Waterwheel *Aldrovanda vesiculosa*: Friend or Foe?

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SŌLITUDE LAKE MANAGEMENT

Restoring Balance. Enhancing Beauty.

April 7, 2016

Waterwheel

Aldrovanda vesiculosa

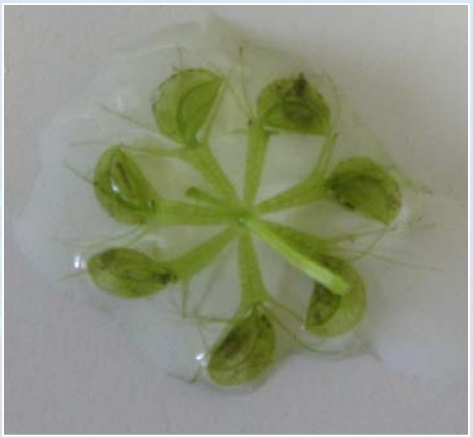
- Perennial, Free-floating, Rootless Herbaceous Aquatic Plant
- Although it looks like a bladderwort:
  - Family: Droseraceae (sundews)
  - Most common: The Venus Flytrap (*Dionaea muscipula*)
- Carnivorous
- Rare, worldwide
- Documented in NJ
  - 2012

Description

- **Simple or sparsely-branched Stem**
  - Stem is air-filled to aid in floatation
  - Stem length varies between four to 20 cm long
- **Whorls Consist of 4 to 9 Leaves**
  - Up to 23 mm in diameter
  - Petioles tipped with a single trap (Lamina)

Waterwheel Growth

- **Plant Growth is Strictly Directional**
  - Continual senescence of older whorls at posterior end
  - Terminal apical bud at anterior end
  - Maintains near constant length during active growth
- **Growth Rate is Determined by Many Factors**
  - Biotic, Abiotic, and Water Chemistry



Growth and Habitat Factors for Waterwheel

Biotic Factors

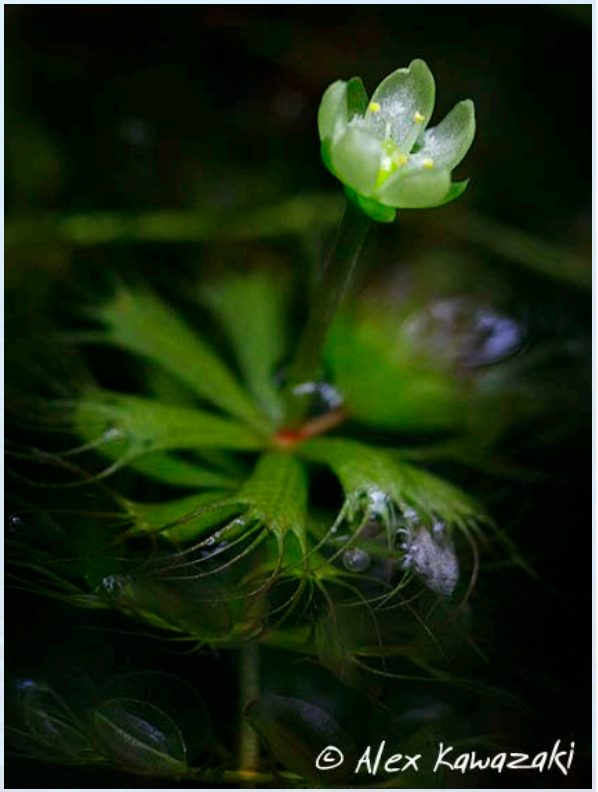
- Associated Vegetation
  - 30-70% cover is optimal
  - Bladderworts, Emergent Plants
- Prey Abundance
  - Zooplankton abundance
  - 6,000 to 20,000/L optimal
- Predation
- Filamentous algae abundance

Abiotic Factors

- Water Temp.
- Water Depth
  - Minimal for turion overwintering
- Irradiance
  - 20% to 60% total sunlight optimal
- pH
  - 5.0 to 6.8 seems optimal
- Nutrient Loading
- Water Chemistry
  - High free CO_2 needed

