THE Water Research FOUNDATION

WRF Webcast

Chemical Management of Hydrilla for Drinking Water Utilities

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Chemical Management of Hydrilla for Drinking Water Utilities
WRF project #4747

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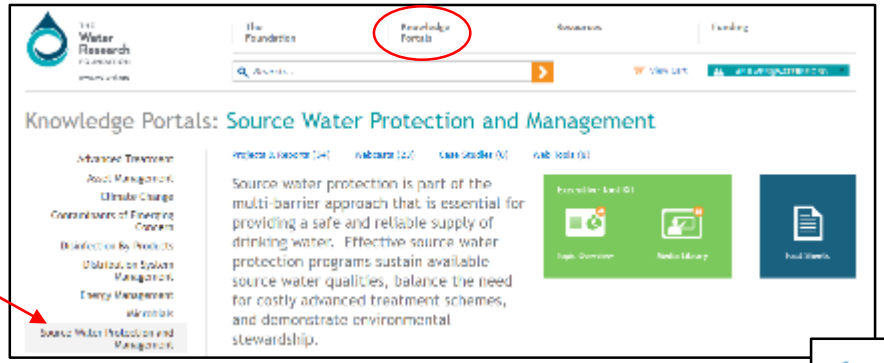
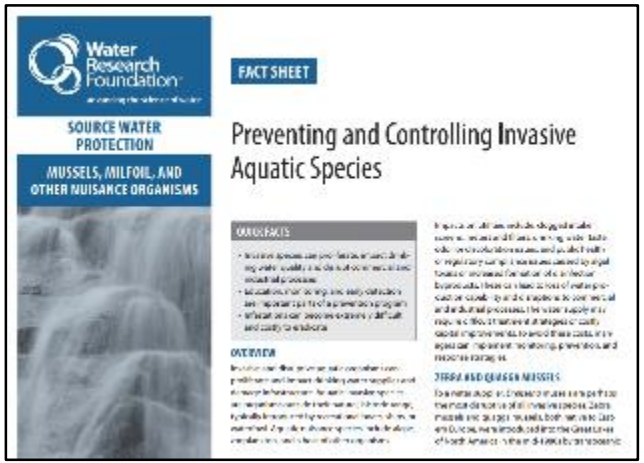
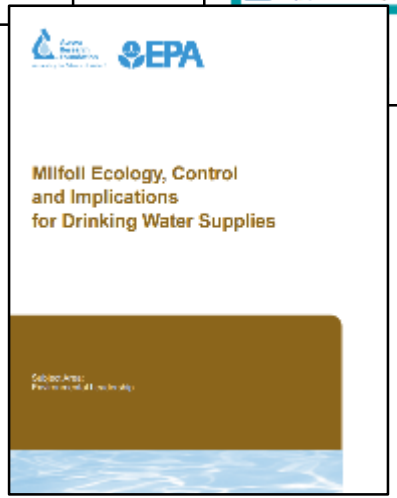
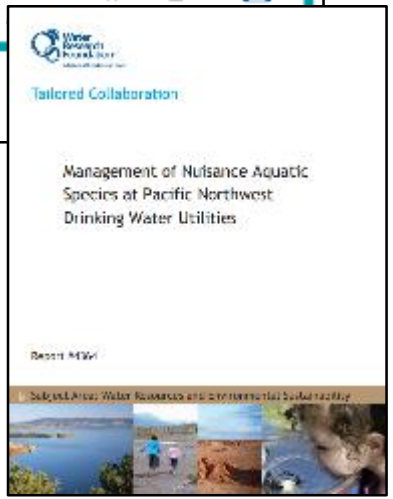
Invasive Species and Reservoir Mgmt Research









Emerging Opportunities Program

- 20% of annual research budget
- Time-critical research on emergent, high priority subscriber issues
- Co-funding for subscriber-relevant research with partners
- Ideas from subscribers, staff, volunteers, partners, researchers, or regulators
- Typically short duration and RFP
- Evaluated and approved by BOD Executive Committee throughout year
- E.g., cyanotoxins, One Water Blueprint, lead sampling, hex chrome

Agenda

- Hydrilla's Natural History, Spread and Impacts
- Physical, Chemical And Biological Control Options
- Hydrilla Management Case Studies
- Public Outreach and Invasive Species
- Conclusions and Recommendations for Drinking Water Utilities

What is Hydrilla?

- Hydrilla is an invasive aquatic plant, that can…
  - outcompete native species
  - infest large portions of lakes and rivers
  - cause a variety of impacts to water quality, natural resources, and recreational use

- It is one of the most costly aquatic invasive species to manage

Hydrilla Management in Florida

Florida spends over half of its annual expenditures (~$10M) for aquatic plant management on hydrilla

Hydrilla in Christmas, FL; Source: Lyn Gettys, University of Florida Department of Agronomy

California Hydrilla Eradication Program

- CA uses an integrated pest management approach with manual removal, small scale dredging, lining of water bodies, biological control and aquatic herbicides.

