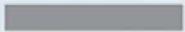


Monitoring and Detecting Hydrilla: Three Case Studies in New York and New Jersey

By Chris Doyle, CLM
Director of Biology



SOLITUDE
LAKE MANAGEMENT

Restoring Balance. Enhancing Beauty.

Types of Aquatic Plant Surveys

- **Visual Surveys**
 - Commonly Used, Easy to Perform
 - Difficult to Quantify Results/Repeat
- **Biomass Sampling**
 - 1-meter quadrant
- **Transect Sampling**
- **New Technology**
 - Remote Sensing, eDNA
- **Point Intercept Method**
 - Developed by ACOE (Technical Note MI-02: 1999)



“Adaptive Monitoring”

Point Intercept Aquatic Plant Survey (PIM)

- **Developed by ACOE**
 - Modified by Cornell University
 - Tweaked by SLM
- **Accepted Methodology by Regulators/Managers**
 - Recommend one survey location/hectare
 - I prefer 1+ location per littoral zone acre (~100-125/day)
- **Assign Plant Mass Densities**
 - No plants, trace, sparse, medium, dense
 - Assigned to overall submersed plants
 - Then assigned to each different plant species



Abundance	Abundance #	Dry Weight (g/m ²)	Mean Weight (g/m ²)	Description
No Plants (“0”)	0	0.0	0.0	Bare Rake
Trace (“T”)	1	~0.0001-0.9999	0.5	Finger-full
Sparse (“S”)	2	~1.0000-24.9999	13.0	Hand-full
Medium (“M”)	3	~25.0000-99.9999	62.5	Covers Rake
Dense (“D”)	4	~100.0000-400.0000+	250.0	Difficult to get plant mass into the boat



Overlay Grid on the Littoral Zone

- **50-meter Grid**
 - Project Specific (Hydrilla)
 - Smaller = more effort
 - Larger = less effort
- **# of Weed Rake Tosses**
 - One, Two or Three
 - More Tosses =  more Target or RTE species
 - But.....
 -  more effort
 -  overall abundance



Grid Size Changes

Fish Kill Creek Bay

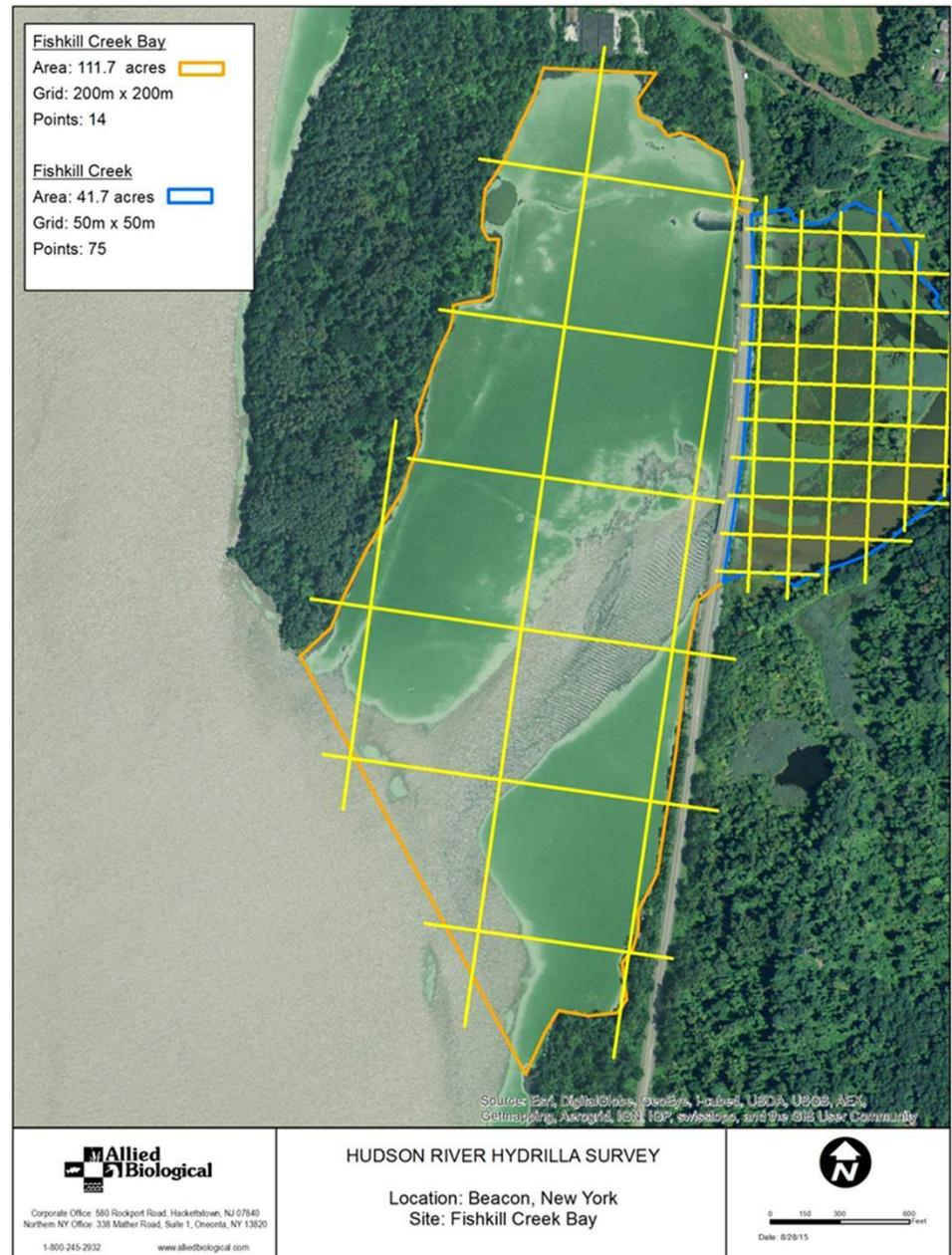
111.7 acres

- 200 m grid: 14 sites
- 100 m grid: 50 sites
- 50 m grid: ~145 sites

Fishkill Creek

41.7 acres

- 50 m grid
- 75 Sites



Field Equipment

- Weed Rake (2)
- GPS Unit
 - GeoXH Handheld
 - Sub-decimeter accuracy
 - w/post processing
- Site Access
 - Prop Motor Boat
 - Access, tides, bridges, SAV growth
 - Air Boat
 - Canoe
 - On Foot



Frequency of Occurrence Table

Aquatic Macrophyte Abundance Distribution September 22, 2015

Aquatic Macrophytes	Total		Trace		Sparse		Medium		Dense	
	Sites	%	Sites	%	Sites	%	Sites	%	Sites	%
Total Sites	50	100%								
Overall Plant Abundance	40	80%	8	20%	5	13%	13	33%	14	35%
Small Duckweed	33	66%	19	58%	10	30%	2	6%	2	6%
Brittle Naiad	31	62%	5	16%	9	29%	9	29%	8	26%
Eurasian Water Milfoil	29	58%	13	45%	10	34%	5	17%	1	3%
Coontail	18	36%	16	89%	1	6%	1	6%	0	0%
Great Duckweed	16	32%	14	88%	2	13%	0	0%	0	0%
Northern Naiad	16	32%	8	50%	6	38%	2	13%	0	0%
Water Chestnut	15	30%	8	53%	5	33%	1	7%	1	7%
Spatterdock	6	12%	4	67%	2	33%	0	0%	0	0%
Wild Celery	4	8%	3	75%	1	25%	0	0%	0	0%
Water Stargrass	4	8%	4	100%	0	0%	0	0%	0	0%
Benthic Filamentous Algae	3	6%	2	67%	1	33%	0	0%	0	0%
Common Waterweed	2	4%	1	50%	0	0%	1	50%	0	0%

Sample Abundance and Distribution Map

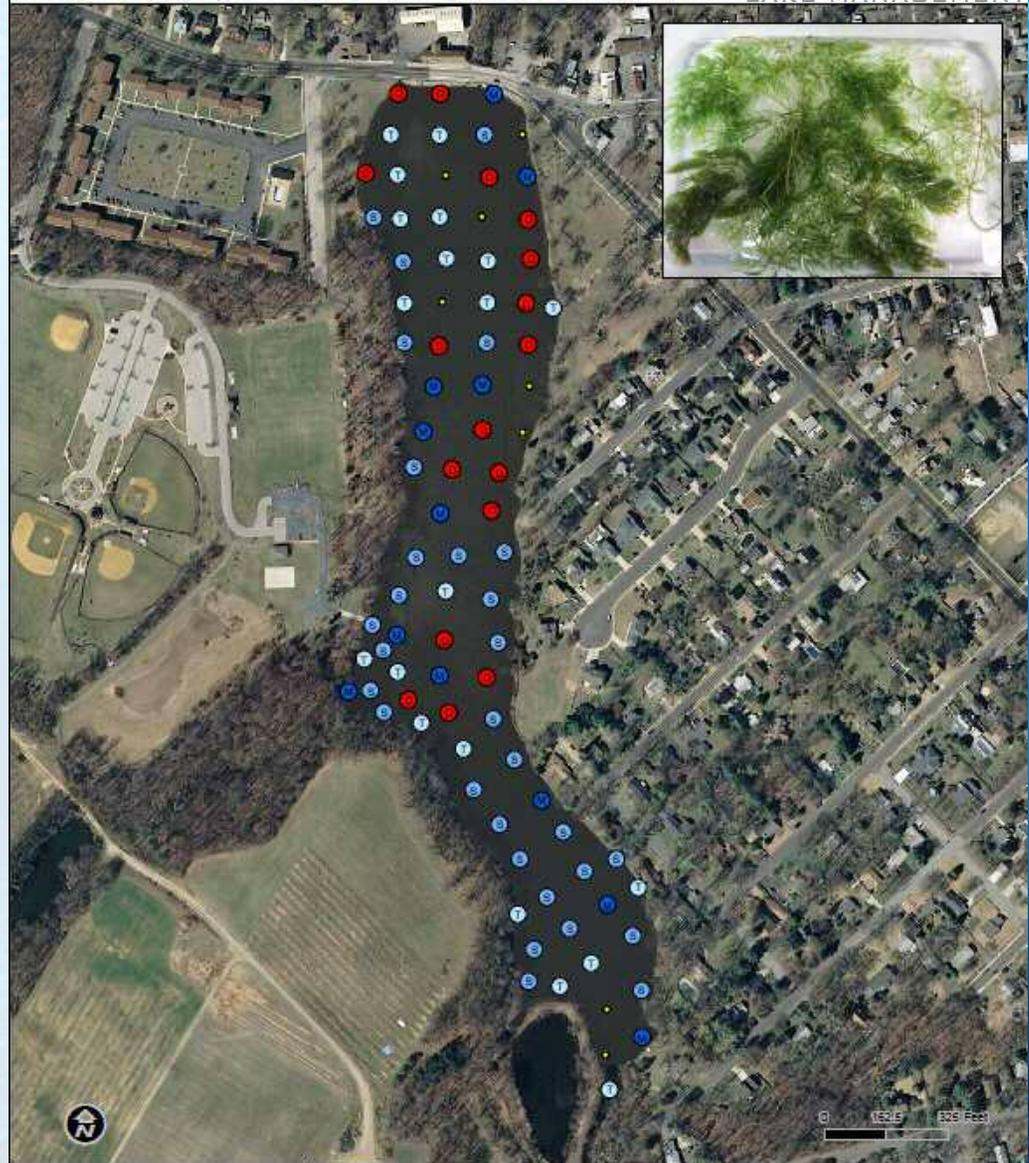
- Project Maps
 - Sample Station
 - Water Depth
 - Total SAV
 - Each Individual Plant

