limits before nearing the intakes. The pilot will aid in monitoring and determining the extent of dispersal of the chemical outside the treatment area, assessing the efficacy of treatment, establishing a public outreach program, gaining familiarity with the permitting process, and identifying an unforeseen logistical or administrative issues. If an unforeseen issue should arise during the pilot, it may be possible to source water from the Catskill Delaware System while it is resolved. The treatment will target sites located in two coves within the reservoir between July 1 and October 31, 2018. A project location map is included in Appendix E.

- Site A is a 12.7-acre cove in the northwest portion of the reservoir where Hunter Brook Creek enters. The cove is relatively shallow and has medium to high density of Hydrilla.
- Site B is a 7-acre site located in a cove along the southern shoreline to the east of the DEP boat launch near the Route 100 Bridge.

Solitude Lake Management was the successful bidder on the project and will conduct pre-treatment and post-treatment detailed Hydrilla surveys in Treatment Sites A and B using a rake toss method to determine extent of Hydrilla bed and categorically measure Hydrilla density as well as survey the tuber bank to assess changes in 2019. Additionally, they will conduct a reservoir-wide rake-toss survey (outside treatment areas) to map the extent and density of Hydrilla beds and sample Hydrilla tuber density in the beds.

DEP Water Quality staff will assess the dispersal through the implementation of a water quality monitoring plan and contract lab testing. DEP is also attempting to do jar tests to assess the ability of UV treatment to breakdown fluridone. The contractor will report on the efficacy of the treatments, problems encountered and recommendations for scaling to a reservoir-wide treatment program. This information will guide the full-scale treatment in 2019.

2019 Full-scale Treatment

DEP is planning to do much more work to survey and control for aquatic invasive species (AIS), including Hydrilla, from 2019 – 2023. The focus will be on the management of Hydrilla in New Croton Reservoir while allowing some flexibility to contend with the potential for Hydrilla to spread into other reservoirs and the detection of other problematic AIS. This work will cover:

- A) *New Croton Reservoir Chemical Treatment and Adaptive Management* – A certified applicator will design and implement a chemical treatment plan, with the goal of eradication, for all known Hydrilla occurrences in New Croton Reservoir. DEP anticipates that fluridone will be the primary chemical used to treat Hydrilla but there will be the opportunity to use endothall upon review if conditions are appropriate. DEP Water Quality staff will implement a robust monitoring program that will look at concentrations within the treatment area and at key points throughout the reservoir before the water enters distribution.

- B) *New Croton Reservoir Benthic Barriers* – As necessary, benthic barriers (Aquascreen) may be used to suppress Hydrilla growth in areas where chemicals can't be used or where the barrier is more suitable.

- C) *Pre and Post-Treatment Hydrilla Surveys* – An aquatic biologist will build on the 2018 survey to assess the condition of Hydrilla before starting treatment and then reassess after treatment each year after the treatment is complete. This survey work will include tuber monitoring in addition to delimiting the extent of the infestation.

- D) *Muscoot Reservoir Survey* – Muscoot directly adjoins New Croton to the east and has a large littoral zone. An aquatic biologist will conduct surveys annually for Hydrilla as well as European water chestnut (*Trapa natans*), which has been detected in this reservoir. The goal of this effort is to ensure that rapid management can occur if Hydrilla makes the jump to this reservoir.

- E) *Other Croton Reservoirs AIS Surveys* – Each of the other reservoirs in the Croton System, not including those that are also in the Catskill Delaware System, will be surveyed twice during the five year contract period for Hydrilla and other AIS detected will be noted.

- F) *Kensico Reservoir, West Branch Reservoir and Boyd Corners Reservoir Hydrilla Surveys* – Each of the Catskill and Delaware System Reservoirs east of the Hudson River, which are part of the unfiltered system, will be surveyed each year to ensure a rapid response if Hydrilla makes the jump to one of these reservoirs.

- G) *Boat Launch* – Additionally, DEP Operations staff will be working on relocating the single boat launch on the reservoir to a new location that is less likely to support Hydrilla beds. As a result, the existing boat launch, which is located in a densely infested area, can be decommissioned.

