2012-13 Cayuga Inlet Hydrilla Eradication Project:

Monitoring Plan

DRAFT

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Introduction

Monitoring is an important component of the larger hydrilla eradication project being conducted in the Cayuga Inlet area, in response to the finding of *Hydrilla verticillata* in early August of 2011. The key elements of a Cayuga Inlet Monitoring Plan in association with the hydrilla eradication project would involve monitoring of the presence and abundance of specific aquatic plant species, hydrilla reproductive tubers, and residual from any aquatic herbicides used for the eradication project. While there are multiple methods available for evaluating plants, tubers, and pesticide residuals, each of these methods exhibit significant advantages and disadvantages to be evaluated in light of monitoring objectives, available resources, monitoring expertise, and available monitoring windows. Each of the methods summarized below reflects the consensus from the monitoring subgroup of the Cayuga Inlet Task Force, external peer reviewers, and accepted methodologies described in the open literature. The methods chosen are believed to be the most effective (feasible, cost effective, and reproducible) methods to satisfy the objectives described in the next section. Where appropriate, "ideal" monitoring strategies are outlined here, with scaled-down options presented in recognition of the potential logistic, fiscal, or temporal limitations cited above. However, the "minimum" strategies described here represent monitoring that would still satisfy the most critical objectives for the monitoring plan.

Objectives

The three monitoring elements described below--plant monitoring, tuber/turion monitoring, and residual monitoring—will meet slightly different objectives, and these objectives may also differ spatially.

Plant monitoring in the proposed treatment area and in the lake needs to evaluate the impact of eradication actions—chemical, physical, or biological control measures-- on hydrilla and the native or resident aquatic plant community, within the 2012 growing season and eventually in future years. This impact should be assessed for both the quality of the flora community (diversity of plants, survival of individual plant species) and the abundance of hydrilla and resident plant community. The growth cycle of the hydrilla—timing of initial tuber/turion germination, impact of eradication actions on tuber/turion re-germination, biomass senescence, and turion production—should also be evaluated as part of the plant

(rake-toss) monitoring and tuber/turion (post-hole) monitoring within the treatment area. This can largely be achieved at a macro scale, provided that it encompasses the entirety of the treatment area. Tuber/turion monitoring within the treatment area is also intended to quantify long-term hydrilla survival rate and to predict future hydrilla colonization.

Outside the treatment area—the south shelf of Cayuga Lake and surrounding waterways—the primary objectives of plant monitoring is to detect any new hydrilla formation at as fine a scale as possible, since it is assumed that an early detection network would find single (pioneering) fragments of hydrilla rooted in isolation. An ideal monitoring plan—with unlimited resources and a sufficient window to allow monitoring to occur only during ideal conditions regarding water temperatures, surface waves, and peak underwater visibility—would deploy diving crews trained in aquatic plant monitoring and experienced in distinguishing monoecious hydrilla from lookalikes common to Cayuga Lake, with limited supplemental rake toss monitoring. However, no monitoring projects possess the resources, "good fortune" of perpetually ideal conditions, and extensive surveyor expertise to implement this monitoring plan. A more realistic monitoring plan entails the use of fine scale point-intercept rake toss monitoring supplemented with diver surveys to validate rake toss data and investigate rake toss "hits" to delineate and fully document hydrilla infestations.

In addition, monitoring will provide public outreach by engaging volunteers and advocacy groups, to generate information to share with the public, and communicate a consistent and trustable message. The inclusion of volunteers in the process will enhance trust, offer a structured way for people to participate if they wish, and open doors to local support, both in-kind service and sponsorships, for the program. It is anticipated that, over the course of the expected 7-10 year project, this will reap significant benefits for overall sustainability of the eradication project.

Chemical residual monitoring is expected to evaluate whether effective dosage rates are maintained to maximize the likelihood of sufficient herbicide exposure for adequate control, while determining the herbicide distribution and dosage or the need for "bump" applications. This monitoring is also intended to safeguard public safety at water intakes and, if appropriate, swimming areas, by comparison against existing state water quality standards and/or maximum allowable contaminant levels associated with the specific herbicides.

