ASSESSING THE HISTORICAL IMPORTANCE OF LIGHT-SEEDED TREE SPECIES IN UPPER MISSISSIPPI RIVER FORESTS, POOLS 3-10

Andy Meier[1]

[1]Lead Forester, US Army Corps of Engineers, St. Paul District, contact info: Andrew.R.Meier@usace.army.mil

US Army Corps of Engineers® St. Paul District

Background:
The species composition of floodplain forests in the Upper Mississippi River (UMR) Valley has changed significantly since European settlement, and particularly since the establishment of the 9-foot navigation channel project in the 1930s. It has been widely thought that a primary result of this change has been an increase in the prevalence and dominance of more flood tolerant light-seeded tree species, especially silver maple (*Acer saccharinum*), at the expense of less flood tolerant hard mast producing species, especially oaks (*Quercus* spp.). However, many of these assumptions are built on datasets from the lower pools of the Upper Mississippi River or datasets that overlap with adjacent blufflands in the upper pools. Though a wider assessment of historic vegetation data from the 1800s in Mississippi River Pools 3-10 does indicate about an 18% decline in hard mast species with concurrent increases in silver maple in the UMR, the same datasets indicate that hard mast species were historically a minor component of the system, comprising only about 25% of total trees. Utilizing UMR landcover datasets for the area, many of the areas with the highest dominance of hard mast species in the early 1800s, particularly species in the marginally flood tolerant red oak group (*Quercus* section Lobatae), were areas that were converted to agriculture or development well before establishment of the locks and dams, with modern silver-maple dominated forest areas occur in more flood-prone zones. Silver maple has substantially increased in dominance in the UMR, but this is primarily at the expense of other light seeded species. Both ash and birch have decreased by more than 10%, while elm and willow have also declined. Further, within the study area, natural regeneration of light-seeded species is far below the threshold required to maintain those species at their current levels. Conversely, hard mast species make up a higher proportion of regeneration plots than they do in the forest canopy, indicating a potentially expanding distribution for those species. These data indicate that forest restoration in the upper pools of the UMR should not discount the importance of light-seeded species in maintaining forest diversity, both from the perspective of historical vegetation and future forest resilience, and management actions should be undertaken that encourage the establishment of light-seeded species as well as hard mast.

