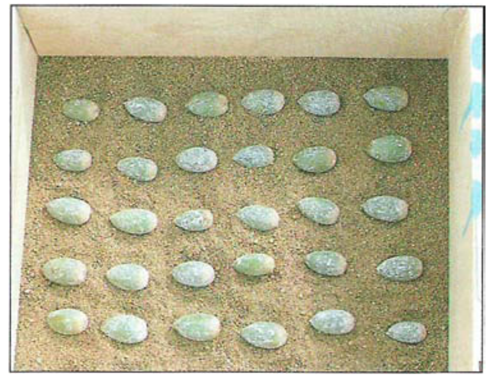
Environmental factors contribute to acorn quality...

Elevation, on- or off-tree collection influence the viability of blue oak acorns



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Concern about the regeneration of California's native oaks has inspired several investigations that indicate acorn quality is one of many factors affecting regeneration. A survey conducted in Kern County in 1990 indicates that elevation influences blue oak and valley oak acorn quality; location with regard to water drainage is another factor for blue oak acorns.

Many resource management professionals, landowners, and conservation groups in California are concerned about long-term sustainability of oaks in hardwood rangelands. A statewide survey concluded that sapling recruitment throughout California appeared insufficient to replace many existing blue oak stands under current environmental and management conditions. That survey prompted one in 1988 that was confined to the South Sierra Hardwood Range Region, which consists of Madera, Tulare, Fresno, and Kern counties (*California Agriculture*, March-April 1991). A cooperative project of a UC hardwood specialist and four county farm advisors, it showed that blue oak regeneration was poorest at elevations below 2,000 feet, probably because of limited moisture, but appeared to improve considerably above 2,000 feet. This information provided the background for a 1990 survey in Kern County.

The South Sierra Hardwood Range Region contains almost 1.5 million acres of hardwood rangeland, mostly under private ownership. The primary land uses are livestock grazing, recreation, and home site development. To date, little information had been developed to help understand the ecology of the oaks in the region. This survey's purpose was to discover whether the differences in oak regeneration observed in 1988 could be explained by differences in acorn quality, elevation, water drainage, and method of acorn collection: whether the acorns were picked from the tree or from the ground.

The 1990 survey

The quality of acorns was assessed by their weight, germination rate, and levels of insect and fungus damage. The survey area is dominated by two species of oaks: blue oak (*Quercus douglasii*) and valley oak (*Q. lobata*). Four geographic areas — Glennville, Walker Basin, Rancheria Road, and Fountain Springs — were designated as water drainages, their elevations ranging from 2,000 to 4,500 feet. Blue oak acorn samples were gathered at the same elevations as in the 1991 survey: low (1,250 to 2,040 feet), medium-low (2,640 to 2,850 feet), medium (3,110 to 3,910 feet), and high (4,200 to 4,690 feet). Valley oak acorn samples were taken at two elevations, low (1,670 to 2,910 feet) and high (4,250 to 4,680 feet). The two oak species were not present together in all of the four water drainages or at all of the six elevations.

Acorns were collected from trees within 100 yards of existing roads. Oak trees were not present at all elevations in each location, and among trees that were present many did not produce acorns. Acorns were collected from October 5 to October 13, 1990. Animal predation of acorns was so extensive in some areas that ground samples could not be collected, and at the higher elevations acorns had not started to drop. When possible, "ground" and "tree" samples were collected from the same tree. All samples were placed in sealed, zip-closing plastic bags, and stored in a cooler at about 34°F for 3 weeks.

Twenty acorns were collected from each of the 82 sample trees. Five acorns were randomly selected from the 20 from each tree to obtain an average fresh weight and to estimate germination rate. For each sample, the five selected acorns were then germinated together in a 1-gallon plastic pot filled with commercial potting soil. Pots were placed outside from early November until early March, and their soil was moistened during periods of no rain. On March 9, 1991, the pots were dumped and the acorns recovered to evaluate signs of germination.

The remaining 15 acorns from each sample were cut open after removal from cold storage and evaluated for the presence of insect activity or of fungi. Insect larvae were filbert weevil (*Curculio occidentis*) or filbert worm (*Cydia latiferreana*). Any kind of insect feeding activity in the kernel (burrowing and frass), even though larvae were not present, was recorded as insect damage. The extent of insect feeding was not evaluated. The presence of fungal growth or deep stains in the kernel were recorded as fungal damage, although some stains could have been caused by bacteria. Data were analyzed using analysis of variance (ANOV) and least-significant difference (LSD).