Index Sites

Index sites are often assigned as part of larger monitoring programs to assure consistent information on which to base "decisions"- evaluation of trends, initiation of management actions, etc.- by assuring that representative sites are always included in the monitoring program. If all sites are sampled—i.e. a complete population is surveyed—then index sites are less important, but the establishment of index sites provides greater assurance that

subsampling includes sampling sites that represent the range of environmental characteristics—sediment type, water depth, plant densities and diversity, flow regimes, etc.—encountered in the areas of concern (the proposed treatment area, Cayuga Inlet and connected waterways, and the south shelf of Cayuga Lake).

Distinctions between Plant and Tuber Monitoring

The proposed monitoring plan below identifies monitoring methods to evaluate aquatic plant and hydrilla tuber/turion populations. During the majority of the sampling period, plant sampling will be accomplished by a combination of rake tossing and plant inspection through hand removal by divers or waders, and tuber/turion monitoring will be accomplished through the use of post-hole diggers. However, during the time of the year when hydrilla growth consists primarily of tuber/turion germination and sprouting—generally early in the growing season—sampling will be accomplished by a combination of these "plant sampling" and "tuber sampling" techniques, depending on site access, water depth, and other factors. The primary purpose of hydrilla monitoring when the plant is found at this growth stage is to evaluate the proper time to initiate management actions. Although it is probably more accurately characterized as tuber/turion germination monitoring, the monitoring will be labeled as "pre-management hydrilla monitoring" as part of the plan described below.

The monitoring conducted to characterize the condition of the aquatic plant or tuber/turion community in advance of management actions may occur in the growing season prior to initiating management actions (summer before). This monitoring may also occur immediately prior to initiating these actions (spring through fall, depending on the timing of the action). In both cases, this can be conducted to track conditions over a consistent time frame (trend evaluation). For the purposes of this plan, this is labeled "trend monitoring".

Role of Volunteer Monitors

The successful management and potential eradication of hydrilla in the Cayuga Inlet and especially surrounding waterways relies very heavily on the early detection of (and rapid response to) pioneering introductions. Volunteer monitors—those with ready access to potential colonization sites and a working familiarity with the visual characteristics of hydrilla- are critical to establishing an early detection network to protect surrounding waterways and engaging the public in the Cayuga Inlet eradication project. This can be accomplished by conducting plant identification workshops in multiple locations in the vicinity of Cayuga Inlet, generating sampling teams to work within the established monitoring framework, particularly through the Cayuga Lake Floating Classroom, providing instructions and tools for monitors to fan out to waterbodies (or portions of waterbodies) not

explicitly covered within the Cayuga Inlet monitoring framework, and establishing a network for sampling site assignments, plant verification, and remote electronic data entry. However, although volunteer monitors are vitally important in this process, it is equally important to avoid compromising the sample and data collection necessary to meet the objectives described above.

Volunteer monitors within the geographic boundaries of the monitoring framework described below may contribute to the project dataset if they are working within established monitoring teams under the direction of the monitoring program, or are responding to a stated need pursuant to the monitoring plan. Additionally, volunteer monitors may also provide support in susceptible areas-near boat launch sites, heavily trafficked areas and at unsampled waterbodies-not included within this sampling framework. The primary goal of this "undirected" volunteer monitoring, however, should be to identify suspicious plants at locations warranting further investigation by established monitoring teams, rather than to collect data for the explicit purpose of driving decision-making associated with management or trend evaluation.

Expected Monitoring Costs

Monitoring costs are expected to average about $20-30 per site for the rake toss monitoring. Some of these costs can be minimized by deploying trained interns and non-monitoring staff to compile data, upload to local and iMapInvasives databases, and to provide assistance in final report generation.

Tuber and turion monitoring costs are more difficult to predict, given the high variability in the size and depth of the tubers and turions, unpredictable substrate conditions, and the time sensitivity of the monitoring results to drive management decisions. It is anticipated that tuber sites will require approximately 8 hours of staff time every 1-2 weeks, with more concentrated sampling (processing time and distribution of sites) prior to treatment to establish accurate pre-treatment data to inform herbicide application timetables.

