TIMING OF DORMANT SEASON INUNDATION IS CRUCIAL TO FLOOD EFFECTS ON BOTTOMLAND RED OAKS

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EXTENDED ABSTRACT

Since flooding in winter and early spring is an integral part of bottomland hardwood ecosystems, moderately flood-tolerant red oaks, such as Nuttall oak (*Quercus texana*), should be well adapted to this dormant season inundation. However, altered hydrologic regimes and unusual weather patterns are now more frequently exposing bottomlands to flooding at times of the year when trees are transitioning into or out of dormancy, which may have physiological impacts on these red oak seedlings.

For example, Sample and Babst (2020) found that soil flooding in fall (from September 20 through December 7) of Nuttall oak seedlings resulted in lower fine root biomass and decreased nitrogen accumulation during flooding and reduced overwinter survival after flooding ended. In unflooded seedlings, there appeared to be much less uptake of some nutrients (e.g., sulfur, phosphorus, and potassium) during the fall compared to nitrogen, and so fall flooding had less impact on accumulation of those nutrients. On the other hand, accumulation of iron, manganese, and sodium greatly increased during soil flooding (Sample and Babst 2020).

To expand upon this work, we examined how the duration of dormant season flooding may affect the performance of seedlings of Nuttall oak and the moderately flood-intolerant Shumard oak (*Q. shumardii*) (Sample and others 2023). We flooded dormant Nuttall and Shumard oak seedlings for 0, 1, 2, or 3 months. Bareroot 1-0 seedlings were potted in January and were in the field with full sun. Pots were placed in tanks to administer flooding to 2.5 cm above the soil line, and all flooding was initiated on February 18. The 1-month flood treatment ended when bud break began, and the 2- and 3-month flood treatments extended 1 and 2 months beyond bud break, respectively.

Flooding that was restricted to the winter dormancy period (i.e., 1-month flood treatment) had no effect on Nuttall oak but reduced the growth of Shumard oak seedlings in the spring. Leaf, root, and whole seedling

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biomass of winter-flooded Shumard oak seedlings remained less than unflooded seedlings at the end of the growing season.

Flooding that extended beyond budbreak (i.e., 2- and 3-month flood treatments) resulted in reduced leaf area and root biomass accumulation for both species. Flooding did not result in increased Nuttall oak seedling mortality, but there was 52 percent and 94 percent mortality in Shumard oak seedlings when flooding extended 1 month and 2 months beyond budbreak, respectively.

Without further flooding during summer, Nuttall oak seedlings in all flood treatments produced leaf area and fine root mass similar to unflooded seedlings by the end of the growing season, indicating the recovery of their ability to take up water and nutrients. The less flood-tolerant Shumard oak seedlings did not fully recover from even the winter-only flood treatment. As a result of slower recovery of resource acquisition tissues, only those Nuttall oak seedlings that had been flooded into late spring (i.e., 3-month flood treatment) had reduced biomass at the end of summer, primarily due to reduced taproot mass. Hence, flooding that extends several weeks beyond budbreak before it subsides will probably have little impact on Nuttall oak but flooding that extends more than 1 month beyond budbreak may cause some stress and reduce the size of the storage organ (i.e., taproot). Such a reduction may have consequences for overwintering or for the ability to tolerate other stresses that may occur over the summer.

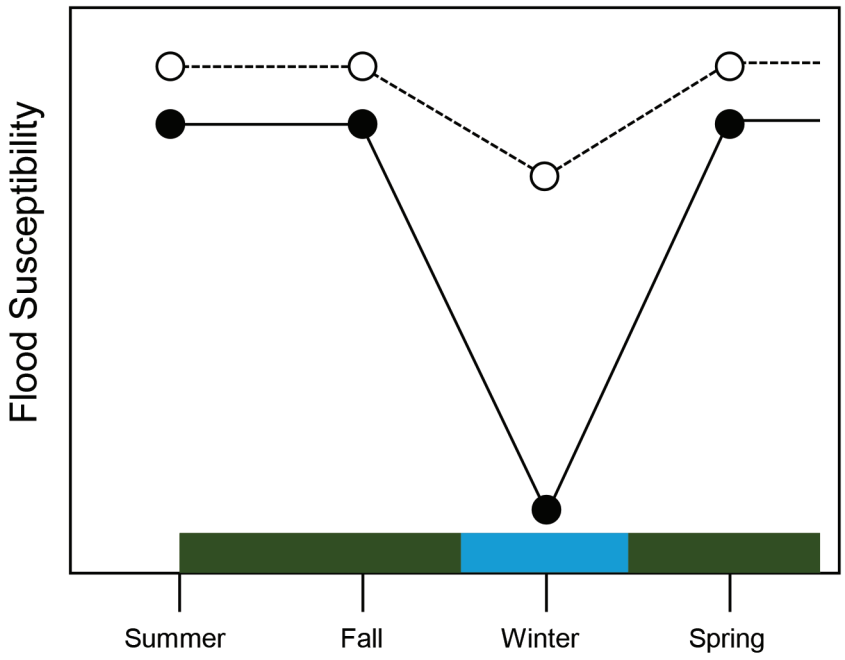

Figure 1—Conceptual model of flood susceptibility in moderately flood-tolerant red oaks, such as Nuttall oak and willow oak (filled symbols, solid line), and flood-intolerant red oaks, such as Shumard oak (open symbols, dashed line). Red oaks do not tolerate prolonged flooding during the summer and fall. The moderately flood-tolerant red oaks become less susceptible to flood only during periods of low activity during winter, whereas the intolerant red oaks do not tolerate prolonged flooding even during the winter. The light blue bar across the bottom indicates the time of year when flooding would be most appropriate in a greentree reservoir to retain red oaks.

To reduce risk of stress and mortality, our results suggest that managers can try to drain flood waters from greentree reservoirs by 1 month after budbreak, where regeneration of Nuttall oak is desired. Bottomland afforestation projects may want to avoid planting Nuttall oak seedlings in locations that are likely to remain flooded in late spring and restrict Shumard oak plantings to higher elevations that typically do not flood.

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