



Nitrogen bioremediation with Phragmites

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Dr. Jamie Vaudrey, University of Connecticut



Funding & Partners

- Edey Foundation Grant 2014
- EPA Healthy Communities Grant 2015
- Jamie Vaudrey, University of Connecticut
- Sheri Caseau & Chris Seidel, MV Commission
- Kristen Fauteux, Sheriff's Meadow Foundation
- Liz Durkee, Oak Bluffs Conservation Commission
- Nathaniel Mulcahy, Worldstove
- Allen Healey & Caitlin Jones, Mermaid Farm



Good water quality is essential to hatchery operations and shellfish restoration



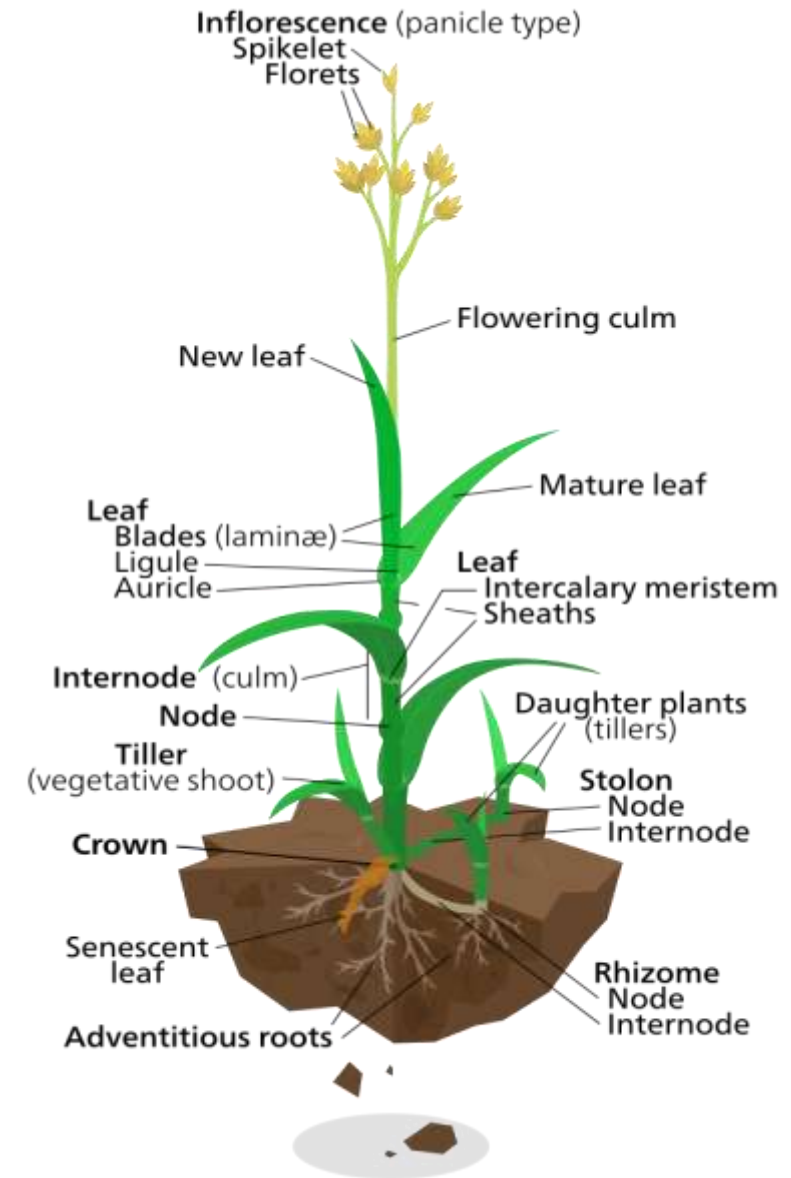
Bioextraction & bioremediation

- Shellfish & seaweed culture
 - Create jobs
 - Invigorate working water fronts
 - Produce food
 - *Require inputs of capitol investment, etc.*
- *Phragmites australis*
 - Wild, **invasive**, already exists all over the place
 - The public and property owners would appreciate it being cut because it blocks their view
 - Does perform ecosystem services



Green-sponge and green-liver

- Requires 50% more N than natives
- 50% more below ground biomass, roots can be 6 feet deep
- Can satisfy up to 42% of nitrogen needs with DON, compared to 24% for *Spartina*
- Can break down CECs (Yujie He et al. 2017)
- Used to clean stormwater and agriculture run off
- Has competitive advantage for light



CUT IT



TAKE IT AWAY



**DO SOMETHING
WITH IT**



**NO PLANTING
NO "ENCOURAGING"**



REMOVE NITROGEN



Many aspects to this project

N content & sequestration

1. Literature review of nitrogen sequestration
2. Bi-monthly plant sampling: June - Oct 2016 & 2017
3. Stalk density surveys
4. Groundwater well monitoring
5. Mapping stands on Chilmark, Farm and Lagoon Ponds

Impacts of harvest

6. Experimental harvest
7. Native plant survey
8. Germination rate of seeds

Product creation

9. Production of pellets from Phragmites and cardboard
10. Palatability of Phragmites to livestock
11. Nutritional and contaminant analysis for animal feed

Tools needed to implement

12. Review and evaluation of the permitting process
13. Water quality monitoring in Chilmark Pond



Questions...

1. What impact does *Phragmites* have on the nitrogen content of groundwater?
2. When is the optimal time to harvest?
3. How much nitrogen is stored in *Phragmites* biomass?