Diver survey costs are expected to average about $1000 per hour of diver time. Chemical residual monitoring costs are not calculated for the purposes of this plan, but are built into the hydrilla management plan budget.

Proposed Monitoring

The proposed monitoring plan discussed below outlines the key components of an aquatic plant, tuber/turion, and pesticide residual monitoring elements. Where appropriate, “ideal”

monitoring is distinguished from “likely” and “minimum” monitoring activities; the latter refers to the least extensive monitoring necessary to meet the objectives outlined above.

1. 2012 Proposed Cayuga Inlet Treatment Area- 166 acres- and upstream sites
    a. Plant Monitoring- USACE-Cornell point-intercept rake toss methodology exceeding NYSDEC Tier I criteria
        i. **Sampler(s)**
            - Racine-Johnson Aquatic Ecologists
            - Cayuga Lake Floating Classroom
            - Ichthylogical Associates
            - local volunteers (upstream of 166 acre area)
        ii. **Sampling method**
            - point-intercept rake toss monitoring, 2 rake tosses per site
        iii. **Sampling frequency**-
            - Pre-management hydrilla monitoring- conducted starting in the spring of 2012 until the use of "primary" management actions, and continuing periodically through the fall.
            - Trend monitoring- conducted in late summer/early fall of 2012, after the application of all localized management actions (herbicides, benthic barriers, hand harvesting) but before the completion of any sustained herbicide "drip"
        iv. **Sample site distribution and location**-
            - **Ideal**- 1 per 50m x 50m grid overlay (appx. 300 sites), equally distributed throughout proposed treatment area, with index sites identified in appx. 1 ha grid increments (up to 75 sites)
            - **Likely**- up to 1 per 50m x 50m grid overlay (appx. 75-300 sites), equally distributed throughout proposed treatment area, with index sites identified in appx. 1 ha grid increments (up to 75 sites)
            - **Minimum**- 1 per each bed of dense hydrilla beds locations (up to 75 sites)
        v. **Site identification**
            - GPS coordinates, NAD83
        vi. **Site mapping and bookkeeping**-
            - All hydrilla sites uploaded to iMapInvasives database; hydrilla overlay maps generated by 12/31/1
            - Plant presence and abundance from the recorded field sheets uploaded to Excel from each sample site and archive field sheets
        vii. **Plant identifications**-
            - **Ideal**- all plants identified to species level
            - **Likely**- hydrilla, other exotics and lookalikes (*Elodea* sp, *Najas quadalupensis*) identified to species level, all others identified to genus

- **Minimum**- hydrilla only identified (to species level)- all others not identified but assessed *in toto* to abundance scale

viii. **Plant abundance**-
- **Ideal**- USACE-Cornell abundance scale with dry biomass measured for 25% of sites
- **Likely and Minimum**- USACE-Cornell abundance scale

ix. Archiving-
- **Ideal-** voucher specimen collected for all plants
- **Likely-** voucher specimen for hydrilla and "representative" other exotics and lookalikes
- **Minimum-** voucher specimen for hydrilla only

x. Reporting-
- **Ideal and likely**- summary report provided to NYSDEC by 12/31/12
- **Minimum-** no reporting required

b. Tuber Monitoring- USACE-Cornell point-intercept post hole digger sampling. Not required by NYSDEC but in support of adaptive management actions

i. Sampler
- Racine-Johnson Aquatic Ecologists

ii. **Sampling method**
- Post-hole samples, 25cm depth, 173 cm^2 cross-sectional area
- 10 post-hole samples per site to establish current seasonal tuber/turion densities
- 3 post-hole samples at each of four monitoring sites per week to be washed and screened after density established

iii. **Sampling frequency**-
- Pre-management hydrilla monitoring: conducted starting in the spring of 2012 until the use of "primary" management actions, and continuing periodically through the fall (latter subset sampled as trend sites)
- Trend monitoring: sampling conducted during period of summer sustained (drip herbicide) treatment in late summer through late fall 2012

iv. **Sample site distribution and location**-
- Pre-treatment hydrilla monitoring: index sites distributed throughout proposed treatment area, over range of depths, sediment types, flow rates

