Phenology of Monoecious Hydrilla Over Three Years

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Hydrilla verticillata

- Federally listed noxious weed
- Hydrocharitaceae family
- Aggressive, opportunistic, nuisance species
- Continuing to spread across the U.S.
- Present on every continent except Antarctica

Hydrilla verticillata

- Reproduces vegetatively
  - tubers, turions, and fragmentation
- Fast growing
- Forms dense mats
- Competitive with native plant species
- Thrives in a wide range of environments

Hydrilla verticillata

- Negatively impacts water quality
  - dissolved oxygen levels
  - affects pH and temperature
- Problematic to hydroelectric dams, irrigation systems, etc.
- Interferes with recreation
- Provides mosquito breeding habitat

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Hydrilla Turions

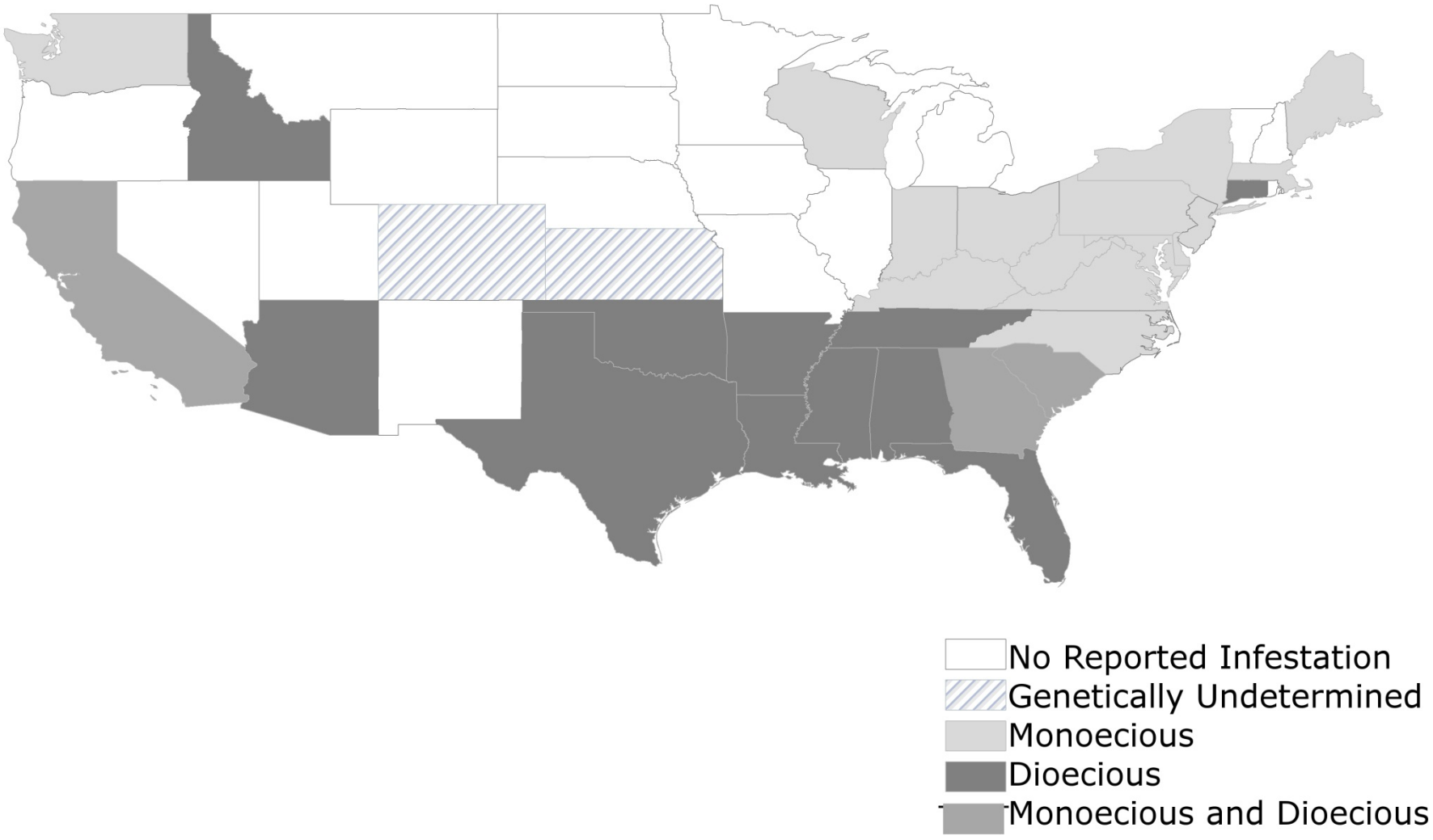
- Form main challenge to management
- Turion – an overwintering bud structure
- Hydrilla forms both axillary turions and subterranean turions (tubers)
- Tuber longevity estimated to be 5+ years, but turions only ~6-8 months
- Long-term management plans must consider and monitor the tuber bank

Tuber vs. Turion

- It has been speculated that turions are a significant source of reproduction and dispersion for monoecious hydrilla
  - The fundamental research is not been conducted to prove this point or mesocosm research has been inferred to be the same as field conditions
- Tubers have a greater production window
- Tubers produce more competitive plants (Spencer & Ksander 1991)
- Turions need to hit the “Sweet Spot” to survive
- Dispersion much more likely from boaters and waterfowl

Differences in Hydrilla Biotypes

Biotype	Monoecious	Dioecious
Possible Origin	Korea	China and India
Introduction Timing	mid 1970s	1950s
US Spread	NC and north	SC and south
Morphology	less robust	more robust
Life Cycle	herbaceous perennial	evergreen perennial
Seed Production	possible	none
Tubers: Formation Timing	June-November	October-April
Weight	76-139 mg	188-290 mg
Density	430-1,700 / m^2	60-900 / m^2


No Reported Infestation
Genetically Undetermined
Monoecious
Dioecious
Monoecious and Dioecious

Monoecious Hydrilla – The Literature

- Much less published research on monoecious hydrilla than dioecious
- Search with BIOSIS
  - 1,246 articles with the topic ‘hydrilla’
  - 53 with additional topic ‘monoecious’
- Biotype often not mentioned

Why this project?