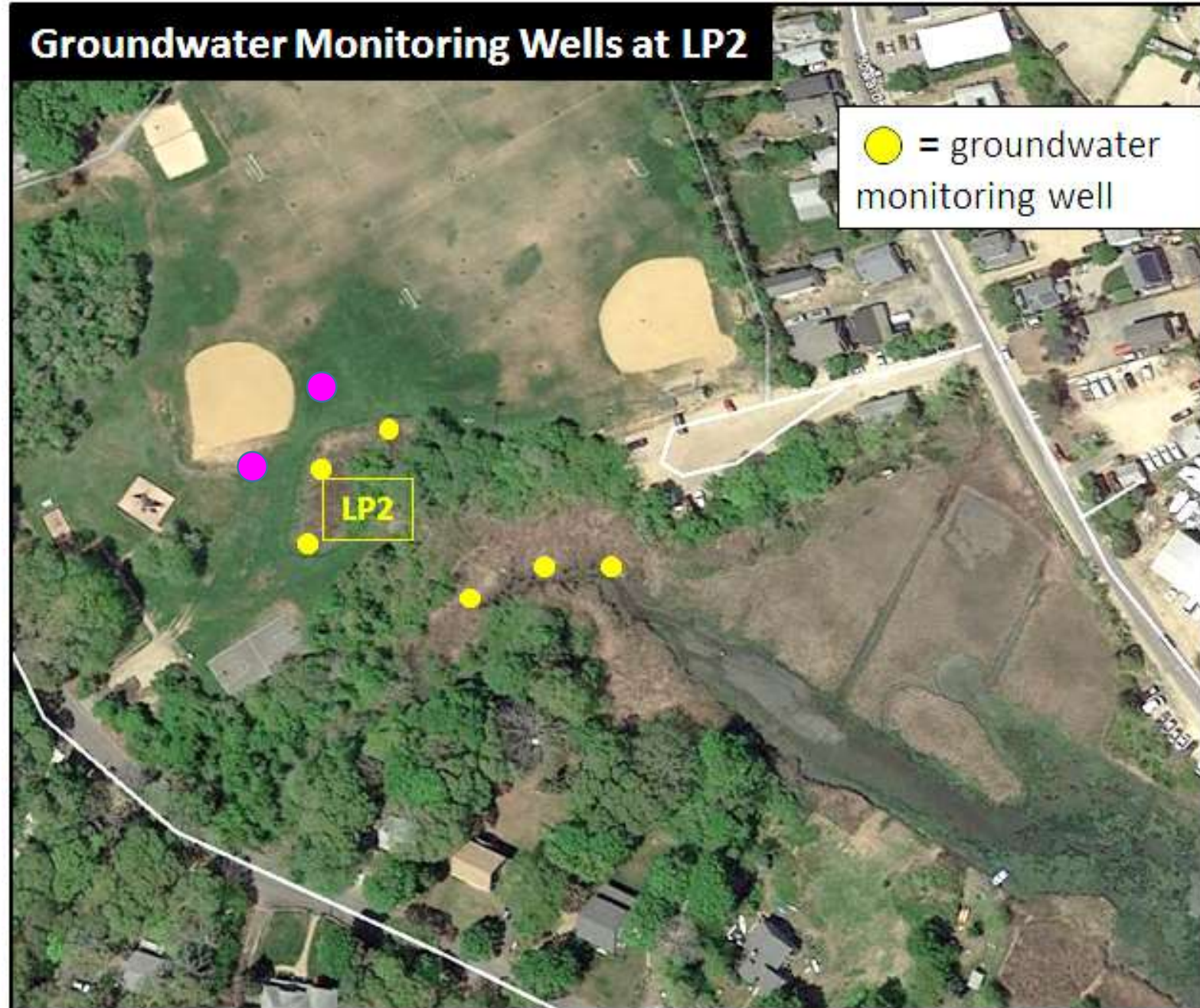
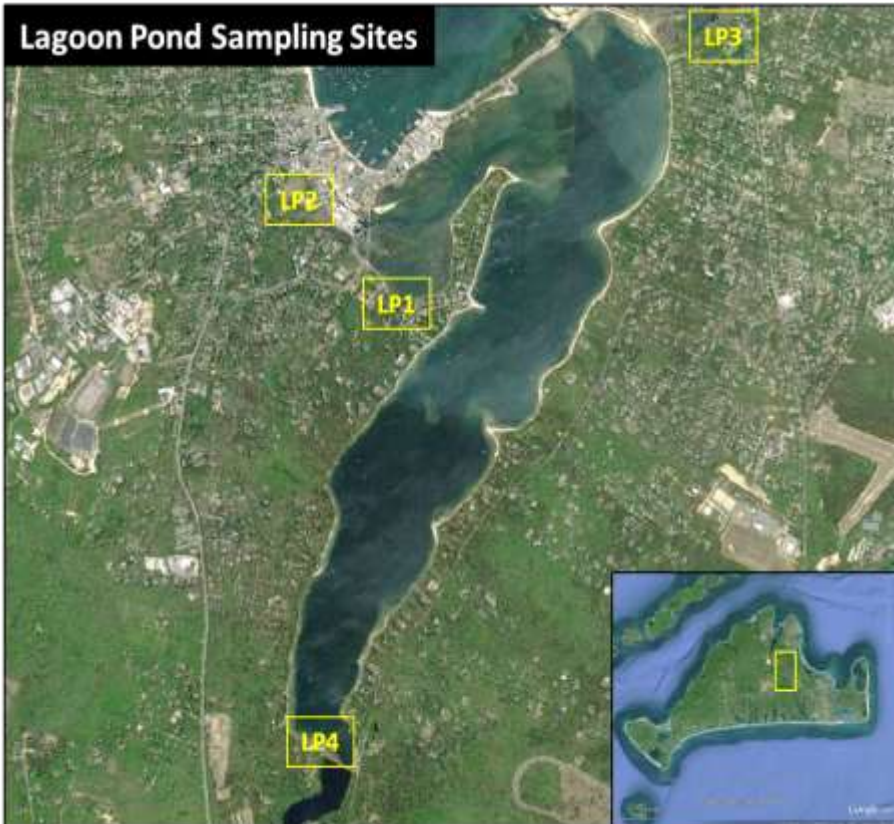


photo courtesy of Jennifer Wozniak, UConn
Lagoon Pond, Martha's Vineyard, MA, 2017

