Hudson River Hydrilla Survey

2015 Hydrilla Monitoring in the Croton River (NY) and Nearby Waters (Hudson River)

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New England Interstate Water Pollution Control Commission
New York State Department of Environmental Conservation

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Hudson River, New York

Introduction

In late October 2013, a New York Botanical Garden Project survey team discovered hydrilla (*Hydrilla verticillata*) in the Croton River System while conducting a rare species inventory. Hydrilla is a highly invasive submersed aquatic plant that can result in significant negative ecological, recreational and economical impacts. Hydrilla is a relatively new invader to New York, with known populations on Long Island (eight sites), in a small pond in Orange County, and several small private ponds in Broome County. Extensive infestations have been documented in the Cayuga Lake Inlet (Tompkins County) and the Erie Canal/Towanda Creek (Towanda, Erie and Niagara Counties). In 2014, Allied Biological, Inc. conducted a detailed aquatic macrophyte inventory of the Croton River System, located in the Village of Croton-on-Hudson (Westchester County). During the survey, 354 GPS referenced locations, divided into nine sections, were sampled for the presence of aquatic macrophytes. The study found that *Hydrilla* is well established throughout the entire length of the Croton River (Allied Biological, 2014). Rooted *Hydrilla* with tubers was also confirmed in the New Croton Reservoir in November, 2014.

The goal of this project is to characterize the submersed aquatic vegetation (SAV) within the Croton Bay, and identify the extent of *Hydrilla verticillata* at selected locations (tidal waters of the Hudson River, tributaries, and upland waters) from the Croton Bay and nearby waters, upstream to Kingston, NY, and to gather information about plant condition (abundance, distribution, tuber bank status) that may be utilized in the formulation of future management strategies. A combination of visual surveys and Point Intercept Methodologies (PIM) were utilized to characterize the SAV and extent of *Hydrilla* in the sampling locations. Tuber monitoring was conducted by North Carolina State University staff in the Croton River and Bay, as part of this project.

Procedures

The Point Intercept Method of sampling aquatic macrophytes is accepted by lake managers as a suitable procedure to map submersed aquatic macrophytes in a lake. The PIM is designed to be utilized by volunteer and citizen science groups, and is the method preferred by the NYSDEC. As

best we could, the methods utilized during the 2014 Croton River Hydrilla Delineation Project (conducted by Allied Biological) was employed for this project for consistency. Prior to conducting that project in 2014, we reviewed the *2013 Monitoring Report of the Cayuga Inlet and Southern Cayuga Lake Monoecious Hydrilla Eradication Project* (Johnson, 2014) to develop similar surveying protocols for that project, which were in turn applied to this study.

The total number of sample locations is typically based on the total acreage of the lake or site. As a rule of thumb, one sample location per acre is preferred at a minimum. This project specified 200 meter by 200 meter grids, with a minimum of six GPS-referenced sites per location. The standard grid size used during the Cayuga Inlet monitoring was a 50 meter by 50 meter grid (Racine-Johnson Aquatic Ecologists, 2014), and this size grid was utilized during the Croton River monitoring in 2014 (Allied Biological, 2014). Thus, it can be assumed that a 50 meter by 50 meter grid is the standard practice for *Hydrilla* monitoring efforts in New York. For this project, we attempted to use a 50 meter by 50 meter grid at as many sites as feasible. However, due to the surface acreage of some sites, and the limited duration to conduct the surveys at all 40+ locations, we had to employ 100 meter by 100 meter grids, or even a few 200 meter by 200 meter grids, at larger sites.

For this project, a variety of habitats along the Hudson River were be surveyed. These sampling locations are summarized in Table 1. This table includes the date of the survey, the name of the actual location to be surveyed, our estimated acreage of the location, the grid size we intend to utilize for sampling, and the estimated number of sampling sites at each location. If two numbers (such as 50/100) appear in the grid column it denotes that two different grid sizes were employed for that particular site.

Before beginning the survey at a location, random sample sites were plotted on a grid overlay map of the target areas focusing on the littoral areas and areas supporting visible SAV beds, based on available bathymetry data, aerial photographs, and anecdotal information on the SAV from project managers. Most on-water surveys were conducted via canoe due to the habitat (tidal fluctuations, limited water depth and clearance under railroad bridges and rocks), and access options. Larger gas-powered motor boats were used to conduct surveys at locations with suitable access and no habitat restrictions. The survey in the Croton Bay was conducted via airboat, and the tuber monitoring was conducted via a power motor boat.

On arrival at a suitable sample site, the GPS coordinates of the sample site were recorded using a Trimble GeoXH 2008 series handheld GPS unit with sub-meter accuracy. The water depth was measured- using a handheld depth gun (HawkEye digital sonar system, or equivalent) - or a calibrated metal pole, as appropriate to the conditions. The water depth was recorded on a field log, along with any other pertinent field notes (such as floating fragments of aquatic plants or established beds of SAV observed nearby but not sampled).

Table 1: Summary of 2015 Location Surveyed for Hydrilla along the Hudson River

#	Date	Location	Acreage	Grid (m)	# Sites
1	8/17/15	Bowline Point Park	72.9	100	35
2	8/18/15	Nyack Memorial Park BLS	5.0	50	16
3	8/18/15	Haverstraw Bay Park	13.7	50	26
4	8/18/15	Haverstraw Marina	58.0	100	16
5	8/19/15	Minisceongo Yacht Club	15.3	50	35
6	8/20/15	Cedar Brook Pond	82.0	100	41
7	8/24/15	Half-moon Bay	76.7	50/100	66
8	8/25/15	Georges Island Park	31.0	50	60
9	8/26/15	Piermont Marsh	330.0	50/100	80
10	8/27/15	Popolopen Creek	13.0	50	35
11	8/28/15	Viking Boat Yard	20.0	50	37
12	8/31/15	Lent's Cove	39.0	50	57
13	8/31/15	Dickie Brook	5.7	50	20
14	9/1/15	Newburgh Boat Launch Site	5.2	50	12
15	9/1/15	Front Street Marina	7.2	50	16
16	9/1/15	Sloop Hill Boat Launch Site	3.5	50	15
17	9/2/15	Croton Bay	639.0	200	71
18	9/3/15	Annsville Creek	144.5	100	75
19	9/8/15	Riverfront Green Park	43.8	50	49
20	9/8/15	Peekskill Land Park	19.0	50	30
21	9/9/15 & 9/23/15	Iona Marsh	152.0	100/200	69
22	9/14/15 & 9/23/15	Moodna Creek	13.0	50	16
23	9/14/15	Moodna Creek Bay	49.0	50	68
24	9/16/15 & 9/17/15	Constitution Marsh	358.0	100	88
25	9/17/15	Foundry Cove Bay	6.75	50	12
26	9/17/15	Foundry Cove	41.5	50	64
27	9/18/15	Denning's Point Cove	91.7	100	35
28	9/18/15	Riverfront Park	31.0	50	53
29	9/21/15	Wappinger's Creek	94.3	100	50
30	9/22/15	Norrie State Park	28.0	50	50
31	9/24/15	Waryas Park	7.3	50	14
32	9/24/15	Poughkeepsie Yacht Club	39.0	50	40
33	9/24/15	Hyde Park Marina	4.2	50	18
34	9/25/15	Black Creek Preserve	36.0	50	48
35	9/28/15	Fishkill Creek Bay	111.7	100	50
36	9/28/15	Fishkill Creek	41.7	50	47
37	9/29/15	Chelsea Boat Launch Site	7.0	50	24
38	9/29/15	Shepherds Landing/Mariner's on Hudson	8.0	50	15
39	10/5/15	Charles Rider Boat Launch Site	24.0	50	35
40	10/5/15	Marlboro Yacht Club	13.7	50	34
41	10/6/15	Sleightsburg Park	224.0	100	100
42	10/7/15	Vanderbilt Mansion Cove	10.0	50	27
43	10/7/15	Vanderburgh Cove	98.6	100	42
44	10/9/15	Scarborough Park	0.7	50	6
45	10/9/15	Kemey's Cove	12.0	50	30
46	10/15/15	Kingston Point Park Marsh	31.0	50	29

Next, a weed anchor was attached to a 10 meter-long piece of rope that was tossed from a random side of the boat. The weed anchor used for aquatic macrophyte surveys has a specific design. It is constructed with two 13.5-inch wide metal garden rakes attached back to back with several hose clamps. The wooden handles are removed and a 10 meter-long nylon rope is attached to the rake heads. We ensured the weed anchor was tossed the full 10 meters (a loop at the end of the rope is attached to the boat to prevent losing the anchor). The weed anchor was slowly retrieved along the bottom, and carefully hoisted into the boat. To determine the overall submersed vegetation quantity, the weed mass is assigned one of five densities, based on semi-quantitative metrics developed by Cornell University (Lord, et al, 2005). These densities are: **No Plants** (empty anchor), **Trace** (one or two stems per anchor, or the amount that can be held between two fingers), **Sparse** (three to 10 stems, but lightly covering the anchor, or about a handful), **Medium** (more than 10 stems, and covering all the tines of the anchor), or **Dense** (entire anchor full of stems, and one has trouble getting the mass into the boat). These densities are abbreviated in the field notes as 0, T, S, M, and D. Next, the submersed weed mass was sorted by species and one of the five densities (as described above) was assigned to each species. At all priority locations and all sites, all SAV will be identified as part of this study. This procedure was then repeated for the remaining sample points. A minimum of six sample sites were surveyed at each location.

Following methods established at Cayuga Lake Inlet for the monitoring of *Hydrilla*, we utilized two anchor tosses per site. The tosses were conducted from opposite sides of the canoe or boat and were labeled Toss A, and Toss B, respectively. For reporting, each anchor toss density was assigned a numeric value: 0 for no plants, 1 for trace, 2 for sparse, 3 for medium, and 4 for dense plants. These mean values were then used to assign overall densities, and are depicted on the distribution maps in the Appendix of the final report. For example, if toss A was dense density (4), and toss B was sparse density (2) for the same macrophyte, the mean density would be medium (4+2=6/2=3). Although using two tosses is ideal for detecting the presence of target species (and species occurring infrequently), these procedures and associated calculations tend to decrease the overall abundance per site.

If identification of a plant species was questionable, voucher specimens were collected in labeled Ziploc-type bags and returned to Allied Biological's lab for identification confirmation. Any submersed aquatic plants collected that might be Rare, Threatened or Endangered, were verified in-lab, and/or voucher specimens were shipped to regional experts.

Hydrilla Tuber Monitoring

Hydrilla tuber monitoring was conducted by staff from North Carolina State University, with assistance by Allied Biological. Tuber monitoring was conducted on October 13th at seven permanent sampling sites in the Croton Bay and River. All tuber monitoring sites were GPS-referenced. The number of cores collected per site varied based on substrate and tuber density, but a minimum of six per sampling location were collected. Sampling was conducted using a 10.2 cm diameter sediment core puller modified from Sutton (1982). Each core sample was roughly 0.008 m^2. Harlan et al. (1985) reported that 93% to 100% of monoecious hydrilla

tubers were found in the top 12 cm of hydrosoil, therefore, the target depth for each sample was approximately 20 cm. All core samples were sifted through 3 mm wire screen using a high volume water pump system. All tubers and turions were collected on site, counted, and recorded by category/site.

Submersed Aquatic Macrophyte Summary

There are many factors that play a role in determining the suitability of habitat to submersed aquatic plant (SAV) communities. And these factors are even more crucial in a dynamic system such as the Hudson River and nearby associated waters. Tidal influence (water depth fluctuation in addition to salinity in lower parts of the river), turbidity, wind, bottom substrate and shoreline composition all conspire to limit established SAV along many locations of the Hudson River. It also can't be underestimated the role recent intense storms (Hurricane Irene and Tropical Storm Lee in 2011, and Super Storm Sandy in 2012) have had on the SAV communities in the Hudson River valley and specifically in the Croton River Watershed.

The following aquatic macrophytes (except Hydrilla) were collected during this project in 2015. The respective aquatic macrophyte percent abundance data are summarized in tables located in Appendix A organized by location. The distribution of all the aquatic macrophytes is summarized in Table #48, following the individual location summaries. In addition, the distribution of each individual macrophyte is depicted on separate maps located in Appendix B of this report, organized by location. Below is a short description and a picture of each macrophyte. Twenty seven aquatic macrophytes (plus stonewort and benthic filamentous algae) were collected during the 2015 survey.

The brief summaries that follow are organized according to overall (all sections) percent occurrence. When possible, pictures of aquatic macrophytes represent the actual plants located at the one of the sampling locations in the Hudson River, either taken in the field, or from samples returned to Allied Biological's laboratory. All other photos are from the archives at Allied Biological. **Please note that although Hydrilla was not found at any locations surveyed during this project, a summary is provided for informational purposes.**

Hydrilla (*Hydrilla verticillata*) Common Name: Hydrilla, waterweed. **Exotic, aggressive, Invasive.)** : Hydrilla is native to parts of Asia, and was introduced to the Northeast region in the mid-1900's. Hydrilla is the perfect weedy species, able to outcompete desirable native species due to an array of adaptations. These include growing in a variety of substrates, moving or still waters, tolerating up to 10 ppt salinity, and adept at low-light growth. It is typically rooted in the substrate, but can persist in drifting mats. Although similar to common waterweed, hydrilla has strongly serrated leaves (visible with the naked eye), and has a barbs on the underside of the midrib. The leaves are typically arranged in whorls of 4 to 8, but lower parts of the plant can be in whorls of three, or even opposite in arrangement. Hydrilla readily reproduces via stem fragmentation, and produces turions and hardy tubers to overwinter. Two distinct forms occur in the Northeast: monoecious (generally found in the north) and dioecious (generally more robust and found in southern climes.

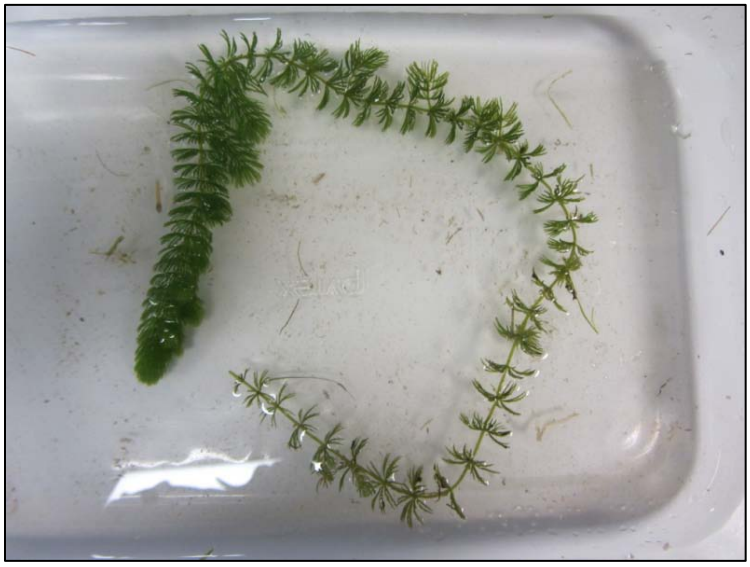
Eurasian Water Milfoil (*Myriophyllum spicatum*. Common Names: Asian Water milfoil. **Aggressive, Exotic, Invasive**.): Eurasian water milfoil has long (2 meters or more) spaghetti-like stems that grow from submerged rhizomes. The stems often branch repeatedly at the water's surface creating a canopy that can crowd out other vegetation, and obstruct recreation and navigation. The leaves are arranged in whorls of 4 to 5, and spread out along the stem. The leaves are divided like a feather, resembling the bones on a fish spine. Eurasian water milfoil is an exotic originating in Europe and Asia, but its range now includes most of the United States. It's ability to grow in cool water and at low light conditions gives it an early season advantage over most other native submersed plants. Although it can reproduce via fruit production, it typically also reproduces via fragmentation.

