

# PROCELLACOR™

## A Novel Herbicide Technology for Selective Management of Aquatic Invasive Plants

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This information is for educational purposes only.  
While its new active ingredient is now USEPA registered,  
PROCELLACOR labels remain pending and the product is  
not yet available for sale or use in the U.S. or globally



# Primary Collaborators / Co-Authors

- Dr. Mike Netherland – US ERDC / APCRP
- Jens Beets – University of Florida
- Dr. Rob Richardson and Erika Haug – NC State University
- Amy Smagula – New Hampshire Department of Environmental Services
- Ben Willis - SePRO

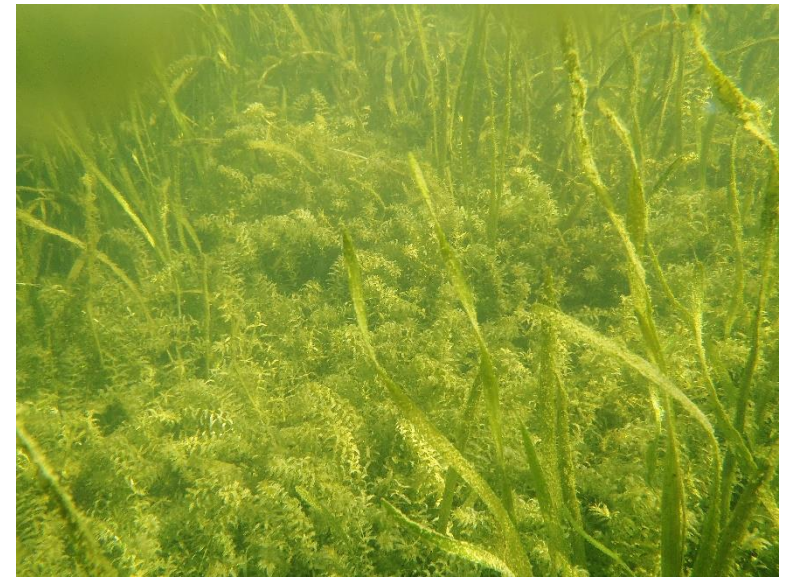






Latin:  
*'heart of the storm'*

- New herbicide active received USEPA registration as a reduced-risk aquatic herbicide in September 2017.
- The first herbicide active to have aquatic use with initial registration in over 30 years.
- New systemic herbicide mode of action for hydrilla
- **High selective activity** on multiple major US weeds and multiple potential global aquatic weed control uses
- **Orders of magnitude lower use rates** versus older herbicides and **excellent environmental profile**
  - In-water applications with short in-water exposure
  - Foliar applications to floating and emergent aquatic weeds



# *USEPA Approval*



- EPA Human Health Risk Assessment
  - No adverse effects were observed in the submitted toxicological studies **regardless of the route of exposure.**
  - No drinking water or recreational use restrictions
  - 'May provide a better alternative to older chemistries that require higher levels of risk mitigation practices in order to reduce exposure.'
  - Eligible for full exemption from the requirement of crop tolerances





# *USEPA Approval*



- EPA Ecological Risk Assessment

- No risk concerns for non-target wildlife
- 'Practically non-toxic' to birds, bees, reptiles, amphibians, and mammals

**In summary, USEPA confirmed that Procellacor is a reduced-risk aquatic herbicide for its major uses.**



# Physical Properties and Fate

- **Rapid dissipation**

- Photolysis (primary) with 1 – 2 day half-life
  - Secondary processes of hydrolysis at high pH (9+) and microbial activity in water and sediment also can enhance dissipation

- **High Koc and low volatility**

- Rapid weed uptake resulting in short exposure requirements with in-water spot/partial treatment
- Low aerial drift potential

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# Aquatic Development Highlights

## **‘Specialized Ecotox’: No effects shown...**

- Freshwater mussel                      Buzcek and Cope, in prep (NCSU)
- Juvenile chinook salmon: Crosson, Grue, Getsinger in prep (U.Wash / USACE APCRP)

## **Collaborative mesocosm and field efficacy studies**

- Dioecious / Monoecious Hydrilla and Crested Floating Heart
- Eurasian, multiple hybrid Eurasian biotypes, and other invasive watermilfoils
- Water hyacinth, water primrose, alligatorweed





# Univ of FL Mesocosm Study Overview

## Hydrilla and Crested Floating Heart (Beets and Netherland, in press)

- Tested Aquatic Plants
  - *Hydrilla verticillata* (dioecious hydrilla)
  - *Nymphoides cristata* (crested floating heart)
  - Native plants *Sagittaria lancifolia* (duck potato) and *Pontedaria cordata* (pickerelweed)
- 6 or 8-week growth periods for establishment prior to treatments