Groundwater Study

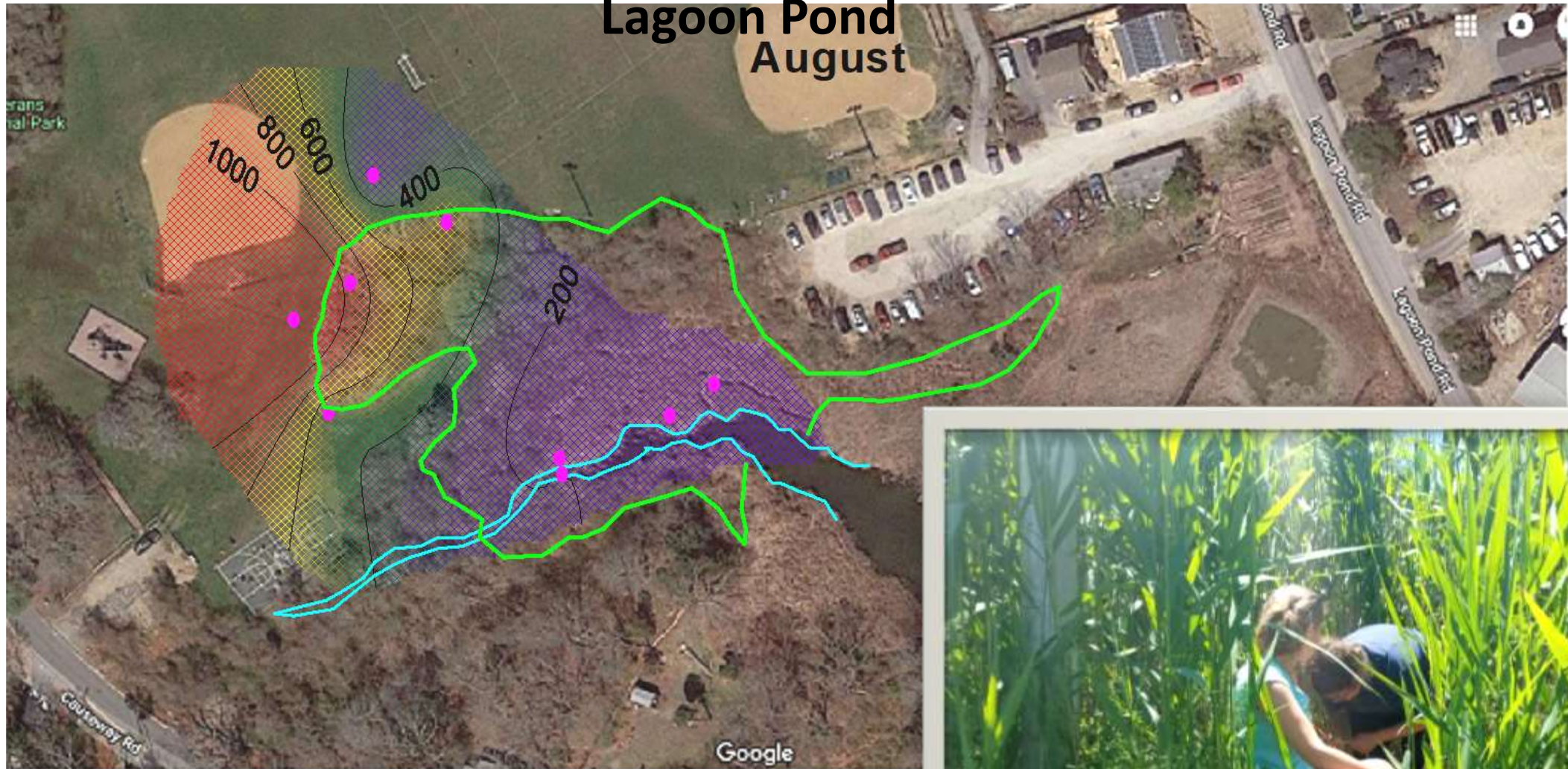
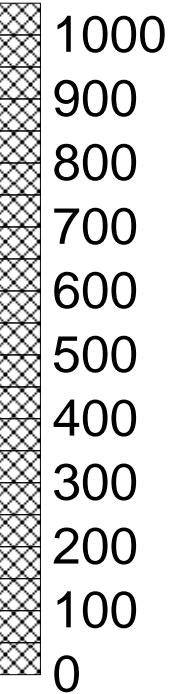
Lagoon Pond

3 dates in 2017, Mar, Jun Aug
- *nitrogen in groundwater*



Lagoon Pond August

TN
(μM)