Outreach and Education

Providing appropriate and accurate information to stakeholder groups is critical to the success of this project. DEP will develop an overall communications strategy in consultation with DEC and other partners. Regulatory notification requirements (NYSDEC aquatic pesticide permit, NYSDEC Wetlands Permit and local municipal permits) will dictate certain elements of the communication program while others will depend on the results of the pilot and the adaptation of the management program. A table included in Appendix F outlines some of the critical stakeholder groups and the outreach and education activities that DEP has done to date, has planned, and considerations for why and how each group should be included.

Emergency Response Plan

Prior to the commencement of treatment with fluridone DEP will develop and distribute an emergency response plan to minimize the risk of accident and injury resulting from any treatment activities. It is unlikely that a spill of chemicals could occur since Sonar H4C is a pellet. If there were some sort of accident, it would be possible to remove the pellets before there was time for them to dissolve and significantly increase the concentration. The emergency response plan will include:

- Contact information for all appropriate local authorities
- Resources that could be mobilized in the event of a spill
- Protocols for testing fluridone levels in an area around a spill
- A notification chart for the contractor to reach appropriate DEP staff and NYSDEC
- A plan to develop an after-action report to review what went wrong and how to avoid it in the future

Permitting

2018 Pilot

DEP will obtain regulatory reviews for the 2018 pilot project at the state and local level in early 2018 prior to the start of the contract for treatment services.

A) *State Environmental Quality Review Act (SEQRA)* – DEP will take lead agency status for the reservoir while working closely with NYSDEC to coordinate the review for treatment in the entire Croton System.

B) *NYSDEC Article 15 Part 327 Use of Chemical to Control Aquatic Vegetation* – DEP will obtain a NYSDEC permit for control of aquatic vegetation. This application will go to NYSDEC prior to bringing on a contractor for an initial review and then NYSDEC will finalize it once the contractor signs onto the terms of the permit. Part of the requirement for this permit is to notify all of the users of the waterbody. DEP will reach access permit holders through a public notification in a local newspaper and more targeted messages to the most likely users such as boat permit holders.

C) *Town of Yorktown Code Chapter 178 - Freshwater Wetland and Watercourse Protection Law* – DEP has met with the Town and submitted a project application. There will be a public comment period at a Town Board Meeting required before the permit can be issued.

D) *NYCDEP Right of Way Application Permit* – DEP requires all pesticide applications on City lands in the watershed to go through a review by the ecotoxicologist through a permit application. This is necessary in order to track the application properly.

2019 – 2023

For the full-scale treatment of the reservoir, DEP will need to build on the 2018 reviews and permits and expand the scope of each of these. The NYSDEC Article 15 Permit will likely include downstream notification requirements for riparian landowners depending on the results of a flow model. A NYSDEC Article 24 Wetland permit will be required for applications within the buffer zone of a number of state

regulated wetlands around the reservoir. Additionally, DEP will need to consult with the Towns of Cortlandt, New Castle, Somers and Bedford regarding the project and any local permit requirements.

Evaluating Success

Adaptive management dictates that the parts of this strategy that are working continue and areas that are not working are changed or discontinued. DEP and the contractors, advised by the PAC, will work together to evaluate success based on plant surveys, tuber surveys (which measure the number of viable tubers that remain in an area after treatment and indicate what may sprout in the following year), and water quality monitoring results for dispersal of the herbicide. DEP will pay special attention to the assessment of consumer impacts, if any.

The metrics for assessing the success of the project will be:

- Decreasing tuber counts (measured in the tuber survey)
- Reduction to the total area infested (measured in the shoreline survey)
- Smaller plants observed (Casual observation)
- Fewer fragments observed moving downstream (Casual observation)
- Detections of fluridone throughout the reservoir and especially in distribution

