Oak Woodland Ecology and Monitoring

Habitat Fragmentation Limits Pollen Availability and Acorn Production in Blue Oak

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Although the negative consequences of habitat fragmentation in forested landscapes are becoming better understood, we still know remarkably little about the effects of tree removal on the pollination dynamics of the remaining trees. Oaks and many other trees of temperate regions worldwide are wind-pollinated and require the transfer of pollen from neighboring trees to produce seed. When pollen is released into the air, the density of pollen grains declines rapidly with increasing distance from the source. Isolated oak trees may therefore receive insufficient pollen, and acorn numbers may be reduced. However, because oak trees generally produce large volumes of pollen, considerable isolation may be required to limit pollen availability and reproduction. The density of trees necessary for optimum pollen transfer is not known.

To investigate the importance of stand density to pollination and reproduction in blue oak, we evaluated pollen and seed production on 100 neighboring adult trees in a fragmented and heavily thinned population (canopy cover reduced from 60% to 6%) located at the University of California Sierra Foothill Research and Extension Center in Yuba County. Some trees within the 0.8km by 0.3km study area were quite isolated, located as far as 60 meters from the closest neighbor, while other trees had multiple near neighbors. Trunk diameters of all trees were measured to estimate size, and location of each tree was mapped using a global positioning system (GPS). We estimated the amount of pollen potentially available to each tree using a "pollen neighborhood" model. This model used map coordinates of each tree to calculate the number of neighboring trees located within 30 to 90 meter radii around each tree, and took differences in tree size, pollen production, and flowering period into account. Size of the acorn crop was evaluated using visual surveys in 1996, 1997, and 1998. We then calculated correlations between the amount of pollen potentially

available to each tree (modeled pollen neighborhood scores) and acorn production.

Trees with the highest predicted pollen neighborhood values—those potentially exposed to higher amounts of pollen—produced the most acorns in 1996, while trees potentially exposed to less pollen due to isolation produced the fewest acorns. Over 90% of trees produced acorns and most trees produced a moderate to large crop in 1996. Overall acorn production was considerably less in 1997 and 1998, with only 61% and 34% of the trees producing acorns, respectively. Because spatial relationships among trees remained the same, it was apparent that factors other than tree density limited reproduction of some trees in the latter two years. When only trees that were at least minimally reproductive (>5 acorns sighted per 30-second count per tree) were considered, a significant positive correlation between pollen availability and acorn production was again found. Acorn production in 1998 was so low that meaningful analysis between pollen availability and acorn crop size could not be conducted.

Factors other than tree density can also limit reproduction in blue oak. Pollen transfer through the air is most efficient in dry and warm conditions. Studies of other oak species have shown that the male flowers do not open and release pollen unless humidity drops below 45% for several hours. In 1998, many of the trees flowered during a period of rainy weather and subsequently produced no acorns. Amount of solar radiation received during the pollination period was positively correlated with acorn production in this year. We additionally found evidence that the size of the prior year's acorn crop influences acorn yields. Trees that produce large numbers of acorns in one year may not have the resources to produce a large crop in the subsequent year. This may have been the cause of low acorn production on many trees in our study in 1997.

Taken together, our results indicate that habitat fragmentation and isolation of trees can alter pollen availability and reduce acorn production in blue oak. This finding has important implications for California's oak woodlands due to the continuing loss of trees caused by urbanization, agricultural clearing, and commercial harvest. In addition, the poor regeneration of blue oak occurring in parts of its range may cause population densities to decline if recruitment does not keep pace with mortality. Our data suggest that the health of California's oak woodlands may depend on maintaining stand densities adequate for efficient wind-pollination.

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