Phragmites Management in the US: 40 years of Methods and Outcomes

Eric L. G. Hazelton, M.S., Doctoral Candidate in Ecology, Utah State University
Ecology Center, Department of Watershed Science

September 30, 2014

The webinar is listen only. You can listen by phone or through your computer’s speakers.

We will begin shortly!
Phragmites Management in the United States: 40 years of methods and outcomes

Webinar presented to the Great Lakes Phragmites Collaborative September 2014.

Eric Hazelton (USU, Smithsonian)
Karin Kettenring (USU)
Dennis Whigham (Smithsonian)
Thomas Mozdzer (Bryn Mawr)
Thanks!

- Kettenring Lab
- Whigham Lab
- GLPC
- Amanda Sweetman
Part 1. Review of Phragmites management in the US

Part 2. How might land use impact management outcomes

Part 3. Some insights into simplified monitoring
Origins

- Prague Symposium organized by Dennis and others.
- Compared EU to US
- Resulted in numerous reviews
- Represents state of knowledge in both native and introduced range.
Invited Review
SPECIAL ISSUE: Phragmites australis in North America and Europe

Ecosystem services of Phragmites in North America with emphasis on habitat functions
Erik Kiviat*

Open access – Review
THIS ARTICLE IS PART OF A SPECIAL ISSUE ENTITLED ‘PHRAGMITES AUSTRALIS IN NORTH AMERICA AND EUROPE’

Hybridization of common reed in North America? The answer is blowing in the wind
L. A. Meyerson1,2*, C. Lambertini3, M. K. McCormick4 and D. F. Whigham4

Invited Review
SPECIAL ISSUE: Phragmites australis in North America and Europe

Physiological ecology and functional traits of North American native and Eurasian introduced Phragmites australis lineages
Thomas J. Mozdzierz*, Jacques Brisson2 and Eric L. G. Hazelton1,3
Review methods

• Comprehensive review of Phragmites management in US
• 1960-2013
• Google Scholar and ISI Web of Science
• Keywords: “Phragmites management” and “Phragmites control”
• 41 Articles included
Duration of studies

- More than 5 years: 5/41
- Majority only report ≤3 years of data post treatment.
Variables recorded

- **Phragmites** alone or functional vegetation: 21/41
- Species composition: 5/41
- Seedbank: 4/41
- Community statistics: 0/41
Methods tested

- Herbicide: 27
- Mowing/cutting: 15
- Grazing: 2
- Manual: 1
Mechanical Methods

- Mowing most prevalent
- Often used in combination with herbicides
- Need to open canopy to stimulate recruitment
- Can act as a disturbance!
Biological Methods

• Grazing
  – Silliman et al. PeerJ

• “Traditional” biocontrols

• Planting diverse functional types!!
  – Makes site resistant to reinvansion (Byun et al.)
Herbicides tested

- Low concentrations effective
- Only 1 study compared combo
- Two studies went “off-label”
Herbicide Methods

• Most methods fairly successful
• Management typically 3 years to in perpetuity.
• Several studies report that mowing/grazing/burning is required for vegetation recovery
Summary Part 1

• Too much emphasis on herbicide
• Emphasis on herbicide reflected in surveys
  – Martin and Blossey
  – Kettenring et al.
• Studies are too short of duration
  – reinvasion
  – lag times
• Only measuring species of interest
• Variables recorded reflect bias toward habitat for fish and game
• Nearly zero knowledge on community recovery
• Need to incorporate reference areas
Part 1. Review of Phragmites management in the US
Part 2. How might land use impact management outcomes
Part 3. Some insights into simplified monitoring
Components of Phragmites Invasion

- Seed Quantity
  - Genet Diversity, Outcrossing Potential
  - Germination & Recruitment
  - Seed Viability
  - Stand Age
  - Herbivory
  - Nutrients
  - Physical Disturbance
Nutrients

• Nutrient increase clone number
  – McCormick *et al.* ‘10a & b

• Nutrients increase seed production
  – Kettenring and Whigham ‘09
  – Kettenring *et al.* ‘10

• Nutrients cause “explosive growth”
  – Saltonstall and Stevenson ‘07

• Nutrients increase Phragmites biomass
  – Mozdzer *et al.* ‘10
Land Use and Buffers

- Nutrient rich watersheds (developed and agriculture) have more *Phragmites*  
  — King *et al.* 2007
- *Phragmites* associated with lawns that lack forested buffer  
  — Bertness and Silliman
- Adjacent land use impacts *Phragmites*  
  — Chambers *et al.* 2009
Disturbance

- Wrack
- Construction
- Seeds
- Rhizomes
Can We Consider Land Use in Management?

- *Phragmites* is only a symptom.
- We do not know how land use will impact restoration outcomes.
- How do we bridge the gap between the science of invasive species and the management?
- Need to prioritize which areas we manage.
- Some areas are likely better off left in the alternative (invaded) state.
What are we doing?

- Large-scale removal experiment
- Looking at how land-use impacts recovery from *Phragmites* invasion
- 9 marshes
  - 3 agricultural
  - 3 developed
  - 3 forested
- 3 treatments
  - *Phragmites* removed
  - *Phragmites* intact (control)
  - Native vegetation (reference)
Methods

- Glyphosate Spraying
  - Helicopter sprayed Oct ‘11
  - Hand sprayed Oct ‘12-’13

- Measuring
  - Plant community
  - Seedbank
  - Nutrients
  - Reproductive output
  - Germination rates
  - Herbivory
  - Clonal richness
Phragmites Vigor
Flowering

Flowering rates of non-attacked stems differed pre-treatment by land-use type but not post-treatment.

