Allied Biological

NYSFOLA
May 5, 2012

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Senior Aquatic Biologist

Using Mapping Techniques to Support Lake Management Activities

What is GPS?

- Global Positioning System
  - A space-based Satellite Navigation System
  - Provides Location and Time Info Anywhere on or Near the Earth
  - Requires Unobstructed View of at Least 4 Satellites
  - Freely Accessible to Anyone with a GPS Receiver
    - Calculates location based on time message sent and satellite position
  - Components
    - Antenna (tuned to satellite frequencies)
    - Receiver/processor
    - Highly Stable Clock
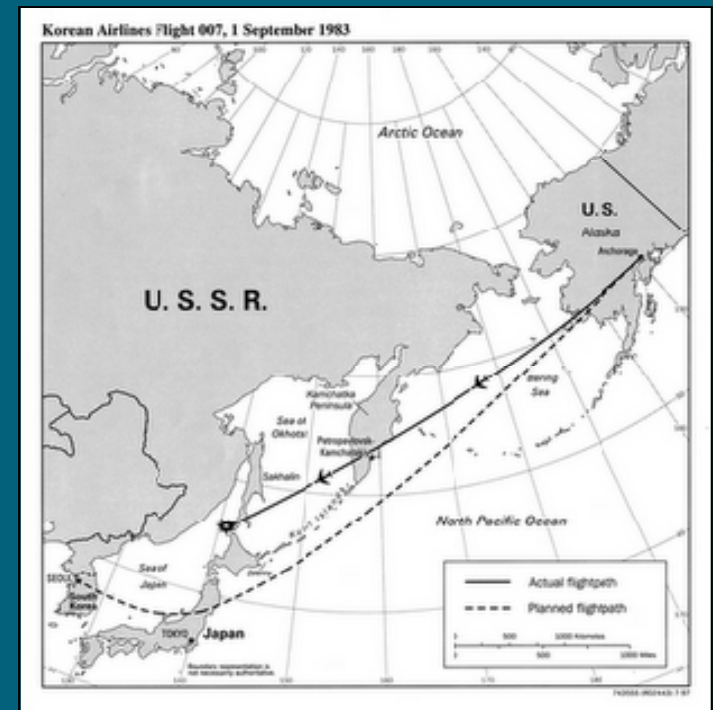
History of GPS Development

- GPS Developed from Ground-based Navigation
  - **1940's** (WWII); LORAN, etc.
- **1957** Sputnik (USSR); 1st Man-made Satellite
  - US Physicists Monitored Radio Transmissions
  - Used the Doppler Effect to Calculate Orbit
- **1958** Commissioned to Reverse Calculate
  - Use Satellites to Find Ground Location
  - Need 24 Satellites
  - Called *Transit* (1960; Navy)
  - One Position Fix per Hour!
- **1960**-Air Force Developed *MOSAIC*
- **1963**-*Project 57*; Concept of GPS Born
- **But, Reserved for Military Use**

JOHNS HOPKINS
UNIVERSITY

The New York Times

"All the News That's Fit to Print"

Late Edition
Weather: Mostly cloudy, warm today, light southwesterly winds, clear tonight. Sunny, more humid tomorrow. Temperatures: today 83-85, tonight 67-73; yesterday 69-84. Details, page B17.

VOL.CXXXII .. No. 45,789   Copyright © 1983 The New York Times   NEW YORK, FRIDAY, SEPTEMBER 2, 1983   30 cents beyond 75 miles from New York City, except on Long Island   30 CENTS

U.S. SAYS SOVIET DOWNED KOREAN AIRLINER; 269 LOST; REAGAN DENOUNCES 'WANTON' ACT

Flight of the Korean 747   SOVIET UNION

- **1983:** Korean Airlines Flight 007
  - Strayed Off Course, into USSR
  - Shot Down by USSR Jet
- President Reagan Passed Directive
  - GPS Freely Available for Civilian Use
  - 1st Satellite launched in **1989**; last in **1994**
- But, Civilian Signal Intentionally Degraded
  - Selective Availability (SA)
  - Precision: 100 meters (330 ft.)
- **2000**; SA Turned Off
  - Precision: 20 meters (66 ft.)
  - Spurred Civilian Use

GPS is Owned and Operated by US Gov't as a Natural Resource (DoD)

Korean Airlines Flight 007, 1 September 1983

Arctic Ocean

U.S.S.R.

U.S. Alaska

North Pacific Ocean

— Actual flightpath
--- Planned flightpath

GPS Applications

- **Military**
  - Navigation (Darkness)
  - Target Tracking
  - Missile and Projectile Guidance
  - Search and Rescue
  - Reconnaissance
  - Nuclear Detonation Detectors

GPS Applications (con't)

- **Civilian**
  - Cell Phones
  - Navigation (automobiles and smartphones)
  - Geotagging (attaching digital objects to location)
  - Recreation
    - Geocaching (high tech "hide and seek")
    - Geodashing
    - Waymarking
  - Clock Synchronization

GPS Applications (con't)

- **Commercial**
  - Air Traffic Control
  - GPS Tours
  - Cartography
  - Surveying (property lines)
  - Robotics
  - Geofencing (vehicle, pet, person tracking)
  - Fleet Tracking (delivery trucks)
  - Scientific Applications
    - Lake Management

'No, I'm wide awake... Why?'

Handheld GPS Units

- Popular Brands
  - Garmin, TomTom, Bushnell, Magellen
- Wide Price Range
  - $70.00 to $700.00
  - Higher Price=more features and better accuracy
- **Features:**
  - Pre-loaded Maps
  - Camera
  - Storage
  - Area Calculations
  - Live Traffic Updates

Accuracy

Typical GPS: 15 meters
DGPS: 3 to 5 meters (post-processed)
WAAS: <3 meters

Trimble GeoXH

- High Performance GPS Receiver and Handheld computer
  - Windows Mobile 6.0
  - 1 GB onboard storage + SD Card
  - High Res. VGA display
  - Bluetooth Capabilities
- Built-in antenna
  - Increase accuracy and reception with external antenna mounted on 2.0m pole
- Accuracy
  - Real-time: Sub-meter
  - Post-processing software and corrections: 20 cm

Lake Management with GPS

- Aquatic Plant Mapping
  - Several Case Studies Presented
  - Can be performed by the Weekend Biologist or Volunteers
- Bathymetry Mapping
  - Several Examples Presented
  - Augment with Support Services
- Sediment Depth Mapping
  - Common in Marine Environments
  - Relatively New Innovation in Inland Waters
  - Less Effort; More Data
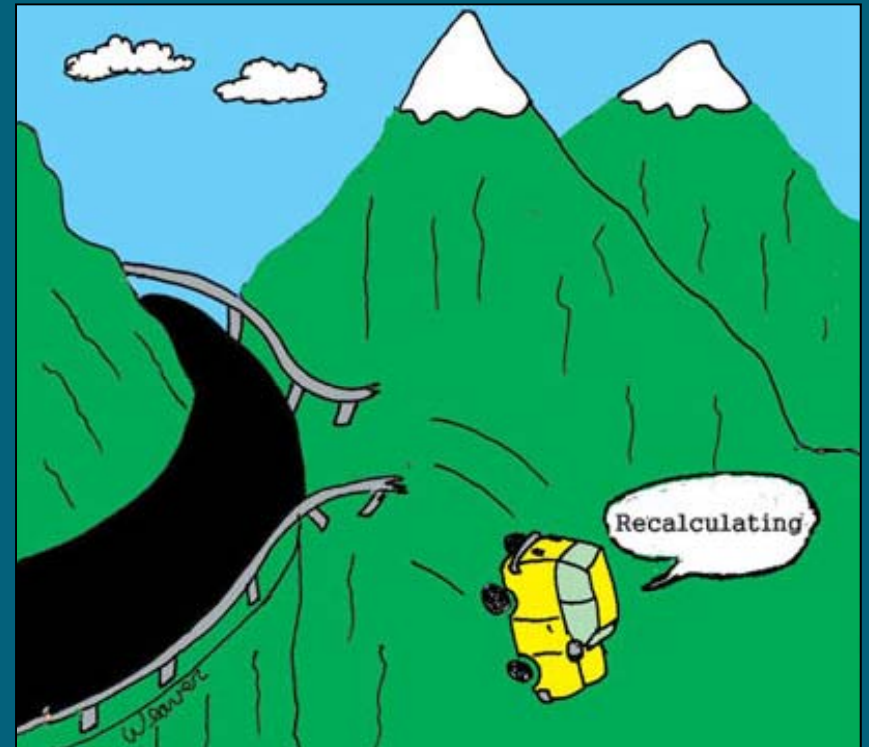
GPS-Referenced Point Intercept Aquatic Vegetation Survey

Based on Point Intercept Methods developed by Madsen (ACOE, 1999) and Lord (Cornell, 2006) and many others

Abundance	Code	Field Measure	Biomass (dry weight; g/m²)
No Plants	"Z"	No plants	0.0000
Trace Plants	"T"	Fingerful (1-2 stems)	0.0001 to 2.000
Sparse Plants	"S"	Handful (3-6 stems)	2.001 to 140.000
Medium Plants	"M"	Rakeful (no tines visible)	140.001 to 230.000
Dense Plants	"D"	Difficult bringing weed mass into boat	230.001 to 450.000+

