Evaluating Multiple Control Methods for *Hydrilla verticillata* in the Silvermine River System

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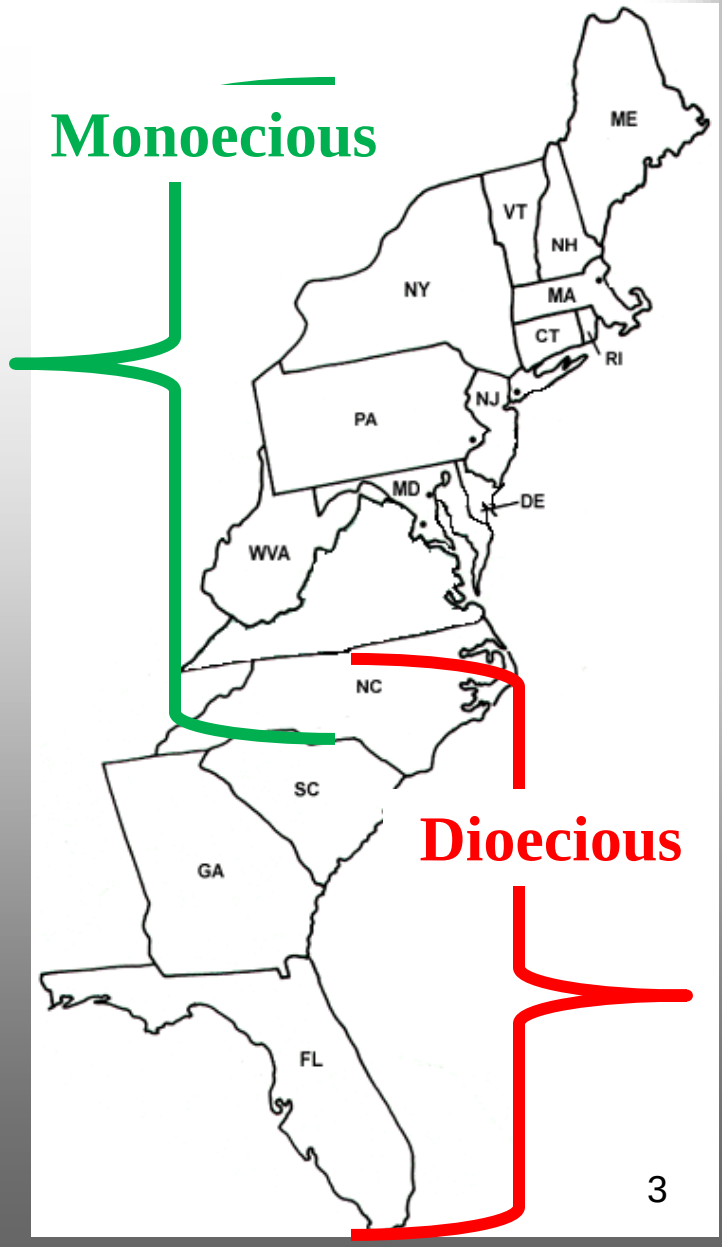
Biological Invasions

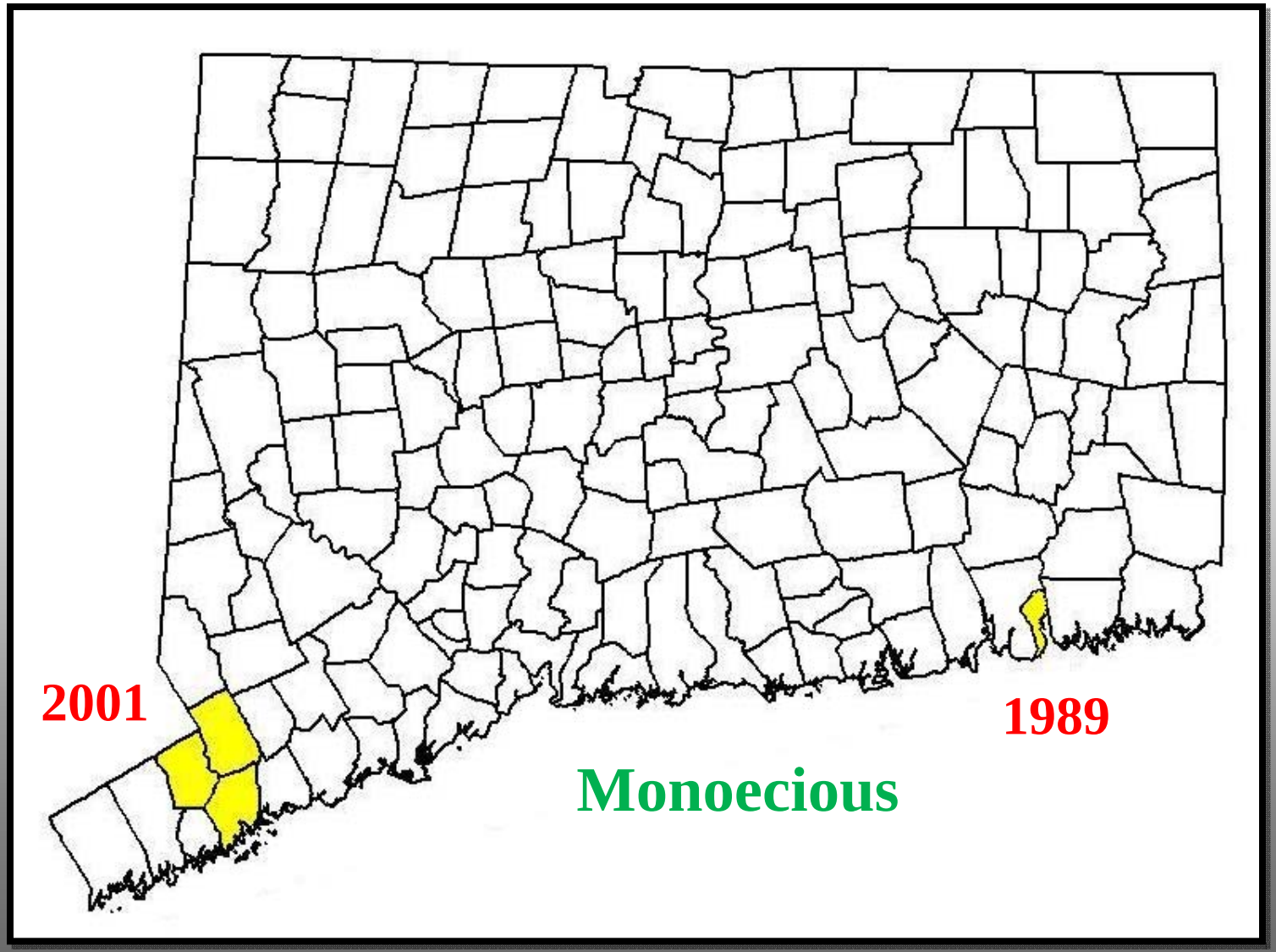
- **Driving global, environmental change**
  - Fire, geochemical, biodiversity, disease
- **Management is complex, particularly in urban/suburban landscapes**
  - Public awareness of impacts
  - Perception of control methods

The Invasion of *Hydrilla verticillata*

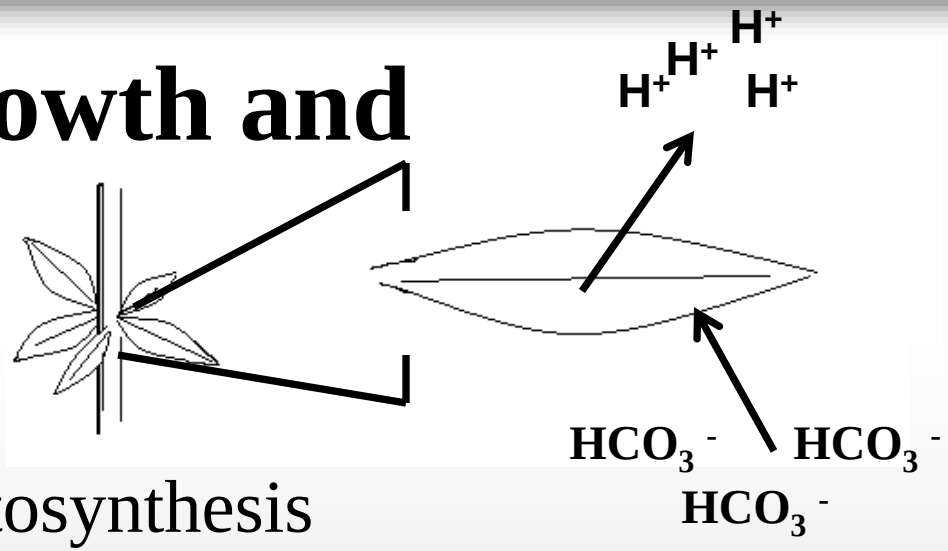
- **Florida: 1958**
  - Private business discards shipment into nearby canal
  - By 1995, coverage *exceeds* 40,000 ha
- **Mid-Atlantic: 1982**
  - Potomac River restoration



