Effects of invasive *Phragmites australis* & control actions on biotic communities in a World Biosphere Reserve

Courtney Robichaud
Dr. Rebecca Rooney
Lake Erie Coastal Marsh

Long Point

Rondeau

> 80% of the remaining marsh on the North shore of Lake Erie

American Lotus

Hognose

Least Bittern

Horsetail

Spike-rush

Spotted Turtle

Giant Silk Moth
Phragmites most often replaced Typha spp. and meadow marsh. 90% of stands were non-native strains of *P. australis* (Wilcox et al. 2003). Still rapidly expanding, no predicted decrease in rate (Jung et al. 2017. *Wetlands*)
Large scale herbicide treatment

Goal to reduce invasive *Phragmites australis* population in coastal marshes, and allow native vegetation to recolonize treated areas

Primary treatment: herbicide
Secondary treatment: cutting, rolling and/or burning

- 2016 – primarily aerial application
- 2017 – primarily ground application
Research Objectives

Objective 1. Treatment efficacy
  1a. *Phragmites australis* population control and recovery of native marsh vegetation
  
  1b. Effects on wetland bird community

Objective 2. Fate and effects of herbicide
  
  • Maximum concentrations, transport and degradation
Objective 1a. *P. australis* control and native vegetation recovery

80 sites total:
- 40 sites with no herbicide (control)
- 40 sites with herbicide (treatment)
  - Long Point; secondary treatment
  - Rondeau; no secondary treatment

Water depth gradient

Application began in September 2016

Sampling happens in August and early September 2016, 2017 and 2018
99.7% reduction in live stem density Y1

Treatment x year interaction

No effect of water depth

Baseline

Baseline

1 year

1 year

Fewer stems = fewer flowers

• Treatment x year interaction ($p < 0.001$)

• No effect of water depth ($p > 0.175$)
Sites are still dominated by a few abundant species.

Slight improvement in treated areas after two years.
Vegetation community changes

NMDS ordination, final stress = 17.5
High water levels slow recovery of native species

Slow recovery and not returned to reference levels in 2 years

- More open water and more floating & submersed veg
- European Frog-bit
  - Secondary invasion
Objective 1b. Invasion and bird communities: A time-lag in *Phragmites* invasion effects

Replicated a study conducted in the early stages of invasion

Early invasion
Contributes to meso-scale habitat diversity

Late stage invasion
Homogenous structure

Adapted from Theoharides and Dukes (2007) *New Phytologist*; inset: Wilcox et al. 2003

**Phragmites** alters wetland bird communities

- **Phragmites** excludes marsh birds of conservation concern
  - Supports hybrid of generalists and widespread marsh-nesters found in meadow and cattail marsh

Invasion reduces foraging activity by aerial insectivores?

Influence of invasion and *P. australis* control on aerial foragers

Is prey quality (size) or quantity (number) driving differences in foraging activity?

1) Does invasive *P. australis* reduce prey quality/quantity and affect foraging activity?

2) Does *P. australis* control affect prey quality/quantity and foraging activity?
2017 and 2018 field methods

• 3 treatments: *Phragmites* invaded, resident veg, herbicide-treated
• 9 sites each, across a water depth gradient (0-100 cm)
Aerial foragers use invaded habitat less often

2017

Aerial forager abundance

Invaded  Treated  Meadow  Cattail

2018

Barn Swallow abundance

Invaded  Treated  Meadow  Cattail

James Hawley...
Prey quality and quantity
2017 data

More individuals emerged in treated habitat

Larger prey items in meadow and cattail

Error bars = standard error

Macroinvertebrate Count

Macroinvertebrate length (mm)

n = 9
n = 9
n = 4
n = 5

Invaded
Treated
Meadow
Cattail

Ephydridae
Chironomidae
Anisoptera
Objective 2. Fate and effects of herbicide

- Where is glyphosate going in the aquatic ecosystem?
- Are concentrations high enough to affect aquatic biota?
- How long does it persist in the system?