# Univ of FL Mesocosm Study Overview

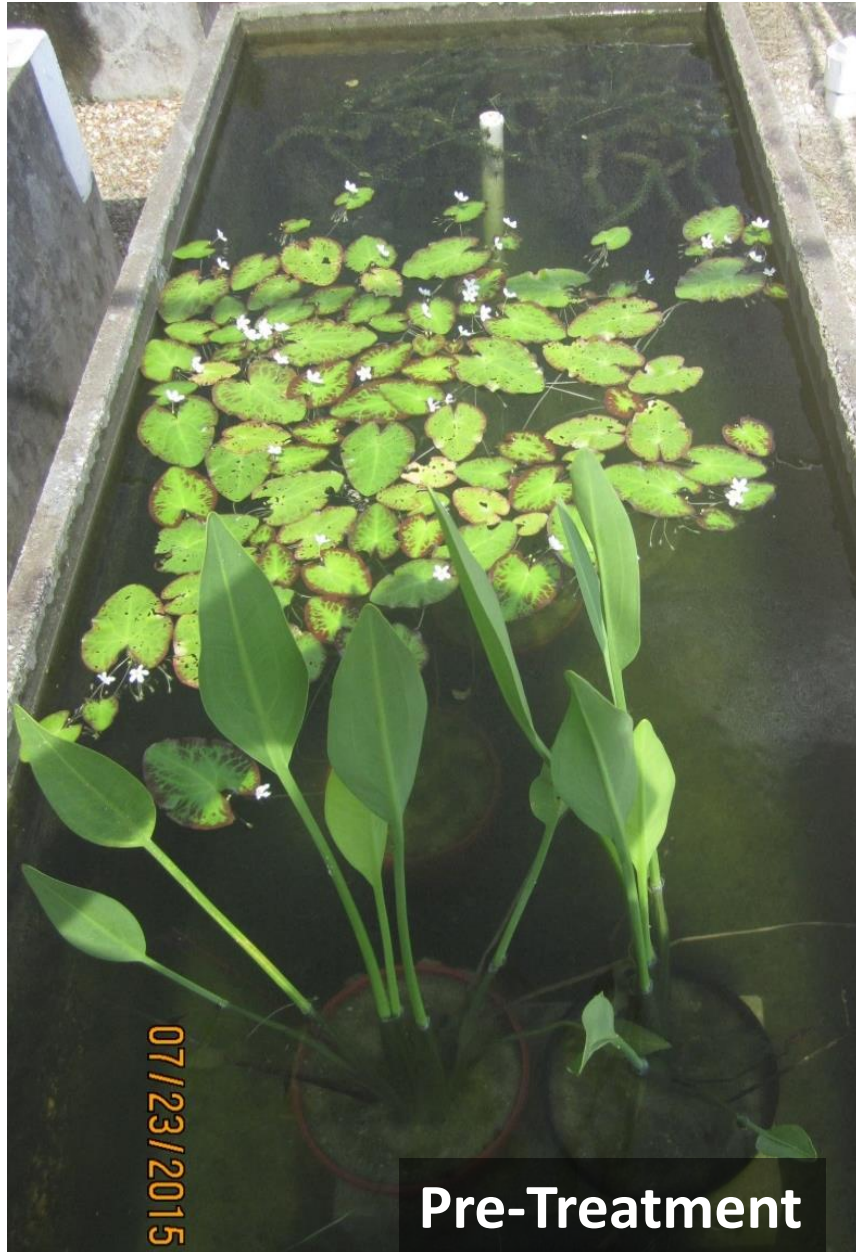
## Hydrilla and Crested Floating Heart (Beets and Netherland, in press)

- PROCELLACOR CET Scenarios
  - 48 ppb PROCELLACOR (5 PDU SC) for 24 or 72-hour exposures
  - 24 ppb PROCELLACOR (2 PDU SC) for 24 or 72-hour exposures
  - 12 ppb PROCELLACOR (1 PDU SC) for 7 days ('static')
  - reference treatment with 24 or 72-hour exposures

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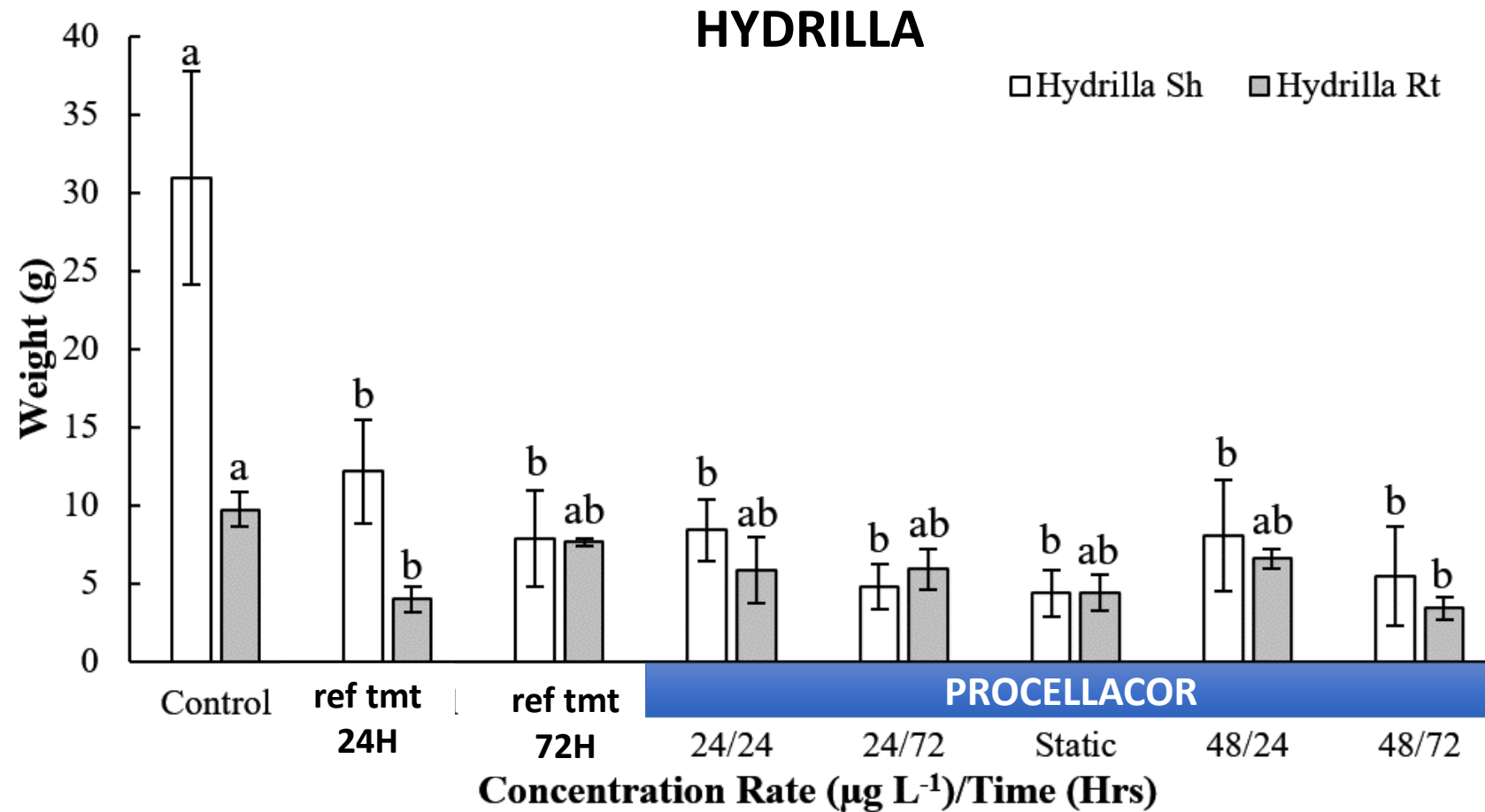


