Southern Oak Woodlands of the Santa Rosa Plateau, Riverside County, California

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INTRODUCTION

The Santa Rosa Plateau is a distinct topographic unit located at the southeastern end of the Santa Ana Mountains (Lathrop and Thorne 1968). The southern oak woodland community in the Santa Ana Mountains is closely associated with grasslands, but mainly occurs from Los Pinos and El Cariso southward, with its greatest development on the Santa Rosa Plateau (Lathrop and Thorne 1968). *Quercus engelmannii* Greene (Engelmann oak, Fig. 1) and *Q. agrifolia* Nee (coast live oak, Fig. 2) are dominant in this community with associated species of *Ceanothus, Rhus, Ribes,* and other shrubby genera, intruding from the chaparral (Thorne 1976). Lathrop and Thorne (1978) presented a brief account of species associated with the oak woodlands on Mesa de Burro of the Santa Rosa Plateau. Snow (1972, 1979) and Zuill (1967) reported on distribution and structure of *Q. engelmannii* and *Q. agrifolia* on the plateau. Zuill (1967) recognized two woodland types here. One was called "dense oak woodland" (Fig. 3) and the other "grass oak woodland" (Fig. 4). Griffin (1977) states that these two types are really two forms of one of the two phases of southern oak woodland, the Engelmann oak phase. Griffin indicates that the second phase, the coast live oak, is not present in the Santa Rosa Plateau. The two woodland types of Zuill (1967) however, are both composed of *Q. engelmannii* and *Q. agrifolia.*

Oak woodlands are discontinuous (Cannon 1914; Cooper 1922), including those in the Santa Ana Mountains. Dispersion patterns may be very complex in communities of this sort (Catana 1963). Particular emphasis in this study, which has spanned intermittently from 1966 to the present, was given to the discontinuity of the oak woodlands on the Santa Rosa Plateau.

METHODS

Dispersion patterns.—Tree density was measured using a modification of the wandering quarter methods developed by Catana (1963). Transects were arranged to accommodate the configuration of the long, narrow woodland patterns.

White (1966) defined grassland intrusions in foothill woodlands to be openings with a diameter about twice that of the largest oak canopies (46 m in both his study and ours). Following his method, we rejected all measurements greater than 46 m.

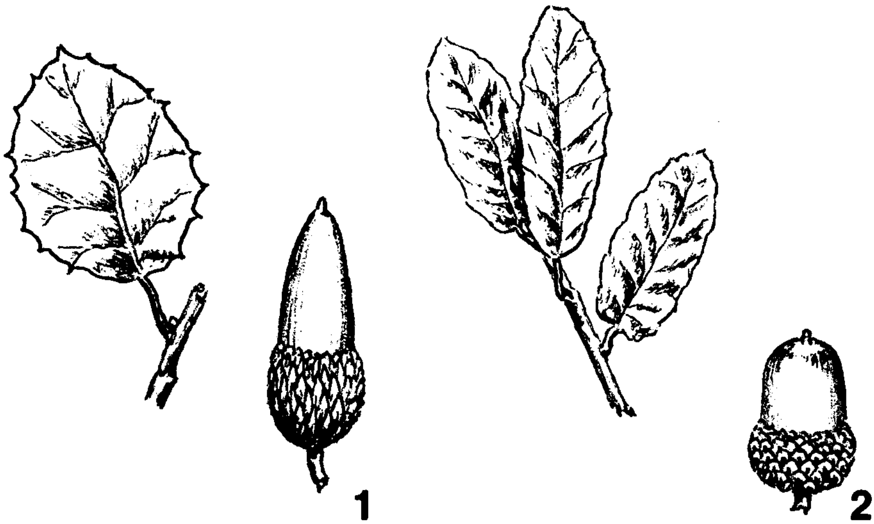

Fig. 1–2.—1. *Quercus agrifolia.*—2. *Q. engelmannii.* (Both $\times 2/3$).