Southern New England



H. verticillata Growth and Reproduction

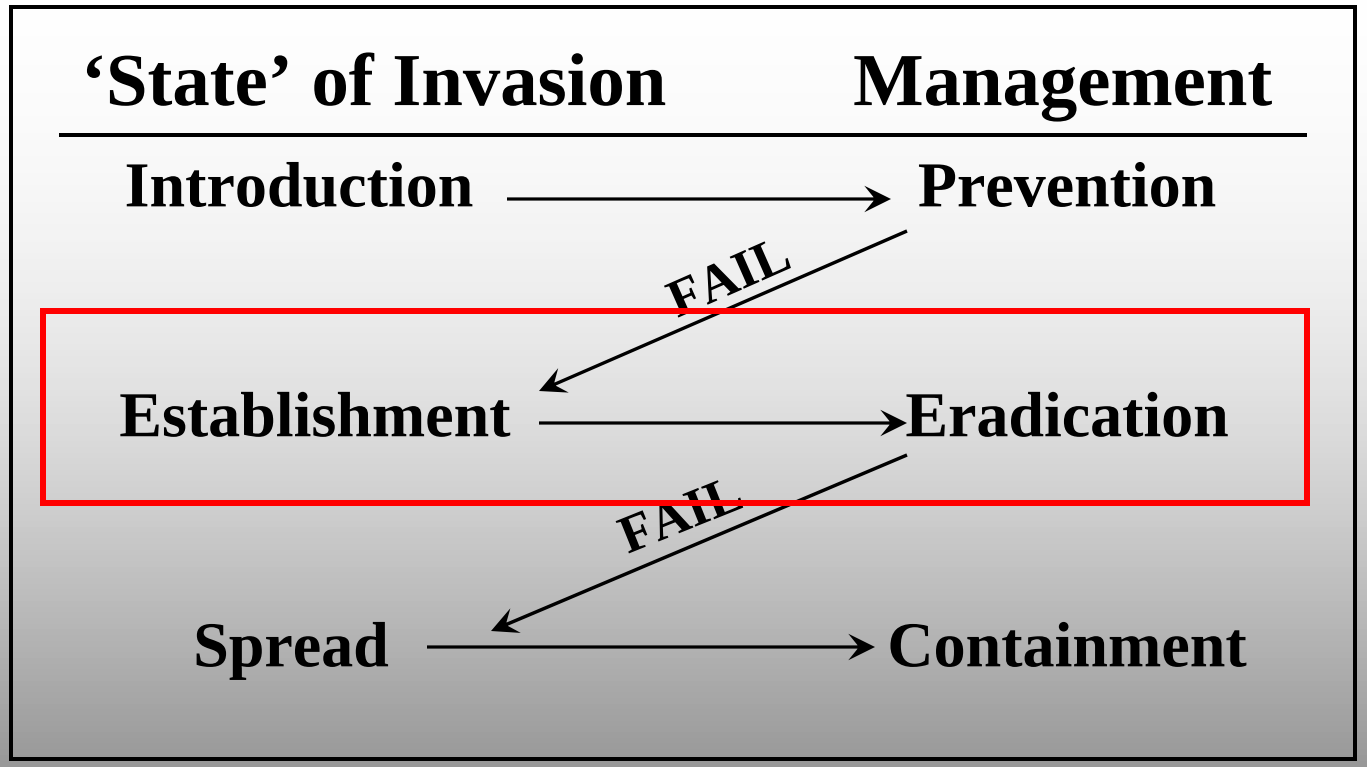


– C_3-C_4 intermediate photosynthesis
  - Stress tolerance and plastic growth mechanisms

– Reproductive strategies
  - fragmentation, sexual, asexual

Consequences of *H. verticillata* invasions…

Controlling Invasive Species



Adapted from Hulme, 2006

Fifty years of management and the struggle continues…

- Low-dose herbicides: chronic exposures (>90 days) systemic acting (**Fluridone**)
  - Herbicide resistant sub-populations

Fifty years of management and the struggle continues…

- **Mechanical harvesting**
  - **Fish kills, non-specific, belowground storage structures left intact**

Study System

The Silvermine River System

- **Numerous, small control-like structures c ~1920. This has partially impounded the natural flow of the system.**

Study System

- **Management must account for human dimensions associated with the watershed.**
    - **Mechanical harvesting is impractical**
    - **Continuous, long-term herbicide application is precluded.**



Objectives:

Evaluate techniques that aim to control and/or eradicate *H. verticillata* from urban watersheds of New England.

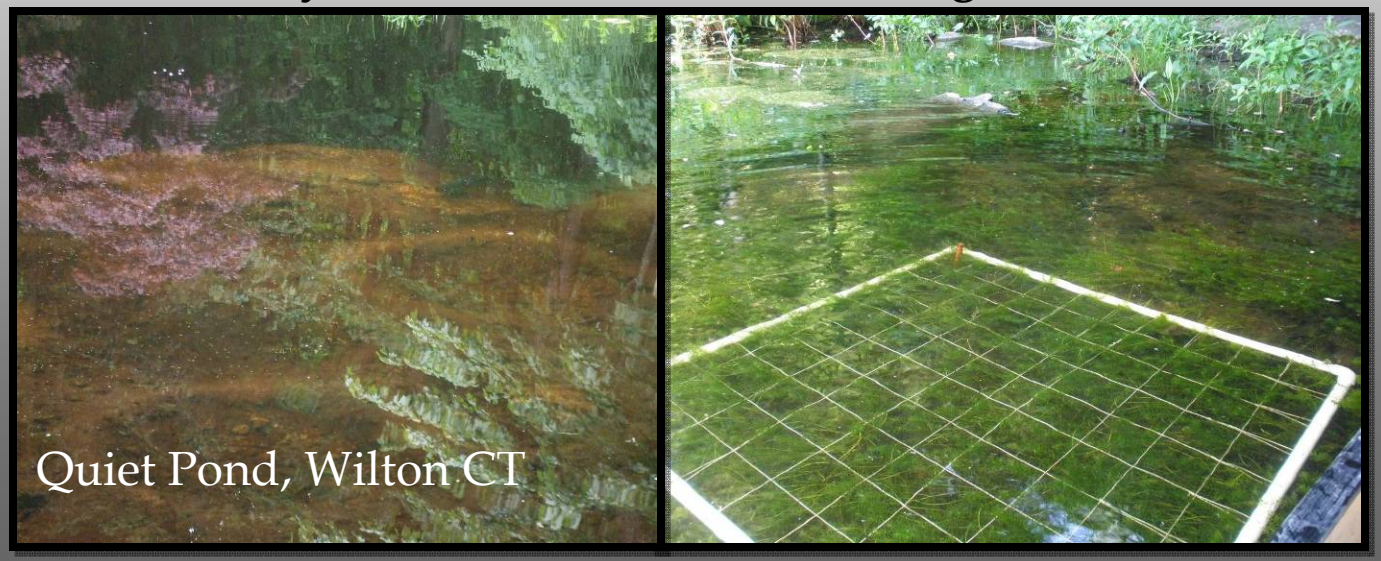
- **Acute chemical agents (Endothall) are moderately effective and fast acting (72 hr min)**
- **Handpulling has also been adopted, but not tested scientifically for *H. verticillata***