- Organized effort accomplished over many decades with substantial funding

YEAR Id'ed	WATERWAY	SIZE	STATUS
1988	Bear Creek	5 miles	Eradicated 2013
1988	Stock Pond	0.5 acres	Eradicated 2013
1977	Imperial Irrigation System	270 ac of ponds, 600 mi of canals	Eradicated 2013
1994	Clear Lake	739 of 43,000 acres	Active
1980	Eight ponds	2 acres	Eradicated
1989	Eastman Lake	1800 acres	Eradicated 2006
1978	Pond	0.01 acre	Eradicated
1985	Three ponds	< 1 acre	Eradicated
1985	Seven ponds	133 acres	Eradicated 1996
1986	Four ponds	23.5 acres	Eradicated 2000
1993	Three ponds	0.6 acre	Eradicated 1998
1996	Seven ponds	20 acres	Eradicated 2013

Source: CA Dept of Food and Agriculture

Hydrilla Natural History

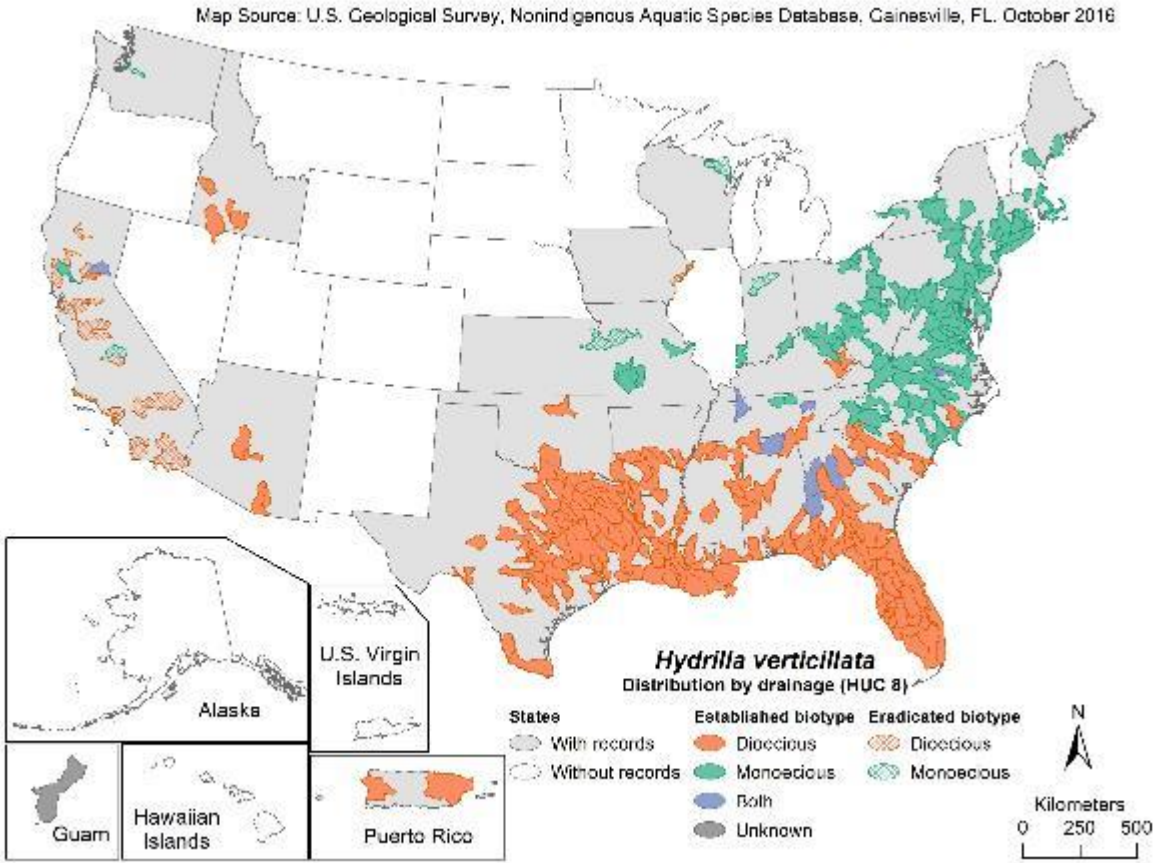
- Introduced in the 1950s as an aquarium plant
- Reproduces from seeds, tubers, turions (buds), and plant fragments
- Sprouts earlier and needs less light than native species
- Grows at depths up to 40 feet and forms dense mats at the surface

Hardiness of Tubers and Turions

Source: Lyn Gettys, University of Florida Department of Agronomy

- Hydrilla relies on a tuber bank in the soil to overwinter and for reproduction
- Tubers and turions in sediment can remain dormant for several years and can withstand ice cover and drying
- Effective control requires depletion of the tuber bank over many years

