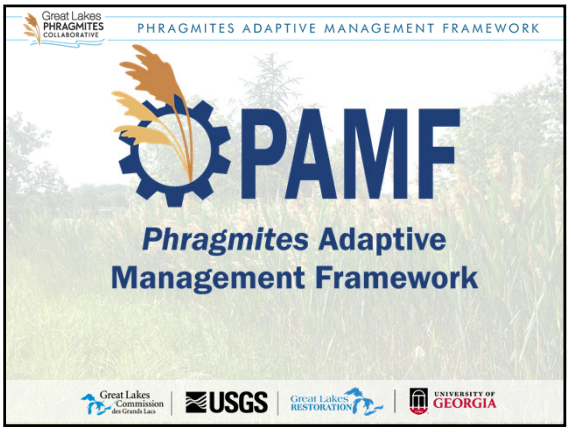
The Great Lakes *Phragmites* Collaborative: Regional Coordination, Adaptive Management, and New Treatments

Dr. Kurt Kowalski
USGS – Great Lakes Science Center

Samantha Tank
Great Lakes Commission

OSU Extensions WWW Conference
Virtual, March 2, 2021

1



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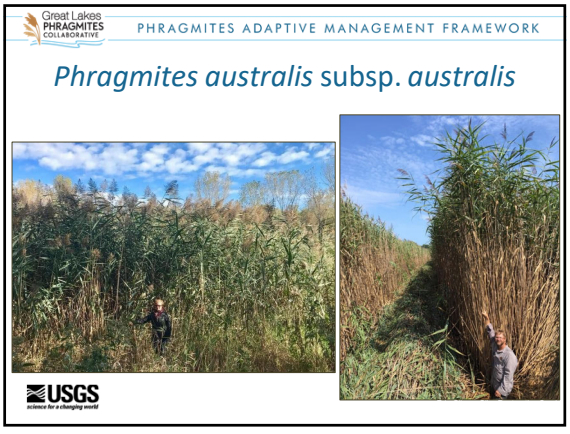

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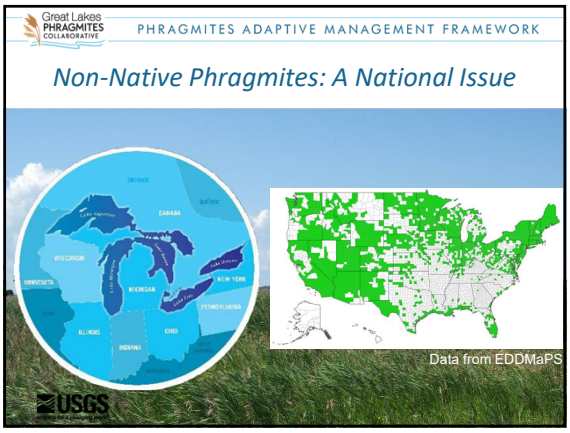
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Non-Native Phragmites: A National Issue
Data from EDDMaPS
USGS

4


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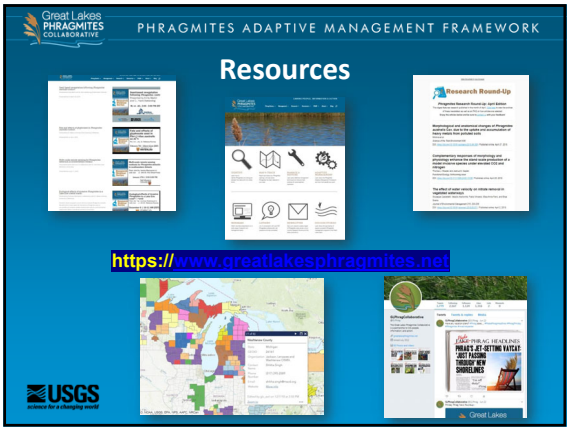
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Resources
https://www.greatlakesphragmites.net
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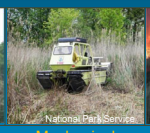
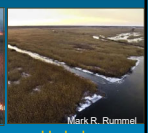
Current Management Approaches