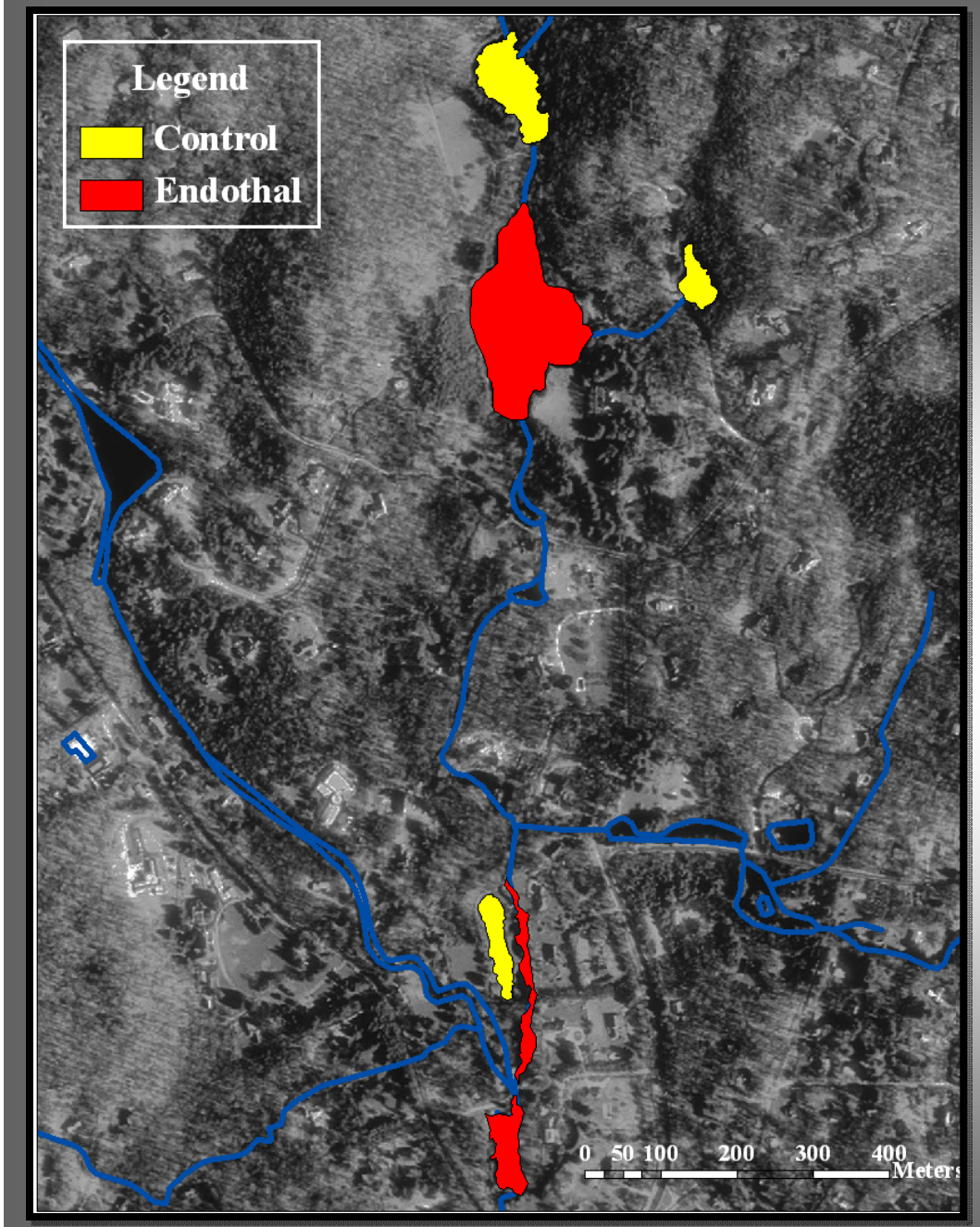
Hypotheses:

1. **Combined methods are more effective for smaller scale infestations where treatment options are limited.**