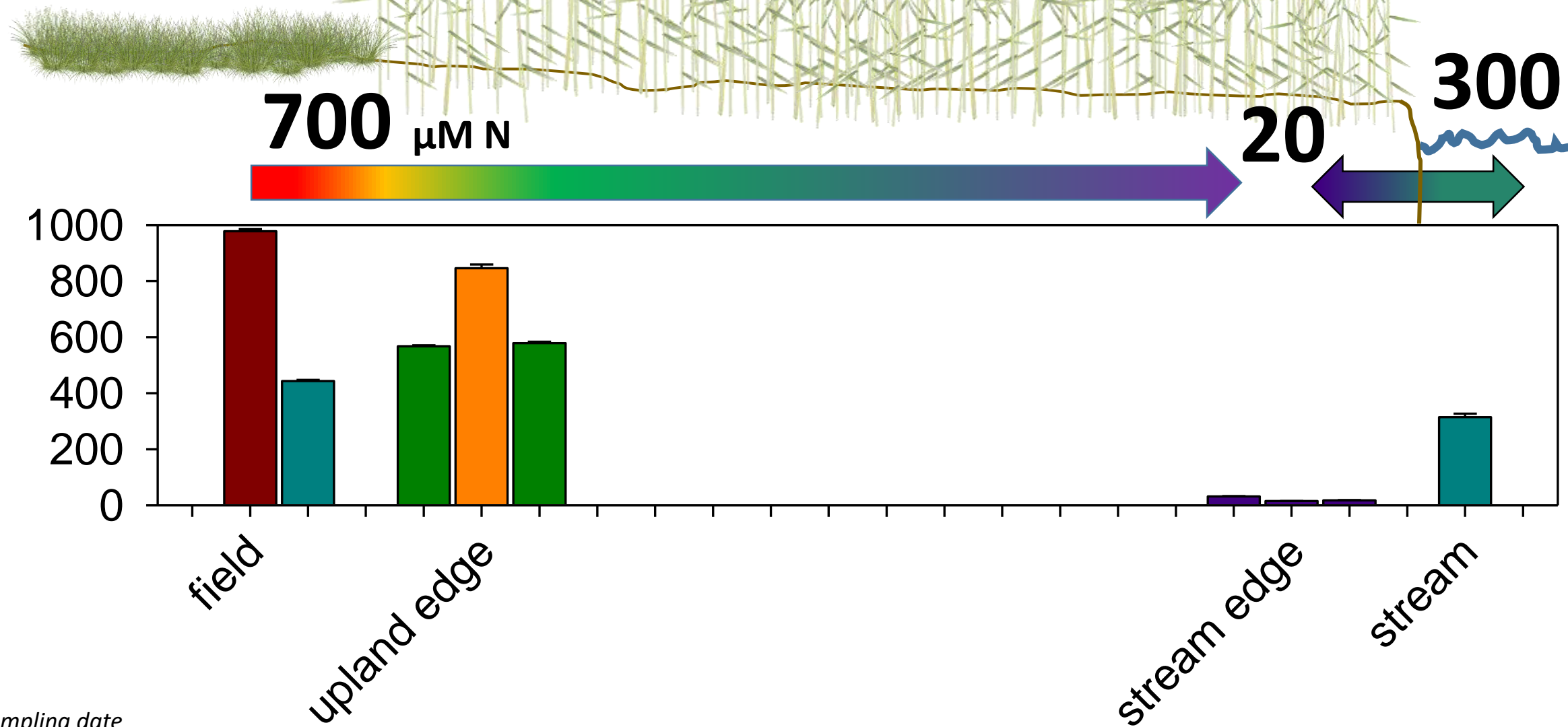
Total Nitrogen in Groundwater
decreases as it flows through *Phragmites*



photo courtesy of Jennifer Wozniak, UConn

Nitrogen in Groundwater

Phragmites removes N from groundwater and estuary water.



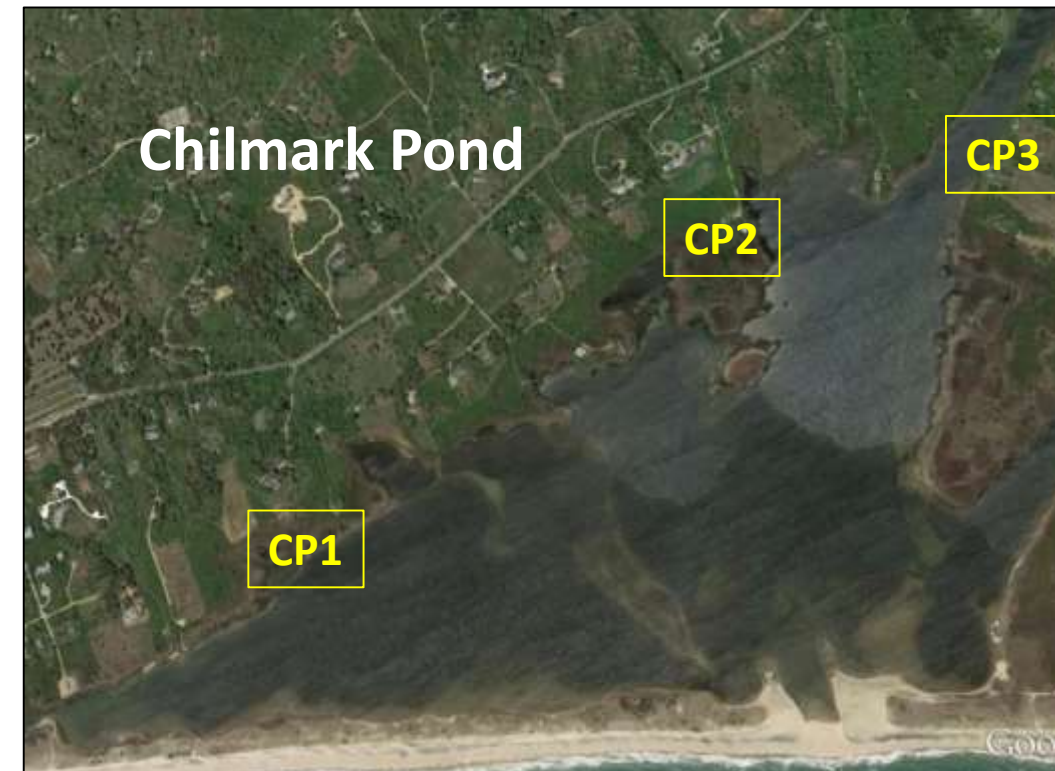
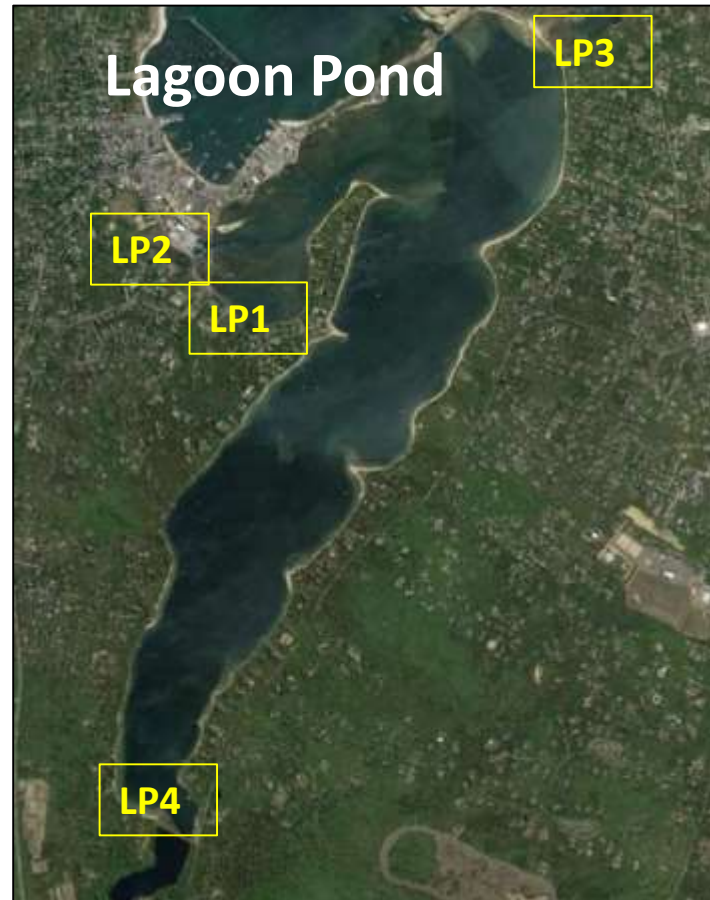
Bi-weekly sampling

