



Department of
Environmental
Conservation

Croton Hydrilla Control Project

FIVE-YEAR MANAGEMENT PLAN

NOVEMBER 30, 2018

Andrew M. Cuomo, Governor | Basil Seggos, Commissioner



Executive Summary

The federally listed noxious weed *Hydrilla verticillata* (monoecious biotype) was first discovered in New York State in 2008. Now found in more than 10 counties, this invasive plant is regulated by 6 *New York Codes, Rules and Regulations Part 575 Prohibited and Regulated Invasive Species*. Hydrilla is a high-priority species for New York and many other states because once it becomes established it is extremely difficult and expensive to remove. It alters native habitats, impacts fisheries, prohibits water recreation, and affects local economies. With the exception of three infestations, the majority of the hydrilla growth in New York is confined to small, isolated ponds and lakes. The three large-scale infestations in the state are located in the Cayuga Inlet/Fall Creek in Ithaca, Tompkins County/Aurora, Cayuga County; the Tonawanda Creek/Buffalo County, Erie Canal, Niagara County; and the New Croton Reservoir/Croton River, Westchester County. Each infestation presents different challenges that influence management decisions. Control and management of the hydrilla infestation in Croton involves the New Croton Reservoir, which provides drinking water for New York City; the upper Croton River which flows over the wellfields and aquifers that provide drinking water for the Village of Croton-on-Hudson; public swimming and fishing areas; a trout fishery managed by New York State Department of Environmental Conservation (DEC) Region 3; rare plants; and tidal influence throughout at least onethird of the Croton River, which flows directly into the Hudson River. To date, control and management of the Croton infestation is the most complex invasive management project in New York.

DEC is the lead agency and the Bureau of Invasive Species and Ecosystem Health (Division of Lands and Forests [DLF]) is the lead program on the Croton River Hydrilla Control Project. In an effort to address the complexities of the project, DLF's Invasive Species Coordination Section (ISCS) staff have outlined a five-year plan that relies heavily upon adaptive management. This plan describes the foundation for the project resulting from several years of studies, field surveys, and the experience of the New York Hydrilla Task Force at other locations. The plan examines all management options available and recommends the best management practice for this site, which was implemented in 2017 (Year 1). Also outlined is the additional work (expanding communication, education and outreach, and assessing impacts) that needs to occur in order to support the project in the future. Flexibility is essential for this project and assessments will be conducted at the end of each season. Annual updates will provide an evaluation of the previous season's results. It is DEC's intention to deliver a thorough and effective control and management plan that can serve as a template for other projects.

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List of Acronyms

CFS	Cubic Feet per Second (1 cfs = 1.858 million gallons per day)
DEC	New York State Department of Environmental Conservation
NYCDEP	New York City Department of Environmental Protection
DLF	DEC Division of Lands and Forests
DMM	DEC Division of Materials Management
DOH	New York State Department of Health
DOW	DEC Division of Water
EAF	Environmental Assessment Form
ELAP	Environmental Laboratory Approval Program
EPA	United States Environmental Protection Agency
NYNHP	New York Natural Heritage Program
OPRHP	New York State Office of Parks, Recreation and Historic Preservation
PPM	Parts per Million (1 ppm = 1 milligram per liter)
PPB	Parts per Billion (1 ppb = 1 microgram per liter)
PRISM	Partnership for Regional Invasive Species Management
SAV	Submerged Aquatic Vegetation
SEQR	State Environmental Quality Review
USACE	United States Army Corps of Engineers
USMA	United States Military Academy

Introduction

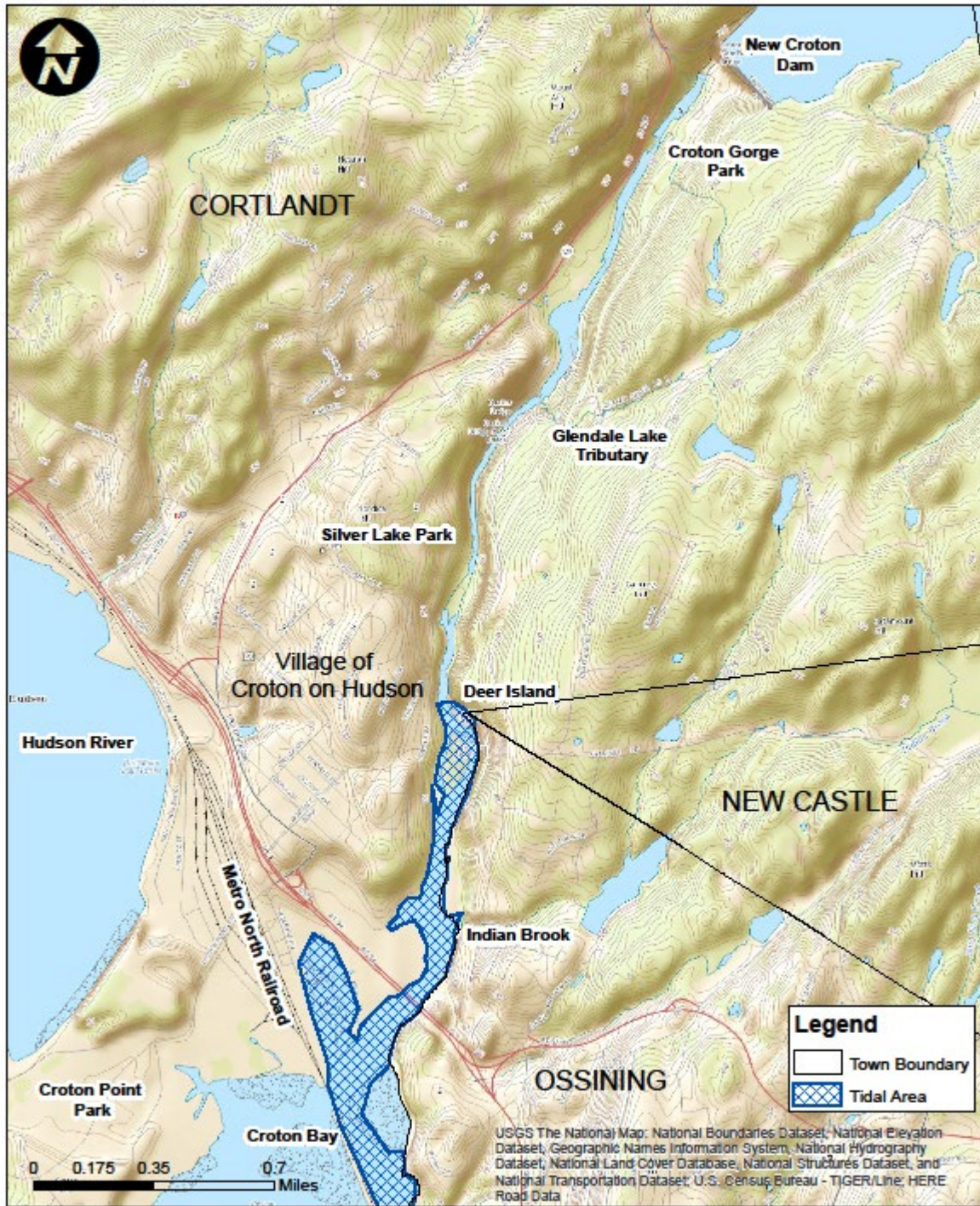
This document provides a five-year management plan for the control of *Hydrilla verticillata*, a highly invasive aquatic plant in the Croton River Watershed, in the towns of Cortlandt and Ossining, Westchester County, New York (see Figure 1). The plan provides transparent information to stakeholders and other interested parties as to the intentions of DEC and New York City Department of Environmental Protection (NYCDEP) to control and manage hydrilla in the Croton River and New Croton Reservoir, and the various constraints, possibilities and potential impacts thereof.