Suitable to Conduct These Surveys with Hand Held GPS Units
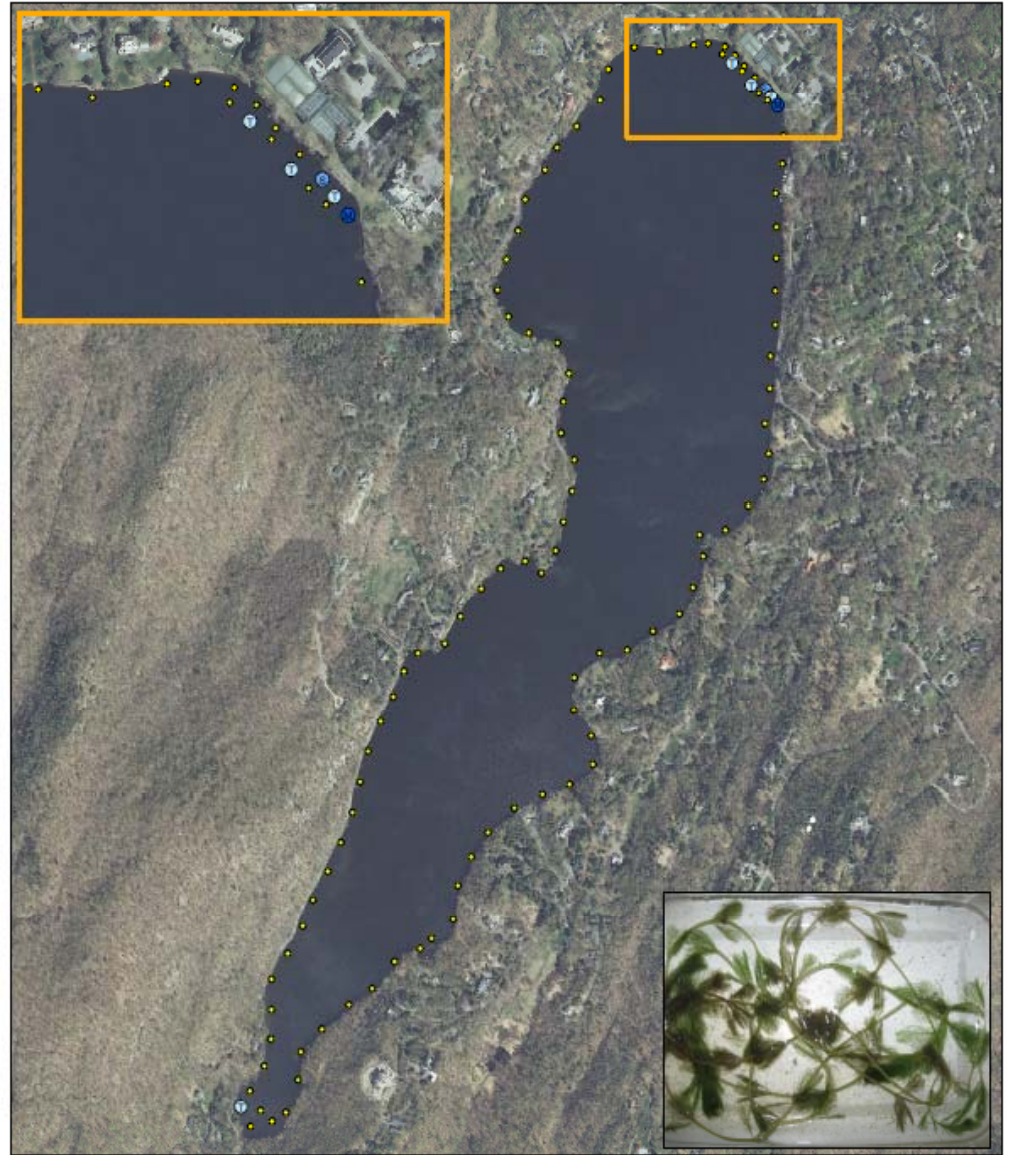
Case Study: Tuxedo Lake

- Located in Southern New York
- 292 Surface Acres
- Mean Depth 26.4 ft.; Max depth 56 ft.
- Limited littoral zone (<10%)
- Eurasian water milfoil (EWM) discovered by resident in early Oct. 2011
- ABI retained to perform GPS Veg. Survey
- Surveyed 104 points on Oct. 21, 2011
- **Survey Goals**
  - Confirm ID of EWM
  - Quantify Abundance and Distribution
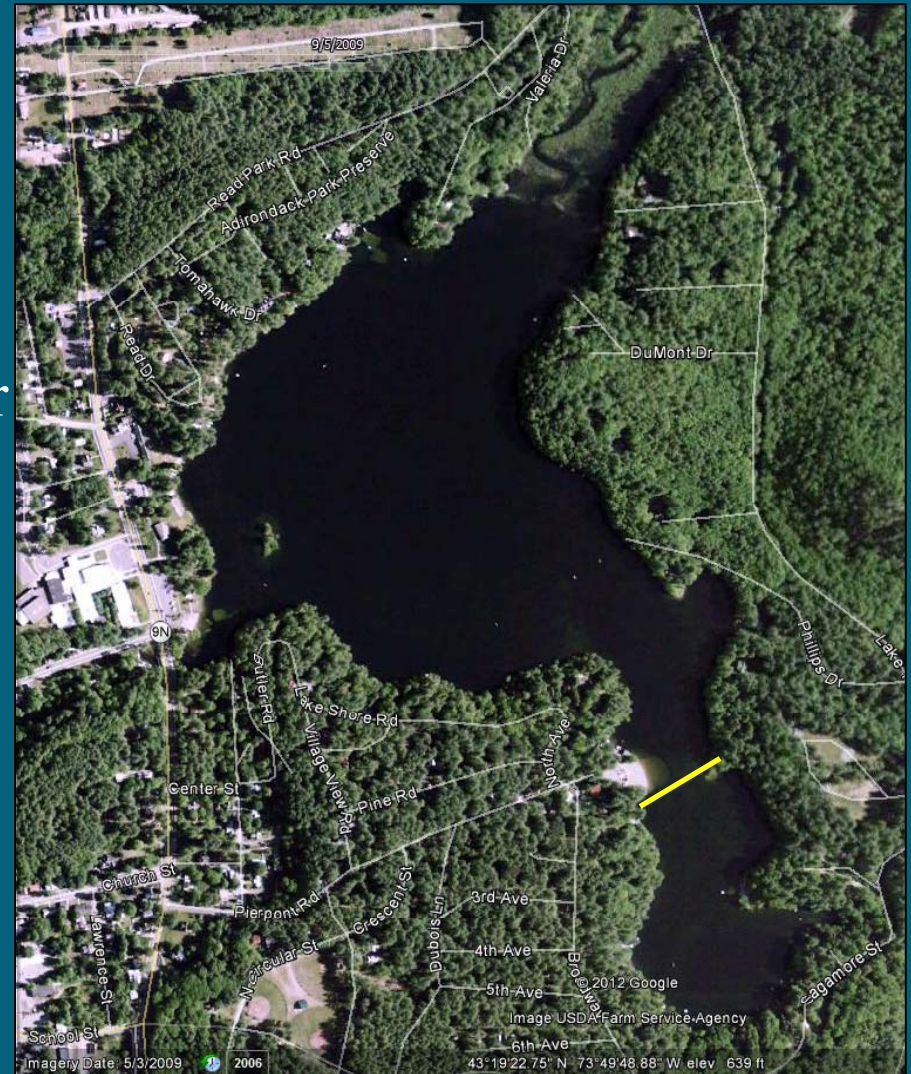 - Recommend Plant Control Options
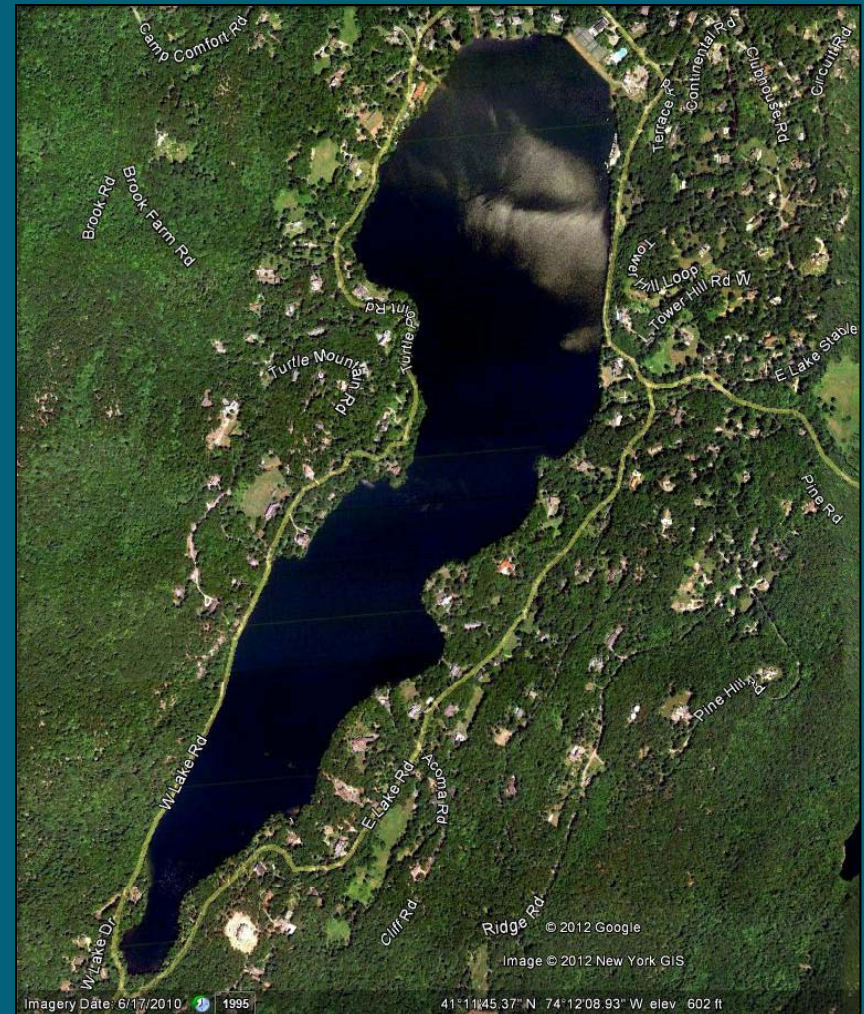
Results