- Trend monitoring: one site per major hydrilla bed (most to all sites also sampled pre-management index site

v. **Site identification**
   - GPS coordinates, NAD83

vi. **Site mapping and bookkeeping**
   - Excel database, hydrilla tuber overlay maps generated by 12/31/12

vii. **Tuber identifications**
   - NA- all tubers assumed to be hydrilla

viii. **Archiving**
   - specimen stored at Johnson-Racine laboratories

ix. **Reporting**
   - summary report provided to NYSDEC by 12/31/12

c. Chemical Residual Monitoring-

i. **Samplers**
   - Tompkins County SWCD, Allied Biological

ii. **Sampling method**
   - surface grab sample

iii. **Sampling frequency**- post treatment
   - **Endothall**:
     a. Treatment efficacy monitoring- 24-48 hours after initial "upper treatment area" endothall application to evaluate need for additional "lower treatment area" dosage to assure 3 ppm concentrations
     b. Public safety monitoring- 13 sites sampled daily for three days
   - **Fluridone**:
     a. Treatment efficacy monitoring-10 samples sites weekly for first 8 weeks; 5 sites weekly for balance of 14 weeks of metered application
     b. Public safety monitoring- to add based on feedback from site investigation

iv. **Sample site distribution and location**- see maps in Attachment C
   - **Endothall**:
     a. Treatment efficacy monitoring- select locations within 166 acre treatment area to assure sufficient endothall dosage- site selections determined at time of treatment based on dosage map and location of densest hydrilla beds

b. Public safety monitoring- 8 sites in south end of lake /3 sites south end of Inlet/1 site Cascadilla Creek/1 site Fall Creek

- **Fluridone**:
  a. Treatment efficacy monitoring: 10 sample sites
  b. Public safety monitoring: see Tompkins County DOH monitoring plan

v. **Site identification - presume TC SWCD will do in coordination with DEC and LTF**
- GPS coordinates, NAD83

vi. **Site mapping and bookkeeping – TC SWCD**
- Excel database, data and maps uploaded to CCE Tompkins County (Cayuga Inlet Outreach) website

vii. Reporting – Who? TC HD? TC SWCD
- summary report provided to NYSDEC by 12/31/12

2. Cayuga Lake- south shelf and shoreline to yacht club (west) and Bolton Point east (and miscellaneous focused sampling)- 280 hectares (appx. 600-700 acres)

d. Plant Monitoring- USACE-Cornell point-intercept rake toss methodology exceeding NYSDEC Tier I criteria and diver swimover surveys

i. **Sampler(s)**-
- Racine-Johnson Aquatic Ecologists
- Cayuga Lake Floating Classroom (including volunteer monitors)
- Ichthylogical Associates
- Dive team(s)
- Volunteers along shoreline outside shelf

ii. **Sampling method**-
- **Ideal**- diver swimover surveys covering the entire 280 hectare areas, supplemented by point-intercept rake toss monitoring to calibrate Inlet plant survey results, 2 rake tosses per site, and networked/directed shoreline/boat launch volunteer monitors
- **Likely**- point-intercept rake toss monitoring (2 rake tosses per site) supplemented by volunteer monitors with up to 10% verification by diver swimover surveys and diver investigation of any point-intercept hits
- **Minimum**- point-intercept rake toss monitoring, 1-2 rake tosses per site, and visual shoreline observation by ID workshop-trained volunteers

iii. **Sampling frequency**-

- Pre-management hydrilla monitoring: none planned
- Trend monitoring:
    a. **Ideal-** primary monitoring conducted in 3rd week June to 3rd week July, 2012, index sites (drawn from entire population sampling grid) re-sampled in the fall (Floating Classroom), supplemented with shoreline/volunteer monitoring throughout hydrilla growing season
    b. **Likely**- primary monitoring conducted in 3rd week June to 3rd week July, 2012), supplemented with shoreline/volunteer monitoring throughout hydrilla growing season (with some directed through Floating Classroom)
    c. **Minimum**- primary monitoring conducted in 3rd week June to 3rd week July, 2012)