Waterwheel Reproduction

- **Reduced Capacity to Sexually Reproduce**
  - Typical of most aquatic plants
  - Sporadic/unpredictable flower production
    - Warmer climates = inc. flower production
  - Flowers borne on pedicels from modified axes
    - Flowers only open for 2-3 hours
      - high irradiance
  - Plants are self pollinated, but poor efficiency
  - Fruit development takes 2-4 weeks
  - **Only 1 to 10 seeds produced per fruit**
- **Vegetative Reproduction More Common**
  - Propagules abundant/available in 100-120 days
    - Stems are brittle and readily fragment
    - Morphology is resistant to desiccation
      - Both facilitate spread (waterfowl grazing)



Waterwheel Overwintering Strategy

- **Over Winter via Turion Production**
  - Turions are extreme condensation of fili-form leaves
  - Situated on modified whorls
  - Produced in temperate regions before frost
  - Can rise or sink based on water temperature

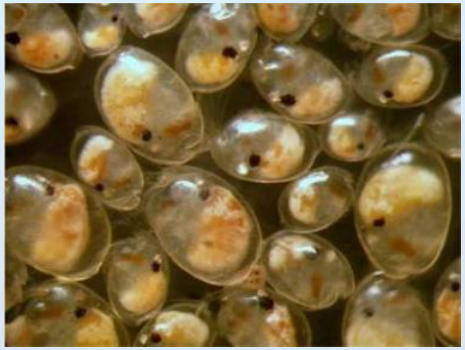
Prey Capture

Lamina (trap) Morphology

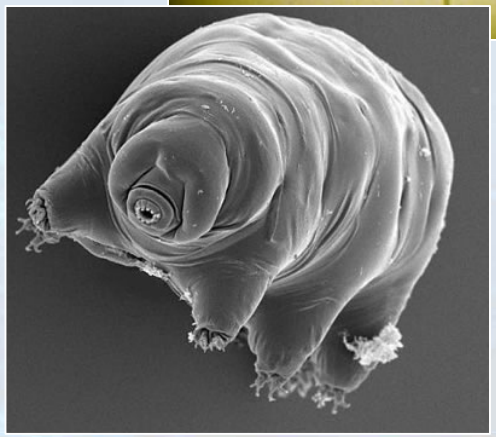
- **Adapted Foliage Designed to Capture/Digest Prey**
  - Twisted orientation opens away from stem
    - Toward open water; Increased prey capture efficiency
- **Two Lobes of Translucent Tissue**
  - Inside studded with trigger hairs (30-40) and digestive glands
  - Margin has delicate flexible membranous “teeth”
  - Possible passive selective feeding
    - Interior hairs mimic algae filaments (Schell, 2003)
    - Mosquito larvae always captured head first
- **Lamina Snaps Shut in 0.01 seconds!**
  - Fastest recorded plant movement in the world
  - Open again in 2-3 hours, if no prey inside

Waterwheel Prey

- **Carnivorous**
  - **Lamina size dictates prey size**
  - Typical prey:

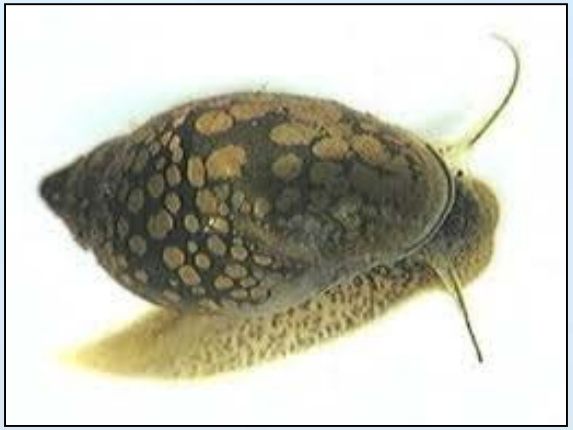


  - Occasional Prey:



Waterwheel Predators

- **Juvenile fish and tadpoles**
- **Herbivorous aquatic snails**

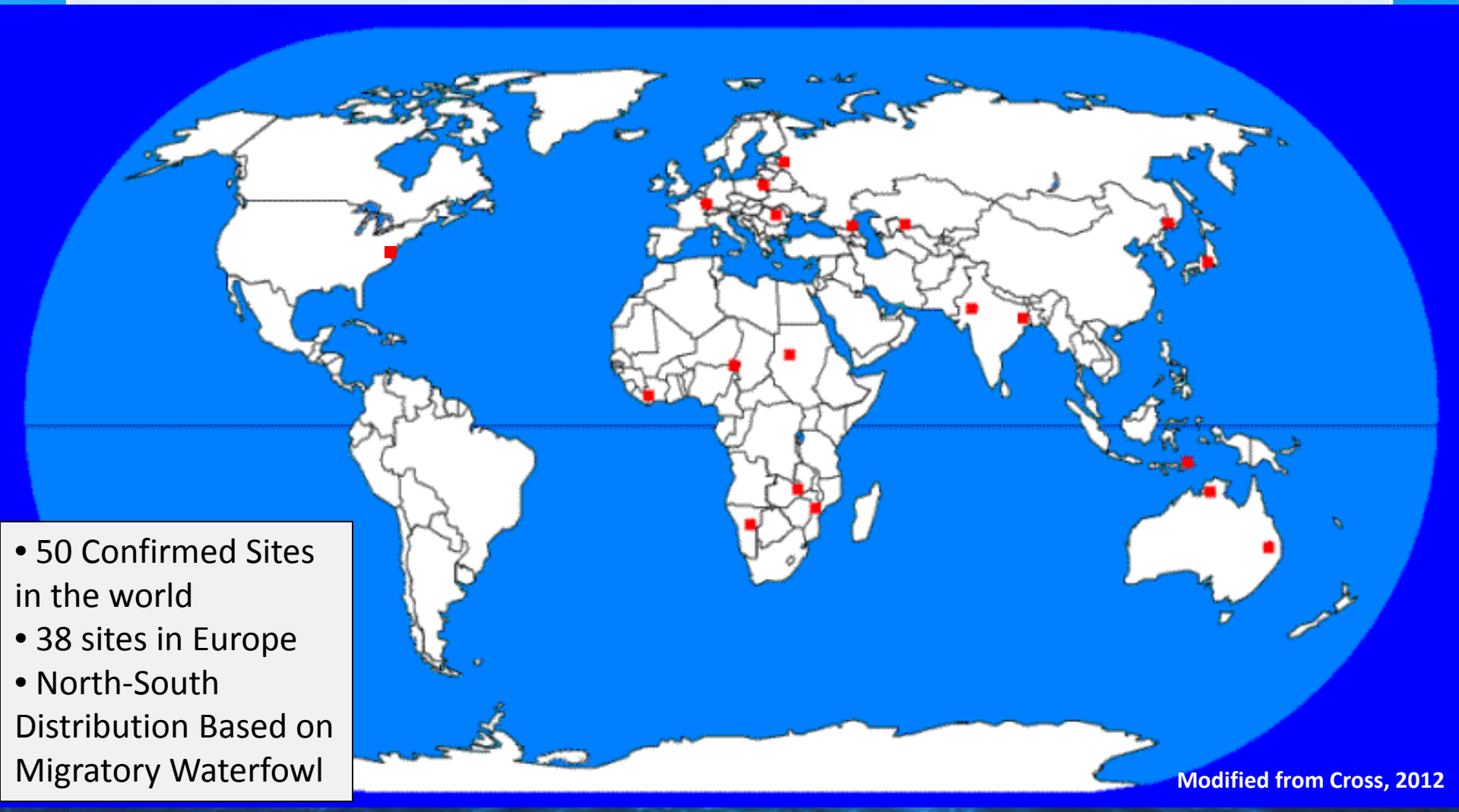


- **Waterfowl (ducks, swans, waders)**
  - Indirect damage during foraging
  - Sometimes directly consumed
- **Other Growth Inhibitors**
  - **Cultivated *Aldrovanda* Susceptible to "*Aldrovanda* Disease"**
    - Linked to a fungal pathogen (*Fusarium*)
  - **Filamentous Algae Inhibits Growth and Feeding of *Aldrovanda***

Ideal Waterwheel Habitat

- **Wetlands, fens, billabongs, streams, and lake littoral zones (Cross, 2012)**
  - Prefers (but not limited to) nutrient impoverished oligo-mesotrophic sites and dystrophic (humic) sites
  - Habitat suitability linked to abiotic and biotic factors
- **Numerous Attempts to Cultivate in Containers**
  - Very limited success