Hydrilla in New York

Hydrilla verticillata is a federally listed noxious weed that is prohibited in New York (6 NYCRR Part 575). Its monoecious biotype (having both male and female organs on the same plant) enables it to overwinter in waters throughout New York State. Hydrilla was first found in 2008 in Orange County and can now be found within 12 counties in New York State. Infestations have been identified in small isolated ponds and lakes as well as in three larger areas. An infestation in Cayuga Lake Inlet and Fall Creek in Ithaca, Tompkins County was first discovered in 2011 and a separate infestation was then discovered in Aurora, Cayuga County in 2016. The second large-scale infestation is located in Tonawanda Creek, Buffalo County and the Erie Canal, Niagara County and was discovered in 2012. The third large-scale infestation is located in the Croton River and New Croton Reservoir, Westchester County and is the subject of this five-year plan.

Background

Hydrilla was reported in the Croton River, New York City's New Croton Reservoir, and Croton Bay of the Hudson River in Westchester County (DEC Region 3, OPRHP Taconic Region) in 2013 and confirmed through extensive surveys in the Croton River in 2014. The infestation is in a New York City (NYC) drinking water reservoir and a tidal river that is adjacent to the Hudson River and in proximity to both rare plants and important native plant habitat that are valuable for native wildlife. DEC convened a preliminary meeting with involved agencies in late autumn 2013 to discuss broad evaluation of the infestation. At that time, limited ancillary surveys by NYCDEP found hydrilla along 5% of shoreline of New Croton Reservoir, mostly within the vicinity of the public boat launch.



**FIGURE 1
LOCATION MAP**

**Croton River Hydrilla Control Project
Five Year Management Plan
Towns of Cortlandt and Ossining
Westchester County, New York**

Urgency for Response

- 1) **Potential impact to Village of Croton-on-Hudson drinking water supply:** Failing to address the infestation in the area below New Croton Reservoir Dam and above Black Rock Dam where the wellfields and aquifer for the village of Croton-on-Hudson's drinking supply are located could allow this area to become a source for re-infestation for downstream habitats. In addition, water quality could eventually be impacted by decomposing hydrilla.
- 2) **Risk to Submerged Aquatic Vegetation (SAV):** Hydrilla threatens to displace SAV beds, particularly those with native *Vallisneria americana*, in both the Hudson River and tidal portions of the Croton River. DEC is highly vested in restoring critical SAV communities lost to recent hurricanes as they play a vital role in maintaining the river's dissolved oxygen levels and providing aquatic habitat in the Hudson River Estuary.
- 3) **Risk to waterfowl and raptors:** A toxic cyanobacteria (*Aetokthonos hydrillicola*) may grow on the underside of hydrilla leaves. This cyanobacterium causes avian vacuolar myelinopathy (AVM), a deadly neurological disease, in waterfowl and the bald eagles that consume them. AVM has been linked to the deaths of more than 100 bald eagles in South Carolina and Arkansas. Although it was not present in hydrilla samples collected from the Croton Reservoir in September 2016, this species of algae is a recent discovery, and little is known about its potential to spread north.

- 4) **Potential impact to the NYC water supply:** If the hydrilla infestation increases to the point of impacting a significant portion of the New Croton Reservoir, there is the potential for some changes in water chemistry such as localized increasing organic content and changing dissolved oxygen and pH levels. In addition, reservoirs nearby may be at risk by accidental transport of hydrilla fragments, turions, or tubers. Turions are overwintering buds found where leaves attach to stems. They may break off and be carried by current to new locations where they can settle, overwinter, and grow into new plants. Tubers are the potato-like reproductive structures that form on the roots of hydrilla plants each fall and allow the plants to store energy and regenerate the following spring.
- 5) **Threat to waters in New York and adjacent states:** Given the proximity to numerous waterbodies and state borders and its direct connection with the entire Hudson River watershed, this infestation poses a threat to the aesthetic values of many waters in New York, Massachusetts, and Connecticut.
- 6) **Threat to fish populations and biodiversity:** Dense mats of hydrilla outshade and displace native plants that are food sources and shelter for native invertebrates and young fish. Decomposition of these extensive mats decrease the dissolved oxygen content in the water and can result in fish kills.
- 7) **Threat to recreation:** Hydrilla produces dense mats of vegetation extending from the bottom of the river to the surface. These mats will prohibit swimming, boating, and fishing in infested areas of the river.

Generic Hydrilla Management Options

No action: No active management, including the use of physical, biological, or chemical control methods, would be employed. Existing populations will continue to grow and spread to new locations. Each season, hydrilla will grow into dense mats that will outshade and outcompete native plants and then will decompose and decrease the dissolved oxygen in the water, which may result in fish kills. DEC-regulated wetlands and Significant Coastal Fish and Wildlife Habitats may also be impacted (see Figure 2). As the infestation spreads throughout the Croton River it will put the Hudson River and surrounding inland waterbodies at risk of infestation. Intensive education and outreach in the surrounding area would be undertaken to raise awareness about hydrilla and other aquatic invasive species in an effort to help prevent the spread of hydrilla and other invasive aquatic species by human activity (transported on recreational water vehicles such as kayaks, canoes, and boats). In addition, annual monitoring of the infestation through volunteer efforts would be recommended. Salinity in Croton Bay may prevent establishment of healthy, reproducing hydrilla, but fragments of hydrilla from the Croton River could be transported by the Hudson River to locations where they can easily become established and grow.

Physical: Benthic barriers (mats) are the most often used physical control methods. They can be effective management tools for suppression in limited instances (infestations of less than 0.25 acre), but are ineffective if eradication is the goal. In autumn 2015, NYCDEP installed several benthic barriers that partly covered the area (8,000 square feet) infested by hydrilla around their boat launch in the New Croton Reservoir with the intent of minimizing spread and containing the infestations as other eradication strategies were considered. Benthic barriers have been used in a very limited capacity as a supplemental control tool in Cayuga Lake Inlet/Fall Creek and Tonawanda Creek/Erie

Canal. However, benthic mats were ineffective as a primary control agent in flowing waters.

Biological: Triploid (sterile) grass carp is a biological control agent used to control aquatic vegetation in small ponds or lakes where fish can be retained within the waterbody. Sterile grass carp have been used for containment in two New York hydrilla sites, but eradication is unlikely at sites with extensive tuber banks due to the inability of the fish to prevent repeated germination of hydrilla sprouts. These fish are not being considered for the Croton River system due to the reservoir's size, connectivity to other waters, and the inability to prevent carp from escaping over the dam and out of the Croton River into the Hudson River.