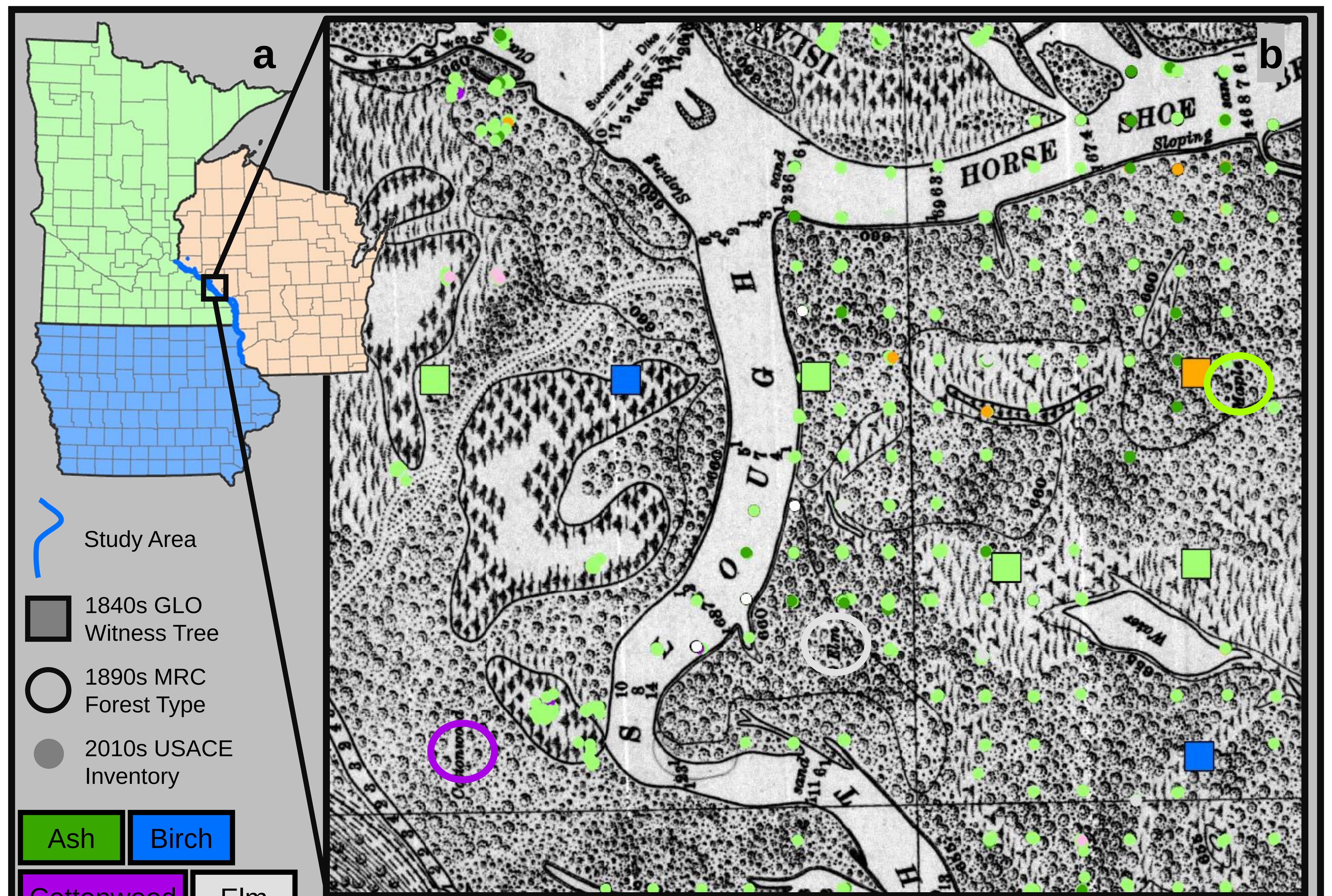

Fig. 1. Map showing the study area for the current analysis (a) and a detail of the 1890 MRC map in Pool 5A, with 1840s, 1890s and 2010s forest data by species group

Methods:
__Data Sources__: For the 1840s dataset, General Land Office (GLO) witness tree data layers for Wisconsin and Minnesota were merged into a single dataset. These data were derived from digitized records available online for each state. There is some variation in witness tree recording between the state datasets, so new data fields were created for tree species and tree number to allow for a crosswalk between the two datasets. Witness trees were generally recorded in these surveys at Public Land Survey section and quarter-section corners, resulting in approximately ½ mile between tree records (Almendinger 2010, He et al. 2000).
For the 1890s dataset, scanned and georectified maps of the 1890 Mississippi River Commission (MRC) surveys were utilized. A new GIS point layer was created to allow for classification of locations on the MRC maps where a forest type was specified. Point classifications were implemented through visual interpretation of text on the scanned maps, and forest types were recorded exactly as noted on the maps. There is no known record of how forest types were classified or whether there were specifications related to how frequently a forest type needed to be identified (USGS 1999).
For the 2010s dataset, data was summarized from the US Army Corps of Engineers Phase II Forest Inventory dataset, Round 1. Forest inventory data in this dataset was collected between 2008 and 2020 on plots on Federally-owned property in the US Army Corps of Engineers-St. Paul District (USACE-MVP). Inventory plots in this dataset are placed at a density of 0.4 plots ac^{-1}. Trees were recorded in this dataset by using a variable radius sampling technique at each survey point, with trees for measurement selected using a 10 BAF sampling tool.
For the 1840s and 1890s, all areas within the pool boundaries delineated in 2010 Mississippi River Long Term Resource Monitoring Land Cover/Land Use (LCLU) layers were assessed (LTRM 2011). 1890s (USGS 1999) and 2010 (LTRM 2011) LCLU layers were also used to generalize land cover changes in areas with oaks in the 1840s surveys..

__Data Analysis__: Tree species and forest type composition between the three datasets was conducted primarily through comparisons of proportions of individual tree species and forest community types relative to the total number of trees in the dataset for the time period of interest. Because of variability in species nomenclature between time periods, individual species were condensed into species groups, forest community types and mast types for comparisons. No formal statistical analyses were conducted with the data.