- **EWM Identification Confirmed**
- **Infestation Quantified**
  - Limited Distribution
  - Six sites had EWM
  - Trace to Medium Density
  - But other EWM observed along dam shore (in 8-12 ft. water)
- **One Trace Site in Southern Cove**
  - ~ 1.75 miles from dam
- **Based on Survey Data**
  - Recommended Hand Pulling
  - Follow-up Survey in 2012
    - Use the Same Locations

Eurasian Water Milfoil (*Myriophyllum spicatum*) Distribution
Tuxedo Lake Aquatic Vegetation Survey
October 21, 2011

Allied Biological

Corporate Office: 580 Rockport Road, Hackettstown, NJ 07840
Northern NY Office: 984 County Highway 53, Maryland, NY 12116

1-800-245-2932   www.alliedbiological.com

LEGEND
- = No Plants
- T = Trace Plants
- = Sparse Plants
- M = Medium Plants
- = Dense Plants

0   850   1,700
Feet

Case Study: Lake Luzerne

- Located in Adirondack Park
- 111 Surface Acres
- Mean Depth 24 ft.; Max. 52 ft.
- Limited Littoral Zone
- Treated with Renovate in 2010 for Control of EWM
- Southern Cove Curtained to Restrict Herbicide Mov't
- Limited Hand Pulling in 2011
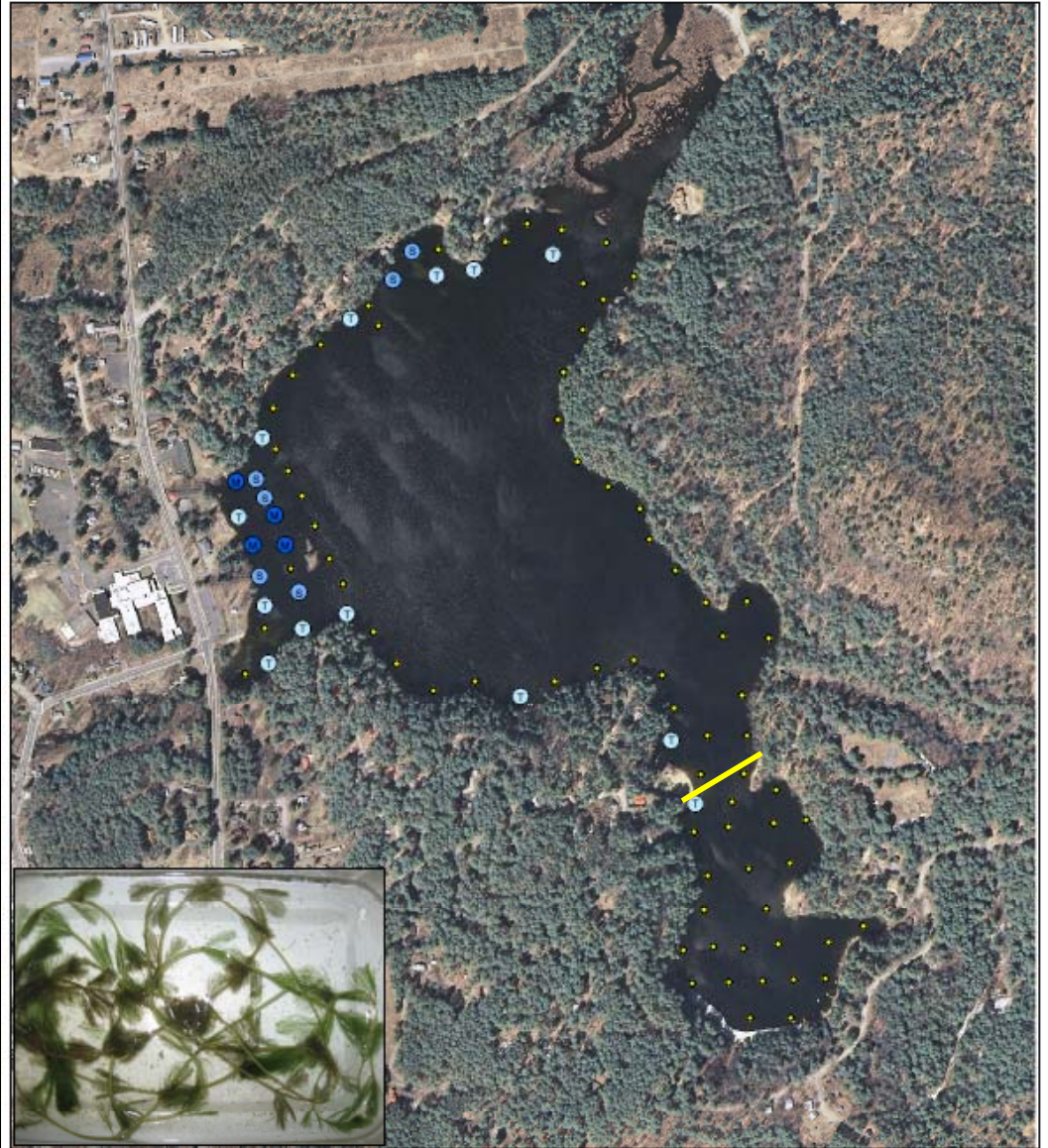- **2010 Winner of the NYSFOLA Raffle for a Free GPS Veg. Survey!**

Survey Goals:

- Efficacy of Cove Treatment
- Effects on Native Plants
- Identify Add. Treatment Areas

Results:

- 38 Different Aquatic Plants Collected
  - 5 different milfoils (3 native)
  - 10 different pondweeds
  - 4 different bladderworts
  - 4 different RTE species
- Good EWM Control in South Cove
  - 2011 Hand pulling
- 2013 West Shore Treatment Zone?

Eurasian Water Milfoil (*Myriophyllum spicatum*) Distribution
Lake Luzerne Aquatic Vegetation Survey
September 14, 2011

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LEGEND
- = No Plants
- T = Trace Plants
- S = Sparse Plants
- = Medium Plants
- = Dense Plants

0   220   440   880
Feet

Case Study: Donahue Pond

- Located on Long Island, NY
- 39 Surface Acres
- Mean depth: 4 ft.; Max Depth 5.5 ft.
- 100% Littoral Zone
- Peconic River Sportsman's Club
- Heavily Infested with Fanwort
- Actively Managed Since 2006
  - Numerous Sonar test studies
  - Hand pulling
  - Benthic barriers
  - GPS Veg. Surveys 2005-2011

Survey Goals:
  - Assess Efficacy of Treatment Methods
  - Track Native Plant Re-colonization
  - Determine Future Treatment Methods