Hydrilla Occurrence and Spread



Impacts from Hydrilla

- The thick mats at the surface have the potential to:
  - interfere with boating and swimming
  - change local ecology by displacing native species
  - reduce fisheries abundance
  - cause water quality changes
  - clog intakes and screens

Hydrilla Control Options

Aquatic Plant Management

- Typical aquatic plant management approaches fall into three categories
  - **Physical** and **mechanical** methods remove plants or disrupt habitat
  - **Biological** methods use introduced species to target specific plants for removal
  - **Chemical** methods use herbicides to kill plants or disrupt reproduction

Useful Resource: *The Practical Guide to Lake Management in Massachusetts* (2004) by Ken Wagner
http://archives.lib.state.ma.us/handle/2452/36455

Audience questions

- Is your organization actively dealing with a hydrilla infestation in a waterbody?

  Yes/no

- For those dealing with hydrilla, what types of control options do you employ?

  - Biological control (grass carp)
  - Physical/mechanical control
  - Chemical control (herbicides)
  - Other?

Physical and Mechanical Control Options

- Physical removal
  - Hand removal, dredging, mechanical harvesting
- Habitat disruption
  - Benthic barriers, rototilling, reservoir drawdown

Physical and Mechanical Control Options

- Physical removal
  - Hand removal
- Habitat disruption
  - Benthic barriers

Effective for hydrilla

Biological Control Options

- Florida Fish and Wildlife Conservation Commission, USACE, USDA, and University of Florida have led much of the research on biological control agents

Common Name	Scientific Name	Status
Hydrilla tuber weevil	Bagous affinis	Failed to establish
Asian hydrilla leaf-mining fly	Hydrellia pakistanae	Limited control
Australian hydrilla leaf-mining fly	Hydrellia balciunasi	Established in Texas, failed elsewhere
Hydrilla stem borer	Bagous hydrillae	Failed to establish
Hydrilla miner	Cricotopus lebetis	Limited control in Florida
Adventive hydrilla moth	Parapoynx diminutalis	Feeding not limited to hydrilla
Chinese grass carp	Ctenopharyngodon idella	Commercially viable, used in many states including Virginia, Texas, Florida, etc.
Fungal pathogen	Micoleptidiscus terrestris	Limited control

Grass Carp for Hydrilla Control

- Grass carp for aquatic weed control must be certified sterile (triploid) by the USFWS
- Grass carp will live 10-15 years, cannot be recovered once released
  - Many states limit their use to contained ponds
- Hydrilla is a favored plant, but grass carp will consume other plant species


Source: USDA

Chemical Control of Aquatic Plants

- Two types of herbicides: contact and systemic
  - Contact herbicides kill plant tissue on contact
  - Systemic herbicides are absorbed by the plant and disrupt plant function
- Contact herbicides typically act quicker than systemic herbicides
- Effectiveness of both types is dependent on contact time between plants and herbicide

Chemical Control Options (herbicides)

Active Ingredient	Type of Herbicide	Year First Registered	Post-Application Drinking Water Restrictions
Copper Complexes	contact	1950s	1,300 ppb MCL
Diquat	contact	1950s	3-day restriction on drinking water use, 20 ppb MCL
Endothall	systemic for hydrilla	1960s	Application not allowed within 600 feet of drinking water intakes, 100 ppm MCL
Fluridone	systemic	1986	20 ppb within ¼ mile of potable drinking water intakes
Imazamox	systemic	2007	50 ppb within ¼ mile of potable drinking water intakes
Penoxsulam	systemic	2009	None
Flumioxazin	contact	2011	None
Bispyribac-sodium	systemic	2011	None
Topramezone	systemic	2013	None up to application rate of 45 ppb

Useful Resources:

Texas A&M AQUAPLANT https://aquaplant.tamu.edu/management-options/hydrilla/

University of Florida IFAS https://plants.ifas.ufl.edu/manage/control-methods/chemical-control/details-about-the-aquatic-herbicides-used-in-florida/

Copper Complexes and Diquat

- Diquat and copper are two of the earliest registered aquatic herbicides
- Used alone provide fair hydrilla control, better in combination or with an added systemic herbicide
- Build-up of copper over time a major concern (toxicity to fish and benthos)

Active Ingredient	Type of Herbicide	Year First Registered	Post Application Drinking Water Restrictions
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Endothall and Fluridone

- Two of the most widely used herbicides for hydrilla control, available in all states
- Endothall is effective with a 2-3 day contact time
- Fluridone at low doses requires sustained treatment over the growing season

Active Ingredient	Type of Herbicide	Year First Registered	Post-Application Drinking Water Restrictions
Endothall	systemic for hydrilla	1960s	Application not allowed within 600 feet of drinking water intakes, 100 ppb MCL
Fluridone	systemic	1986	20 ppb within ¼ mile of potable drinking water intakes

