

***Phragmites* Stakeholder Meeting Summary**

This report provides a summary of the *Phragmites* Stakeholder meeting summary, held on February 1, 2017, in Ann Arbor, Michigan. It provide an introduction to the purpose of the meeting, a methods section that explains how the workshop was organized and delivered, and a results section that lists the participants and facilitators and provides bulleted lists of input by discussion topic area, followed by a summary and comments for each. The final section includes a brief wrap-up paragraph and a bulleted list of take-home message that rose to the top of all the discussion points. We encourage readers to read the entire report, however, as there are many important points that were made during the discussions that did not make the top take-home list that will be of interest or that you may want to address or help solve. Since *Phragmites* management is an ever moving and evolving target, we encourage your input and further discussion through the Great Lakes *Phragmites* Collaborative or by contacting members of the overall project team or workshops participants or facilitators. We greatly appreciate everyone's participation in and contributions to this workshop as well as your inspiring dedication to *Phragmites* management in the Great Lakes and beyond. Please let us know of anything that we failed to capture in this document.

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I. Introduction

Abundant information on managing invasive *Phragmites* is available, including a well-crafted third edition to the Michigan Departments of Environmental Quality *Phragmites* Control manual (MDEQ 2014) and access to current, relevant research via the Great Lakes *Phragmites* Collaborative (GLPC). However, invasive *Phragmites* management in the U.S. continues to be criticized for lacking quantitative monitoring data that are routinely made public, in spite of the millions of dollars that are spent controlling this species every year (Blossey 1999, Martin et al. 2013, Hazelton et al. 2014, Quirion et al. 2017). Indeed, few grant sources require and fund more than minimal, short-term monitoring activities. Direct discussions with many resource managers indicate that although they believe their management results are generally good, when pressed for details, they often do not have hard data to back up their assertions, or their data is limited, e.g., qualitative or quantitative changes in percent cover or density of invasive *Phragmites*, but no other important ecosystem or landscape level measures, and sometimes their assertions are simply gut level assertions. There are some clear exceptions to this.

It was this concern that prompted one objective of our *Implementing Adaptive Management and Monitoring for Restoration of Invasive Phragmites* project: to compile information on relevant monitoring protocols, tying them to specific management goals, and implementing and quantifying the cost of several different levels and methods. Although not all managers are rigorously monitoring or publicizing their treatment results, many do appear to be achieving considerable success in controlling invasive *Phragmites* in the Great Lakes region, at least for the short-term (3-4 years) and at a site level scale. We wanted to capture the knowledge and experience of managers who have been working with invasive *Phragmites* for a long time, to inform our compilation of practical monitoring protocols and to facilitate the telling of their story.

We convened a stakeholder meeting for practitioners to share their experiences with one another; to learn 1) what management goals they have and how they are monitoring progress towards them; 2) how they are prioritizing and sustaining invasive *Phragmites* management; 3) what control methods they are using and the difficulties and/or successes they are having with them; 4) what information gaps exist; and 5) if they have novel approaches that aren't widely known or used. Discussions were focused on four key topic areas to help answer these questions: a) measures of success and monitoring; b) prioritizing management action and sustaining management over time; c) control methods and unintended impacts; and d) pathways, re-invasion, secondary invasions and decontamination.

II. Methods

A. Workshop Logistics and Format

Invitations were sent to natural resource professionals across the Great Lakes who directly manage invasive *Phragmites* or work with others that do. Prior to the workshop, participants were assigned to one of four groups, each with representation from as many different agencies and organizations as possible. Each group was assigned to one of four stations corresponding to the four key topic areas (a-d) noted above. Facilitators and note-takers were selected from our project team for each topic area. They were primed with questions designed to assess the level of understanding and experience participants have with currently published control practices and how successful they are, and to draw out concerns, novel practices or other important considerations relating to each of the four topic areas. A note-taker was also selected to assist each facilitator and to capture key points from participant discussions.