Waterwheel World-wide Distribution



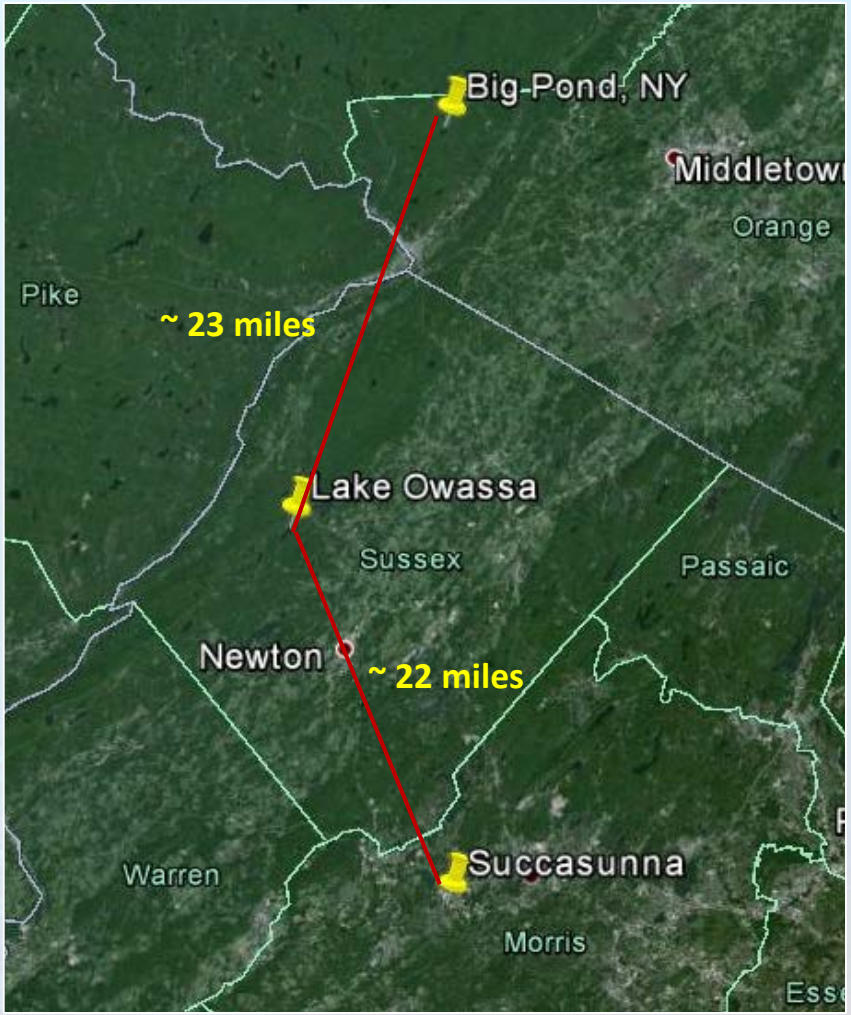
- 50 Confirmed Sites in the world
- 38 sites in Europe
- North-South Distribution Based on Migratory Waterfowl

Modified from Cross, 2012

NJ/NY Populations of Waterwheel

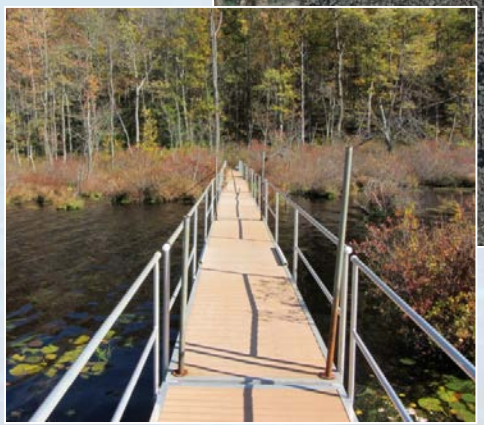
Carnivorous Plant Enthusiast

- **Began in 1999**
- 12-15 attempted establishments
  - In NJ, along Rte 206 corridor
  - 15 mile radius of Succasunna
  - Small, isolated sites
  - Private property only
- **Only the Succasunna site successfully overwintered**
  - Monitored until 2005/2006
  - No *Aldrovanda* in 2013
- Permission granted by resident of Big Pond to establish at that site