Other herbicides Registered in last 10 Years

- These newer herbicides may not be approved in all states
- Largely tested on dioecious hydrilla

Active Ingredient	Type of Herbicide	Year First Registered	Post-Application Drinking Water Restrictions
Imazamox	systemic	2007	50 ppb within ¼ mile of potable drinking water intakes
Penoxsulam	systemic	2009	None
Flumioxazin	contact	2011	None
Bispyribac-sodium	systemic	2011	None
Topramezone	systemic	2013	None up to application rate of 45 ppb

Herbicide Application Considerations

- Best time is to apply herbicides as new growth emerges, but before the plant begins to form new tubers and turions
- Tubers are not directly affected by herbicides, protected by the soil
- Tuber germination can occur once per year or a multiple times per year
- Consider water supply operations and recreational users to plan application

Source: Andrew Kornacki/USACE

Herbicide Considerations (cont'd)

PROS

- Herbicides provide predictable performance based on scientific studies and field trials
- Easily targeted and scalable based on size of the infestation
- Low risk of spreading hydrilla

CONS

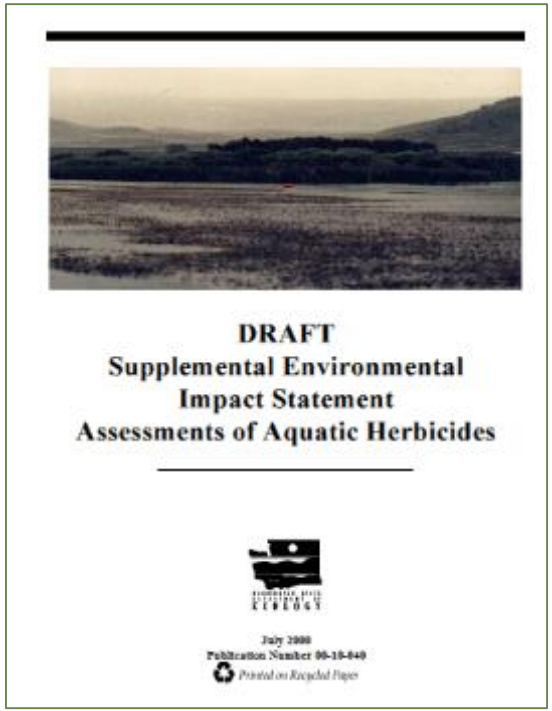
- Some impacts to non-target species possible
- Public reaction to herbicides in sources of drinking water a critical issue

Herbicides and Public Health of Drinking water Supplies

- Using data and models USEPA conducts extensive human health and ecotoxicology studies before allowing herbicide use
- Process takes many years of lab studies and experimental trials
- USEPA sets the dose, exposure limit, drinking water restrictions, etc., specific to each compound
- Herbicides are re-registered on a ~15-year cycle to update with new data and science

Herbicides and Public Health of Drinking water Supplies

- In addition to USEPA assessments, reviewed 10 human health and ecological risk assessments of fluridone and endothall
  - New York State Department of Environmental Conservation
  - Washington State Department of Ecology
  - North Carolina Division of Public Health
  - US Bureau of Land Management
  - US Department of Agriculture Forest Service
  - California Department of Boating and Waterways
- Conclusions identified no significant adverse effects when following the label restrictions



What about drinking water treatment?

- Herbicides with MCLs have a best available technology (e.g. diquat, endothall)
- No identified BAT for other herbicides
- Powdered Activated Carbon (PAC) may be a good option

- Jar tests are needed to confirm removal efficiency for specific PAC/herbicides combinations

Recommendations for Herbicide Control of Hydrilla

- Herbicide labels are legally enforceable and must be followed for regulatory compliance
- Work with a local herbicide applicator or lake management professional to develop the management plan that conforms with all laws and drinking water operations constraints
- A public outreach program will take time, but will help reduce community concerns and potential backlash

Hydrilla Management Case Studies

Croton River, NY

Discovered: 2013; Confirmed: 2014; Treatment: 2017

- Potential Hydrilla Risks:
  - Spread to adjacent waterways
  - Fish populations and biodiversity
  - Recreation
- Site Specific Constraints:
  - Village of Croton-on-Hudson Drinking Water Supply
  - Dye study necessary to predict flow of herbicide in stream
- Selected Treatment: Fluridone