Introductions were accomplished by asking participants to state their name, where they work and one word they think of when they are asked about *Phragmites* management. Participants were directed to their assigned group, each of which was assigned one of the four topic areas. A timer was set and facilitators led a discussion with their initial group for 27 minutes, after which, each group rotated to the next station.

Discussions and rotations were repeated until all groups had participated in all four topic areas. After the rotations, each facilitator was asked to present a summary of the discussions for their topic area to the entire group and entertain questions and discussion. At the end, each participant was also asked to share one new thing that they learned or one thing that stood out to them as very important during the workshop. The workshop was concluded with an overview presentation of the Saginaw Bay project. The agenda is shown in Figure 1.

Agenda: Sharing Insights on Invasive <i>Phragmites</i> Management Michigan Tech Research Institute, Ann Arbor, Michigan; Feb. 1, 2017			
Meeting Goals:			
• Gather practitioner knowledge that will improve planning, decision-making and implementation of strategic actions that address <i>Phragmites</i> invasions in Saginaw Bay • Identify gaps in knowledge and resources • Learn how to avoid unintended impacts from <i>Phragmites</i> management			
Schedule:			
(Rotation time)	9:00 – 9:15	Introductions and Instructions	
(9:42)	9:15 – 9:45	Station 1:	Measures of Success and Monitoring
(10:12)	9:45 – 10:15	Station 2:	Prioritizing Management Action & Sustaining Management over Time
(10:27)	10:15 – 10:30	BREAK	
(10:57)	10:30 – 11:00	Station 3:	Control Methods and Unintended Impacts
(11:27)	11:00 – 11:30	Station 4:	Pathways, Secondary Invasions and Decontamination
(11:57)	11:30 – 12:00	Wrap Up:	Breakout Summaries and Discussion; Round Robin of one thing learned or one thing that stood out.
	12:00 – 1:00	LUNCH:	Overview of Saginaw Bay <i>Phragmites</i> Projects

Figure 1. Sharing Insights on *Phragmites* Management Meeting Agenda

B. Topic Area Questions for Facilitators

The workshop team brainstormed on relevant questions that would provide a sense of 1) how managers were setting goals and monitoring, 2) how they prioritize and sustain where treatments occur, 3) what treatments they are using, how they are working, and if there are any specific problem areas or unanticipated consequences, and finally 4) what secondary invasions were occurring and were they prepared for them, whether they are following decontaminating procedures, and whether they are considering pathways and attempting to block them. Questions about ultimate cause of invasive were also developed, but due to the limited time of the workshop, they were not used for this workshop. The lists of questions used to guide break-out group discussions by the facilitators are listed below. Facilitators were not limited to these questions, rather they were intended to stimulate discussion and allow participants to share anything valuable related to the topic areas.

Station 1: Measures of Success and Monitoring

- Do managers believe they are doing a good job?
- Do managers have explicit goals and how are they determined? If not, why? If yes, what are examples and how are they determined?
- Are there important goals that are not considered?
- Do they consider only decrease of *Phragmites* or also ecosystem impacts?

- What is important to measure, e.g., % cover of all species, some species, root biomass, stem density, stem height, stem diameter, water level, soil, other?
- What is their sampling scheme - quadrats, transects, etc.?
- Is monitoring important or are we doing OK?
- How much time should be spent on monitoring?
- Do you have the resources to monitor well?
- What information is needed to improve management?
- Do you believe that monitoring can inform your management?

Station 2: Prioritizing and Sustaining Management

- What things are considered when choosing where to manage? e.g., public perceptions, recreation, ecosystems, pathways...
- Are there tools or information that you need to help you prioritize better?
- Is regional decision-making important? How would it affect you?
- Is anyone considering likelihood of sexual vs vegetative reproduction and how that might affect colonization and therefore management decisions and priorities?
- How strictly are they using the prioritization of outliers approach? There is a fair amount of evidence that outliers provides genetic diversity that increases seed viability; therefore even more important to get to outliers.
- Whose job is it to sustain management?
- What are sources of funding or other mechanisms for sustaining management?