June – October 2016 & 2017

1. Size of plants
2. Nitrogen content
3. Seasonal variation

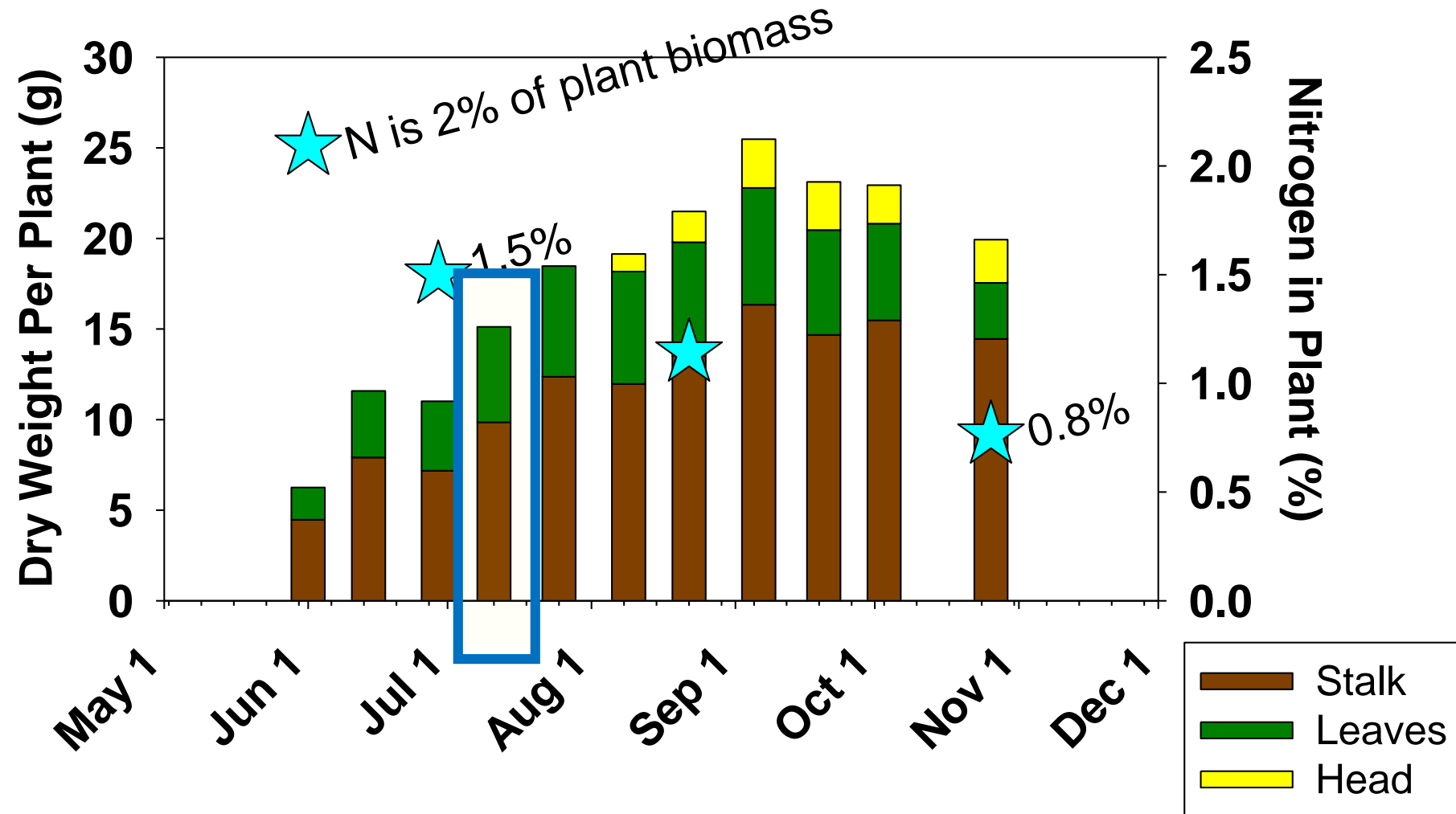


- Plants measured
- Separated leaves, stem and flower
- Wet and dry weights
- Sent to Dr. Vaudrey at UConn



