Raising the Bar of Floodplain Forest Restoration: Elevation Modification as a Restoration Strategy

Lisa Maas[1], Nathan DeJager[2], Rich King[1], Jason Rohweder[2], Randall Urich[3], and Bobby Jackson[3]

1. Upper Mississippi River National Wildlife & Fish Refuge, McGregor District, McGregor, IA, 52157; 2. Upper Midwest Environmental Sciences Center, La Crosse, WI, 54603
3. U.S. Army Corps of Engineers, St. Paul District, La Crescent, MN, 55947

Introduction

The spatial extent and species diversity of floodplain forests along the Upper Mississippi River (UMR) have declined since the inception of the locks and dams (Figure 1). The relative abundance of flood tolerant species such as silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), and American elm (*Ulmus americana*) have increased while less flood tolerant species such as swamp white oak (*Quercus bicolor*) have decreased.

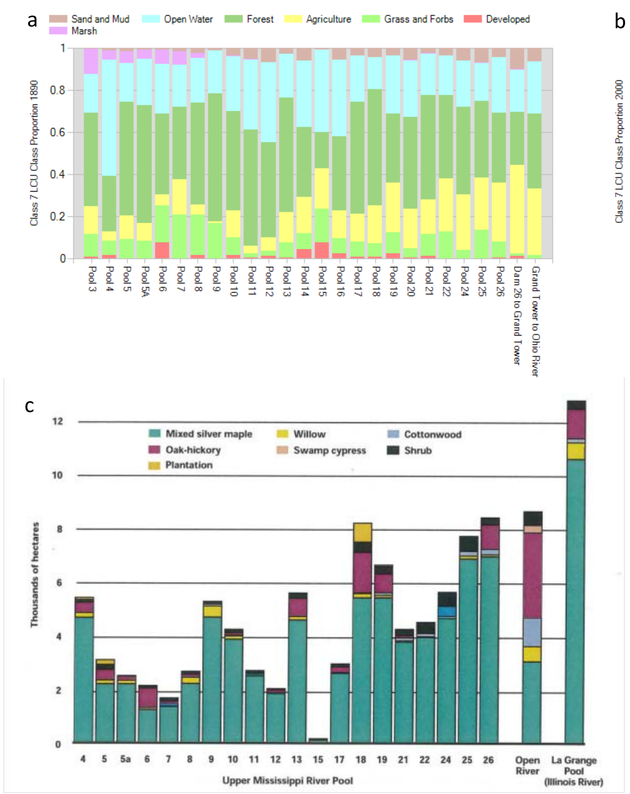


Figure 1. Proportion of Land cover classes by pool for (a) 1890 and (b) 2000, showing a loss of forest cover throughout the UMR, and c) the present day distribution of major forest types throughout the UMRS.
Sources: http://umesc-gisdb03.er.usgs.gov/landscape_viewer/indicators.aspx, Yin 1999

Floodplain forest restoration has been identified as a priority in the Upper Mississippi River National Wildlife and Fish Refuge (Refuge) Comprehensive Conservation Plan (CCP, Hultman 2006) and in the U.S. Army Corps of Engineers (USACE) Systemic Forest Stewardship Plan (Guyon et al. 2012). As water levels have risen due to the locks and dams, strategies that would promote more diverse floodplain forests on the Refuge include: 1) identification of existing areas with flooding regimes suitable to a wide range of tree species and 2) raising the elevation of island and shoreline forests to reduce flood frequency and duration, thereby improving growing conditions for less flood tolerant plant species.
However, it is unclear what elevations and flood durations might correspond with more diverse forest communities, particularly those that include swamp white oak and other hard mast tree species.