Delaware & Raritan Canal, NJ

Discovered: 2016; Confirmed: 2016; Treatment: 2017

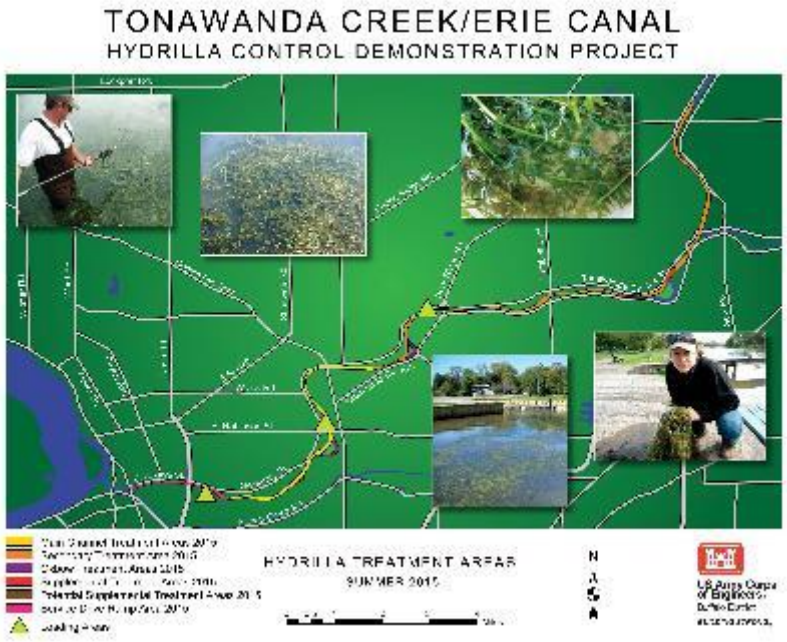
- Potential Hydrilla Risks:
  - Reduced flows through canal
  - Spread to adjacent waterways
- Site Specific Constraints:
  - Nine intakes for drinking water, irrigation, and process water
- Selected Treatment: Fluridone

Source: New Jersey Water Supply Authority

Tonawanda Creek/Erie Canal, NY

Discovered: 2012; Confirmed: 2013; Treatment: 2014 to 2017

- Potential Hydrilla Risks:
  - Spread to adjacent waterways
  - Boat traffic/navigation
- Site Specific Constraints:
  - High flow rates, short term operational changes reduced flow rates for a few days to allow treatment
- Selected Treatment: Endothall



Cayuga Inlet, NY

Discovered: 2011; Confirmed: 2011; Treatment: 2011 to 2016

- Potential Hydrilla Risks:
  - Boat traffic/navigation
  - Spread to adjacent waterways

- Selected Treatment: Endothall and Fluridone

- Monitoring is continuing on the inlet to ensure no new populations of hydrilla are present

Lessons Learned from Case Studies

- Incorporate adaptive management into hydrilla management plans
- Develop a robust public outreach program
- Consult with professional lake managers and herbicide applicators
  - Herbicide application programs
  - Aquatic plant surveys
  - Tuber germination studies
  - Dye studies for developing herbicide application
- Act quickly to prevent further spread

Audience Questions

- Do you survey for aquatic vegetation?
  - Yes/no
- Do you include invasive species in source water protection or other planning activities?
  - Yes/no

New Croton Reservoir Case Study

New York City Department of Environmental Conservation

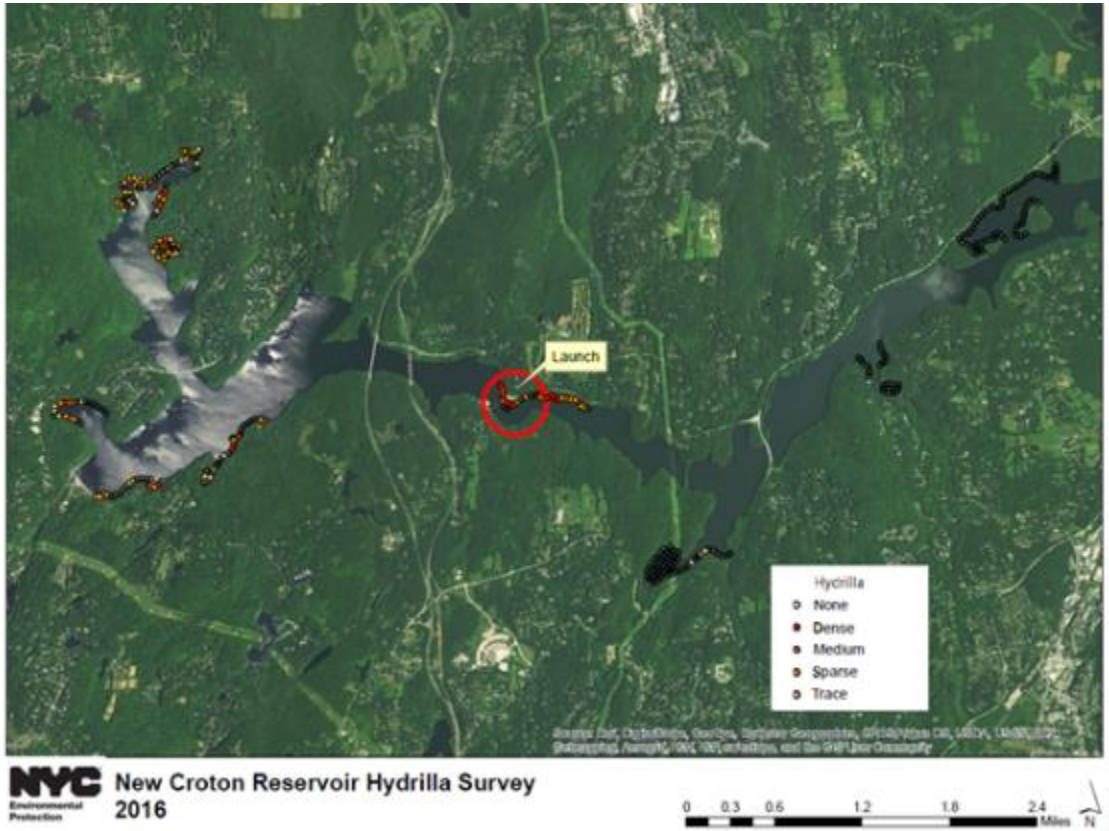
DEP's Invasive Species Prevention Program