Waterwheel in the Northeast USA

- Lake Owassa, Sussex Cty. NJ
- **October, 2012 (ABI)**
- Found in southern inlet stream (only)
- Part of NJDEP's Bear Swamp Wildlife Man. Area
  - ~3,000 acre forest, freshwater wetland and open water
- Identification confirmed by Barre Hellquist
  - Surveyed the site with other experts in Sept. 2013



Waterwheel in the Northeast USA

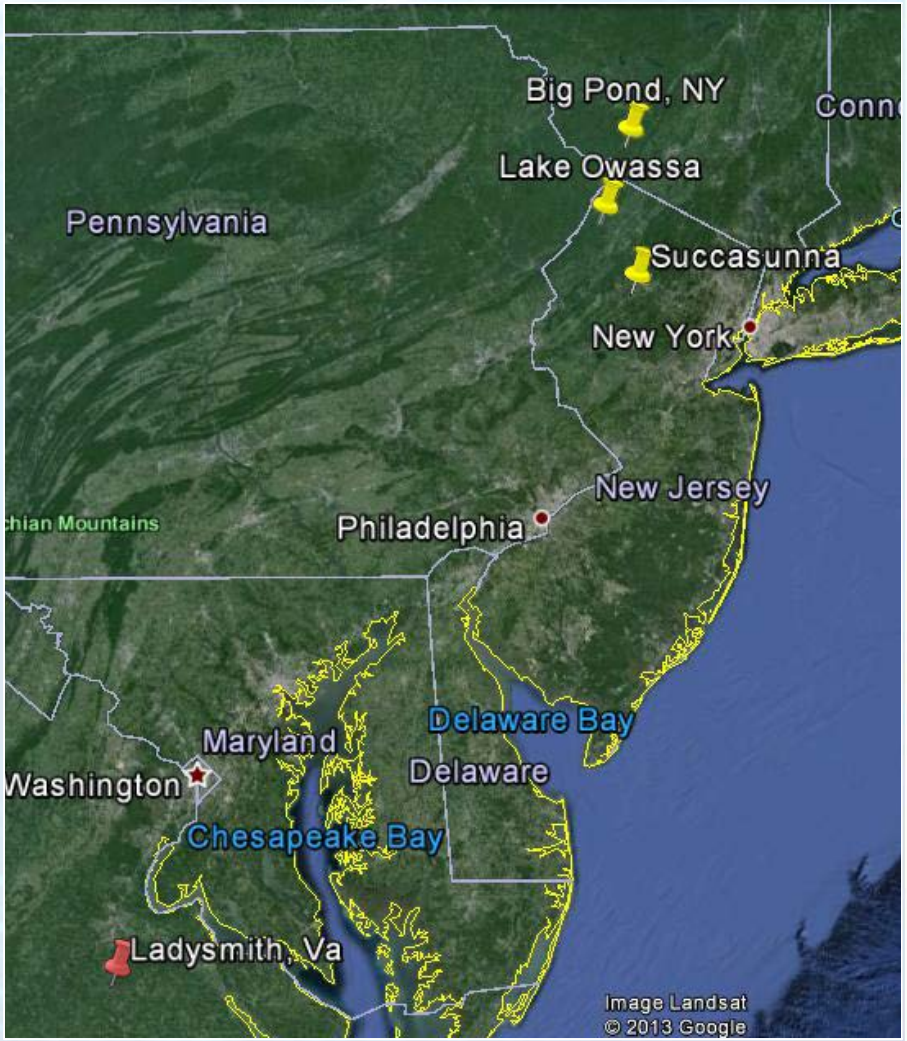
- **Big Pond, NY**
  - Border of Sullivan/Orange County
  - Private Lake
  - ~ 72 surface acres
  - *Aldrovanda* common marshy margins
  - 2013 population was massive (“feral”)
    - Millions of stems!

Why Establish Waterwheel in N. America?

- *Aldrovanda* is on the brink of extinction worldwide
  - Save the genus!
- Possible mosquito control agent? However…

Most likely to make $$$

- Internet search = 6-10 sites that sell *Aldrovanda*
- $5-$12/strand
- One site had a sale: $1/strand!