Station 3: Control Methods, Difficulties and Unintended Impacts

- Compare experiences with herbicides; why are they using what they use?
- How do they assess effectiveness?
- Is anyone using herbicides in June? How is that working? Pros and cons?
- Is anyone cutting in June or other times before herbicide treatments? How high is the cutting? How is that working?
- Is anyone doing biomass removal? How? Results?
- Is anyone treating more than once in a single field season?
 - Is this legal; how is it accomplished?
 - Is it applicable to other regions?
- Flooding? Any new thoughts about flooding regime where management levels can be controlled? Are people using flooding effectively where they don't have complete control of water levels?
- Are there other novel methods?
- What difficulties are managers having, e.g., helicopter spraying near trees at inland edges of large lake infestations? Other problem areas?
- What unintended impacts have managers experienced? How did they address them?
- Are there other unintended impacts we haven't thought of, e.g., negative impacts to vulnerable systems such as lake plain prairie because control of adjacent *Phragmites* alters the hydrology of the adjacent prairie?
- What about witches brooms? What do you do with them?
- Where is native planting needed? There are lots of sites that still have a good seedbank. If N loading determines when *Phragmites* wins, perhaps planting natives would be a waste of money?
- Are managers planting native species? How is that working?
- Would managers be willing to alter their treatment regimes, based upon tools developed from this project?

Station 4: Pathways, Re-invasion, Secondary Invasions and Decontamination

- What other invaders or other undesirable species are coming in after treatment?
- Are managers prepared to treat these new invaders or undesirable species?
- Do certain management practices facilitate invasions? If so how can this be addressed?
- Are there specific herbicides or other treatment methods that result more frequently in secondary invasions? Why?
- Do managers have ideas about how to prevent/minimize secondary invasions?
- Is anyone looking at pathways and trying to block dispersal? Do managers believe that their activities may spread *Phragmites*?
- Are managers following decontamination procedures and principles?
- Why or why not? What are they doing specifically?
- Do they have the resources to decontamination well?

III. Results

A. Participants

Thirty-one participants attended the workshop including wetland managers from Saginaw Bay and other regions of the Great Lakes, and representatives from USFWS, MDNR, MDEQ and USGS that are working on invasive *Phragmites* management (Table 1).

Table 1. Participant list grouped by initial topic. (Some shifts may have occurred due to late arrivals.)

Meeting Facilitator		
Phyllis Higman	Michigan Natural Features Inventory	Senior Conservation Scientist
Measures of Success and Monitoring		
Endres, Sarah (facilitator)	Michigan Tech Research Institute	Assistant Research Scientist
DaSilva, Abram (note-taker)	U.S. Geological Survey	Ecologist
Grout, Teri	U.P. Phragmites Coalition	Regional Project Manager
McFadden, Terry	MDNR-WD St. Claire Flats	Wildlife Biologist
Mindell, David	PlantWise, LCC	Owner
Schaefer, Emily	Saginaw Bay Cisma	Monitoring Team Leader
Smith, Brian	USDOT - Federal Highway Administration	Ecologist
Tangora, Sue	MDNR - Forest Resources Division	Forest Health and Cooperative Programs Section Manager
Prioritizing Management Action and Sustaining Management over Time		
VanderHaar, Michelle (facilitator)	USFWS – Shiawassee National Wildlife Area; Partners for Fish and Wildlife	Biologist
Putt, Doug (note-taker)	Wayne State Univ. (Prev. MDNR-WD)	Student
Bonello, Jake	Detroit International Wildlife Refuge	Lead Technician
Borneman, Dave	Parks & Recreation Services, City of Ann Arbor	Deputy Manager – Natural Areas Preservation (NAP)
Cohen, Josh	Michigan Natural Features Inventory	Lead Ecologist
Darling, John	MDNR-WD St. Claire Flats	Wildlife Technician
Majka, Brian	GEI Consultants of Michigan, P.C.	Environmental Consultant
Walters, Kevin	Michigan Dept. of Environmental Quality	Aquatic Biologist – Inv. Species