## UF Trial: PRE and 16 Days Post



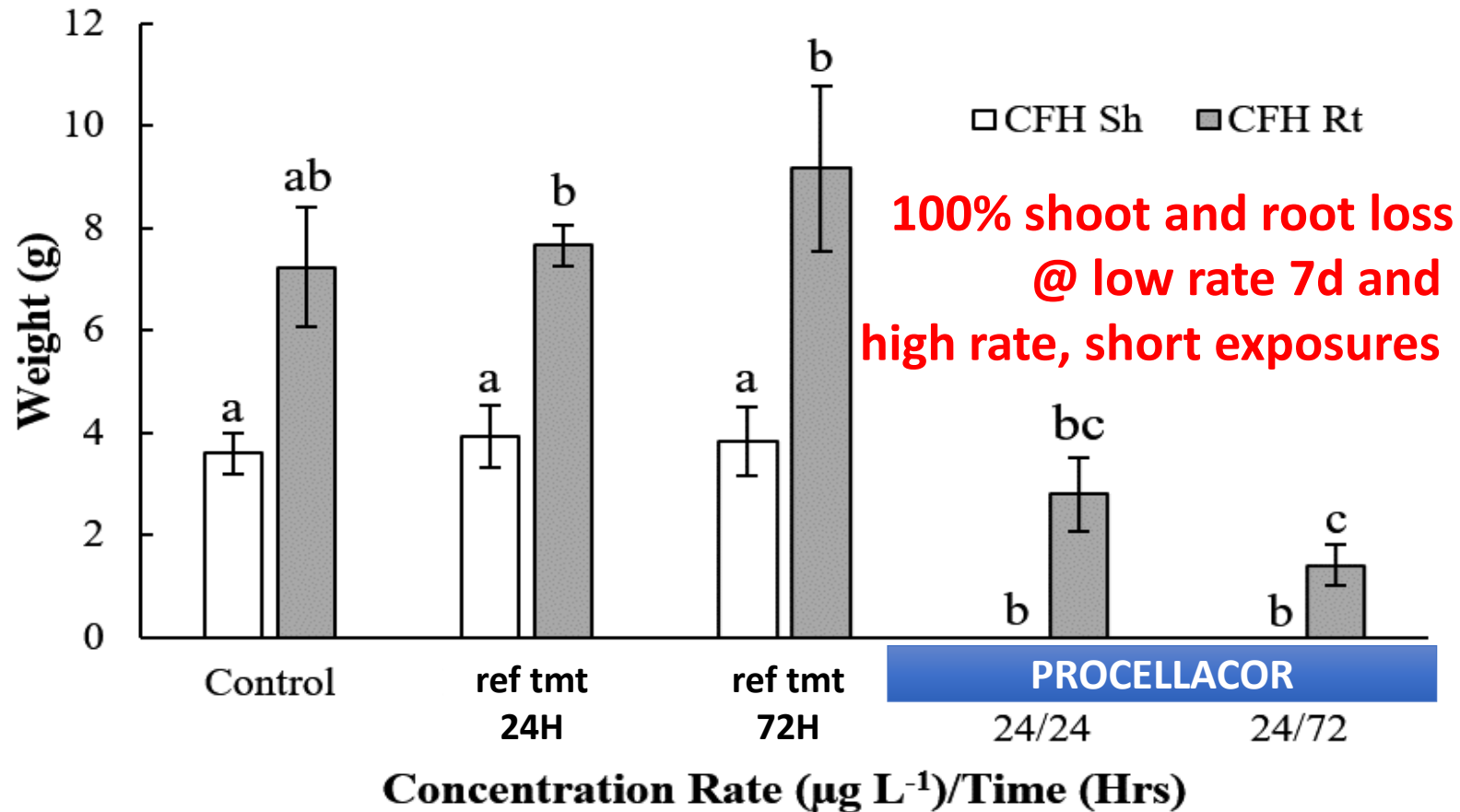


# UF Trial: Shoot and Root Biomass @ 4 weeks



## UF Trial 2: Shoot and Root Biomass @ 4 weeks

### CRESTED FLOATING HEART



Arrowhead → minimal injury; pickerelweed → light to moderate



# TX Study Overview

- Tested Aquatic Plant
  - *Hydrilla verticillata* (hydrilla)
- Hydrilla was grown 7 weeks prior to treatment Aug 4
  - ~90F or 32 C during study
- Multiple in-water rates and flow scenarios
  - 6h or 24h DT50 or static







