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Predicting Rootstocks for the Conservation of Rare Oaks

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Biodiversity is declining at unprecedented rates around the world, with tree diversity representing an ecologically and commercially valuable resource that is increasingly at risk. In the United States alone, as many as 135 tree species are threatened or endangered, as urban environments rapidly expand. One promising way to maintain populations of declining species is to integrate conservation into existing urban forestry planning. Incorporating declining species into street-tree and urban planting decisions could dramatically expand conservation capacity. However, not all species can thrive in urban conditions, and substantial tree diversity may still be lost unless new strategies are developed.

Grafting offers one such strategy for *ex-situ* conservation in urban environments. Grafting joins a shoot from an endangered species (the *scion)* to the root system of a more common, urban- tolerant species (the *rootstock*). Although graft compatibility often follows taxonomic relatedness, suitable relatives may be unavailable or lack desirable traits such as disease resistance or environmental tolerance. To address this limitation, we apply data-driven methods to predict novel graft combinations based on the hypothesis that graft compatibility is transitive: if species A is compatible with species B, and species B is compatible with species C, then species A and C are also likely to be compatible (Figure 1A). This framework captures patterns rooted in shared molecular and structural properties, enabling compatibility predictions that extend beyond traditional taxonomic expectations.

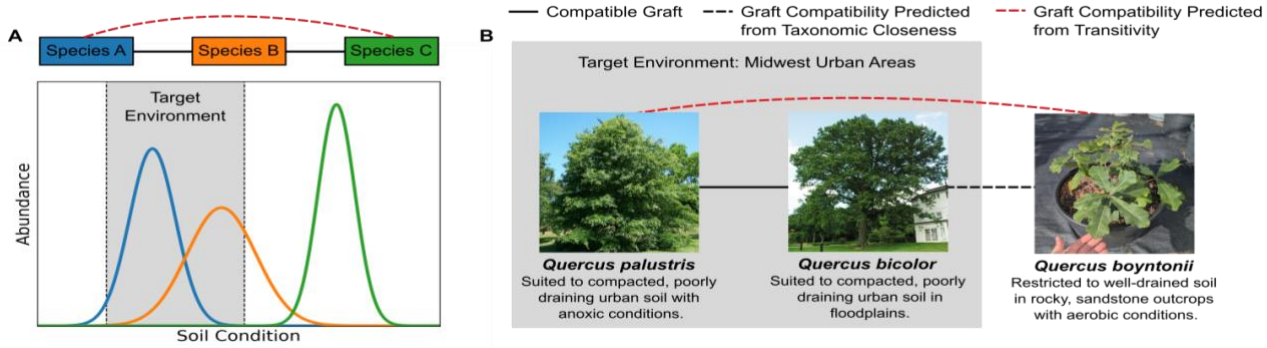

Figure 1: Transitivity-based network prediction of graft compatibility. **(A)** Species A, B, and C thrive in different soil conditions. Grafting species C onto A or B lets it grow where it otherwise couldn't. Since species B is compatible with both A and C, transitivity suggests that A and C should also be compatible. **(B)** For conserving the endangered *Quercus boyntonii*, its close relative *Q. bicolor* is a likely compatible graft partner. Although less closely related, *Q. palustris* is a desirable rootstock for anoxic soils. Because *Q. palustris* and *Q. bicolor* are graft-compatible, we predict that *Q. palustris* and *Q. boyntonii* are compatible as well.

We are using this approach to identify potential rootstocks for the conservation of Boynton oak (*Quercus boyntonii*) (Fig. 1B), a critically endangered tree species endemic to Alabama, now largely reduced to just three remaining natural populations. Leveraging the Chicago Botanic Garden's nationally accredited oak collection, we are experimentally testing which species can serve as viable rootstocks capable of supporting the long-term survival of Boynton oak. If successful, this method can be applied to other rare tree species, offering an innovative strategy for global tree conservation and biodiversity.

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