Control Methods and Unintended Impacts		
Bourgeau-Chavez, Laura (facil.)	Michigan Tech Research Institute	Senior Research Scientist
Serocki, Nor (note-taker)	MACD-SW by SW Corner Cisma	Stewardship
Clancy, Bob	MDNR-PRD-Stewardship	Ecological Restoration Specialist,
Hahn, Michael	City of Ann Arbor	Stewardship specialist
Heise, Jeremiah	Michigan Department of Natural Resources	Wildlife Biologist
Howard, Shaun	The Nature Conservancy	Eastern Lake Michigan Project Coordinator
Nelson, Linda	US Army Corps of Engineers	Res. & Dev. Ctr, Environ. Lab
Pathways, Secondary Invasions and Decontamination		
Cronk, Kip (facilitator)	Michigan Sea Grant	Educator
Januska, Fallon (note-taker)	Saginaw Bay Cisma	Acting Coordinator
Bohn, Christine	Ozaukee Washington Land Trust	Project Coordinator
Cooley, Zach	MDNR – Point Mouille	Wildlife Biologist
Fahlsing, Ray	DNR-PRD	Stewardship Unit Manager
Januska, Fallon	Saginaw Bay Cisma	Coordinator
Jones, Tim	MDOT - Operations Field Services	Roadside Operations Specialist
Nelson, Danielle	Illinois Coastal Management Program	Associate Ecologist
Norwood, Greg,	USFWS Detroit International Wildlife Refuge	Wildlife Biologist (Currently- Inv. Spp. Coordinator, MDNR-WD

B. One Word about Invasive Phragmites Management

Twenty-five participants provided one-word each that reflected the first thing that came to mind when asked about invasive *Phragmites* management. The remaining participants arrived late due to traffic slow-downs. The words provided by participants prior to the station rotations were sorted after the meeting and they all aligned nicely with one of the four topic areas suggesting that the topic areas were indeed relevant to participants (Table 2).

Table 2. First word that comes to mind for participants.

Success	Prioritizing	Control	Control cont.	Pathways
Monitoring	Prioritize	Site specificity	Persistence	Dispersal
Learn	When, when not	Standing water	Hot	Spread
Education	Where	Re-treat	Miserable	Decontamination
Cause		Post-treatment	Unknowns	Re-invasion
Symptom		Follow-up	Collateral damage	
Buy-in		After	Buy time	

C. Key Topic Area Discussions

Summaries for each of the four topic areas compiled from the facilitator notes are presented below along with a bulleted comment section derived from reflections of the facilitators after the meeting, based upon the manager discussions and the expertise and experience of the facilitators with each of the topic areas. The detailed notes from each group discussion compiled by the facilitators are provided separately in Appendix A. Different points of view were expressed for some items in each breakout session and all views are reflected in the facilitator notes. Thus, contradictions in the notes reflect some level of uncertainty or difference of opinions by managers. The summaries, comments and facilitator notes do not imply endorsement one way or

another by the project team; rather they simply represent the many varied inputs provided by the meeting participants, who have different sets of experience, expertise and opinions.

1. Measures of Success and Monitoring

Summary

In general, managers are focused on measuring the reduction in invasive *Phragmites* cover and/or stem densities, with very little explicit mention of other goals. They recognize the value of assessing more than this; however, they don't often measure additional parameters. Their measures of invasive *Phragmites* are often qualitative (estimates or photos) or sometimes anecdotal in nature, and based upon assessments from outside invasive *Phragmites* patches, rarely within patches. This is primarily due to the lack of funding, since many granting sources currently provide little funding or incentives for monitoring. There are some clear exceptions, where systematic quantitative monitoring is occurring. Typically this monitoring focuses on invasive *Phragmites* cover or density, plant diversity measures or sometimes specific wildlife measures. Very little attention is paid to monitoring at different scales or identifying and mitigating ultimate causes of invasive *Phragmites* invasion.