- Lots of dioecious phenology research
- Little done *in situ*
- Much less research available concerning *in situ* monoecious hydrilla biology
- Conflicting research

?

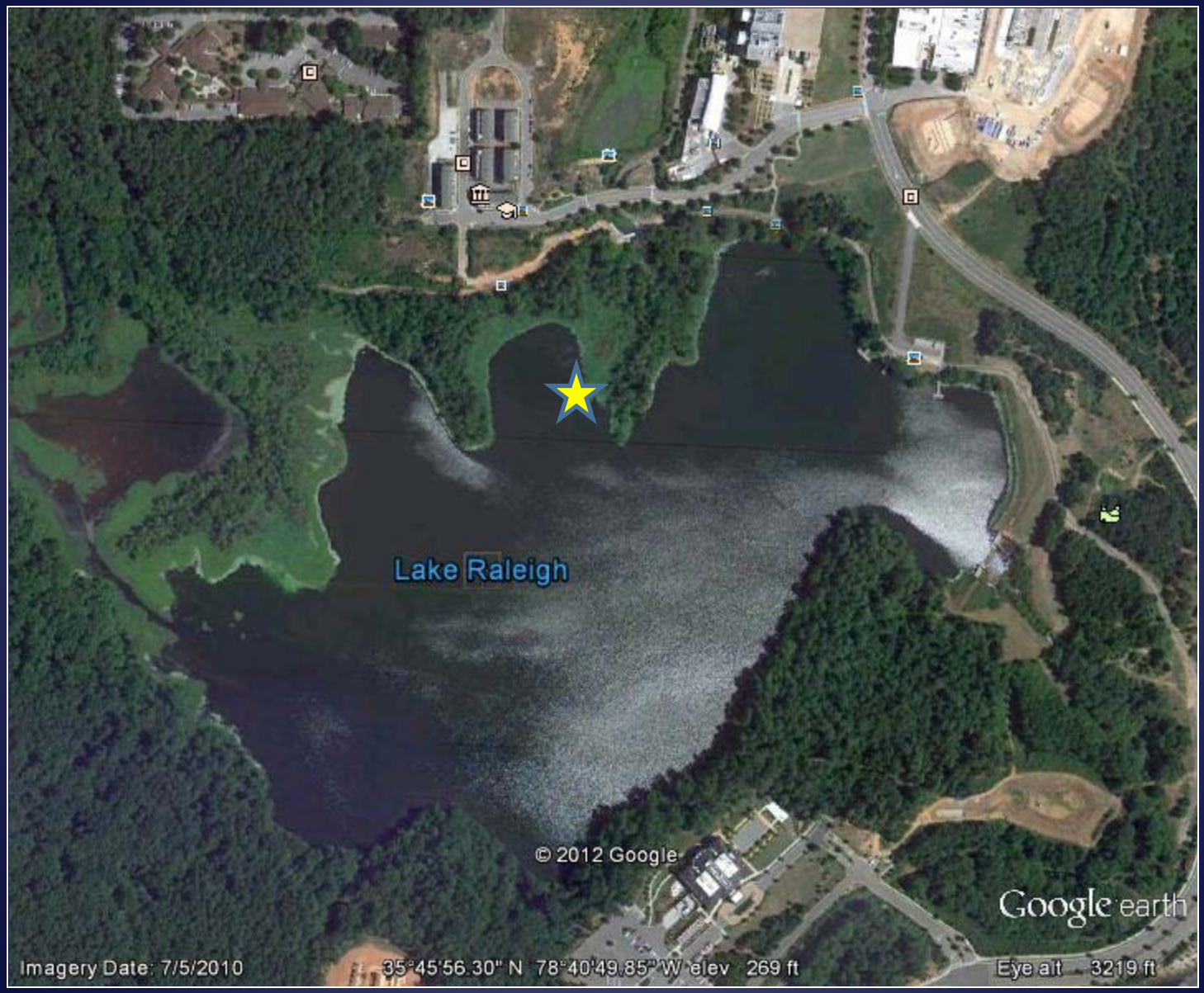
Study Objectives

- Gain a more thorough understanding of the monoecious hydrilla life cycle
- Use findings to aid management plans