Wild Celery (*Vallisneria americana*. Common Names: Wild celery, eel-grass, tape-grass. **Native**.): Wild Celery has long flowing ribbon-like leaves that have a basal arrangement from a creeping rhizome. The leaves can be up to two meters long, have a cellophane-like texture, with a prominent center stripe and finely serrated edges. The leaves are mostly submersed, although they can reach the surface allowing the tips to trail. Male and female flowers are produced on separate plants, but reproduction is usually via over wintering rhizomes and tubers. Wild celery usually inhabits hard substrate bottoms in shallow to deep water. It can tolerate a wide variety of water chemistries. Wild celery is the premiere food source for waterfowl, which greedily consume all parts of the plant. Canvasback ducks (*Aythya valisneria*) go so far as to alter their migration routes based on its abundance. Extensive beds of wild celery are considered excellent shade, habitat and feeding opportunities for fish, and commonly are used in submersed vegetation restoration projects due to its availability ease of growth and high quality.

Brittle Naiad (*Najas minor*. Common Names: brittle water nymph, European naiad. **Exotic, Invasive.**): Brittle naiad is a submersed annual that flowers in August to October. It resembles other naiads, except its leaves are highly toothed with 6-15 spinules on each side of the leaf, visible without the aid of magnification. The leaves are opposite, simple, thread-like, and usually lime-green in color, often with a "brittle" feel to them. Brittle naiad fruit are narrow, slightly curved, and marked with 10-18 longitudinal ribs, resembling a ladder. Brittle Naiad has been introduced from Europe in the early 1900's, and can be found in most of the northeastern states. Brittle naiad prefers sandy and gravel substrates, but can tolerate a wide range of bottom types. It's tolerant of turbid and eutrophic conditions. Waterfowl graze on the fruit.

Common Waterweed (*Elodea canadensis*: Common Names: elodea, common waterweed. **Native.**): Common waterweed has slender stems that can reach a meter in length, and a shallow root system. The stem is adorned with lance-like leaves that are attached directly to the stalk that tend to congregate near the stem tip. The leaves are populated by a variety of aquatic invertebrates. Male and female flowers occur on separate plants, but it can also reproduce via stem fragmentation. Since common waterweed is disease resistant, and tolerant to low-light conditions, it can reach nuisance levels, creating dense mats that can obstruct fish movement, and the operation of boat motors. There is some debate about identifying Elodea to species in New York. *Elodea canadensis* can easily be confused with *Elodea nuttallii* (slender waterweed), which also occurs throughout the state. For the purposes of this study, waterweed samples collected were assumed to be *E. canadensis*.

Water Stargrass (*Zosterella dubia* (=*Heteranthera dubia*): Common Name: Water stargrass. **Native.**)): Water stargrass has slender free-branched stems that originate from rhizomes. The leaves are narrow and alternate, attaching directly to the stem. Leaves can be up to 15 cm long, and lack a prominent midvein, a distinguishing characteristic. Water stargrass can inhabit a wide range of water depths and sediment types, and can tolerate reduced clarity environments. Yellow star-shaped flowers are produced by midsummer, but reproduction is usually via over wintering rhizomes. Water stargrass is a locally important waterfowl food source, and provides suitable cover and foraging for fish.



Coontail (*Ceratophyllum demersum*. Common Names: coontail, hornwort. **Native**.): Coontail has long trailing stems that lack true roots, although it can become loosely anchored to sediment by modified leaves. The leaves are stiff, and arranged in whorls of 5-12 at each node. Each leaf is forked once or twice (only), and has teeth along the margins. The whorls of leaves are spaced closer at the end of the stem, creating a raccoon tail appearance. Coontail is tolerant of low light conditions, and since it is not rooted, it can drift into different depth zones. Coontail can also tolerate cool water and can over winter as a green plant under the ice. Typically, it reproduces via fragmentation. Bushy stems of coontail provide valuable habitat for invertebrates and fish (especially during winter), and the leaves are grazed on by waterfowl.

Benthic Filamentous Algae: Filamentous algae is a chain or series of similar algae cells arranged in an end to end manner. Benthic filamentous algae is attached to a hard substrate, such as logs, rocks, a lake bottom, or even other aquatic plants. When growing in heavy densities, benthic filamentous algae can appear as brown or green mats of vegetation that can reach the surface. When large pieces break off the bottom substrate they become floating filamentous algae patches. Benthic filamentous algae can comprise an entire range of morphologies, but flagellated taxa are far less common.

Heart Pondweed (*Potamogeton perfoliatus:* Common Names: Redhead pondweed, heart pondweed, perfoliate pondweed. **Native**.): Heart pondweed is similar to other clasping-leaf pondweeds. The alternate leaves of heart pondweed tend to be shorter (ranging from 1 to 6 cm), somewhat rounded, and completely wrap around the base of the stem, the latter being a distinguishing characteristic. Leaves typically have 7-15 veins. Stipules are present, but tend to disintegrate later into the season. Floating leaves are not produced, but cylindrical flower spikes adorned with fruit are produced. Fruits have a short beak and 3 indistinct dorsal ridges. Heart pondweed prefers clear soft water, but can occur in shallow or deep water, with a preference for sandy substrates.

Slender Naiad (*Najas flexilis*: Common Names: slender naiad, bushy pondweed. **Native**.): Slender naiad has fine-branched stems that can taper to lengths of one meter, originating from delicate rootstalks. Plant shape varies; sometimes compact and bushy, other times long and slender, depending on growing conditions. The leaves are short (1-4 cm long) and finely serrated (magnification required), tapering to a point. It is found in a variety of habitats, and can colonize sandy or gravelly substrates. If conditions are ideal, it can reach nuisance densities. It is a true annual, and dies off in the fall, relying on seed dispersal to return the next year. It is an important food source for waterfowl.

Northern Naiad (*Najas gracillima*: Common Name: northern naiad. **Native.**) Northern naiad has fine branched stems that can reach lengths of up to one meter. These stems emerge from a delicate rootstalk. The leaves are thread-like with a jagged lobed base, a distinguishing characteristic from other naiad species. The leaves are usually in pairs, but can be bunched at the ends of stems. Growing conditions can affect the overall structure of northern naiad growth. Reproduction is by seed production and stem fragmentation. Seeds are light brown with 20 to 45 rows of stretched pits, another consistent distinguishing characteristic. Northern naiad prefers soft-water lakes or sluggish streams, and is extremely sensitive to pollution. Like other naiads, northern naiad is an important food source for waterfowl, as the seeds, stems and leaves are all consumed. The submersed growth is also prime food and shelter for fish.

Sago Pondweed (*Stuckenia pectinata*: Common Name: Sago, Sago Pondweed. **Native.**). The stems of sago pondweed originate from fine rhizomes studded with starchy tubers. The leaves are three to 10 cm long and very thin, resembling pine needles, complete with a sharp point. The branches often are forked several times, resulting in a fan-like arrangement. Stipules are fused to the leaves creating a stipular sheath. Flowers and fruit are produced on a slender stalk that can be submersed, or float on the water. Sago pondweed is widespread, and often inhabits water one to two meters deep. It can tolerate a variety of sediment types and a wide range of water conditions. It is adapted to thrive in low-light, high turbid conditions, and is often the last surviving plant when such conditions persist for an extended amount of time. Sago pondweed is considered a top food producer for waterfowl, which graze heavily on its fruit and tubers. Juvenile fish also utilize sago pondweed as a food source and shelter.

Long-leaf Pondweed (*Potamogeton nodosus*. Common Name: Long-leaf pondweed. **Native.**): Long-leaf pondweed has stems up to two meters long that originate from a branching rhizome. Submersed leaves can be up to 30 cm long, lance-shaped, and taper to a long leaf stalk. Floating leaves also taper on long leaf stalks, which distinguish this pondweed from other similar pondweed species. Flowers and fruit are produced on a thick cylindrical spike. Fruits are somewhat oval, have a short beak, and a lumpy dorsal ridge. Long-leaf pondweed prefers flowing water versus lakes. It inhabits a variety of sediments and can tolerate eutrophic conditions and turbid water. Long-leaf pondweed fruit are grazed on by waterfowls, and portions of the plant are eaten by muskrat, beaver, deer and even moose. Long-leaf pondweed offers excellent invertebrate habitat. Researchers estimate a 20 by 60 meter standing patch can support 33 million invertebrates.

Giant Arrowhead (*Sagittaria montevidensis*. Common Names: giant arrowhead, California arrowhead, hooded arrowhead, long-lobed arrowhead. **Native, Rare.**): Giant arrowhead is a robust submersed plant that eventually emerges above the water's surface. Submersed growth is a spongy rosette form, while emergent leaves are arrow-shaped. It is in the water plantain family. Its spongy petioles can reach 2.5 feet long. Tiny flowers (~2.5 cm) occur in whorls or pairs at nodes. Flowers have three white petals with a striking purple staining. Flowering occurs from June to October. Fruit are flattened, with a distinct wing. Although it occurs in a widespread area on North America, its distribution is disjunct with isolated occurrences in New York and New Jersey. It typically grows along stream or lake margins or in tidal freshwater wetlands. There are several subspecies, one of which (*S. montevidensis* var. *spongiosa)* is on the New York State Active Inventory Rare Plant List. It is considered Threatened and carries a state rank of S2 (imperiled with 6-20 sites).

Curly-leaf Pondweed (*Potamogeton crispus*. Common Name: curly-leaf pondweed. **Exotic, Invasive.**): Curly-leaf pondweed has spaghetti-like stems that often reach the surface by mid-June. Its submersed leaves are oblong, and attached directly to the stem in an alternate pattern. The margins of the leaves are wavy and finely serrated, hence its name. No floating leaves are produced. Curly-leaf pondweed can tolerate turbid water conditions better than most other macrophytes. In late summer, curly-leaf pondweed enters its summer dormancy stage. It naturally dies off (often creating a sudden loss of habitat and releasing nutrients into the water to fuel algae growth) and produces vegetative buds called turions. These turions germinate when the water gets cooler in the autumn and give way to a winter growth form that allows it to thrive under ice and snow cover, providing habitat for fish and invertebrates.

Horned Pondweed (*Zannichellia palustris*. Common Name: Horned Pondweed. **Native.**): Horned pondweed has slender stems as fine as fish line, which originate from delicate rhizomes. The leaves are long and equally slender, situated in an opposite arrangement on the stem, although they can appear whorled near the ends of the stem. Abundant flattened fruit are produced that have a slightly curved wavy margin and a persistent beak. This delicate submersed plant is often overlooked as it is buried in silt or mud. It can be found in shallow zones to water several meters deep. Horned pondweed relies on seed production to over winter. The fruit and the foliage are grazed upon by waterfowl, and it is also a fair food source for trout.

White Water Lily (*Nymphaea* sp. Common Name: white water lily, fragrant water lily. **Native.**): White water lily leaf stalks emerge directly from a submerged fleshy rhizome. White water lilies have round floating leaves. Flowering occurs during the summer, and the flowers open during the day, and close during the night. Water lilies typically inhabit quiet water less than two meters deep, such as ponds, shallow lakes and slow-moving streams. The leaves offer shade and protection for fish, and the leaves, stems, and flowers are grazed upon by muskrats, beaver, and sometimes even deer.

Spatterdock (*Nuphar variegata*. Common Name: yellow pond lily, bullhead pond lily, spatterdock. **Native.**): Spatterdock leaf stalks emerge directly from a submerged fleshy rhizome. Spatterdock has heart-shaped leaves with a prominent notch. Depending on the habitat, these leaves can be held aloft via erect stems. A distinguishing characteristic of spatterdock is the leaf stalk, which bears a winged margin. Flowering occurs in the summer and, the flowers open during the day and close at night. Spatterdock typically inhabits quiet water less than two meters deep with a soft substrate, such as ponds, shallow lakes and slow-moving streams. The leaves offer shade and protection for fish, and the leaves, stems, and flowers are grazed upon by muskrats, beaver, and sometimes, even deer.

Water Moss (*Fontinalis* sp. Common Name: water moss. **Native.**): Water mosses are submerged mosses that are attached to rocks, trees, logs, and other hard substrates by false rootlets located at the base of their stems. The stems are dark-green to brown, and about one foot long. The leaves share a similar color as the stems, and are usually ovate with fine-toothed margins. Water moss is utilized by aquatic invertebrates, and as a breeding site for small fish. Water moss rarely reaches nuisance levels.

Common Watermeal (*Wolffia columbiana*. Common Names: common watermeal. **Native.**): Common watermeal appears as pale green globes of vegetative matter without roots, stems or true leaves. It's one of the world's smallest flowering plants, but flowers are rarely found and require magnification to see. Watermeal usually reproduces by budding. Watermeal is typically found on the surface, intermingled with duckweeds. It drifts with the water's current or wind, and therefore it grows independent of water depth, clarity or sediment type. In the fall it produces winter buds that sink to the bottom. In the spring, the buds become buoyant and float to the surface. Waterfowl, fish, and muskrats all include watermeal in their diets.

Small Duckweed (*Lemna minor.* Common Names: Small duckweed, water lentil, lesser duckweed. **Native.**). Small duckweed is a free floating plant, with round to oval-shaped leaf bodies typically referred to as fronds. The fronds are small (typically less than 0.5 cm in diameter), and it can occur in large densities that can create a dense mat on the water's surface. Each frond contains three faint nerves, a single root (a characteristic used to distinguish it from other duckweeds), and no stem. Although it can produce flowers, it usually reproduces via budding at a tremendous rate. Its population can double in three to five days. Since it is free floating, it drifts with the wind or water current, and is often found intermixed with other duckweeds. Since it's not attached to the sediment, it derives nutrients directly from the water, and is often associated with eutrophic conditions. It over winters by producing turions late in the season. Small duckweed is extremely nutritious and can provide up to 90% of the dietary needs for

waterfowl. It's also consumed by muskrat, beaver and fish, and dense mats of duckweed can actually inhibit mosquito breeding.

Great Duckweed (*Spirodela polyrhiza*. Common Names: Great duckweed, large duckweed. **Native.**). Great duckweed is the largest of the duckweeds, but it is still very small compared to other aquatic macrophytes. It has simple flattened fronds with irregular oval shapes, often up to 1 cm in length and 2.5 to 8.0 mm long. The frond surface is usually green with a conspicuous purple dot. The underside of the frond is magenta with a cluster of 5-12 roots that dangle into the water. Indeed, peering at great duckweed from under the water grants it the appearance a tiny jellyfish. Although great duckweed produces flowers, it usually reproduces via budding, and like other duckweeds, it is capable of rapid growth. It often occurs with other duckweeds, and since it is free floating, it can be moved via the wind or water currents. It derives its nutrients from the water column and often occurs in eutrophic systems. It's an excellent food source for waterfowl, and is also used by muskrat and fish. The dense mats offer shade and cover for fish.

Water Fern (*Azollo caroliniana*. Common Names: mosquito fern, duckweed fern, fairy moss, water velvet. **Native.**). Water fern is a reduced fern that floats on the surface of the water, similar (and often found intermixed with) duckweeds. It is native to eastern North America. It has scale-like fronds that are green with a reddish tint at the edges. It displays more of a reddish color late in the season or in the winter. The fronds are coated with fine hairs, giving it a velvety appearance and texture. Water fern can fix nitrogen from the air via symbiotic cyanobacteria. Water fern is a very efficient reproducer (both sexual, and asexual, via division) and can double its biomass in a few days to a week. It often develops dense surface mats under ideal growing conditions, which

can shade out submersed aquatic plants and cause oxygen depletion. Although not generally consumed directly by wildlife, water fern mats provide excellent habitat for microscopic organisms, which are often consumed by aquatic biota.