Lack of quantitative monitoring does not mean that treatments are not successful, but it does mean that success cannot be easily quantified and shared. There remains, however, considerable uncertainty on the effectiveness of many control efforts, particularly at large sites, and over the long-term. For the most part currently published control practices are well known and utilized by managers, but are subject to site specific conditions and logistical constraints, as well as the level of experience of those doing the control. The conditions conducive to using imazapyr or imazapyr-glyphosate mix, vs glyphosate need to be better understood in order to tease out cause and effect. In addition, there is a lack of specific published monitoring protocols that address specific management goals. Those that do exist are often impractical to implement or may even pose safety concerns, especially when conducted in large, dense infestations in standing water.

Comments

- While there is a lack of published protocols, in many cases, there also appears to be a lack of attention by some managers to specifying explicit management goals that would dictate the type and level of monitoring needed.
- Effective reduction of invasive *Phragmites* alone does not necessarily equal success. For example, if the goal is to restore a native wetland, and treatment results in a high reduction of invasive *Phragmites*, but a low number of native plants returning, or the site is re-invaded or invaded by a secondary invader, in year 2, success has not been achieved. Success should be measured by how well the treatment of invasive *Phragmites* moves the project towards specific management goals. Potential management goals are diverse and may include things other than restoring native flora and fauna, such as improving water availability, restoring aesthetic qualities, improving ecosystem function, establishing a no-vegetation zone, and others. Appropriate monitoring will vary depending upon specific goals.
- Measures of acres treated alone cannot be relied upon as a good measure of success. For example, treating 500 acres in invasive *Phragmites* with poor results is likely worse than treating 25 acres with high success. Or, preventing new invasions in pristine areas may achieve greater long-term success than trying to eradicate 500 acres in a highly invaded region. Additional measures provide a more complete story.
- Practical, efficient protocols are needed so that managers can quantify their success in order to justify continued funding for treating invasive *Phragmites*, as well as to inform and improve management strategies. These should include one or more minimum protocol(s) that should be implemented for all treatments.

- It is critical to communicate to funders the need for adequate monitoring funds in order to determine if treatments are successful or not and to inform and improve management. At least some funding should be provided for long-term and multi-scale monitoring as well as short term funding.
- It may not be practical or possible to achieve the level of monitoring desired with on-the-ground methods alone, particularly for large sites with dense invasive *Phragmites* stands. High statistical power typically requires large sample sizes, which is hugely time consuming in dense *Phragmites* stands. It is likely that combinations of on-the-ground monitoring with aerial imagery interpretation, including the use of drones will be a necessary part of the long-term solution to measuring success. Imagery and interpretation methods continue to improve and their use will help minimize treatment costs, by more precisely pinpointing where initial and follow-up treatment is most needed.

2. Prioritizing Management Action and Sustaining Management over Time

Summary

Managers are well aware of commonly suggested criteria for prioritizing treatment, however, no “one size fits all”. In addition, prioritization is often driven by logistical considerations and funding priorities, rather than strictly by desired criteria. In spite of the best prioritization efforts, there is considerable concern about the ability to sustain treatments over time; there appears to be more emphasis on funding the treatment of new sites, rather than re-treating sites that have already been invested in. Finally, since consistent, multiple year monitoring is limited, it is not being used as effectively as it could be to inform priorities.

Comments

- It is important for managers to regularly step back and take stock of invasive *Phragmites* treatments in their areas of influence, to assess if they are truly optimal and to consider whether there are better ways to achieve greater long-term success.
- Consider whether a rush to treatment due to immediate funding opportunities is always the best choice; perhaps better evaluation of the most impactful choices would produce better results in the long term.
- In order to better convince funders and critics of the wisdom of manager’s priorities and effectiveness of treatments, monitoring must be implemented, analyzed, and shared to demonstrate successes and failures.