Untreated



## TX mesocosm study of dioecious hydrilla

Photos @ 1 month post

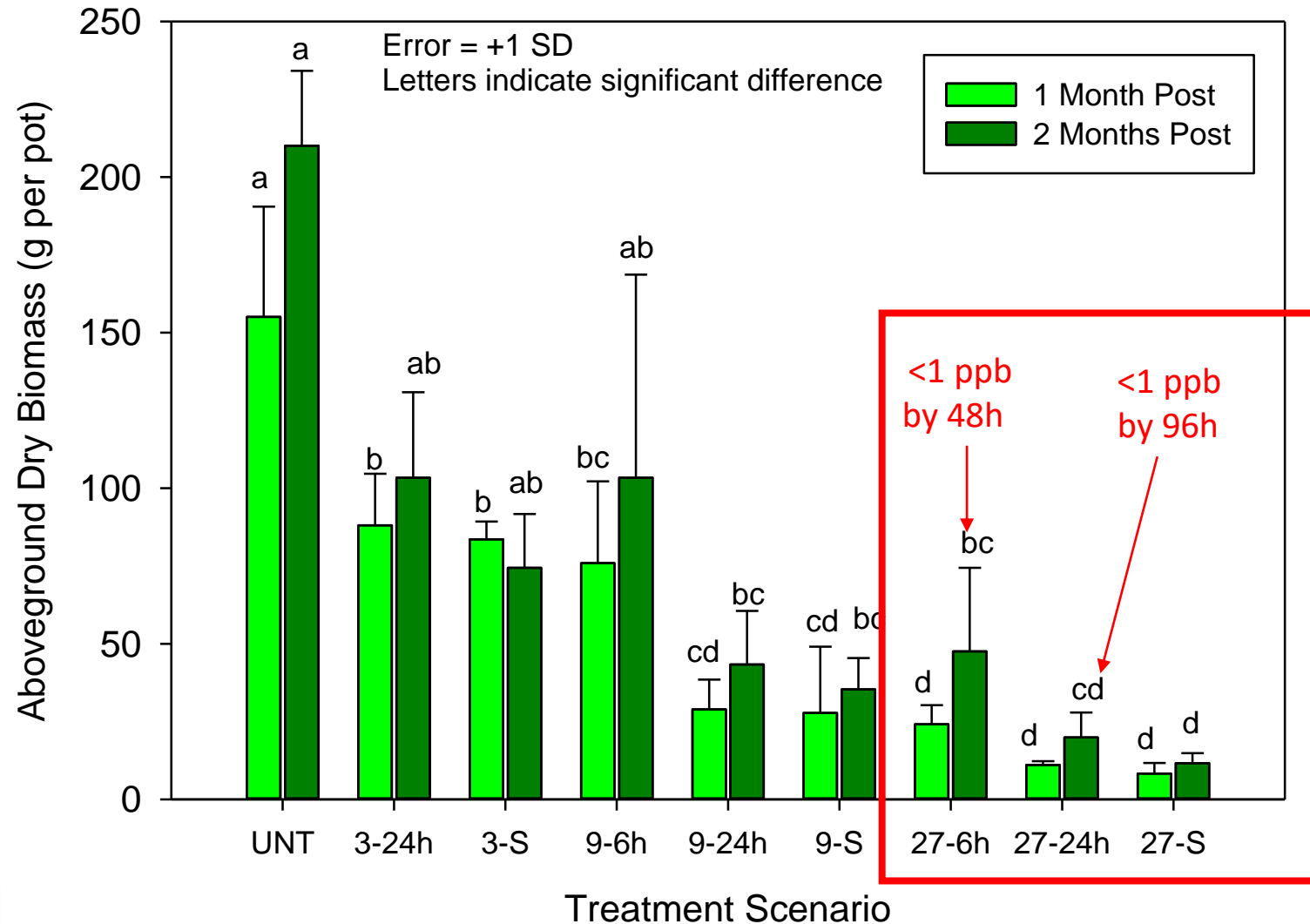
Left: Untreated hydrilla

Right: Hydrilla treated with a 24-hour exposure @ ~3 PDU SC (27 ppb)



# TX Mesocosm Trial

## Aboveground Hydrilla Biomass: 1 and 2 MAT



**Monoecious hydrilla..**  
**Similar CET behavior**

**Also native coontail**  
**response is similar**  
*(Ceratophyllum demersum)*







Untreated (left) and treated (right) hydrilla ponds in TX at 4 months post

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# Yellow Floating Heart NC 2017

- Very dense infestation discovered in 2016 and targeted for eradication by NCDACS with NCSU and NCDEQ support
- 1A acre treated, 3.5 ft avg depth
- Treated June 13



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**June 13, 2017 – Yellow floating heart on day of treatment**





**June 30, 2017 – Highly injured yellow floating heart @ 17 DAT**





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**July 27, 2017 – Remnant dying YFH @ 44 DAT**





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July 27, 2017 – Remnant dying YFH @ 44 DAT





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**September 26, 2017 – 100% YFH Control @ 105 DAT**





# TX Mesocosm Study Overview – Selective milfoil control

- Tested Aquatic Plants

- *Myriophyllum spicatum* (Eurasian watermilfoil)
- *M. spicatum* X *M. sibiricum* (Hybrid Eurasian watermilfoil)
  - Highly 2,4-D tolerant - Hayden Lake, Idaho
- *Vallisneria americana* (tapegrass)
  - 'southern' & 'northern' biotypes
- *Potamogeton illinoensis* (Illinois pondweed)
- *Potamogeton nodosus* (American pondweed)
- *Elodea canadensis* (Canadian or common waterweed)
- *Heteranthera dubia* (water stargrass)

- Growth Period – 7 months

- Planted September 17, 2015
  - 1 gal pots with local topsoil and Osmocote
- Study initiated April 12, 2016