Small Bladderwort (*Utricularia minor*. Common Names: Small bladderwort, lesser bladderwort. Native.). Small bladderwort is a free floating aquatic perennial herb. The delicate stems can be both floating and creeping usually, no more than 75 cm long. The leaves are linear, flat, and bristle-tipped, generally three parted at the base and forked three to seven times. The stem is densely lined with leaves bearing the bladders. The bladders are used to capture prey, such as protozoa, zooplankton, and even small insect larvae. Small yellow snap dragon-like flowers are produced. Since it is free floating, and it derives nutrients from captured prey, it can inhabit low nutrient waters. It is not limited to substrate type, water clarity, or water depth, due to its lack of roots, but it is at the mercy of wind or water currents. Thus it prefers the shallow quiet waters of lakes, ponds and sluggish stream margins, or among stands of lilies at the surface.

Stonewort (*Nitella* sp. Common Names: stonewort, nitella. Native.): Stonewort is actually a multi-branched algae that appears as a higher plant. It lacks conductive tissue and roots, using simple anchoring structures called rhizoids. Stem lengths can reach 0.5 meters, and leaves are arranged in whorls. Although similar in appearance to muskgrass, stonewort has smooth stems and branches, and lacks the distinct musky odor. Nitella inhabits soft sediments in the deeper water of lakes. It can be found as deep as 10 meters. Fish and waterfowl graze on Stonewort.

Arrowhead (Submersed Rosette) (*Sagittaria* sp. Common Name: Arrowhead. Native.): This plant is the submersed rosette of a species of arrowhead. The submersed rosette lacks both flowers and seeds, so further identification is not possible. Arrowhead has emergent leaves, and usually inhabits shallow waters at pond or lake edges, or along

sluggish streams. It can tolerate a wide variety of sediment types and pH ranges. Arrowhead is very suitable for constructed wetland development due to its tolerance of habitats, and ability to act as a nutrient sink for phosphorous. Typical arrowhead reproduction is via rhizomes and tubers although seed production is possible if conditions are ideal. Arrowhead has high wildlife value, providing high-energy food sources for waterfowl, muskrats and beavers. Arrowhead beds provide suitable shelter and forage opportunities for juvenile fish as well.

Spikerush (*Eleocharis* sp.: Common Names: hairgrass, spikerush. **Native.**): The stems of spike rush are usually slender and short (up to 12 cm long), but certain species can have stems that are about one meter long. The stems emerge in tufts from fine spreading rhizomes. Sometimes the stems are topped with a spikelet of a tight spiral and flowers and eventually nutlets. The nutlets widely vary in surface patterns, and this characteristic is needed for identification to species level. There is also a sterile form of at least one genus that is completely submerged and usually found away from the shoreline. Spikerush prefers firmer substrates, and can tolerate turbid conditions. The leaves provide suitable food for waterfowl, and excellent habitat and shelter for aquatic invertebrates.

Bass Weed (*Potamogeton amplifolius*. Common Names: Large-leaf Pondweed, Bass Weed, Musky Weed. **Native.**): Bass weed has robust stems that originate from black-scaled rhizomes. The submersed leaves of bass weed are among the broadest in the region. The submersed leaves are arched and slightly folded, attached to stems via stalks, and possess many (25-37 veins). Floating leaves are produced on long stalks (8-30 cm). Stipules are large, free and taper to a sharp point. Flowers, and later in the season fruit are densely packed onto a spike. Bass weed prefers soft sediments in water one to 4 meters deep. This plant is sensitive to increased turbidity and also has difficulty recovering from top-cutting, from such devices as boat propellers and aquatic plant harvesters. As its name implies the broad leaves of this submersed plant provides abundant shade, shelter

and foraging opportunities for fish. The high number of nutlets produced per plant make it an excellent waterfowl food source.

Ditch Grass *(Ruppia maritima*. Common Names: tasselweed, tassel pondweed, widgeon grass. **Native.**): Ditch grass leaves emerge from a shallow root system. The leaves are slender but stiff, with an expanded open sheath at the base. Flowers are produced on an elongate stalk, often spirally twisted. As the fruits mature, they are elevated on an umbrella-like structure called an umbel. The flower/fruit stalks are a distinguishing characteristic that sets this macrophyte apart from closely related thin-leaved pondweeds and horned pondweed. Ditch grass is usually found in brackish, slightly saline, or very alkaline waters. Its range includes locations along the coast, but select inland sites as well. It can grow in water several meters deep. It overwinters by seed or rhizome. Ditch grass foliage and seeds are highly sought after and consumed by a wide variety of water fowl. Ditch grass is also considered high quality habitat and high quality food for fish.

Submersed Aquatic Plant Abundance and Distribution Discussion by Location

Below is a summary discussion of our results organized according the location, sorted alphabetically. Please refer to the map bundle of the specific location while reviewing this section. Also please note that "location" refers to the overall area that we surveyed (ex. Annsville Creek), while "site" refers to the individual GPS-referenced points where aquatic plants were collected during the survey.

Table 2 Annsville Creek Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
18	Annsville Creek	44	9/3/15	144.5	75

Annsville Creek (Peekskill, RM 44) was surveyed on September 3rd via canoe, accessed at the Annsville Creek Paddlesport Site off Route 6. All areas surveyed were behind the railroad tracks, and accessed as far north as possible due to water depth and bridge clearance. A total of 75 sites were surveyed on this date. Sixty of the sites (or 80%) supported SAV, but most sites were at trace density (65%). Twelve sites (or 20%) were considered sparse density. Medium density sites (four, or 7%) and dense sites (five, or 8%) rounded out the distribution of SAV abundances at this location. The heaviest density plants occurred in the bay, south of the Route 6 Bridge. Eleven different aquatic plant species were collected at this location.

Eurasian water milfoil was the dominant aquatic plant collected, occurring at 37 (or 49%) of the sites surveyed. Most of the Eurasian water milfoil sites were located in the bay south of the Route 6 Bridge. Common waterweed was the second most common aquatic plant collected, at 29 (or 39%) of the sites surveyed. Most common waterweed occurrences were north of the

Route 6 Bridge, including the one dense and two sparse sites. Most sites in the upper creeks supported some common waterweed growth. All common waterweed samples were closely examined in the field or back at our laboratory to confirm identification. Coontail occurred at 33% of the sites surveyed, and wild celery occurred at 16 (or 21%) of the sites surveyed. Large established beds of wild celery (including three medium and three dense sites) occurred in the bay south of the Route 6 Bridge, especially at the east side, which appeared to be deeper water and thus less influenced by tidal fluctuations.

The following aquatic plants rounded out the assemblage at this site: horned pondweed (mostly north), northern naiad, small duckweed (only three trace sites), arrowhead rosettes (lacking flowers, so we could not identify to species), spatterdock (one site in the eastern creek finger), curly-leaf pondweed, and stonewort (a macro-algae). Due to the high diversity of SAV, suitable SAV habitat, presence of common waterweed and proximity of the location to the Croton River system, **Annsville Creek should be a high priority site for future hydrilla monitoring efforts**.

Table 3 Black Creek Preserve Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
34	Black Creek Preserve	83	9/25/15	36.0	48

Black Creek Preserve (Esopus, RM 83) was surveyed on September 25th via canoe, accessed at the Black Creek Preserve along Winding Brook Road. The creek itself was surveyed along with the cove at the mouth of the creek extending south along the Hudson River about 2,200 feet. A total of 48 sites were surveyed on this date. Twenty of the sites (or 42%) supported SAV, with most sites at trace density (65%). Four sites (or 20%) were considered sparse density. Medium density sites (2, or 10%) and a single dense site (5%) rounded out the distribution of SAV abundances at this location. The heaviest density plants occurred in the creek mouth and cove. Ten different aquatic plant species (but one was benthic filamentous algae) were collected at this location, with most individual species occurring at less than 10% of the sites surveyed.

Small duckweed (although not true SAV) was the most common aquatic plant collected or observed at this location, occurring at 14 (or 29%) of the total sites surveyed. Most (71%) were at trace density, although a medium dense site was observed along the Hudson River. A few sites (3) of great duckweed were also observed. Duckweed abundance is dictated by the winds and tides at sites along the Hudson River, and thus is considered temporal. The most common rooted aquatic plant was Eurasian water milfoil (23%) followed by brittle naiad (13%). Both of these plants occurred primarily in the creek and the cove mouth.

Two rooted patches of water chestnut were observed in the mouth of the creek. Wild Celery was collected at a single site along the Hudson River, but it was a single plant fragment, and could have been floating in the water column, or attached to other SAV. Due to the high diversity and suitable SAV habitat, **Black Creek Preserve should be a high priority for future hydrilla monitoring**. However, the creek, creek mouth and cove areas should be the focus of SAV surveys, as the margins of the Hudson did not appear to be suitable SAV habitat.

Table 4 Bowline Point Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
1	Bowline Point Park	37	8/17/15	72.9	35

Bowline Point Park (Haverstraw, RM 37) was surveyed on August 20th via canoe, accessed at the end of the parking lot of the Park. The cove was surveyed, but only the shorelines, as the open water exceeded 15 feet deep. We also surveyed the outer Hudson River Shoreline of the Park, north along the Park access road, and the creek up to a concrete spillway. A total of 35 sites were surveyed on this date. Twenty three of the sites (or 66%) supported SAV, with 43% at trace density (10) and 17% (4) at sparse density. Seven sites (or 30%) were considered medium density. Two dense sites (9%) rounded out the distribution of SAV abundances at this location. The heaviest density aquatic plants occurred in the cove, with five medium sites along the northern shore, and two more medium sites plus both dense sites scattered along the southern shore. Only three different aquatic plant species and benthic filamentous algae were collected at this location.

Eurasian water milfoil was by far the most common aquatic plant collected, occurring at 20 (or 57%) of the sites surveyed. Thirteen of the Eurasian water milfoil sites were sparse density or greater, including seven at medium density and two that were considered dense. Well established Eurasian water milfoil beds were located along the northern shore of the cove, in the western cove (especially along the southern shore) and a dense patch in the corner of the southern cove. Benthic filamentous algae occurred at nine (or 26%) of the sites surveyed, but nearly all were considered trace sites. It was most common along the western shoreline in the cove, but also at two sites in the nearby creek.

Coontail (4 sites, or 11%) and wild celery (3 sites, or 9%) rounded out the SAV we collected at this location. The coontail was restricted to four trace sites along the western shore of the cove. The wild celery occurred at three trace sites, two along the outer shoreline of the Hudson River and one along the shore at the mouth of the cove. Although the latter site was observed as a rooted bed of wild celery, the two other trace findings could have been floating fragments. Piles of accumulating fragments of wild celery were observed at the access site and occasionally while paddling in the open water along the Hudson River. Although the SAV habitat is somewhat restricted at the Bowline Point Park location, established beds of SAV were observed. Coupled with the proximity of the Croton River System (essentially on the opposite bank and slightly downstream of the Hudson River), **Bowline Point Park should be a Moderate Priority for future hydrilla monitoring efforts.**

Table 5 Cedar Pond Brook Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
6	Cedar Pond Brook	38	8/20/15	82.0	41

Cedar Pond Brook (Stony Point, RM 38) was surveyed on August 17th via canoe, accessed at the Haverstraw Kayak Launch located on Beach Road (across from the Haverstraw Marina). The marsh was surveyed north of the access point (save for a few southern points) up to the bridge over Grassy Point Road (leading to the Hudson River). One could also access this site from the Hudson River, going under the Grassy Point Road Bridge. This marsh is extensive, and future monitoring should include more sites south of the access point, and west of the unnamed bridge. This site is extremely tidal, with significant areas exposed at low tide. The tidal pull is also quite strong at locations which added to the difficulty sampling here via canoe. A total of 41 sites were surveyed on this date. Only nineteen of the sites (or 46%) supported SAV, with 63% at trace density (12) and 16% (3) at sparse density. Two sites (or 11%) were considered medium density, and two dense sites (11%) rounded out the distribution of SAV abundances at this location. The heaviest density aquatic plants occurred in the northern portion of this location, near the bridge to the Hudson River. This location was deeper and appeared to be less influenced by tidal fluctuations. We were not shocked to find SAV here, as the opposite side of the bridge (surveyed as part of the Minisceongo Yacht Club location) supported established beds of SAV. Eight different aquatic plant species were collected at this location.

Spikerush was the most common submersed aquatic plant collected at this location. However, all samples collected lacked distinguishing features, so we could not identify it to species. It occurred at 11 (or 27%) of the sites surveyed, with most (82%) being considered trace density. Spikerush was scattered along the margins of the emergent growth and at low tide some plants were exposed. Eurasian water milfoil (10 sites, or 24%) and wild celery (7 sites or 17%) were the next two most common aquatic plants collected. Most Eurasian water milfoil sites were trace density. Wild celery established beds (two medium and two dense sites) occurred in the open water at the northern end of this location.

Coontail, giant arrowhead, horned pondweed, sago pondweed, and common waterweed rounded out the aquatic plants collected at this location, but each occurred at three or fewer sites. The giant arrowhead was keyed out to species due to the presence of flowers (confirmed by C. Hellquist), and is considered a rare plant in New York (State Rank S2, Threatened). Due to the high diversity and some suitable SAV habitat, **Cedar Pond Brook should be a Moderate Priority for future hydrilla monitoring**. However, more intensive surveys should be conducted on both sides of the Grassy Point Bridge, in the marsh south of the access location, and the western marsh.

Table 6 Charles Rider Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
39	Charles Rider Park	94	10/5/15	24.0	35

Charles Rider Park (East Kingston, RM 94) was surveyed on October 5th via power boat, accessed at the park boat launch site. The surveyed locations included the Hudson River shoreline, about 1,000 feet north of the boat launch, and down south to include the Robert E. Post Memorial Park site. The water gets very deep a short distance off the shoreline, and

therefore is poor SAV habitat. This shoreline included several small coves, which supported limited SAV habitat. This site was the furthest north that was surveyed during this project.

A total of 35 sites were surveyed on this date. Only fourteen of the sites (or 40%) supported SAV, with 64% at trace density (9) and 29% (4) at sparse density. One medium site rounded out the distribution of SAV abundances at this location. The heaviest density aquatic plants occurred in the cove near Robert E. Post Memorial Park, with a few scattered sparse sites along the Hudson Shoreline. Open water sites had decreased true rooted SAV, being dominated by small duckweed. Duckweeds (both small and great) dominated the aquatic plants that were observed and collected. Small duckweed occurred at 12 (or 34%) of the sites, while great duckweed occurred at three sites (or 9%).

Spatterdock, wild celery, benthic filamentous algae, Eurasian water milfoil and watermoss rounded out the submersed aquatic plants at this location, although all occurred at two or fewer sites. The spatterdock was well established in the cove just north of the Robert E. Post Memorial Park. Due to the limited SAV habitat at this location, we recommend that **Charles Rider Park be a Low Priority Site for future Hydrilla monitoring.**

Table 7 Chelsea Boat Launch Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
37	Chelsea Boat Launch	64	9/28/15	7.0	24

Chelsea Boat Launch (Chelsea, RM 64) was surveyed on September 28th via canoe, accessed at the boat launch site located at the end of Front Street. The surveyed locations included the Hudson River shoreline, about 1,300 feet north of the boat launch, and approximately 1,500 feet south of the boat launch site. This southern shoreline includes the Chelsea Yacht Club property. The shoreline here was very rocky, and the water depth increased rapidly a short distance from the shore, and thus is a popular location to moor large sailboats. Water depth around these sailboats often exceeded 30 feet. Despite this, aquatic plants were collected at 19 (or 79%) of the sites surveyed at this location. All sites were considered trace or sparse abundance and were scattered along the shoreline. There tended to be more sites and higher abundance to the south. Six different aquatic plants and benthic filamentous algae were collected at this location.

The dominant aquatic plant collected at this location was small duckweed, occurring at all 19 sites that had aquatic plants. Most small duckweed sites (14, or 74%) were trace density, but five sparse sites were also observed. Brittle naiad was the dominant true rooted aquatic plant, occurring at nine (or 38%) of the sites surveyed. Northern naiad occurred at five (or 21%) of the sites. Naiad abundance was limited to south of the boat launch site and along the Chelsea Yacht Club property.