3. Control Methods and Unintended Consequences

Summary

Most managers are implementing accepted, published control practices, varying the herbicide used and method of application according to site specific conditions. Generally aerial spraying is used on large sites, then ATV, then backpacks sprayers and then hand application, as sites or retreatment areas get smaller in size. There is widespread agreement that long-term maintenance will always be needed, with best case scenarios of 3-4 years before re-treatment is required.

It appears that the use of imazapyr has declined due to observed negative impacts on native plant emergence on land; manager experiences have been mixed, which has resulted in a fair amount of uncertainty. The cause and effect of “dead zones” when imazapyr, has been used, needs further study and clarification to determine whether it is due to the chemical or site conditions (water vs soil) or something else entirely. Better guidance on appropriate use of imazapyr and mixes of imazapyr and glyphosate is

needed in order to ensure that native seed banks are utilized to the fullest extent possible to compete with *Phragmites* re-invasion.

Removal of thatch by prescribed burns is considered optimal but in many instances it not feasible due to logistical constraints and weather patterns. Mowing and then crushing are second and third choices, however many managers are hampered by lack of proper equipment and man-power as well as weather conditions. Where water level manipulation is possible there can be good results, but draw-downs too early in the season, can result in *Phragmites* invasion or resurgence. Seeding in native species on treated sites in Michigan has not typically been necessary or recommended; however, it is being utilized in some restorations where native regrowth is limited.

There is considerable debate about the value of early pre-herbicide cuts with some strong proponents of this technique and others stating that it doesn't show good results. Most agree that it can be useful in some cases, e.g., when the height and density of invasive *Phragmites* makes herbicide treatment unsafe or where the management goal is to maintain good views. If pre-herbicide cutting is used, it is important to consider impacts to nesting birds and other animals, as well as the total amount of herbicide applied to ensure regulatory compliance. Further study of this method is warranted to better quantify achievable results and should include consideration of site specific conditions and local weather variables.

Relatively new on the horizon, in addition to pre-herbicide cuts, are a) the practice of multiple herbicide treatment in one season, b) the use of amphibious vehicles to cut *Phragmites* below the waterline where herbicides are not permitted, and c) drone technology to capture pre and post-treatment conditions. Optimal uses of these techniques and tools will no doubt be determined in the coming years. In addition, research on biocontrols is ongoing, including disruption of root endophytes, identifying selective herbivores that eat various parts of invasive *Phragmites*, gene silencing and grazing.

Concerns were expressed about a) potential impacts to native *Phragmites* during treatments as well as the potential consequences of native *Phragmites* becoming aggressive in high nutrient areas; b) severe long-term impacts with the use of imazapyr in some settings; c) risks to native birds with pre-herbicide cutting; d) how to address ultimate causes of invasion, such as nutrient inputs; e) the impact of water level manipulation on fish movements; and f) potential herbicide resistance. These all need to be addressed by clarifying known information or conducting further research.

A number of specific questions relating to control methods were also put on the table. These centered around a) the advisability of seed head removal; b) risk of moving mowed biomass; c) risk of summer burns; d) comparisons of the amount of herbicide used by different application methods; e) timing of multiple treatments in a season; how to set up controls without risk of them being sources for re-invasion; f) applicability of stem injections; g) and how to make the final kill with small, sometimes stunted seed and rhizome sprouts.

Comments

- Implementation of consistent monitoring is needed to accumulate evidence that will address the uncertainties in management techniques and to demonstrate the true value of funding invasive *Phragmites* control.
- Research studies to clarify the impacts of and appropriate uses of imazapyr and assess the efficacy and risks of pre-herbicide cutting are needed
- Resources are needed to fully equip managers with the tools needed for most effective control practices.
- More opportunities are needed for managers to consider large landscapes together to reflect and fine-tune management decisions.