Methods

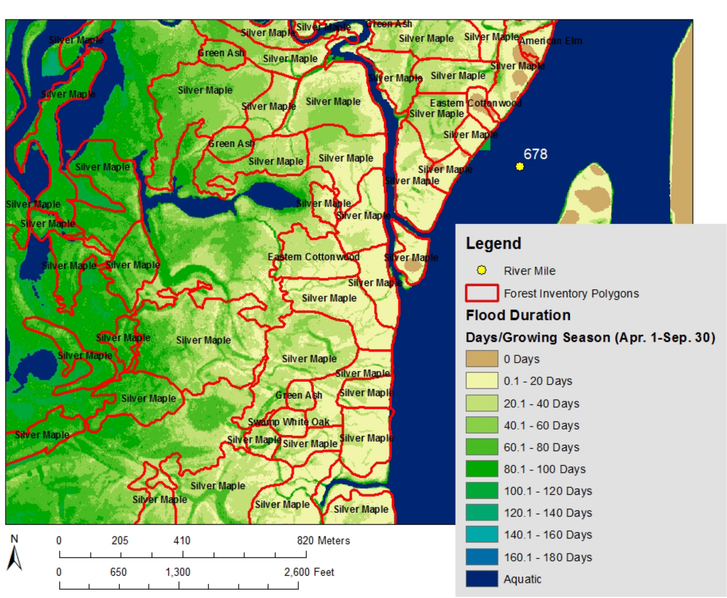
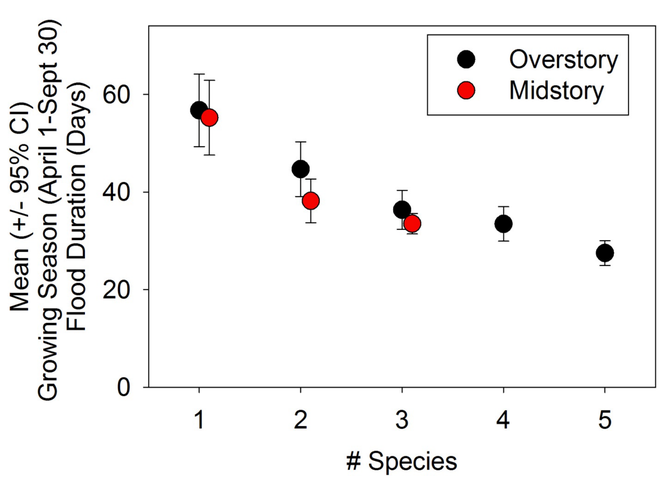


Figure 2. Forest Inventory Polygons, showing the most dominant overstory species, overlaid on a map of mean growing season flood duration.

We addressed this question using forest inventory data collected by the Refuge and USACE as well as models for the mean duration (# of days) during the growing season (April 1-Sept 30) that forest stands were inundated over a 30 year period (1975-2004, Fig. 2).

Relationships between the relative abundance of various tree species and mean flood duration are being used to develop some criteria for site selection and elevation modifications that should promote diverse tree assemblages.

Results



A negative association was observed for the number of over and mid-story species found in forest inventory polygons and mean growing season flood duration (Fig. 3). Stands dominated by a single species had flood durations greater than 50 days, while plots with 3 and 5 species had flood durations closer to 35 days and 30 days, respectively.

These results suggest that increasing floodplain elevation ought to promote more diverse forest stands by reducing flood-related mortality rates of less flood-tolerant species.

Figure 3. Mean Average Flood Duration by Number of Dominant Species (Species Richness).

Results

Silver maple was the most dominant species in areas with longer flood durations (~40-65 days) and co-dominant with other species in areas with shorter flood durations (<40 days, Fig. 4a). Dominance by swamp white oak did not appear to be associated with flood duration (Fig. 4b). This species was typically found in areas that flooded between 30-40 days. Red oak (*Quercus rubra*) was the most dominant species in areas that flooded for short durations (<25 days) and became a co-dominant species in lower elevation areas that flooded for longer durations (>30 days) (Fig. 4c).

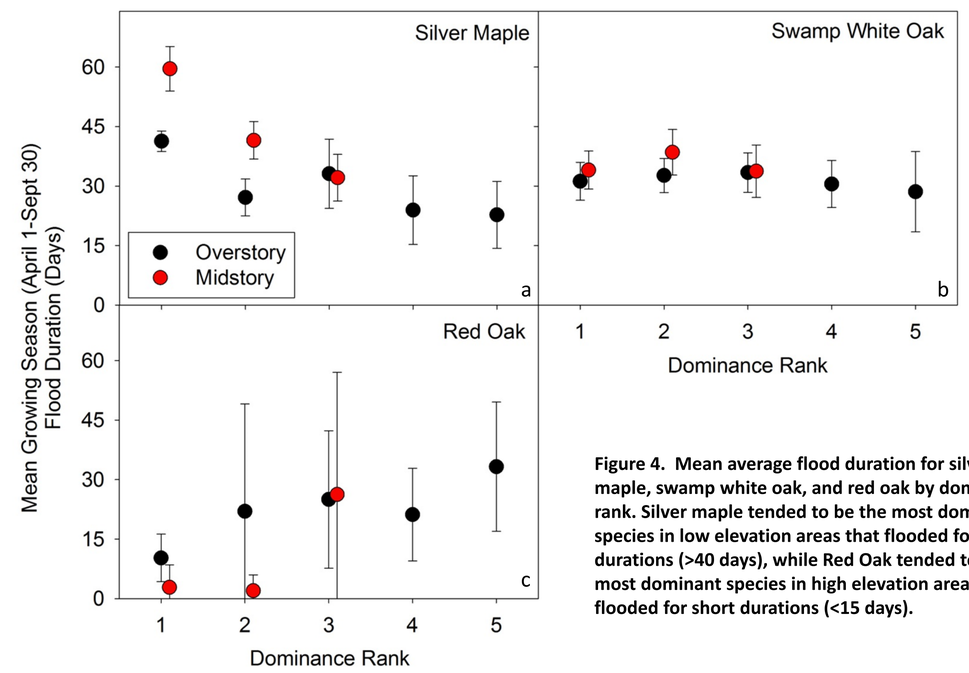


Figure 4. Mean average flood duration for silver maple, swamp white oak, and red oak by dominance rank. Silver maple tended to be the most dominant species in low elevation areas that flooded for long durations (>40 days), while Red Oak tended to be the most dominant species in high elevation areas that flooded for short durations (<15 days).