Harvest should be before August 1

- Reduce spread through seeds
- July harvest yields slightly more nitrogen (21% gain) than June
- but at the cost of handling much more biomass (84% increase)



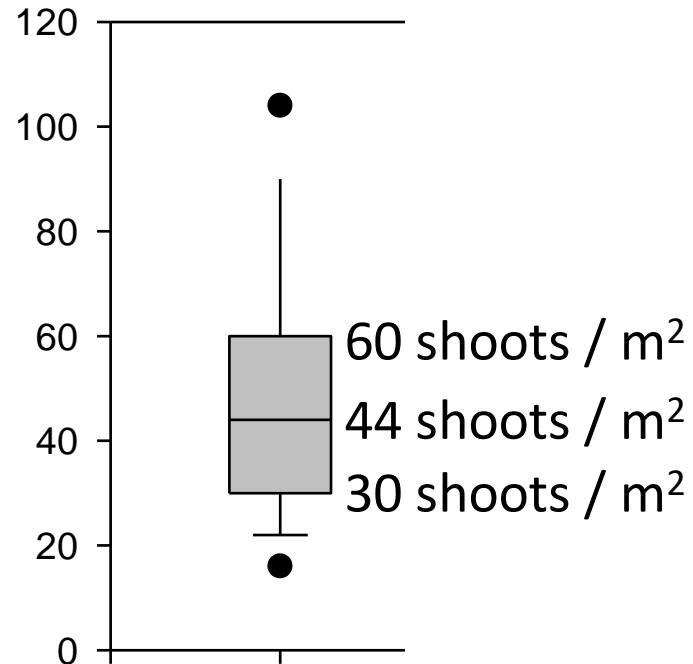
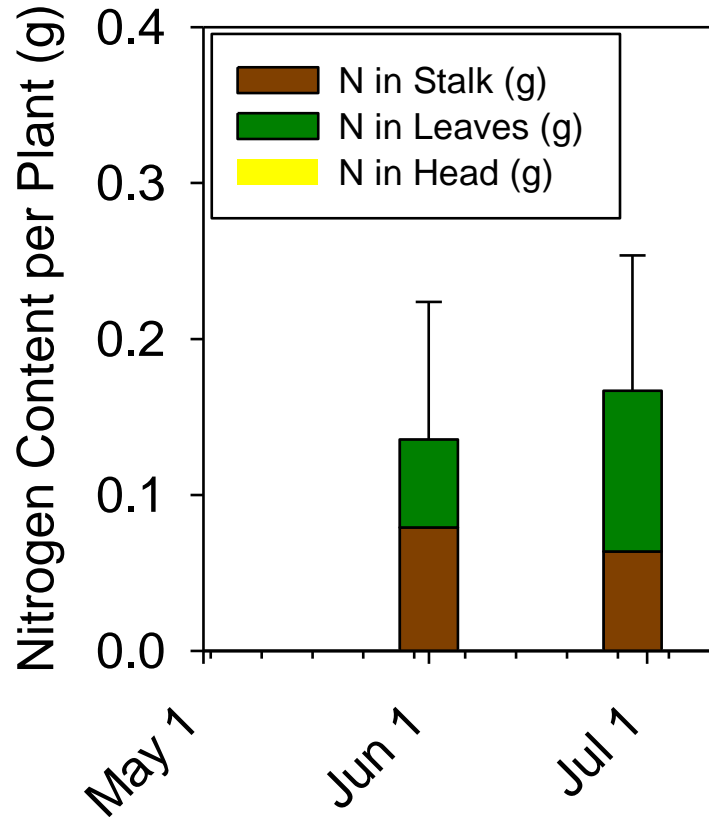
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photo courtesy of Jennifer Wozniak, UConn
Lagoon Pond, Martha's Vineyard, MA, 2017