Recall: Very Difficult to Cultivate *Aldrovanda*

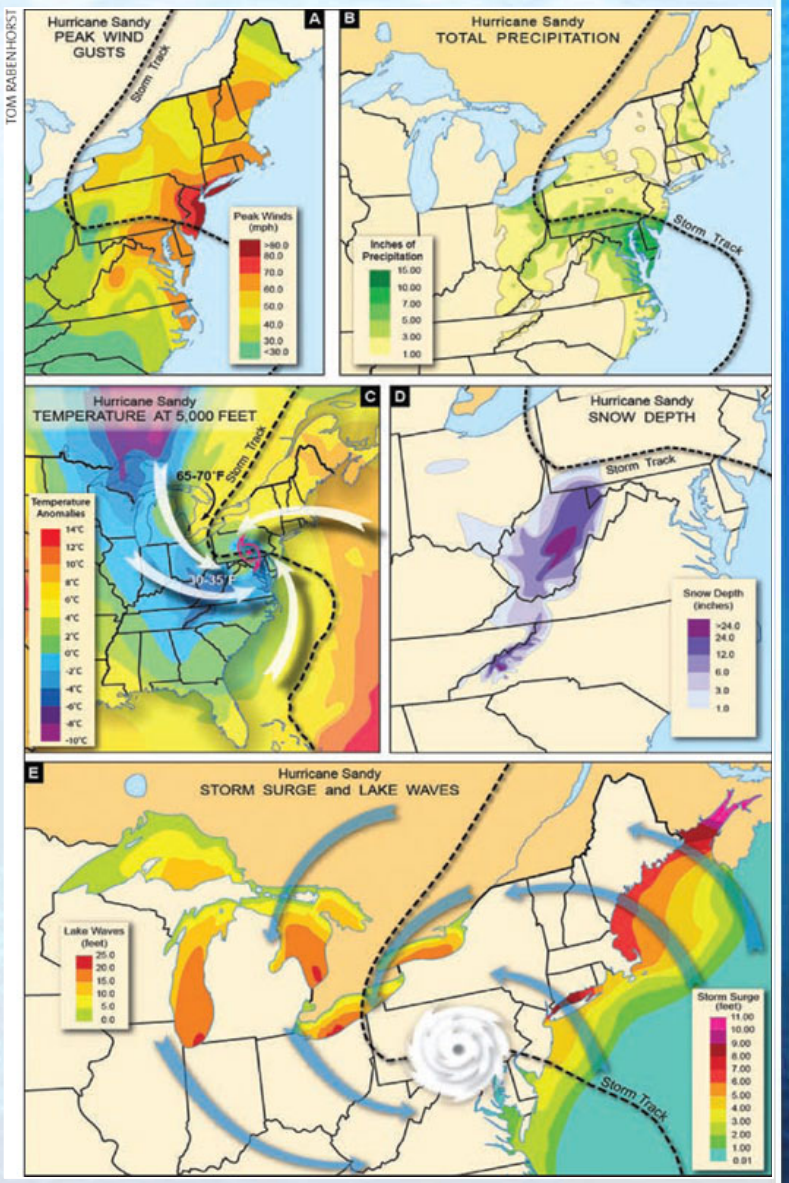
This picture alone displays an estimated 375 strands of *Aldrovanda*.

Assuming a price of $5/strand:

This picture represents nearly $2,000 of plants!

Vectors of Spread

- **Humans**
  - Advertent and Inadvertent
- **Migratory Waterfowl**
  - Likely inadvertent
    - Usually not directly consumed
  - Likely turions
- **Water Movement/Flooding**
  - Hurricane Irene: 2011
  - Super Storm Sandy: 2012



Waterwheel On the Move?