Discussion

These associations suggest targeting elevations that typically flood for less than 45 days to promote the development of multi-species forest stands. This threshold flood duration is consistent with the findings of De Jager et al. (2012), which showed that flood durations longer than 40-60 days correspond with dominance by silver maple and a strong reduction in species diversity. These associations further suggest targeting flood durations shorter than 25 days to promote establishment of red oak stands.

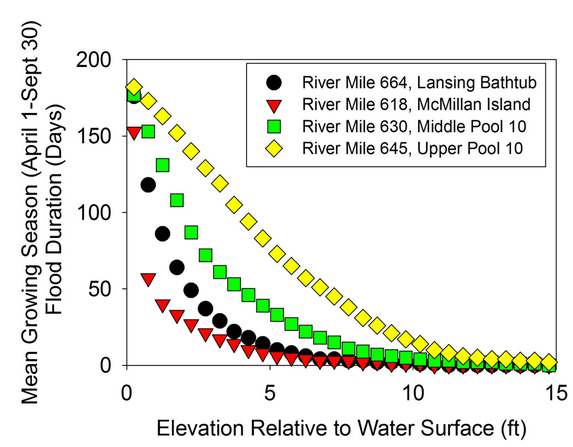


Figure 5. Flood duration plotted as a function of relative elevation (feet above water level) at four river miles in pools 9 and 10, including two project locations.

The Refuge has identified the Lansing Bathtub site outside of Lansing, IA (river mile 664) and the USACE has identified McMillan Island near Guttenberg, IA (river mile 618) as sites that could benefit from increased elevation. At both sites, dredge material already present will be used to increase the elevation of the floodplain and a diverse assemblage of tree species will be planted including swamp white oak, red oak, and black walnut (*Juglans nigra*).

In order to achieve flood durations of <25 days at the Lansing Bathtub and McMillan Island sites, the Refuge and the USACE will need to establish elevations at least 3.5 and 2.5 feet above pool level during summer low-flow conditions, respectively (Fig. 5)

Monitoring of these sites would allow us to determine the degree to which these data and this statistical approach are applicable to other forest restoration projects across the UMR.

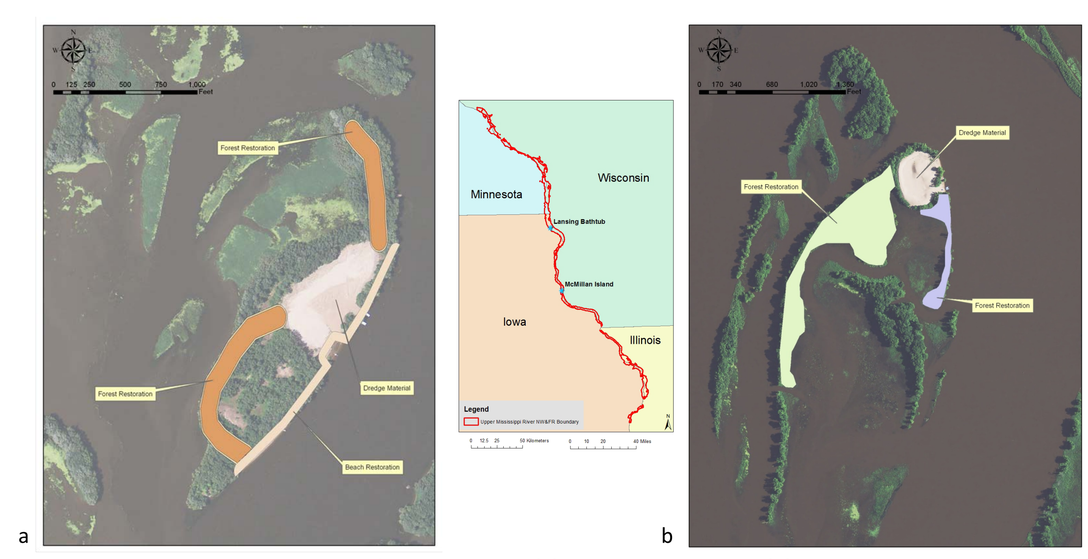


Figure 6. Proposed elevation modification areas at (a) Lansing Bathtub and (b) McMillan Island.

Literature Cited

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