Herbicides



Mechanical

Prescribed Burn



Hydrology

- Variable effectiveness
  - Site-specific conditions
  - Implementation technique
- Resource intensive
- Expert disagreement
- Minimal knowledge sharing

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PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

PAMF

Phragmites Adaptive Management Framework

Establishing effective and efficient *Phragmites* management throughout the Great Lakes

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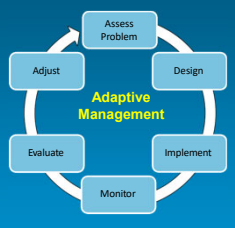
8

PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

PAMF

Phragmites Adaptive Management Framework



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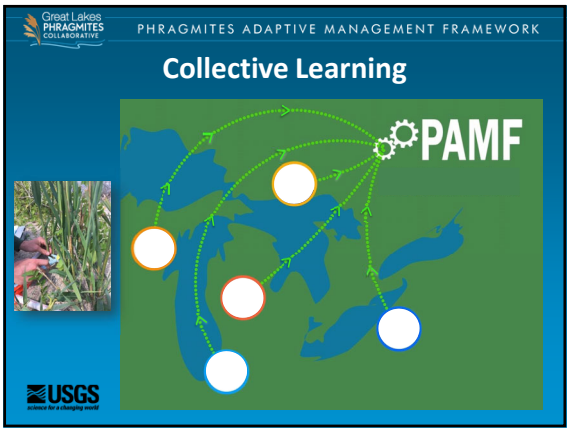
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Collective Learning
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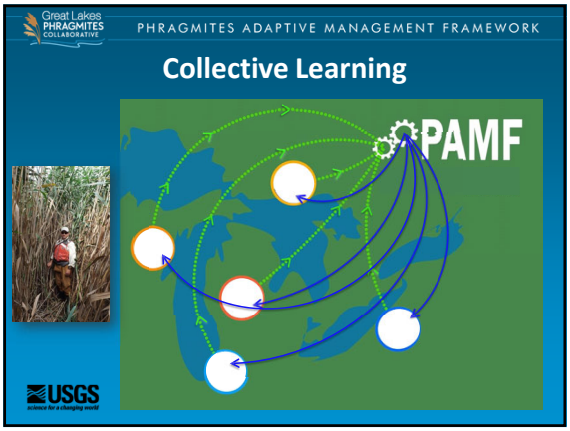
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PAMF: The perfect combination
Participatory Science
Adaptive Management
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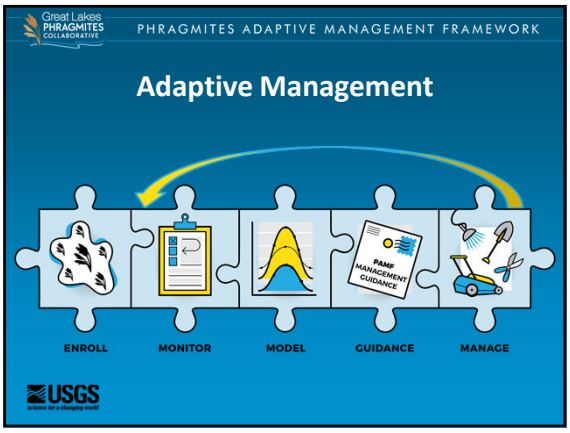
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Adaptive Management
PAMF MANAGEMENT GUIDANCE
ENROLL
MONITOR
MODEL
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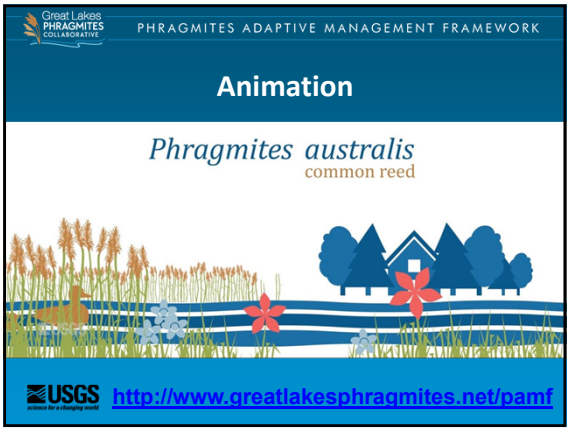
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Animation
Phragmites australis
common reed
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http://www.greatlakesphragmites.net/pamf