Date: 3/6/2012   1994   40°53'52.32" N 72°46'40.28" W elev 29 ft
© 2012 Google
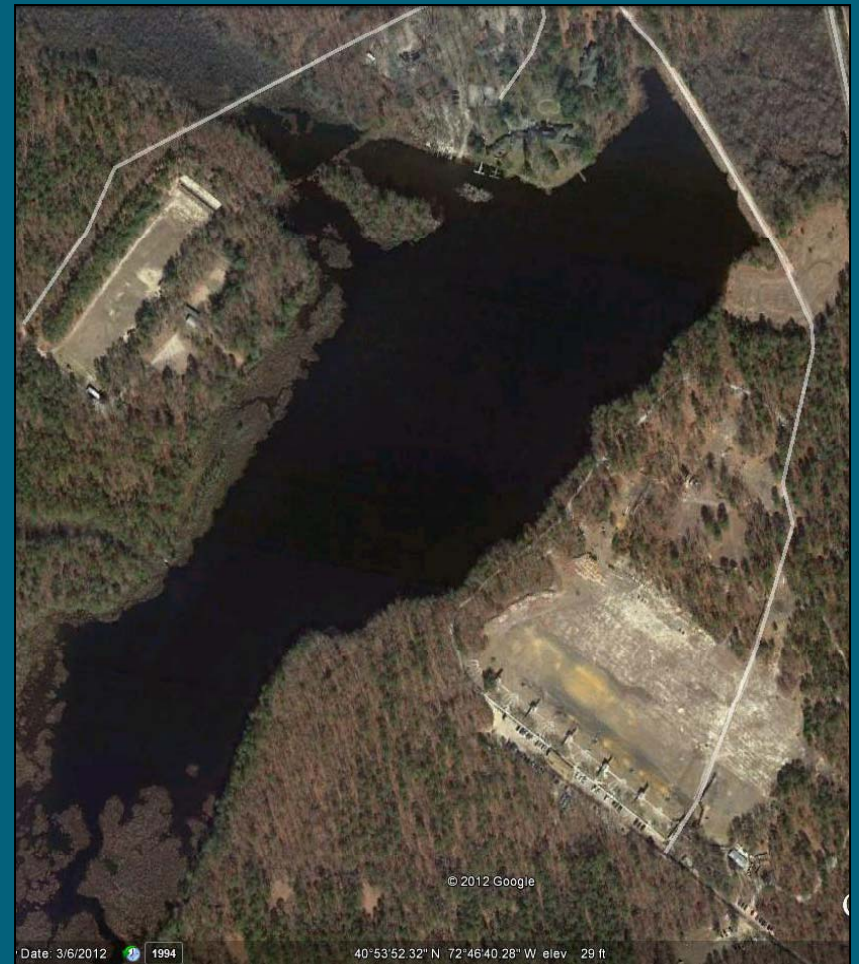
Fanwort (*Cabomba caroliniana*) Distribution
Donahue Pond Aquatic Vegetation Survey
August 6, 2009
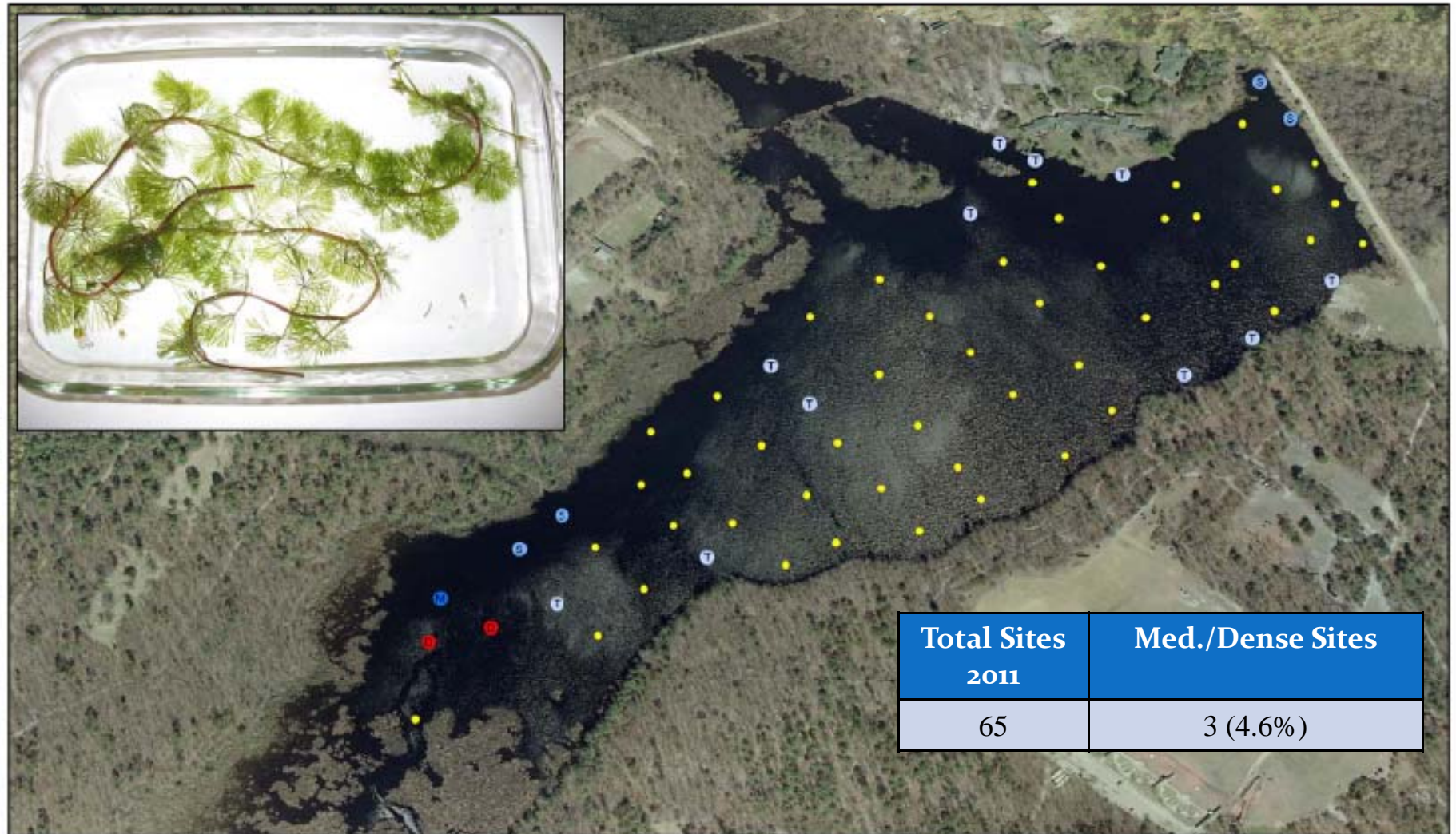
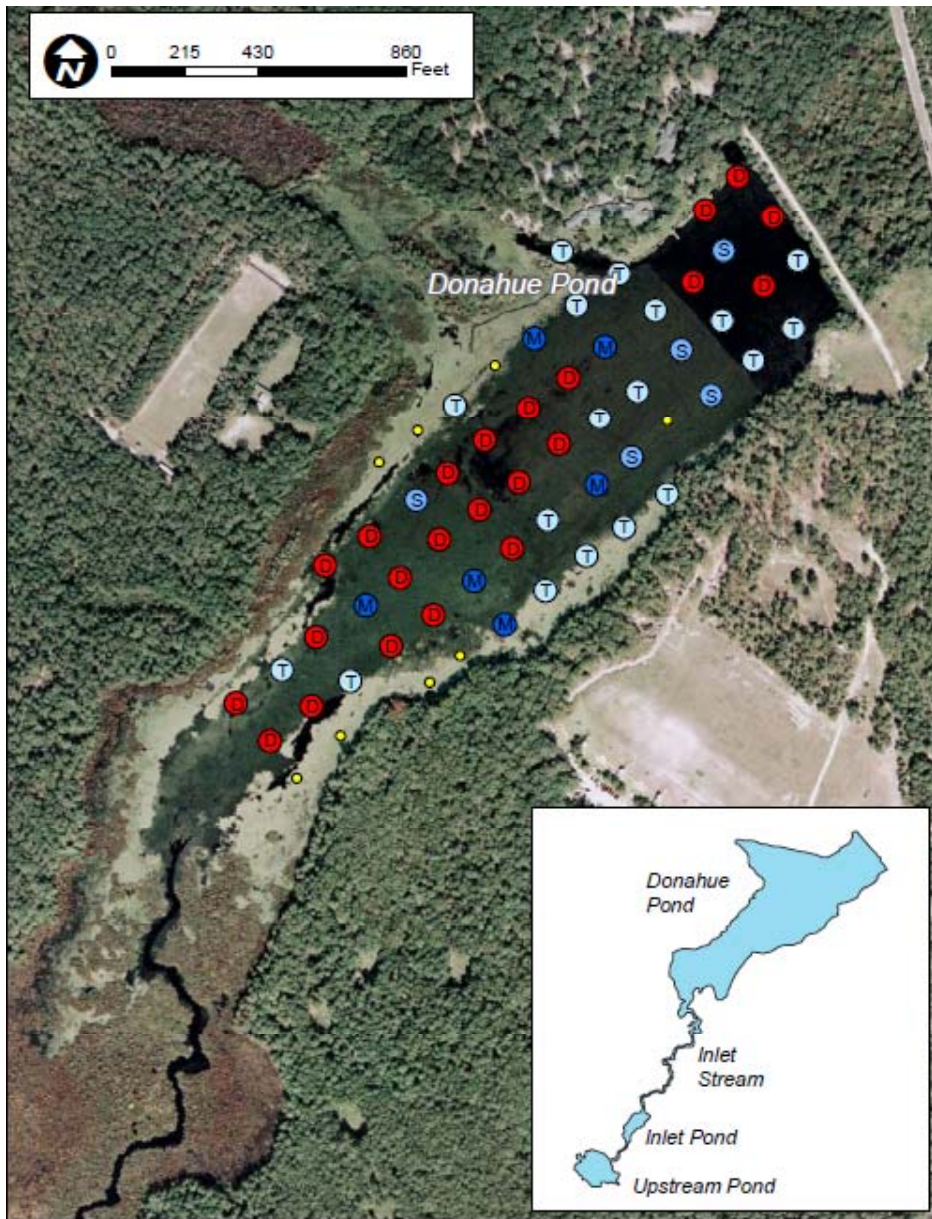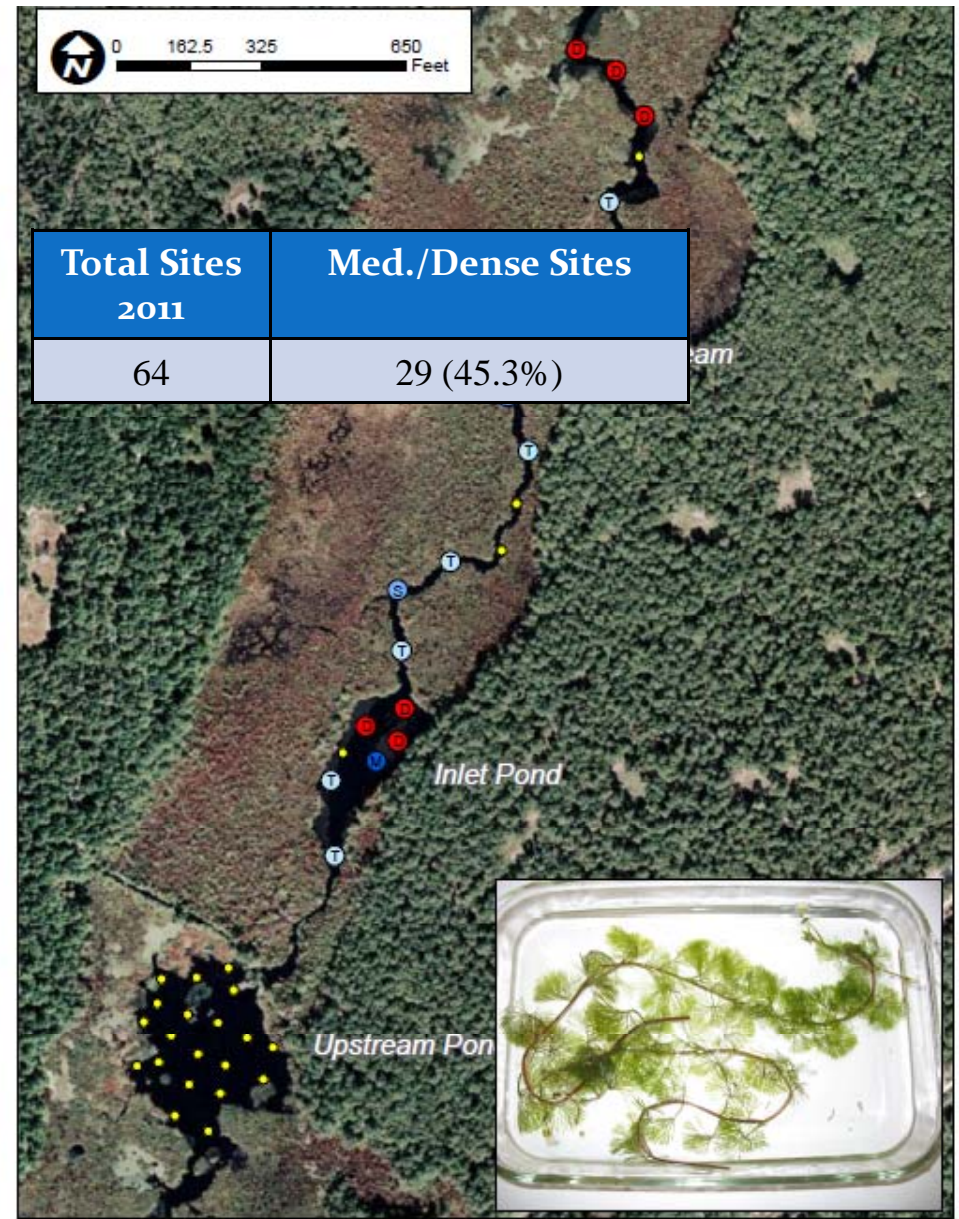| Total Sites 2011	Med./Dense Sites
65	3 (4.6%)