2. **Timing is critical for optimization of treatments.**

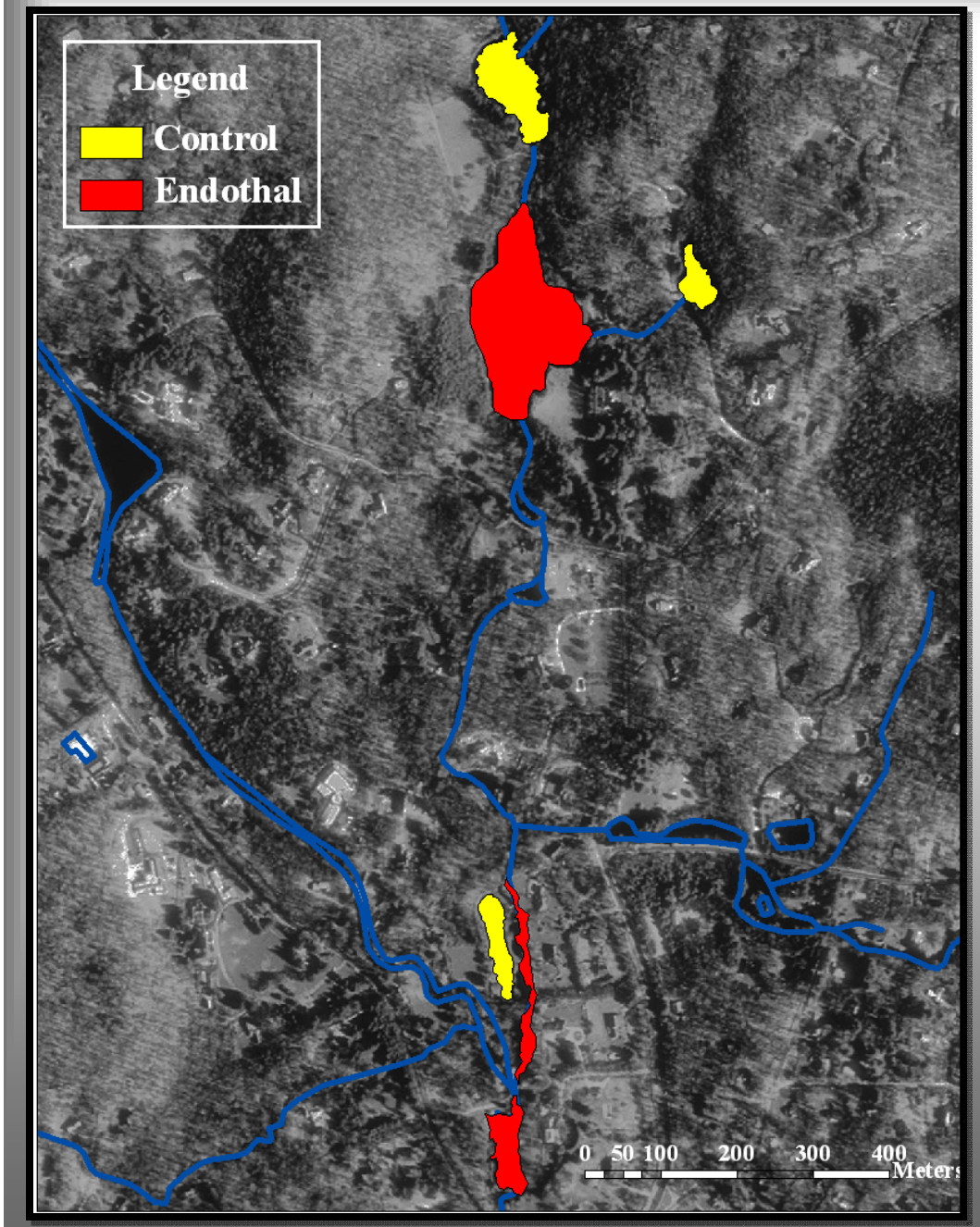
May 2009 → **August 2009**





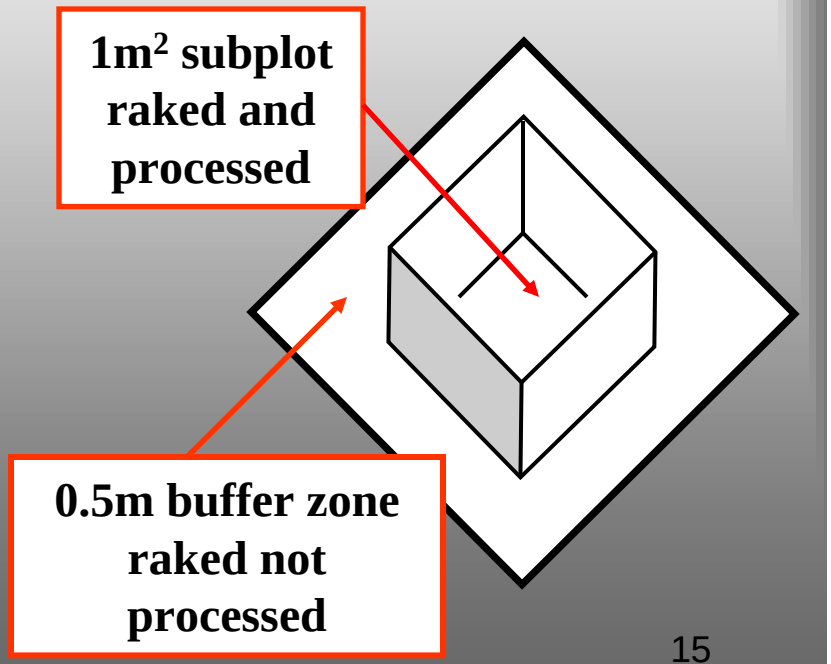
Herbicide Treatment

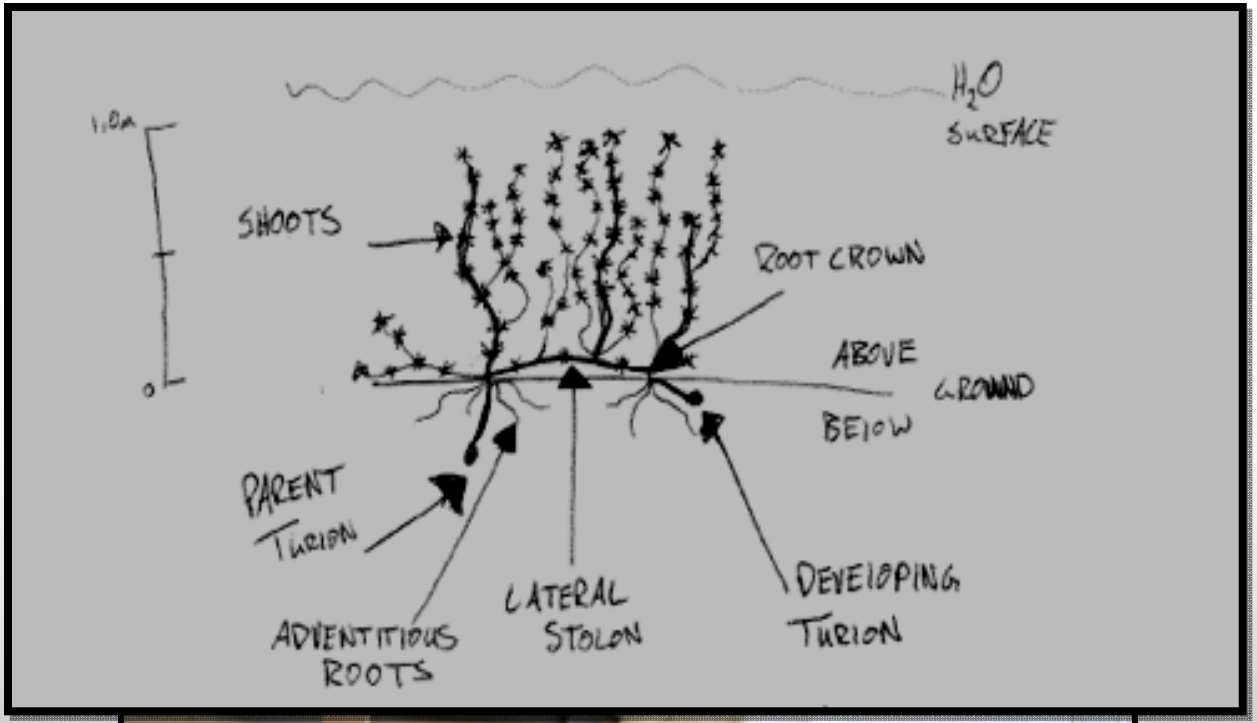
- Whole-pond Endothall application (n=3)
- Target Rate: 5 mg L^{-1}
- Residue analysis of herbicide concentration: 0, 24, 48, 120 168 hours after treatment



Handpulling Treatment

- 15 subplots per pond (90 total)
- Early, Late, and End-of-Season: (n=5 per pond)





Biomass Processing…

Treatment Schedule 2009 Season

Early	Middle	Late	
June 22-25 Coverage & Density	July 21-28 Coverage & Density	Aug. 18-27 Coverage & Density	Sept 25-Oct 2 End-of-Season Handpulling
June 30-July 6 'Early' Handpulling	July 28-Aug 6: Endothall Application	Aug. 18-27 'Late' Handpulling	

2010 Season

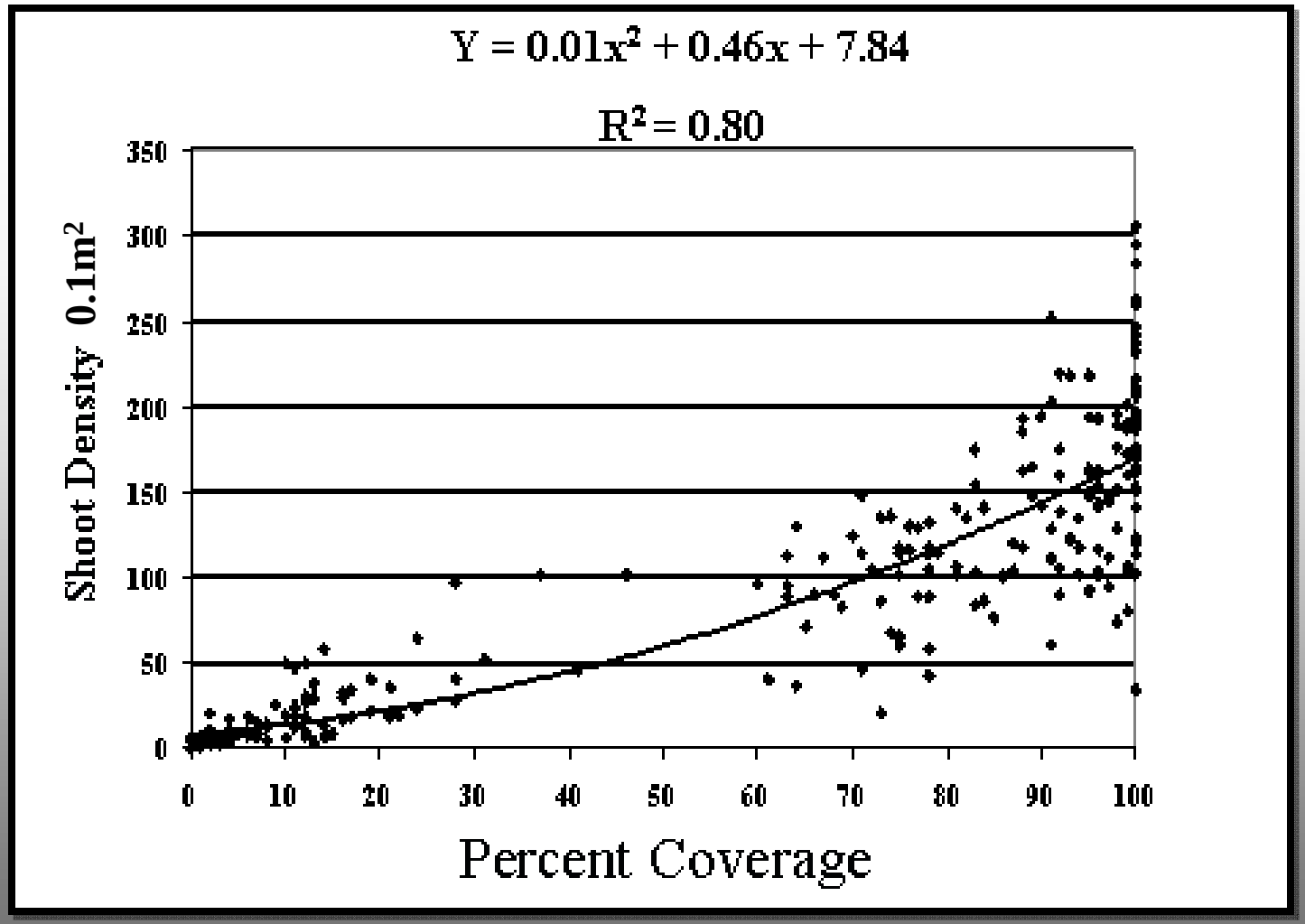
June 15 – July 1
Final Harvest of all 90 Plots