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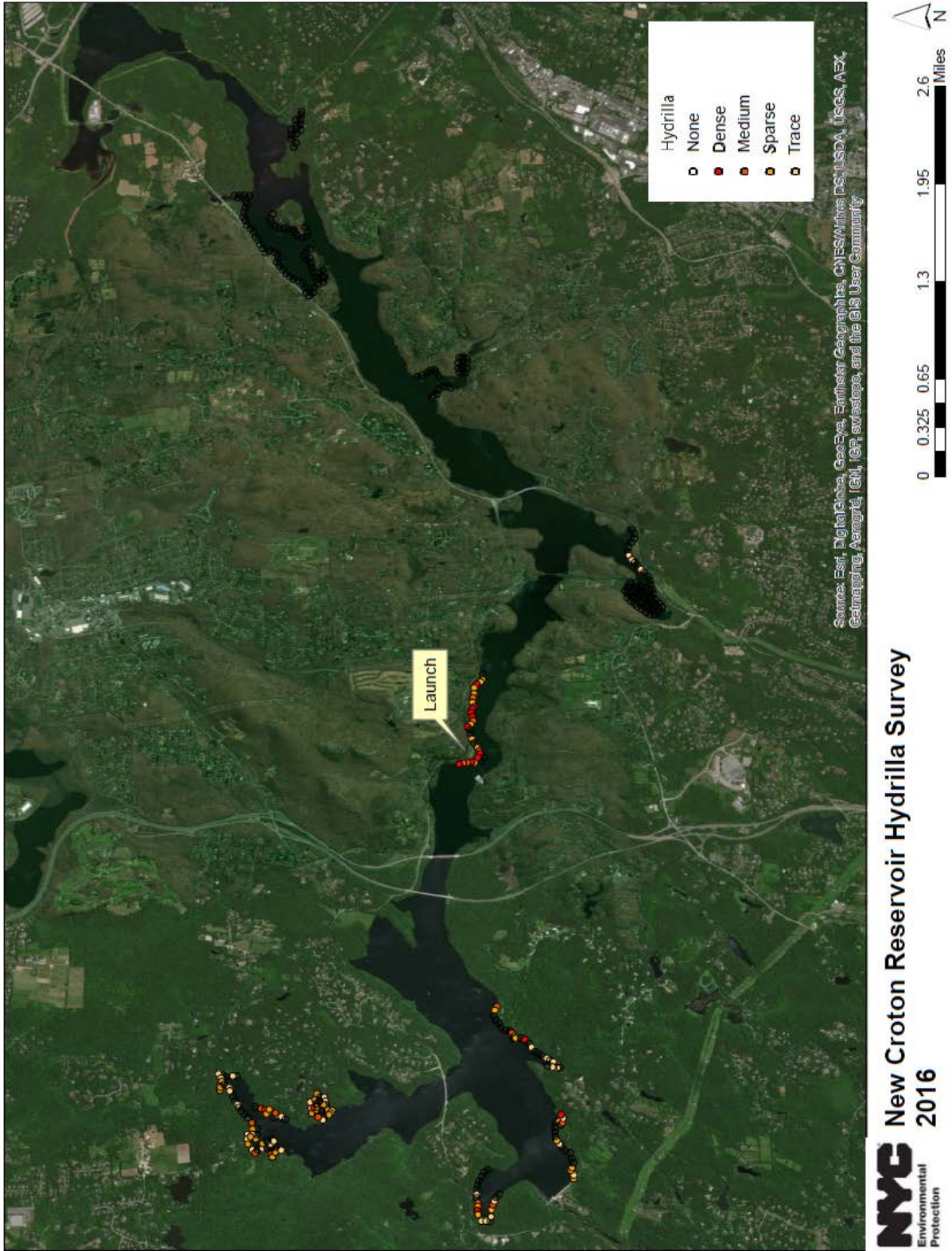
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