- Restricted Access
  - Must have a recreation access permit
  - Only metal Jon boat/row boats are allowed for fishing at most reservoirs
  - All boats need to be cleaned prior to launching – even DEP boats

- Recreation Rules
  - Guide the use of the reservoirs to minimize impacts
  - Non-motorized recreational boating is only allowed in some reservoirs with cleaning

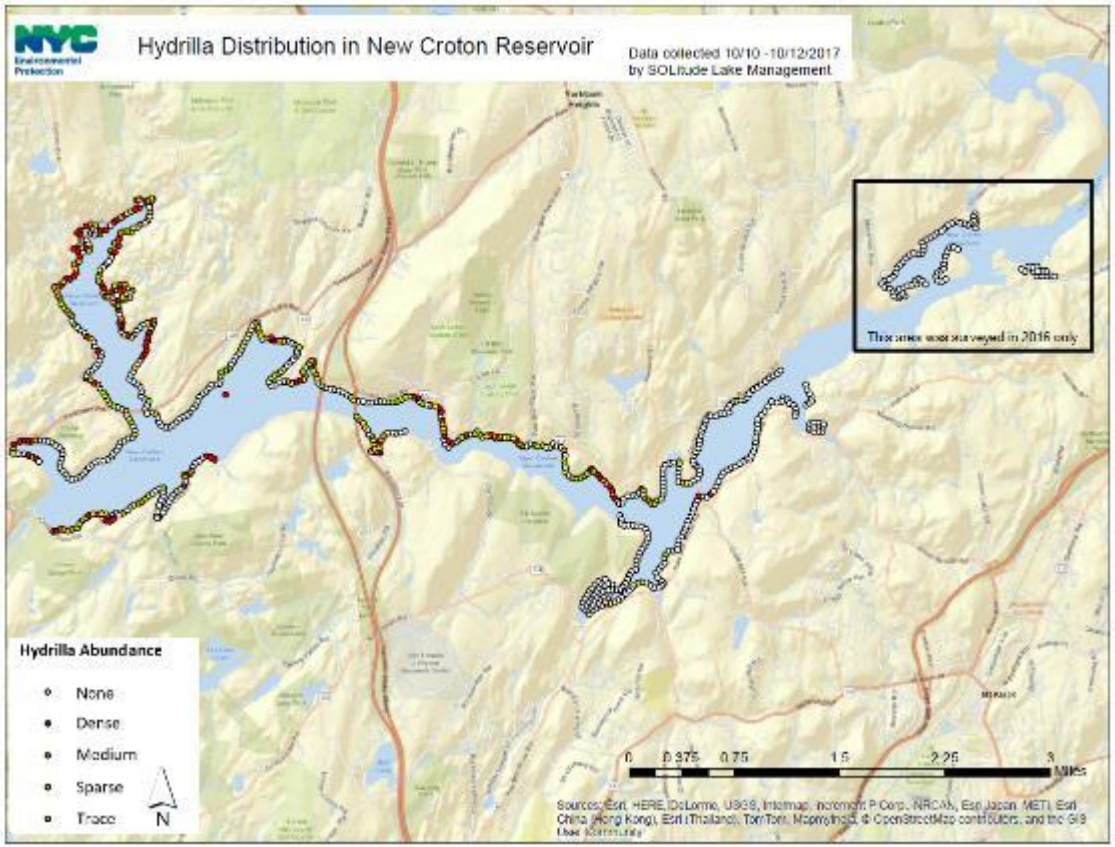
Hydrilla in New Croton Reservoir

- Hydrilla discovered October 2014
  - Found in reservoir during river survey
  - Initial informal survey revealed four discrete patches



Hydrilla in New Croton Reservoir

- 2017 survey targeted areas detected in 2016
- Estimate 20/34 miles of shoreline
- Restricted to downstream section of reservoir
- Density/spread increasing