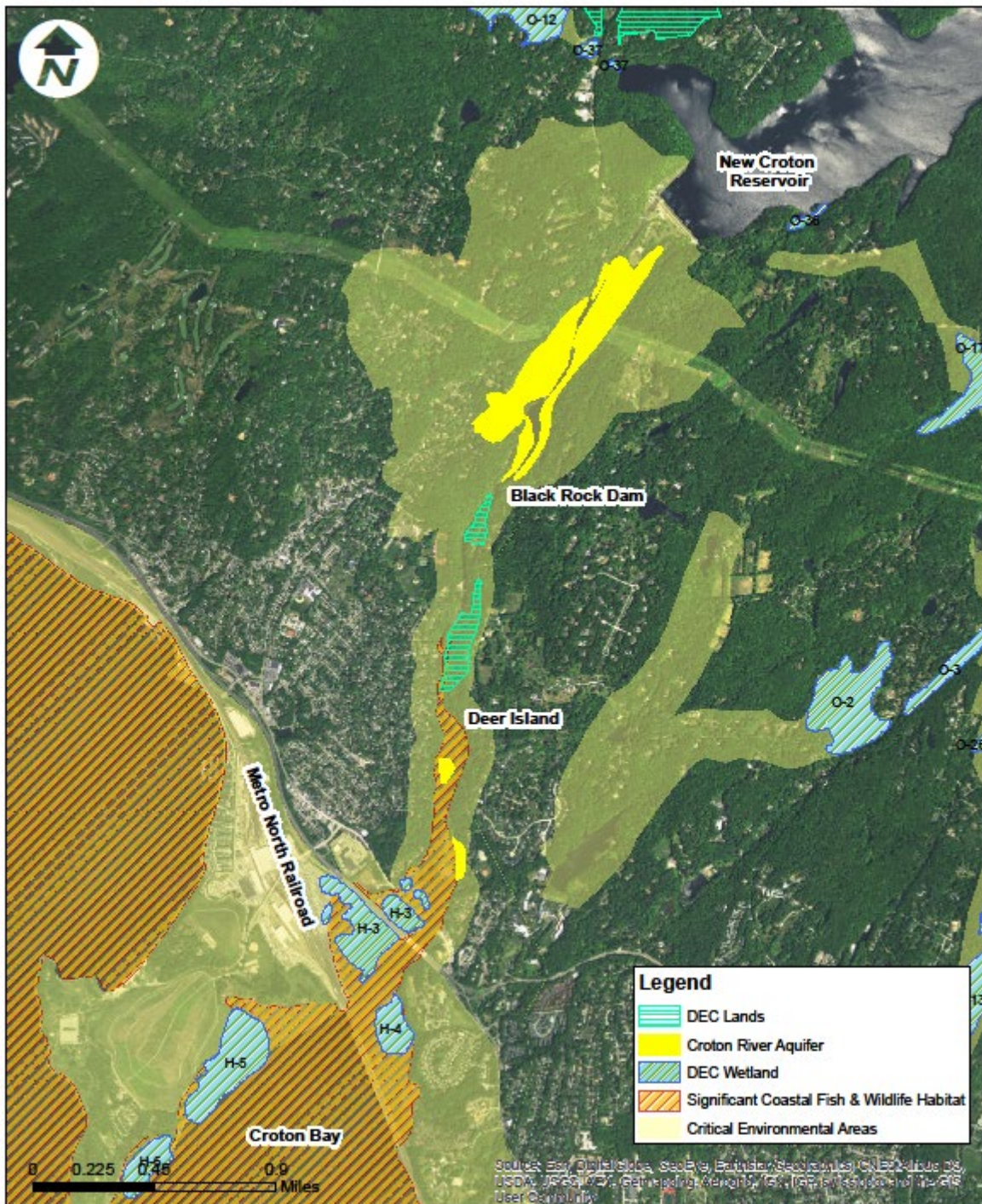
Chemical: Several herbicides have been used to control hydrilla. Autumn treatments combining contact (copper-based herbicides or endothall) and systemic herbicides (fluridone) can provide both short- and long-term benefits. Contact herbicides immediately kill the above-ground parts of plants and can hinder growth of new reproductive structures (i.e., turions and tubers). Systemic herbicides can provide longer-term control by eliminating the below-ground parts of plants that can overwinter and sprout into new plants each spring. This cycle needs to be repeated until the tuber bank in the sediment is exhausted.

Data from the Cayuga Lake Inlet, Tonawanda Creek/Erie Canal and management projects in other states indicate that depletion of the tuber banks will require several consecutive seasons of treatment. The progression of the Croton infestation is similar to that of the infestation in the Cayuga Lake Inlet, suggesting that a minimum of five years will be needed for tuber bank exhaustion and possible eradication of hydrilla.

Staff recommendation: The recommended management option is the use of herbicide. Eradication may not be feasible even with the

chemical option. Herbicide treatment may greatly reduce the size of the infestation, but it is expected that continued maintenance efforts will be required to keep the remaining small populations in check. Benthic barriers may be appropriate as maintenance for infestations

under one acre. As with any control project, adaptive management will be applied and changes made to strategies as treatment outcomes are assessed and options are weighed.



**FIGURE 2
ENVIRONMENTAL AREAS**

**Croton River Hydrilla Control Project 2016
Five Year Management Plan
Towns of Cortlandt and Ossining
Westchester County, New York**

Croton Infestation Overview

- 2013: Hydrilla was first discovered by a private sector ecologist in the Croton River near the mouth of the Hudson River (Westchester County).
- 2014: An aquatic plant survey of the Croton River revealed patches of sparse and dense hydrilla at nearly 150 out of 275 points (54.5%) from the reservoir dam to the confluence with the Hudson River. In the area near Black Rock Park, 2 of 29 points yielded “dense” hydrilla (6.9%).
- Summer and autumn 2015: An aquatic plant survey of the Croton River yielded “dense” hydrilla at 66 out of 120 points (55%) during a more intensive survey. In addition, 2015 aquatic plant surveys were conducted at more than 40 sites (located up to 60 river miles north and 9 river miles south of Croton Bay and in ponds within a 10-mile radius of the Hudson River) and yielded no hydrilla. In both 2014 and 2015, hydrilla fragments were found at several locations in Croton Bay, but no rooted plants were found.
- Autumn 2015: More than 30 sites in the New Croton Reservoir were surveyed for aquatic invasive plants. The surveyors found up to five patches of hydrilla at the dam, the boat launch, and northeast of the boat launch (personal communication Meredith Taylor, ND).
- October 2015: Flow dynamics of the Croton River were assessed through a dye study. Results of the study indicated that the half-life of the dye was 3–5 days with no dye detection after 10 days (10th day readings were 1ppb). According to the final report of this study, “the October 2015 dye study results support an ability to conduct management with aquatic herbicides if water exchange is properly accounted for in the management design” (Heilman 2015).
- December 1, 2015: A public stakeholder meeting was held at the Croton-on-Hudson Library and was attended by more than 30 different groups including state and local government agencies, a state legislative representative, residents, and non-governmental organizations. Five experts gave presentations about the biology of hydrilla, case studies in New York and other states, its impacts, and the methods used for its control.
- Spring 2016: DEC held numerous conference calls and meetings with Hudson Valley environmental stakeholders and the Village of Croton-on-Hudson Water Control Commission and Waterfront Advisory Committee. These interactions revealed that the Village of Croton-on-Hudson’s drinking water supply comes from an aquifer and wellfield that draw from the Croton River in the area below the New Croton Reservoir and above the Black Rock Dam.
- May 2016: DEC contracted SŌLitude Lake Management to conduct pre- and post-treatment aquatic plant surveys, tuber monitoring in the entire Croton River, and an endothall herbicide treatment of the non-tidal target area below Black Rock Dam to Deer Island later that summer.
- June 28, 2016: DEC co-hosted a public stakeholder meeting at the Croton-on-Hudson Village Hall. The meeting was attended by more than 40 residents, members of state and local government, and non-governmental organizations. DLF gave presentations about the natural history of hydrilla, why its control is a priority for DEC, and details about the current Croton River Hydrilla Control Project. SŌLitude Lake Management provided details about the infestation in the Croton River including results of previous aquatic plant monitoring efforts.