# Selective Milfoil Control @ 2 MAT

Untreated



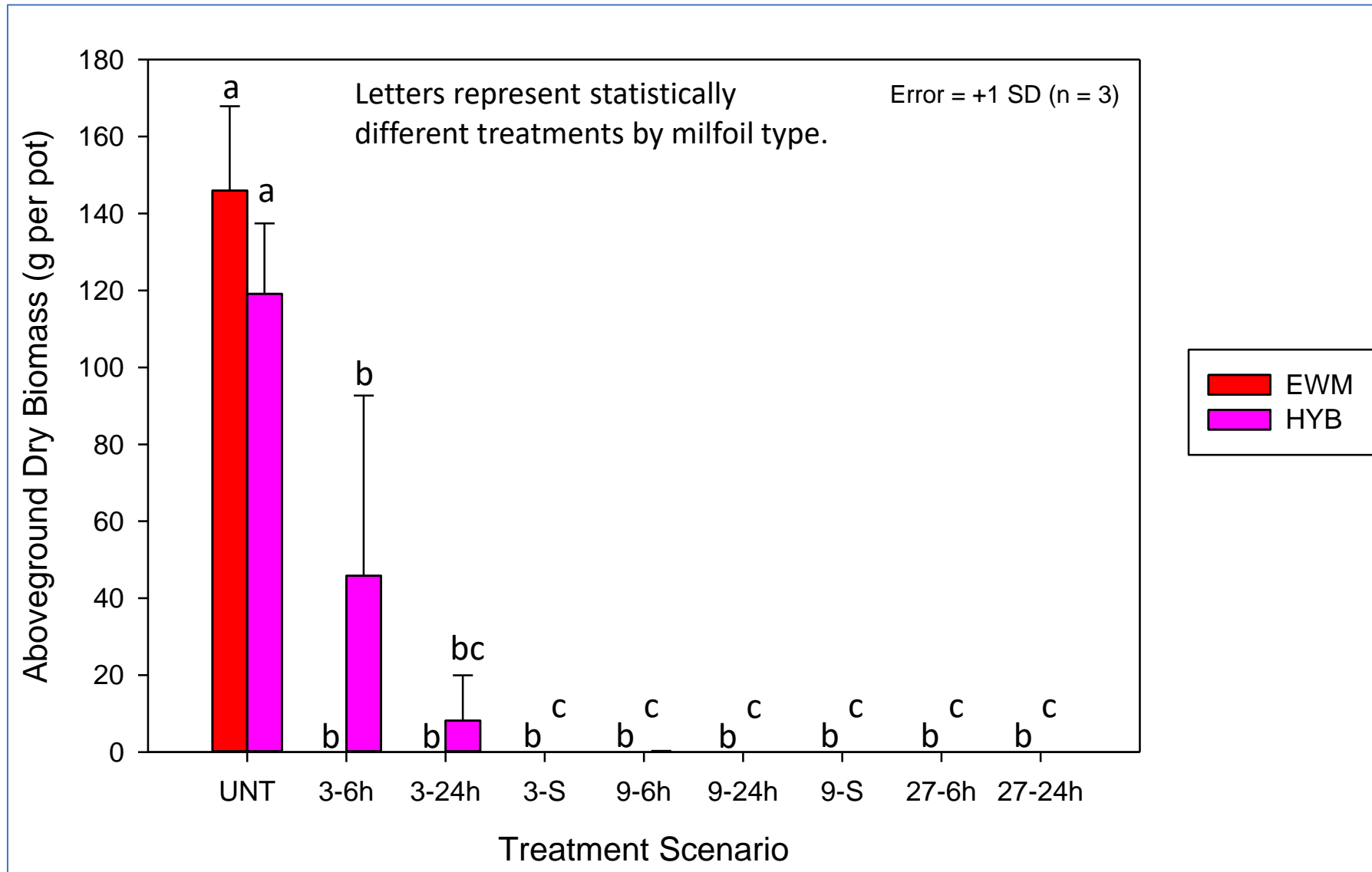


# Selective Milfoil Control @ 2 MAT

9 ppb 24 hours



# Aboveground Biomass @ 2 MAT (Milfoils)





# Underwater photos of native vallisneria and American pondweed at 1 month post in 2016 TX Mesocosm study



**Stargrass**  
some sensitivity

**Elodea**  
Tolerant to low CET



# Variable Watermilfoil New Hampshire 2016

- Cooperative effort with New Hampshire DES and USACE New England District and USERDC APCRP
- 1-acre partial-site application to invasive variable watermilfoil at the Hopkinton-Everett Flood Control Area
- Special permit from NH Department of Agriculture in consultation with EPA
- Full control of affected water use per experimental testing requirements
- Treated August 8