4. Pathways, Re-Invasion, Secondary Invasion and Decontamination

Summary

Invasive *Phragmites* control frequently results in conditions ripe for secondary invasions and managers are increasingly more prepared for them than in the past. However, sometimes they lack the staff and funding to deal with them and there are some species that come in that are very difficult to effectively control, such as reed canary grass. In addition, they are just beginning to deal with some newer species, such as European frog-bit, and are still learning what the best control methods are. Other species, such as non-native cat-tails, that have long been considered fairly benign, are showing increasing evidence of negative impacts to ecosystems and wildlife after invasive *Phragmites* removal. This is exacerbated by hybrid cat-tail, which is becoming increasingly common.

Where imazapyr is used over land, many managers have observed dead zones that inhibit native plants from re-establishing; this leaves the site vulnerable to re-invasion by invasive *Phragmites* when the effects of imazapyr in the soil finally wear off.

Regeneration of native species is good in many places; however, some managers are including revegetation after treatment, e.g., in streambank restorations and some site-based restorations

Managers are generally well versed in the need for decontamination, however implementation is variable. This is in part, due to specifics of contracts and the time and expense to carry them out, but sometimes due to lack of information about specific decontamination procedures. Managers generally appear to be more concerned and careful when going to high quality sites and less so when going from one invaded site to another. Managers are concerned about other vectors, especially hunters, some of whom use *Phragmites* in blind construction and for deer habitat.

Comments

- It is a good practice to scout for potential secondary invaders at every treatment site in order to be prepared for them and design your treatment accordingly.
- While it may take time and money to decontaminate, it takes more money to treat new invasions, and it is a waste of money to treat a site that was re-infested by vectors that could have been prevented. Vigilance about not spreading propagules is imperative and teaching others about this is important.
- Targeted messaging to hunters and enforcement seems important; it is illegal to transport invasive *Phragmites*.
- Better understanding of the effects of imazapyr on treated sites is needed in order to minimize its influence as a factor in facilitating secondary invasions.
- Larger landscape level planning may help mitigate secondary invasions and re-invasion.

D. One thing learned or most important take-home message from today

All participants provided one or more take-home messages from the day. They were reviewed and sorted after the meeting. Most of them fit in one of the four topic areas, while several spanned all topics. Several participants identified new tools and a couple suggested limitations to our overall management approach and the mix of participants at this workshop. These are listed by categories below.

Overarching Thoughts

- We are in a good place in Michigan

- Funding is a concern on many fronts
- Complexity of it all
- I am not alone, lots of uncertainty

Measure of Success and Monitoring

- Framework shift – what’s best for the environment, community buy-in
- Redefining success
- Different measures / kinds of success CLARIFY I think the comment was different mgmt. goals, but maybe different ways of measuring progress towards goals
- Monitoring to track better indicators than acres treated
- Move from acres treated to other parameters
- Intensive monitoring
- Follow-up monitoring
- Language in grants is too narrow
- *Phragmites* is a symptom of other problems, e.g., nutrient inputs; should reducing this be a measure of success?

Prioritizing and Sustainability

- To sustain management
- Sustainability
- Prioritization should expand to take into account the necessary logistics
- MISGP focuses only on early detection species, but needs to allow for secondary invasions that are not target species for the grant.
- Seed viability in outliers higher – did not know that
- Seed viability varies by stand age – evidence for higher genetic diversity in outliers which can have more than genetically diverse propagules

Control Methods and Unintended Consequences

- No one way
- Different methods
- Variations
- Commonality and differences
- Open water control contact
- Presence of water buffers impact of imazapyr
- Imazapyr impacts seems to vary with water level
- Imazapyr and seed banks
- More research on biocontrol
- Been treating invasive *Phragmites* the same way since I was 18 years old and little has changed; this problem has not been elevated in importance, like research on drugs, for example (editorial; it has been elevated in the sense that tons of money goes to treating it, but less to the needed research)