LEGEND

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

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0   225   450   900 Feet

Total Sites 2011	Med./Dense Sites
64	29 (45.3%)

LEGEND

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

Fanwort (*Cabomba caroliniana*) Distribution
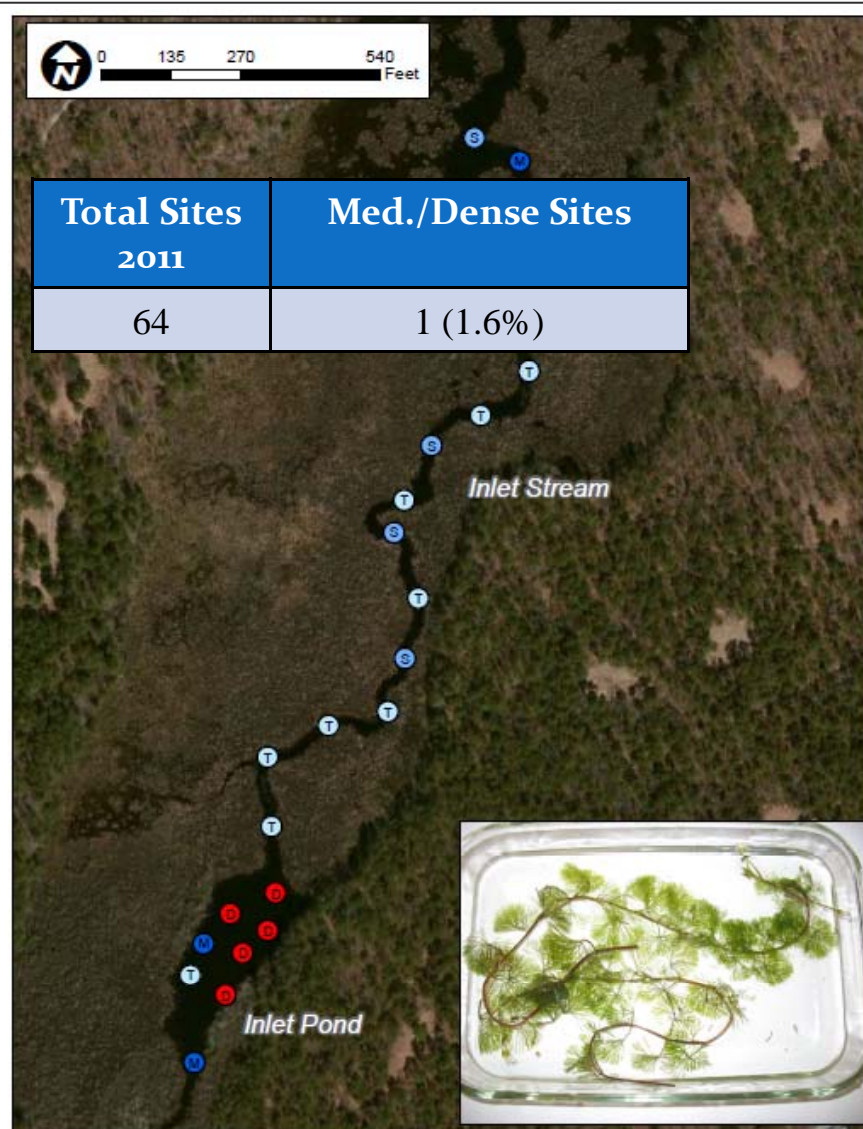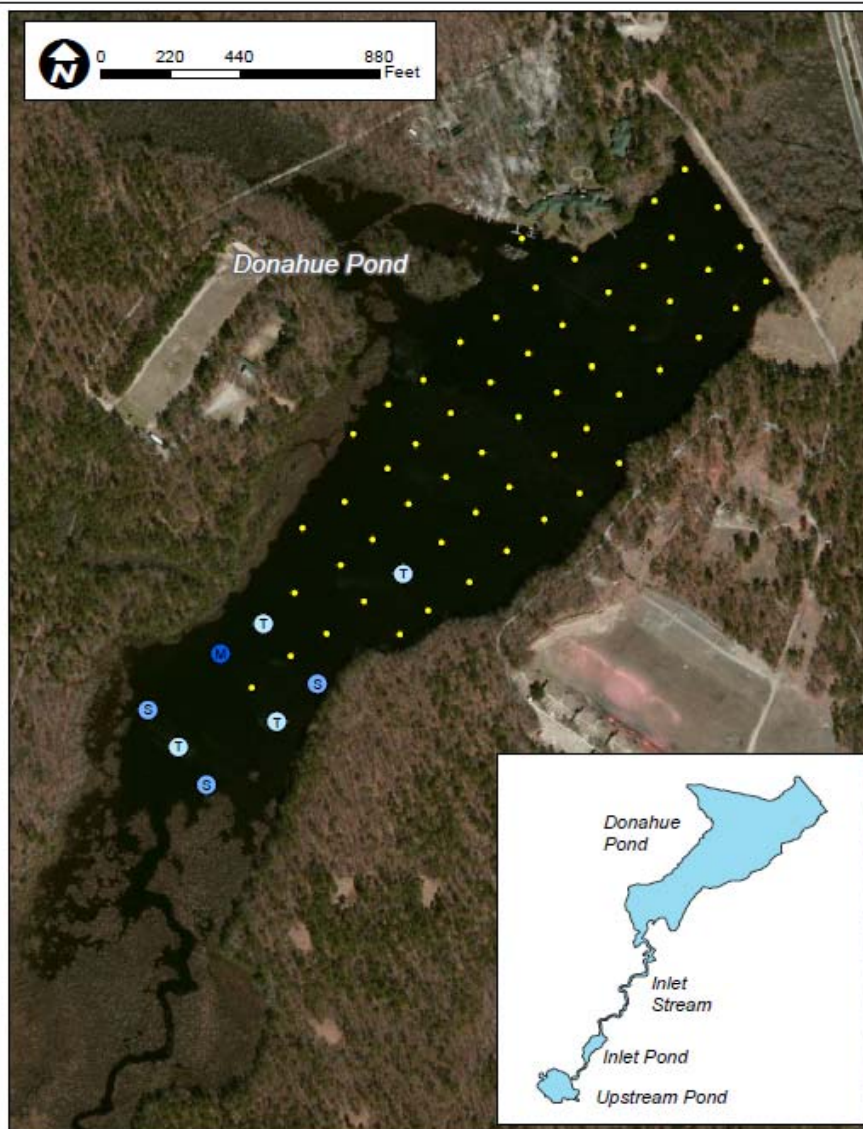**Donahue Pond Aquatic Vegetation Survey**
September 9, 2010

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800-245-2932 • www.alliedbiological.com

Total Sites 2011	Med./Dense Sites
64	1 (1.6%)

Fanwort (*Cabomba caroliniana*) Distribution
Donahue Pond Aquatic Vegetation Survey
September 8, 2011

LEGEND

- ○ = No Plants
- ⓣ = Trace Plants
- Ⓢ = Sparse Plants
- Ⓜ = Medium Plants
- Ⓓ = Dense Plants

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Bathymetry Mapping

Bottom Contour Mapping of a Water Body
- Requires a GPS Unit that can Receive Data from a Fathometer
- High Initial Equipment Costs
    - But Not Labor Intensive
- Post Survey Data Handling
    - Variety of Map Outputs

Lake Management Applications:
- Dredging Studies
- Lake Draw Down
- Volume Calculations
- Locate Underwater Structures
- Aquatic Plant Control Options
- Fish Habitat Enhancement