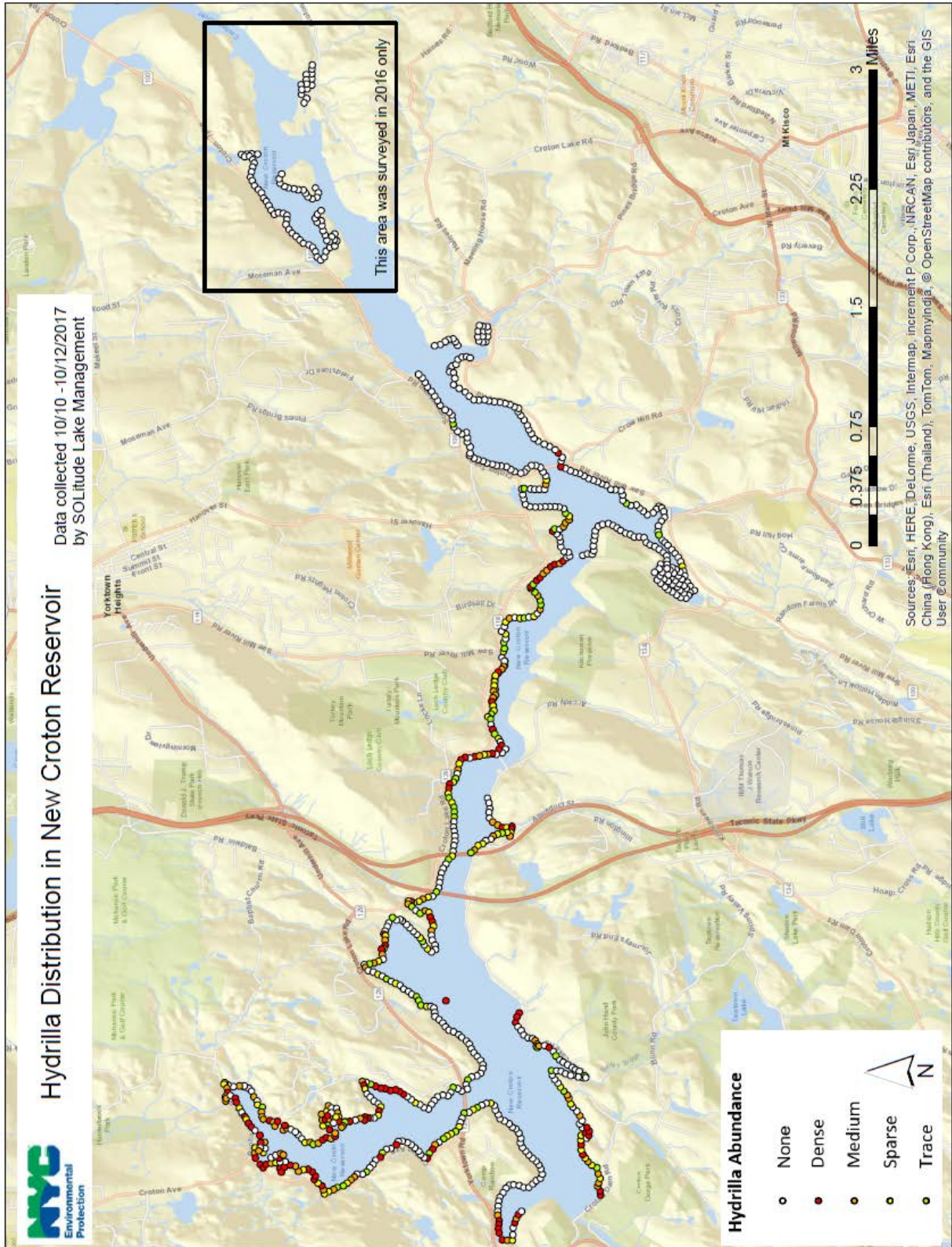
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Appendix A. 2016 New Croton Hydrilla Survey Results