Great duckweed, water stargrass, wild celery and benthic filamentous algae rounded out the aquatic plant community, but each occurred at only one site each. The water stargrass and wild

celery fragments collected on the anchor could have been tide-swept fragments, as we did not observe any rooted beds of these desirable plants. Although there were pockets of naiad growth at a few sites, **Chelsea Boat Launch should be a Low Priority for future Hydrilla monitoring.**

Table 8 Constitution Marsh Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
24	Constitution Marsh	52	9/16 & 17/15	358.0	88

Constitution Marsh (Cold Spring, RM 52) was surveyed on September 16th and 17th via canoe, accessed at the Audubon Society car-top launch site. The northern part of the marsh was accessed via Foundry Cove and the Foundry Dock car-top launch site. The surveyed locations included the open water south of the marsh and the marsh proper. All survey sites were located behind the railroad tracks. This was the second largest location surveyed during this project, and due to access needed to be surveyed via canoe. Due to the expansive size of the marsh, and numerous channels, additional surveying effort could be warranted in the future. Aquatic plants were collected at 72% (or 63) of the 88 sites surveyed over the course of two days. Just under half of the sites (28, or 44%) were trace density, with another 21 sites (or 33%) being considered sparse abundance. Eleven medium (or 17%) and three dense sites (or 5%) rounded out aquatic plant abundance at this location. Aquatic plants were scattered throughout much of the marsh and the open water to the south. Aquatic plant abundance increased in the south of the open water (all three dense and two medium sites) and in the southern part of the marsh proper, with six clustered medium sites. Nine different aquatic plants were collected at this location.

Coontail was the dominant aquatic plant collected at 56% (or 49) sites. Most of these sites were trace (57%) or sparse (39%) abundance. Two medium sites, located in the southern part of the open water, were also collected. Small duckweed was the second most common aquatic plant, occurring at 31 (or 35%) of the sites. Small duckweed was scattered about, but commonly occurred mixed in with other plants at the surface or in the marsh proper. Water chestnut occurred at 30 (or 34%) of the sites surveyed. About half of the sites (14, or 47%) were trace density, with another 10 sites (or 33%) being sparse density. Four medium sites and two dense sites of water chestnut were observed. An even mixture of water chestnut sites were located in the open water and marsh sections of this location. In the field, the water chestnut plants were already dying back naturally due to cooler temperatures, and thus our abundance and (possibly) distribution could be under-estimated. This is supported by information provided by Audubon Society staff and examination of aerial photography of the location.

Eurasian water milfoil was collected at 27 (or 31%) of the sites surveyed. Established beds of Eurasian water milfoil were found in both sections of this site, but usually at trace or sparse abundance. One medium site was at the mouth of the access stream. Brittle naiad was collected at 18 sites (or 20%). Most sites wee trace density, but three medium sites were also collected. Most brittle naiad sites (and all three medium sites) were in the marsh area of this

location. Great duckweed was observed at 14 (or 16%) of the sites. Common waterweed, spatterdock, and wild celery rounded out the aquatic plants collected at this location. Spatterdock was well established in the far southern reach of the open water section. Wild celery was only collected at one trace location. Anecdotal reports from Audubon Society staff reveal previous higher abundances of this highly desirable native aquatic plant. This location would be ideal for potential re-introduction of wild celery plots. Due to the increased SAV habitat and relative high diversity of SAV, **Constitution Marsh should be considered a High Priority for future hydrilla monitoring**. We recommend additional effort in the northern marsh section of this location as well.

Table 9 Croton Bay Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
17	Croton Bay	34	9/2/15	639.0	71

The Croton Bay (Croton-on-Hudson, RM 34) was surveyed on September 2nd via airboat, accessed at the Senasqua Park boat launch located on the opposite side of Croton Point. An airboat was employed to survey this location due to the large size of the bay, and the shallow water in areas. Due to the size of the location (exceeding 600 acres, and by far the largest location of this project) a 200 m by 200 m grid was employed here. This location is closest to the Croton River and the documented hydrilla infestation, therefore making it a top priority. In 2014, the shorelines of the bay were surveyed, but no rooted plants of hydrilla were documented. Earlier in 2015, the client provided ABI with two data points of rooted hydrilla reported by other scientists working at this location. Aquatic plants were collected at 25 (or 35%) of the sites surveyed. Only 24% of the sites were trace density, and over half the sites were sparse density. Five medium sites (20%) and one dense site (4%) were collected. All SAV occurred in the interior and shoreline sites in the bay. Only five different aquatic plants were collected here.

Wild celery was the dominant aquatic plant collected, occurring at all 25 (or 35%) of the sites that supported SAV. The highest abundance of wild celery occurred along the shoreline north of the railroad tracks and along the southern shoreline. These areas supported established beds of wild celery. Despite the proximity to the Croton River, no hydrilla was collected in the Croton Bay in 2015. As a matter of fact, no floating fragments were observed either, but it should be noted that the tide was coming in during most of the survey.

Eurasian water milfoil was the second most common aquatic plant collected at this location. Yet it only occurred at 11% of the sites surveyed, and all sites were considered trace abundance. Sago pondweed, common waterweed and slender naiad rounded out the aquatic plants collected at this location, but all occurred at five or fewer sites and all sites were trace density.

Due to suitable SAV habitat, and the proximity of the Croton River system, the **Croton Bay should be a High Priority for future hydrilla monitoring**. The location's size, limited access options (due to the low railroad bridge) and the shallow nature of the interior of the cove make

surveying this crucial site difficult at best. However, increased effort during future monitoring of this location is needed to discover any rooted hydrilla beds. A 50 m by 50 m grid is recommended, but focus should be on the shorelines, and the interior of the bay.

Table 10 Denning's Point Bay Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
27	Denning's Point Bay	60	9/18/15	91.7	35

Denning's Point Bay (Beacon, RM 60) was surveyed on September 18th via canoe, accessed at nearby Riverfront Park. Despite the size of this location, plus nearby Riverfront Park, a canoe was used to survey these locations due to posted signage limiting power motor boats near the shoreline. Aquatic plants were collected at 30 (or 86%) of the sites surveyed. All sites were trace or sparse density, with 73% of the sites being considered trace abundance. Only four different aquatic plants were collected here, and two of them were duckweeds, which are not considered true submersed aquatic plants.

Duckweeds dominated the aquatic plant community at this location. Small duckweed was collected at all 30 of the sites that supported aquatic plants. At 73% of the sites, small duckweed was trace, while the remaining 27% of the sites were sparse abundance. Great duckweed was less common, only occurring at 13 (or 37%) of the sites. All great duckweed sites were trace density.

Water chestnut (three sites, or 9%) and coontail (one site, or 3%) rounded out the aquatic plant assemblage at this location. Similar to other locations, the water chestnut beds were dying back and breaking up on this date. Examination of aerial photos, plus evidence of water chestnut fragments and nutlets on the shore likely means our results underestimate the true water chestnut abundance at this location. Due to the limited SAV habitat and rooted aquatic plants collected at this location, **Denning's Point Bay is a Low Priority for future hydrilla monitoring.**

Table 11 Dickie Brook Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
13	Dickie Brook	43	8/31/15	5.7	20

Dickie Brook (Buchanan, RM 43) was surveyed on August 31st via canoe, accessed at the boat launch at Lent's Cove, and paddling through the culvert under John Walsh Boulevard. Aquatic plants were collected at 18 (or 90%) of the sites surveyed. The only sites that lacked aquatic plants were at the mouth of the culvert and the shallow creek site at the far end of the location (with heavy tree coverage). Trace abundance sites accounted for 61% (or 11 sites), while 22% were sparse sites. Three medium sites (or 17%) rounded out the abundance of aquatic plants at this location. Seven different aquatic plants and benthic filamentous algae were collected here which is considered suitable diversity for such a location.

Common waterweed was the dominant submersed aquatic plant collected at this location. It occurred at 13 (or 65%) of the sites surveyed, with nine of those sites considered trace density. Three sparse sites (or 23%) and one medium site rounded out the common waterweed abundance. Common waterweed was scattered throughout the location. All samples of common waterweed collected were examined to confirmed identification. Small duckweed was also collected at 13 sites. Most of these sites (12, or 92%) were trace density.

The remaining aquatic plants included horned pondweed, coontail, Eurasian water milfoil, sago pondweed and brittle naiad all occurred at six or fewer sites. Benthic filamentous algae was collected at four sites. Due to the suitable SAV habitat, abundant common waterweed (which could easily be confused for hydrilla) and the reasonably close proximity to the Croton River, **Dickie Brook should be a High Priority for future hydrilla monitoring**.

Table 12 Fishkill Creek Bay Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
35	Fishkill Creek Bay	59	9/28/15	111.7	50

Fishkill Creek Bay (Beacon, RM 59) was surveyed on September 28th via canoe, accessed at the Beacon Institute property, near the old paper mill. This is a car-top launch also used to access the Fishkill Creek, but is highly tidal. Aquatic plants were collected at 22 (or 44%) of the sites surveyed. Half of the sites (11) were trace density, while nearly half (10 sites, or 45%) were sparse density. One dense site rounded out the aquatic plant community at this location. Seven different aquatic plants plus benthic filamentous algae were collected at Fishkill Creek Bay. However, three aquatic plants are floating species.

Small duckweed was the most common aquatic plant collected at this site. It occurred at 14 (or 28%) of the sites surveyed, almost equally divided between trace and sparse density. Eurasian water milfoil accounted for 20% (or 10) of the sites surveyed. These sites, including a well-established dense bed, occurred in the open water of the bay, which are likely deep enough to minimize tidal fluctuation. Rooted water chestnut was only collected at one site during our survey. However, examining aerial photos of the bay, and observations of water chestnut beds at other nearby sites, we assume that the water chestnut abundance was underestimated on this date.

Common watermeal, water fern, coontail, spatterdock, and benthic filamentous algae were all observed at this location, but at limited sites. Water fern (*Azolla caroliniana*) is not commonly observed in New York (personal observation), and occurred at six (or 12%) of the sites surveyed. All sites occurred near the railroad track bridges, and we suspected (correctly) that more water fern occurred in the Fishkill Creek proper. Spatterdock only occurred at two sites in the bay, both considered sparse density. This was one established bed located in the interior of the bay, along the west shore. At high tide, the spatterdock leaves were underwater, but at low tide, they were emergent and erect. Although there is limited SAV habitat in the bay, some

submersed plants are established here and the proximity to the Fishkill Creek (which is High Priority), the **Fishkill Creek Bay should be Moderate Priority for future hydrilla monitoring.**

Table 13 Fishkill Creek Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
36	Fishkill Creek	59	9/28/15	41.7	47

Fishkill Creek (Beacon, RM 59) was surveyed on September 28th via canoe, accessed at the Beacon Institute property, near the old paper mill and by paddling through the Fishkill Creek Bay and under the railroad bridge. We could not access the creek north of the old factory and the South Avenue Bridge due to depth and rocks. Aquatic plants were collected at 43 (or 91%) of the sites surveyed. Only four of the sites (or 9%) were trace density, while 14 sites (or 33%) were sparse density. Sixteen sites (or 37%) were medium density, and nine sites (or 21%) were dense abundance. The heaviest abundance was found in the creek proper, but generally south of the fork in the creek. By our classification in the aquatic plant management field, we would therefore consider 58% of these sites to be at nuisance abundance levels. These are some of the greatest abundance amounts of any location surveyed during this project. Nine different aquatic plants and benthic filamentous algae were collected at this location.

Small duckweed was the dominant aquatic plant at this site, collected at 43 (or 91%) of the sites surveyed. As a matter of fact, floating aquatic plants (such as duckweeds) were very common at this location. Other floating aquatic plants included common watermeal (40 sites, or 85%), water fern (32 sites, or 68%) and great duckweed (18 sites, or 38%). These species represented the second, fifth and seventh most common aquatic plants at this location. Water fern is not typically observed at locations in New York (personal observation), but we were not surprised by its occurrence here, since limited amounts of water fern were observed at nearby Fishkill Creek Bay.

As for true rooted submersed aquatic plants, coontail was the most common species located. Coontail occurred at 39 (or 83%) sites, with nearly half of them being trace density. Coontail occurred at most sites in the marsh area of the creek, although two trace sites were located north in the creek. Water chestnut occurred at 35 (or 74%) of the sites, and similar to coontail, about 50% of the sites were trace. As previously noted, water chestnut die-back was already undergoing as we were surveying the more northern sites, so our results might not be a true representation of the actual abundance and distribution of this species. Eurasian water milfoil occurred at 40% of the sites, including four medium and two dense sites. Unlike most of the other aquatic plants, Eurasian water milfoil preferred the northern part of the creek and the open water of the southern fork. Common waterweed also mimicked the distribution of Eurasian water milfoil, occurring at 26% of the sites. All common waterweed samples were closely examined to confirm the identification.

Fishkill Creek boasts abundant SAV habitat, despite the nuisance abundance of floating aquatic plants. Based on this suitable habitat and the presence of common waterweed (which can be confused with hydrilla), **Fishkill Creek should be a High Priority for future hydrilla monitoring.**

Table 14 Foundry Cove Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
26	Foundry Cove	53	9/17/15	41.5	64

Foundry Cove (Cold Spring, RM 53) was surveyed on September 17th via canoe, accessed at the Foundry Dock car-top launch and paddling under the railroad bridge to access the cove. Due to tides, following surveying this location, we proceeded to Constitution Marsh, and exited via that site (see discussion, above). This location was a former Superfund Site, and was dredged and capped with clay, according to locals familiar with the area. The northern part of the marsh section of the cove displayed aquascaping exclosures. These areas were not surveyed, as we did not want to disturb any of the plantings and exclosures. At this location, 64 sites were surveyed. Aquatic plants were collected at 41, or 64% of the sites surveyed. At 27 sites, the abundance was considered trace, along with six sites each of sparse and medium density sites. Finally, two dense sites were collected. Aquatic plants were scattered about the cove, except for the moving water sites, as this area experiences significant tidal influences. Eight different aquatic plant species were collected at this location.

Eurasian water milfoil was the most common submersed aquatic plant collected, occurring at 32 or 50% of the sites. At 81% of the sites, the density was trace, but three sparse, two medium and a single dense site of Eurasian water milfoil was also collected. Higher density Eurasian water milfoil occurred along the northern parts of the cove. Coontail occurred at 27 or 42% of the sites surveyed, and enjoyed a similar distribution to Eurasian water milfoil. Water chestnut was collected at 11, or 17% of the sites, occurring at trace (5), sparse (5) and medium (1) density. All of these sites were located in the northern marsh section of the cove.

Two species of duckweed (small and great), brittle naiad, common waterweed and spatterdock rounded out the aquatic plant assemblage at this location. All of these species occurred at 10 or fewer sites. Since much of this location appears to be suitable SAV habitat, **Foundry Cove should be a High Priority for future hydrilla monitoring efforts.**

Table 15 Foundry Cove Bay Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
25	Foundry Cove Bay	53	9/17/15	6.75	12

Foundry Cove Bay (Cold Spring, RM 53) was surveyed on September 17th via canoe, accessed at the Foundry Dock car-top launch. As we were paddling toward Foundry Cove, we observed significant SAV growth at the surface in the Bay, and decided to drop a dozen GPS-logged sites to establish a unique sampling location (not included in the original project). We surveyed from to tip of the Foundry Dock peninsula, along the entire shoreline along the train tracks to the

opposite corner. Much of the bay was shallow, and if future monitoring is performed at this location, we would recommend additional effort in the open water. Aquatic plants were collected at 10 (or 83%) of the 12 sites surveyed. Only two of these sites were trace density, while five sparse and two more medium sites were also collected. Aquatic plants occurred throughout much of the shoreline, although higher densities occurred along the shoreline from the access point to the railroad bridge. Four aquatic plants (three rooted submersed species) and benthic filamentous algae were collected.