October 2012

- *Aldrovanda* in Inlet Stream

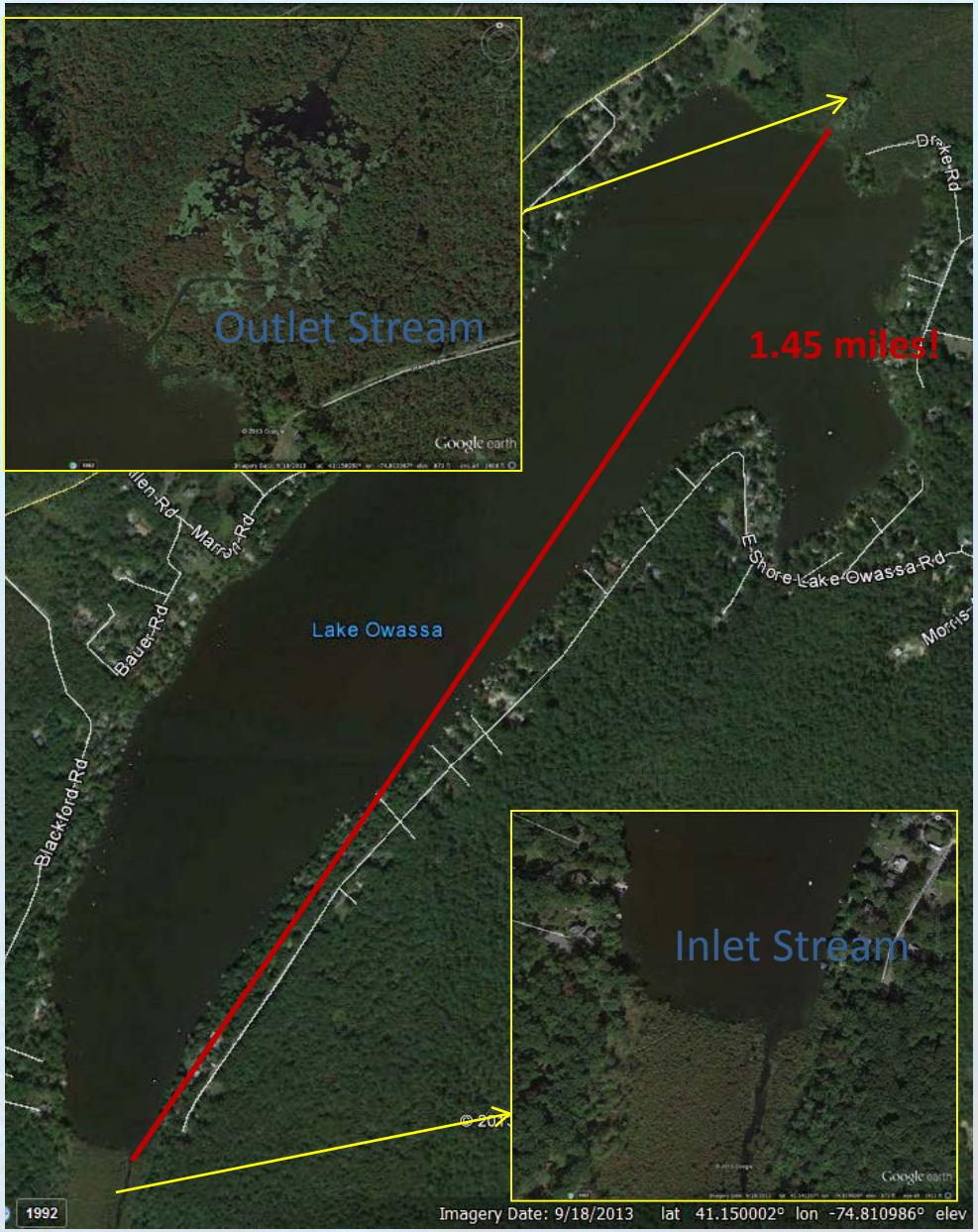
May 2013

- Confirmed over wintered in Inlet Stream
- Residents confirmed occasional mov't to open water, but no persistence