You really are a gadget freak you know: You don't need a GPS receiver to find your way around here...
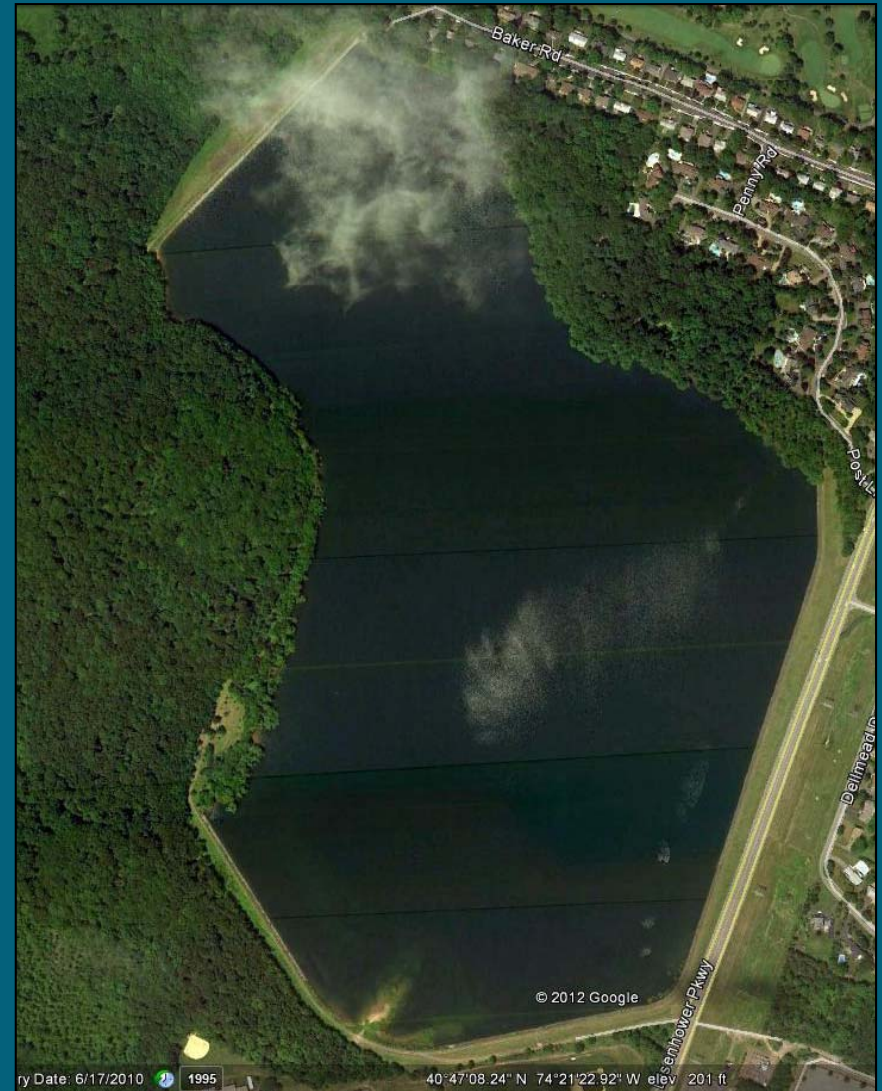
Case Study: Canoe Brook Reservoir

- Located in Northern New Jersey
- 162.1 Surface Acres
- Mean Depth: 33.1 ft.; Max Depth: 54.2 ft.
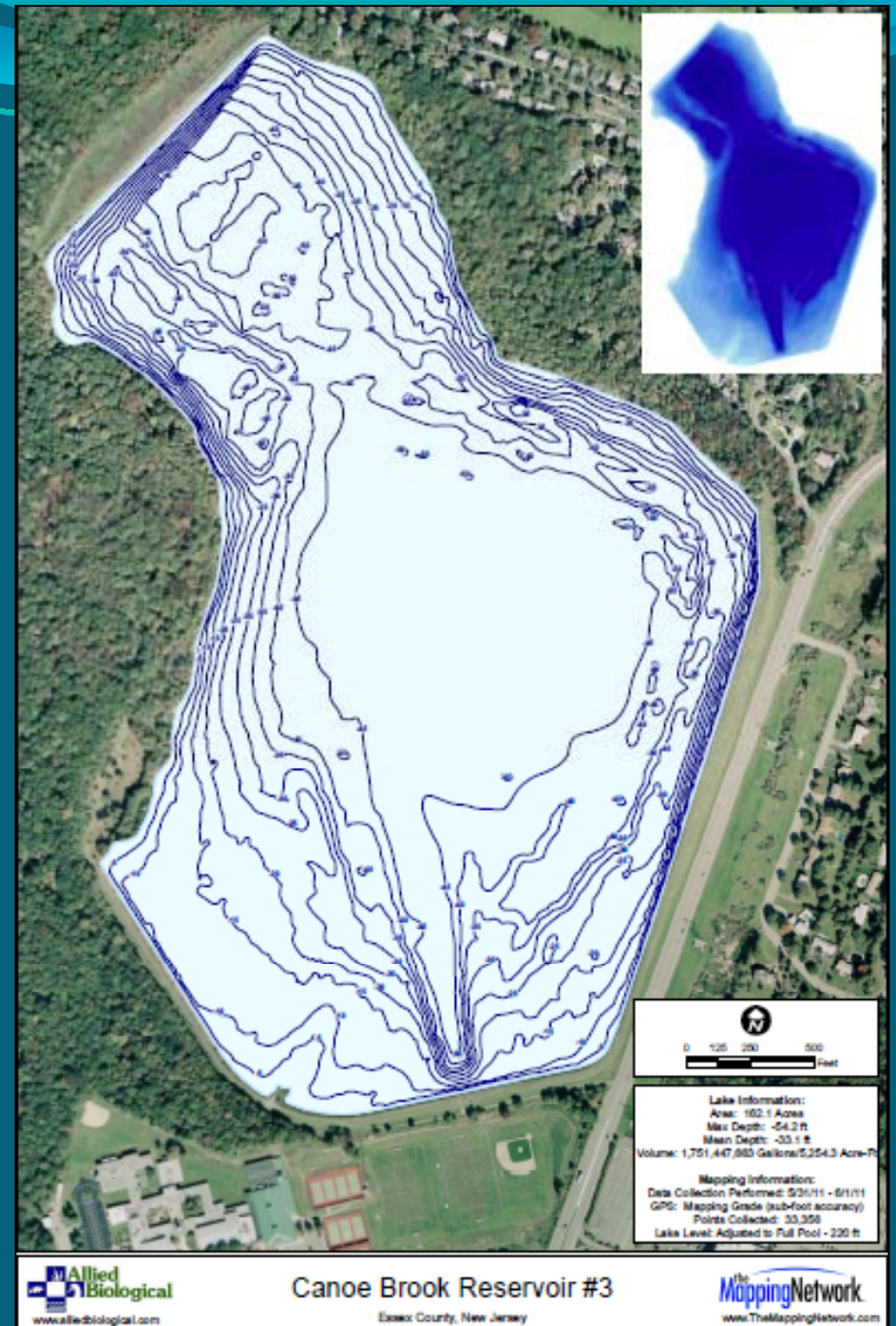- 5,253.4 acre/feet
- Provides Drinking Water to NJ Residents

Project Goals:

- Identify Suitable Boat Access Site
- Update 50+ year old Data
- Accurate Volume Calculations
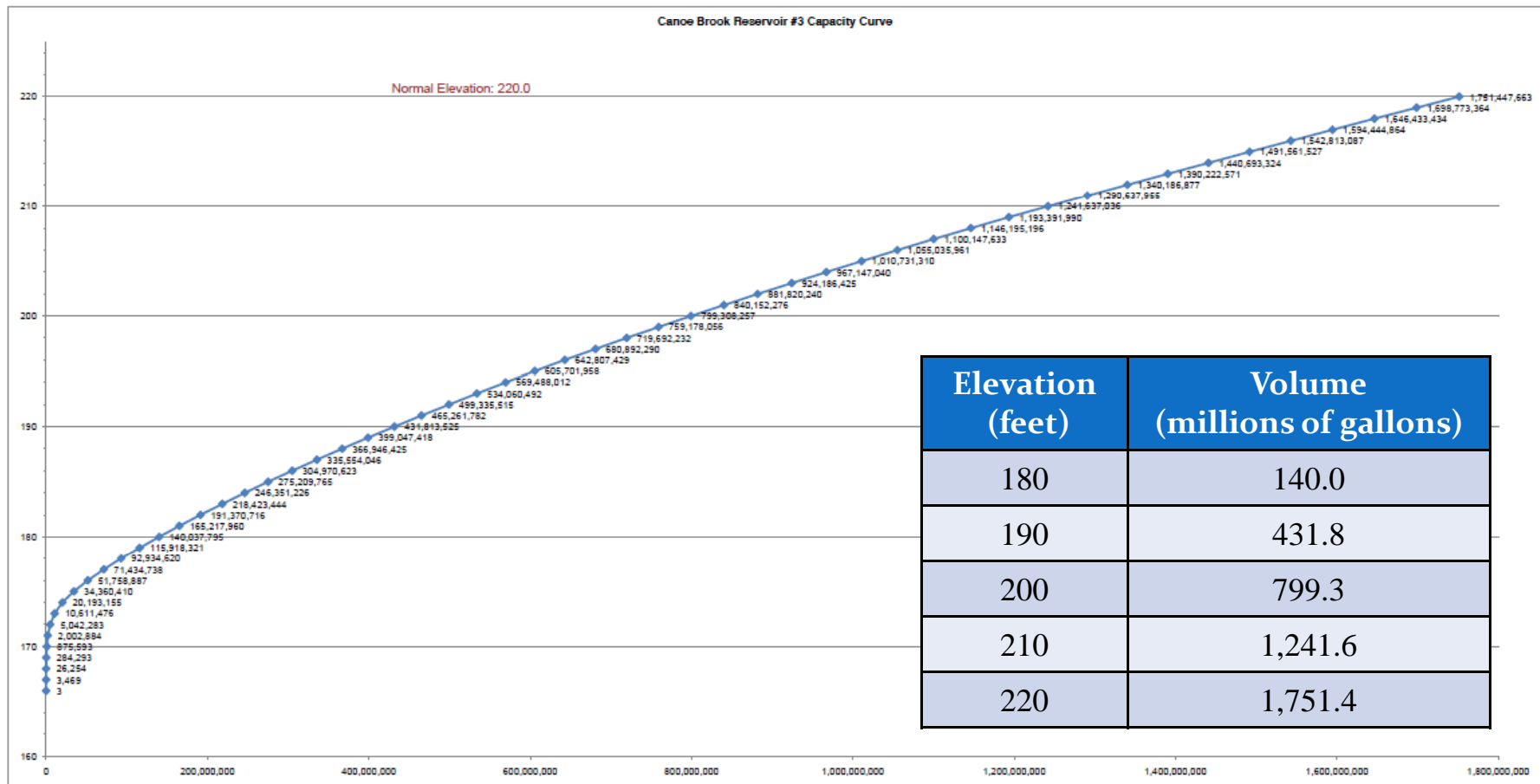- Accurately Locate Intake Structures