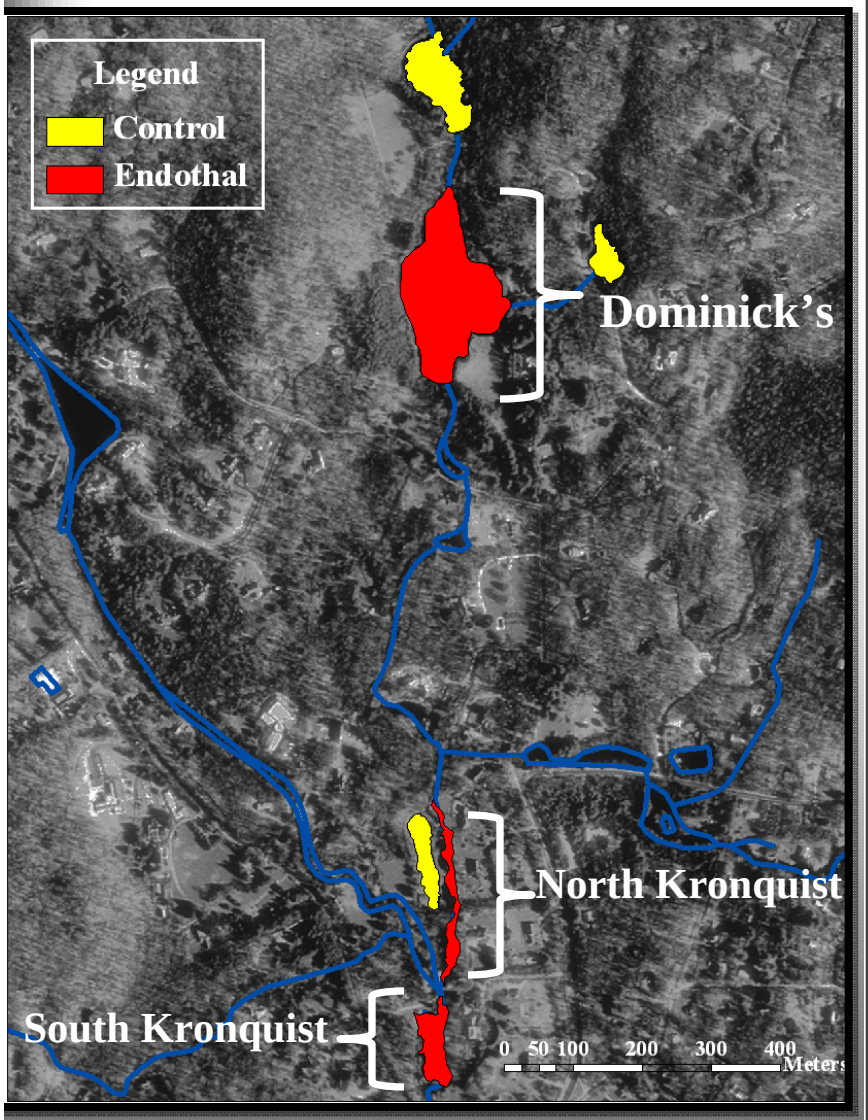
Analysis

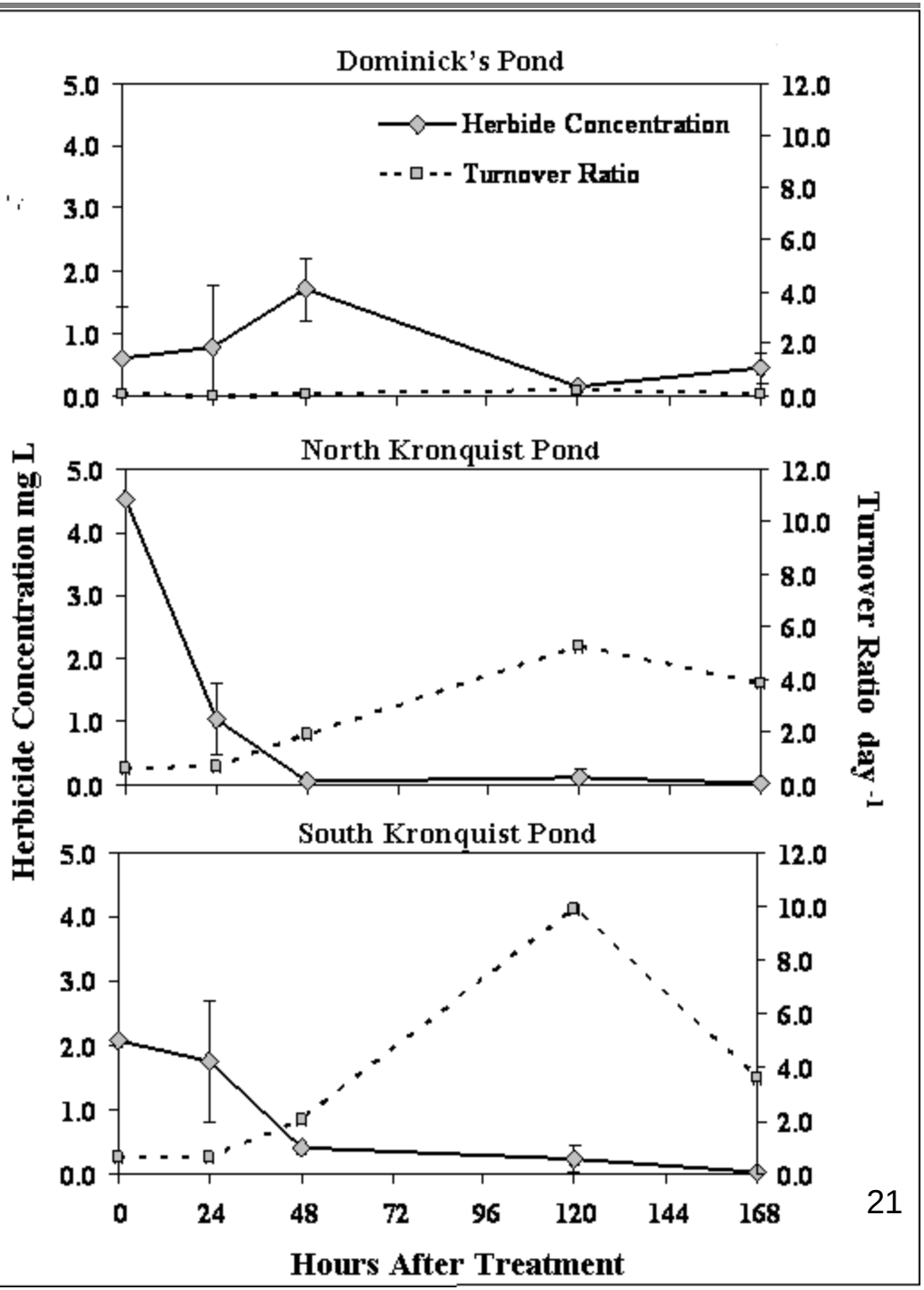
- Rank transformation of ‘Estimated Shoot Density’ measurements
  - Repeated measures ANOVA testing for differences across time, within main effect treatments
- Natural log transformation of biomass data
  - ANOVA testing for differences across handpulling intervals for above- and belowground structural components