The dominant submersed aquatic plant was Eurasian water milfoil, collected at all 10 sites that had growth. Three trace sites, five sparse sites and two medium sites were collected, with heavier Eurasian water milfoil northwest from the railroad bridge. Coontail and brittle naiad occurred at eight (or 67%) and seven (or 58%) of the sites. Small duckweed occurred at five sites (or 42%), but all were considered trace density. Benthic filamentous algae was collected at 25% of the sites. Since the bay is shallow, and protected by Constitution Island to the south, and we observed established beds of submersed aquatic vegetation, **Foundry Cove Bay should be a High Priority for future hydrilla monitoring.** If additional monitoring occurs here, it should not be limited to the shoreline sites that we surveyed in 2015. Additional monitoring should be conducted in the open water of the bay, until water depth discourages rooted aquatic plant growth, but this might be significant acreage given the protection afforded by Constitution Island.

Table 16 Front Street Marina Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
15	Front Street Marina	61	9/1/15	7.2	16

Front Street Marina (Newburgh, RM 61) was surveyed on September 1st via canoe, accessed at the Newburgh boat launch site, which is located just south of this location. This location is on the open water of the Hudson, so the survey was limited to shoreline sites in and around the various docks and moored barges common in this area. Overall SAV habitat was poor as the water depth exceeded 8.0 feet at nearly all of the survey sites. Aquatic plants were collected at just four (or 25%) of the sites, with one site considered trace and the remaining three sites being sparse abundance. Two aquatic plants were collected/observed during our survey.

Small duckweed, a floating aquatic plant, was the dominant species collected on this date. It occurred at 25% of the sites. Since tidal and wind patterns influence the distribution of this floating plant, it likely varies on an hourly basis. Coontail was the only true rooted aquatic plant collected. It occurred at only one (or 6%) site, at trace density. It's likely the trace site was simply a floating fragment, as we did not observe any established beds of SAV at this location. We did observed numerous floating fragments and nutlets of water chestnut, and some naiad fragments as well. Based on the water depth and lack of true SAV habitat, **Front Street Marina should be a Low Priority for future hydrilla monitoring.**

Table 17 George's Island County Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
8	George's Island County Park	39	8/25/15	31.0	60

George's Island County Park (Montrose, RM 39) was surveyed on August 25th via canoe, accessed at the boat launch at the park. In retrospect, due to the water depth around the park and the state of the art boat launch site, this location could have surveyed with a powerboat for increased efficiency. We surveyed the boat launch cove, the larger cove to the north, and the shoreline in between, plus about 700 feet down the south shoreline. Aquatic plants were collected at 37 (or 62%) of the sites surveyed. About half of the sites were trace abundance (17, or 46%), with another nine sites (or 24%) considered sparse. Medium sites (6, or 16%) and dense sites (5, or 14%) were somewhat common here. Only four different aquatic plants were collected at this location.

Wild celery was the dominant aquatic plant at this location, with well-established beds located in both coves. Wild celery preferred sites off the shore, in water that was slightly deeper. These sites are likely less influenced by extreme tidal fluctuations. Wild celery accounted for nearly 50% of the total sites (28 sites, or 47%) with a near even distribution of trace and sparse sites (nine and eight, respectively) and medium and dense sites (six and five, respectively). In short these are some of the healthiest and established wild celery beds we observed during this project.

Small duckweed (14 sites or 23%), Eurasian water milfoil (12 sites, or 20%), and coontail (one site, or 2%) rounded out the aquatic plant community at this location. All small duckweed sites were considered trace density, while 75% of the Eurasian water milfoil sites were trace abundance. Although there appeared to be suitable SAV habitat in many locations at this site, the reduced diversity of aquatic plant growth is somewhat surprising. Due to the available SAV habitat, relatively robust wild celery growth and proximity to the Croton River (it's on the same bank of the Hudson), **George's Island County Park should be a High Priority for future hydrilla monitoring.**

Table 18 Halfmoon Bay Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
7	Halfmoon Bay	35	8/24/15	76.7	66

Halfmoon Bay (Croton-on Hudson, RM 35) was surveyed on August 24th via canoe, accessed at the Croton Point Park car-top launch site, although we pulled out at the northern marina. In retrospect, due to the water depth at this location, future monitoring at this location could be performed with a power motor boat, with access at the Senasqua Park boat launch. Due to the water depth, our survey was restricted to the shoreline of the bay, starting at the southern point, working our way past the beach, and up the shoreline. Our beach sites were situated off the shore slightly, as observed SAV beds occurred away from the sandy beach. Our survey points were spaced out 100 meters, but we also surveyed each of the two marinas located in

the north part of the bay, with 50 meter grids. Aquatic plants were collected at 26 (or 39%) of the sites surveyed with most sites (20, or 77%) being considered sparse or medium abundance. Only four trace sites were collected, although two dense sites were collected. Five different aquatic plants and benthic filamentous algae were present.

Eurasian water milfoil was the dominant aquatic plant collected at this location. It occurred at 22 (or 33%) of the sites surveyed. Half of the sites were trace density. Seven sites (or 32%) were sparse density, while four sites were considered medium density. Eurasian water milfoil was scattered along the shoreline, but higher density sites tended to occur at the marinas or in between the marinas. Wild celery occurred at 17 (or 26%) of the sites surveyed. It too was scattered, but several well-established beds (medium and dense abundance) were surveyed. Five medium sites and the dense site occurred off the beach or along the park shoreline.

Heart pondweed, sago pondweed, benthic filamentous algae and curly-leaf pondweed rounded out the aquatic plant community at this location. All of these plants occurred at five or fewer sites, and all occurred along the beach, or the southern shoreline at the park. Heart pondweed (*Potamogeton perfoliatus*) was collected at five sites (four trace and one sparse) in this area. This was the only location that heart pondweed was collected at during our 2015 survey efforts. Due to the proximity of the bay to the Croton river system (its right around Croton Point Park), and the suitable SAV habitat observed (especially near the beach and surrounding shorelines), **Halfmoon Bay should be a High Priority for future hydrilla monitoring.**

Table 19 Haverstraw Bay Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
3	Haverstraw Bay Park	37	8/18/15	13.7	26

Haverstraw Bay Park (Haverstraw Bay Park, RM 37) was surveyed on August 18th via canoe. This location consisted of two very different areas. The first was a small pond used for fishing, which topped out aquatic plants throughout much of the basin. There was no true access to the pond so we carried our canoe into the water along the dock. The second area was the boat launch site, two man-made coves, and a few sites along the Hudson River. We accessed this area from the boat launch, and although we used a canoe in 2015, future monitoring of the boat launch could be accomplished with a power motor boat. Overall, aquatic plants occurred at 20, or 77% of the sites surveyed. All 18 of the sites in the pond had aquatic plants (typically medium or dense abundance), while the boat launch sites had aquatic plants at only two sites (one trace and one sparse). Both sites with plants were in the interior man-made coves. The open water sites were dominated by large rocks (jetty-like), and were typically deeper than 5.0 feet. Only two aquatic plants were collected at this location.

Eurasian water milfoil occurred at 20 (or 77%) of the sites surveyed. Nearly half of these sites were dense abundance (nine, or 45%). Six sites were sparse and three sites were considered medium density. The final two sites were trace. All eighteen sites in the pond had Eurasian water milfoil, most at medium (3) or dense (9) abundance. A sparse site and a trace site were

located in each man-made cove on the Hudson River. Coontail occurred at seven (or 27%) of the sites at this location. All seven sites (one was sparse and the remaining were trace) were located in the pond. Due to the lack of suitable SAV habitat in the open water on the Hudson, and the lack of access to the pond (despite it being excellent SAV habitat), **Haverstraw Bay Park should be a Low Priority for future hydrilla monitoring.** Although one could make an argument for additional monitoring in the pond.

Table 20 Haverstraw Marina Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
4	Haverstraw Marina	38	8/18/15	58.0	16

Haverstraw Marina (Haverstraw, RM 38) was surveyed on August 18th via canoe and off the docks. We started out surveying in a canoe, but high winds and boat traffic forced us to conduct most of the survey off the docks of the marina. The marina was a former gravel pit (according to the manager) and thus lacked suitable SAV habitat. The water depth at most of the sites exceeded 8.0 feet. Three sites (or 19%) had aquatic plants. All three sites were considered trace density, two of which were situated near the interior shore of the marina. One aquatic plant was collected at this location, and we didn't even observe any additional floating plant fragments. However, the wind and outgoing tide could have had an impact.

Eurasian water milfoil was the only aquatic plant collected at this location. All three sites were considered trace, and based on the water depth at two of the sites, these occurrences could have been floating fragments attached to the weed anchor. Although conditions on this date were not ideal for surveying, water depth seems to be the limiting factor regarding SAV at this location. Therefore, **Haverstraw Marina should be considered a Low Priority for future hydrilla monitoring efforts.**

Table 21 Hyde Park Marina Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
33	Hyde Park Marina	77	9/24/15	4.2	18

Hyde Park Marina (Hyde Park, RM 77) was surveyed on September 24th via canoe, accessed off the docks along the east shore. There was no other suitable launch access due to the slopes surrounding the marina, although there appeared to be a private boat launch just north of the marina (near sample point 1). This location consisted of two cove-like basins (the marina) plus a few exterior Hudson River sites. At 11 (or 61%) of the 18 sites, we found aquatic plants. These sites had and assortment of differing abundances from trace (2) to sparse (4) to medium (3) and finally dense (2). Most of the exterior open Hudson River sites lacked rooted SAV, although the shoreline south of the marina appeared suitable and shallow, but had a hard clay bottom. Seven different aquatic plant species were collected at this location. In our opinion, this was a high sample diversity considering the size of the location (just over 4 acres). It should be noted that the marina performs mechanical aquatic plant removal at this site with a custom designed harvester barge.

Eurasian water milfoil was the dominant aquatic plant we collected, occurring at 10 (or 56%) of the sites surveyed. Four sites were trace, with three sparse, two medium and one dense site rounding out the abundances of this species. Both medium and the one dense site were located in the larger basin along the southern docks. Two species of naiad were collected: Brittle naiad (nine sites, or 50%) and northern naiad (eight sites, or 44%). Seeds were used to confirm the identity of these two species. Brittle naiad occurred at greater abundance, including a dense site on the exterior of the marina on the peninsula between both basins.

Small duckweed, coontail, water chestnut, and white lily rounded out the aquatic plant community at this location. The white lily occurrence was a trace patch situated at the end of one of the docks, between the shore and docks, and only consisted of a few leaves at the surface. This was only one of two observations of white lily during our 2015 project. Based on the diversity (seven) of aquatic plants, and reasonable SAV habitat, especially in the two basin/coves, **Hyde Park Marina should be a Moderate Priority for future hydrilla monitoring.**

Table 22 Iona Marsh Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
21	Iona Marsh	45	9/9 & 23/15	152.0	69

Iona Marsh (Doodletown, RM 45) was a challenging location to survey based on the acreage of the marsh (152.0), the tidal influences, and the limited access. The nearest boat launch was over one mile to the north. On September 9th, we accessed the marsh with a canoe off the causeway (twice) to access the southern part of the marsh, and the northern part of the marsh (including the open water behind the railroad bridge). These sites employed a 100 m grid. The exterior of Iona Island was accessed on September 23rd via foot. This shoreline was surveyed every 200 m with anchor tosses from the shore as appropriate. Aquatic plants were collected at most (48, or 70%) of the sites surveyed. Most sites were trace (48%) or sparse (44%), with 8% of the sites being considered medium density. It's likely the tidal influence restricts more abundant SAV growth in the marsh. Most sparse sites (15) were located in the northern section of the location. The four medium sites were scattered throughout the north, south and exterior island sites. In general, the open water (Hudson River) sites had lower abundance of aquatic plant growth, likely a function of the rocky shoreline and wind activity. Aquatic plant diversity was high (as compared to other sites during this project) with nine different aquatic plants documented.

Eurasian water milfoil was collected at 33 (or 48%) of the sites. Most sites were trace (22, or 67%), with 10 (or 30%) sparse sites also recorded. One medium site occurred in a cove along the outer exterior of the island. Horned pondweed commonly occurred at this location, occurring at 22 (or 32%) of the sites. Most sites (17) were trace density. The majority of horned pondweed sites were located in the open water section of the northern marsh, especially along the west shoreline. Common waterweed was collected at 21 (or 30%) of the sites surveyed. All common waterweed was closely examined to confirm identification, since it can be confused

with hydrilla. All sites save three were trace density, and were scattered about both the north and south sections of the marsh. Two sparse sites were situated along the southern shore in the southern section of the marsh. Coontail was collected at 19 (or 28%) of the sites, with most (12) being located in the northern section (including both sparse sites). Small duckweed occurred at 18 (or 26%) of the sites. Most sites were trace, but a few sites were considered sparse (typically accumulating in corners of the open water).

Wild celery occurred at nine (or 13%) of the sites. Although five trace sites were collected, two sites each of sparse and medium wild celery were also collected. The two medium sites were established beds in the southern part of the marsh. The two sparse sites were along the northern edge of the causeway. At low tide, these beds could be observed, and numerous floating fragments were present here. Giant arrowhead (confirmed with the presence of flowers), northern naiad, and water chestnut rounded out the aquatic plants at Iona Marsh, but all were collected at four or fewer sites. The water chestnut (trace) was a few rooted rosettes in the marsh stream at the southern part of the marsh. However, numerous floating fragments and nutlets of water chestnut were observed in both sections. Due to the abundant SAV habitat, diverse aquatic plants collected and reasonably close proximity to the Croton River, **Iona Marsh should be a High Priority for future hydrilla monitoring.** Future monitoring should likely exclude the exterior Hudson River sites and focus on the marsh areas behind the railroad tracks.

Table 23 Kemey's Cove Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
45	Kemey's Cove	31	10/9/15	12.0	30

Kemey's Cove (Scarborough, RM 31) was surveyed on October 9th via canoe accessed at the southeast corner of the cove (next to the bus parking). Although there is access to the cove from the Hudson River under the railroad tracks, clearance is restricted except at low tide. There is a car-top access point at nearby Scarborough Park, located just south of the cove. This location was not part of the original project and was added when we could not access the Cove at FDR National Historical Site. Verbal approval to survey this location was granted by NYSDEC. Aquatic plants were collected at 15 (50%) of the 30 sites we surveyed. Most sites were trace density (11, or 73%) with the remaining four sites being considered sparse density. Two aquatic plants and benthic filamentous algae were collected here.

Horned pondweed was the dominant aquatic plant collected at Kemey's Cove. It occurred at 14 (or 47%) of the sites surveyed. Ten sites were trace density while four sites were sparse density. Horned pondweed was scattered about the cove, but generally preferred the shoreline sites. The sparse sites were all located in the northern half of the cove. Benthic filamentous algae was collected at three (or 10%) of the sites, all considered trace density. Two trace sites of Eurasian water milfoil were present in the cove. One was situated in the northwest corner of the cove, while the other was a rooted bed in the open water. Although we founded limited aquatic plant growth in the cove, clearly it can support SAV growth. Coupled with the fact that the cove is

downstream of the Croton River (and on the same bank of the Hudson River) **Kemey's Cove should be a High Priority for any future hydrilla monitoring.**

Table 24 Kingston Point Park Marsh Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
46	Kingston Point Park Marsh	91	10/15/15	31.0	29

Kingston Point Park Marsh (Kingston, RM 91) was surveyed on October 15th via canoe. This location was observed when we were conducting the Sleightsburg Park survey, but we could not access the marsh with our power motor boat, due to the bridge and water depth. Water depths at these sites were typically less than 2.0 feet. However, a quick survey on foot at the park revealed abundant SAV habitat and plant growth. This site was then added to the project after we could not access the Cove at the FDR Historical Site. We accessed from the shoreline in the park, but since the marsh is tidal, and the spatterdock and emergent vegetation is quite dense, only limited open water sites could be surveyed. Twenty nine sites were surveyed, and all sites had aquatic vegetation. Most sites (83%) were sparse or medium density. One dense site (3%) and four trace sites (14%) were also collected. Six different aquatic plants were collected at this location, including five true rooted aquatic plants. The heaviest density of aquatic plants occurred at the interior sites of the marsh.