For Example:

If a site has 17 different aquatic plants; 20 total maps will be produced

Project Specific Maps: Richness, Plant Groupings: Native/Invasive, or Pondweeds, etc.

Coontail (*Ceratophyllum demersum*) Distribution



ALCYON LAKE
Aquatic Vegetation Survey
August 28, 2014

87 sampling points

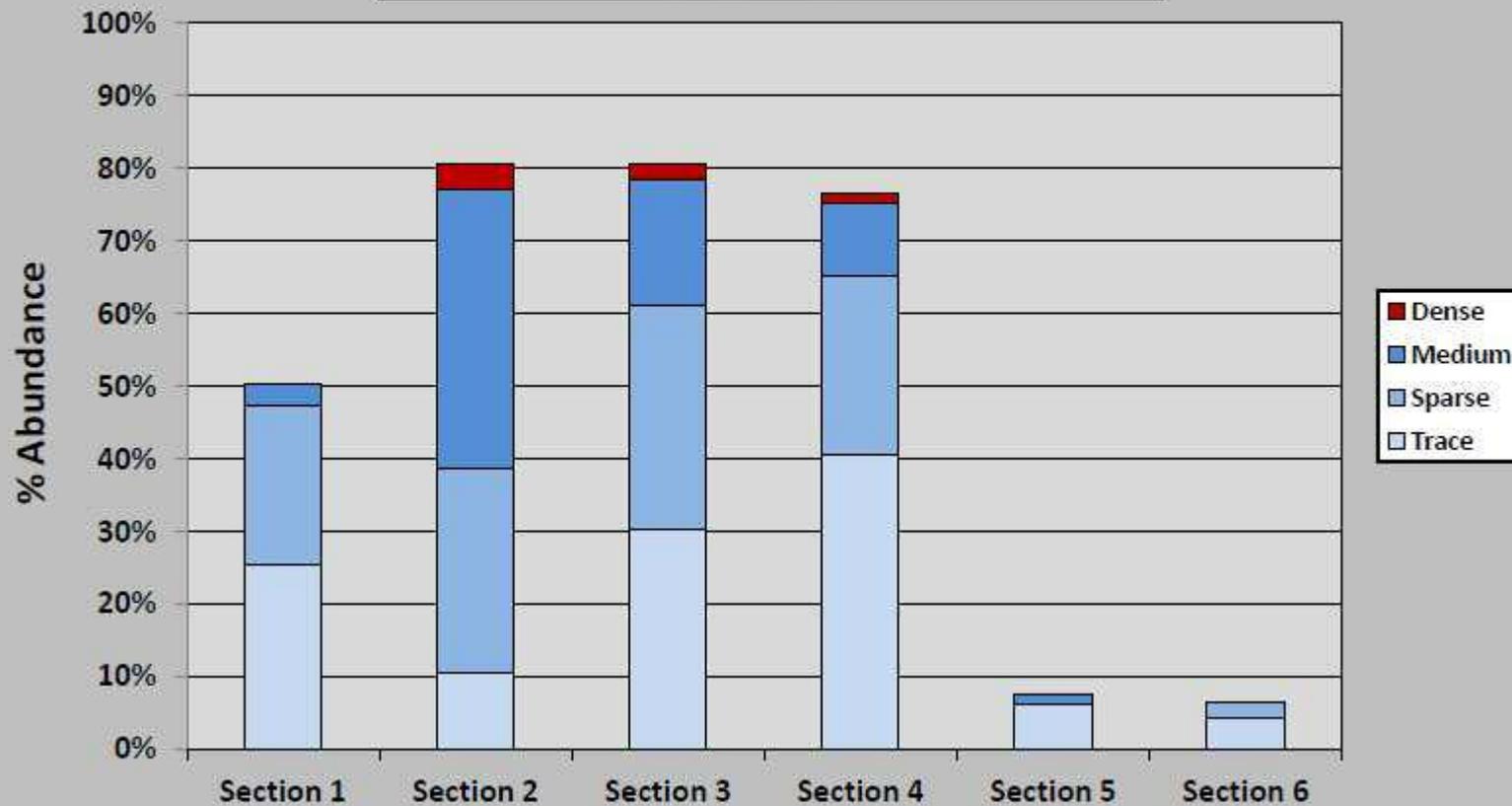
Plant Density

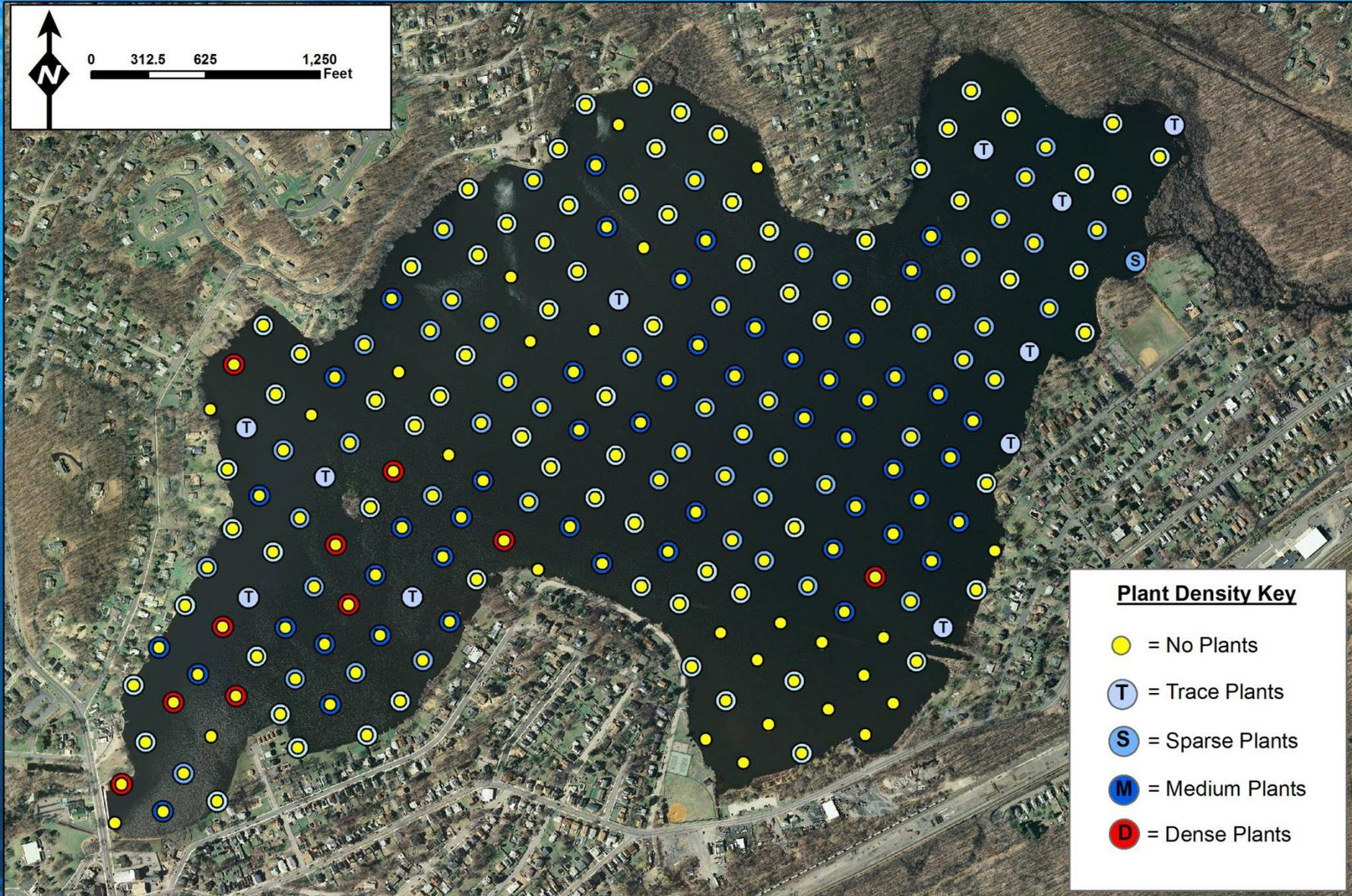
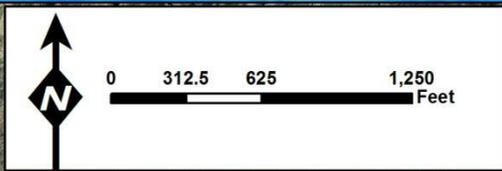
●	= No Plants
○	= Trace Plants
○	= Sparse Plants
○	= Medium Plants
●	= Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	79	91%
Trace	20	23%
Sparse	30	38%
Medium	12	15%
Dense	17	22%