Appendix B. 2017 New Croton Hydrilla Survey Results



Appendix C.

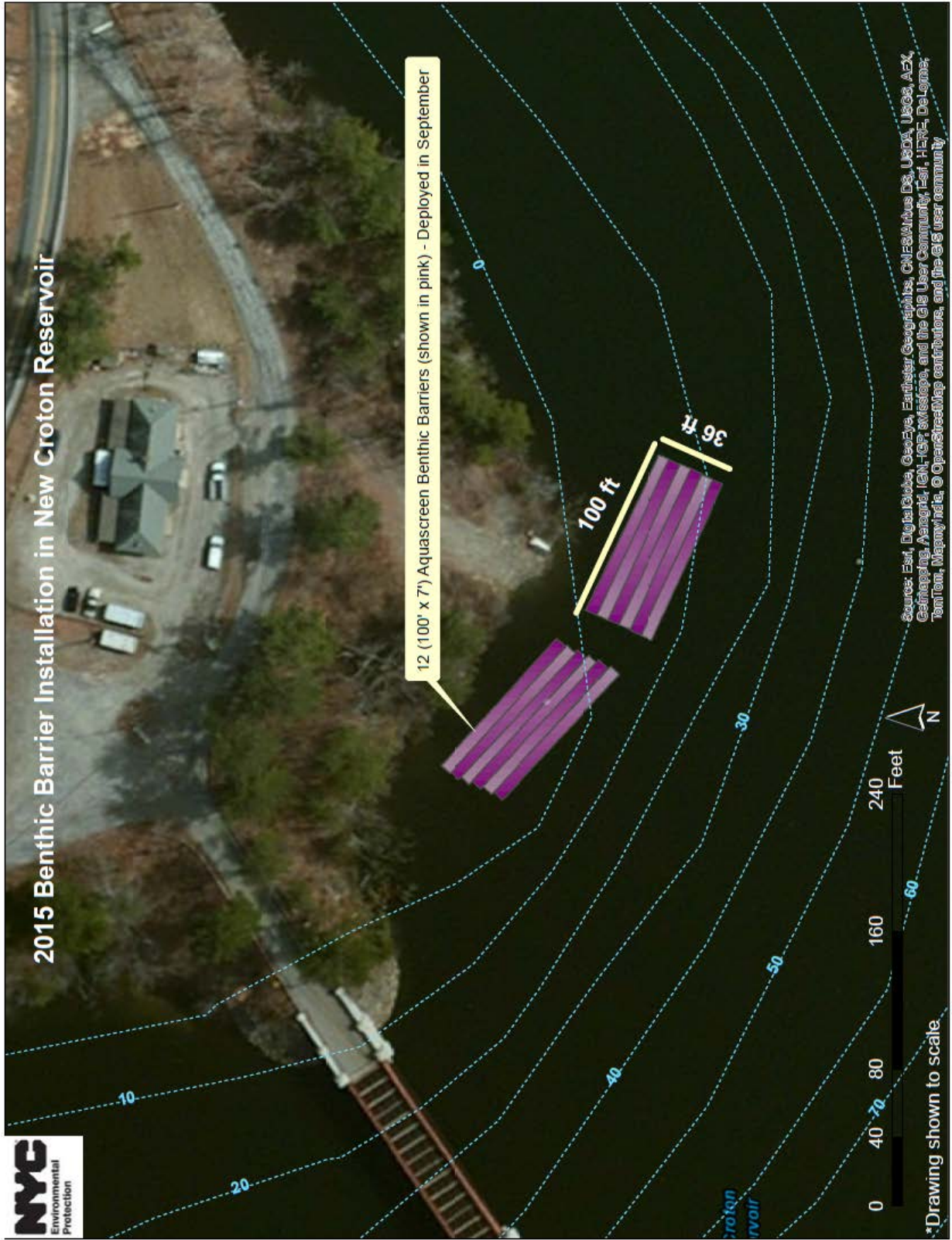
Option	Advantages	Disadvantages	Comments
<p>1) Benthic Barriers</p> <p>Types of barriers:</p> <p>a) Porous or loose weave synthetic materials</p> <p>b) Non-porous or sheet synthetic materials</p> <p>c) Sediments of a desirable composition</p>	<ul style="list-style-type: none"> • Highly flexible control • Reduces turbidity from soft bottoms • Can cover undesirable substrate 	<ul style="list-style-type: none"> • May cause anoxia at sediment-water interface • May limit benthic invertebrates • Non-selective interference with plants in target area • May inhibit spawning/feeding by some fish species 	<ul style="list-style-type: none"> • US Army Corps and NYSDEC Article 15 regulations restrict the total area/volume of materials (fill) used. This is a feasible control strategy on a small scale. • Attempted a porous barrier installation at the New Croton boat launch with limited success in 2015 and 2016.
<p>2) Dredging</p> <p>Types of dredging:</p> <p>a) “Dry” dredging</p> <p>b) “Wet” dredging</p> <p>c) Hydraulic dredging</p>	<ul style="list-style-type: none"> • Plant removal with some flexibility • Increases water depth • Can reduce pollutant reserves • Can reduce sediment oxygen demand • Can improve spawning habitat for many fish species • Allows complete renovation of aquatic ecosystem 	<ul style="list-style-type: none"> • Temporarily removes benthic invertebrates • May create turbidity • May eliminate fish community (complete dry dredging only) • Possible impacts from containment area discharge • Possible impacts from dredged material disposal • Interference with use during dredging • Usually very expensive 	<ul style="list-style-type: none"> • US Army Corps and NYSDEC Article 15 regulations restrict removal of fill and could limit the scope of where DEP would be able to do this. • Too expensive for aquatic plant control purposes.
<p>3) Dyes and Surface Covers</p>	<ul style="list-style-type: none"> • Light limit on plant growth without high turbidity or great depth 	<ul style="list-style-type: none"> • May not control peripheral or shallow water rooted plants • May facilitate anoxia at 	<ul style="list-style-type: none"> • Much of the infestation in New Croton Reservoir is in shallow water • The area is too large to cover • Too much flow