Eurasian water milfoil occurred at 24 (or 83%) of the sites surveyed. Most sites were trace density (63%) and this plant was scattered about the marsh. Well-established beds of spatterdock were present in the marsh. It was collected at 24 (or 83%) of the sites surveyed with 75% of the sites being sparse or medium density. In the northeast corner of the marsh, access was very limited to a single stream due to low tide, but most of the area was medium to dense spatterdock beds. Small duckweed was scattered about the marsh, typically at trace density. Of the 22 sites collected, only one site could be classified as sparse density. Wild celery was well-established in the marsh, occurring at 66% (or 19) of the sites surveyed. One medium bed was located in the interior of the marsh, while sparse (8 sites) and trace (10 sites) rounded out this species abundances.

Horned pondweed (four sites, or 14%) and coontail (three sites, or 10%) were also collected in at limited sites in the marsh. Both of these occurred in the interior streams of the marsh. Although rotted beds of water chestnut were not present in the marsh, we did observe several floating plant fragments, and nutlets throughout the location. Due to the excellent SAV habitat in this marsh, plus the presence of highly desirable wild celery, **Kingston Point Park Marsh should be a High Priority for future hydrilla monitoring.**

Table 25 Sloop Hill Boat Launch Site Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
16	Sloop Hill Boat Launch Site	57	9/1/15	3.5	15

Sloop Hill Boat Launch (New Windsor, RM 57) was surveyed on September 1st via canoe accessed at the car-top launch at the park. The shoreline of this open water Hudson site was littered with plant fragments, mostly various naiad species. We surveyed both shorelines along the beaches north and south of the manmade (?) cove. This site is just north of the Moodna Creek Bay and Moodna Creek. Despite the abundance of aquatic plants washed upon the shoreline, we only found aquatic plants at eight (or 53%) of the sites were surveyed. Six of the sites were trace density, with a single sparse and medium site rounding out the assemblage. Six different aquatic plants were collected at this location.

Small duckweed was the most common aquatic plant observed. It occurred at eight (or 53%) of the sites surveyed, most being considered trace density. Coontail occurred at four (or 27%) of the sites surveyed, while Eurasian water milfoil (two sites, or 13%) also was collected. The remaining three aquatic plants (Northern naiad, slender naiad and common waterweed) all occurred at a single site. Although rooted plants were observed at both sites in the cove, the remaining occurrences could have been floating fragments that were collected on the weed anchor. The coontail collected at site 11 was rooted, however. Due to the limited SAV habitat at this location, **Sloop Hill Boat Launch Site should be a Low Priority for future hydrilla monitoring.**

Table 26 Lent's Cove Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
12	Lent's Cove	43	8/31/15	39.0	57

Lent's Cove (Buchanan, RM 43) was surveyed on August 31st via canoe accessed at the Lent's Cove Park boat launch. In the future, this site could be surveyed via a power motor boat, but due to tide fluctuations, only at or near high tide. The survey included the whole cove, the marina, and the shoreline north to Charles Point Pier Park, and south along the Lent's Cove Park a short distance. Dickie Brook (see discussion above) was accessed via this site, underneath one of the culvert pipes. We surveyed 57 sites at this location, and collected aquatic plants at 35 (or 61%) of the sites. At 71% of the sites (25), the abundance was considered trace. Nine sparse sites and one medium site were also collected. All interior cove sites supported SAV growth, as well as most sites in the marina. The medium site was situated on the open water, but most shoreline sites supported some kind of aquatic plant growth. Seven different aquatic plants plus benthic filamentous algae wee collected here. However, by far the most common plant was small duckweed, and most other aquatic plants occurred at fewer than 10% of the sites.

Small duckweed was the dominant aquatic plant, occurring at 26 (or 46%) of the sites. Most sites were trace density (19, or 73%) and as expected this tiny floating plant was often found accumulating on the shoreline or at marina sites. Common waterweed was the next most common plant collected, but it only occurred at 10 (or 18%) of the total sites. Eight sites were trace, but single sparse and medium sites were also collected. The common waterweed plants at this site appeared to be very robust, and all were closely examined to determine identity.

Coontail, Eurasian water milfoil, wild celery, benthic filamentous algae, sago pondweed and brittle naiad were all collected at this location at five or fewer sites. Since there is suitable SAV habitat at the cove (especially the interior), and the presence of common waterweed, **Lent's Cove should be a High Priority for future hydrilla monitoring.**

Table 27 Marlboro Yacht Club Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
40	Marlboro Yacht Club	68	10/5/15	13.7	34

Marlboro Yacht Club (Marlboro, RM 68) was surveyed October 5th via a power motor boat accessed at the boat launch on the Yacht Club property. At this location, we surveyed both north and south dock areas, the shoreline in between, and a limited area of a nearby marsh, located just to the south of the property, under the railroad tracks. We could not get very far into this marsh with our powerboat and the outgoing tide, but suitable SAV habitat is present, so this marsh area warrants additional monitoring in the future. We surveyed 34 sites at this location, with aquatic plants being collected at 15 (or 44%) of the sites. Most sites (74%) with plants were at nuisance abundance (medium or dense). That said, aquatic plants were restricted to the interior sites around the docks, and in the nearby marsh area. Nine different aquatic plants were collected at this site.

Eurasian water milfoil was the dominant aquatic plant, occurring at all 15 of the sites that supported aquatic plant growth. Eurasian water milfoil occurred at a variety of abundances from trace (5) to sparse (4) to medium (4) and even dense (2). Brittle naiad was the next most common aquatic plant. It occurred at 13 (or 38%) of the sites, with nearly all of them being sparse or greater abundance, including three dense sites. Small duckweed occurred at 10 (or 29%) of the sites, along with eight trace sites of great duckweed mixed in. Coontail occurred at nine sites, but two sites were considered moderate density and another dense site was collected.

Northern naiad, wild celery, water chestnut and spatterdock all occurred at five or few sites. Most of the wild celery sites occurred along the shore of the northern docks. Rooted water chestnut plants were observed along the shore of the southern docks, and the spatterdock was restricted to the marsh area under the railroad bridge. Due to the increased aquatic plant diversity at this location, coupled with the nearby marsh area, **Marlboro Yacht Club should be a Moderate Priority for future hydrilla monitoring.**

Table 28 Minisceongo Yacht Club Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
5	Minisceongo Yacht Club	39	8/19/15	15.3	35

Minisceongo Yacht Club (Stony Point, RM 39) was surveyed on August 19th via canoe accessed at the boat launch at the Yacht Club. Future monitoring at this location could be accomplished via a power motor boat. We surveyed the Yacht Club marina cove, the outer shoreline of the

marina extending all the way to the bridge leading to Cedar Brook Pond (see discussion, above), and the private marina to the east. We surveyed 35 sites at this location, but only 12 (or 34%) supported aquatic plant growth. A reasonable distribution of trace (4), sparse (5) and medium sites (3) were collected. All sites, save for one, occurred along a shoreline, or the interior of one of the marinas. Four total aquatic plants were collected at this site.

Eurasian water milfoil and wild celery were the dominant aquatic plants collected at this location, each occurring at eight (or 23%) of the sites surveyed. Eurasian water milfoil occurred at six sites in the Minisceongo marina, and two sites near the Grassy Point Road Bridge. Wild celery was well established in the corner by the Grassy Point Road Bridge, with two more sites around the Minisceongo docks, and three more sites around the docks of the private marina. Coontail was located at two locations near the Grassy Point Road Bridge, and small duckweed was found accumulating between the docks and shore of the Minisceongo marina. Due to the limited SAV habitat in and around this location, the **Minisceongo Yacht Club should be a Low Priority for future hydrilla monitoring.** That said, since some SAV habitat was observed near the Grassy Point Bridge (adjacent to Cedar Brook Pond), perhaps some portions of the Stony Point Bay (such as the marinas and park shoreline) should be considered for future monitoring.

Table 29 Moodna Creek Bay Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
23	Moodna Creek Bay	57	9/14/15	49.0	68

Moodna Creek Bay (New Windsor, RM 57) was surveyed September 14th via canoe accessed at the car-top launch located near the Route 9W Bridge. All sites south of the Route 9W Bridge were considered the Moodna Creek Bay, while all sites north of the bridge were considered Moodna Creek (see below). We surveyed 68 sites at this location, primarily two extensive fingers of the creek that cut through a marsh area. Some additional sites were surveyed in the marsh, but access was restricted by islands and terrestrial growth. At the western side of this location is a railroad bridge that could provide access to the Hudson River, but this area was not surveyed due to high winds on the day of sampling. Aquatic plants were collected at 72% (or 49) of the sites, with 38% of the sites being considered medium of dense abundance. Compared to other locations surveyed during this project, Moodna Creek Bay had excellent diversity (for this project) with 11 different aquatic plants and benthic algae present.

Coontail was the dominant aquatic plant we collected, occurring at 22 (or 32%) of the sites surveyed. Over half the sites were trace density, but one medium and two dense sites were also collected. Coontail was scattered, but it more commonly occurred along margins and in small marsh streams. Eurasian water milfoil and small duckweed were both collected at 19 (or 28%) of the sites. Eurasian water milfoil, at medium or dense abundance at times, seemed to prefer the northern part of the larger finger. Small duckweed was scattered, typically at trace or sparse density, and often accumulating in corners, or along shorelines. Spatterdock occurred at 17 (or 25%) of the sites at varying abundances from trace to dense. A large dense patch of spatterdock filled a cove just northwest of sample point #38. This area could not be accessed

due to low tide, but we estimate a two acre spatterdock bed exists here. Common waterweed was also present, collected at 14 (or 21%) of the sites. Most sites were trace density, but a single dense site occurred off the main tributary of the creek, and along the west fork, two medium sites and a dense site was located in very shallow water as we neared the Route 9W Bridge.

Brittle naiad (nine sites, or 13%), benthic filamentous algae (seven sites), water stargrass (seven sites), arrowhead (submersed rosettes), great duckweed (four sites), water chestnut (three rooted sites), and common watermeal (one site) rounded out the aquatic plant community at this location. We also discovered a patch of long-leaf pondweed (*Potamogeton nodosus*) just south of the bridge, along a spit of land in the middle of the creek. However, no long-leaf pondweed was retrieved on any weed anchor tosses in this area. Due to the abundant SAV habitat, presence of common waterweed and high diversity of aquatic plants, **the Moodna Creek Bay should be a High Priority for future hydrilla monitoring.** Should additional surveys be conducted here, surveying the Hudson River sites on the opposite side of the railroad tracks is encouraged.

Table 30 Moodna Creek Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
22	Moodna Creek	57	9/14 & 23/15	13.0	16

Moodna Creek (New Windsor, RM 57) was surveyed September 14th via canoe accessed at the car-top launch located near the Route 9W Bridge. The upper part of the creek was surveyed September 23rd via kayak accessing near the Forge Hill Road Bridge. All sites south of the Route 9W Bridge were considered the Moodna Creek Bay, while all sites north of the bridge were considered Moodna Creek (see below). The Moodna Creek sites were more typical of a shallow swifter moving creek with a rocky bottom as opposed to the Moodna Creek Bay sites which were more sluggish and typical of a marsh. Due to the shallow nature of the creek and swift moving water, we could not safely access the middle portion of this site. Future surveys of this section would likely need to be conducted on foot. Sixteen sites were surveyed in the Moodna Creek. Aquatic plants were collected at all sixteen sites. Diversity was decreased, favoring species that could inhabit moving water with a rocky substrate.

Benthic filamentous algae occurred the most frequent. It was collected at 13 (or 81%) of the sites. Common waterweed was the most common true aquatic plant collected at this location, occurring at 75% of the sites. This included one medium site located just north of the Forge Hill Road Bridge. Water stargrass, Eurasian water milfoil, small duckweed and bassweed rounded out the aquatic plant community in the creek, all occurring at three or fewer sites. The bassweed bed located in the upper part of the creek represents the only finding of this aquatic plant during the entire project. **The Moodna Creek should be a Moderate Priority for future hydrilla monitoring** due to the faster moving water and the rocky substrate found at this location.

Table 31 Newburgh Boat Launch Site Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
14	Newburgh Boat Launch Site	60	9/1/15	5.2	12

The Newburgh Boat Launch Site (Newburgh, RM 60) was surveyed September 1st via canoe accessed at the boat launch located off Water Street. One site south, and 11 sites north of the boat launch were surveyed, with all sites being on the Hudson River. Water depth quickly exceeded 10 feet, so shoreline sites only were surveyed. Please note that the aerial photo with the data overlaid depicts a different configuration of the docks and barges (used as docks and buffers) at this site. At the boat launch numerous aquatic plant fragments were observed, including naiads, wild celery, duckweed and water chestnut. Three different aquatic plants were collected at this location.

Small duckweed was the most common aquatic plant observed at this site. It occurred at nine or 75% of the sites, with six trace and three sparse density. Two naiads were also collected: one site each of brittle naiad, and slender naiad both located just south of the boat launch. Numerous floating plant fragments were accumulating in this small cove, but we did not observe any rooted aquatic plants. Due to the lack of SAV habitat at this location, the **Newburgh Boat Launch Site should be a Low Priority for future hydrilla monitoring.**

Table 32 Norrie State Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
30	Norrie State Park	84	9/22/15	28.0	50

Norrie State Park (Staatsburgh, RM 84) was surveyed September 22nd via canoe accessed corner of the cove near the Environmental Center. This location included the massive water chestnut bed and cove south of the Environmental Center, the shoreline north, the northern cove and marina, the tidal creek up to the railroad tracks, and 600 feet of shoreline north. At this location, 50 sites were surveyed. Aquatic plants were collected at 40 (or 80%) of the sites with most sites (68%) being considered medium or dense abundance. Significant dead vegetation was recovered at several anchor tosses in the southern cove, likely remnants of the extensive water chestnut beds since dying back late in the season. Diversity was excellent here, with 11 different aquatic plants and benthic filamentous algae.

Small duckweed was the most common aquatic plant collected, occurring at 33 (or 66%) of the sample sites. Most sites were trace density (58%) but even a few medium and dense sites were observed. These occurred in the southern cove with most of the duckweed accumulating around floating water chestnut fragments. Brittle naiad occurred at 31 (or 62%) of the sites. Although only six trace sites of brittle naiad were collected, spares (9), medium (9) and dense (8) were much more common. Increased brittle naiad density occurred in the open water sites of the Hudson River plus in and around the docks of the marina in the north cove. Eurasian water milfoil occurred at 29 sites (or 58%) with a wide range of abundances. Eurasian water milfoil seemed to prefer the northern cove and tidal creek sites.

Coontail, great duckweed, northern naiad, and water chestnut all occurred between 30% and 36% of the sites surveyed. Many of these sites were at trace density, but water chestnut for example had two medium sites and a dense site as well. It's likely the water chestnut abundance, especially in the southern cove, was underestimated due to the extensive bed present earlier in the season, based on the author's personal observations.