**Wild Celery (*Vallisneria americana*)
Percent Abundance by Section
D&R Canal**





Plant Density Key

-  = No Plants
-  = Trace Plants
-  = Sparse Plants
-  = Medium Plants
-  = Dense Plants

**Eurasian Water Milfoil (*Myriophyllum spicatum*) Distribution
Lake Musconetcong Aquatic Vegetation Survey
September 20, 2010**

Advantages of PIM Plant Mapping

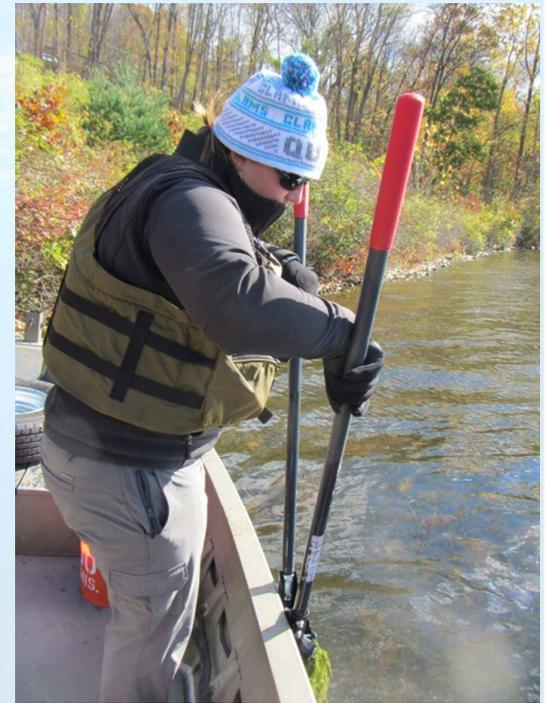
- **Standard Method**
 - Important Part of Multi-year SAV Control Projects
- **Repeatable**
 - Suitable to track abundance and distribution changes of specific plants over time
 - Pre and Post SAV Control Efficacy
 - Site Comparisons
- **Can be Conducted by Volunteer Groups**
 - **Limitations:** GPS capabilities and Plant ID Skill

Hydrilla Tuber Monitoring

Hydrilla Tuber Density

- Hydrilla tuber density over time
- Based on methods described by Johnson (2013) and NC State
- Post Hole Digger
 - 187 cm² plug
 - Calculate tubers/m²
- 3 mm mesh screen

Nawrocki, et al.: J. Aquat. Plant Manage. 54: 2016



Hydrilla Tuber Monitoring

Hydrilla Tuber Density

- Tubers occur in top 12 cm of sediment (Harlan, 1985)
 - Target 20 cm
 - Don't use a Ponar or Ekman Sampler
- Increase # cores over time
 - Adjust for decrease in tuber production (if control)
 - Spencer (1994)

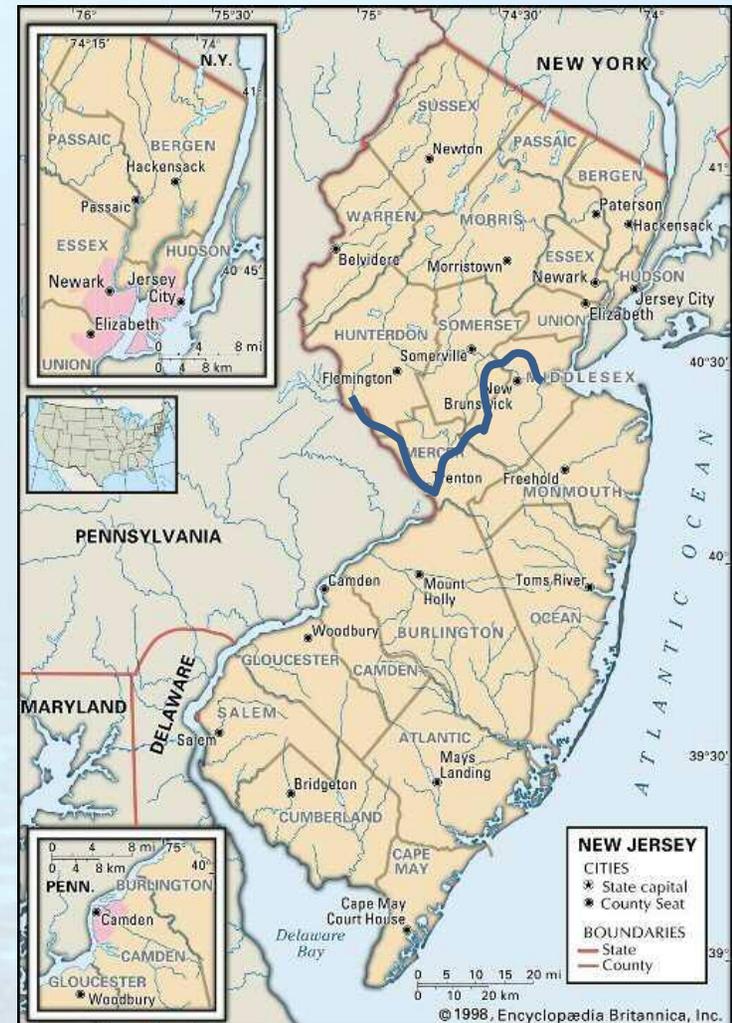


Case Study #1: The D&R Canal

Project Site

- Delaware & Raritan Rivers
- Central New Jersey
- Constructed in 1830's
 - Mostly hand-dug
 - Anthracite: PA to NJ
- Length: 66 miles
- Operated by the NJWSA
- 100 MGD Water Transfer
 - Primary Function

For more information on the Project:
<http://www.njwsa.org/hydrilla.html>



D&R Canal



- **Numerous Stakeholders**
 - NJDEP, NJDF&W, D&R Canal Commission, NJ Div. of Parks, ACOE, Many Friends Organizations
 - Nine Canal Water Users (5 potable)
- **Primary Goal: Suitable Water Flow**
- **2016: Flow Decrease → Mechanical SAV Removal**
 - July discovered **hydrilla**
- **2016 SAV Monitoring**
 - Modified PIM Mapping (Sept.)
 - Hydrilla Tuber Monitoring (Nov.)

D&R Canal: Getting it Right

2016 Project Goals

- Determine Extent of Hydrilla Infestation
- Develop a Multi-year Control Project
 - Consider all the Stakeholders
- Repeatable
- Develop Hydrilla/SAV Man. Plan

2016 Hydrilla Monitoring

- **18.31 Miles**
- **597 GPS-referenced Stations**
 - 2 tosses per station (West/East Shore)
 - 50 meters apart

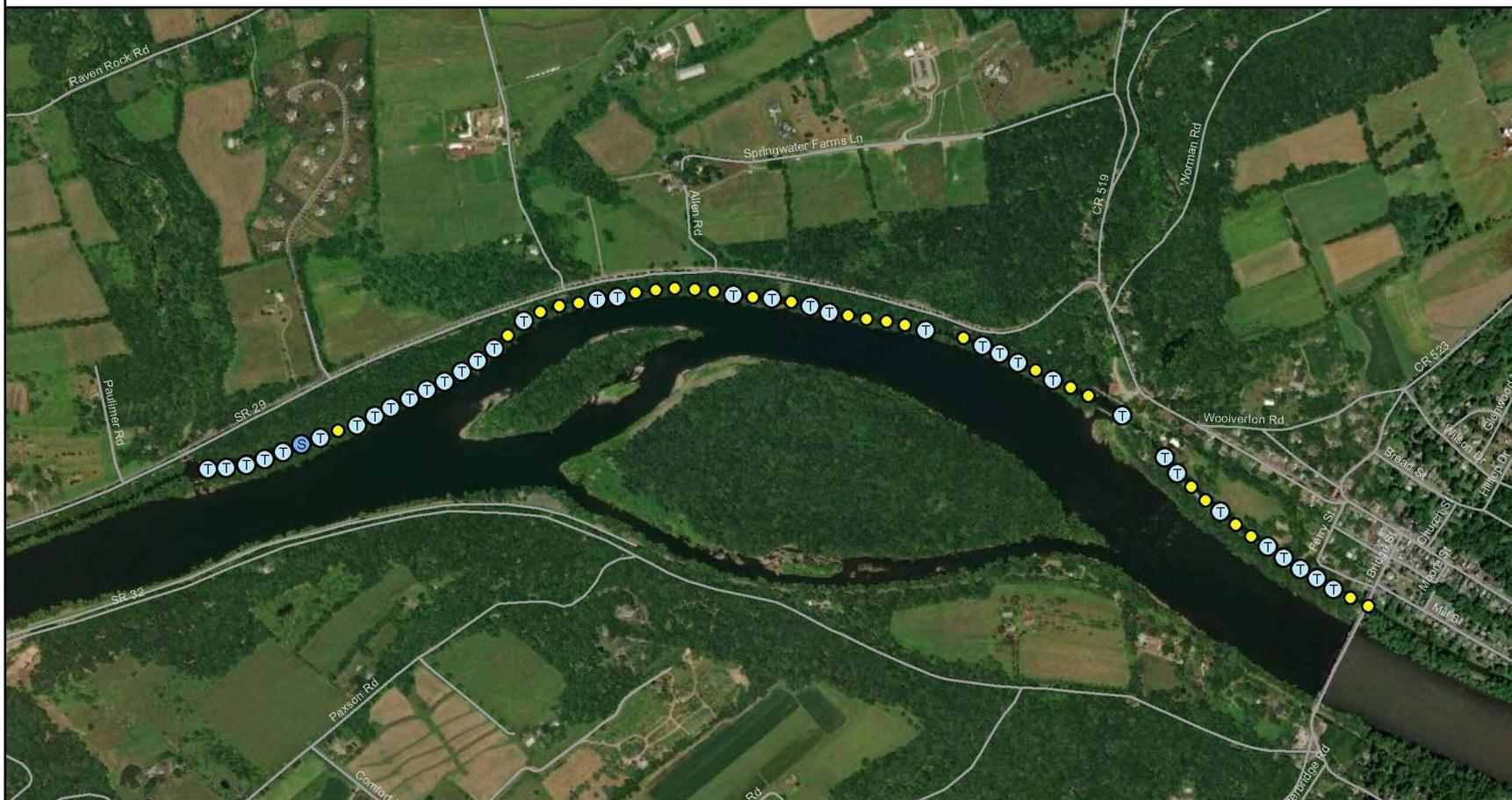




50-75 ft.