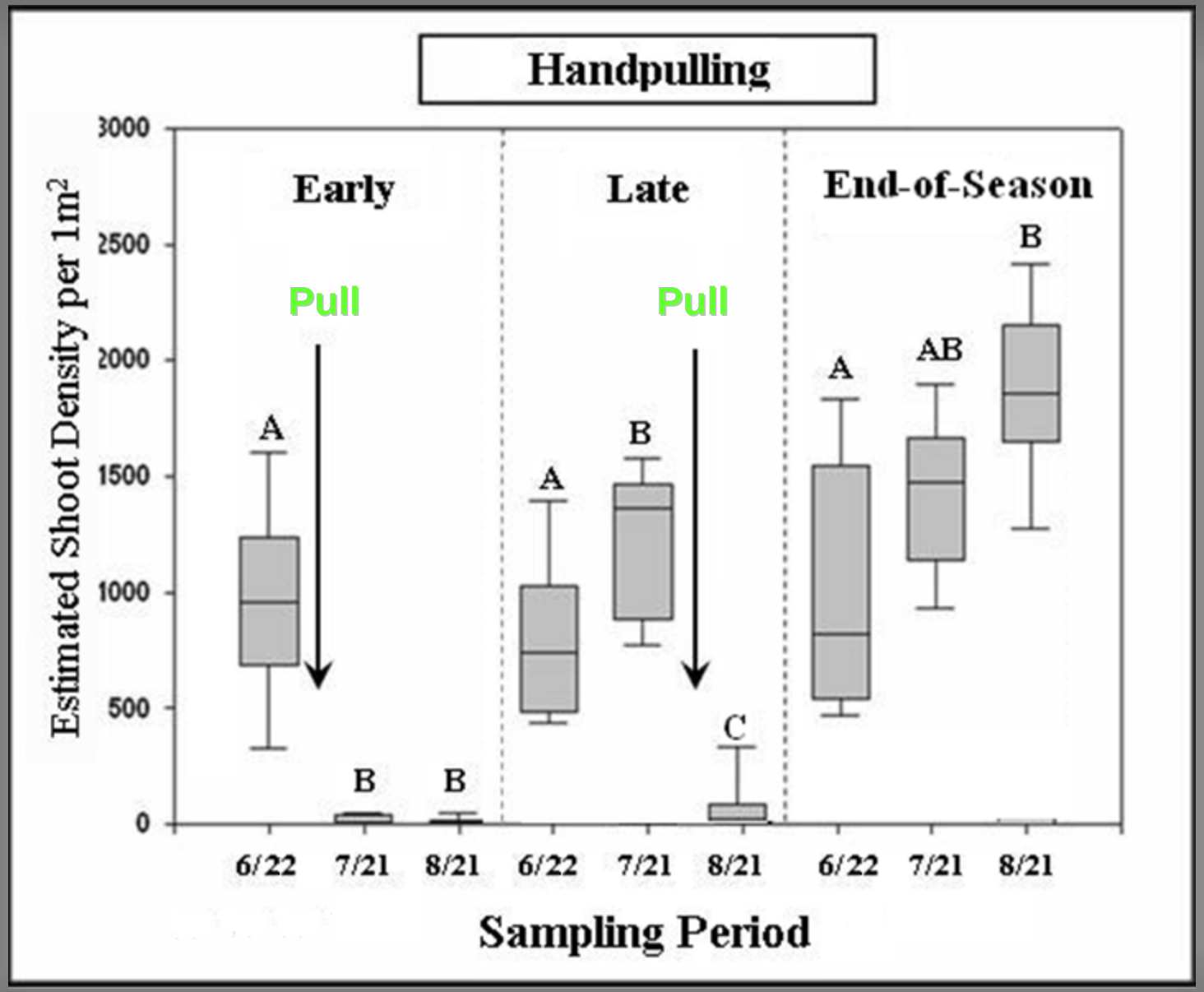

09/18/

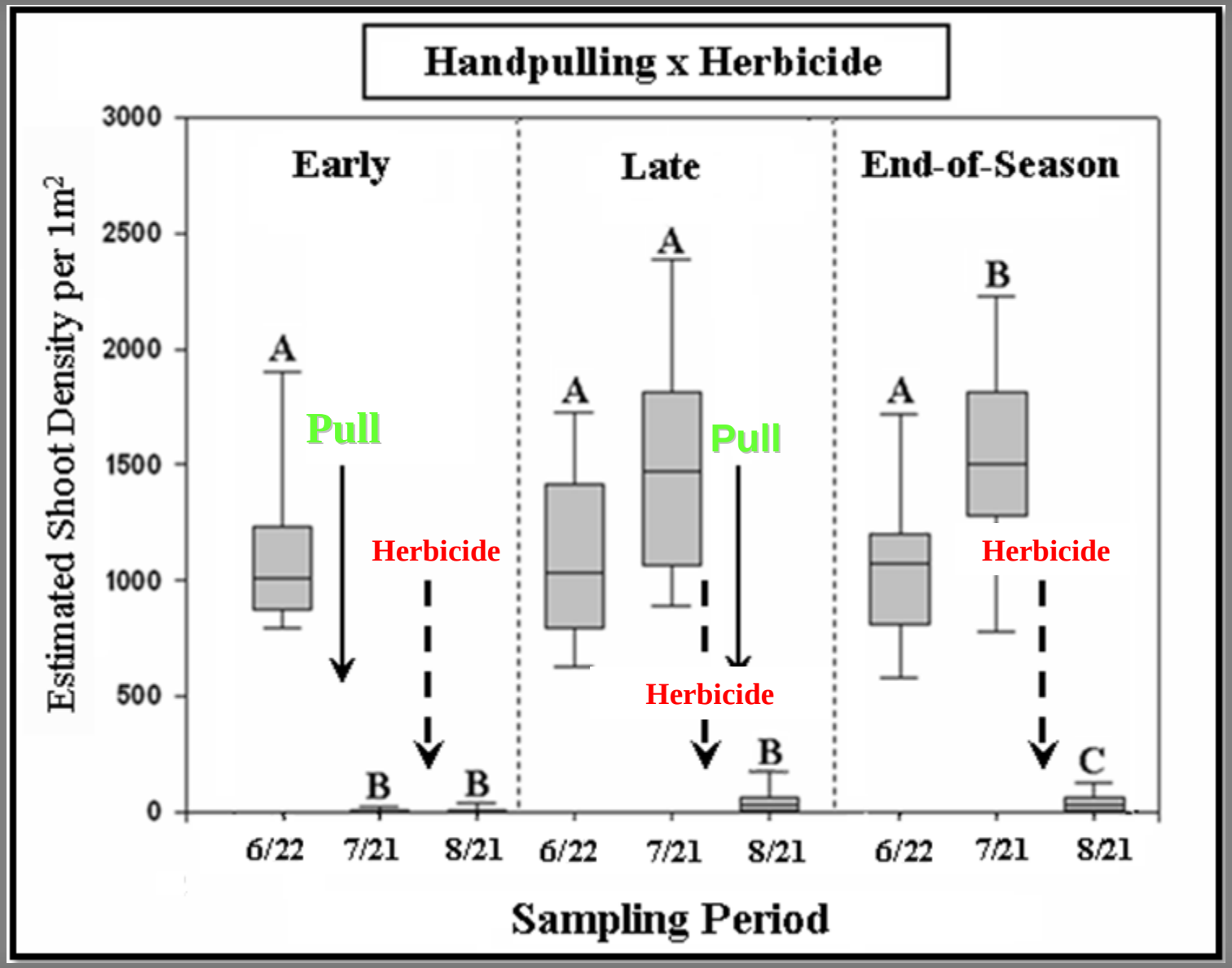
Results

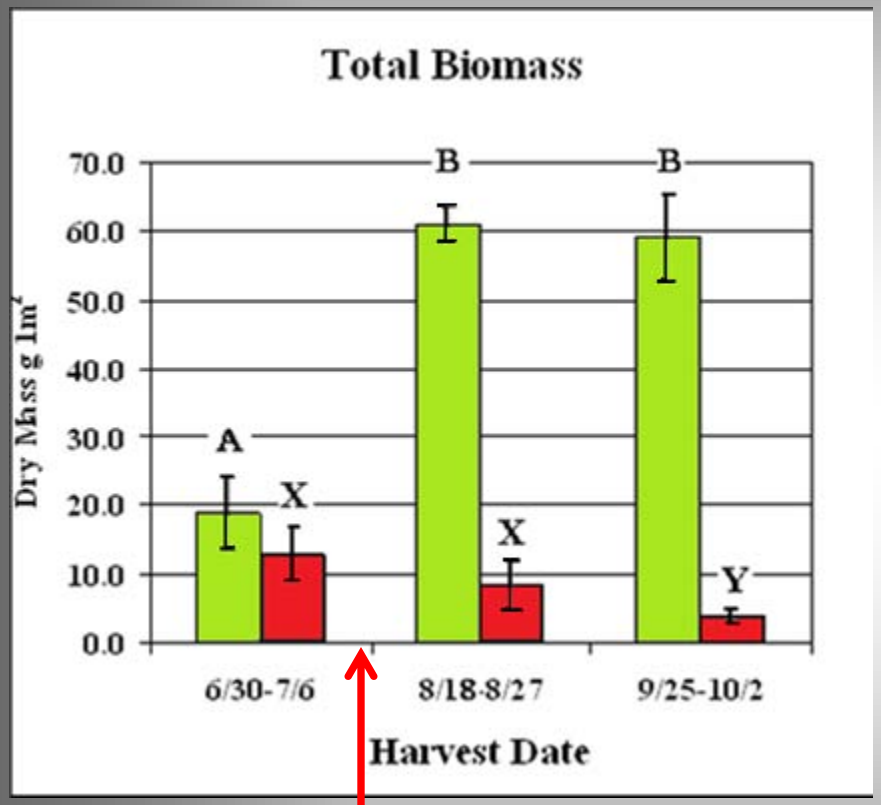

Y = 0.01x² + 0.46x + 7.84
R² = 0.80
Shoot Density 0.1m²
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
100
Percent Coverage

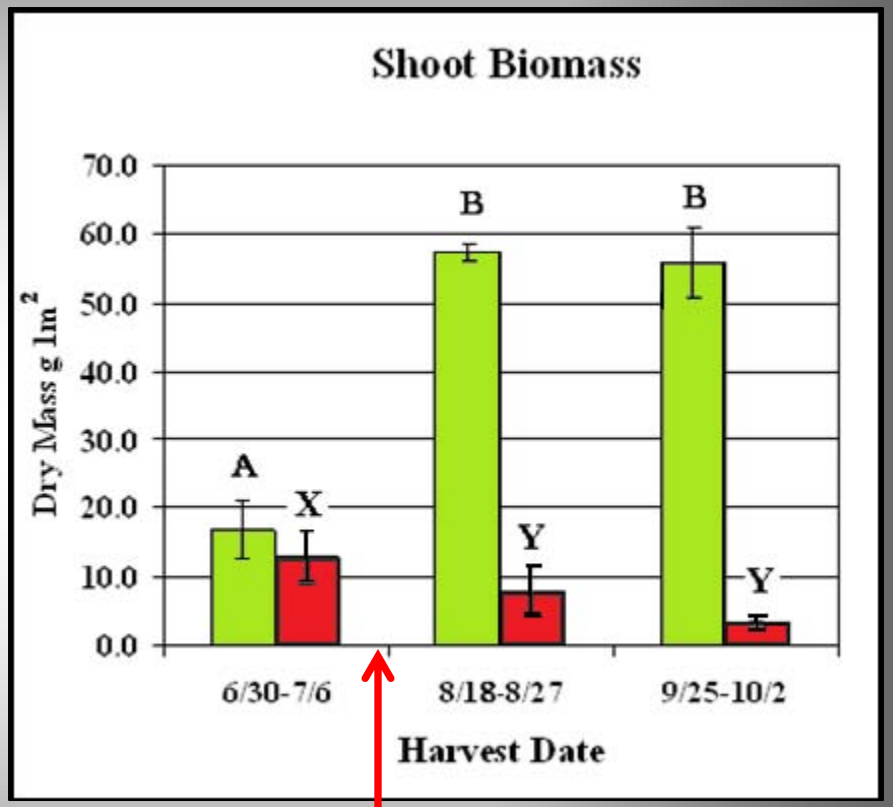

Legend
Control
Endothal
Dominick's
North Kronquist
South Kronquist
0 50 100 200 300 400
Meters