Spatterdock, wild celery, water stargrass, benthic filamentous algae and common waterweed all occurred at few than six sites. It should be noted that two small plots of planted wild celery plots with exclosures were positioned in between points 21 and 22. We observed wild celery growth in both plots during our survey. It should also be noted that mud plantain (*Heteranthera reniformis*) was observed at several locations along the margins and in the water of the tidal creek, but none of these plants were collected on weed anchor tosses. Photographs of this plant were sent to C. Barre Hellquist for identification confirmation. Due to the excellent SAV habitat and abundant diverse aquatic plants collected at this location, **Norrie State Park should be a High Priority for future hydrilla monitoring.**

Table 33 Nyack Memorial Park Boat Launch Site Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
2	Nyack Mem. Park Boat LS	28	8/18/15	5.0	16

Nyack Memorial Park Boat Launch Site (Nyack, RM 28) was surveyed August 18th via canoe accessed at the public boat launch off Burd Street. Due to the suitable boat launch and deep water, in the future this site can be surveyed via a power motor boat. Our survey sites at this location were restricted to the two coves south of the boat launch and one cove north of the boat launch. Sixteen total sites were surveyed, with aquatic plants being collected at six (or 38%) of the sites. Three trace and three sparse sites were collected. All aquatic plant growth occurred at deeper water sites. Only one species of aquatic plant was collected; wild celery. The six wild celery sites were located in the open water between both southern coves. Due to the lack of suitable SAV habitat and low diversity of aquatic plants collected, **Nyack Memorial Park Boat Launch Site should be a Low Priority for future hydrilla monitoring.**

Table 34 Peekskill Land Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
20	Peekskill Land Park	43	9/8/15	19.0	30

Peekskill Land Park (Peekskill, RM 43) was surveyed September 8th via power motor boat accessed at the public boat launch at the nearby Riverfront Green Park off Hudson Ave. Thirty sites were surveyed at this location, encompassing the entire shoreline along the park, extending about 200 feet off the shore. Water depth typically exceeded 5.0 feet and since this was an open water Hudson River location, SAV habitat was limited. Aquatic plants were collected at only three (or 10%) of the sites surveyed. Three different rooted aquatic plants comprised the aquatic plant community at this location.

Eurasian water milfoil, wild celery, and coontail were all collected at two trace sites. These sites occurred either at the northern end of the location, among submerged docks and bulkhead, the interior of the middle cove, or by the metal docks at the southern end of the location. Floating aquatic plant fragments, mostly wild celery, but a few water chestnut and common waterweed fragments were observed during our survey. Due to the reduced SAV habitat at this location, **Peekskill Land Park should be a Low Priority for future hydrilla monitoring.**

Table 35 Piermont Marsh Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
9	Piermont Marsh	25	8/26/15	330.0	80

Piermont Marsh (Piermont, RM 25) was surveyed August 26th via canoe accessed at the NYSDEC car-top launch site off Paradise Ave. The marsh is very tidal, which restricted our time at this location. This location was 330 surface acres, although most of it was not open water. Our survey efforts focused on the two northern marsh creeks, the marsh creek about halfway down the location, the open water Hudson River shoreline, and the southern shoreline along the pier. We surveyed 80 sites, but only collected aquatic plants at 19 (or 24%) of the total sites. All sites were considered trace density, save one. Due to the wind, and outgoing tide, we did not survey south of the third marsh creek. Five different aquatic plants were collected, but all at very limited abundances. It's likely that the extreme tidal influence and shallow water limits SAV habitat at this location.

Spikerush and small duckweed were the two most common aquatic plants collected at this location, each occurring at eight (or 10%) of the sites. Spikerush was scattered about in several marsh creeks, while small duckweed was limited to the main creek used to access the site. Sago pondweed (three sites), ditch grass (two sites; this was the only occurrence of this aquatic plant during our project), and benthic filamentous algae (one site) rounded out the aquatic plant community at this location. Although there seems to be suitable SAV habitat in the marsh creeks, due to the lack of rooted aquatic plants collected (or observed) at this location, **Piermont Marsh should be a Low Priority for future Hydrilla monitoring.**

Table 36 Popolopen Creek Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
10	Popolopen Creek	46	8/27/15	13.0	35

Popolopen Creek (Fort Montgomery, RM 46) was surveyed August 27th via canoe accessed at base of the pedestrian bridge located on the Fort Montgomery State Historical Site. We had to carry our equipment down to the access site along a 550 foot rocky, steep road. We surveyed the creek as for upstream as possible, until we reached an impassable waterfall. A short hike up to the waterfall revealed a small pool, but no aquatic plants were observed growing here. We surveyed the entire creek, and even passed under the railroad tracks to survey a few points on the Hudson River. These few latter points had limited SAV habitat. Thirty five sites were

surveyed at this location. Aquatic plants were collected at 31 (or 89%) of the sites with just over half being considered trace density. Five sparse and seven medium sites were also collected along with a single dense site. Nine different aquatic plants and benthic filamentous algae occurred at this location.

Common waterweed was the dominant aquatic plant, collected at 22 (or 63%) of the total sites. At 14 (or 64%) of the sites, it was trace, with another three (or 14%) sparse sites recovered. Four medium (or 18%) and one dense (or 5%) site rounded out common waterweed abundance. Common waterweed was scattered about the creek, save for the upstream sties, and the sites near the railroad tracks. All samples of common waterweed were examined closely to confirm identification. Eurasian water milfoil occurred at 20 (or 57%) of the sites. At 11 (or 55%) of the sites it was trace density. Six (or 30%) of the sites were sparse, and three (or 15%) of the sites were medium density. Small duckweed (nine sites, or 26%) and coontail (seven sites, or 20%) were somewhat common at Popolopen Creek.

Water chestnut, spikerush, brittle naiad, wild celery, benthic filamentous algae and sago pondweed all occurred at three or fewer sites. The water chestnut sites (three, or 9%) were confirmed rooted plants. There were many floating fragments of water chestnut observed in the creek. It was surprising more water chestnut was not established in rooted beds. Due to the excellent SAV habitat and high occurrence of common waterweed, **Popolopen Creek should be a High Priority for future hydrilla monitoring.**

Table 37 Poughkeepsie Yacht Club Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
31	Poughkeepsie Yacht Club	83	9/24/15	39.0	40

Poughkeepsie Yacht Club (Hyde Park, RM 83) was surveyed September 24th via canoe accessed at the Yacht Club boat launch. According to the manager of the club, the water depth increases quickly a short distance off shore. So we limited our survey to the shoreline north and south of the club, including the two coves to the south, and the water chestnut bed to the north, and the areas around the docks. We surveyed 40 sites at this location, with aquatic plants being collected at 32 (or 80%) of the sites. Many sites (11, or 34%) were dense abundance, along with four (or 13%) at medium abundance. Trace and sparse sites accounted for 10 and seven sites, respectively. The dense sites were scattered, but typically occurred off the shoreline about 50 meters. Increased aquatic plants seemed to occur to the north. Eleven different aquatic plants were collected at this location, one of the highest diversity locations we surveyed during this project.

Brittle naiad was the dominant aquatic plant collected, occurring at 24 (or 60%) of the sites surveyed. Brittle naiad occurred at a wide range of abundances with 58% being trace or sparse, and 42% of the sites being medium or dense. Small duckweed occurred at 53% of the sites, also at various abundances. Most sparse and dense sites were observed north of the Yacht Club. Water chestnut was clearly dying back by the time of our survey. Still it occurred at 33% of the

sites. Water chestnut preferred the northern cove and shoreline (which is part of the large bed observed south of Norrie State Park), but there was a well-established bed along the southern part of the small cove just south of the club.

Great duckweed (12 sites), Eurasian water milfoil (11 sites), coontail (10 sites) and northern naiad (8 sites) all shared similar abundances. As did spatterdock, common waterweed, small bladderwort and water stargrass, each occurring at one or two sites. Due to the suitable SAV habitat, and diverse aquatic plants collected, the **Poughkeepsie Yacht Club should be a High Priority for future hydrilla monitoring efforts**.

Table 38 Riverfront Green Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
19	Riverfront Green Park	43	9/8/15	43.8	49

Riverfront Green Park (Peekskill, RM 43) was surveyed on September 8th via power motorboat, accessed at the park boat launch, located at the north end of the site. We surveyed the shoreline of the entire park, south to the marina (and around the docks), and the southern cove up to Charles Point Pier Park. Very little SAV habitat was present at this location, due to the water depth (typically greater than 5.0 feet) and the fact this is open to the Hudson River. We surveyed 49 sites, but only four sites (three trace and one sparse) had aquatic plants. Three different aquatic plants were collected.

Small duckweed was the most common aquatic plant observed at three (or 6%) of the total sites surveyed. All sites were trace density. Eurasian water milfoil was collected at two sites; one at trace density, the other at sparse density. The rooted sparse site was located at the southern corner of the park, behind the marina docks. One sparse rooted wild celery site was located in this area as well. Due to the lack of SAV habitat and the lack of rooted aquatic plants, **Riverfront Green Park should be a Low Priority for future hydrilla monitoring.**

Table 39 Riverfront Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
28	Riverfront Park	61	9/18/15	31.0	53

Riverfront Park (Beacon, RM 61) was surveyed on September 18th via canoe accessed at the car-top launch at the park. Although water depths were suitable for a power motor boat signage forbids the use of such power boats near the site. Three areas were surveyed, including the small access cove, the larger cove to the north, and part of the shoreline north that appeared to be good SAV habitat. We surveyed 53 total sites, and although we recovered aquatic plants at 89% of the sites, most of these occurrences were duckweeds and not true rooted aquatic plants (see below). We collected six different plants and benthic filamentous algae at this location.

Duckweeds were by far the most common aquatic plant observed here. Small duckweed was collected at 87% of the sites, while great duckweed was collected at 30%. Most sites were trace

and sparse density. Brittle naiad, northern naiad, water chestnut, benthic filamentous algae and wild celery were collected at six of fewer sites. The water chestnut abundance was likely underestimated at this location, as the beds were already dying back and breaking up. Numerous floating fragments and nutlets were present throughout the location and along the shore. Due to the lack of rooted aquatic plants, **Riverfront Park should be a Low Priority for future hydrilla monitoring.**

Table 40 Scarborough Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
44	Scarborough Park	31	10/9/15	0.7	6

Scarborough Park (Scarborough, RM 31) was surveyed October 9th via canoe accessed at the car-top access point (a set of stairs leading down to the Hudson River) at the Park. This location was surveyed due to its proximity to Kemey's Cove, and originally we planned to access the cove from the Hudson River under the railroad tracks. But on the day of the survey, high winds, rain and high tide forced use to seek alternate access for the cove (see above). Since we were on site, we still surveyed the shoreline around the park, although we did not find any rooted or floating aquatic plants on this date. The shoreline was massive jetty-like rocks, and water depth exceeded 4.o feet at most sites. Due to the lack of suitable SAV habitat, **Scarborough Park should be a Low Priority for future hydrilla monitoring.**

Table 41 Shepherd's Landing/Mariner's on the Hudson Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
38	Shepherd's Landing/Mariner's Hudson	76	9/29/15	8.0	15

Shepherd's Landing/Mariner's on the Hudson (Highland, RM 76) was surveyed on September 29th via canoe access at the Shepherd's Landing Park boat launch. This site could have been (and due to the current, probably should have been) surveyed by a power motor boat. The location included the Hudson River shoreline south of the park (including Mariner' on the Hudson, a restaurant), along the shoreline of the park, into a small creek north of the park, and the cove beyond. The water depth rapidly increases along this shoreline. About 50 meters off the shore the depth exceeded 60 feet! We surveyed 15 sites, close to the shore at this location, but only found aquatic plants at three (or 20%) of the sites. Only one aquatic plant (small duckweed at two trace sites) and benthic filamentous algae (one site) were collected. Due to the lack of SAV habitat and lack of aquatic plants, **Shepherd's Landing/Mariner's on Hudson should be a Low Priority for future hydrilla monitoring**.

Table 42 Sleightsburg Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
41	Sleightsburg Park	90	10/6/15	224.0	100

Sleightsburg Park (Kingston, RM 90) was surveyed on October 6th via power motorboat accessed at the Sleightsburg Park public boat launch site located off Everson Street on the

south side of the Roundout Creek. Surveyed areas included the margins of the Roundout Creek, the cove to the south and shoreline extending to the Canal Street Park, the cove behind the lighthouse, and the shoreline north to the mouth of the Kingston Point Park Marsh (see discussion, above). At these areas, 100 sites were surveyed, with aquatic plants occurring at 59% of the sites. About 33% of the sites were considered trace density and another 30% were sparse density. Medium and dense abundance sites accounted for 39% of the total sites. Heaviest aquatic plant growth was along the southern shore of the Roundout Creek, the cove behind the lighthouse, and the interior southern cove. Aquatic plants were absent along the northern shore of the Roundout Creek, where water depths frequently exceeded 10 feet. Twelve different aquatic plants were collected at this site.

Eurasian water milfoil was the dominant aquatic plant collected at this site, occurring at 41% of the sites. Half of these sites were at trace density, and 41% were sparse density. The remaining three sites were medium (1) and dense (2). Small duckweed was collected at 37% of the sites with nearly all of them being trace or sparse. Coontail was collected at 26% of the sites, with most being considered trace or sparse. Brittle naiad was collected at 23% of the sites. Water chestnut was collected at 20% of the sites, but only 40% of the sites were trace. Sparse (15%), medium (15%) and dense (30%) sites also occurred. It is likely that water chestnut was actually underestimated at this location, as some of the massive bed in the southern cove was breaking up, especially the exterior edges (the interior was still dense and difficult to motor through). One site was in the creek proper, and three sites (one being dense) was in the northern cove behind the lighthouse.

Common waterweed also occurred at 20% (or 20) of the sites. Many of these were trace density (70%), but some sparse (25%) and medium (5%) were collected. Most common waterweed sites were located along the creek marsh margins, or the southern cove marsh margins. All common waterweed samples collected were carefully examined to confirm identity. Spatterdock, wild celery, great duckweed, water stargrass, giant arrowhead (confirmed to species with flowers) and northern naiad rounded out the aquatic plant community on this date. Due to the excellent SAV habitat and diverse aquatic plants collected at this location, **Sleightsburg Park should be a High Priority for future hydrilla monitoring.**

Table 43 Vanderbilt Mansion Cove Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
42	Vanderbilt Mansion Cove	82	10/7/15	10.0	27

Vanderbilt Mansion Cove (Staatsburgh, RM 82) was surveyed via canoe on October 7th, accessed at the nearby Bard Rock launch site. This site was originally not part of the project, but was added after we could not access the cove of the FDR Historic Site, just to the south. We surveyed 27 sites in the 10 acre cove. At 19 (or 70%) of the sites, we collected aquatic plants. Eights (or 42%) of each trace and sparse abundance were collected, along with three (or 16%) medium sites. Eight different aquatic plants were collected at this location.

The dominant aquatic plant collected was small duckweed, which occurred at 13 (or 48%) of the sites. Most sites (85%) were trace density, but one sparse and one medium site were also present. Small duckweed was scattered about the cove, typically near the shoreline, or in the southern part of the cove. Water chestnut occurred at 11 (or 41%) of the sites, mostly along the eastern shore, and in the southern half of the cove. It is likely water chestnut abundance is higher in this cove, as the plants appeared to be dying back, plus personal communication with staff at the FDR Historical Site nearby.

Brittle naiad, great duckweed, spatterdock, coontail, Eurasian water milfoil and northern naiad all occurred at four or fewer sites at this location. Due to the reasonable SAV habitat and rooted aquatic plants collected, **Vanderbilt Mansion Cove should be a Moderate Priority for future hydrilla monitoring.**

Table 44 Vanderburgh Cove Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
43	Vanderburgh Cove	87	10/7/15	98.6	42

Vanderburgh Cove (Staatsburgh, RM 87) was surveyed on October 7th via canoe accessed off South Mill Road. We surveyed the entire cove, but a few locations were inaccessible at low tide or due to dense emergent plant growth. Access to the cove is limited although there was a bridge under the railroad. Still, most sites were shallow and marshy, so a canoe would be the preferred method for future surveys here. We surveyed 42 sites, and 41 (or 98%) of the sites contained at least trace density aquatic plant growth. Actually, most sites were medium (51%) or dense (20%) abundance, with trace and sparse sites only accounting for 29% of the sites. Eleven different aquatic plants were collected at this location.

Eurasian water milfoil and small duckweed were the dominant aquatic plants collected. Each occurred at 29 (or 69%) of the sites. Both species were typically collected at trace or sparse density. Both were scattered about the cove, but Eurasian water milfoil abundance was increased along the railroad tracks shore, and in the access stream. Coontail occurred at 24 (or 57%) of the sites, and water chestnut occurred at 50% (21) of the sites. As at previous locations, water chestnut abundance was likely reduced as the plants were dying back at the end of the season. Spatterdock was common in this cove, occurring at 19 sites, with an even distribution of trace, sparse, medium and dense sites. Spatterdock preferred the interior of the cove.