iv. **Sample site distribution and location**-

- **Ideal**- diver swimover survey visually observing entirety of south shelf supplemented by 1 per 10m x 10m grid (appx. 25,000 sites), equally distributed at 10% of sites throughout south end of lake, and supplemented by directed systematic monitoring by volunteers at each South shelf shoreline property and all launch sites on lake; specific targeted sampling at key sites (Poison Ivy Point, Crowbar Point, shoreline sampling, etc.)
- **Likely**- 1 per 50m x 50m grid (appx. 1600 sites), equally distributed equally throughout south end of lake, supplemented by volunteer monitoring at shoreline properties and launches, with up to 10% of sites and all hydrilla hits surveyed by divers, specific targeted sampling at key sites (Poison Ivy Point, Crowbar Point, shoreline sampling, etc.)
- **Minimum**- 1 per 100m x 100m grid (appx. 250 sites), equally distributed equally throughout south end of lake, supplemented by marginally -directed volunteer monitoring along shoreline

v. **Site identification**-

- **Ideal and Likely**- GPS coordinates, NAD83
- **Minimum**- GPS coordinates, NAD83 for professionally monitoring sites, location description by volunteers

vi. **Site mapping and bookkeeping**-

- all hydrilla sites uploaded to iMapInvasives database; hydrilla overlay maps generated by 12/31/12
- Plant presence and abundance from the recorded field sheets uploaded to Excel from each sample site and archive field sheets.

vii. **Plant identifications**-

- **Ideal**- all plants identified to species level
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x. Reporting-

- **Ideal and likely**- summary report provided to NYSDEC by 12/31/12
- **Minimum-** no reporting required

Glossary

Benthic barriers: mats or screens that are placed on a stream or lake bottom to kill aquatic plants by blocking their access to light during the growing season, most effective when used in small areas (such as between docks or when a new population is found)

Biomass: The total mass of living organisms within an environmental area

"Bump" application - re-application of herbicide to maintain desired concentrations throughout the treatment period. "Bump" applications may not be at the same volume or concentrations as initial treatments and will be determined based on water quality sampling results.

Chemical, Physical, or Biological control measures *(separate?)*

- Biological – reduce the growth of the plants by introducing a predator – *e.g.* grass carp and weevils will eat hydrilla
- Physical/Mechanical – intended to impact the plant's ability to grow by altering the light, soil, or water conditionals or physically removing the plants (and/or roots) – *e.g.* dredging, harvesting (divers), drawdowns
- Chemical – aim to kill the plants by applying herbicides

**more info on stophydrilla.org under Fighting Hydrilla*

Dioecious hydrilla: A population that has separate reproductive units; individual plants are either male or female and cannot self-fertilize. Hydrilla (which has only 1 species in the world) has both dioecious and monoecious types. The dioecious has female flowering plants and originated in Southern India. It was often used in aquariums and is thought to have been dumped in Miami and Tampa in the 1950s. From there it has spread and found in much of the Southern US.

Diver swimover survey: Surveying done by divers that examine plant occurrence and abundance through different depths at representative points throughout the water body. *Methodology:*http://el.erdc.usace.army.mil/aqua/apis/Ecology/PlantSampling/VegetationMonitoring/AquaticPlantMethodologicalOverviewMain.aspx#DiverSwimOver *** This may be deleted from the 2013 monitoring plan based on the latest feedback from John Madsen.*

Effective Dosage Rates (herbicide):

- Endothall – Tompkins County Soil and Water Conservation district is proposing an application rate of 3.0 ppm, the recommended dosage for hydrilla on the Aquathol K label (NY label: http://ccetompkins.org/sites/all/files/8/aquathol-k-ny.pdf)
- Fluridone – It is being applied at a low dose (2-8 ppb) through three metered injection units: one at the DEC fish ladder, one on Cascadilla Creek, one on Six Mile Creek, and throughout this treatment area until for about 4 months. In order for the treatment to be successful, the concentration of fluridone in the water must remain within this range throughout this time period.