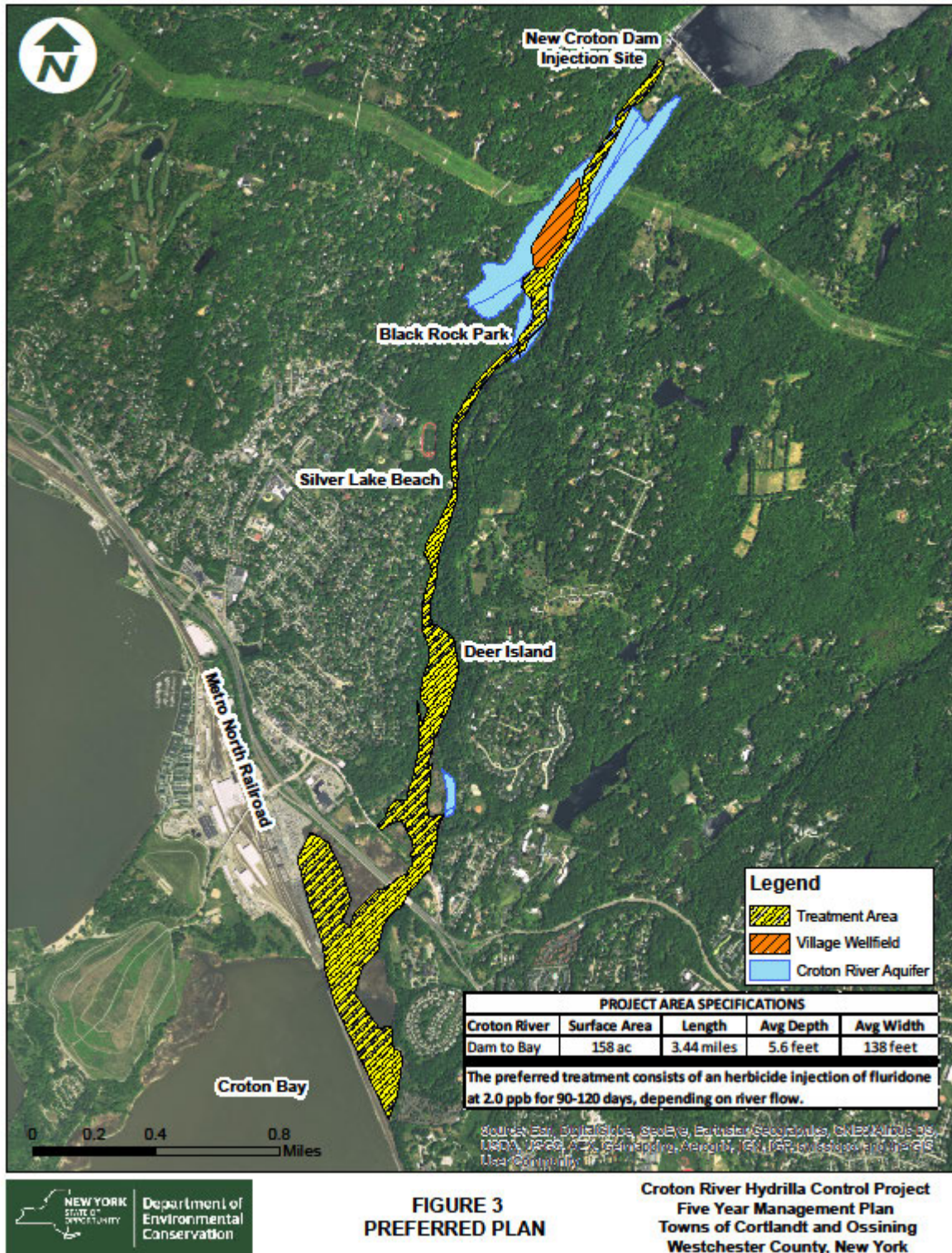
- Summer and autumn of 2016: SÖLitude Lake Management was contracted to conduct aquatic plant surveys of the Croton River (Doyle 2016a) and New Croton Reservoir (Doyle 2016b). In the 2014 survey, 28% of the sample points at Black Rock Park were classified as having medium or dense hydrilla cover, while in the autumn 2016 survey, 54% of points had medium or dense cover (2016a). In addition, hydrilla was the most commonly occurring aquatic plant at Silver Lake Beach and in the River Islands section, but was only found at 28% of sample points in the lower portion of the Croton River and at no points in the coves or Croton Bay wetlands area (2016a). In the New Croton Reservoir, hydrilla was found in shallow water close to the shoreline in 33.3% of sample points (114 of 342 sites) (2016b). Within the total New Croton Reservoir sites sampled in 2016, hydrilla was dense at 15 points, medium at 16 points, sparse at 45 points, trace at 38 points, and absent at 230 points (Doyle 2016b).

The infestation appears to be contained in the Croton River system, but this may only be a short-term scenario because hydrilla fragments have been found floating in the Croton Bay and Hudson River. Experts noted that the hydrilla from the tidal mouth of the Croton River lacked vigor and in 2016 was not growing there, likely due to salinity at the confluence with the Hudson River. However, a number of locations along the Hudson River contain suitable habitat for hydrilla and fragments transported there could result in new infestations.

Management Scenarios in the Croton River

Preferred scenario: A five-year plan would involve pre- and post-treatment aquatic plant monitoring, tuber monitoring, and herbicide treatment for locations of infestation within the entire Croton River (see Figure 3). A systemic herbicide (fluridone) released at low concentration (2.0–5.0 ppb) into the Croton River will minimize impacts to the fishery, rare wetland plants, and other native aquatic plants. The systemic herbicide has no label restrictions regarding swimming and potable water when administered at concentrations less than required by the product label. The proposed concentration range is also well below the EPA standard of 150 ppb and below the NYS DOH's Maximum Contaminant Level (MCL) for fluridone in drinking water of 50 ppb. The amount of fluridone used will be adjusted throughout the treatment period to maintain the effective concentration. The application time frame would most likely be July through October when the optimal growth stage has been achieved. The treatment would be modeled after the very successful efforts in the Cayuga Lake Inlet.

The desired scenario would include a full assessment of the Croton River aquifer and subsequent approval by DOH and DEC (Divisions of Water and Materials Management) to ensure that no contamination of the Village of Croton-on-Hudson drinking water would result. Treatment concentration (2–4 ppb) is well below both Federal and New York State maximum application rates. The herbicide fluridone has demonstrated no impacts on vertebrates (mammals, birds, amphibians, reptiles, and fish) at such a low concentration. **Currently, the 2017–2021 DEC treatment plan follows this preferred scenario for the Croton River.**



Limited scenario: This scenario employs herbicide treatment in the lower two-thirds of the Croton River (below Black Rock Dam) and benthic mat placement in the remaining third and the New Croton Reservoir. A five-year plan would include pre- and post-treatment aquatic plant monitoring, tuber monitoring, mechanical control, and herbicide treatment for the Croton River. The Task Force will employ a separate contractor to conduct benthic mat installation for one season from the base of the New Croton Reservoir Dam to the Black Rock Dam spillway (see Figure 4). NYCDEP will continue to deploy benthic mats in the New Croton Reservoir. Past field use indicates that benthic mat placement is less than ideal for control of hydrilla infestations larger than one acre and may have mixed results. Assessment of outcomes will determine the efficacy of this method. Below the Black Rock Dam spillway, the release of a contact herbicide (dipotassium salt of endothall: Aquathol K) at a concentration of 1.5–5.0 ppm over several days early in the growing season (early July to early August) will prohibit turion production and remove above-ground plant growth. However, this treatment will not impact the below-ground parts of plants as effectively as a systemic herbicide, thus many existing tubers will sprout in the spring. In addition, endothall may have non-target impacts on some native plants. Note: Treatment of the Croton River without treatment occurring in the New Croton Reservoir will still provide benefits. Hydrilla fragments, turions, and tubers will be carried downstream from the reservoir, but the fluridone in the river water will render them non-viable and unable to establish new infestations (personal communication M. Heilman ND).