$\text{N per plant} * \# \text{ plants per square meter} = \text{harvest of N}$

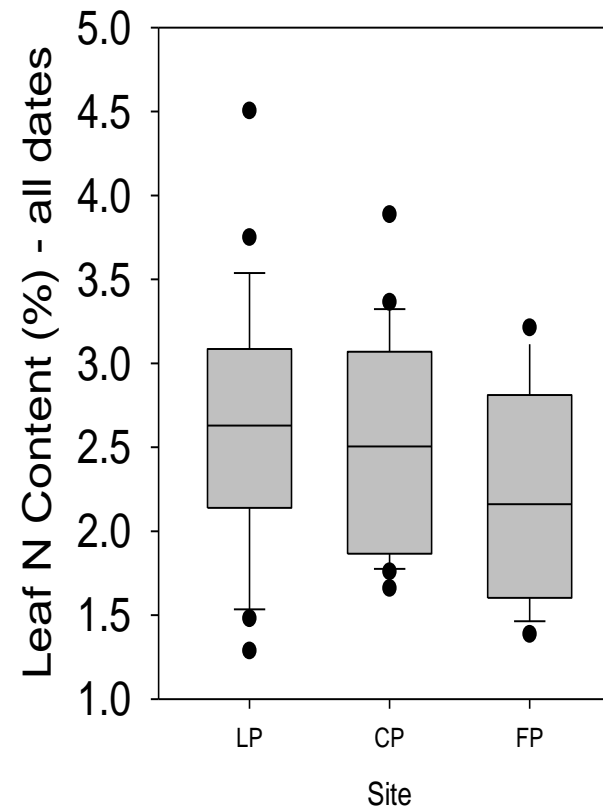
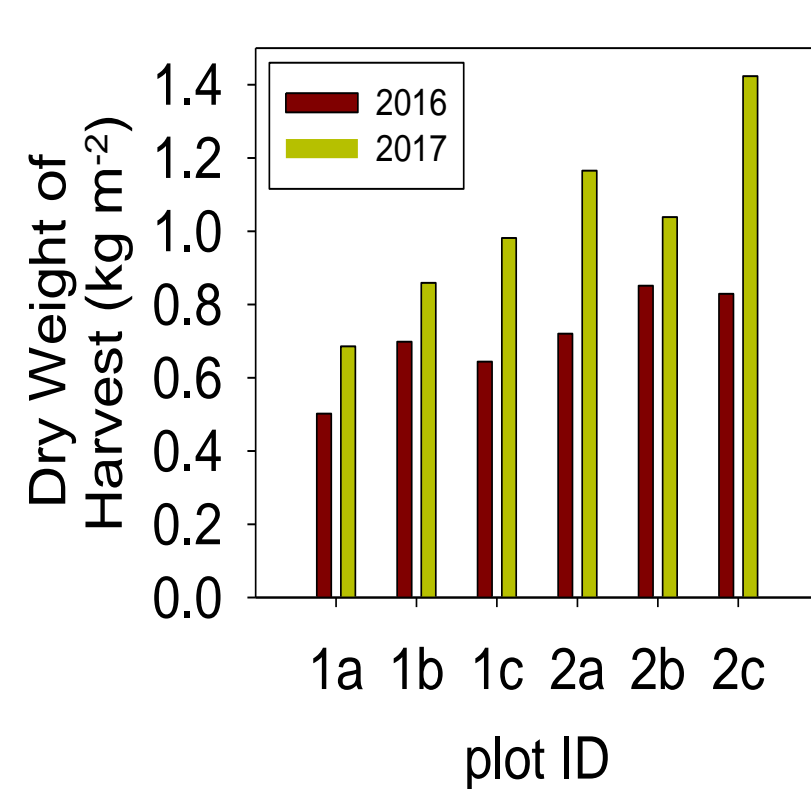


| N per square meter (g N / m ²) | harvest as pounds of nitrogen per acre |
|---|---|
| 6.0 (1.4 – 13.5) | 53 (12 – 120) |
| 7.3 (2.3 – 15.4) | 65 (20 – 137) |

for reference, the load to Lagoon Pond is ~11,000 lb N / y

<http://www.mvtimes.com/2016/05/25/tisbury-proposes-new-development-fees-offset-nitrogen-loading/>

harvest estimate * %N = harvest of N



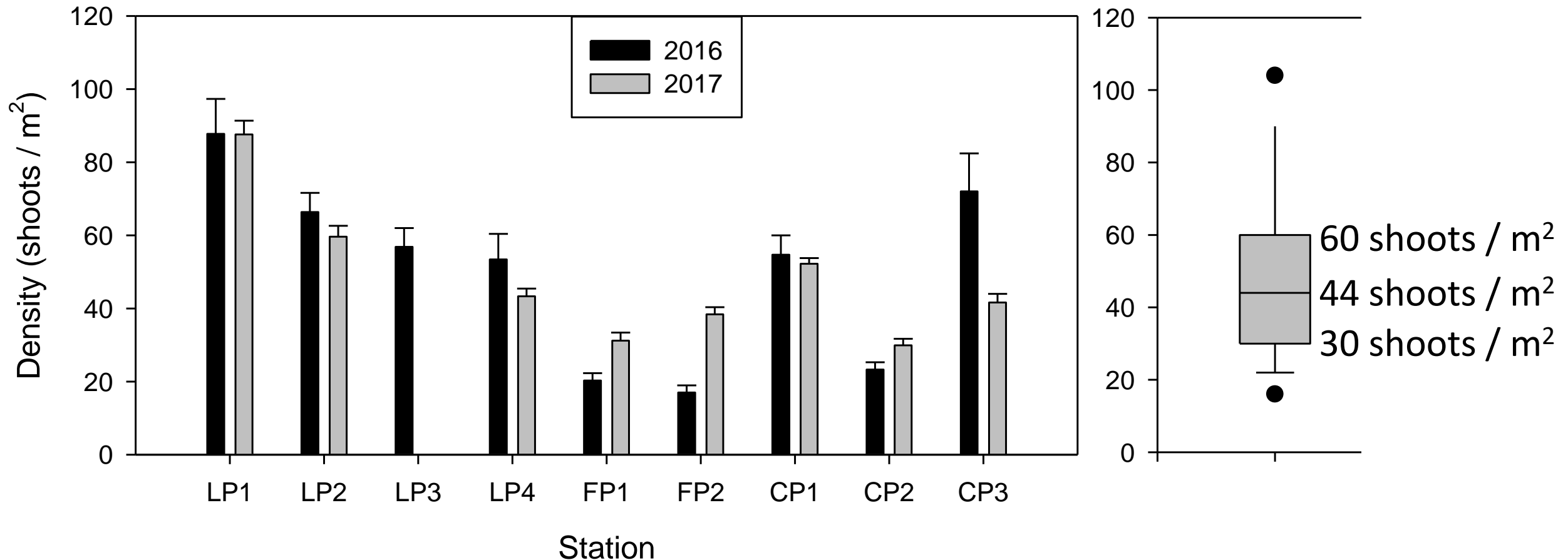
| N per square meter (g N / m ²) | harvest as pounds of nitrogen per acre |
|---|---|
| 11.5 (6.8 – 17.2) | 102 (61 – 153) |

Chilmark Pond at this station had 53 shoots / m², on the high end of the density range of 30-60 shoots/m² with a median of 44 shoots/m².

for reference, the load to Lagoon Pond is ~11,000 lb N / y

<http://www.mvtimes.com/2016/05/25/tisbury-proposes-new-development-fees-offset-nitrogen-loading/>

Density shows significant differences.
of all parameters, this one showed the greatest difference