Endothall: a selective contact herbicide that is being applied to the Cayuga Inlet in the continued effort to eradicate hydrilla. Endothall kills the growing green vegetation that it contacts in the

water. Hydrilla is much more sensitive to the effects of endothall than most native plants. The application of the chemical occurs below the surface of the water and is conducted by licensed herbicide applicators over 36 hours. The chemical degrades naturally by bacterial action in the water, and has a half-life ranging from 5 to 8 days. (stophydrilla.org)

Fine scale point-intercept rake toss: A means of sampling by pre-selecting points (usually by GPS) in grid form in order to keep consistency and clearly plot the data later. *Example of Point-Intercept/Line-Intercept methods (Feb, 2009):* http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA361270

Fluridone: a selective systemic herbicide that is being applied to the Cayuga Inlet in the continued effort to eradicate hydrilla. Fluridone has been used to control invasive plants, including hydrilla where it has shown up in New York lakes and other parts of the United States. The chemical is a slow-acting herbicide, effective over long time periods at very low concentrations. It is absorbed through submersed shoots and roots, and is then transported throughout the plant, where it acts by inhibiting photosynthesis. Evidence of plant damage may appear within 7-10 days of application, but 30-90 days of continuous application is required to kill the plants. (stophydrilla.org)

Germination: process by which a dormant reproductive structure begins to sprout and grow under the right growing conditions

Herbicide "drip": Application of herbicide at low concentrations over a sustained period of time using injector units in the upstream portions of the treatment area. Stream flow carries the herbicide throughout the treatment area.

iMapInvasives database: New York State's online all-taxa invasive species database and mapping tool found at http://www.nyimapinvasives.org/
The comprehensive database can be used for:

- the collection, distribution and analysis of invasive species observation, survey, assessment and treatment data
- the coordination of early detection and rapid response efforts though email alerts
- analysis in GIS and modeling programs

Maximum Allowable Contaminate level: Highest allowable concentration of certain contaminants in water (usually pertaining to public drinking water supply)

Monoecious hydrilla: Each individual has both reproductive units that are merely female *and* reproductive units that are merely male. Monecious hydrilla is thought to have originated in Korea and was introduced in the US decades later than the dioecious strand in the Potomac Basin and no spans north from South Carolina.

NAD83: North American Datum of 1983

Post-hole diggers: a tool used to dig narrow holes (used in taking samples down to the root of the plant??)

Potential colonization sites: According to the Center of Aquatic and Invasive Plants (University of Florida (http://plants.ifas.ufl.edu/node/183), *hydrilla has the potential to grow in the following conditions:*

- Hydrilla can grow in almost any freshwater: springs, lakes, marshes, ditches, rivers, tidal zones.
- Can grow in only a few inches of water, or in water more than 20 feet deep.
- Can grow in oligotrophic (low nutrient) to eutrophic (high nutrient) conditions.
- Can grow in 7% salinity of seawater
- Temperature tolerance: hydrilla is somewhat winter-hardy; its optimum growth temperature, 20-27°C (68-81°F); its maximum temperature, 30°C (86°F)
- U.S. southern populations overwinter as perennials; northern populations overwinter and regrow from tubers.
- Can grow in only 1% of full sunlight.
- Low light compensation and saturation points and low CO2 compensation point make it a competitive plant because it can start growing in low light before other plants do

Rake-toss survey: A form of surveying aquatic plant matter by tossing a rake at selected points and sorting through the plants/measuring their abundance. *DEC's Instructions for Rake-Toss Surveying:* http://www.dec.ny.gov/docs/water_pdf/cslapratoss.pdf

Residual: any leftover trace of the chemical

Senescence: biological aging; the change in the biology of an organism as it ages after its maturity.