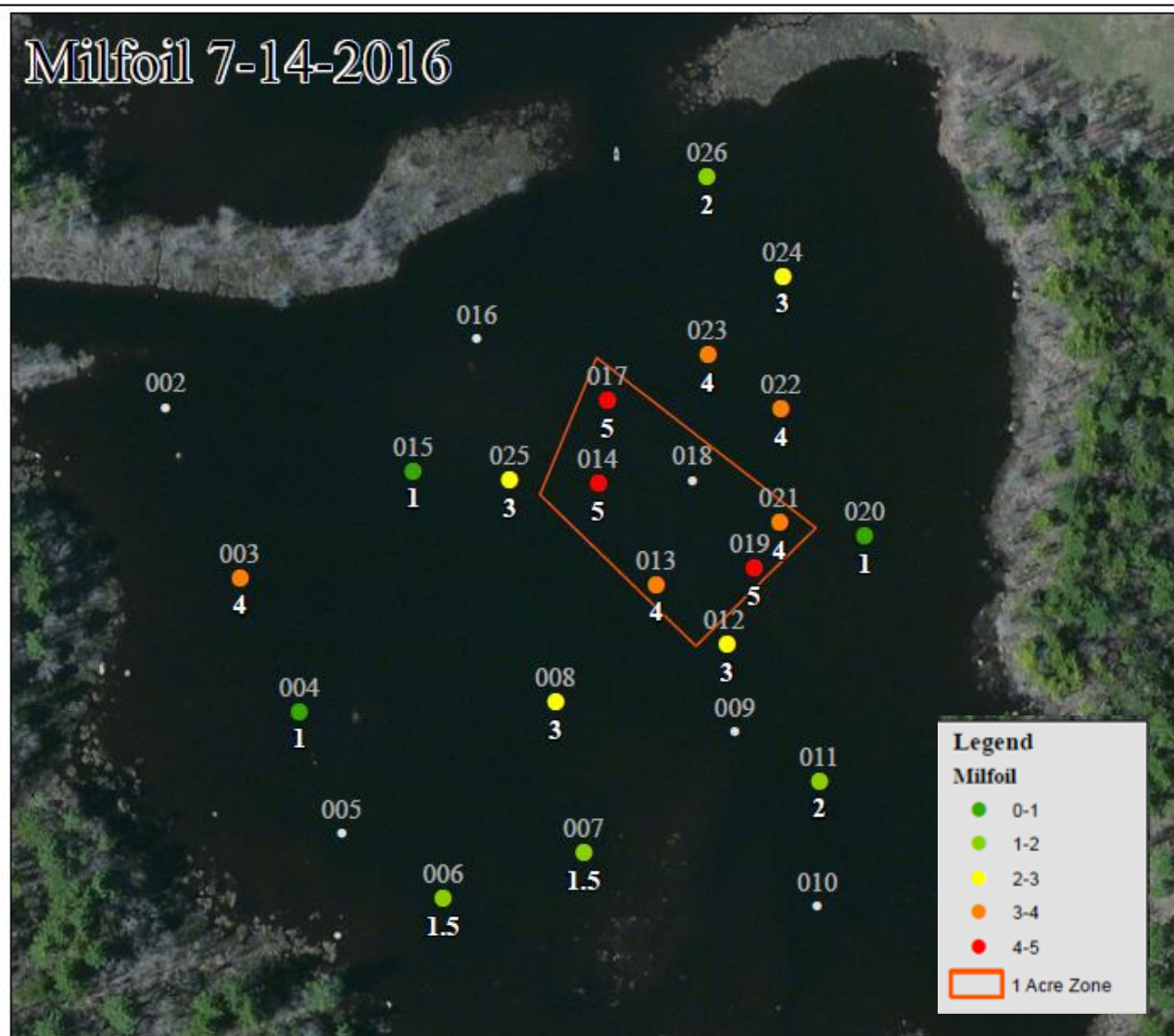




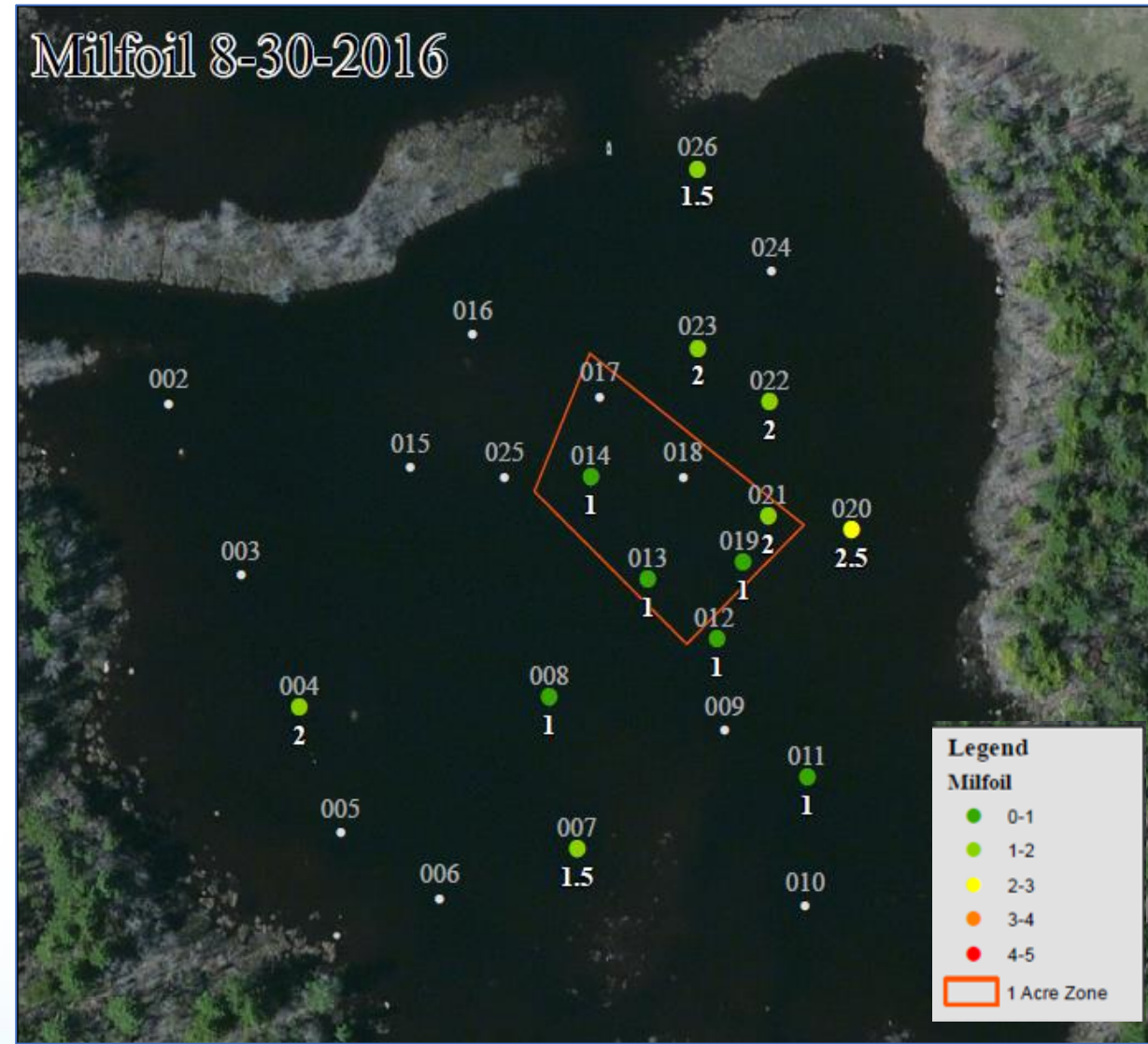
Dense topped-out VWM  
in selected 1-acre zone in July 2016