No-treatment scenario: DEC would take no action to control and manage hydrilla in the Croton River. The infestation would be monitored on a regular basis and large-scale efforts will be made to increase public awareness and the practice of measures to prevent spread into other waterbodies. Additional monitoring of priority waterbodies within a 10-mile radius of the Hudson River will also continue. The hydrilla infestation will grow unchecked and spread to new areas of the river. During summer and early autumn,

dense mats of vegetation growing from the bottom of the river to the surface will prohibit swimming, kayaking, canoeing, boating, and fishing. In mid- to late autumn, the thick mats of vegetation will start to decompose, which would impact the taste and odor of the water, and greatly reduce the dissolved oxygen in the water, likely resulting in fish kills.

New Croton Reservoir Management

Prompt treatment of the Croton River hydrilla infestation is essential to protect the ecosystem of the river as well as reduce the risk of spread of hydrilla into the Hudson River. However, treatment of the upstream source of the infestation in the New Croton Reservoir is vital to ensuring the Croton River does not continue to be infested via hydrilla fragments being transported over the New Croton Reservoir Dam during spill. The New Croton Reservoir is under the jurisdiction of the NYCDEP and will subject to a pilot study in 2018.

The same systemic herbicide (fluridone) that is proposed for use in the Croton River is recommended for release into the New Croton Reservoir. Use at low concentration (2.0–5.0 ppb) will minimize impacts to the fishery, rare wetland plants, and native aquatic plants. The systemic herbicide has no label restrictions regarding swimming and potable water when administered at concentrations less than required by the product label. The proposed concentration range is also well below the EPA standard of 150 ppb and below the New York State Department of Health Maximum Contaminant Level (MCL) for fluridone in drinking water of 50 ppb.

NYCDEP may require additional mitigating techniques when using the herbicide in the New Croton Reservoir such as containment barriers, limited application areas, or treatment during reservoir shutdowns. A detailed monitoring plan for fluridone will also be required during treatment applications. Because the New Croton Reservoir is an integral part of the NYC water supply, additional regulatory approvals may be necessary to enable chemical treatment.

Results of 2016 Pilot Study

In 2016, DEC planned to treat the hydrilla infestation below the Black Rock Dam spillway to Deer Island (an area of the river that is not under strong tidal influence (Heilman 2015) and does not have brackish water) using a three-day endotoxin treatment to reduce hydrilla plant growth and the number of tubers and turions produced.

Unfortunately, although permits and support were obtained, DEC was not able to conduct the endotoxin treatment for the pilot project due to permitting delays and subsequent unforeseen circumstances affecting the flow rate from the New Croton Reservoir into the Croton River. However, the contractor was able to complete the aquatic plant survey and tuber monitoring for the entire Croton River. Data indicated that the hydrilla infestation had expanded in the upper portion of the river. NYCDEP also conducted a comprehensive survey of hydrilla growth in the New Croton Reservoir through a contract that included aquatic vegetation biovolume measurements, rake toss surveys, and tuber sampling. In addition, the efforts of the 2016 season created a substantial communication network, increased awareness of the threat of hydrilla, and revealed the various potential obstacles to treatment and increased understanding of the lead time needed to work through them.

Outreach and Communication

Educational Materials

The DEC's Bureau of Invasive Species and Ecosystem Health will continue to work with the Lower Hudson Partnership for Regional Invasive Species Management (PRISM), Hudson River Sloop Clearwater, Friends of the Old Croton Aqueduct, Cornell Cooperative Extension – Westchester County, Saw Mill River Audubon Society, Croton River Task Force, and other partners to provide education and outreach products (ID cards, ID sheets, and fact sheets) and messaging to target audiences that include residents, municipalities, recreationists, yacht clubs, marinas, etc. The file for the hydrilla fact sheet can be found on the species webpage <http://www.dec.ny.gov/animals/104790.html>. Waterproof hydrilla ID sheets and cards can be requested from the DEC Invasive Species Coordination Section (ISCS) at isinfo@dec.ny.gov or 518-402-9425.

Responsible use of the river by boaters, anglers, and swimmers will be an integral part of preventing the spread of hydrilla in future years. Outreach regarding compliance and awareness of 6 NYCRR Part 576 Aquatic Invasive Species Spread Prevention will be increased in the Croton River area, particularly at boat launches and public access areas. More information on the regulations of Part 576 and aquatic invasive species spread prevention can be found on the webpage <http://www.dec.ny.gov/regulations/104431.html>. Aquatic invasive species tip strips can be requested from the DEC ISCS (see above for contact information). More information about boat steward programs can be found on the webpage <http://www.dec.ny.gov/animals/107807.html>.

Public Stakeholder Meetings

DEC will hold biannual public stakeholder meetings to provide updates on the project. An annual early summer meeting will outline the plan for the coming season and an end-of-year meeting will provide the results of the treatment and monitoring conducted by the contractor.

Web Page

The project webpage on the DEC website will be updated regularly with information from the contractors and staff and will provide resources for residents, municipalities, and environmental stakeholders. Annual updates, work plans, and survey results will be made available on the project webpage <http://www.dec.ny.gov/animals/106386.html>.

Shoreline Signs

As per the request of the Village of Croton-on-Hudson, permanent, weatherproof, bilingual signs with information about the project were created for public access areas (see below).

STOPPING AN INVADER IN YOUR WATERS



This river is being treated to reduce the spread of hydrilla. Herbicide applications will occur during the summer and fall. Read all posted warnings on water use for this water body.

Recreational water activities will be limited at herbicide release locations.

Hydrilla is a weed that grows uncontrollably in the water. It crowds out other plants and ruins swimming, boating, and fishing opportunities. The Department of Environmental Conservation will be using a low dose of herbicide in the summer and early fall until 2021 to prevent hydrilla from reaching the Hudson River, where it will be impossible to control.



STOP THE INVASION
PROTECT NEW YORK FROM INVASIVE SPECIES

PARANDO A UN INVASOR EN SUS AGUAS



Este río está siendo tratado para reducir la propagación de hydrilla. Aplicaciones de herbicida ocurrirán durante el verano y el otoño. Lea todas las advertencias publicadas sobre el uso del agua en estas aguas.

Las actividades acuáticas serán restringidas en las localidades donde se aplique herbicida.

Hydrilla es una mala hierba que crece sin control en el agua. Desplaza a otras plantas y arruina la natación, navegación, y oportunidades para la pesca. El Departamento de Conservación Ambiental usará una dosis de herbicida baja durante el verano y comienzos del otoño hasta 2021 para prevenir que hydrilla llegue hasta el Río Hudson, donde sería imposible de controlar.

www.dec.ny.gov/animals/106386.html

Monitoring

Plants

Aquatic plants will be surveyed throughout the Croton River pre- and post-treatment in order to track herbicide impacts on native vegetation and assess the efficacy of a select herbicide regime to reduce hydrilla populations. Pre-treatment surveys will occur up to one month prior to treatment and post-treatment surveys will be conducted four to six weeks after treatment. Survey grids of various scales, depending on level of detail needed, will be placed over sections of the Croton River. Intersection locations of the grid will serve as sampling points with two rake tosses conducted at each. Samples from the rake toss will be identified to species when possible and percent cover estimated. Additional information about this protocol can be found in several publications (Johnson 2014; Doyle 2014, 2015, 2016a and b).