NON-TREATMENT AREA
 OVERALL AQUATIC PLANT ABUNDANCE
 SEPTEMBER 21, 2018



DELAWARE & RARITAN CANAL
 Non-Treatment Area
 Aquatic Vegetation Survey
 September 21, 2018

Total Sample Sites: 63

- Plant Density**
- = No Plants
 - ⊕ = Trace Plants
 - ⊙ = Sparse Plants
 - ⊗ = Medium Plants
 - = Dense Plants

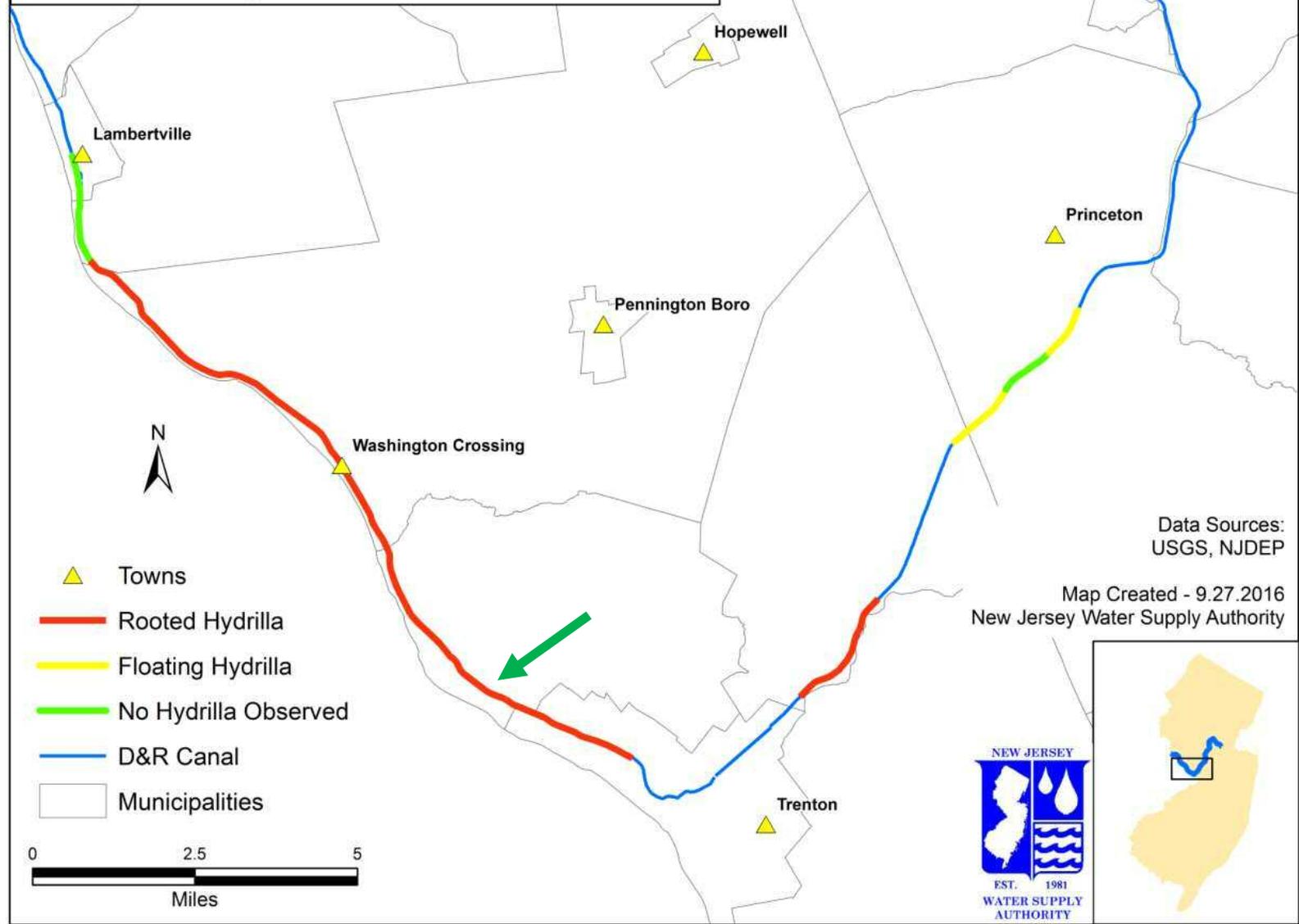
Percent Distribution

Abundance	Sites	Percent
Total	37	59%
Trace	36	97%
Sparse	1	3%
Medium	0	0%
Dense	0	0%