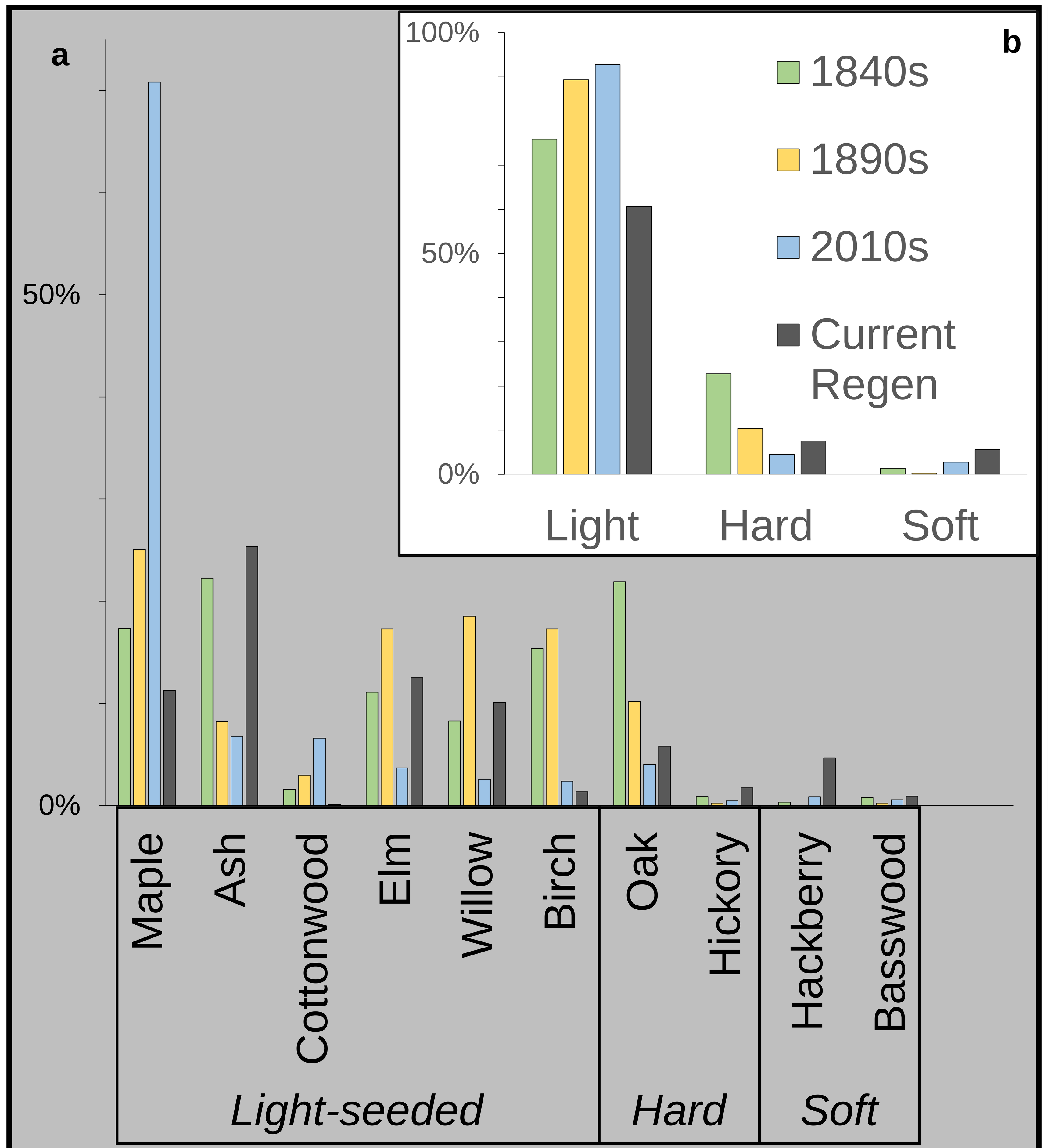

Fig. 2. Graphs showing the proportion of trees by species group (a) for each time period relative to the total number of trees in the dataset and for the mast (seed) type (b). Current regen is assessed using the prevalence of species in the two most dominant understory species classes in the USACE inventory dataset relative to the total number of plots surveyed.