## Pre-Treatment



## 3 weeks post treatment







**Heavily injured VWM fragment  
@ 3 weeks post in treated area**



**VWM 20 yards outside treated area**

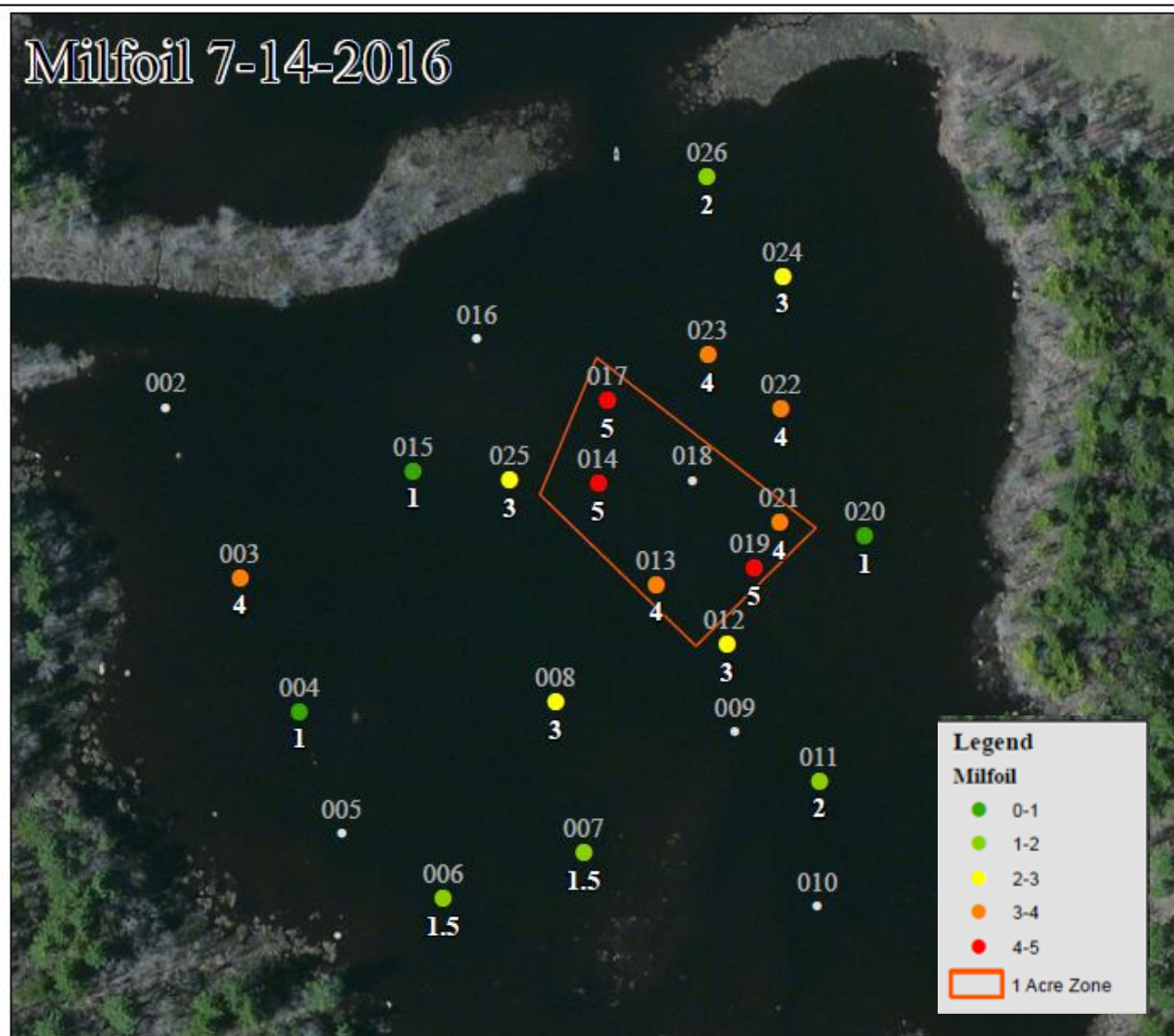




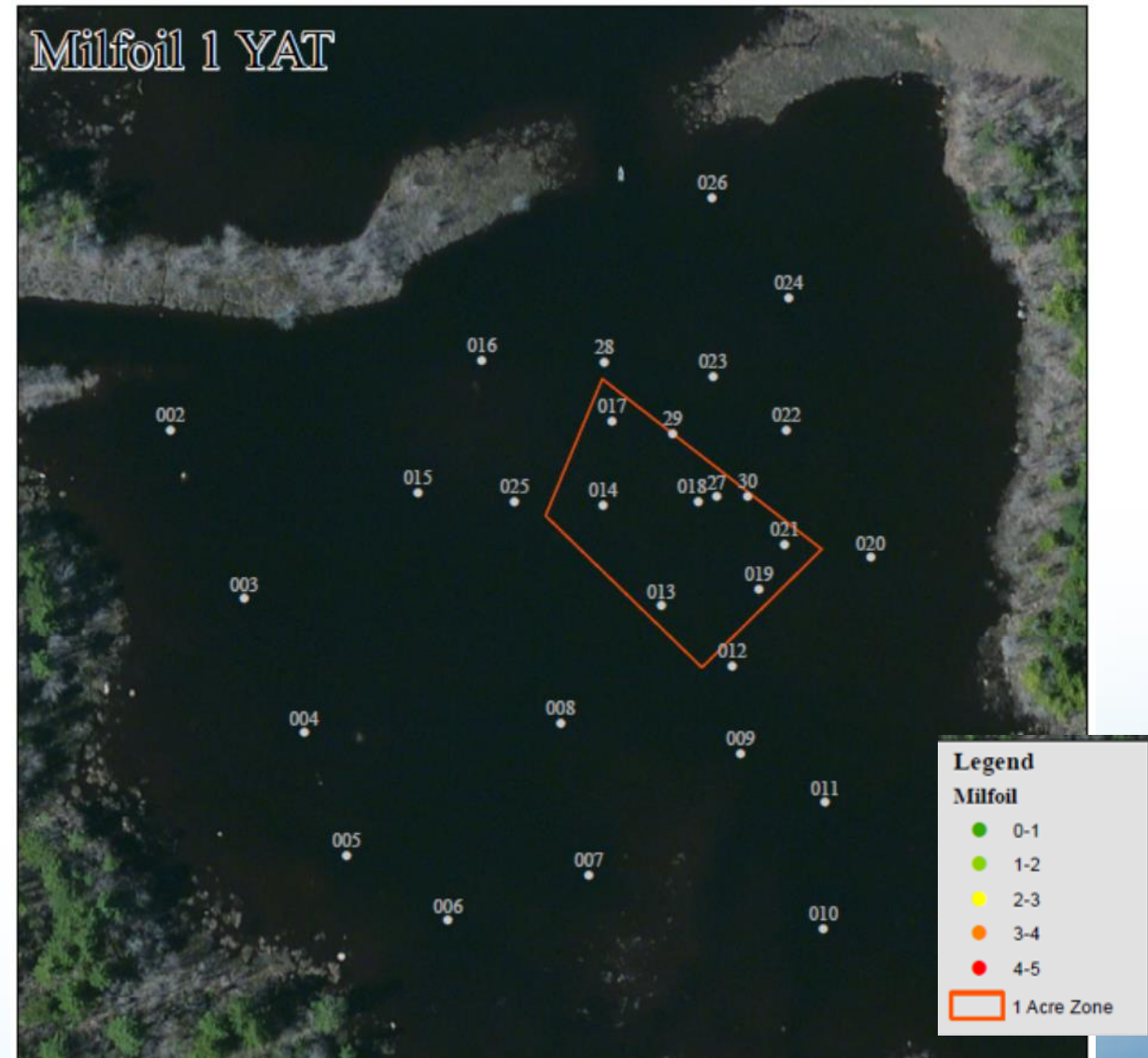
**Selective VWM control  
@ 6 weeks post treatment**



## Pre-Treatment



## 1 year post treatment (no finds in rake survey)



1 YAT VWM patches were noted outside treatment area, just not collected on formal rake throws.





Google Earth  
Sept 26, 2015





SePRO / NHDES UAV  
July 10, 2017





# Parrotfeather

- Dense PF population subjected to numerous other herbicide strategies in last few years
- 0.6 acre treated, 5 ft avg depth
- Treated in-water in mid June 2016