October 2013

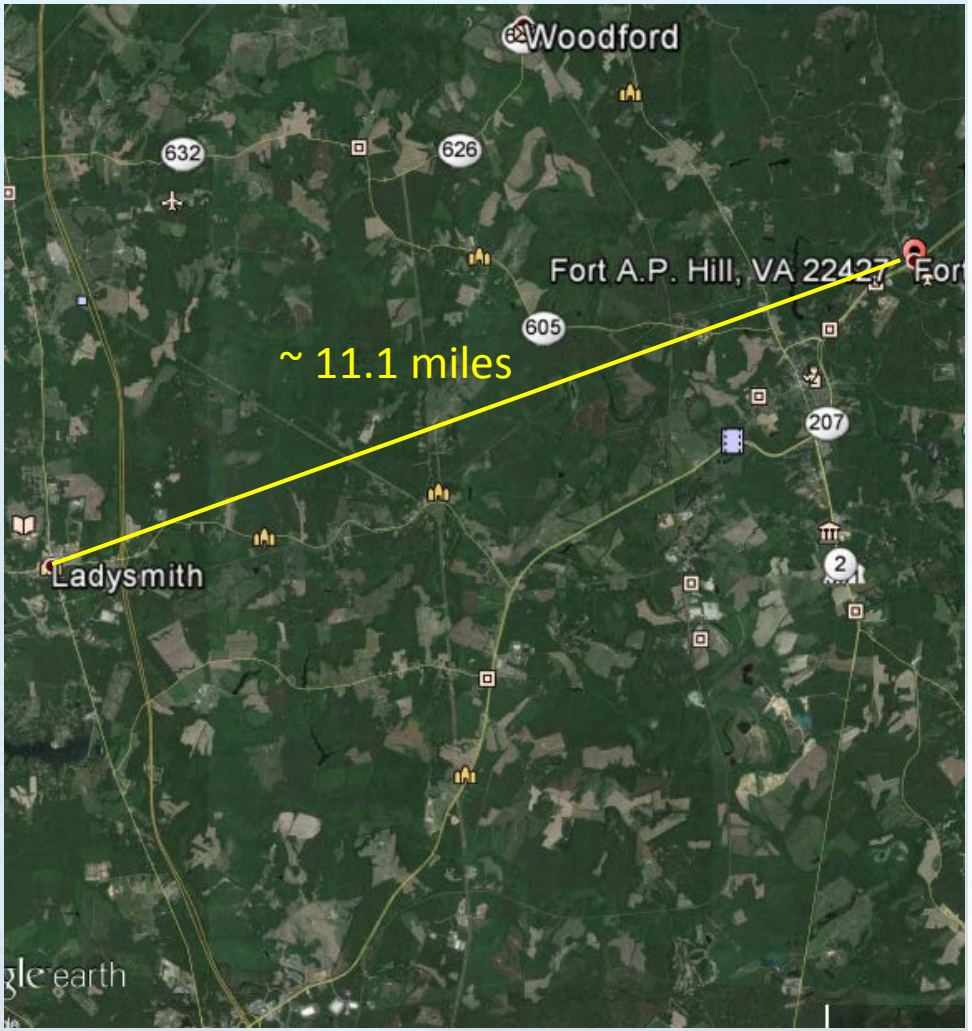
- Confirmed it was in the Outlet Stream/Marsh

But no official surveys of nearby waters…



Waterwheel on the Move?

- **Fort AP Hill, VA**
  - 2014 Survey
  - Rob Richardson, PhD from NC State
    - Hydrilla Expert
- Five Ponds infested with Waterwheel
  - Drafting a White Paper on need for Control
  - 2016: Grass Carp Stocking Pilot Study



Thank You!

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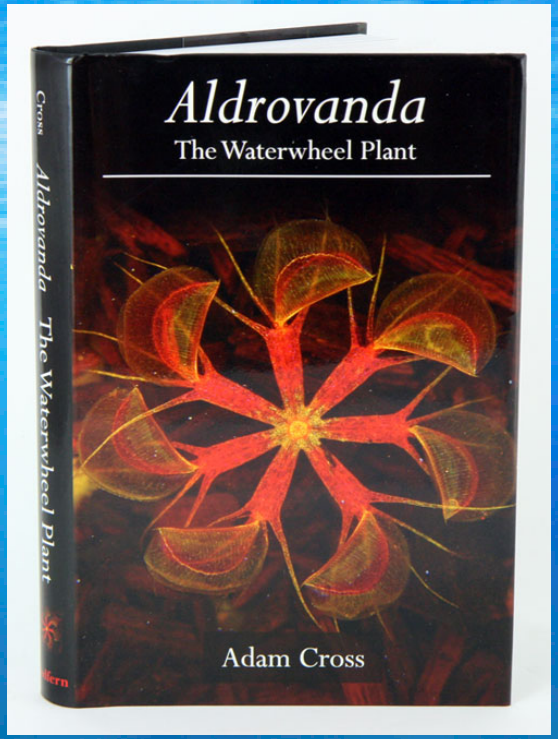

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