Blue versus valley oaks

Blue oaks and valley oaks grow in the same general location, but have distinct micro-environment requirements. For this reason, data about them were pooled over elevation, water drainage area, and location of acorn collection (tree or ground). As would be expected, the larger valley acorns weighed significantly more than

TABLE 1. Acorn quality of blue oaks and valley oaks
Factors influencing acorn quality

Species	Trees sampled	Ave. acorn weight	Germination	Insect damage	Fungus damage
		g	%		
Blue oak	57	2.69 a*	51.6 a	10.6 a	12.1 a
Valley oak	25	5.34 b	65.8 a	20.7 b	18.7 a

*Values with different letters within acorn quality groups were different at $P < 0.05$.

Acorn germination rate varies from one ecological site to the next. These acorns were gathered from one site; as they sprout and grow in the laboratory, data on their emergence will be correlated to environmental conditions at the collection site.

blue oak acorns: 5.3 grams (g) versus 2.7 g (table 1).

Under this survey's conditions, germination rates were similar for the two species (blue oak, 51.6%; valley oak, 65.8%). Compared with blue oak acorns, twice as many valley oak acorns had insect damage (20.7% versus 10.6%). Of those observed with insect damage, filbert weevil larvae were found in 58.8% of the blue oak samples and in 56.1% of the valley oak samples. Only 0.8% of the larvae identified were filbert worm larvae. Fungal damage was similar in both species (12.1% in blue oak; 18.7% in valley oak).

Blue oaks: germination and damage

Water drainage was the only environmental parameter in this survey that influenced blue oak acorn weight. Walker Basin had the smallest blue oak acorns (1.36 g), and Fountain Springs had the largest (3.98 g) (see table 2).

Elevation appeared to greatly influence blue oak germination rate. Acorns at the lowest elevation (under 2,040 feet) had the lowest germination rate (19%). The medium-low elevation group had the highest germination rate (82.5%). Germination rates for the higher elevations were similar: 55% at 3,110 to 3,910 feet and 46.2% at 4,200 to 4,690 feet.

One possible explanation for the difference in germination rates at the lower elevation level was the difference in moisture content of the acorns. Acorns at the lowest elevation probably mature earlier in the year and are exposed to higher temperatures than are acorns at higher elevations; thus, acorns from lower elevations lose more moisture. Previous work reported in *California Agriculture* (January-February 1989) showed that as acorn moisture decreases, germination also decreases. Preliminary data from the 1990 survey would indicate that elevation does not have as great an effect on germination as is indicated by the 1990 data. It should be kept in mind that this survey was conducted in the fourth year of drought conditions in the study area. Information regarding the relationship between drought, elevation, and germination is limited.

Acorns collected from blue oak trees had higher germination rates (58.5%) than those collected from the ground (25.5%). A 1990 report noted that blue oak ground samples had greater insect damage, greater fungal damage, and lower germination rates than acorns collected from trees. Preliminary data from a 1991 study conducted by the author showed that acorns collected from the tree had 91.3% germination compared with 30% germination for acorns collected from the ground. The difference between germination rates in the two studies could be attributable to differences in environmental conditions or in the moisture content of tree-collected acorns. Also, there was more insect damage in acorns collected from the ground than in acorns collected on the tree. This could be expected because insect-damaged acorns tend to fall first; consequently, a higher percentage of insect-damaged acorns can be found on the ground. Also, more acorns sampled from the ground had fungal damage than did those sampled from the tree.

The 1990 report also noted that blue oak acorns damaged by insects drop to the ground before uninfected acorns drop; therefore, in that survey, acorns from the tree had 12.9% internal insect damage, whereas 87.1% of the acorns collected from the ground were damaged by insects. Also, 4.5% of the acorns collected from the tree reportedly had internal fungal damage, whereas acorns picked up from the ground had 95.5% internal fungal damage. Considerable differences in insect and fungal damage of acorns were reported between years and between locations.

The Glennville water drainage had the highest germination rate (72.7%), followed by Walker Basin and Rancheria Road (36% each) and Fountain Springs (25%). Elevation apparently has little influence on the amount of insect damage, but there was considerably more fungal damage at the lower elevations. Of the four water drainages, Glennville and Walker Basin had the least amount of insect and fungal damage.