Dominick's Pond
Herbide Concentration
Turnover Ratio
North Kronquist Pond
South Kronquist Pond
Herbicide Concentration mg L
Turnover Ratio day -1
Hours After Treatment
0
24
48
72
96
120
144
168


Handpulling
Estimated Shoot Density per 1m²
3000
2500
2000
1500
1000
500
0
Early
Late
End-of-Season
Pull
Pull
A
B
B
A
B
C
A
AB
B
6/22
7/21
8/21
6/22
7/21
8/21
6/22
7/21
8/21
Sampling Period

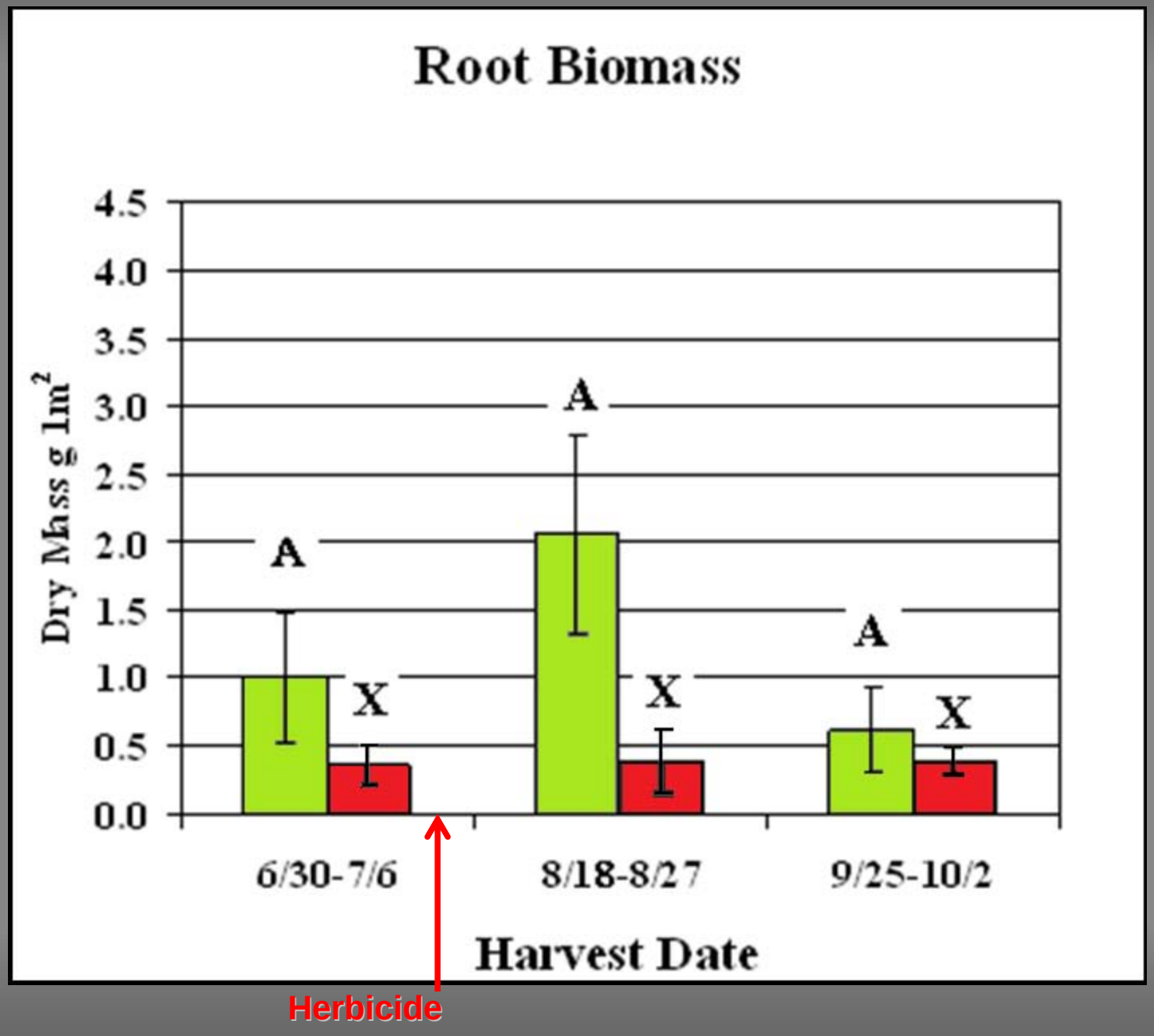

Handpulling x Herbicide
Estimated Shoot Density per 1m²
3000
2500
2000
1500
1000
500
0
Early
Late
End-of-Season
A
Pull
Herbicide
B
B
A
A
Pull
Herbicide
B
A
B
Herbicide
C
6/22
7/21
8/21
6/22
7/21
8/21
6/22
7/21
8/21
Sampling Period

