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California's Hardwood Resource: Seeds, Seedlings, and Sprouts of Three Important Forest-Zone Species

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Abstract

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Although California black oak, tanoak, and Pacific madrone are the principal hardwood species in the forest zone of California and Oregon and are key components of many plant communities, their seed production, regeneration, and early growth requirements have received little study. Information is presented on seed production, storage, and germination, and on the density, survival, and growth of three types of hardwood reproduction: seedlings, seedling-sprouts, and root-crown sprouts. Many trials showed that establishing planted seedlings in conventional sunlit plantations is difficult. Although initial stocking levels were high, height growth was poor. Dieback and death were common. Application of fertilizer and water and concomitant foliar analysis and tests of xylem sap tension indicated that internal moisture levels were inadequate to sustain seedling height growth. Thus, manipulating seedling-sprouts and root-crown sprouts currently are the silviculturist's best techniques for establishing new stands. On a good site, root-crown sprouts of California black oak and tanoak were 20 feet tall in 10 years and those of Pacific madrone were 22 feet tall in the same time span. However, more information is needed on overstory-understory relationships for promoting the growth of seedling-sprouts and more knowledge is needed on clump density and thinning regimes for root-crown sprouts.

Retrieval Terms: California black oak, ecology, growth, Pacific madrone, regeneration, tanoak, vegetative propagation

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In Brief . . .

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California black oak, tanoak, and Pacific madrone are California's most widespread and most valuable forest-zone hardwoods. They are found throughout California and in part of Oregon and grow from near sea level to the 7,500-foot elevation. They occur as pure hardwood stands, as components of mixed hardwood and conifer stands, and as occasional trees, clumps, and groves within the conifer forest. Their ecosystems are both numerous and complex. More than 300 species of wildlife use these hardwood-dominated habitats for reproduction, many people enjoy the contrast and beauty of these hardwoods in spring and fall, and many acre-feet of water originate in the hardwood forest.

In spite of their recognized value as habitats and important components of ecosystems, these hardwood species are scarcely utilized and virtually unmanaged. Currently, the best "management" they receive is not cutting them. In some areas, these species have been eliminated in favor of other species or uses, and managers now want to reestablish them. In other areas, the old trees that are present have lost their ability to sprout, and seedlings are not present to replace them. In still other areas, small seedlings are plentiful, but never seem to grow larger. Plainly, silviculturists need to know how to successfully regenerate the hardwood forest. More specifically, they need to be able to secure regeneration, however initiated, that will be reliable and consistent and that will rapidly grow and become trees. This paper presents what is known on the reproductive silviculture of California black oak, tanoak, and Pacific madrone in the forest-zone of California and southwest Oregon.

California black oak, tanoak, and Pacific madrone regenerate via three reproductive modes to form seedlings, seedling-sprouts, and root-crown sprouts. Seedlings, like their name suggests, originate from seed and their tops have never died back to the root crown (burl); seedling-sprouts also originate from seed, but their tops have died back and sprouted from small burls at least once; root-crown sprouts originate from larger burls on top-killed trees, and although they die, they seldom die back. Each reproductive type is unique, and the individual seedlings, single sprout stems, or multiple sprout stems develop differently and have different growth potentials.

Although we present information on seed production, storage, germination, and direct seeding, we collected even more information on the three types of reproduction. In general, where a seed source is present, the seedlings of each of these three species can number 1,000 or more per acre. Some remain as single stems, but many die back one or more times, depending on the amount of light and other factors, to become seedling-sprouts. Populations of seedling-sprouts beneath tree crowns constitute an in-place resource that can be managed to form new stands. Research is needed on manipulating the overstory and in thinning the number of seedling-sprouts to provide adequate site resources for enhanced growth. Root-crown sprouts, which benefit from existing portions of parent-tree root systems, are another established resource that can be manipulated to form stands of these hardwood species. Much is known on root-crown sprout density, number per stump, and growth rates in various environments. Equations are available for projecting this information.

Artificial regeneration with planted seedlings is a reproduction mode that needs more work. Although some research has been done in conventional sunlit plantations, and results from trials with fertilizer, water, and shading are available, knowledge on seedling growth in partially shaded plantations is needed.

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The Forest Service, U.S. Department of Agriculture, is responsible for Federal Leadership in forestry. It carries out this role through four main activities:

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