The boundary between woodland and chaparral is not always distinct. A common chaparral species (*Quercus dumosa* Nutt.) hybridizes with Engelmann oak. Although some hybrids were encountered, the chaparral proper was avoided by rejecting all trees with less than 6.5 cm dbh. Sometimes individual trees occur between clumps or in the open spaces. Distance measurements to such trees were treated as in Catana (1963). The two or more distance measurements were combined and corrected. Even though the combined and corrected measurements might exceed 46 m, they were retained unless the individual measurements exceeded this distance. Distances were tested for homogeneity at the 95 percent significance level using the adaptation of the Wald and Wolfowitz test described by Catana (1960). Distances were then divided into within-clump and between-clump subgroups using three times the mode of the measurements as the separating value. Between-clump distances were used to test the adequacy of the sample. An adequate sample had a standard error of the mean less than 10 percent. In a random population there is no separation as all measurements fall within a range of

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Fig. 3–4.—3. View of the "dense oak woodland" form of the Engelmann oak phase of southern oak woodland community. This woodland type usually occurs in swales and shallow valleys, often amid large basaltic boulders.—4. View of the "grass oak woodland" form, most often found on slopes and rolling hills.


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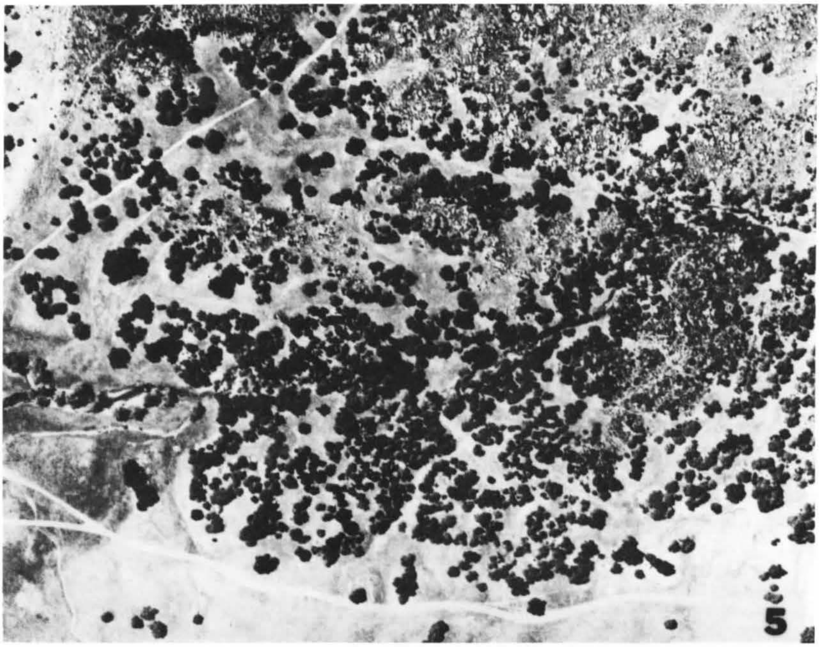


Fig. 5–6.—5. Aerial photograph (1949) taken along the Tenaja Rd. on the Santa Rosa Plateau showing a typical stand of the DOW form of southern oak woodland.—6. Aerial view (1949) of a portion of the Santa Rosa Plateau with a view of the GOW form of southern oak woodland.

plus or minus three times the mode. Further indication of dispersion pattern is given by the coefficient of variation of the distance measurements, which is between 40 percent and 60 percent for random distribution and is less than 40 percent for regular distributions and above 60 percent for clumped distributions.

The Wald and Wolfowitz test was given to the transect data. This test divided woodlands into two classes, the two forms of the Engelmann oak phase of southern oak woodlands according to Griffin (1977). The more dense of the two forms will hereafter be referred to as dense oak woodland (DOW) and the less dense will be referred to as grassy oak woodland (GOW).