0 280 560 1,120 Feet

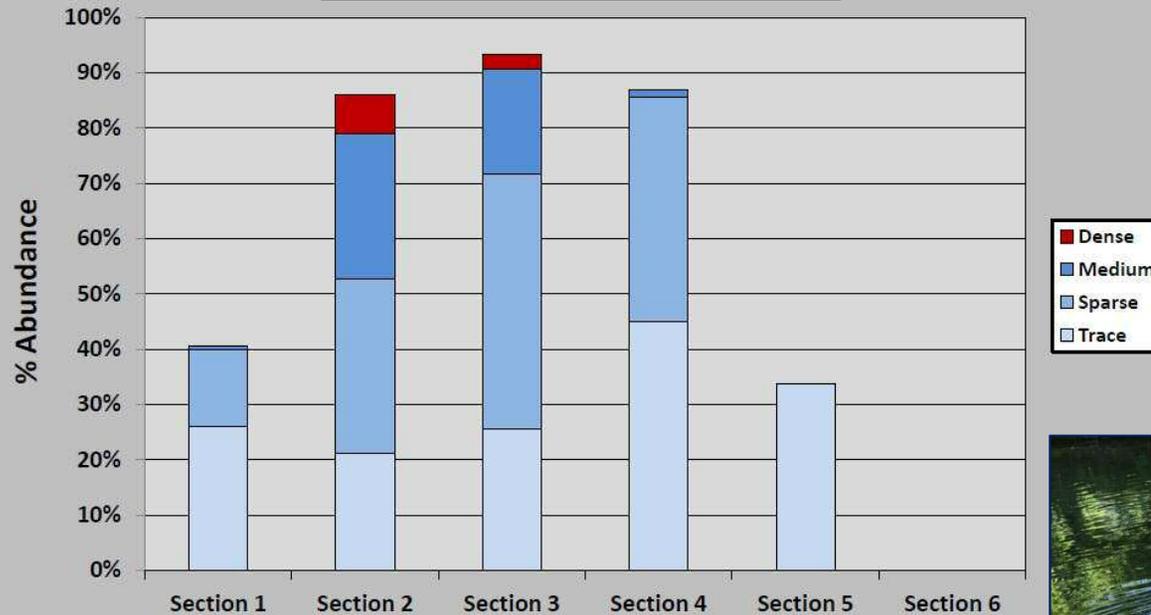
Survey of Hydrilla In the D&R Canal



2016 D&R Canal SAV Monitoring



Hydrilla (Hydrilla verticillata)
Percent Abundance by Section
D&R Canal

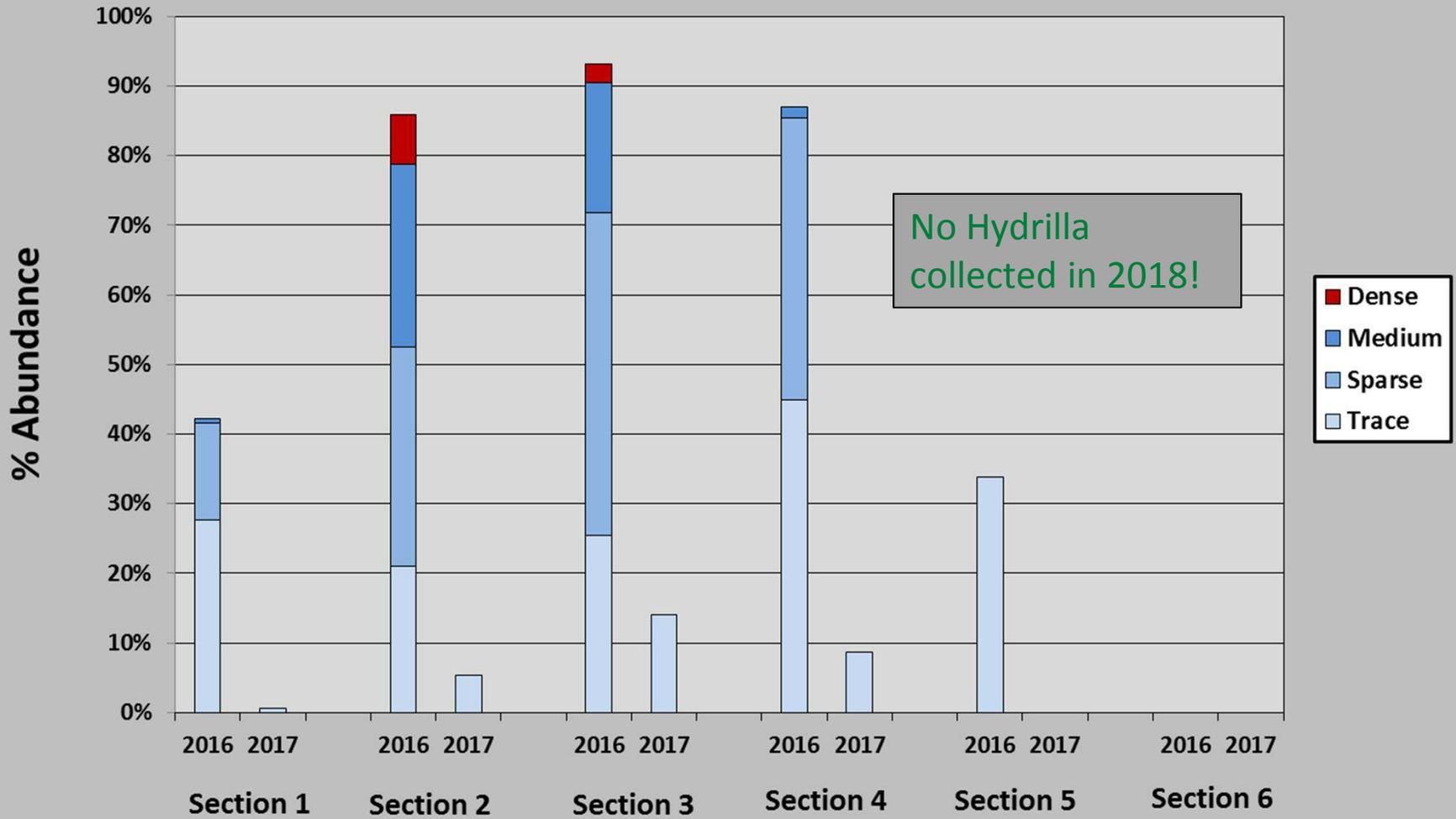


2017-2019 Hydrilla Control Program

- **Low-dose Fluridone Injection (May-Sept.)**
- **2017 SAV Monitoring**
 - Re-map Treatment Area
 - Hydrilla Tuber Monitoring
 - Map Entire D&R Canal
 - 1,813 GPS-referenced Stations
 - Confirmed Hydrilla Extent
 - Supplemental Weekly/Monthly Surveys
- **2018/2019 SAV Monitoring**
 - Treatment Area and Tuber Monitoring only



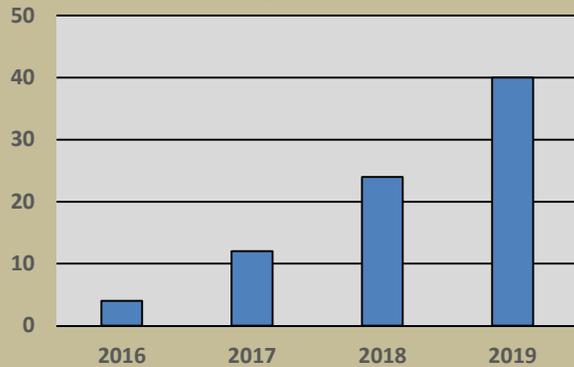
**Hydrilla (*Hydrilla verticillata*)
2016 vs 2017 Percent Abundance by Section
D&R Canal**



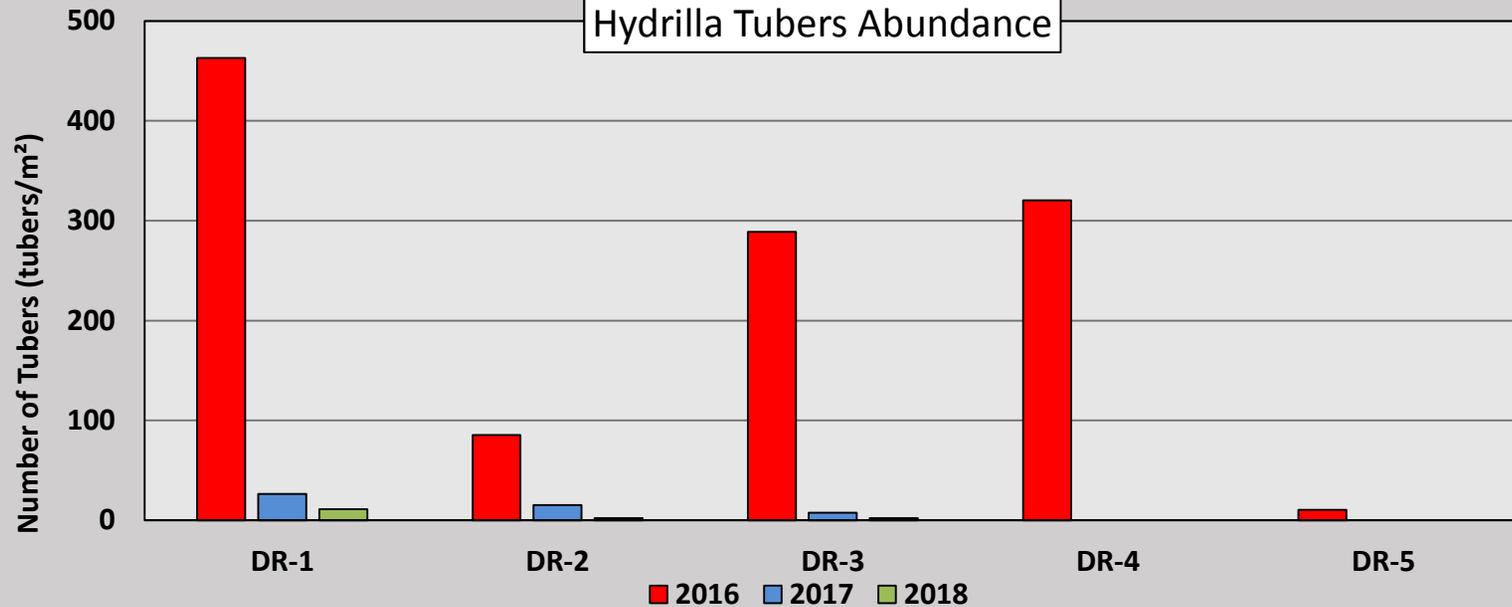
Hydrilla Tuber Monitoring

Tuber Sampling Stations	2016 (tubers/ m ²)	2017 (tubers/ m ²)	2018 (tubers/ m ²)
DR-1	462.8	26.5	11.2
DR-2	85.6	15.2	2.2
DR-3	288.9	7.6	2.2
DR-4	320.4	0	0
DR-5	10.7	0	0

Tuber Sampling Increase Over Time



D&R Canal
2016 vs. 2017 vs. 2018
Hydrilla Tubers Abundance



Case Study #2: Lower Hudson River SAV Monitoring

- **Croton River, Westchester County, NY**
 - Downstream of the New Croton Reservoir
 - Flows into Hudson River
 - **Hydrilla Discovered 2013**
 - Croton River Mapped in 2014
- **2015 SAV Monitoring**
 - Funded by Hudson River Estuary Program
 - NYSDEC
 - Support from New England Interstate Water Pollution Control Commission (NEIWPC)



2015 Project Goals

2015 Hudson River SAV Monitoring

- **Identify Suitable Hudson River SAV Locations**

- PIM Mapping (**Reasonable Effort**)
- Hydrilla and Wild Celery Target Species
 - But document all species

- **If Hydrilla Confirmed at Site:**

- Increase Mapping Effort
- Hydrilla Tuber Sampling

- **Develop a Priority Ranking for Locations**

- Future Monitoring Efforts



Meanwhile: NYSDEC developed a Hydrilla Control Program for the Croton River

2015 Sampling Locations

46 Locations

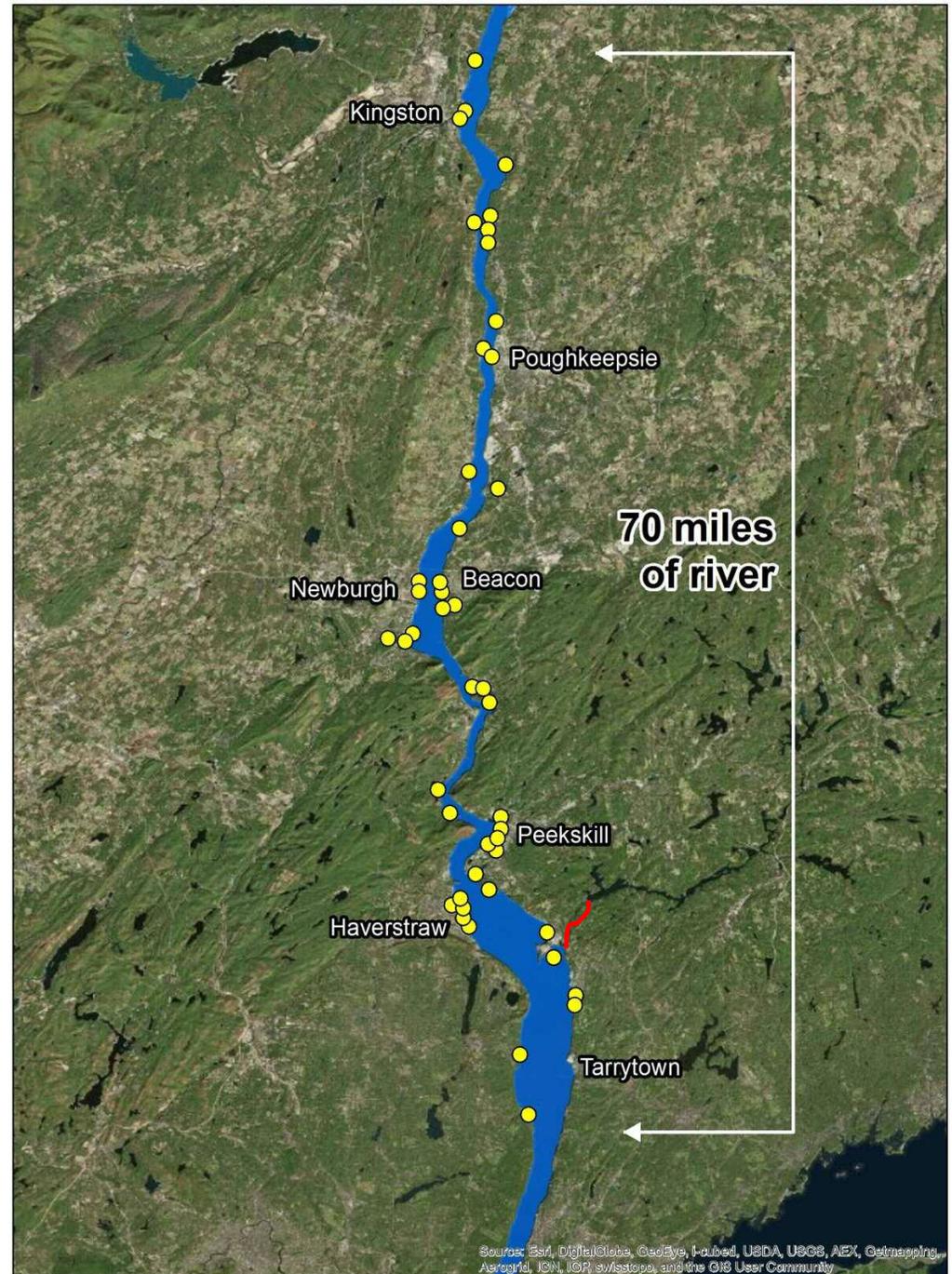
- 70 mile stretch of the Hudson River
- Marinas, boat launches, backwaters and marshes
- Six Counties