<table>
<thead>
<tr>
<th>2011 Factor</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Land-use</td>
<td>5.9</td>
<td>0.04</td>
</tr>
<tr>
<td>Treatment * Land-use</td>
<td>4.6</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2012 Factor</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2.8</td>
<td>0.1</td>
</tr>
<tr>
<td>Land-use</td>
<td>1.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Treatment * Land-use</td>
<td>0.03</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Inflorescence Size

<table>
<thead>
<tr>
<th>Factor</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>3.1</td>
<td>0.08</td>
</tr>
<tr>
<td>Land-use</td>
<td>0.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Land-use * Treatment</td>
<td>0.9</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Inflorescences are larger in control treatment than in sprayed plots.
Plants in control plots produced more florets than sprayed plants.
Nutrients
PO$_4$ varies by land use, but not vegetation. This is likely the result of improve wastewater practices in developed regions.

<table>
<thead>
<tr>
<th>Factor 2011</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>1.3</td>
<td>0.26</td>
</tr>
<tr>
<td>Land-use</td>
<td>4.0</td>
<td>0.004</td>
</tr>
<tr>
<td>Land-use * Treatment</td>
<td>6.2</td>
<td>0.03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor 2012</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>1.3</td>
<td>0.29</td>
</tr>
<tr>
<td>Land-use</td>
<td>3.3</td>
<td>0.12</td>
</tr>
<tr>
<td>Land-use * Treatment</td>
<td>2.0</td>
<td>0.09</td>
</tr>
</tbody>
</table>
Nutrient Resin NH$_4$

NH$_4$ varies by landuse and by vegetation. There is less ammonium under *Phragmites* than native vegetation. There is higher ammonium in developed watersheds.

<table>
<thead>
<tr>
<th>Factor 2011</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>5.7</td>
<td>0.004</td>
</tr>
<tr>
<td>Land-use</td>
<td>6.4</td>
<td>0.03</td>
</tr>
<tr>
<td>Land-use * Treatment</td>
<td>4.0</td>
<td>0.004</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor 2012</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>3.7</td>
<td>0.03</td>
</tr>
<tr>
<td>Land-use</td>
<td>0.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Land-use * Treatment</td>
<td>1.5</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Plant Community Recovery
Vegetation is not returning to the uninvaded communities. Transition to a “novel state”
Rhode River (Mixed-Developed)

Vegetation is transitioning to the uninvaded communities.
Sites with vegetation Overlap
Developed Sites

Severn

Rhode

Patapsco

Sights with more intact native vegetation recover better after management
Management Implications

- Perennial plants may colonize later than annuals, but initially management is a disturbance.
- Substrate is likely to impact outcome:
  - Breakdown of peat (phrag rhizomes)
  - Sandy sites may recover better
- Fetch may help in clearing canopy.
- Consider potential for total wetland acre loss in some sites:
  - Phrag → Pontederia!
  - Subsidence
  - We hope to draw further conclusions on this!
- Sites with native peat/rhizome matrix should retain integrity better than large monocultures:
  - Higher quality sites
Summary Part 2

• Nutrient and disturbance control (watershed and landscape scale) will benefit management
• Working Hypothesis: Transition to reference state requires intact native marsh surrounding Phragmites
• Two more years of data pending
• Site selection is likely critical
  – Early Detection, Rapid Response
  – Restore higher quality sites
  – Haphazard management may result in marsh loss (substrate breakdown)
  – Ecosystem services of invader
  – Management outcomes may not be desirable
  – Allocate resources to higher quality areas that are more likely to recover
• Some watersheds should be left in alternative stable state
Part 1. Review of Phragmites management in the US
Part 2. How might land use impact management outcomes
Part 3. Some insights into simplified monitoring
Simplified Monitoring Technique

• Goal: rapidly determine plant health in response to management
• Grasses do not have “secondary thickening”
  – Basal diameter can predict biomass potential
• Insect damage changes stems
  – *Lipara* flies stunt stems
    • Attack rates up 90%
    • Abort inflorescences
  – *Giraudiela* Impact biomass production
Simplified Monitoring Technique

- Stem Biomass vs Stem Diameter
- Only flowering stems included
- Preliminary data
- No attacked stems

\[ R^2 = 0.8061 \]
Add stem diameter to monitoring programs!

• Stem Height vs Stem Diameter
• Only flowering stems included
• Preliminary data
• No attacked stems

$y = 29.545x + 23.181$

$R^2 = 0.6939$
Summary Part 3

• Add stem diameter to monitoring variables
• Faster and more accurate than height
  – Removes bias caused by herbivory
• Predictive of biomass
• Combine with stem counts (live) for broader estimates of management impacts
Conclusions 1

• Monitor
  – Use effective, sound science
  – Streamline methods for efficiency
  – Incorporate reference sites
  – Increase duration
  – I am not naïve, I know $$ is a problem

• Need more research on community response
  – Do wetlands recover to their native state?
Conclusions 2

• There is a knowledge gap in non-chemical *Phragmites* management

• Some watersheds should be left in alternative stable state
  – Ecosystem services of invader
  – Management outcomes may not be desirable
  – Allocate resources to higher quality areas that are more likely to recover
Questions?
Works Cited

• Kiviat, Erik. "Ecosystem services of Phragmites in North America with emphasis on habitat functions." AoB Plants 5 (2013): plt008.
Q & A

Eric L. G. Hazelton, M.S.

Doctoral Candidate in Ecology
Utah State University
Ecology Center
Department of Watershed Sciences
eric@hazelton-ecological.com
THANK YOU!

Great Lakes Phragmites Collaborative: www.greatlakesphragmites.net
email: phragmites@glc.org
Twitter: GLPhragCollaborative (@GLPhrag)
Facebook: Great Lakes Phragmites Collaborative