The contractor will conduct the aquatic plant survey of the entire Croton River (from New Croton Reservoir Dam to Croton Bay using rake toss protocols and DEC-approved remote survey methods and a pre-determined GPS survey grid based on the 2016 aquatic plant survey (Doyle 2016a). The area of the Croton River below the New Croton Reservoir Dam and above the Black Rock Park area can be difficult to access and may require remote sensing methods to assess. Outside of this area, a double-sided rake head will be tossed 10 feet from the intersect points on the grid and pulled in toward the boat or shore. Two tosses will be made at each intersection. The surveyor will identify and record the plant species found on the rake and estimate the percentage of each plant species in the sample. When identification is questionable, voucher specimens will be collected for verification by local botany experts identified by DEC. GPS point locations (survey grids) will remain the same throughout the length of the project. The protocol for this procedure is outlined in Doyle 2015 and 2016a.

In addition to the aquatic plant survey, tuber monitoring will take place at designated locations each season. Density of tubers in each sediment core sampled will be used to assess effectiveness of herbicide treatment. Controlling tuber development is key to preventing further establishment of hydrilla. The contractor will conduct tuber monitoring at the five locations recorded in the 2016 Croton River survey (GPS coordinates will be provided to contract awardee) and up to seven additional locations that will be georeferenced (total of 12 samples per season). Sampling will be conducted with a 10.2-cm diameter sediment core puller. One sediment core (0.008 m²) per site will be collected at designated sites and sieved, and tubers and turions collected and counted to provide information on tuber density to assess effectiveness of herbicide treatment.

In addition, the contractor will survey 21 high-priority Hudson River sites north of Croton with habitat characteristics suitable for hydrilla (Table 1.) outlined in the 2015 report from the Hudson River aquatic plant survey (Doyle 2015). Grid size and GPS points will be provided for the 21 priority sites from the original survey to the contract awardee. These sites will remain the same throughout the project.

Table 1. High Priority Sites for Hydrilla Monitoring				
Site Name	River Marker	Size (Acres)	Grid (m)	Points
Half Moon Bay	35	76.7	50/100	66
George's Island Park	39	31	50	60
Popolopen Creek	46	13	50	35
Lents Cove	43	39	50	57
Dickey Brook	43	5.7	50	20
Croton Bay	34	639	200	71
Annsville Creek	44	144.5	100	75
Iona Marsh	45	152	100/200	69
Moodna Creek Bay	57	49	50	68
Constitution Marsh	52	358	100	88
Foundry Cove Bay	53	6.7	50	12
Foundry Cove	53	41.5	50	64
Wappingers Creek	67	94.3	100	50
Mills-Norrie State Park	84	28	50	50
Black Creek Preserve	83	36	50	48
Fishkill Creek	59	41.7	50	47
Sleightsburg Park	90	224.0	100	100
Vanderburgh Cove	87	98.6	100	42
Kemey's Cove	31	12	50	30
Kingston Point Marsh	91	31	50	29
Poughkeepsie Yacht Club	83	39	50	40

Water

Herbicide level monitoring is designed to fulfill three purposes:

- Drinking water safety (Village of Croton-on-Hudson drinking water wells)
- Environmental protection (DEC sites)
- Maintenance of adequate herbicide levels for effective treatment (monitored by the Croton Hydrilla Task Force and SePRO, the manufacturer of Sonar®, during fluridone treatment)

Drinking water: As a precaution, water will be sampled from the drinking water wells (raw water pre-treatment) and the finished water at

the entry point (post-treatment water and location of water blending) to determine if the herbicide concentration remains at 2–4 ppb or below. Concentration in the well water could never exceed the concentration in the river. Water will be collected using 30-ml amber Nalgene bottles (for SePRO) and up to 2 amber glass bottles (for New York State Department of Health Environmental Laboratory Approval Program (DOH ELAP)-certified laboratory). Water samples will be collected from the drinking water wells daily for one week after treatment has begun and then on a weekly basis after day 7 of the treatment during the herbicide treatment period and after treatment until the concentration of fluridone is below 1 ppb (the

level for restrictions of using water for irrigation) and for at least two months after the end of the treatment or until concentration is below detection level (non-detect) for more than two consecutive days. All samples will be kept in amber bottles on ice while being stored and transported to labs for analysis as fluridone degrades quickly in sunlight and at higher water temperatures.

One of each sample set will be sent to the herbicide manufacturer's lab (SePRO) and the other will be sent to a DOH ELAP-certified subcontract laboratory. Samples sent to SePRO will be analyzed using high performance liquid chromatography (HPLC) which can detect concentrations of fluridone as low as 1 ppb. Results from the samples analyzed by SePRO will be returned within 24 hours and will be posted on the project website (<http://www.dec.ny.gov/animals/106386.html>). Samples sent to the DOH ELAP-certified subcontract laboratory will be analyzed using EPA Method 525.3 (Version 1.0, February 2012) with a 0.30 ppb detection level (based on 1-liter sample limit). Results from the samples from the DOH ELAP-certified subcontract laboratory will be posted several days after submission to verify the results from SePRO.

Public messaging for each potential detection level has been developed in collaboration with the DOH Bureaus of Water Supply Protection and Toxic Substances, NYCDEP, and DEC's Division of Water and Division of Materials Management – Bureau of Pest Management. Messaging will be posted on the project webpage, Town of Cortlandt and Village of Croton-on-Hudson websites and sent out by email by the Village of Croton-on-Hudson and DEC (listserv from sign-in information from stakeholder meetings). Water use restrictions apply to irrigation at ≥ 1 ppb for hydroponic



Upper Croton River, Autumn 2015 (Photo: C. McGlynn, DEC)

farming and greenhouse and nursery plants and ≥ 5 ppb for tobacco, tomatoes, peppers or other plants within the Solanaceae family and newly seeded crops or newly seeded grasses, such as overseeded golf course greens. Therefore, the greenhouse owner and golf course management within Croton will be notified directly.

Croton River: In addition, water samples will be collected weekly at 3–4 locations in the target area within the river: upper, middle, and lower portions (north and south ends). Locations will be chosen by DEC based on flow dynamics. The sampling regime could be reduced to 3 locations after results from the first 2–3 weeks of treatment are available to compare target versus achieved concentrations. These data will be used to confirm anticipated retention time in the target zone. Based on sample analysis, the amount of herbicide injected will be adjusted to maintain the target concentration at 2.0–4.0 ppb to ensure an effective treatment of hydrilla and minimal non-target impacts. All river water samples will be sent to SePRO's lab. Based on results of the analysis, the amount of fluridone used in the treatment will be adjusted to maintain the concentration at 2.0–4.0 ppb in the Croton River.

Control and Management

Experts from consulting firms and United States Army Corps of Engineers (USACE) conceptually divided the geographic area of this project into four sections for the purposes of management recommendations: New Croton Reservoir infestation that may be managed by NYCDEP; the Croton River between the New Croton Reservoir and the Black Rock Dam (including Village of Croton-on-Hudson aquifer and wellfield);

the Black Rock Dam spillway to the mouth of the Croton River (which includes both non-tidal and tidal sections); and the Croton Bay at the mouth of the Croton River. Croton Bay is a tidal area which is a poor candidate for any control measures due to the lack of evidence of rooted hydrilla, the suppression of sustained robust hydrilla growth due to highly variable salinity and water levels, and the extreme technical challenges in developing a feasible treatment regime.

In 2016, NYCDEP agreed to coordinate discharge increases from the New Croton Reservoir in order to increase efficacy of the herbicide treatment. NYCDEP will work with DEC to determine what volume of water is needed for effective herbicide coverage in the non-tidal portion of the Croton River. For a multi-day to multi-week interval in summer 2017 and subsequent years until 2021, NYCDEP may increase or decrease discharge to achieve the target flow rate (below 500 cubic feet per second [cfs]) needed to maximize herbicide efficacy. However, adjustments to the flow will only be made if hydrologic conditions and water supply needs allow.