Pathways, Re-invasion, Secondary Invasion and Decontamination

- Decontamination is still an idea for many - not implemented yet
- Secondary invasions are problematic, e.g., non-native cat-tail appears to be affecting mammal use; don’t know how to treat incoming reed canary grass
- A preview of site conditions, would allow the prediction of secondary invasions and therefore the ability to include the cost of treating them into treatment plans
- Landscape level planning is needed

New Tools:

- Arc Collector
- Ecological economist
- Drone pre- and post-monitoring
- Drone detection and auto treatment of invasive *Phragmites*, like agricultural weeds

Other Important Comments

- We need to move beyond *Phragmites* control, to serious site restoration; i.e., specifying management goals and addressing all aspects of restoration, only one of which is invasive *Phragmites*.
- This participant group was somewhat biased towards groups with access to good funding sources and equipment, etc.; landowners were not represented well, but need to be a big part of the solution.

IV. Take home messages

While it is hard to distill such an enormous and complicated topic across so many ecological conditions and levels of expertise and resources, some key messages from the workshop are bulleted below. We encourage participants to continue their conversations and share insights and concerns as they come to light – it is through shared examples and dialogue that improvements will be made most efficiently and effectively. Using the Great Lakes *Phragmites* Collaborative is an excellent way to do that, and we will be sharing the outcomes from our overarching MISGP and EPA projects at several webinars in 2018-2019 – please stay tuned! We thank everyone for their hard work and continued willingness to try and move the needle on *Phragmites* management in the Great Lakes.

- Attention to explicit goals and practical, consistent monitoring that is tied to those goals is needed to improve *Phragmites* management and provide funders justification for funding management efforts.
- Adequate, practical monitoring protocols are not easily available and funding is frequently lacking to implement effective monitoring.
- Management goals should go beyond *Phragmites* kill to defining a desired future condition and monitoring to determine if management is moving the site or region towards the desired future condition.
- In addition to identifying desired future condition, ultimate causes of *Phragmites* invasion must be addressed, particularly high nitrogen levels.
- Use of high resolution satellite imagery and drones will ultimately be a necessary part of *Phragmites* monitoring.
- Prioritizing is not a one size fits all and often logistical constraints dictate what gets done; managers need to be flexible to take advantage of opportunities, yet they need to ensure that alternative treatments to those planned are the best use of limited resources.
- There is a need to move beyond site level management to considering landscape scale approaches, including watersheds.
- There is a need to bring managers together more frequently to brainstorm on larger scale efforts.
- Sustainability of management and funding priorities are major concern of managers.
- Generally managers are using recommended practices and learn from their mistakes to improve management; however, there are several key areas of uncertainty:
 1. What are the appropriate uses and methods for imazapyr?

2. When is early cutting prior to later herbicide treatments an effective approach
 3. Is there any advantage to early burns vs winter burns?
 4. Where and at what interval can multiple herbicide applications per season be effective?
 5. Are there non-target impacts on native *Phragmites* because we aren't taking the time to identify and map it?
 6. What are unintended consequences of water level manipulations, e.g., impacting fish movements, and can flooding through other methods, such as cutting under water be an effective means of control?
- Decontamination is difficult and expensive and is not being used consistently, although generally managers are paying attention to moving from highly invaded areas to less invaded or uninvaded sites.
 - Setting a good example with decontamination will help encourage other natural resource user groups, such as hunters and recreationists, to be a part of the solution to stopping the spread of *Phragmites*.
 - There is more awareness of secondary infestations and readiness to treat them, however some species have uncertain or unknown best treatment methods; e.g., European frog-bit, flowering rush, reed canary grass.
 - Private landowners must be a key part of the solution to sustaining management of *Phragmites*, yet they are not well represented currently.

V. References

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