Methodology

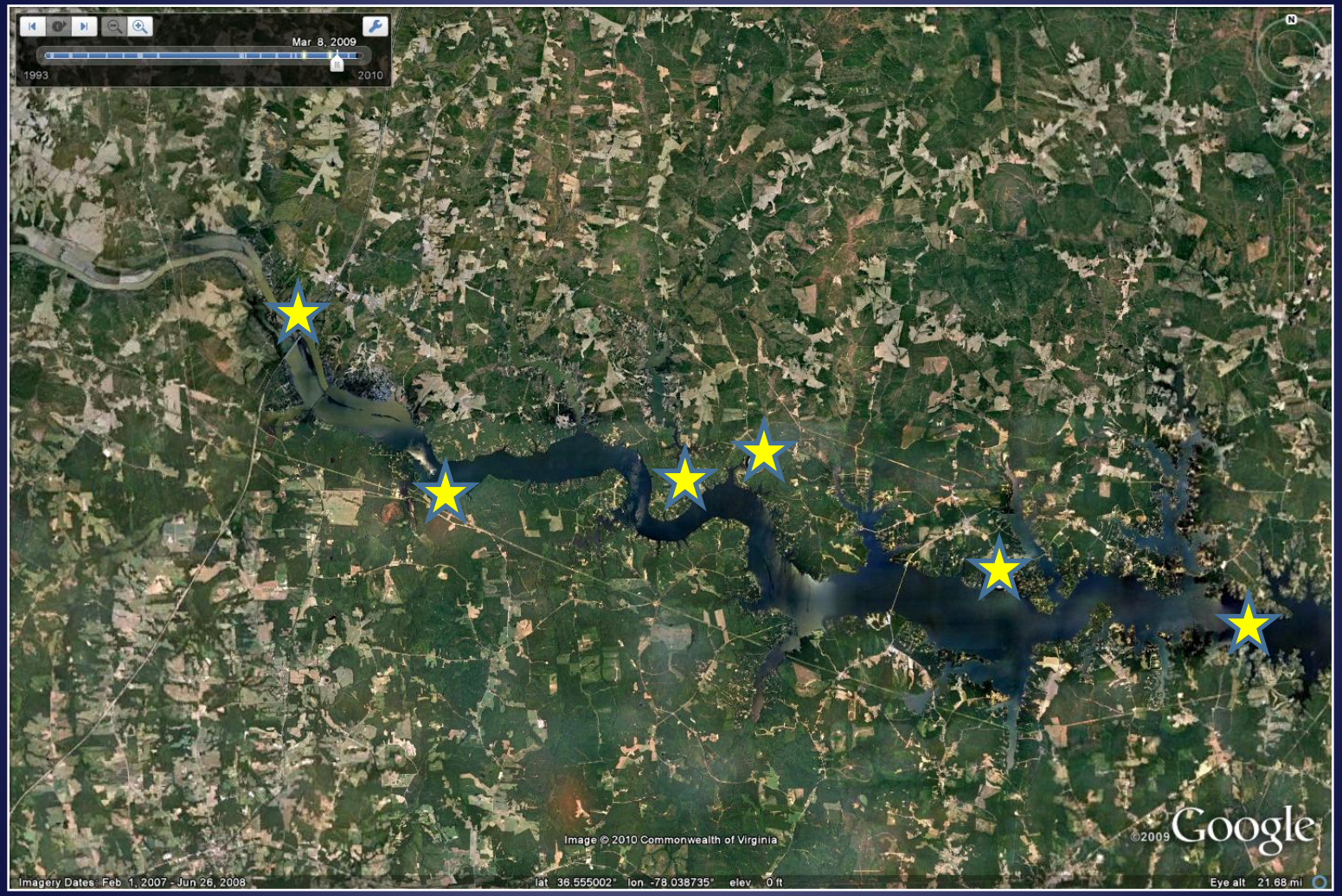
Lake Raleigh

- One study location
- Located on North Carolina State University's Centennial Campus in Raleigh, North Carolina.
- 75-acre lake
- Non-motorized watercraft only
- Limited management


Lake Raleigh
© 2012 Google
Google earth
Imagery Date: 7/5/2010
35°45'56.30" N 78°40'49.85" W elev 269 ft
Eye alt 3219 ft

Lake Gaston

- 20,000 acre hydroelectric reservoir
- Located in NC and VA
- Six locations established
- Sampling across a gradient of conditions
- Chosen in non-treated areas


Mar 8, 2009
1993
2010
Image © 2010 Commonwealth of Virginia
©2009 Google
Imagery Dates: Feb 1, 2007 - Jun 26, 2008
lat 36.555002° lon -78.038735° elev 0 ft
Eye alt 21.68 mi

Methodology

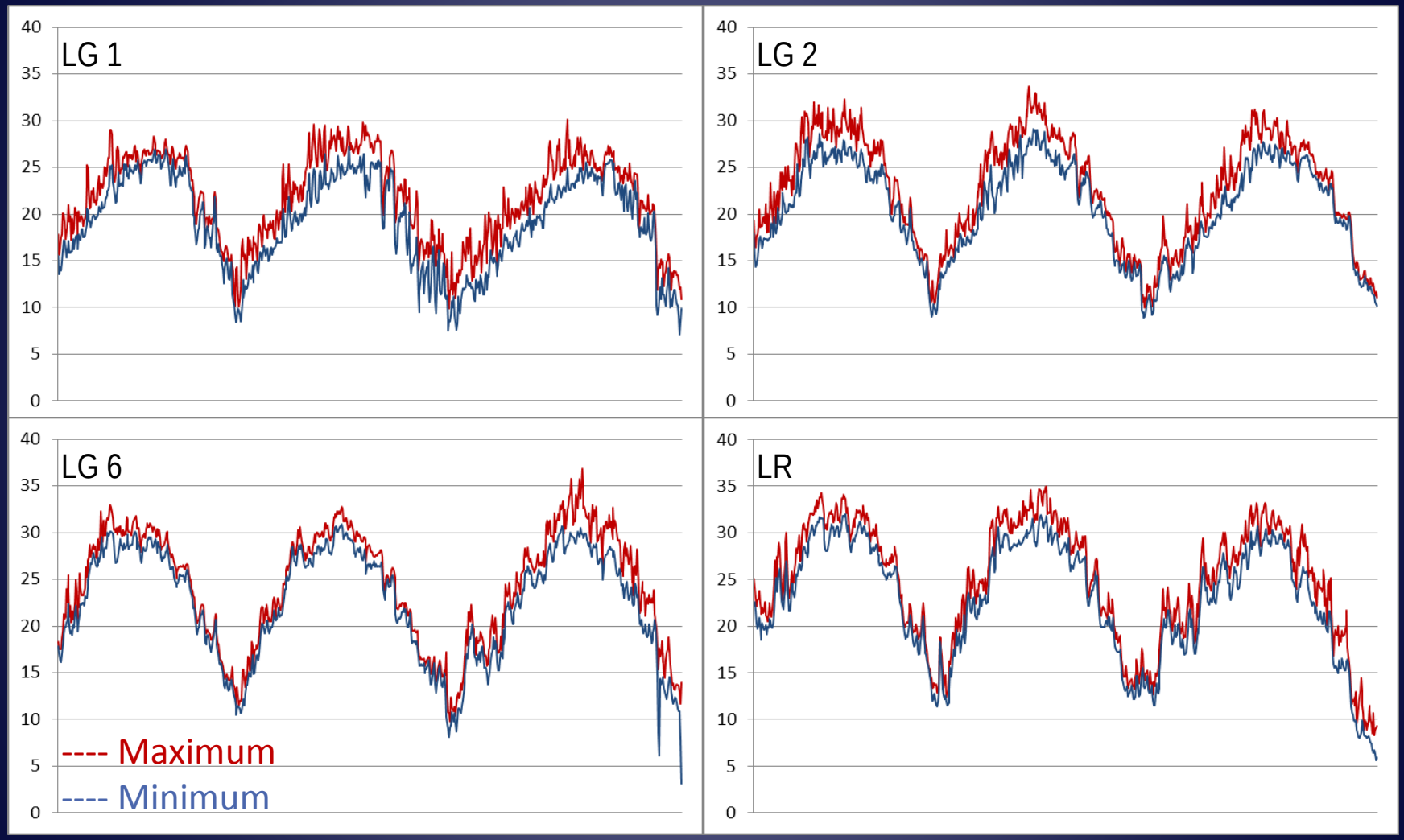
- In March 2010, data loggers were set up at each location and set to record water temperature and light intensity values every four hours throughout the year.
- As there are grass carp present in Lake Gaston, fenced exclosures were built at the study locations around sample points, to allow hydrilla to mature without herbivory.