Cover.—Crown cover was estimated by marking line intercept transects over 1949 aerial photographs of the study areas (Figs. 5, 6). One cm on the photograph was equal to 48 m on the ground. A comparison of the photographs with field sites indicates there has been little change during the intervening years. Forty 10-cm transects were made, equally divided between the DOW and GOW forms of the woodlands on the photographs. The transects were made on portions of the woodland that had been shown to be homogenous by the modified Wald and Wolfowitz test.

RESULTS

Distribution.—Distribution data for both oak species together in each of the woodland forms is given in Table 1. The coefficients of variation for all measurements (with the exception of those made for the Engelmann oak alone in GOW) indicate that nonrandomness (aggregated) is caused by large holes (gaps in the woodland greater than 46 m distance) in an otherwise randomly distributed population. The coefficient of variation of Engelmann oak alone on GOW (58) indicates a statistically random population, but tends toward aggregated. Mean distance between trees in DOW is about three-fourths that of GOW. Density in DOW is about three times greater than in GOW, but crown cover of both woodland forms is about the same (Table 1). Intrusion of grassland into both DOW and GOW is 8 percent. Frequency distribution by trunk diameter (dbh) of the two main tree species in both GOW and DOW woodland forms is given in Figures 7 and 8, respectively.

Composition.—Relative dominance was approximately equal in DOW (48 and 52 for *Quercus agrifolia* and *Q. engelmannii,* respectively). Engelmann oak, however, dominated over coast live oak almost 9 to 1 in GOW (relative dominance of 90 and 10, respectively).

CONCLUSIONS

The oak woodlands on the Santa Rosa Plateau are considered to be the Engelmann oak phase of the southern oak woodland community (Griffin

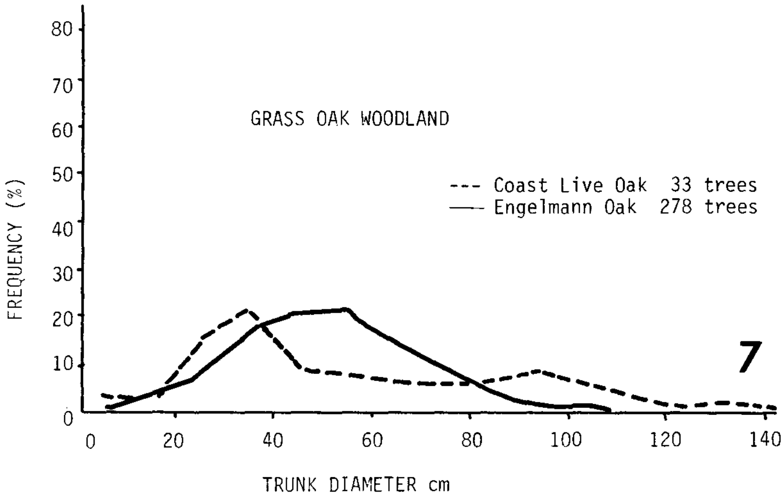
Table 1. Comparison of distribution and clumping characteristics for the dense oak (DOW) and grassy oak (GOW) forms of the oak woodlands on the Santa Rosa Plateau.

Measurement	DOW	GOW
Number of individuals (N)	182	317
Mean distance between trees (M)	12	15
Mean distance between trees corrected (M)	7	13
Coefficient of variation for distance measurements	76	62
Mean distance across holes (M)	31	46
3 × mode	15	31
Mean area of holes (M^2)	1400	3500
Density of holes (no/ha)	7	3
Density (no/ha) in woodland	56	27
Crown cover (%)	64	57

1977). Analysis of measurements of *Quercus agrifolia* and *Q. engelmannii* on the plateau, obtained by the use of the wandering quarter method indicate that this woodland phase (of Griffin 1977) could possibly be divided further into two forms: 1) the "dense" form (Figs. 3, 5); and 2) the "savanna" form (Figs. 4, 6).