Nitrogen Harvest Estimates

| | N per square meter (g N / m ²) | harvest as pounds of nitrogen per acre |
|------------------------------|---|---|
| June 1, plant est. | 6.0 (1.4 – 13.5) | 53 (12 – 120) |
| July 1, plant est. | 7.3 (2.3 – 15.4) | 65 (20 – 137) |
| July 27, harvest est. | 11.5 (6.8 – 17.2) | 102 (61 – 153) |

*plant est. = based on the nitrogen per plant * density accounts across Island*

*harvest est. = based on nitrogen per plant * harvest at Chilmark Pond (53 shoots / m²)*

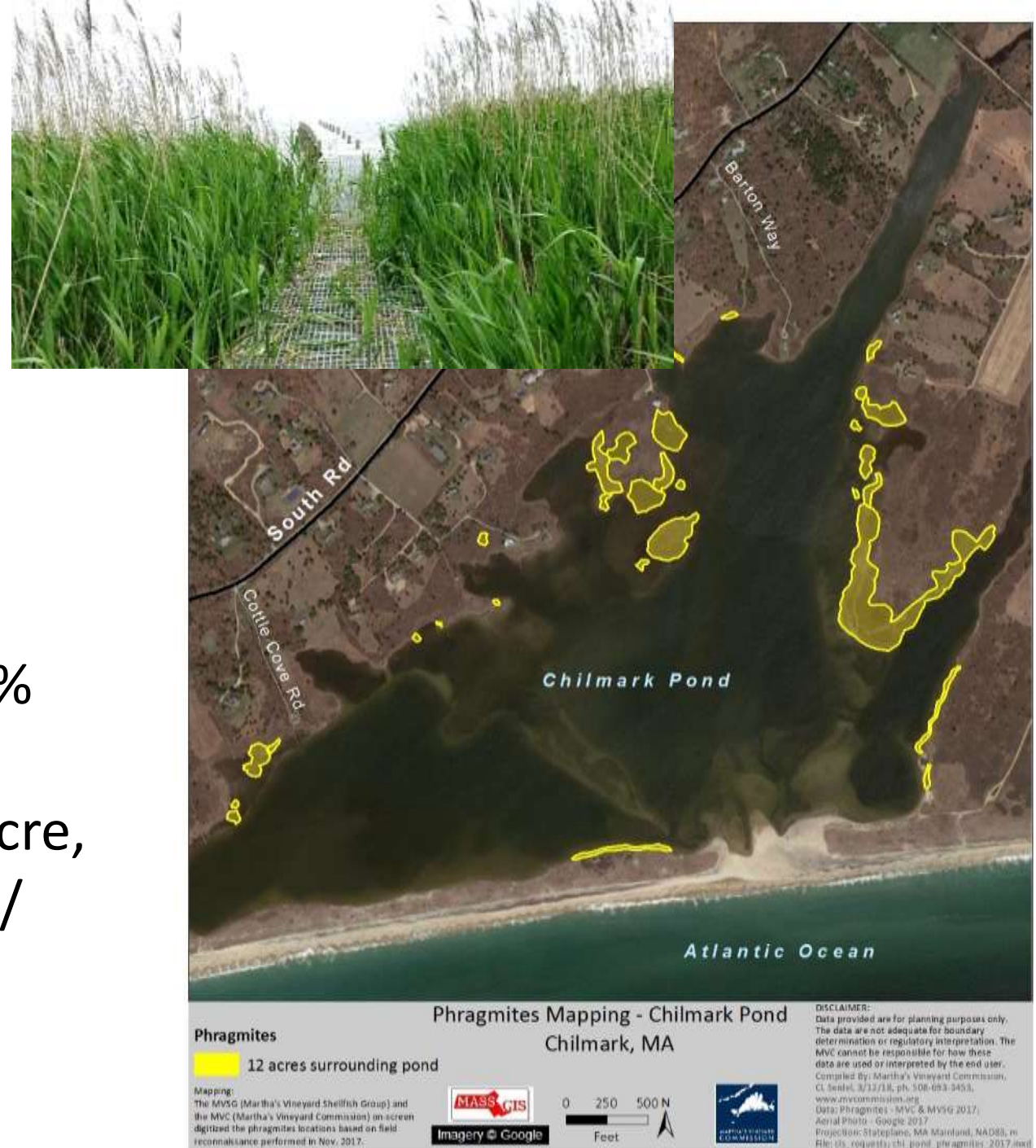
There are ~2 acres in the West Arm of Lagoon Pond

- 60 kg N (maybe as much as 200 kg)
- MEP says that nitrogen inputs to the West Arm needs be reduced by 870 kg N/year
- Harvesting 2 acres of Phragmites could meet 7% of this (or as much as 23%)
- Equal to 200,000 oysters (@0.3gN each)



Chilmark Pond has >12 acres

- Chilmark Pond needs to reduce N inputs by 840 kg N/yr
- 10 acres x 30kg/acre = 300 kg = 35%
- At the highest estimate of 100kg/acre, 8.5 acres could remove all 840 kgN/year



Implementation challenges

- Finding the right equipment for different terrain types
- Should be managed like any other crop to avoid biomass reduction with time
- Who is going to do this?
- How will it be paid for?
 1. Land owners that want a view
 2. Municipality responsible for cleaning the pond
 3. Value added products (compost, animal feed, fuel pellets)



HUGE team effort

Oak Bluffs Conservation Commission
Sheriff's Meadow Foundation
MV Commission
Mermaid Farm
World Stove
Polly Hill Arboretum
Island Grown Initiative, Farm Hub
The Edey Foundation, pilot funding
Tisbury Public Works



Zach Gordon

Jen Wozniak

Marcella Andrews

Chris Edwards

Amandine Surier Hall

Alison Ballek

Lee Faraca