Methodology

- Sites monitored biweekly from April 2010 until late fall 2010, after hydrilla senesced.
- Data collection:
  - hydrilla life stage
  - sediment core samples
  - measurements of hydrilla growth
- Soil cores were sifted for tuber and turion count, and sprouting of tubers and turions was noted.
- Repeated in 2011 and 2012 on the same locations.

Results

Water Temperature Over Three Years



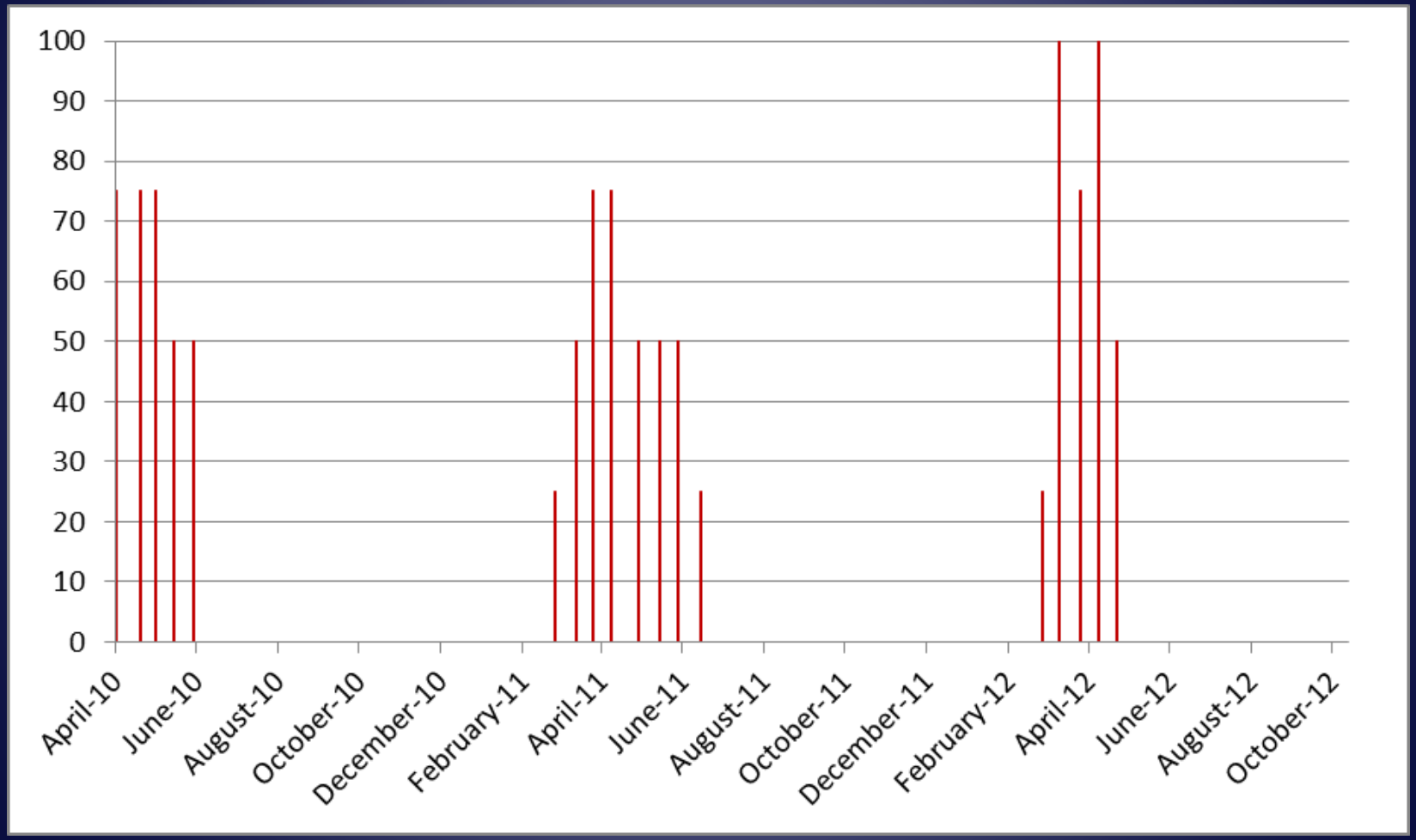
Monoecious Hydrilla Life Cycle Events and Corresponding Water Temperatures Over Three Years at Four Sites in NC

Life Stage	Water Temperature (°C)		
	Mean	Max	Min
Sprouting Turions	17.0	24.5	11.5
Sprouting Tubers	26.2	35.0	16.1
Tubers Forming	24.2	32.3	3.0
Flowering	21.5	27.4	13.7