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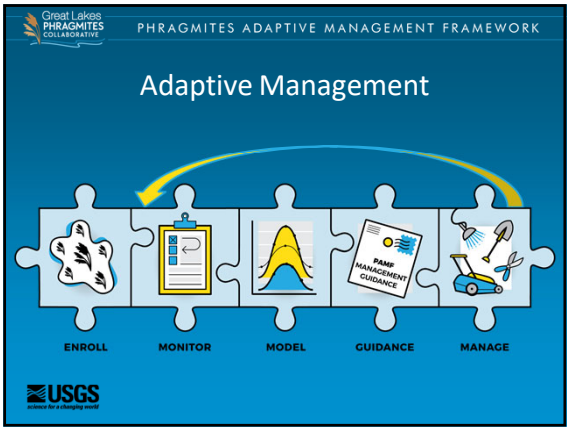
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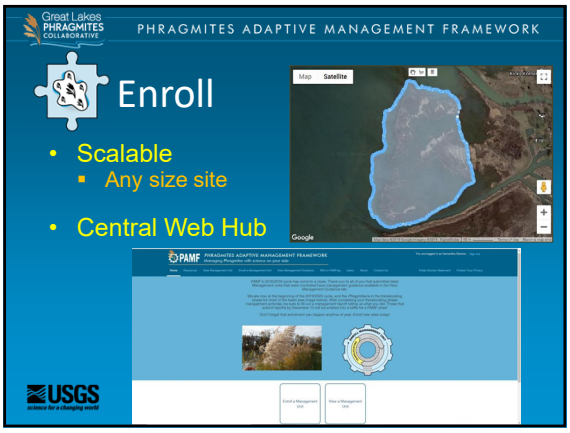
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Enroll
• Scalable
▪ Any size site
• Central Web Hub
Map
Satellite
Google
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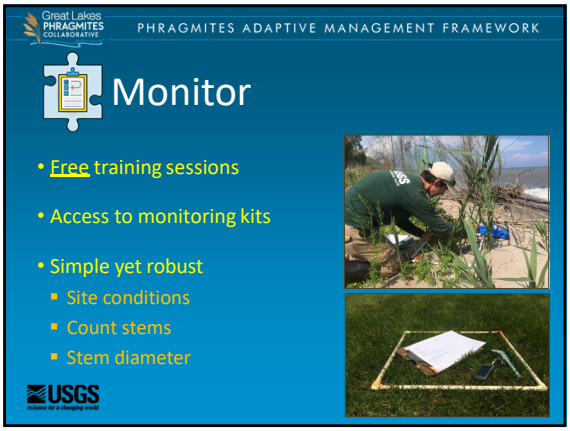
16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Monitor
• Free training sessions
• Access to monitoring kits
• Simple yet robust
▪ Site conditions
▪ Count stems
▪ Stem diameter
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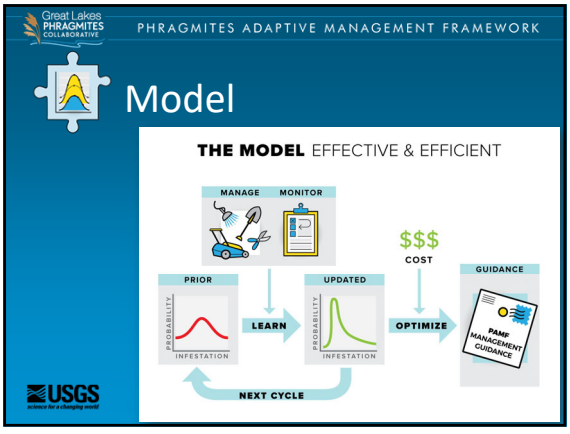
17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Model
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MONITOR
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COST
GUIDANCE
PRIOR
UPDATED
PROBABILITY
INFESTATION
LEARN
OPTIMIZE
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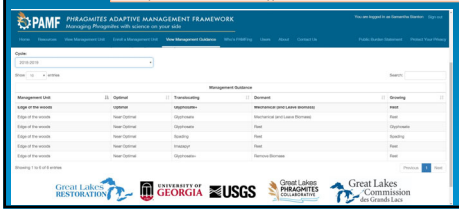
18

PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Guidance

Management Unit	Translocating	Dormant	Growing
Optimal	**Glyphosate**	**Pre-Flood Clear**	**Flood**
Near-Optimal	Spading	Rest	Spading
Near-Optimal	Glyphosate+	Rest	Rest



19

PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Guidance

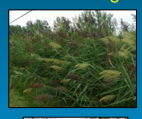
- Guidance is a recommendation
- Flexibility in application and flexibility in timing

20

PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Three Biological Phases of *Phragmites*

Translocating | Dormant | Growing





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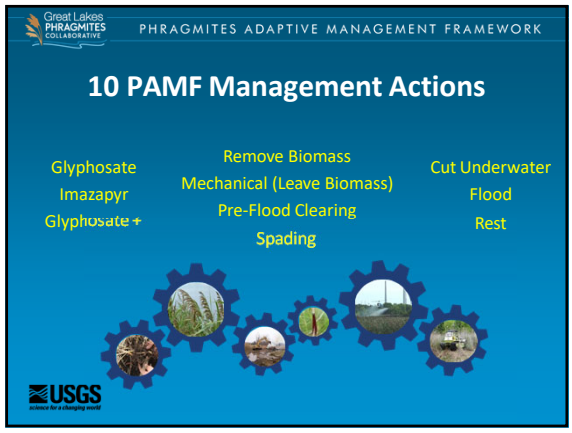

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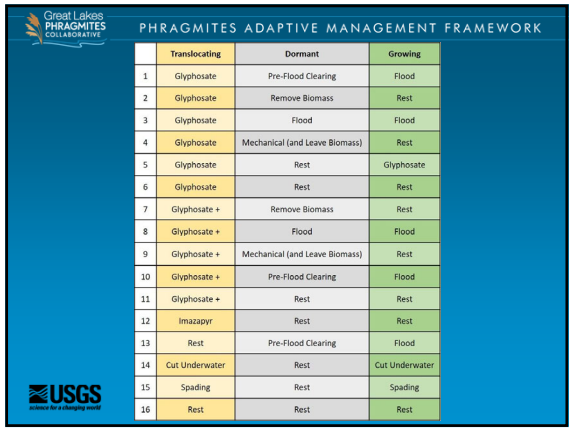
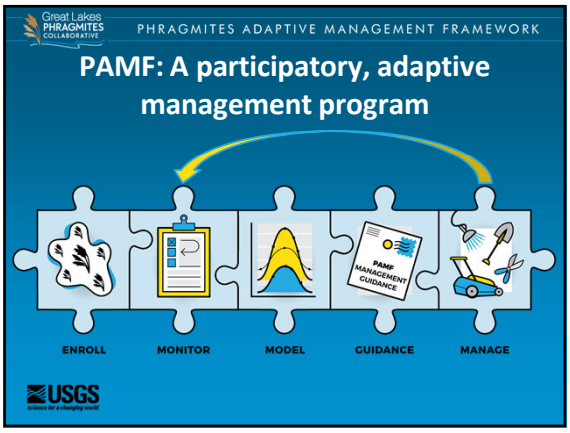


	Translocating	Dormant	Growing
1	Glyphosate	Pre-Flood Clearing	Flood
2	Glyphosate	Remove Biomass	Rest
3	Glyphosate	Flood	Flood
4	Glyphosate	Mechanical (and Leave Biomass)	Rest
5	Glyphosate	Rest	Glyphosate
6	Glyphosate	Rest	Rest
7	Glyphosate +	Remove Biomass	Rest
8	Glyphosate +	Flood	Flood
9	Glyphosate +	Mechanical (and Leave Biomass)	Rest
10	Glyphosate +	Pre-Flood Clearing	Flood
11	Glyphosate +	Rest	Rest
12	Imazapyr	Rest	Rest
13	Rest	Pre-Flood Clearing	Flood
14	Cut Underwater	Rest	Cut Underwater
15	Spading	Rest	Spading
16	Rest	Rest	Rest