Results

- Mapped in 2011
- Sub-foot Accuracy
- Adjusted to Full Pool
- 33,356 data points collected
- **Output:**
    - 1 ft. and 5 foot Contour Maps
    - Intake structures logged
        - Not Displayed to the Right
- Decided Not to Construct a Boat Launch (to deep)
- Volume Calculations

Canoe Brook Reservoir #3

Essex County, New Jersey

Water Volume Calculation Chart

Canoe Brook Reservoir #3 Capacity Curve

Elevation (feet)	Volume (millions of gallons)
180	140.0
190	431.8
200	799.3
210	1,241.6
220	1,751.4

Case Study: Lake Dutchess

- Located in Holmes, NY
- 50.1 surface acres
- Mean Depth: 6.3 ft.
- Max Depth: 11.7 ft.
- Increased Algal Production

Project Goals:

- Component of LMP
    - Littoral Zone Determination
    - Feasibility of:
        - Dredging
        - Lake-wide Draw Down
    - Limited Sediment Probing
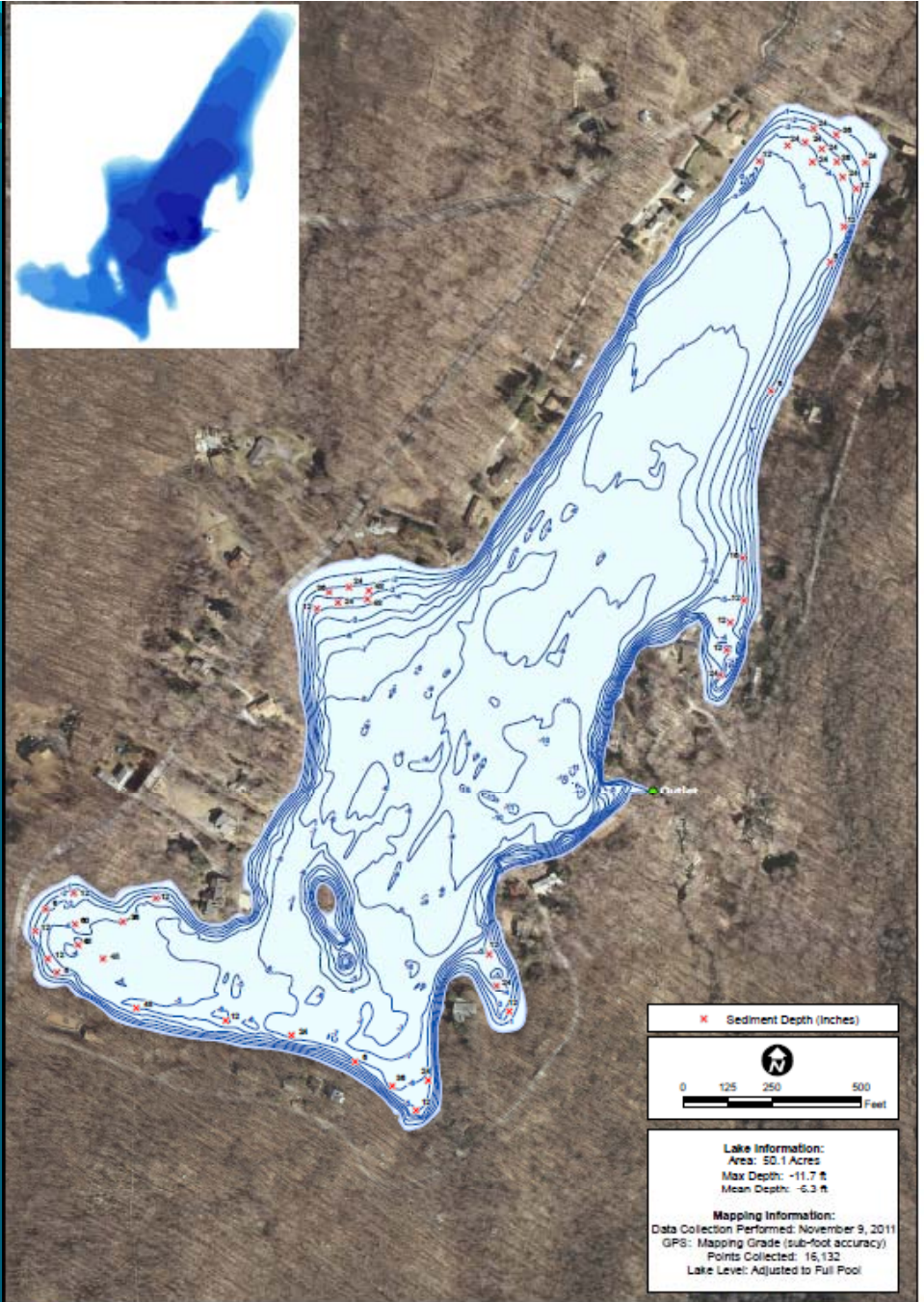   - Coves and Inlets

Results

- Conducted in November, 2011
- Sub-foot Accuracy
- 16,132 Data Points Collected
- Adjusted to Full Pool
- Limited Sediment Probing
  - Manual with calibrated pole
  - 44 Sediment Data Points

Distribution of Sediment Depth in Lake Dutchess Locations

Location	# of points	6"	12"	24"	36"	48"	60"
South Shoreline	7	1	2	2	1	1	
Southwest Cove	10	2	4		1	2	1
West Cove	6		1	2	1	2	
North Cove	11		2	7	2		
East Shoreline	4	2	2				
East Cove	4		3	1			
Southeast Cove	3		2	1			

Sediment Depth (inches)

Lake Information:
Area: 50.1 Acres
Max Depth: -11.7 ft
Mean Depth: -6.3 ft

Mapping Information:
Data Collection Performed: November 9, 2011
GPS: Mapping Grade (sub-foot accuracy)
Points Collected: 16,132
Lake Level: Adjusted to Full Pool

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Lake Dutchess
Dutchess County, New York

the MappingNetwork
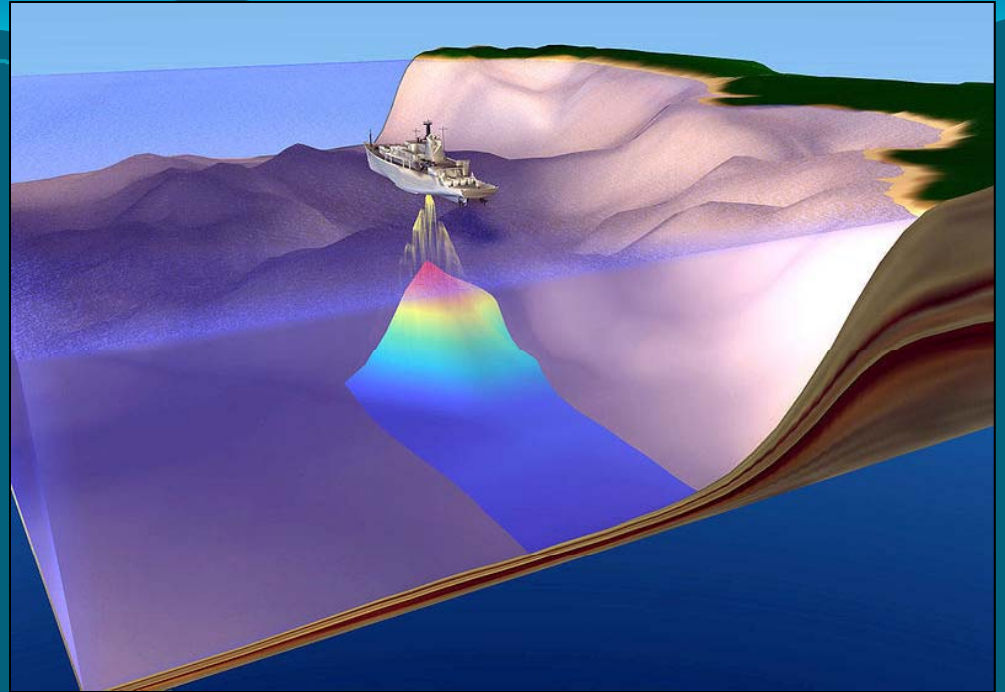www.TheMappingNetwork.com

Sediment Mapping

Traditional Method
- Calibrated Pole
- Manually Probe Sediment
- Labor Intensive
 - More Data=Better Survey
- Accuracy?