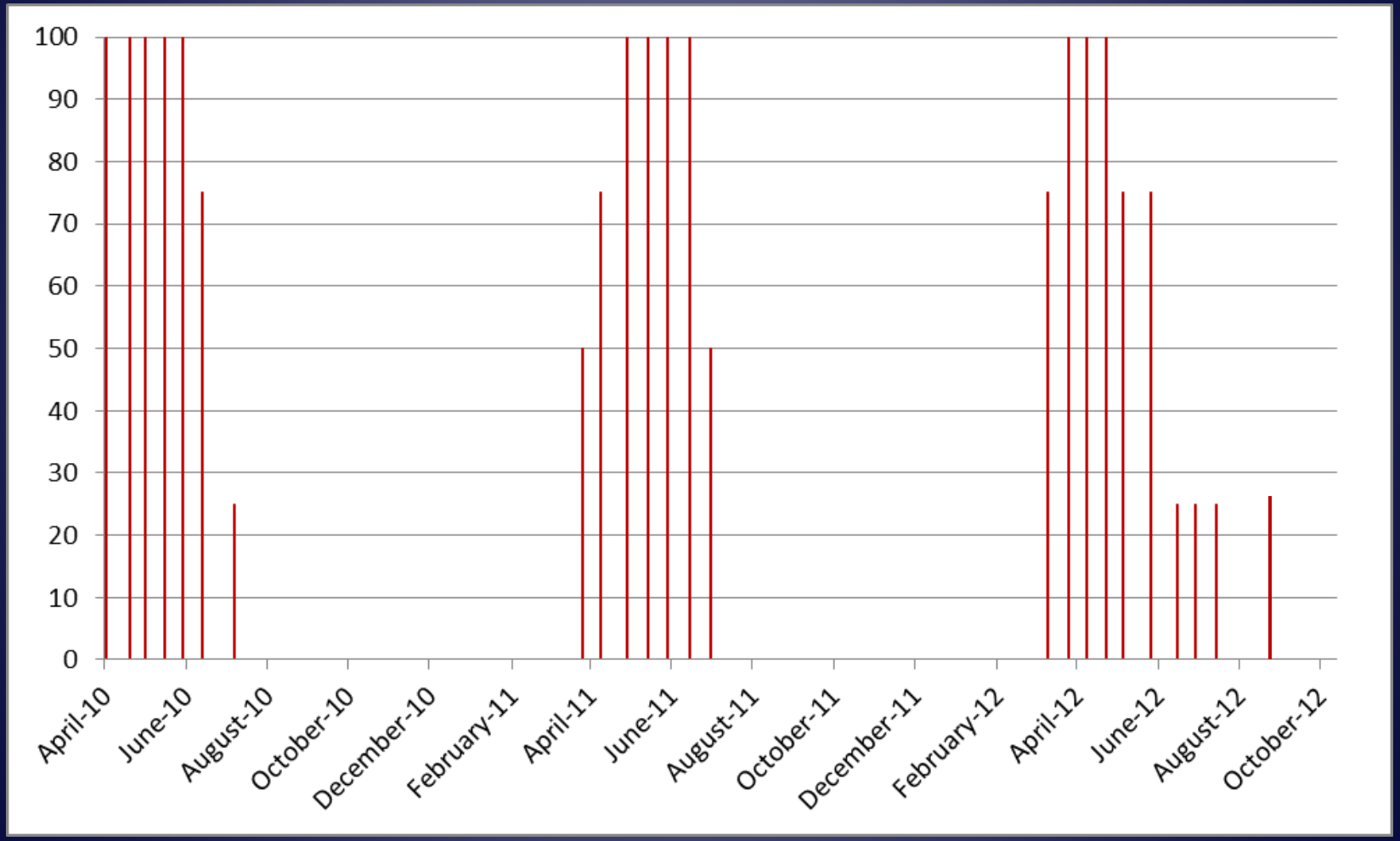
Monoecious Hydrilla Life Cycle Events and Corresponding PAR Over Three Years at Four Sites in NC

Life Stage	Maximum PAR ($\mu mol/s/m^2$)
Sprouting Turions	286
Sprouting Tubers	846
Forming Tubers	385
Flowering	12

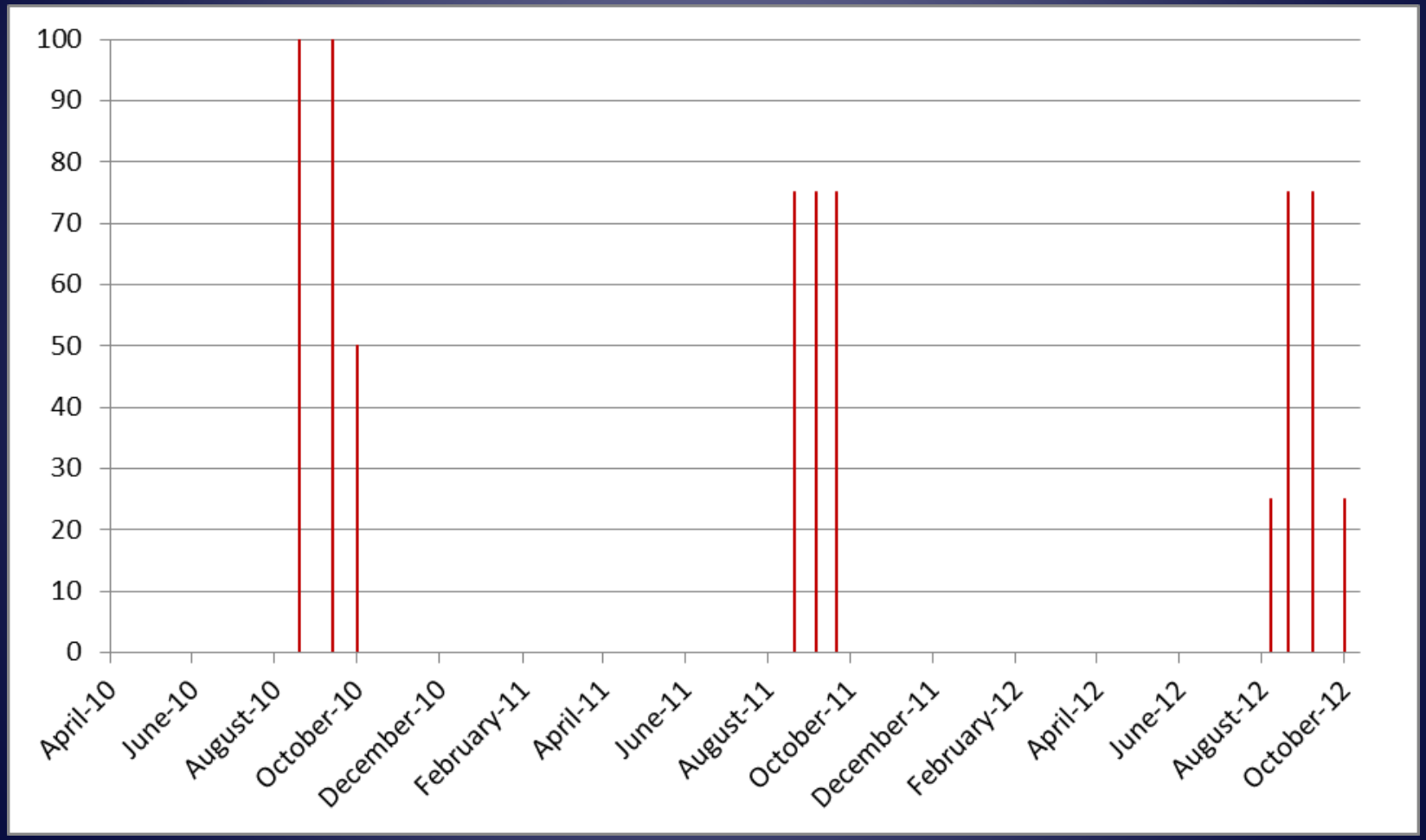
Sites where sprouting turions were found over three years