Option	Advantages	Disadvantages	Comments
	<ul style="list-style-type: none"> • May achieve some selectivity for species tolerant of low light 	sediment interface with water	<ul style="list-style-type: none"> • Hydrilla is most tolerant of low light
4) Mechanical Removal (“harvesting”) Types of removal: a) Hand pulling b) Cutting c) Harvesting with collection d) Rototilling e) Hydroraking	<ul style="list-style-type: none"> • Highly flexible control • May remove other debris • Can balance habitat and recreational needs 	<ul style="list-style-type: none"> • Possible impacts on aquatic fauna • Non-selective removal of plants in treated area • Possible spread of undesirable species by fragmentation • Possible generation of turbidity 	<ul style="list-style-type: none"> • Hand pulling may be appropriate on very small scales • Not feasible at the scale of this infestation • Fragmentation could spread infestation further • Need a suitable disposal site • NYSDEC Article 15 and Article 24 regulations may limit the allowable area
5) Water level control Types of level control: a) Drawdown b) Flooding	<ul style="list-style-type: none"> • Requires only outlet control to affect large area • Provides widespread control in increments of water depth • Complements dredging and flushing 	<ul style="list-style-type: none"> • Potential issues with water supply • Potential issues with flooding • Potential impacts to non-target flora and fauna • Hydrilla tubers are resistant to brief periods of drying and freezing 	<ul style="list-style-type: none"> • Minimum flow requirements and water supply needs make this option impossible
6) Herbicides Types of herbicides: a) Forms of copper b) Forms of diquat c) Forms of glyphosate d) Forms of fluridone e) Endothal acid f) Amine salt of triclopyr g) Flumioxazin h) Bispyribac-Sodium	<ul style="list-style-type: none"> • Wide range of control is possible • May be able to selectively eliminate species • May achieve some algae control as well 	<ul style="list-style-type: none"> • Possible toxicity to non-target species • Possible downstream impacts • Restrictions of water use for varying time after treatment • Increased oxygen demand from 	<ul style="list-style-type: none"> • Copper use is restricted in NYC waters by NYS Department of Health • Herbicide labels and registration in NY state limit the products that are effective and can be used for Hydrilla to fluridone and endothal acid (endothall)

Option	Advantages	Disadvantages	Comments
i) k Imazamox		decaying vegetation <ul style="list-style-type: none"> • Possible recycling of nutrients to allow other growths 	
7) Biological introductions Types of biological introductions: a) Herbivorous fish b) Herbivorous insects c) Pathogens d) Selective plantings	<ul style="list-style-type: none"> • Provides potentially continuing control with one treatment • Harnesses biological interactions to produce desired conditions • May produce potentially useful fish biomass as an end product 	<ul style="list-style-type: none"> • Typically involves introduction of nonnative species • Effects may not be controllable • Plant selectivity may not match desired target species • May impact non-target species 	<ul style="list-style-type: none"> • NYSDEC will not permit grass carp • There are no commercially available insects or pathogens at this time • Selective plantings would not compete with Hydrilla

Modified from: New Jersey Water Supply Authority 2017

Appendix D. Benthic Barrier Placement



Appendix E. Pilot Project Map



Sources: Esri, HERE, DeLorme, USGS, Intermap, incrementP Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

NYC Environmental Protection
New Croton Reservoir Pilot Hydrilla Control Program
Locator Map - 2017

