

Further battles with the green giant: a comparison of factors critical to reed canarygrass control in herbaceous vs. forested wetlands

Meredith Thomsen¹, Nathan De Jager², Benjamin Cogger³, and Michael Merriman¹

¹University of Wisconsin-La Crosse; ²USGS Upper Midwest Environmental Science Center; ³University of Wisconsin-Superior

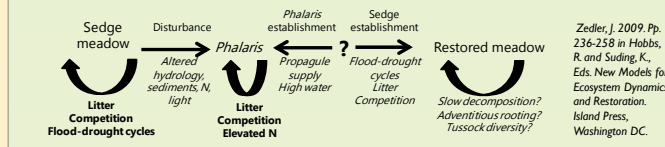
The problem

- Reed canarygrass (*Phalaris arundinacea*) is widely regarded as one of the worst invaders of North American wetlands
- The numerous habitats it invades provide a unique opportunity to compare the invasion of a single species across multiple ecosystems
- Beginning in 2006, we have studied *Phalaris* invasion in the floodplain forests of the Upper Mississippi River (UMR)




Fig. 1: Much of the UMR floodplain is a mosaic of forest and *Phalaris* (smoother dark green areas; the chartreuse color is duckweed in areas of slower-moving water). The competitive dominance of the "green giant" in open-canopy sites has generated concern among land managers and others about the long-term fate of forested areas.

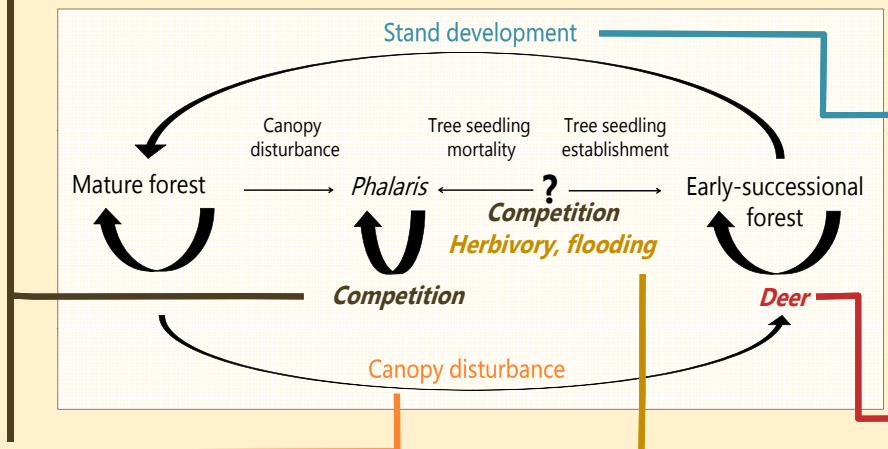
Our approach

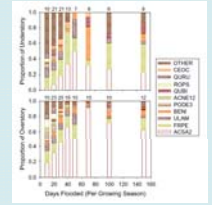
- Zedler (2009) summarized the invasion of sedge meadows by *Phalaris* and their restoration using a conceptual state-and-transition model:
- 
- We have adapted that model for the UMR floodplain forest; here, we review our research using that framework, comparing the two systems

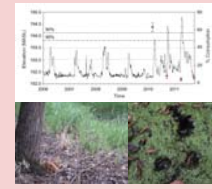
Next steps

- Many of the factors influencing the invasion of *Phalaris* and the success of restoration efforts are similar between the two wetland types
- The existence of transitions between the undisturbed and restored states offer some additional management opportunities for forested wetlands as compared to sedge meadows; the importance of herbivory in the floodplain is another point of contrast
- We have started to investigate differences among our ecosystem states in N cycling; see De Jager et al. talk on Friday morning
- Additional comparisons across ecosystems are bound to generate further insights: what are your experiences with this species?

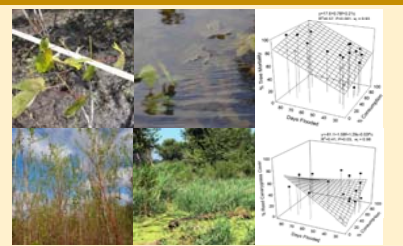
- Similar to sedge meadows, we have found strong competitive effects of *Phalaris* on floodplain forest native species, both reinforcing *Phalaris* dominance and decreasing tree seedling survival in restorations (Fig. 2)
 - Fall application of pre-emergent and glyphosate herbicides result in decreased *Phalaris* cover the following growing season, increasing the establishment of trees and other natives
 - High tree seedling densities (~50/m² the first year) and growth rates (~50 cm/yr) can result in rapid canopy closure, decreasing the chance of re-invasion
 - In sedge meadows, feedbacks that maintain the restored condition remain an active area of research (Zedler 2009)
- 
- Fig. 2: Control of *Phalaris* using fall applications of pre-emergent herbicides created the opportunity for tree seedling and native forb establishment. Six years post-treatment, the edges of treated plots are clearly visible as a wall of young trees. Thomsen et al. 2012, *Wetlands* 32:543-555



- The potential for succession to result in a transition from the "restored" (early-successional) forest to mature forest is a critical difference between floodplain forest and sedge meadow
 - Similar to mature forests (Fig. 6), our sites are dominated by silver maple and their long-term resistance to *Phalaris* invasion
- 
- Fig. 6: Forest plots sampled by the USACE along 300 km of the UMR showed strong dominance by silver maple, particularly in the overstory layer. De Jager et al. 2012, *Forest Ecology and Management* 270:135-146.