New Croton Reservoir

In 2014, NYCDEP conducted a visual aquatic plant survey throughout the littoral areas of the New Croton Reservoir and confirmed the presence of hydrilla at four locations. In autumn 2015, more than 30 locations in the New Croton Reservoir were surveyed for aquatic invasive plants. The surveyors found up to five patches of hydrilla at the dam, the boat launch, and northeast of the boat launch.

In September 2016, SŌlitude Lake Management conducted detailed acoustic scanning of the aquatic plant community throughout the entire littoral zone of the reservoir to identify “hot spots” of plant growth that will then be mapped using the point intercept method (which includes plant identification). Based on the findings from this survey, NYCDEP will determine the techniques for hydrilla control in the New Croton Reservoir: an integrated long-term management approach in combination with pre- and post-treatment aquatic plant surveys and tuber monitoring. The New Croton Reservoir is the jurisdiction of the NYCDEP. NYCDEP will work closely with DEC and other stakeholders to coordinate control efforts in the New Croton Reservoir with those in the Croton River.

Croton River below Black Rock Dam to the mouth of the river

This section of the river includes both a non-tidal portion (Black Rock Dam to Deer Island) and a tidal portion (Deer Island to the mouth of the Croton River). Salinity changes downstream from freshwater to brackish via a tidally influenced gradient. There is a large section below the Quaker Bridge Road auto bridge with many large boulders and crevices where hydrilla can grow. The flow rate of the river will need to increase well above 13–20 cfs, which is the current maintenance level of the New Croton Dam, in order for water (and the herbicide in solution) to reach hydrilla plants in these crevices and close to the shoreline.

The 2015 flow dynamics study (Heilman 2015) in the tidal section of the Croton River indicated that herbicide concentration and retention will be in flux with each tidal cycle. Several deep areas located near the wetlands will need to receive a focused treatment. The brackish nature of the water may also limit the choices of herbicide that can be used here.

Croton Bay

In 2014, a few plants were found growing along the shoreline, and in 2015 and 2016, fragments were found floating in the Croton Bay area. DEC will continue to monitor the Croton Bay for hydrilla growth in an effort to assess the risk to the Hudson River and adjacent bays and tributaries. Management and control efforts will be developed and implemented for this area if the need arises.

Adaptive Management

Given the complexity and significance of the Croton River Hydrilla Control Project, it is critical to recognize that flexibility and adaptability are essential. Each year of management will involve its own process of analyzing the success of the previous year's efforts, determining and implementing the appropriate control strategy, properly documenting of variables and results, and follow-up monitoring and communication, etc. In other words, a detailed plan for each season is not described herein because it is anticipated that each year will be more progressive and fine-tuned. Instead, it is expected that the efforts for the current year will be dependent on the previous year.

Ongoing Project Considerations

Several site constraints and limitations must be considered with project design each year. The project must carefully develop annual management plans in order to protect local ecological communities. The tidal portion of the Croton River is designated by the New York Natural Heritage Program (NYNHP) as a Significant Natural Community which has "rare or high quality" habitats or ecosystems

(see Figure 2). Several threatened and endangered plant species were identified in the tidal portion of the river during a 2013 survey conducted by New York Botanical Garden staff. While this NYNHP designation has no regulatory consequence, it is important to consider non-target impacts to these communities.

Other considerations include the four DEC-regulated wetlands located at the mouth of the Croton River as well as unintended impacts to fisheries if potentially altering flow regimes and water temperatures in the system. Lastly, the Hudson River, Croton Bay, and Croton River are very popular for recreational activities that include many high-traffic public-use areas for boating, swimming, fishing, etc. Management activities that limit or prevent these uses will require detailed coordination and outreach efforts with various municipalities, businesses, residents, and the general public.

Certainly not least, the use of chemical treatment in a public water supply is a complicated strategy that requires extensive public outreach and education, coordination with regulators, and balancing the countless variables involved with operating a reservoir as well as coordinating releases. It is important to note that these variables may be beyond the control of any of the involved agencies, which underscores the need for continued communication and cooperation for all involved. In particular, water releases will depend upon hydrogeological conditions and being able to use enough water from the Croton River.

Permitting

DEC regulates the use of aquatic herbicides under *6 NYCRR Article 15 Part 327 Use of Chemicals to Control Aquatic Vegetation*. An application for this permit will be submitted annually for the use of herbicide as proposed in the project description and according to product label restrictions. If the choice of herbicide, flow rates, target area, etc., are modified any year after, the Article 15 permit will need to be re-submitted or amended. Program staff will need to work closely with Region 3 staff to determine permitting needs for each season.

As part of the Article 15 permit program, a Notice of Intent is required to be completed and submitted to the Bureau of Water under the State Pollution and Discharge Elimination System (SPDES). An individual permit will be required for this project and will need to be obtained each year.

Under 6 NYCRR Article 24 Parts 663-664, DEC regulates activities conducted in wetlands greater than 12.4 acres in

size such as vegetation removal and pesticide applications. Several of these wetlands are located at the mouth of the Croton River (see Figure 2) and hydrilla control activities potentially impacting the wetlands will require a Freshwater Wetlands Permit.

Any hydrilla control activity in the Croton River that proposes to alter vegetation populations greater than 10.0 acres will constitute a Type 1 Action under the State Environmental Quality Review Act (SEQRA). As of August 2016, it is assumed that DEC will seek to maintain its role as lead agency of the project in future years and will thus be required to determine significant impacts for proposed work. In 1981, a Programmatic Environmental Impact Statement (EIS) for the Aquatic Vegetation Control Program was prepared to satisfy SEQR for projects with impacts covered in the document. In addition, an Environmental Assessment Form (EAF) was prepared to address impacts not included in the EIS, which include impacts to wetland vegetation and endangered species. To comply with SEQR, the Village of Croton-on-Hudson and any other entity with jurisdiction in the proposed project area participated in the process and the coordinated review. Ultimately, a Negative Declaration was declared for the project and the determination was published in the DEC Environmental Notice Bulletin on 04/26/2017.



Aquatic plant sample collection using rake toss method
(Photo: Chris Doyle, SÖLititude Lake Management)

The Department of State regulates designated waterbodies and inland waterways as “Coastal Areas of New York”, which include the Hudson River and Croton Bay area. The Village of Croton-on-Hudson participates in the Coastal Management Program and has prepared and adopted a Local Waterfront Revitalization Program. Components of a proposed hydrilla control project will need to comply with the adopted program as determined in part by the Water Control Commission and the Waterfront Advisory Committee. A Coastal Assessment Form will also need to be completed and submitted to the Department of State.

NYCDEP requires a land use permit to stage an injection unit on their property by the New Croton Reservoir dam. In addition, access to the area where fluridone first enters the river (and is most concentrated) needs to be restricted. DEC and the County of Westchester will work together to determine the best means of keeping swimmers out of this area.

Hydrilla Hunters

In 2015, DEC contracted Allied Biological (now SÖLitude Lake Management) to conduct aquatic plant surveys at 46 select locations along the Hudson River to determine if hydrilla had spread outside the Croton River. No hydrilla was found, but 21 of the sites surveyed were ranked as high-priority for monitoring based on characteristics suitable for hydrilla establishment. In addition, the Office of Parks, Recreation, and Historic Preservation (OPRHP) and the United States Military Academy (USMA) surveyed waterbodies on their land within a 10-mile radius of the river. In 2016, the Lower Hudson Partnership for Regional Invasive Species Management's (PRISM) aquatic invasive species coordinator and her assistant surveyed all 20 high-priority sites and found no hydrilla. OPRHP, USMA, and Scenic Hudson also surveyed several locations without finding hydrilla.