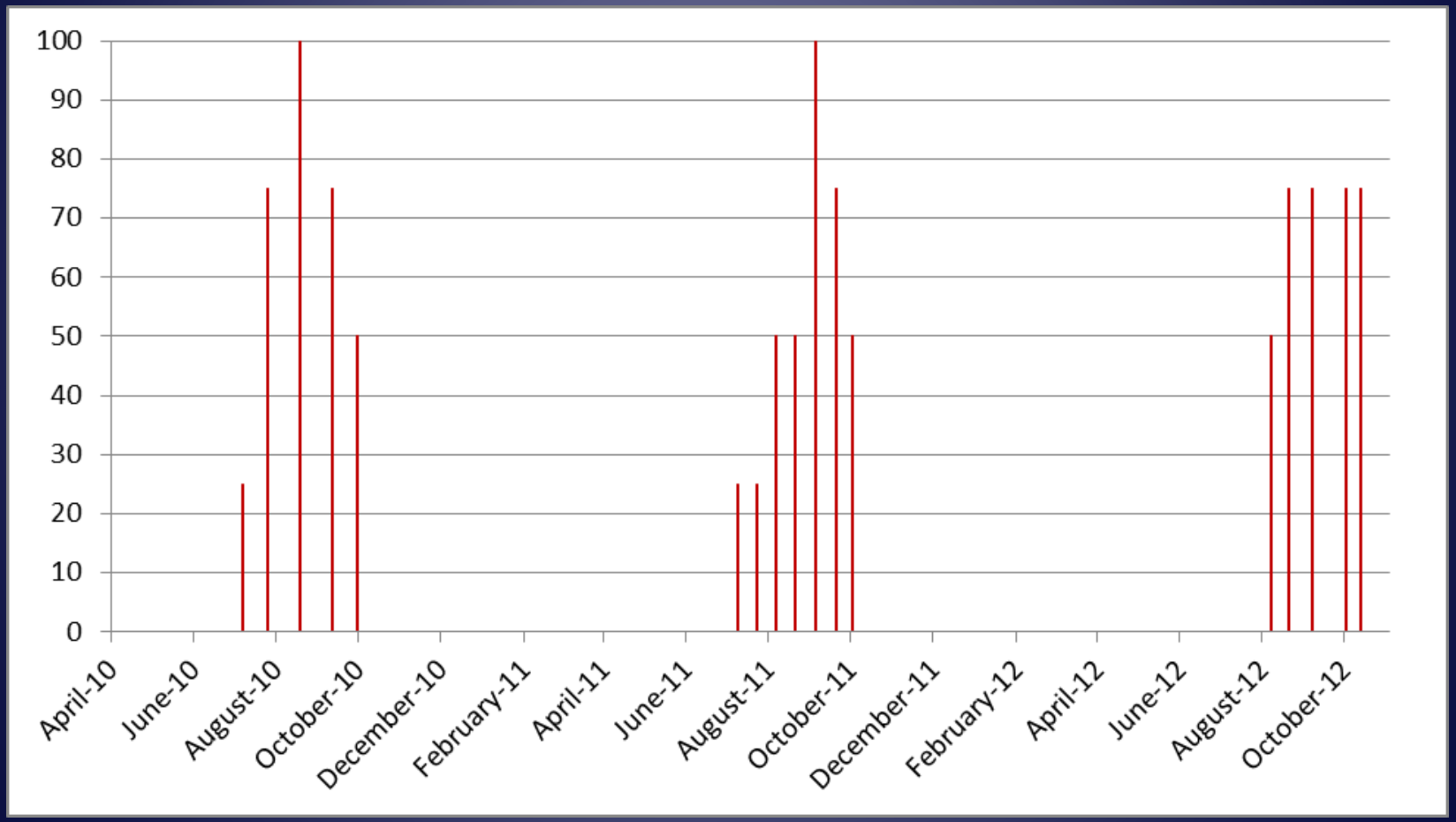
Sites where sprouting tubers were found over three years