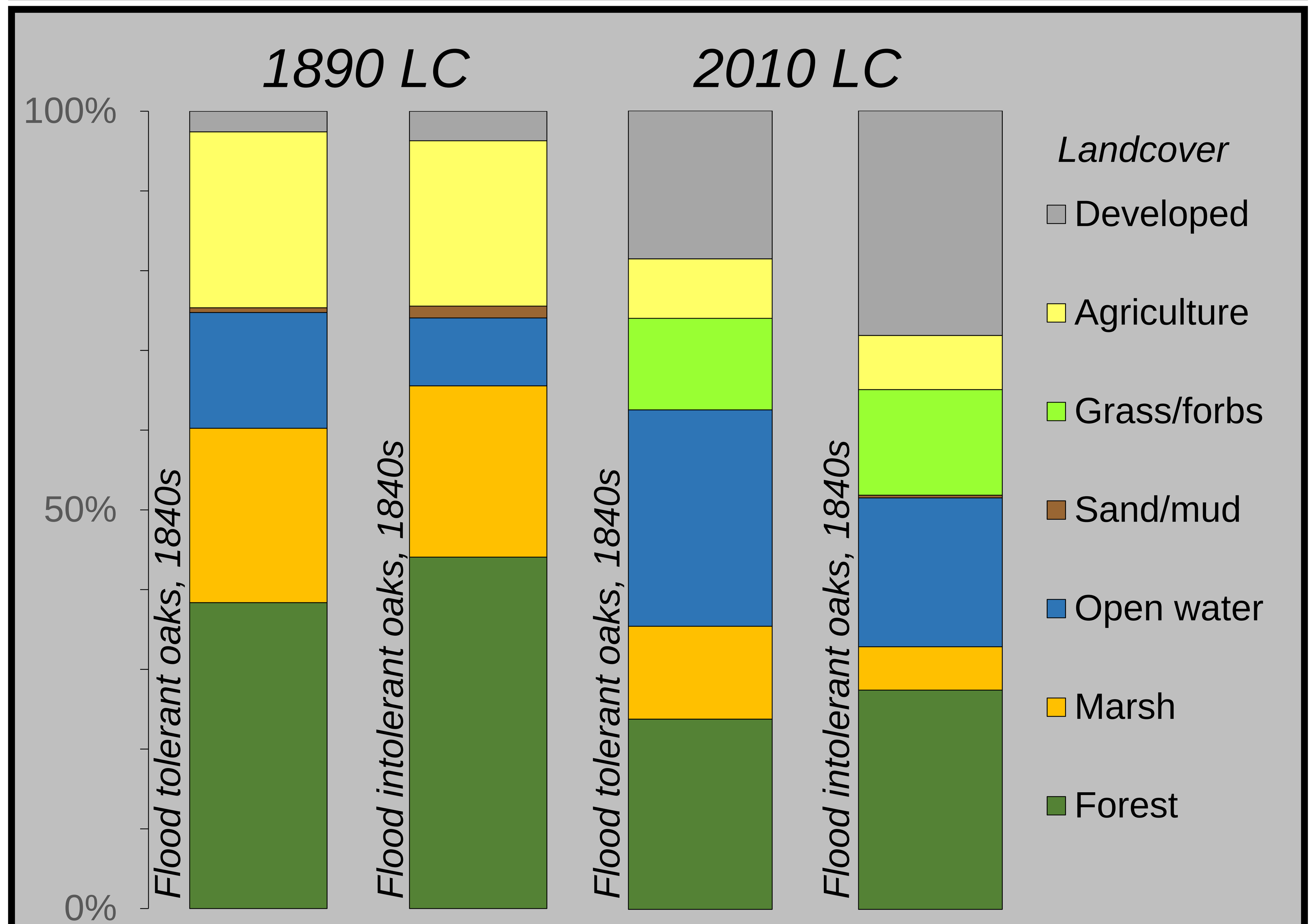

Fig. 3. Landcover changes by 1890 (left) and 2010 (right) at locations with oaks in the 1840 GLO surveys.

Results:
- *Historic datasets for the St. Paul District indicate that light-seeded, early-successional tree species have been predominant since the time of European settlement (Fig. 2b)*
- *Hard mast species have declined by about 18% from the early settlement period (Fig. 2b), though much of that decline occurred prior to 1890 due to development of less flood prone areas (Fig. 3)*
- *All light-seeded species other than silver maple and cottonwood are less common in current surveys, with birch declining by 13% and ash declining by 15% (Fig. 2a)*
- *Current regeneration trends are positive for hard mast species, but mixed for light-seeded species (Fig. 2a)*
- *Ash and elm are the predominant species of regeneration, but these species are under threat from major forest pests (Fig. 2a)*
- *Maple and cottonwood regeneration is present on barely 10% of plots (Fig. 2a)*

Fig. 4. Conceptual process for utilizing natural processes of light-seeded tree species regeneration to promote diverse forest types in the future

Management Implications:
- *Managing for light-seeded tree species is consistent with historical conditions; these actions can generally be implemented without geomorphic modifications, thus reducing costs*
- *Light-seeded species could be used to provide initial cover to prevent establishment of invasive species and provide young forest habitat, while allowing for more targeted restoration of diverse tree species (Fig. 4)*
- *Understanding natural processes allows for leveraging of limited resources to maximize restoration benefits*

__References:__
Almendinger, J.C. 2010. Using Public Land Survey (PLS) records for silvicultural interpretation. Minnesota Dept. of Natural Resources. Available online at: https://files.dnr.state.mn.us/forestry/ecssilviculture/communityTables_Figures/methods/PLSData_%20Methods.pdf
He, H.S., Mladenoff, D.J, Sickley, T.A. and G.G. Guntenspergen. 2000. GIS interpolations of witness tree records (1839-1866) for northern Wisconsin at multiple scales. J. Biogeogr. 27: 1031-1042. Available online at: https://doi.org/10.1046/j.1365-2699.2000.00444.x
LTRM. 2011. UMRS LTRMP 2010/11 LCU mapping. US Army Corps of Engineers Long Term Resource Monitoring Program, US Geological Survey Upper Midwest Environmental Sciences Center, La Crosse, WI. Vector digital data. Available online at: https://www.umesc.usgs.gov/data_library/land_cover_use/2010_lcu_umesc.html
USGS. 1999. 1890's land cover/use – Mississippi River Commission Surveys. US Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI. Digital geospatial database. Available online at: https://www.umesc.usgs.gov/data_library/maps_quads_figs/1890s_mrc.html