- Decreased height gain of browsed seedlings could slow or prevent succession in restored sites
 - Across multiple sites and years, deer avoided flooded conditions, providing a temporal refuge for trees tall enough to survive the high water (Fig. 5)
 - Browsing was also lower on island than mainland sites (3 vs. 46% of available stems), suggesting that islands may serve as refuges from browsing at a regional scale (Cogger et al. in press. *Natural Areas Journal*)
- 
- Fig. 5: Top panel shows the hydrograph for one experimental site, overlaid with browsing estimates (red dots). Deer are more active in the floodplain when water levels are lower; high water years may thus provide an opportunity for young trees to escape browsing. Observations suggest, however, that deer return quickly as floodwaters recede.

- Our model differs from the sedge meadow model in that we predict it is possible to "short circuit" *Phalaris* invasion when canopy disturbance occurs
 - We thus regard areas of natural windthrow and timber harvest (Fig. 3) as important management targets
 - Current senescence of large even-aged stands along the UMR makes the development of these techniques a priority
- 
- Fig. 3: We are working with the USACE to test strategies for preventing *Phalaris* establishment in timber harvest sites. Another project is testing methods for maximizing the success of planted stakes, which could be used in canopy gaps.

- Similar to sedge meadows, hydrology plays a strong role in our system. We have found, however, that flooding acts synergistically with herbivory, which is not included as a major factor in the sedge meadow model
 - Browsing significantly slowed the height gain of young trees (60 vs. 30 cm/yr in fenced vs. unfenced plots)
 - During an extended period of high water in 2010-11 (see red box for hydrograph), flood duration acted synergistically with browsing in its effects on tree mortality (Fig. 4)
 - *Phalaris* has re-invaded the low-elevation sites with lowest tree seedling densities (Fig. 4)
 - We have also found high rates of damage to planted stakes from meadow voles, another potential feedback to *Phalaris* in early-successional forested wetlands
- 
- Fig. 4: top row: browsing decreased tree height gain, increasing the likelihood that individuals were submerged during floods. Tree mortality in experimental plots was greater in plots flooded longer and with a history of greater browsing. Bottom row: following the 2010-11 flood (see red box), we have documented continued dominance of young trees in high-elevation, low-browse plots, and re-invasion of *Phalaris* in low-elevation areas not protected from deer. Thus, under some circumstances, protection from herbivory will give young trees the opportunity to get tall enough to escape flooding, browsing, and competition from *Phalaris*. De Jager et al. 2013, *Forest Ecology and Management* 303:11-19.

Acknowledgements

- Thanks to Eileen Kirsch, Randy Urich, Kurt Brownell, Eric Strauss and others at UMESC, USACE and UW-L who contribute to these projects
- Funding provided by UW-L College of Science and Health, UW-L River Studies Center, the Upper Mississippi River Restoration-Environmental Management Program and the National Great Rivers Research and Education Center Summer Internship Program

References cited

- Zedler, J. 2009. Feedbacks that might sustain natural, invaded, and restored states in herbaceous wetlands. Pp. 236-258 in Hobbs, R.J., and K.N Suding, Eds. *New Models for Ecosystem Dynamics and Restoration*. Island Press, Washington, DC.
- Thomsen, M.A., K. Brownell, M. Groshek, and E. Kirsch. 2012. Control of reed canarygrass promotes wetland herb and tree seedling establishment in an Upper Mississippi River Floodplain Forest. *Wetlands* 32:543-555.
- De Jager, N.R., M.A. Thomsen, and Y. Yin. 2012. Threshold effects of flood duration on the vegetation and soils of the Upper Mississippi River floodplain, USA. *Forest Ecology and Management* 270:135-146.
- De Jager, N.R., B.J. Cogger, and M.A. Thomsen. 2013. Interactive effects of flooding and deer (*Odocoileus virginianus*) browsing on floodplain forest recruitment. *Forest Ecology and Management* 303:11-19.
- Cogger, B.J., N.R. De Jager, and M.A. Thomsen. In press. Winter browse selection by white-tailed deer and implications for bottomland forest restoration in the Upper Mississippi River valley, USA. *Natural Areas Journal*.