Sites where flowers were found over three years



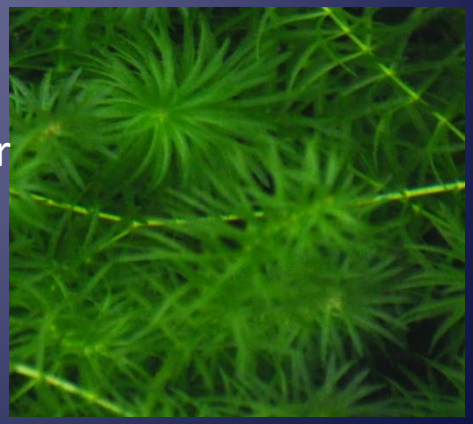
Sites where newly formed tubers were found over three years



Turions Sprout: March- June

Tubers Sprout: March- September

Biomass Increases: March-October



Tubers Form: August-November

Flowers: September-October

Dormant: November-February

Turions Sprout: March- June

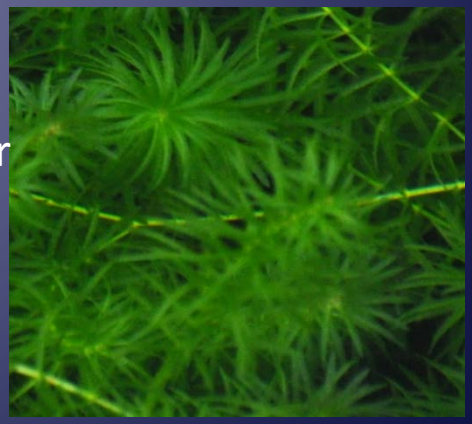
Dormant: November-February

Tubers Sprout: March- September

Tubers Sprout: March-August*

Flowers: September-October

Biomass Increases: March-October



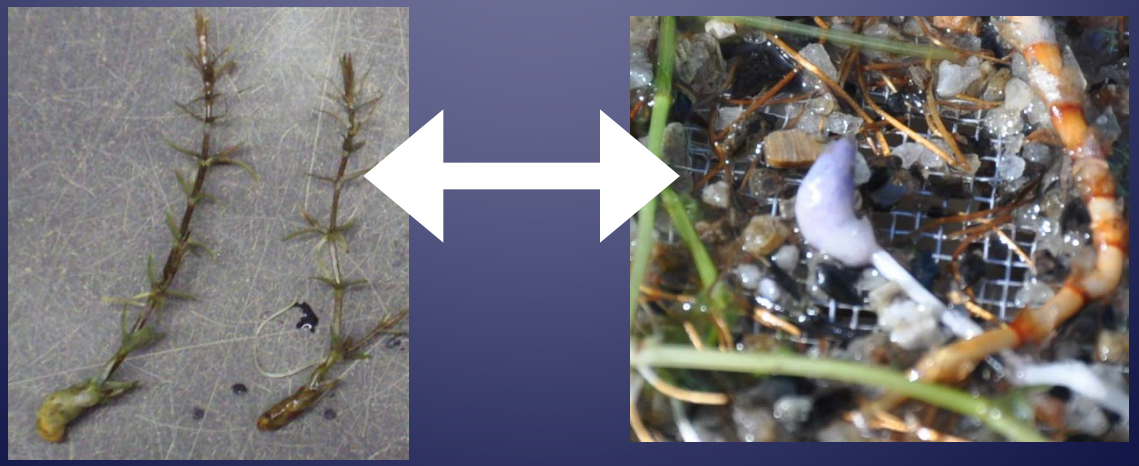
Tubers Form: August-November

Tubers Form: June-October*

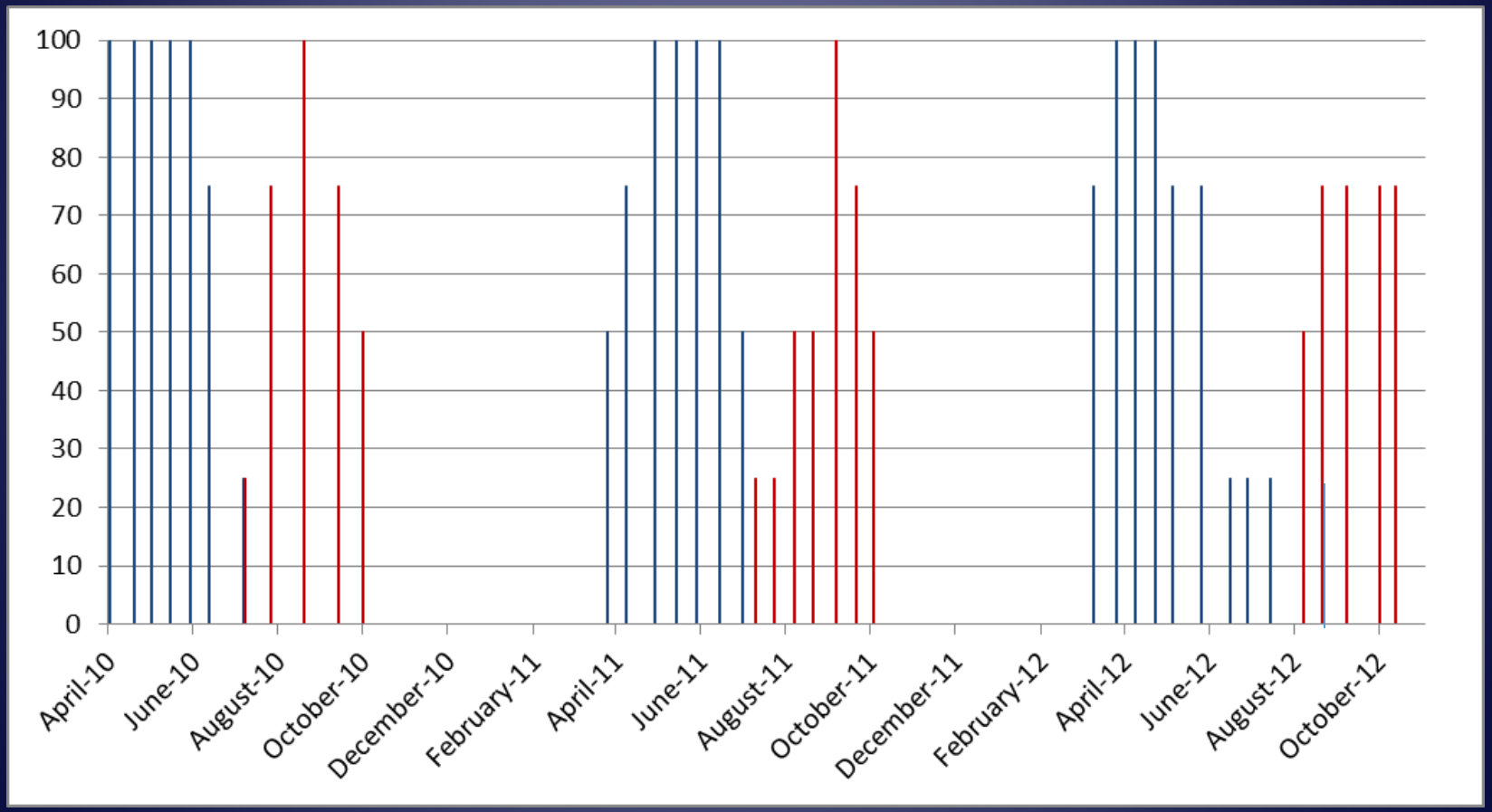
*(Harlan et al. 1985)