- Sampled baseline (before treatment), within 24 hours, and 30 days after and 1 year after
Transportation: Aerial application (2016)

• CCME guideline for long term protection of aquatic life: 0.8 ppm
• CCME guideline for acute exposure of aquatic life: 27 ppm

Loading rate by aerial is higher than by ground

Ground (2017) values
• Lower: < 0.02 ppm
• Closer: < 100 m

Glyphosate was not detected in water samples one year after application.
Objective 2. Fate and effects summary

- Maximum environmental levels are low and pose minimal risk to aquatic biota
- Dispersal is limited to within 100 m of application sites
- Sampling top 10 cm of sediment may not best capture glyphosate dispersal
Summary and implications for control

1) Herbicide application significantly reduces *Phragmites* regrowth
2) Benefits to aerial foragers from greater forage quantity

Implications:
- Concern regarding secondary invasion
- Passive recovery of native species takes > 2 years
- Influences of water levels
- Reduce regeneration from seedbank
Acknowledgements

Grad Students and Research Technicians: Sarah Yuckin, Jessie Pearson, Jacob Basso, Bailey Ruest, Neva Demules, Graham Howell, Matt Bolding, Jody Daniel, Heather Polowyk, Calvin Lei, Dr. Laura Beecraft, Hillary Quinn-Austin, Lauren Koiiter, Jordan Reynolds

Collaborators: Dr. Jan Ciborowski, Dr. Christina Davy, Dr. Andrea Farwell, Dr. Janice Gilbert, Dr. Diane Orihel, Dr. Claudia Sheedy, Lynn Short, Melody Cairns, Eric Cleland, Jenni Kaija, Jenny Fulton, Linda Lissemore, Francine MacDonald, Claire Paller, Geoff Quan, Dustin Veenhof

Courtney Robichaud cdrobich@uwaterloo.ca
Dr. Rebecca Rooney rrooney@uwaterloo.ca
• **Aerial application**
  • Glyphosate (Roundup Custom) over wet areas: 4210 g ae/ha as isopropylamine salt
  • Surfactant 0.5 L/ha Aquasurf: an alcohol ethoxylate homologue $C_{11}EO_{10}$

• **Ground application**
  • Roundup Custom: 1200-3600 g ae/ha as isopropylamine salt
  • Surfactant 0.5-1.5 L/ha Aquasurf: an alcohol ethoxylate homologue $C_{11}EO_{10}$
<table>
<thead>
<tr>
<th>Analyte</th>
<th>Sample Matrix</th>
<th>Desired Limit of Detection (ppm)</th>
<th>Desired limit of quantification (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate &amp; AMPA</td>
<td>Water</td>
<td>0.001</td>
<td>0.008</td>
</tr>
<tr>
<td>Glyphosate &amp; AMPA</td>
<td>Sediment</td>
<td>0.005</td>
<td>0.020</td>
</tr>
<tr>
<td>Total alcohol ethoxylates (including (C_{11}EO_{10}))</td>
<td>Water</td>
<td>0.03</td>
<td>0.06</td>
</tr>
<tr>
<td>Total alcohol ethoxylates (including (C_{11}EO_{10}))</td>
<td>Sediment</td>
<td>0.3</td>
<td>0.9</td>
</tr>
</tbody>
</table>
Effect on benthic invertebrates

- Three replicate Ponar grabs from four transects in Long Point Bay
- Collected in 2017
- Sampled 100 m to 0 m stations on each transect
No pattern in benthic invertebrate abundance or community composition

- Family-level taxonomy
- No significant interaction between transect and sampling period

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>Pseudo F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transect</td>
<td>1</td>
<td>0.80315</td>
<td>4.0555</td>
<td>0.0012*</td>
</tr>
<tr>
<td>Sample date</td>
<td>2</td>
<td>0.77183</td>
<td>1.9487</td>
<td>0.0248*</td>
</tr>
<tr>
<td>Interaction</td>
<td>2</td>
<td>0.49227</td>
<td>1.2429</td>
<td>0.2320</td>
</tr>
<tr>
<td>Error</td>
<td>30</td>
<td>5.9412</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>