Concerns and Constraints

Concerns

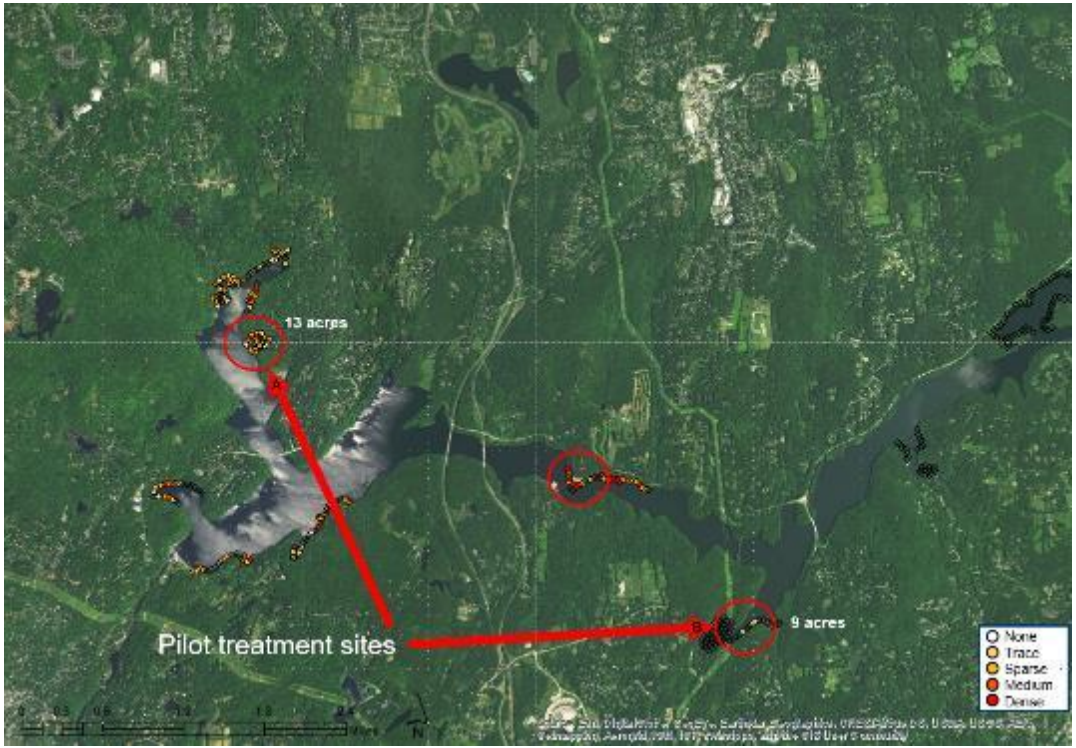
- Spread to unfiltered supply
- Block intakes
- Drinking water quality and treatment processes
- Economic consequences

Constraints

- Cascading system connected by natural watercourses
- Full capacity required for upcoming shutdowns 2018 – 2023
- Grass carp aren't permitted
- Min. Flow Required

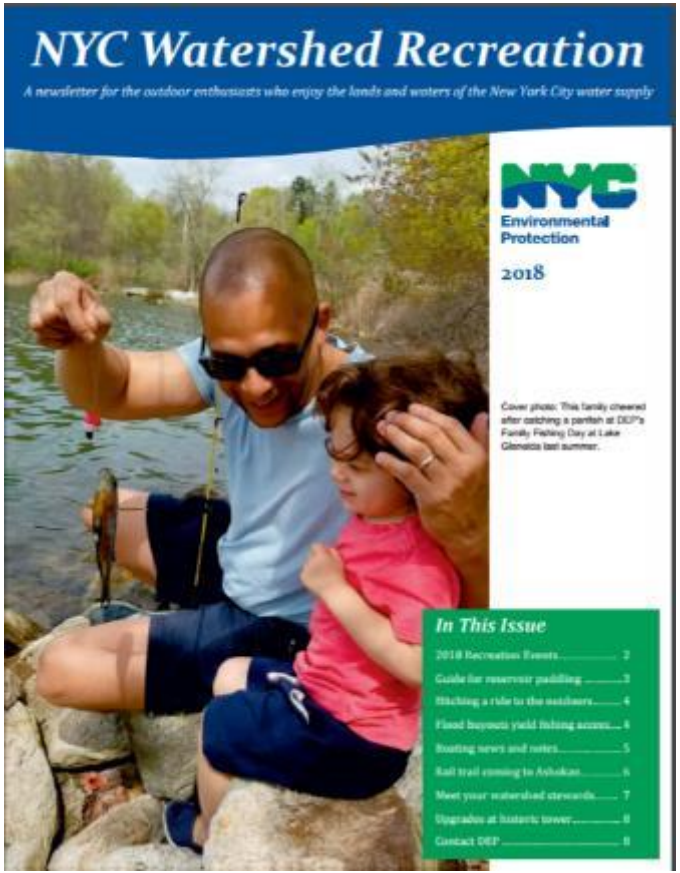
DEP's Approach

- 2018 - Pilot planned in 2 isolated coves away from intakes in New Croton
- 2019 - RFP will go out to scale up treatment to full infestation