What do we know?

- Treatment timing is critical for long term hydrilla management.
- The ideal treatment would eliminate hydrilla biomass between the end of tuber sprouting and the beginning of tuber formation.



Sites where sprouting and newly formed tubers were found over three years



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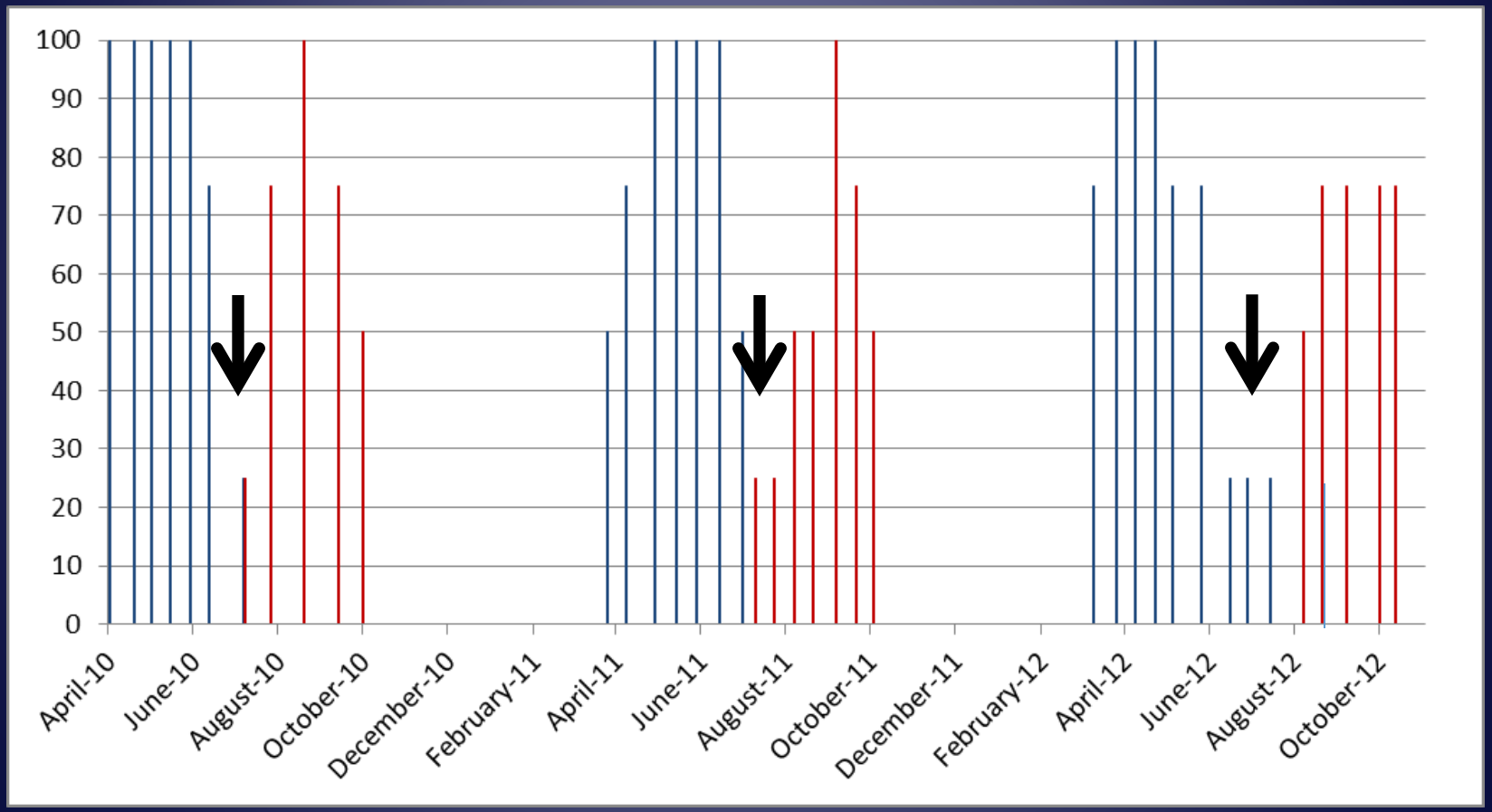

Conclusions

- Our results indicate that a short window is present for an ideal treatment timing that managers can exploit.
- On these two NC lakes, this window occurs around the end of July to early August.

Thank you!

- APMS
- NCSU Aquatics Group

Reference:
Harlan, S. M., G. J. Davis, and G. J. Pesacreta. 1985. Hydrilla in three North Carolina lakes. Journal of Aquatic Plant Management. 23:68-71.