Selected by NYSDEC

- +/- Four Locations

Size Range:

- .07 acres to 639 acres



2015 Results

46 Different Locations

- Most used a 50 m grid

1,838 GPS-referenced Sites

- Two tosses/site

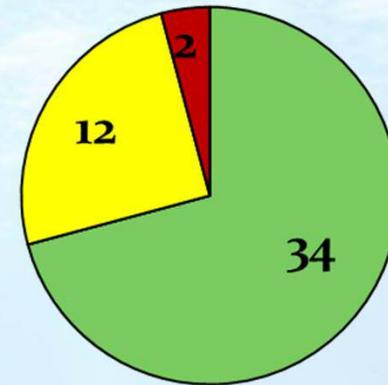
1,102 sites with SAV

- 59.95% of the sites
- Most species collected at >5%

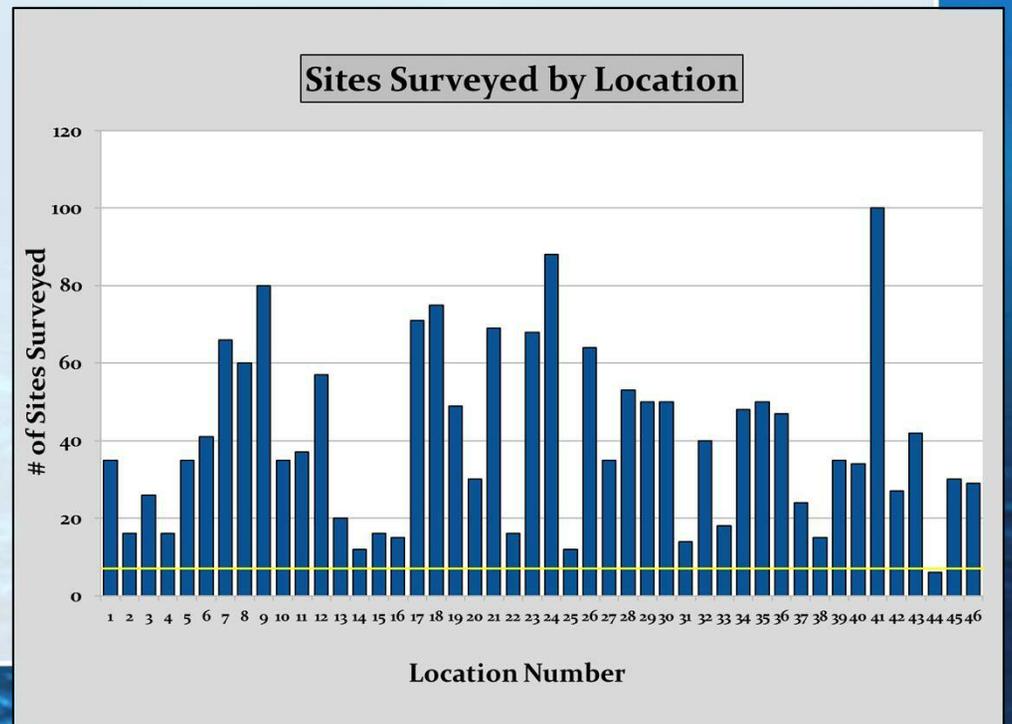
384 Maps Generated

No Hydrilla Documented!

- Dominant: Small Duckweed
- 3 of top 4 SAV were Invasive
 - EWM, WC, BN



■ 50 m grid ■ 100 m grid ■ 200 m grid



Project Challenges

Finding SAV Habitat

- Turbidity, wind, tidal action, shoreline, water depth

Location Access

- Limited boat launches
- Tidal
- Bridges
- Property Owners

Time Line

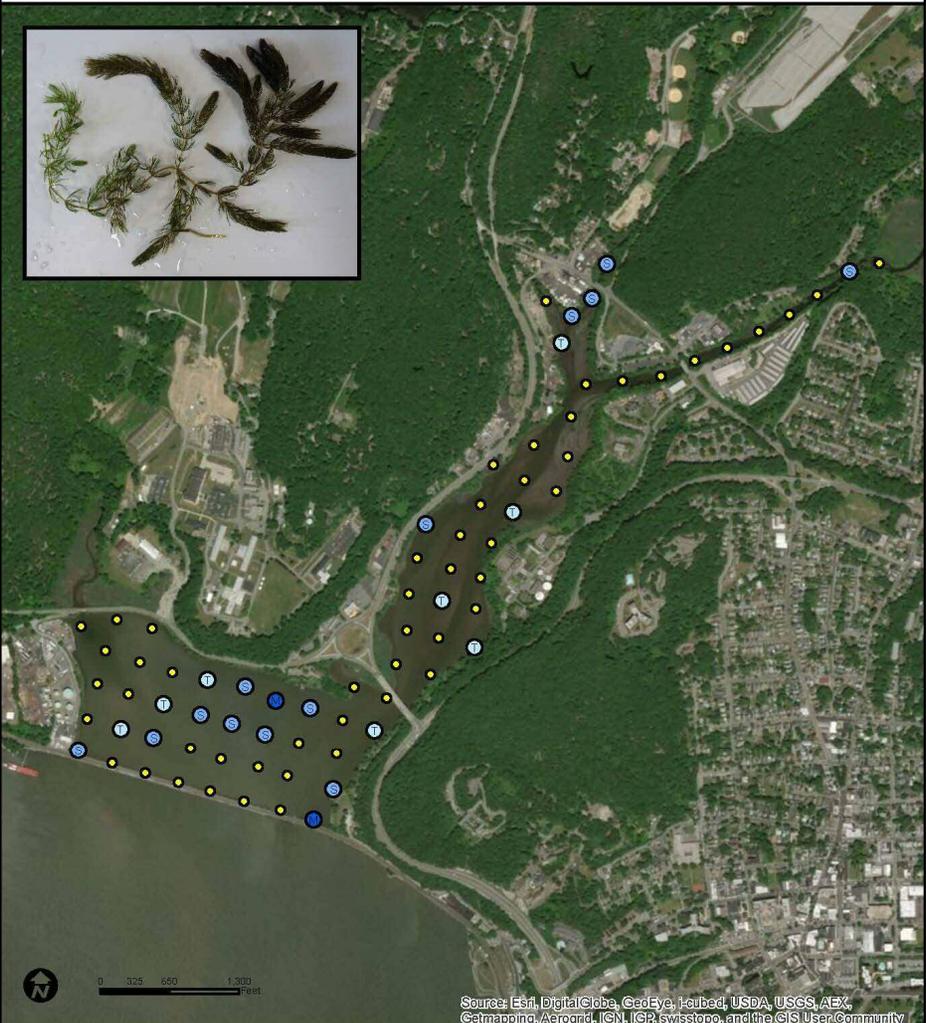
- 8 weeks for field surveys

Location Variability/Acreage

Travel Time

- Estimated 120 hours driving to/from sites

COONTAIL (*Ceratophyllum demersum*) DISTRIBUTION



ANNSVILLE CREEK
Hudson River Hydrilla Monitoring
September 22, 2017

Sampling Stations: 75

Plant Density	Symbol
No Plants	Yellow circle
Trace Plants	White circle with black outline
Sparse Plants	Blue circle with black outline
Medium Plants	Dark blue circle with black outline
Dense Plants	Red circle with black outline

Percent Distribution	Abundance	
	Sites	Percent
Total	23	31%
Trace	8	35%
Sparse	13	57%
Medium	2	9%
Dense	0	0%

Site Variability



COMMON WATERWEED (*Elodea canadensis*) DISTRIBUTION



DEVRIES PARK
Hudson River Hydrilla Monitoring
August 22, 2018

Sampling Stations: 45

Plant Density	Symbol	Description
No Plants	Yellow circle	No Plants
Trace Plants	White circle with 'T'	Trace Plants
Sparse Plants	Light blue circle with 'S'	Sparse Plants
Medium Plants	Dark blue circle with 'M'	Medium Plants
Dense Plants	Red circle with 'D'	Dense Plants

Percent Distribution	Abundance	
	Sites	Percent
Total	36	80%
Trace	19	53%
Sparse	6	17%
Medium	7	19%
Dense	4	11%

Priority Ranking Criteria

- **SAV Habitat Quality**
 - SAV Diversity
 - SAV Abundance
- **Keystone Species Present**
 - Common Waterweed
 - Wild Celery
- **Proximity to Croton River**

In General: Marinas and Boat Launches on the Hudson River are **Poor** SAV Habitat

