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MICROHABITAT AFFINITIES OF GAMBEL OAK SEEDLINGS

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ABSTRACT.—Previous work suggested that Gambel oak seedlings are rare in the northern parts of its range in Utah where summer rainfall is relatively low but should be abundant in southern parts of the range where summer rainfall is usually high. Gambel oak grades from a relatively minor component of a ponderosa pine/mixed conifer assemblage in the south to a virtually monotypic formation in the north, where it exists as long-lived clones.

Quadrat analysis in Arizona and New Mexico, within the oak zone, revealed a seedling density ranging from 120 to 1320 per hectare. We found a significant tendency of seedlings to be located on the NE (cool, shady) side of sheltering objects in the environment. Mature ponderosa pine ranged in density from ca 40 to 500 stems per hectare, whereas mature Gambel oak ranged from ca 10 to 20 genets per hectare with ca 1 to 7 ramets per clone. These results support our previous conclusion that Gambel oak in northern Utah probably became established as a minor component of a mixed pine/oak woodland at a time in mid-Holocene when summer rainfall was much higher than today.

Gambel oak (*Quercus gambelii* Nutt.), a deciduous, white oak, is the dominant oak of the southern Rocky Mountain region. Its distribution is primarily encompassed by the states of Utah, Colorado, Arizona, and New Mexico. We previously demonstrated that the northern limits of Gambel oak in Utah appear to be constrained by the combined effects of two distinct airmass gradients (Neilson and Wullstein 1983). Probabilities of late spring freeze as determined by the polar front gradient and summer drought as determined by the "Arizona Monsoon" gradient appear to covary during global warming and cooling trends and appear to have synergistically produced a relatively sharp northern boundary (Neilson and Wullstein 1983). At present, seedling establishment of Gambel oak is rare in the northern part of its range (Neilson and Wullstein 1983). Our transplant studies (seeds and seedlings, Neilson and Wullstein 1983) and physiological studies (Neilson and Wullstein 1986) indicate that natural seedling establishment may be expected to occur only in the parts of the range where summer rains are sufficient for seedling survival.

Gambel oak persists at its northern limits today by virtue of rhizomatous, asexual reproduction (Neilson and Wullstein 1983). We believe that these oaks became established at their northern limits through sexual reproduction and seed dispersal at some time during the mid-Holocene thermal maximum when limiting stresses would have been reduced (Neilson and Wullstein 1983). At that time the shrub and tree community composition in northern Utah, near the northern limits of distribution for this species, might have been similar to that where the species is capable of sexual reproduction and seedling establishment today. Near its northern limits today, where it reproduces asexually, Gambel oak forms an essentially monotypic plant formation, or "mountain brush community" (Ream 1963). In the southern part of its range, where it reproduces sexually, Gambel oak is a relatively minor component of a mixed pine-oak woodland. The purpose of this study is to document the density of Gambel oak seedlings in regions of high summer rainfall, their microhabitat affinities and the general canopy composition of their associated plant communities.

METHODS

In September 1979, 15 quadrats were established in Arizona and New Mexico to ascertain the density of Gambel oak seedlings in various habitats. Excavation of root systems revealed that seedlings can usually be distinguished from suckers on the basis of clustering. Suckers tend to occur in tight clusters, while seedlings are widely dispersed. In many

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