Parrotfeather  
Day of Treatment





Parrotfeather

2 DAT – June 22, 2016





Parrotfeather  
11 DAT – July 1, 2016







APW with with trace dying PF  
43 DAT - August 1, 2016





July 2016

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American Pondweed and no PF  
10 MAT - May 2017



American Pondweed and no PF  
10 MAT - May 2017





# Emergent and Floating Aquatic Weeds

(examples: Water hyacinth, waterprimrose and alligatorweed)

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PRE



3 days

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## Water hyacinth

(Foliar with 5 – 10 PDU  
EC or 30 – 60 g ai/ha)



10 days



25 days

**Cooperative  
study with  
USACE-APCRP  
(Dr. Chris Mudge)**





# Invasive Water Primrose

- Enloe and Lauer 2017.  
Uruguay waterprimrose control with herbicides.  
JAPM 55:71-75

1 – 2 PDU SC  
(30-60 g ai / ha)

TABLE 1. COMPARISON OF URUGUAY WATERPRIMROSE PERCENTAGE OF INJURY 10 AND 35 D AFTER TREATMENT (DAT) FOR EXPERIMENT-TREATMENT COMBINATIONS.

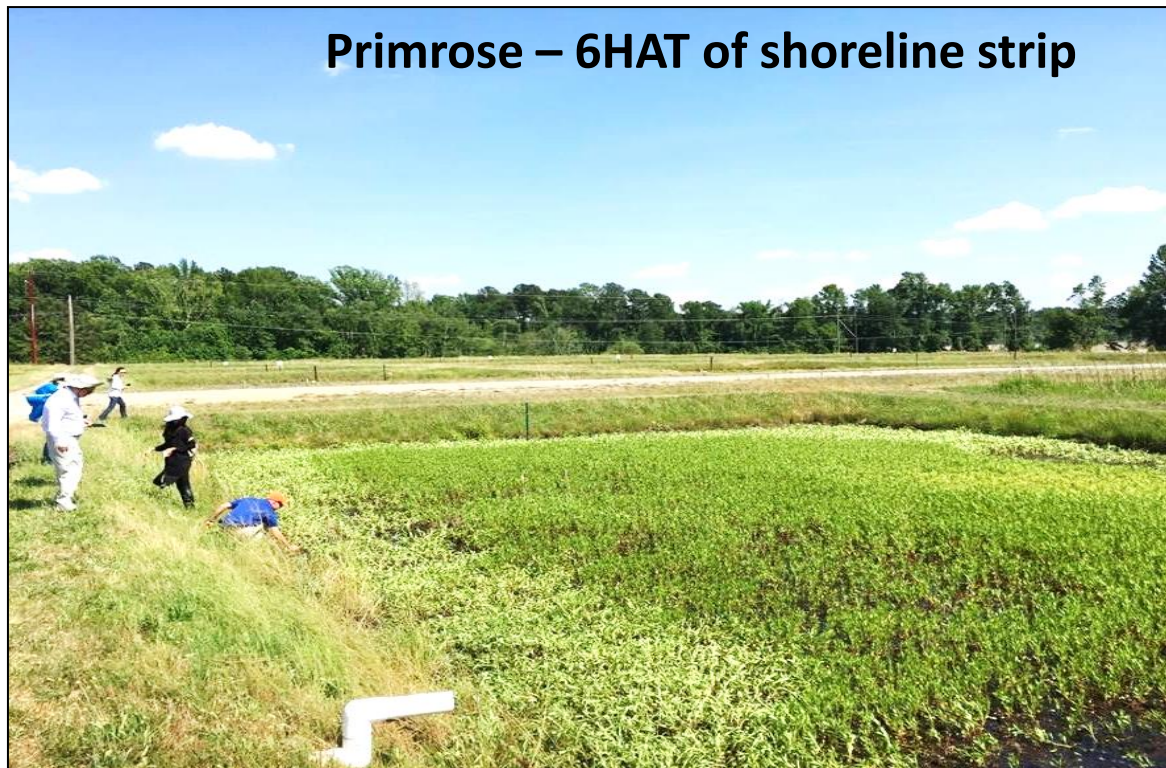
	Rate	Experiment 1		Experiment 2	
		10 DAT	35 DAT	10 DAT	35 DAT
Aminopyralid	0.11	47 ab	98 a	40 bcd	99 a
	0.22	58 a	98 a	68 ab	100 a
Glyphosate	4.2	28 b	78 b	18 de	62 b
Glyphosate + flumioxazin	4.2 + 0.14	48 ab	93 ab	77 a	95 a
Glyphosate + 2,4-D	4.2 + 4.3	53 ab	98 a	75 a	99 a
Imazamox	0.28	23 b	73 b	12 e	21 c
Imazamox + flumioxazin	0.28 + 0.14	40 ab	87 ab	82 a	93 a
florpyrauxifen-benzyl	1.35	48 ab	80 b	23 cd	100 a
	2.7	52 ab	77 b	22 cd	92 a

<sup>1</sup>Means followed by the same letter within a column are not significantly different at  $P = 0.05$  using Tukey's adjustment for multiplicity.



## Invasive water primrose pond demonstration (NC) – 60 g ai/ha (10 PDU EC / acre)

Primrose – 6HAT of shoreline strip



4WAT



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Untreated **Alligatorweed** on day of treatment – 10 August 2015



1 week post  
Foliar (2 PDU SC)



1 month post  
foliar

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**Alligatorweed  
Foliar 2 PDU SC  
(60 g ai / ha)**

**Good activity also  
documented in  
greenhouse studies  
(Richardson et al. 2016)**





# Conclusions



- **Novel, reduced-risk, low-rate herbicide technology is now USEPA registered**
- **US commercial labels are anticipated by early 2018. International uses are also planned.**
- **Mesocosm evaluations on well-established plants confirm excellent selective activity on several major US target weeds, which has been confirmed in field evaluations.**
- **A 'virtuous cycle' of continued partnership will demonstrate and refine new management practices.**





# Acknowledgements

- **US Army Corps of Engineers Aquatic Plant Control Research Program**
- **NC State University**
- **University of Florida**
- **University of Washington**
- **New Hampshire DES and Department of Agriculture**
- **Many other university, agency, and private management partners**





Thank you!

Questions?

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