Valley oaks: influences

Both elevation and water drainage appeared to influence the weight of valley oak acorns. The heaviest were found at the lower elevations and at the Glennville water drainage (table 3).

Water drainage was the only factor influencing the germination rate for valley oaks. The Glennville drainage produced acorns with the highest germination rate. Elevation and where acorns were collected (from trees or ground) appeared to have no influence on the germination rate for valley oaks. Valley oak acorns collected from higher elevations had more insect damage, which was not seen in blue oak.

TABLE 2. Influence of elevation, water drainage, and origin of acorns on quality of blue oak acorns

		Factors influencing acorn quality			
Species	Trees sampled	Avg. acorn weight	Germination	Insect damage	Fungus damage
		g	%		
Elevation (ft)					
1,250–2,040	14	2.94 a*	19.0 a	18.3 a	37.8 a
2,640–2,850	16	2.90 a	82.5 c	6.2 a	0.4 b
3,110–3,910	12	2.10 a	55.0 b	1.7 a	4.2 b
4,200–4,690	15	2.72 a	46.2 b	15.2 a	7.1 b
Tree versus ground					
Tree	45	2.79 a	58.5 a	7.5 a	5.1 a
Ground	12	2.09 a	25.5 b	22.1 b	38.5 b
Water drainage					
Glennville	30	2.91 ab	72.7 a	5.5 a	1.9 a
Walker Basin	5	1.36 a	36.0 b	0.0 a	0.0 a
Rancheria Road	14	1.93 a	27.1 b	21.8 b	32.6 b
Fountain Springs	8	3.98 b	25.0 b	16.6 b	22.4 b

*Values with different letters within different parameters and acorn quality groups differ at $P < 0.05$.

TABLE 3. Influence of elevation, water drainage, and origin of acorns on quality of valley oak acorns

		Factors influencing acorn quality			
Species	Trees sampled	Avg. acorn weight	Germination	Insect damage	Fungus damage
		g	%		
Elevation (ft)					
1,670–2,910	16	6.34 a*	67.9 a	16.0 a	12.7 a
4,250–4,680	9	3.56 b	62.2 a	29.1 b	22.2 a
Tree versus ground					
Tree	13	5.06 a	68.2 a	21.3 a	1.8 a
Ground	12	5.63 a	63.3 a	21.1 a	37.1 b
Water drainage					
Glennville	15	6.63 a	70.7 a	17.2 a	18.5 a
Rancheria Road	10	3.40 b	58.6 b	25.9 a	18.9 a

*Values with different letters within different parameters and different acorn quality groups differ at $P < 0.05$.

The absence of sapling-size oak trees from many stands in California is cause for concern. Each blue flag at this site marks a seedling growing from a fallen acorn, but few of these young oaks can be expected to grow into adult trees.

There was no difference in the amount of insect damage to tree- versus ground-collected valley oak acorns, or to acorns from different water drainages.

The only environmental factor influencing fungal damage to valley oak acorns was whether acorns were collected from trees or from the ground (1.8 versus 37.1%, respectively). Like blue oak acorns, valley oak acorns may have been damaged when they dropped to the ground, or the level of fungi may have been greater on the ground. The differences in fungal damage in blue oak acorns relative to elevation and water drainage did not hold true for valley oak acorns.

Conclusions

Elevation and tree or ground collection of acorns were the two greatest environmental influences on the acorn quality of blue oaks. The South Sierra Hardwood Range survey showed that the greatest number of small blue oaks (less than 1 foot tall) were found at elevations from 2,000 to 3,000 feet. The current survey indicated that the highest-quality blue oak acorns, as measured by germination rate and insect and fungal damage, were collected from this same elevation range. These results would suggest that blue oak acorn quality can influence regeneration, but several years of more detailed studies should be conducted before definite conclusions can be drawn.

Elevation and water drainage where acorns were collected did not influence the quality of valley oak acorns as they did blue oak acorns. Elevation, however, did influence the amount of insect damage found in acorns, and acorns collected from trees had less fungal damage than did those collected from the ground, a factor that may affect long-term survival of valley oaks. This survey would suggest that data from one species are not applicable to other species, even when they grow in the same general area.

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