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	Lent's Cove	Popolopen Creek
Minisceongo Yacht Club	Moodna Creek	Dickie Brook
Piermont Marsh	Hyde Park Marina	Croton Bay
Viking Boat Yard	Fishkill Creek Bay	Annsville Creek
Newburgh Boat Launch Site	Marlboro Yacht Club	Iona Marsh
Front Street Marina	Vanderbilt Mansion Cove	Moodna Creek Bay
Sloop Hill Boat Launch Site		Constitution Marsh
Riverfront Green Park		Foundry Cove Bay
Peekskill Land Park		Foundry Cove
Denning's Point Bay		Wappinger's Creek
Riverfront Park		Norrie State Park
Waryas Park		Black Creek Preserve
Poughkeepsie Yacht Club		Fishkill Creek
Chelsea Boat Launch Site		Sleightsburg Park
Shepherd's Landing/Mariners		Vanderburgh Cove
Charles Rider Boat Launch Site		Kemey's Cove
Scarborough Park		Kingston Point Park Marsh

Moving Forward

2016

- Volunteer Surveys

2017 to 2021

- Surveys Added to Croton River Hydrilla Control Project
- 21 High Priority Locations

2018

- Added 8 new Lower Hudson Locations (***Adaptive Monitoring***)
- NYSDEC Funded Upper Hudson Surveys
 - 18 Locations
 - North of Kingston, NY

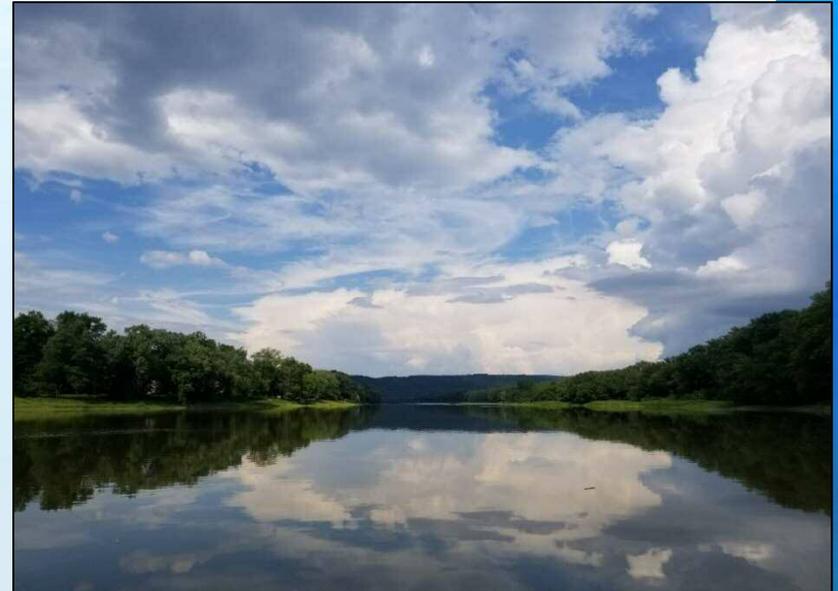


For more information on the Project:
<https://www.dec.ny.gov/animals/106386.html>

Case Study #3: Spencer Pond

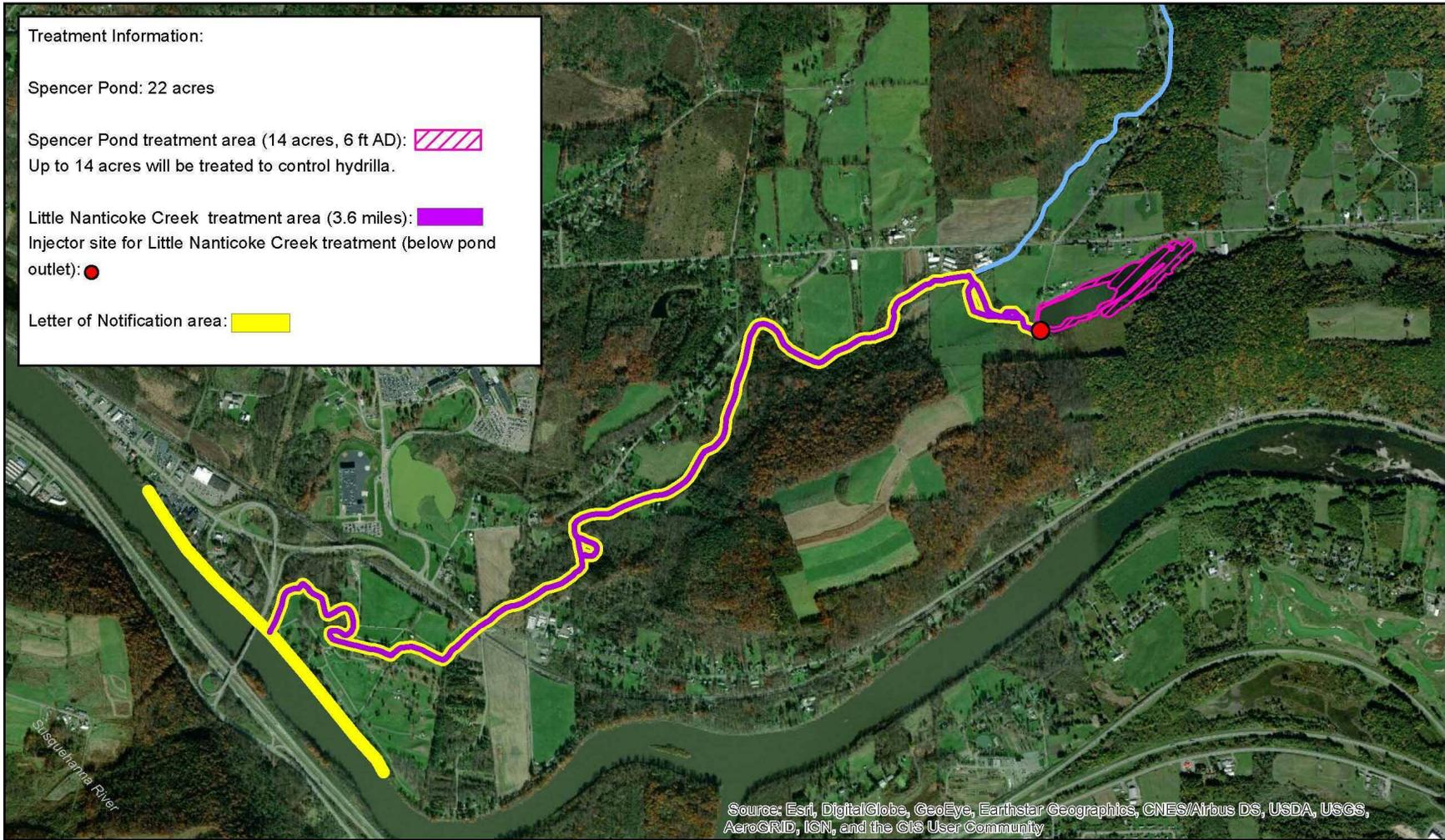
Tioga County, NY

- **Spencer Pond**
 - 22 acre private pond
- **Little Nanticoke Creek**
 - 3.6 miles long
 - Flows into Susquehanna River
- **Susquehanna River**
 - Flows from Otsego Lake (NY) to Chesapeake Bay, MD
 - 444 miles long
 - Longest R. on East Coast
 - 16th Longest in USA



- 2017: Late Season Pond Treatment
2018-2022: 5 Year Control Program
- Herbicide Treatment in Pond
 - Herb. Conc. Monitoring
 - SAV Mapping (3 Habitats)
 - Pre and Post
 - Pond Tuber Monitoring

FIGURE 2: HERBICIDE APPLICATION AREA



Tioga County Hydrilla Control Project
Owego, New York
[Tioga County]
42.105643°, -76.184787°



SPENCER POND and LITTLE NANTICOKE CREEK

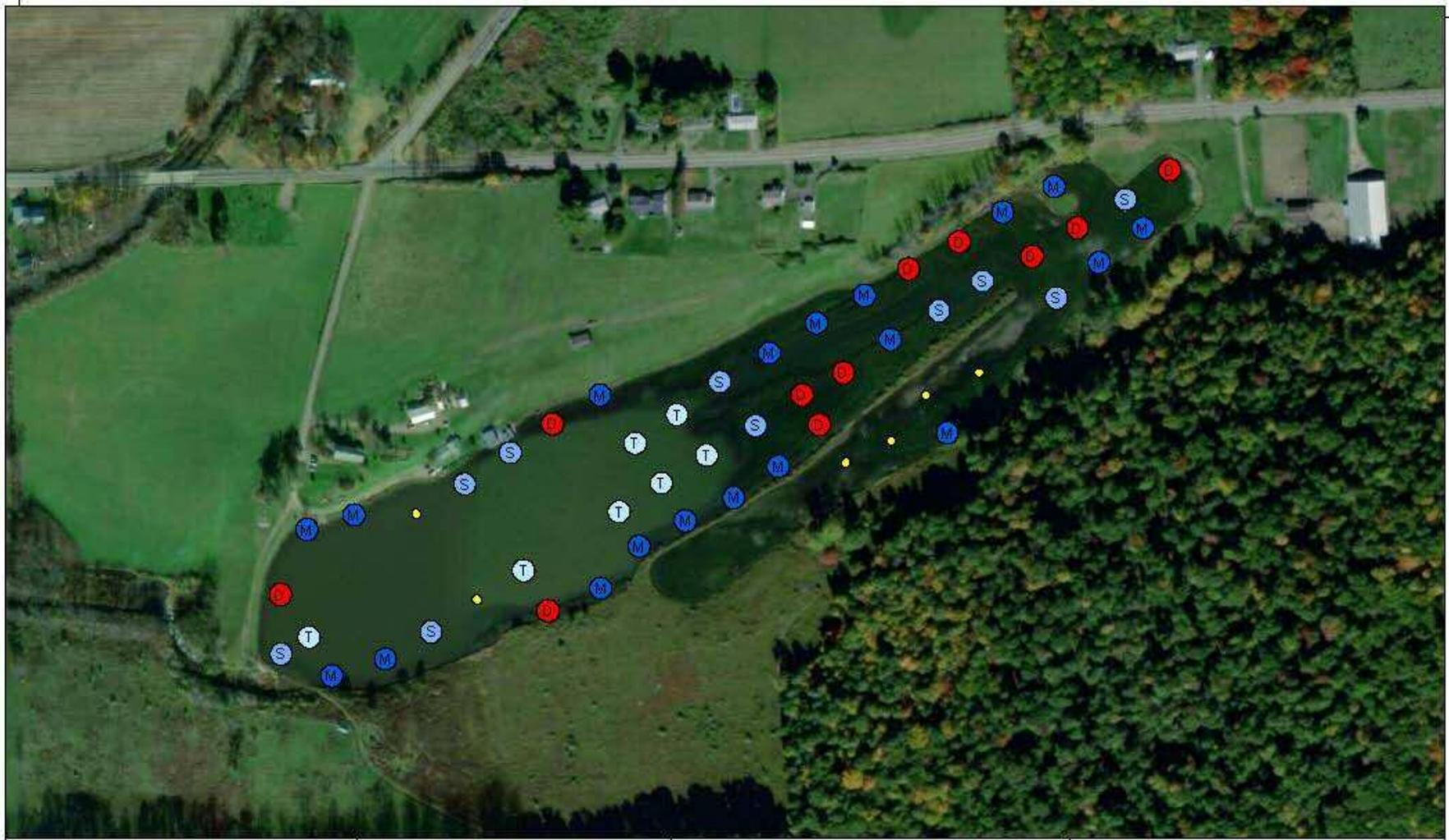
1:23,752

0 650 1,300 2,600
Feet



Map Date: 7/10/2018
File: Spencer_HerbTrtArea_2018
Prepared by: KM
Office: Washington, NJ