DEC and Lower Hudson PRISM will expand the network of hydrilla monitoring that takes place throughout the Hudson Valley through continued outreach and education to lake associations and water recreationists. While floating fragments from the Croton River pose a serious threat to the Hudson River and connected waterbodies, other vectors, such as watercraft and birds, could also introduce hydrilla to new locations.

Additional Impact Assessment

Benthic Macroinvertebrate Survey

According to the Environmental Protection Agency (EPA), little information is known about impacts of endothall and fluridone on the macroinvertebrate community outside the laboratory. Research on the impacts of endothall (Aquathol K) on the benthic community, a food resource for fish, indicates that larvae and juvenile freshwater molluscs are more susceptible to endothall than adults at dosages of 30 ppm at exposure times of 48–72 hours (Archambault et al. 2015). However, no freshwater molluscs are known from the Croton River. The Croton River was surveyed in 1998 and 2001 as part of the statewide water quality monitoring and assessment program. In 2001, the benthic macrofauna was dominated by filter-feeding caddisflies and midges. DEC Region 3 Fisheries reports that crayfish, mayflies, stoneflies, caddisflies, and blackfly larvae have recently been found during habitat assessments. To date, few studies have been published regarding impacts of herbicide on the majority of species found in the benthic macroinvertebrate community. One study from 1991 indicated that a treatment dosage of 4–8 ppm of endothall was associated with considerable mortality of *Hydrellia* fly larvae, but it was unclear if the mortality was a direct result of the endothall treatment or the death of the larvae's food source – hydrilla leaflets (Haag and Buckingham 1991).

DEC also retains information about the assemblage of macroinvertebrates found in the Croton River in 2012 from the surveys that are conducted every five years by the statewide monitoring Rotating Integrated Basin Studies <http://www.dec.ny.gov/chemical/30951.html>.

DEC plans to work with Hale Creek Field Station and SUNY Oneonta staff and students to assess impacts of herbicide treatments to macroinvertebrates populations in the Croton River. Pre-treatment surveys will be conducted in May 2017 and post-treatment surveys in May 2018. Additional information about the survey protocol will be added to the plan as available.

Vallisneria Biotype Tests

Populations of *Vallisneria* in the Croton River area represent unique, high-quality native plant habitat and some of the largest, healthy SAV beds in the Hudson River Estuary. This habitat provides food and shelter for a plethora of aquatic species and contributes various services important to the health of the ecosystem, such as improving water clarity and oxygenation and removing pollutants. Limiting herbicide impacts to these populations is a priority of the five-year management plan.

DEC will work with researchers from Louisiana State University and University of Maryland Center for Environmental Sciences to determine genotypes and assess potential impacts of fluridone on different biotypes (genotypes) of *Vallisneria americana* growing in the Croton River. Results of genetic testing of numerous plant samples collected from the Croton River indicate very high genetic diversity at the mouth of the Croton River project site (personal communication, Katia Englehardt and Maile Neel, ND).

Cyanobacteria Testing

The cyanobacteria *Aetokthonos hydrillicola* grows on the undersides of hydrilla leaves and is incidentally consumed by waterfowl that in turn are consumed by raptors and other waterfowl, including bald eagles. *A. hydrillicola* contains a toxin that causes a neurological breakdown producing unique holes in the brain and spinal cord and then death. (Wilde et al. 2005). In autumn 2016, a member of the Croton River Task Force and resident of Croton-on-Hudson collected samples of hydrilla from the Croton River and sent them to Dr. Susan Wilde at University of Georgia. No cyanobacteria was found on the samples. DEC plans to submit samples on a regular basis to determine the presence of this bacteria. More information about this research can be found at <https://www.warnell.uga.edu/research/dr-susan-wilde-avm-research>.

Information About Fluridone

The product: Fluridone was first registered with the EPA in 1986 and has been used in New York since 1996. Sonar® Genesis has no label restrictions for swimming. It is an extremely selective chemical that works by destroying aquatic plant pigments, rendering them unable to produce food. The product is restricted for use for irrigation at concentrations above 1 ppb for greenhouse plants and at 5 ppb for turf grass, based on label requirements. The concentrations used for the Croton River Hydrilla Control Project (2–4 ppb) are well below NYSDOH Maximum Contaminant Level (MCL) of 50 ppb (considered an unspecified organic contaminant) and far below the EPA label's maximum allowable application rate of 150 ppb (SePRO Corporation 2013). EPA Human Health Benchmarks for fluridone indicate that to show adverse health effects, a person would need to consume 41,250 ppb one-day exposure (drinking water only) or 1,050 ppb/day lifetime exposure through drinking water, consuming food, breathing in volatilized herbicide, or coming into physical contact with the liquid herbicide <https://iaspub.epa.gov/apex/pesticides/f?p=HHBP:home>. No reproductive or neurotoxic effects from fluridone were found in reviewed studies and fluridone is not likely to be carcinogenic to humans (EPA 2004a).

Fluridone does not persist in the environment or bioaccumulate in aquatic organisms or the soil. Photodegradation is an important loss pathway for fluridone, meaning the chemical is destroyed when exposed to sunlight. Fluridone is stable to hydrolysis, volatilizes slowly from water and adsorbs to suspended solids and sediments. Fluridone has low potential to leach into groundwater and is not known to contaminate groundwater (Oregon BLM, 2009).

In addition, fluridone and endothall treatments have been conducted at Cayuga Lake Inlet, Tompkins County, NY since 2011 in a high-recreational use area without reported adverse effects. In the Eno River (Durham County, NC) fluridone is used to control hydrilla in flowing water adjacent to drinking water intake and a popular swimming locale (North

Carolina Division of Public Health 2015). In 2000, a study done by the Washington State Department of Ecology concluded that the use of fluridone according to label instructions does not pose any effect to human health (Washington State Department of Ecology 2000).

Breakdown products: N-methyl formamide (NMF) is the major breakdown product of fluridone in waterbodies. Research in the field suggests that NMF is undetectable in water treated with fluridone at the maximum application rate (150 ppb) (USEPA 2004). The drinking water margins of exposures (MOEs) for fluridone are $\geq 7,500$ and exceed the target MOE of 100 which means that the drinking water exposure is well below the USEPA level of concern (2004). The State of North Carolina Public Health assessment of the Eno River Hydrilla Management Project did consider NMF with some dissipation scenarios and still determined that there was negligible risk to human health (North Carolina Division of Public Health 2015).

Inert ingredients: 93.7% of the ingredients in Sonar® Genesis are not fluridone, which is the active ingredient in Sonar® Genesis. The inert ingredients are considered confidential business information and cannot be released by the DEC. USEPA does approve inert ingredients to be used in products and NYSDOH checks products to see what the inert ingredients are. NYSDOH does not conduct a human health review associated with these ingredients. Information on inert ingredients can be found on the EPA's website at: <https://www.epa.gov/pesticide-registration/inert-ingredients-overview-and-guidance>.

Interaction with disinfectants: The Village of Croton-on-Hudson uses a chlorination process to disinfect its water. Fluridone is not affected by the chlorination process in typical water treatment protocols (personal communication, Mark Heilman SePRO ND). On a related note, because there is no oxidation by chlorine in this process, there are no chlorinated byproducts associated with low-level fluridone in source water. Low-level concentrations of the herbicide can be further removed using activated carbon in the treatment process.

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