Outreach Efforts

- Recreation users
  - Website
  - Recreation newsletter
  - Mailings/meetings with angler groups
- Notifications required by pesticide permit
  - Newspaper
  - Signage around applications sites
- Stakeholder advisory group



Public Outreach and Invasive Species

Public Outreach and Invasive Species

- Multiple scales of public outreach
  - Prevention: Target recreational users to prevent introduction/spread
  - Decision-making: Target community members and consumers when developing hydrilla mgmt. plan
  - Safety: Target recreational users during herbicide application

Source Water Protection Planning

- Develop a vision
- Involve stakeholders
- Characterize source water risks
- Develop goals and a plan
- Implement the plan and evaluate results

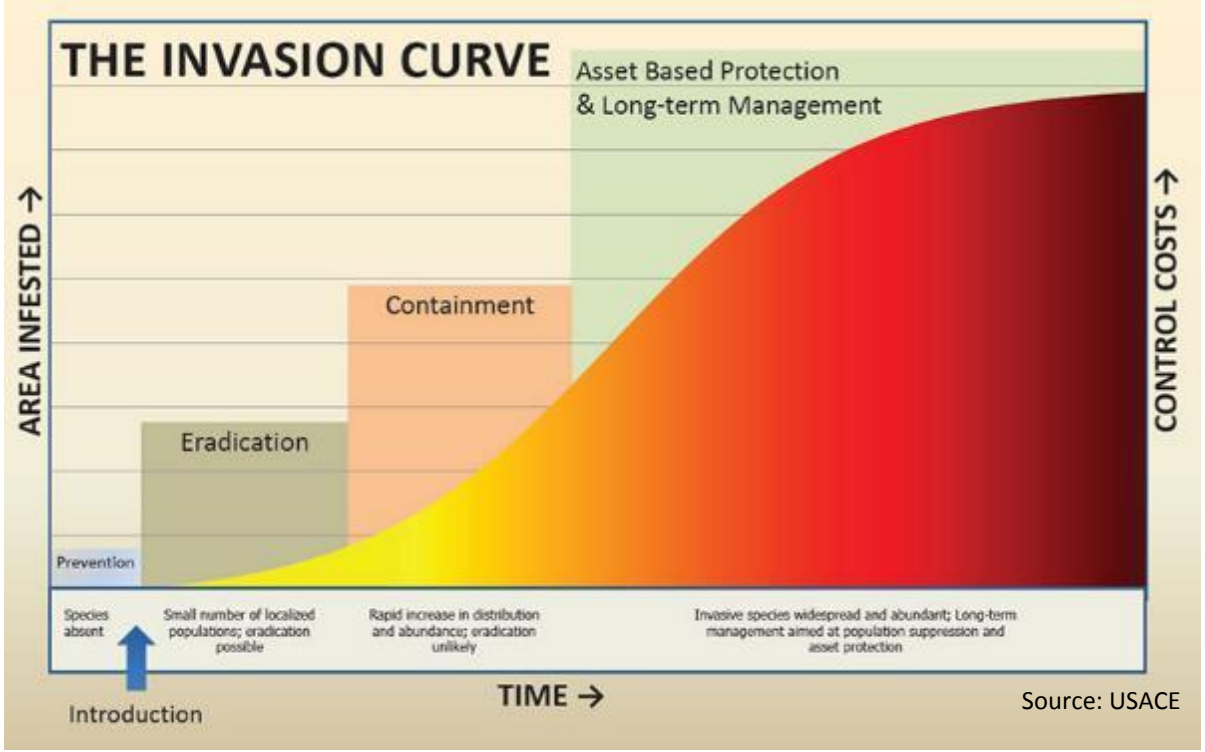
Ways to Engage Stakeholders in Planning

- No involvement (not recommended)
- Passive outreach (flyers, signage, etc.)
- Public review of draft management plan
- Public meetings to solicit comments
- Direct engagement of stakeholder organizations
- Steering committee with stakeholder participation

Conclusions and Recommendations

Selecting the Best Management Approach

- Preventing invasive species is the most effective and least costly option



Source: USACE

Hydrilla Management Recommendations

- Physical and mechanical methods that disperse fragments are not recommended for hydrilla control
- Benthic mats and hand pulling can be effective for small scale occurrences, not cost-effective for large infestations
- Biological options currently limited to sterile grass carp
  - state restrictions are important
- Herbicides provide predictable control

Herbicide Application Program Recommendations

- Discuss herbicide options with state regulators and licensed pesticide applicators
- Application rates should be developed by a licensed pesticide applicator after review of water quality conditions and usage of a waterbody
- Beneficial to develop a public outreach program
  - provide justification for herbicides
  - present information on protection of public health
  - get feedback from stakeholders and address their concerns

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Q&A

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Thank you

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