Great duckweed (12, or 29% of the sites), brittle naiad (nine or 21%) and common waterweed (nine, or 21%) all shared similar occurrence. Common waterweed was scattered about the cove and all samples were closely examined to confirm identity. Arrowhead (submersed rosettes lacking flowers), small bladderwort and white water lily rounded out the aquatic plant community at this location. Small bladderwort and white lily were both only collected at one additional location during this project. Due to the abundant aquatic plant diversity and growth at this location, **Vanderburgh Cove should be a High Priority for future hydrilla monitoring.**

Table 45 Viking Boat Yard Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
11	Viking Boat Yard	40	8/28/15	20.0	37

The Viking Boat Yard (Verplanck, RM 40) was surveyed on August 28th via canoe accessed at the boat yard. Most of the cove and around the docks were surveyed, but water depths were typically greater than 6.0 feet limiting aquatic plant growth throughout this location. Aquatic plants were collected at only one (or 3%) of the 37 sites surveyed. This site contained trace density rooted coontail and was located on the spit of land (a border with another nearby marina) at the east side of location. No floating aquatic plant fragments were observed either. Due to the lack of suitable SAV habitat and the lack of aquatic plants, the **Viking Boat Yard should be a Low Priority for future hydrilla monitoring.**

Table 46 Wappinger's Creek Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
29	Wappinger's Creek	67	9/21/15	94.3	50

Wappinger's Creek (New Hamburg, RM 67) was surveyed on September 21st via canoe accessed at the public boat launch located off Creek Road. The location was surveyed from the north (just past the industrial buildings, when the water became to shallow) to the south end at the railroad tracks, and near the railroad station. We did not go under the bridge to the open Hudson River, although there is a small cove and private marina that might warrant future monitoring at this nearby this location. We surveyed 50 sites, finding aquatic plants at most (41, or 82%) of the sites. Many of the sites that lacked aquatic plant growth were the deeper water channels of the creek. Trace sites only accounted for 10% of the sites, and sparse only accounted for 15%. Medium sites accounted for 24%, while dense abundance sites were the most common, accounting for over 50% of the sites with aquatic plant growth. Dense sites typically occurred along the margins of the creek and were likely influenced by abundant water chestnut beds and floating plants (duckweeds and watermeal) accumulating on the floating stems. This was the highest percentage of sites with dense growth we observed during the survey. Ten different aquatic plants and benthic filamentous algae occurred at this location.

Floating aquatic plants dominated the aquatic plant community at Wappinger's Creek. Small duckweed was collected at 40 (or 80%) of the sites, at varying abundances. At 50% of the small duckweed sites, the abundance was considered medium or dense. Great duckweed was the third most abundant aquatic plant, occurring at 26 (or 52%) of the sites. Most great duckweed sites were trace density. Common watermeal, a diminutive floating aquatic plant was collected at 19 or 38% of the sites. Water chestnut was the most common rooted aquatic plant collected. It occurred at 31 (or 62%) of the sites, with most sites (71%) being considered medium or dense abundance. Unlike other locations surveyed to this date, the water chestnut beds here were not dying back as completely, so we feel our data is close approximation of peak water chestnut growth. Coontail occurred at 22 (or 44%) of the sites and was scattered about the length of the

creek. Eurasian water milfoil was collected at 19 (or 38%) of the sites, with higher abundance located in the northern reach of the creek.

Spatterdock, brittle naiad, wild celery, common waterweed and benthic filamentous algae rounded out the aquatic plant community at this location, but all occurred at five or fewer sites. The single common waterweed site (medium abundance) was located at the mouth of a small tributary entering the creek just south of the access point. Due to the excellent SAV habitat and high abundance and distribution of the aquatic plants at this site, **Wappinger's Creek should be a High Priority for future hydrilla monitoring.**

Table 47 Waryas Park Summary

Location #	Location Name	River Marker	Date Surveyed	Acreage	# Sites Surveyed
31	Waryas Park	75	9/24/15	7.3	14

Waryas Park (Poughkeepsie, RM 75) was surveyed on September 24th via canoe accessed at the public boat launch located in the park. In the future, a power motor boat could easily be used at this location for surveys. Since this was an open water Hudson River site, only the shoreline sites were surveyed. Water depth rapidly increased a short distance off the rocky (jetty-like) shoreline. We surveyed 14 sites to the north (extending to Landing Park) and to the south (extending nearly to Kaal Rock Park). Aquatic plants were collected at 12 (or 86%) of the sites surveyed, but see the discussion below. All sites were trace density except for a sparse site (located at the mouth of a small tributary) and a medium site (located in the small tributary). Two different aquatic plants were collected at this location, although we observed numerous plant fragments (naiad species, water stargrass, duckweeds, and water chestnut) floating along the shore and accumulating at the boat launch.

Small duckweed was the dominant aquatic plant collected, occurring at 12 (or 86%) of the sites. Ten sites were trace, along with one sparse and one medium site, both located at the mouth or in the small tributary. Coontail was the only rooted aquatic plant collected at this location, accounting for one trace site located at the mouth of the tributary. Due to the lack suitable SAV habitat and the lack of aquatic plants, Waryas Park should be a **Low Priority for future hydrilla monitoring.**

Summary of Aquatic Plant Species Collected

Table 48 is summary of the occurrence of all aquatic plants collected during the 46 surveys of this project. The table includes common and scientific names, number of occurrences, the percent occurrences, and the number of locations each individual species was collected at. Small duckweed was the most common aquatic plant collected (at 31.8% of the sites at 35 locations), even though it is not considered a true rooted aquatic plant. Eurasian water milfoil was the most common rooted aquatic plant collected. Coontail was the third dominant aquatic

plant, and two more invasive species (water chestnut and brittle naiad) rounded out the top five. Most aquatic plants collected during this project occurred at less than 5% of the survey sites. Plant names in red indicate exotic invasive species, while plant names in green indicate macroscopic algae. All remaining plants are considered native species.

Table 48 Summary of Aquatic Plant Occurrences during 2015 Sampling

Common Name	Scientific Name	# Occurrences	% Occurrence	# Locations
Small Duckweed	*Lemna minor*	585	31.8%	35
Eurasian Water Milfoil	*Myriophyllum spicatum*	517	28.1%	35
Coontail	*Ceratophyllum demersum*	358	19.5%	33
Water Chestnut	*Trapa natans*	209	11.4%	18
Brittle Naiad	*Najas minor*	184	10.0%	19
Common Waterweed	*Elodea canadensis*	179	9.7%	17
Wild Celery	*Vallisneria americana*	169	9.2%	23
Great Duckweed	*Spirodela polyrhiza*	158	8.6%	16
Spatterdock	*Nuphar variegata*	110	5.9%	15
Common Watermeal	*Wolffia columbiana*	66	3.6%	4
Horned Pondweed	*Zannichellia palustris*	64	3.5%	7
Northern Naiad	*Najas gracillima*	61	3.3%	12
Benthic Filamentous Algae		59	3.2%	19
Water Fern	*Azolla caroliniana*	38	2.1%	2
Spikerush sp.	*Eleocharis* sp.	22	1.2%	3
Water Stargrass	*Zosterella dubia*	20	1.1%	6
Sago Pondweed	*Stuckenia pectinata*	18	0.9%	7
Arrowhead (rosette)	*Sagittaria sp.*	10	0.5%	3
Giant Arrowhead	*Sagittaria montevidensis* ssp *spongiosa*	9	0.5%	3
Heart Pondweed	*Potamogeton perfoliatus*	5	0.3%	1
Slender Naiad	*Najas flexilis*	3	0.2%	3
Curly-leaf Pondweed	*Potamogeton crispus*	2	0.1%	2
White Lily	*Nymphaea odorata*	2	0.1%	2
Ditch Grass	*Ruppia maritima*	2	0.1%	1
Small Bladderwort	*Utricularia minor*	2	0.1%	2
Stonewort	*Nitella* sp.	1	0.1%	1
Watermoss	*Fontinalis* sp.	1	0.1%	1
Bassweed	*Potamogeton amplifolius*	1	0.1%	1
Long-leaf pondweed	*Potamogeton nodosus*	0	0.0%	1

Future Hydrilla Monitoring

The individual location discussions above all conclude with our recommendations on the frequency of future monitoring. These are merely our suggestions, and are based on several factors. These factors include the amount of suitable SAV habitat at a location (which in turn is

highly influenced by wave action, tidal influences including salinity, substrate composition turbidity and shoreline characteristics), the presence of rooted aquatic plants, the diversity of rooted aquatic plants, the presence of common waterweed (which can easily be confused with Hydrilla), and the proximity of the location to the Croton River (and which bank of the Hudson is on). Table 49 is a summary of the Locations according to Low, Moderate, or High Priority.

Table 49 Future Hydrilla Monitoring Location Priority List

Low Priority	Moderate Priority	High Priority
Nyack Memorial Park BLS	Bowline Point Park	Half-moon Bay
Haverstraw Bay Park	Cedar Brook Pond	Georges Island Park
Haverstraw Marina	Moodna Creek	Popolopen Creek
Minisceongo Yacht Club	Hyde Park Marina	Lent's Cove
Piermont Marsh	Fishkill Creek Bay	Dickie Brook
Viking Boat Yard	Marlboro Yacht Club	Croton Bay
Newburgh Boat Launch Site	Vanderbilt Mansion Cove	Annsville Creek
Front Street Marina		Iona Marsh
Sloop Hill Boat Launch Site		Moodna Creek Bay
Riverfront Green Park		Constitution Marsh
Peekskill Land Park		Foundry Cove Bay
Denning's Point Bay		Foundry Cove
Riverfront Park		Wappinger's Creek
Waryas Park		Norrie State Park
Chelsea Boat Launch Site		Black Creek Preserve
Shepherd's Landing/Mariners		Fishkill Creek
Charles Rider Boat Launch Site		Sleightsburg Park
Scarborough Park		Vanderburgh Cove
		Kemey's Cove
		Kingston Point Park Marsh
		Poughkeepsie Yacht Club

Croton River/Bay Hydrilla Tuber Monitoring

On October 12 and 13, 2015 a monoecious hydrilla tuber survey was initiated on the Croton River and Croton Bay, NY. A total of seven sites were selected ranging from Black Rock State Park (BRSP) down to uppermost part of Croton Bay (Figures 1-3). A 4" sediment core sampler was used to collect samples that were then sieved, and all tubers and turions were collected and counted. Results are represented as tubers per square meter (T/m^2). Higher tuber density represents a greater number of vegetative plants, greater reproduction potential, and possibly the duration of the infestation. In other words an older infestation tends to have buiklt up a larger tuber bank over time as compared to a newer infestation. Unlike most other aquatic plants, the production of tubers is crucial to the over-wintering of hydrilla. Since many control

techniques don't impact the tuber bank in the sediment, tracking the changes in tuber density over time is an important step to determine the efficiacy of the control technique.

Tubers were not detected in the two sites at which hydrilla biomass had been previously detected west of the railroad bridge separating the lower Croton River and upper Croton Bay. Upon scouting the immediate area, no rooted or floating hydrilla fragments were found to help direct further sampling in this region. The three sites in the lower Croton River were found to have tuber densities ranging from 31 to nearly 300 tubers/m^2 (Table 50). The two sites in BRSP had densities of 161 and 284 T/m^2.

Black Rock State Park had a large amount of topped out hydrilla, much more than was seen in the lower Croton River. The sediment makeup in BRSP was fine gravel to medium sized rocks with very little orgainc matter.

The sites on the Lower Croton had sediment consisting of fine gravel, sand with a fair amount of organic material. The area is tidal influenced and at high tide when sampled, these sites they were 6-7 feet in depth.

Table 50 Croton River/Bay Tuber Sampling Site Locations and Tuber Densities.

Site	Lat	Long	Cores	Tubers	Turions	T/M^2
1	41.214597	-73.866178	10	13	1	161.499
2	41.214573	-73.865622	28	64	0	283.9543
3	41.195797	-73.873283	8	2	0	31.0575
4	41.196178	-73.872963	10	24	0	298.152
5	41.196262	-73.872559	10	7	0	86.961
6	41.181061	-73.878967	10	0	0	0
7	41.180119	-73.878143	10	0	0	0

Monoecious hydrilla tuber densites range in North Carolina lakes from approximately 300-700 T/m^2 in Lake Gaston which uses both herbicides and grass carp to control the hydrilla to over 3,200 T/m^2 in Shearon Harris reservoir which is umanaged. For further comparison, tuber densities at the Cayuga Inlet infestation in early in 2011 and 2012 ranged from 150 T/m^2 to 809 T/M^2. However, these samples were collected using the Haller Hydrilla Sediment Corer (a post-hole digger), which samples a reduced surface area (173 cm^2) which was then calculated to m^2 (Johnson, 2014). Densities could be supressed on the Croton due to 1) this being a relatively new infestion, 2) the sediment and salinity having a fitness cost on the hydrilla and 3) the fluctuating water from tidal influences could be reducing the available habitat.

For future tuber monitoring at this site, it is recommended that the tuber survey be expanded to include sites of known infestation in the New Croton Reservoir. Thus, three tuber monitoring

locations are recommended: The New Croton Reservoir, The Croton River (Black Rock Park, and the lower river) and the Croton Bay. The New Croton Reservoir sites and (new) sites in the Croton Bay need to be established in 2016. The Black Rock Park and Lower River sites utilized in 2015 should form a base for exapanded monitoring in 2016. Once these sites are assigned, they should become the standard for following years monitoring programs.

A good baseline and yearly tracking of densities can aid in planning the management needed to achieve either eradication where feasible or strong maintenance control that would improve habitat and reduce risk of further spread within the watershed or other regional sites within the adjacent Hudson River. Future tuber sampling in the lower Croton River should also be timed for mid-tide (or when water clarity is favorable) to improve visual location of dense hydrilla and assisting navigation to monitored locations. Also, final planning of future tuber survey efforts should ideally immediately follow a recent mid-late summer vegetation survey to help locate potential new sampling sites.

Figure 1. Black Rock State Park Tuber Sampling Sites.

Figure 2. Lower Croton River Tuber Sampling Sites.

Figure 3. Upper Croton Bay Tuber Sampling Sites.

Summary of Findings

- From mid-August to mid-October, 2015 Allied Biological conducted GPS-referenced Submersed Aquatic Plant Point Intercept Surveys at 46 locations along a 70 mile stretch of the Hudson River.
- Of the original 43 locations, all were surveyed except for the Cove at the FDR Historical Site, which could not be accessed due to beaver activity. Four replacement sites (following verbal approval from the NYSDEC) were added to the project: Vanderbilt Mansion Cove, Kemey's Cove, Scarborough Park, and Kingston Point Park Marsh.
- A total of 1,838 GPS-referenced sampling sites were surveyed throughout the 46 project locations. Aquatic plants were collected at 1,102 (or 59.95%) of the sites surveyed.
- Twenty-seven different aquatic plants plus two macro-algae were collected during the surveys. Aquatic plant diversity ranged from zero to 12 different species per location.
- **No Hydrilla was collected or observed at any of the 46 locations surveyed in 2015.**
- Small duckweed (although not a true rooted aquatic plant) was the most common species collected, occurring at 35 locations and 585 (31.8%) of the sites surveyed.
- Eurasian water milfoil was collected at 35 locations and 517 (28.1%) of the sites surveyed.
- Wild celery, a desirable native species of concern was collected at 23 locations and 169 (9.2%) of the sites.
- The author of this report ranked all of the 2015 sampling locations low, moderate or high priorities for potential future monitoring efforts.
- Tuber monitoring was conducted at seven sites in 2015. Two sites were located in Black Rock Park, three sites in the Lower River, and two sites in the Croton Bay.
- Hydrilla tuber densities ranged from 0.0 to 283.95 tubers per m^2. Higher densities were collected at Black Rock Park sites, and no tubers were collected in the Croton Bay.

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