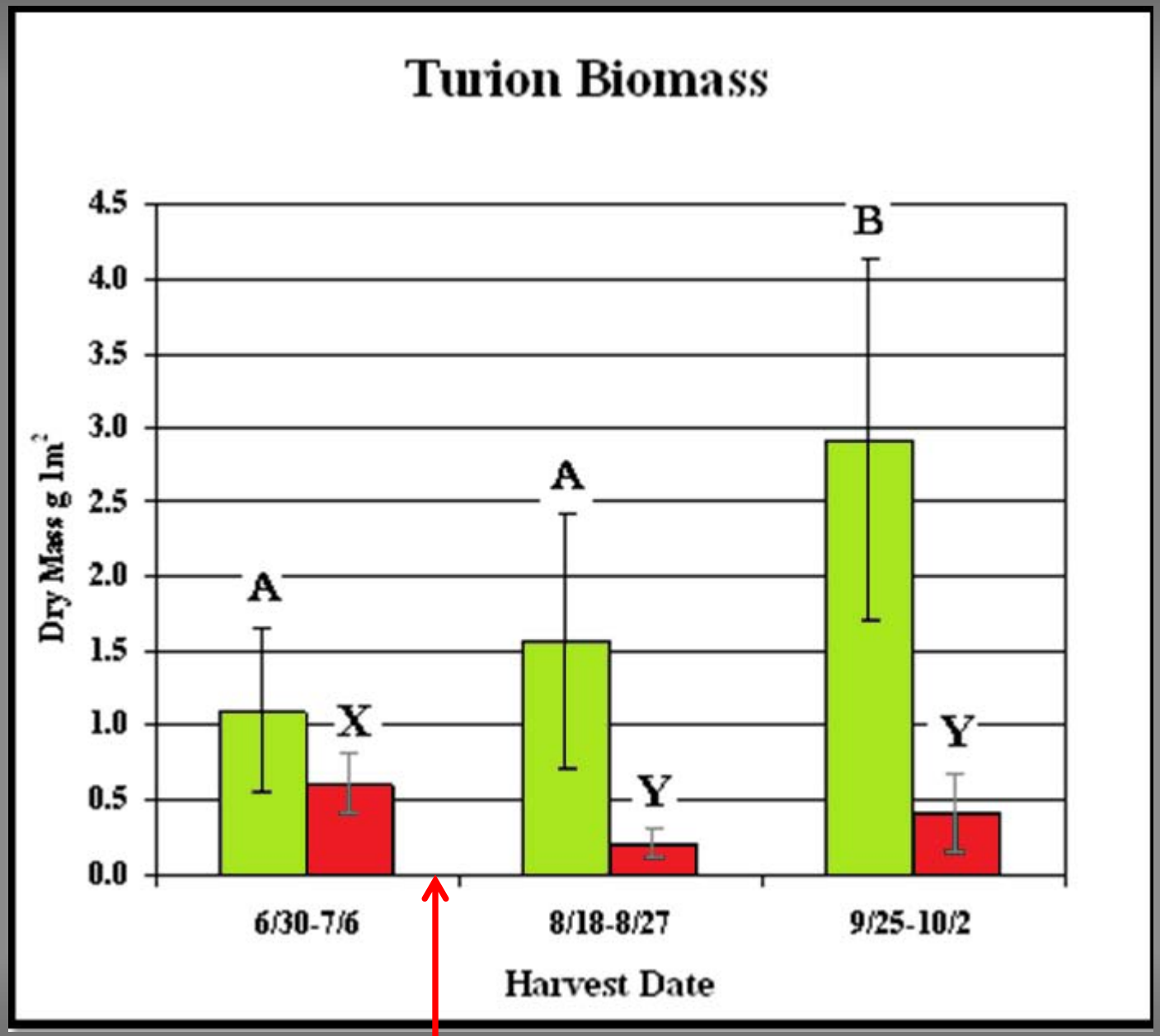


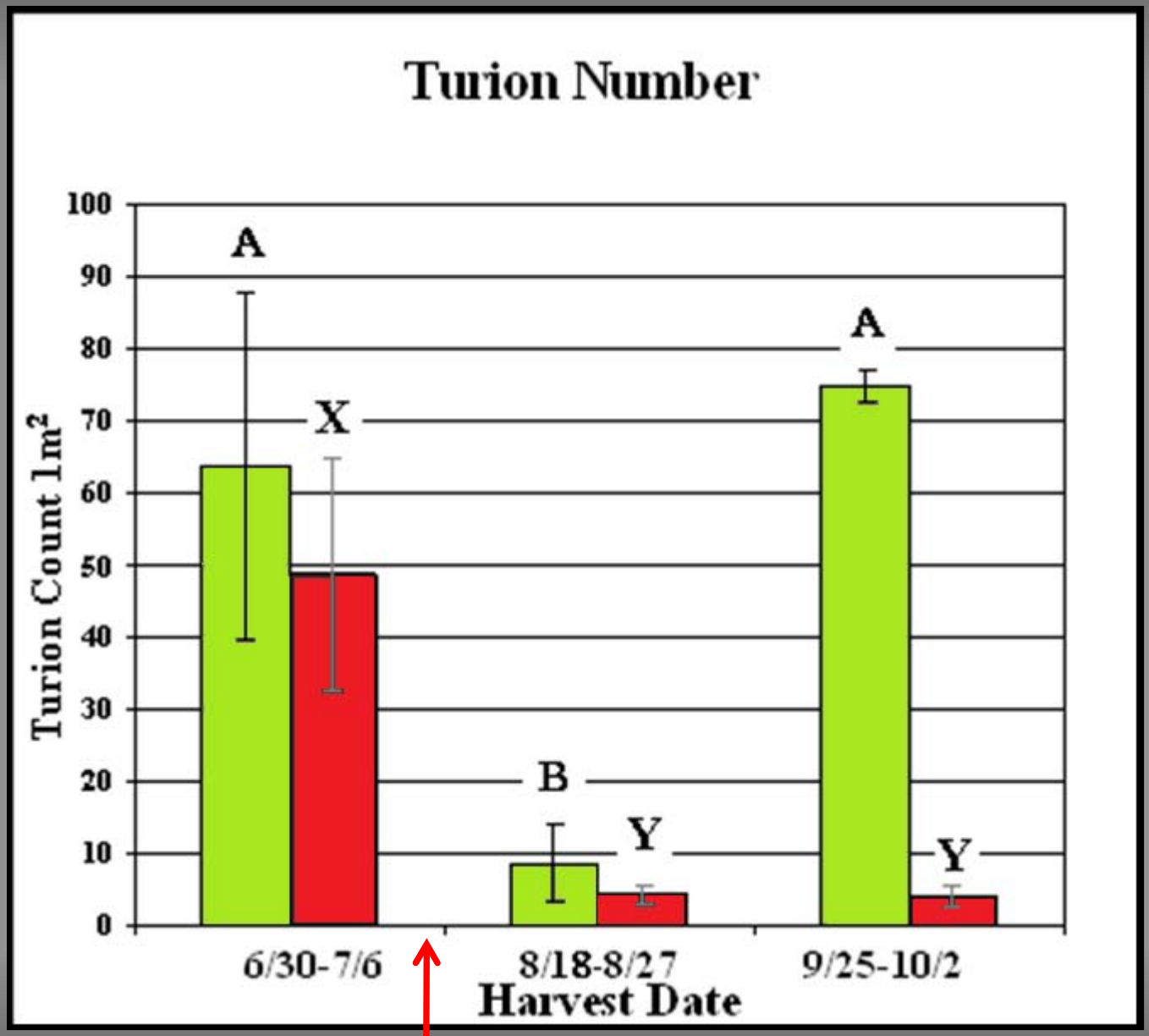


Herbicide

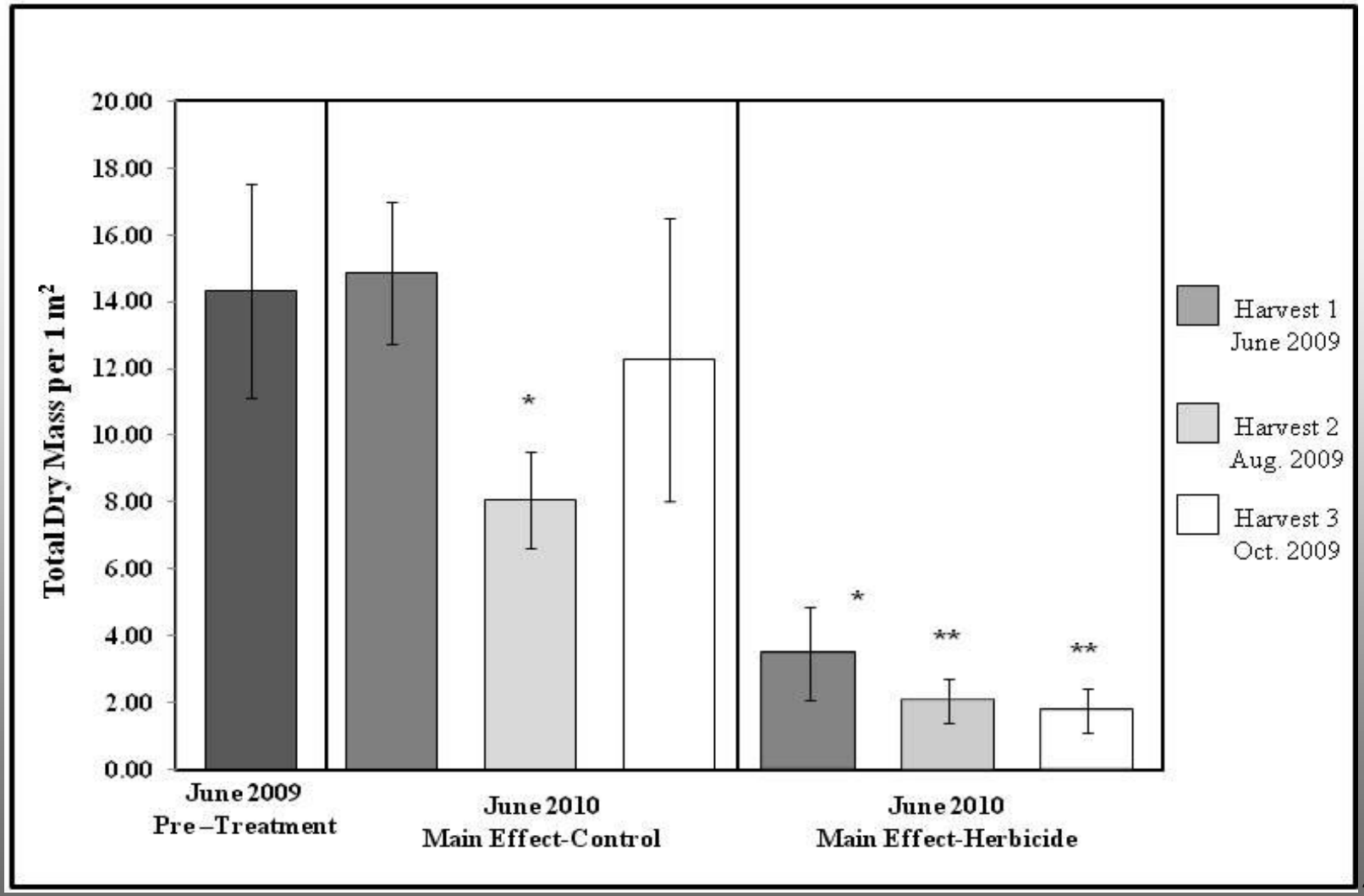
Herbicide


Root Biomass
Dry Mass g 1m²
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
A
X
A
X
A
X
6/30-7/6
8/18-8/27
9/25-10/2
Harvest Date
Herbicide


Turion Biomass
Dry Mass g 1m²
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
A
X
A
Y
B
Y
6/30-7/6
8/18-8/27
9/25-10/2
Harvest Date
Herbicide


Turion Number
Turion Count 1m²
100
90
80
70
60
50
40
30
20
10
0
A
X
B
Y
A
Y
6/30-7/6
8/18-8/27
9/25-10/2
Harvest Date
Herbicide

Effects of Treatment after One Year



Management Recommendations

- The combination of Endothall and handpulling are effective techniques for reducing standing biomass of *H. verticillata* **between** growing seasons

- One seasonal handpulling event was less effective at controlling *H. verticillata* biomass than the combination of handpulling with herbicide

Recommendations Continued

- If handpulling is employed, it should occur in the mid-growing season

- Notable phenological trends in turion development represent a ‘window of opportunity’ for management

  – Regular monitoring of seasonal growth should increase precision, directing treatments to occur ~mid-July to mid-August

Acknowledgments:

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Questions