Appendix F. Outreach to Stakeholder Groups

Stakeholder Group	Communication to Date	Planned Outreach Activities	Considerations
DEP Field Staff	<ul style="list-style-type: none"> • Email sent to alert staff to initial Hydrilla detection • Field based training held on 10/1/15 for field staff likely to encounter Hydrilla • Articles sharing information distributed through internal newsletters • Open house day table outreach on Hydrilla with staff in Kingston office 	<ul style="list-style-type: none"> • Additional training sessions for field staff held every other year • Additional newsletter articles to share information 	<p>Field staff remain a good resource for early detections in other reservoirs. They are also an important vector for the movement of Hydrilla from one reservoir to another with their activities. They also interact with contractors and other users of New Croton Reservoir.</p>
Anglers	<ul style="list-style-type: none"> • Signs have been posted to alert anglers to Hydrilla and the risk of spread • Articles have appeared in the Recreation Newsletter and e-newsletter • Information is distributed regularly at Family Fishing Day and other outreach events • Several key stakeholders have been in communication with Natural Resources staff regarding the infestation and impacts to fishing 	<ul style="list-style-type: none"> • Angler group representative(s) will be invited to join in discussions • A dedicated webpage will be developed for the project that will be updated regularly to include monitoring and survey results and have links to it from the recreation pages. • Informational signs will be posted ¼ mile around 2018 pilot treatment sites with emphasis at parking areas regarding the treatment and Hydrilla 	<p>Anglers are an important vector for Hydrilla and may unintentionally spread fragments in tackle and gear as well as intentionally moving the plants to new areas for the perceived benefits to fishing. Working with anglers from the start will be important to ensure that they support control efforts. They may also be an important resource for early detections in other reservoirs.</p>

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		<ul style="list-style-type: none"> • For the full reservoir treatment, signs will be required at every access point/boat area. Informational signs will be posted along with treatment notification signs. • Articles will continue to appear in the Recreation Newsletter to notify anglers of the progress in the project • The DEC aquatic pesticide permit will require notification of the treatment program to every access permit holder through a direct communication or notification in local newspapers 	
Local Communities	<ul style="list-style-type: none"> • DEP has attended local stakeholder meetings for the NYSDEC’s control project in the Village of Croton-on-Hudson • DEP has met with the Town of Yorktown Engineer and staff to go over plans for the pilot and has been discussing a public information meeting with them in 	<ul style="list-style-type: none"> • DEP staff will continue to participate in the NYSDEC public stakeholder meetings semi-annually. • DEP staff will continue to meet with the Town of Yorktown and plan for a public stakeholder meeting in 2018 	The support of local communities is critical to receiving required permits and support for activities that are necessary for the management of Hydrilla. The Village of Croton-on-Hudson and the town of Ossining both rely on the reservoir’s water for their water supply.

Stakeholder Group	Communication to Date	Planned Outreach Activities	Considerations
	<p>preparation for a Town Wetland and Watercourse Permit</p>	<ul style="list-style-type: none"> • The Town/Village of Ossining has a connection to the reservoir and DEP has notified them of the treatment. • The towns of Bedford, Somers, New Castle and Cortlandt will need to be notified and local permits may be required for the full reservoir treatment. 	
<p>Greenhouses/Irrigation users</p>	<ul style="list-style-type: none"> • NYSDEC has been working with a local greenhouse in the Village of Croton-on-Hudson and monitoring fluridone levels very closely in the wells for the Village to ensure the water can be used for irrigation 	<ul style="list-style-type: none"> • DEP does not anticipate having to do any notification during the pilot • Notification might become necessary in a full-scale treatment if bench tests do not demonstrate that filtration would remove all traces of fluridone 	<p>NYSDEC’s Aquatic Pesticide Permit requires that the applicator must notify greenhouses and others who would use water for irrigation if the level were greater than 2 ppb in distribution. This is unlikely given the conditions in the reservoir but it is prudent to be prepared for this as part of an emergency response plan. For those using the water for watering turf the limit is 5 ppb.</p>
<p>Customers</p>	<ul style="list-style-type: none"> • There has been no communication with customers regarding the presence of Hydrilla or the potential for treatment to date. 	<ul style="list-style-type: none"> • DEP Public Affairs staff will determine the best methods to communicate with this audience as necessary. Notification may not be necessary if 	<ul style="list-style-type: none"> • Notifying this audience effectively may present a large challenge.

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		no fluridone reaches distribution due to distance of treatment from intakes, the thermocline and UV treatment.	
Environmental Groups	<ul style="list-style-type: none"> • DEP has been in regular communication with Riverkeeper regarding this project. • NYSDEC held a special stakeholder meeting with environmental groups with a focus on the Hudson River and DEP in 2016 providing a baseline of awareness regarding this issue. 	<ul style="list-style-type: none"> • DEP intends to work with the groups NYSDEC has been working with for the Croton River. 	These groups advocate for the resources that are under threat. There is general support for controlling Hydrilla among all environmental groups since the research indicates that there are worse impacts to natural resources from Hydrilla than the treatment.