23

24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PAMF: A participatory, adaptive management program
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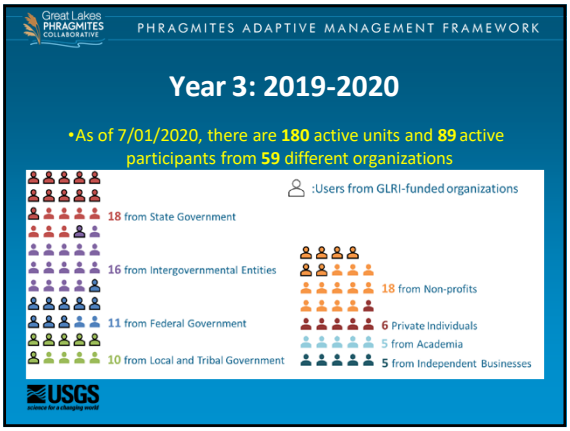
25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Year 3: 2019-2020
•As of 7/01/2020, there are 180 active units and 89 active participants from 59 different organizations
:Users from GLRI-funded organizations
18 from State Government
16 from Intergovernmental Entities
11 from Federal Government
10 from Local and Tribal Government
18 from Non-profits
6 Private Individuals
5 from Academia
5 from Independent Businesses
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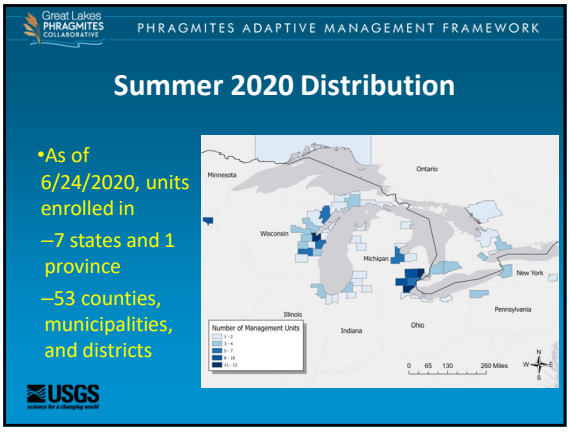
26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Summer 2020 Distribution
•As of 6/24/2020, units enrolled in
–7 states and 1 province
–53 counties, municipalities, and districts
Minnesota
Ontario
Wisconsin
Michigan
New York
Pennsylvania
Illinois
Indiana
Ohio
Number of Management Units
0 65 130 260 Miles
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27

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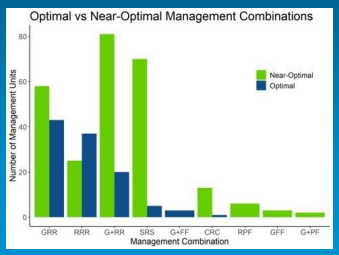
2019 Guidance Breakdown



Management Action Key	
Management Action	Code in Model
Glyphosate	G
Imazapyr	I
Glyphosate+	G+
Rest	R
Cut Underwater	C
Spading	S
Pre-Flood Clearing	P
Remove Biomass	B
Flood	F
Mechanical & Leave	L

28

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PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Current outreach

- Remote Training Webinars
- Monitoring assistance in the field
- Online resources:
  - Self-guided online participant training
  - "How-to" instructional videos
  - Instructive guides on all phase of the PAMF cycle
- Regular updates – blogposts, emails, and social media

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29

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PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Future of PAMF

- Build participant involvement
- Refine components of PAMF
- PAMF 2.0: What comes after Phrag?