Why Sediment Map?
- Dredge Feasibility Study
  - Determine the Volume of Sediment
  - Removal Costs are Based on Volume
- Accurate Location of Underwater Infrastructure

Dual Frequency Fathometer

- Traditional Fathometer Uses One Beam
- Dual Frequency Uses Two
  - High (200 Hz)-Soft Surface
  - Low (24 Hz)-Hard Bottom
  - Difference is Sediment Depth
- Collects Bathymetry Data too
- Increased Accuracy
- Less Labor, but…
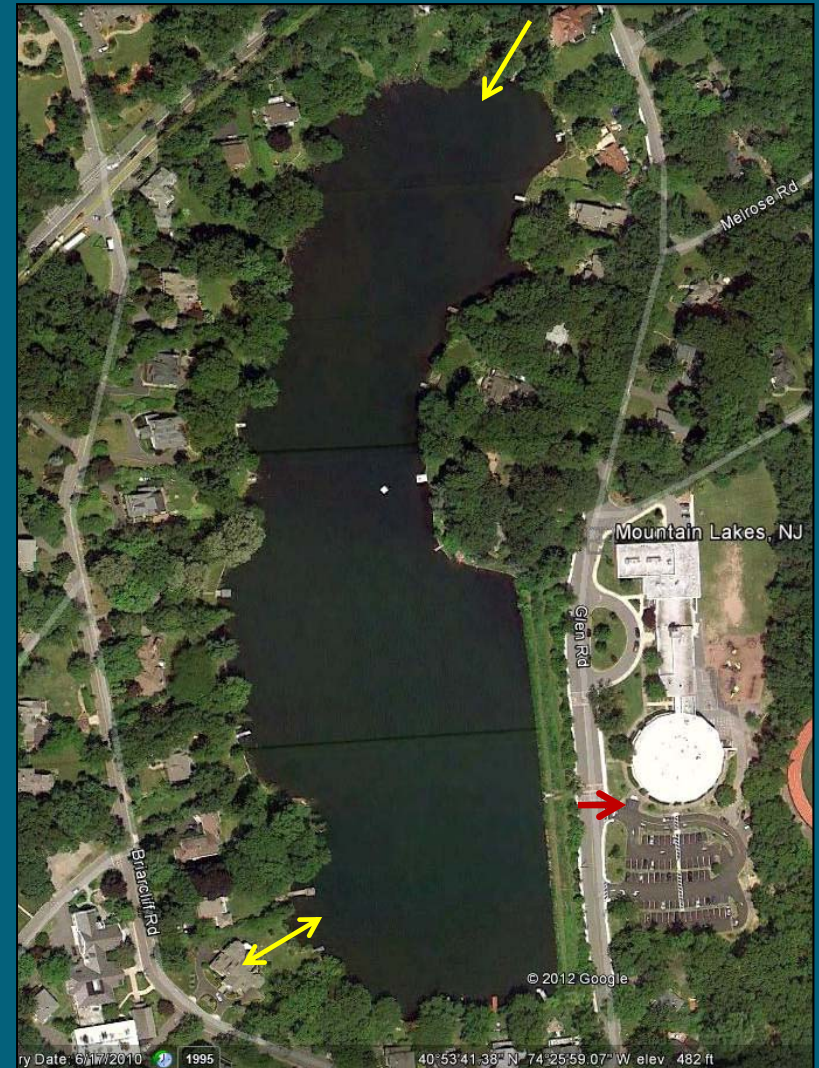 - High Initial Equipment Costs
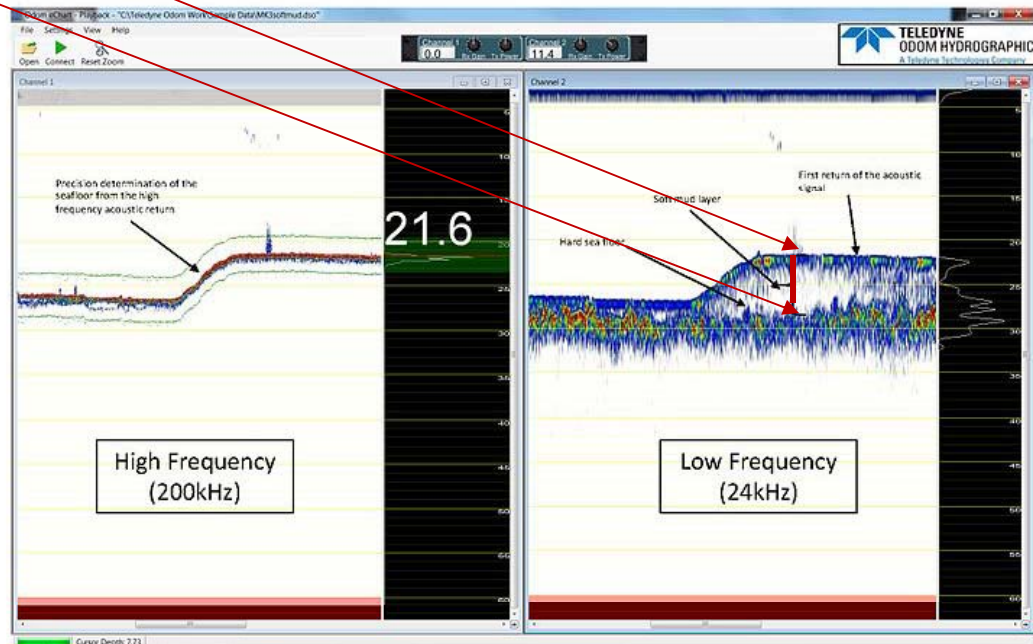
Case Study: Wildwood Lake

- Located in Northern NJ
- 15.7 surface acres
- Mean Depth: 5.8 ft.
- Max Depth: 12.7 ft.
- Bathymetry Conducted in 2010
- CLP and EWM throughout
- Hydro-raked every 4-5 years
    - Northern Cove (inlet)
    - SW corner (canal inlet/outlet)

Project Goals:
- Identify Future Hydro-rake Sites
- Pilot Test Equipment

Sediment Mapping in Action

Setting the System Up

Dual-Frequency Transducer

Ground Truthing Data

Fathometer Calibration

Water and Sediment Depth
via Calibrated Pole

Functions like an
Enormous Secchi Disc

Results

- Sediment Thickness
    - Light Color is Low (0 ft.)
    - Darker Color is High (5.1 ft.)
- Measurable Sediment Volume
    - Excludes Large Rocks
    - 37,505 cubic yards
    - Manual Data Points: **54**
        - 2.5 hours labor (0.36 points/min.)
    - Automated Data Points: **4,377**
        - 2.0 hours labor (24.32 points/min.)

Sediment Thickness
- Low : 0 ft
High: 5.1 ft

Wildwood Lake
Borough of Mountain Lakes, New Jersey
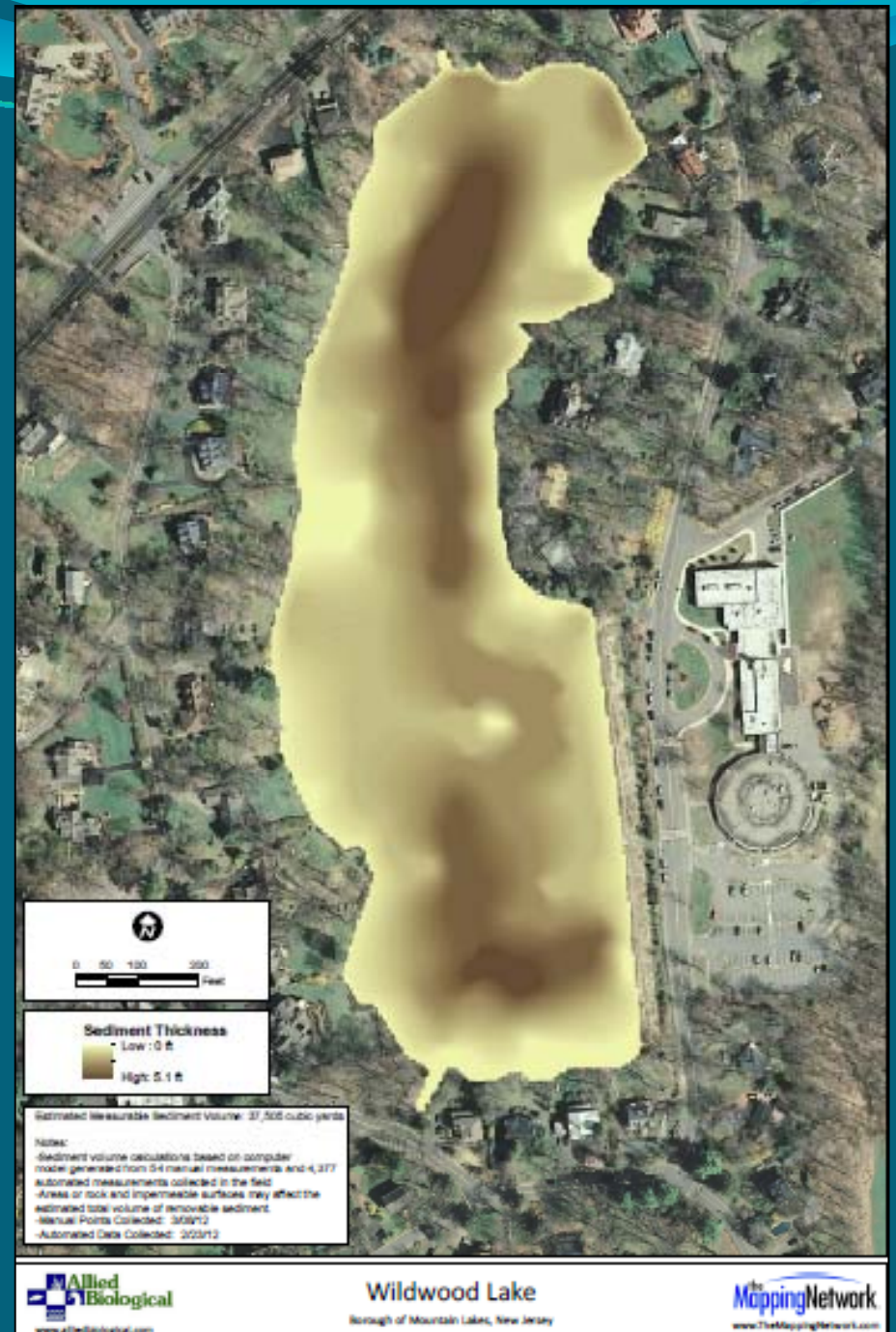
Thank you!

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