Hydrilla (*Hydrilla verticillata*) Distribution



Spencer Road Pond
 Aquatic Vegetation Survey
 July 18, 2018
 53 Sites

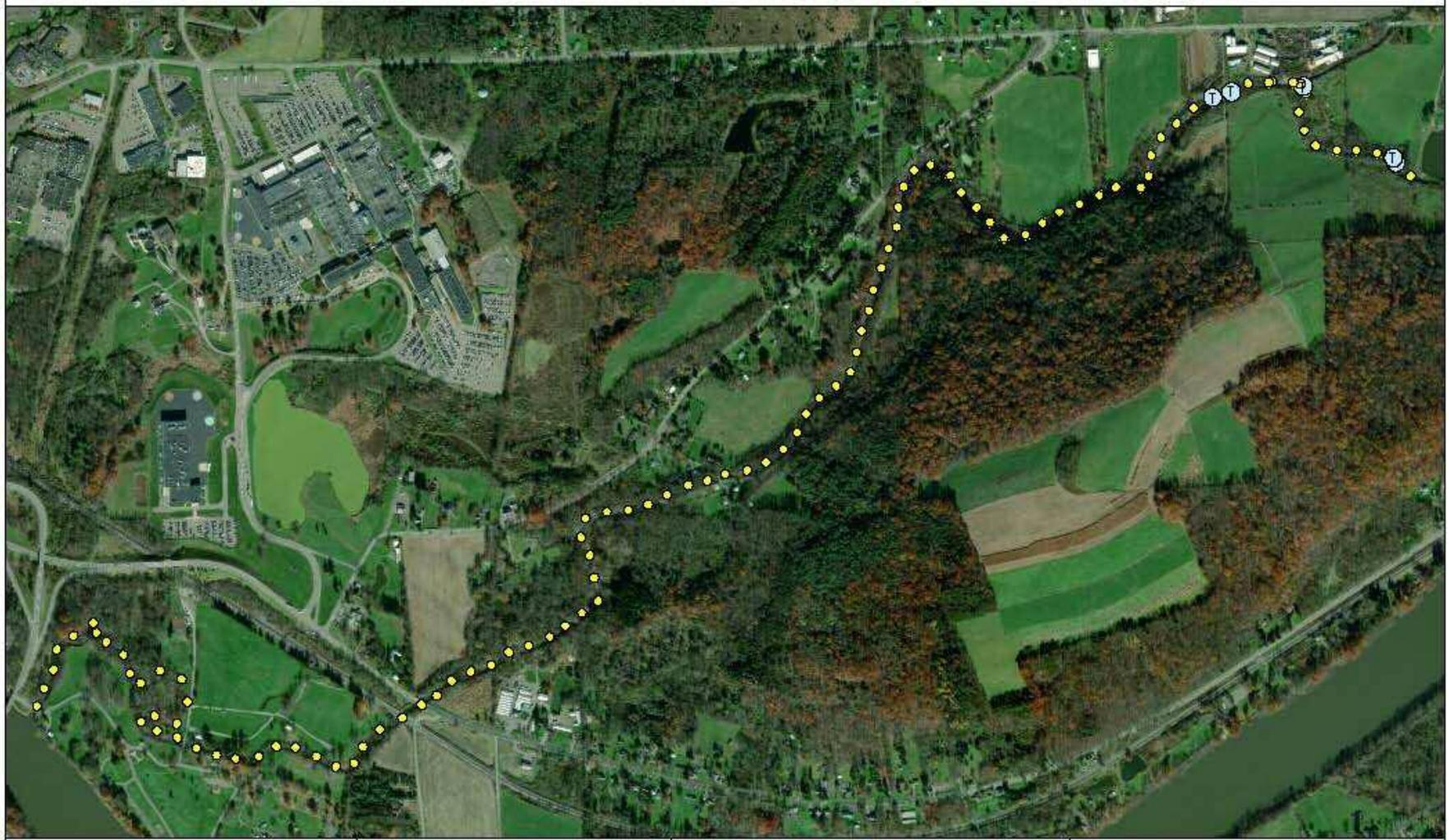
Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Plant Distribution

Abundance	Sites	Percent
Total	47	89%
Trace	7	15%
Sparse	10	21%
Medium	19	40%
Dense	11	23%

Hydrilla (*Hydrilla verticillata*) Distribution

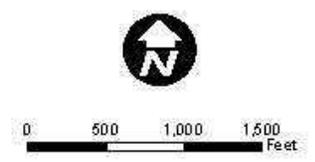


Little Nanticoke Creek
 Aquatic Vegetation Survey
 July 18-19, 2018
 107 Sites

- Plant Density Legend
- = No Plants
 - T = Trace Plants
 - = Sparse Plants
 - = Medium Plants
 - = Dense Plants

Plant Distribution

Abundance	Sites	Percent
Total	5	5%
Trace	5	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%



Susquehanna River Challenges

- **High Flows, Reduced SAV, Rocks**
 - Surveyed with an airboat
 - Determined 5 likely Sites SAV Growth (324 locations)
 - From 2017 surveys, then adapted
 - Added boat launch site upstream

Susquehanna River
Aquatic Macrophyte Abundance Distribution
August 8 & 9, 2018

	Total		Trace		Sparse		Medium		Dense	
	Sites	%	Sites	%	Sites	%	Sites	%	Sites	%
Total Sites	324									
OVERALL	113	35%	65	58%	25	22%	16	14%	7	6%
COMMON WATERWEED	67	21%	44	66%	18	27%	5	7%	0	0%
EURASIAN WATERMILFOIL	60	19%	41	68%	13	22%	5	8%	1	2%
WATER STARGRASS	42	13%	34	81%	6	14%	2	5%	0	0%
COONTAIL	16	5%	13	81%	2	13%	1	6%	0	0%
WILD CELERY	13	4%	9	69%	4	31%	0	0%	0	0%
LONG-LEAF PONDWEED	7	2%	2	29%	0	0%	1	14%	4	57%
CURLY-LEAF PONDWEED	2	1%	2	100%	0	0%	0	0%	0	0%
SAGO PONDWEED	2	1%	2	100%	0	0%	0	0%	0	0%
FLATSTEM PONDWEED	1	0%	0	0%	1	100%	0	0%	0	0%
HEART PONDWEED	1	0%	1	100%	0	0%	0	0%	0	0%
SMALL DUCKWEED	1	0%	0	0%	1	100%	0	0%	0	0%
THIN-LEAF PONDWEED	1	0%	1	100%	0	0%	0	0%	0	0%

Sample Point Location: Apalachin Launch



Susquehanna River

Sample Point

Aquatic Vegetation Survey
August 8-9 & October 9, 2018
324 Sites



0 2,000 4,000 6,000 8,000 10,000 Feet

Acknowledgements

NEANS Panel

ACOE (Mike Greer)

NYSDEC (Cathy McGlynn,
Nicole White)

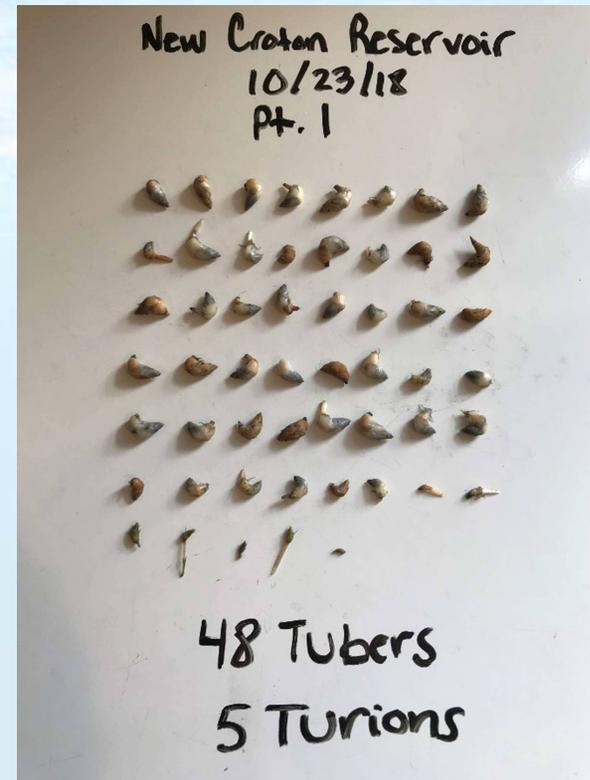
NJWSA (Heather Desko)

NYDEP (Meredith Taylor,
Mike Usai)

SePro Corp. (Mark Heilman,
Shaun Hyde)

SLM Bio Team (Emily, Brea,
Amanda, Kate, and Kendra)

SLM Mapping Team (Krista,
Matt)



Thank you! Questions?

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