Subsampling: samples taken from a larger sample or predefined sample area.

Tuber: The thickened part of an underground stem of a plant that bears buds from which new plant shoots arise. Can remain viable for more than four years

Turion: a wintering bud which becomes detached and remains dormant at the bottom of the water

USACE: US Army Corps of Engineers

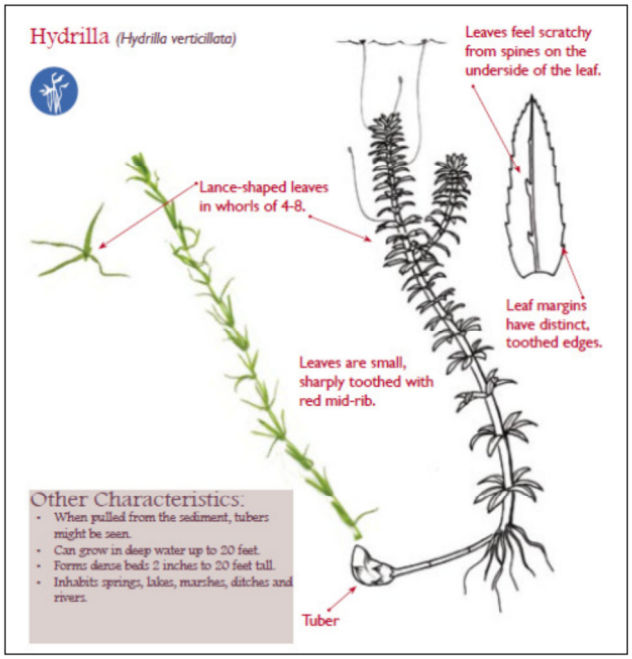
USACE-Cornell abundance scale:
"Zero" = no plants on rake
"Trace" = fingerful of plants on rake
"Sparse" = handful of plants on rake
"Medium" = most to all tines on rake covered with plants
"Dense" = difficult to bring into boat

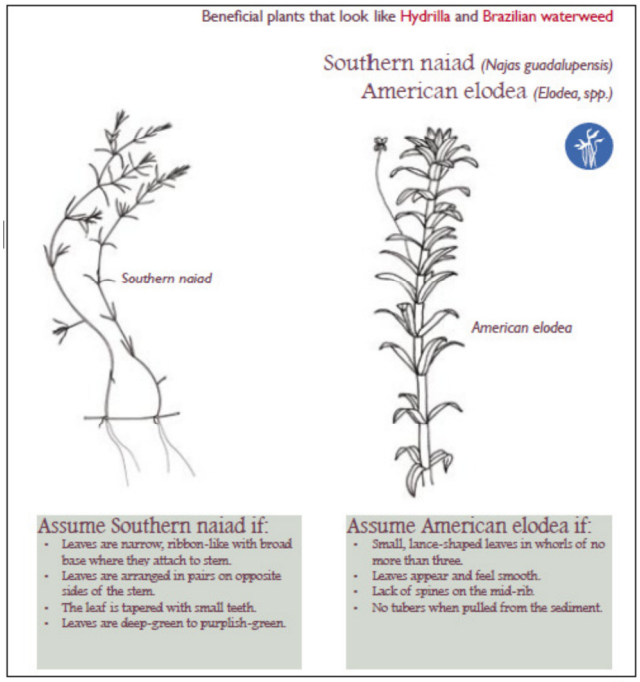
Voucher specimen: any specimen that serves as a basis of study and is retained as a reference

POSSIBLE ADDITIONS

NYSDEC Tier 1 Criteria: http://www.catskillstreams.org/pdfs/guidancedoc.pdf (pg. 11)

Hydrilla Lookalikes (common to Cayuga) elodea, southern niad, http://ccetompkins.org/sites/all/files/8/hydrilla-update1pageclwn.pdf





Images from Invasive Weed Identification Guide by Cayuga Lake Watershed Network

Hydrilla Management Plan Budget (*just link?)*
http://ccetompkins.org/sites/all/files/53/2012Hydrilla_Work_Plan.pdf