30

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31

PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Innovative Control Strategies

Microbiome

USGS

Phragmites Symbiosis Collaborative

Gene Silencing

Wayne State University

US Army Corps of Engineers

USGS

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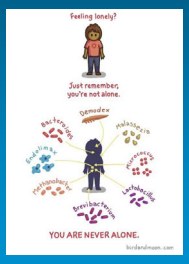
32

PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Phragmites-Microbe Symbiosis



Lessons Learned from Human Microbiome

In the human body:
Number of bacterial cells = Number of human cells

Benefits include: Food Digestion, Immune Response, Hormone Levels, Disease resistance

The appropriate community keeps you healthy and maintains bodily function

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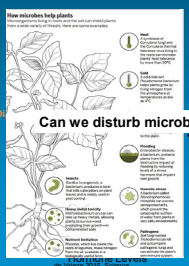
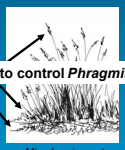
Phragmites-Microbe Symbiosis



Phragmites



Foliage

Seeds

Can we disturb microbes to control *Phragmites*?

Microbes impact:
Biomass Production, Stem Density, Rhizome Growth, Seed Output, Growth Rate, Drought, Temperature, Salt Tolerance

Fluctuating Levels
de Vitaze 2015, Science

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34

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PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Phragmites-Microbe Symbiosis

- Created a multi-institution research collaborative to collectively address:
  - Microbiome research gaps
  - Novel microbe-based management
- Published ~15 papers to date
  - Microbial inventories
  - Functional assessments
- Research focused on microbe-based control

Tulane University · Rutgers · Indiana University · Michigan

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35

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PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Phragmites-Microbe Symbiosis

Microbial control next steps

- Non-toxic treatments have been effective
- Pinpoint mechanisms
- Scale up for field trials
  - Summer 2021

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36

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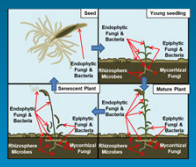
Phragmites-Microbe Symbiosis

- Microbes are an understudied aspect of plant invasions
- Microbial disruption is an effective, novel control
- Could translate to other invasives
- Provides new tools for managers



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Innovative Control Strategies

Michigan State University · Rutgers · University of Michigan · Tulane University

Microbiome — USGS — *Phragmites Symbiosis Collaborative*

Gene Silencing — Wayne State University — US Army Corps of Engineers — USGS

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38

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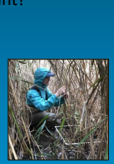
PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Gene Silencing

- Why is *Phragmites* so dominant?
  - Tall
  - Dense stems
  - Vigorous roots and rhizomes
  - High seed output
- Its traits have a genetic basis
  - Can we "switch them off"?



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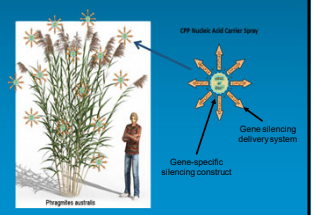
39

PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Gene Silencing

- Genetic biocontrol
  - Not altering DNA, but blocking expression (RNA interference)
  - Transient
- Target genes involved in:
  - Photosynthesis
  - Flower development
  - Root development
- Test for reduction in competitive dominance of *Phragmites*



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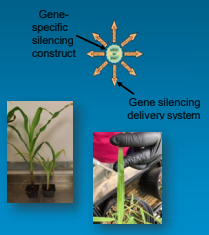
PHRAGMITES ADAPTIVE MANAGEMENT FRAMEWORK

Gene Silencing

- Sequenced the *Phragmites* transcriptome (road map)
  - Developed numerous gene targets
- Tested many silencing vectors in model species and in *Phragmites*
- Developing cutting-edge delivery system for *Phragmites*



Demonstrated in:

Tobacco (Lakshmanan et al., 2013)
Rockcress (Ng et al., 2016)

USGS US Army Corps of Engineers. Wayne State University

41

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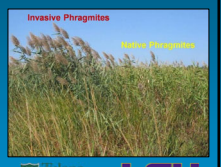
Gene Silencing

Next Steps

- Optimize delivery system
- Explore new targets
- Scale up to field trials
- Continue outreach and regulatory groundwork



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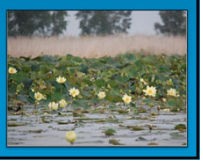
Gene Silencing

Genetic biocontrol could improve outcomes and species-specificity of *Phragmites* control



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43

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44