In classifying woodlands with respect to crown cover, both the plateau oak woodland forms fall into the semidense type of Jensen (1947). Cover difference between the woodlands is only 7 percent—64 percent for DOW as compared to 57 percent in GOW. Differences show up, however, when other parameters of the two woodland forms are compared. The number of holes (density) is greater in DOW than in GOW, but the area of each hole is less than in GOW (Table 1). Comparing the total area devoid of trees (holes or gaps) in both DOW and GOW the two woodlands are probably similar in this respect. Reference has previously been made to the idea that holes in both woodland forms contribute to their somewhat nonrandom distribution.

There is a contrast in total density between the two woodlands, with a mean density of 56/ha in DOW as compared to 27/ha in GOW. A comparison of composition (relative dominance) indicates that the two oak species are represented approximately equal in DOW but Engelmann oak dominates almost 9 to 1 in GOW. It appears that the increase in density in DOW is not due to an increase in numbers of Engelmann oak in that woodland type, but rather that the coast live oak is superimposed on the Engelmann oak distribution in DOW resulting in over twice the density here. In this respect, Engelmann oak unifies the two woodland forms, attesting to Griffin's classification of the Engelmann oak phase for the southern oak woodlands on the Santa Rosa Plateau.



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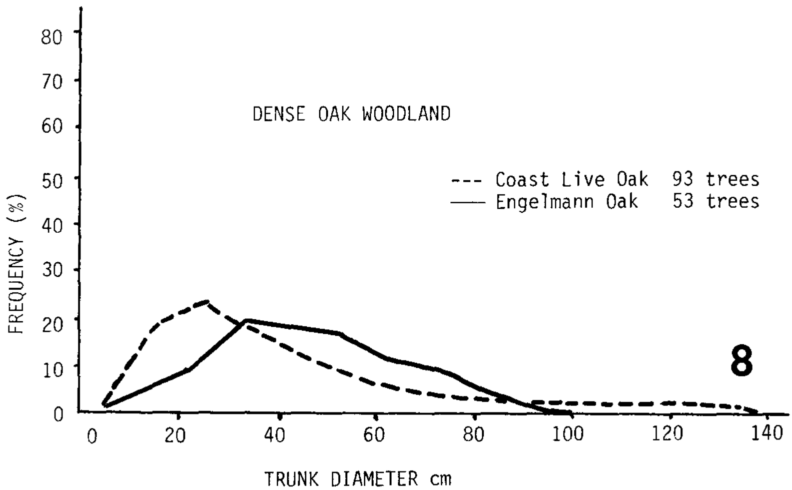

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Fig. 7–8.—7. Graph showing frequency of coast live and Engelmann oaks in relation to trunk diameter in GOW.—8. Frequency distribution in relation to trunk diameter of coast live oak and Engelmann oak species in DOW.

The two woodlands are approximately the same when considering sizes of trees, except that there is a slightly higher frequency of larger-diameter trunks, in the low to medium range, in GOW compared to DOW (Figs. 7, 8). Coast live oak tends to show higher frequencies at both ends of trunk-diameter range whereas Engelmann oak has higher frequencies in the middle-diameter range. This latter trend is true for both woodlands.

DISCUSSION

The oak woodland trees on the Santa Rosa Plateau were measured (N = 499) using the wandering quarter method. Trees primarily associated with the riparian community were not included. Thus the woodlands on the plateau consisted of only two species, *Quercus agrifolia* and *Q. engelmannii.* The Wald and Wolfowitz test, given to the transect data, divided the woodlands into two classes—subsequently labeled DOW for the "dense" form and GOW for the "savanna" or less dense form. From there the various parameters measured were compared to these two artificial forms.

Except for cover, one aspect of holes and the somewhat unifying characteristic of the Engelmann oak populations on both woodland forms, most of the other parameters seem to indicate differences. These differences may well be artificial and arbitrary and should be considered such until they can be tested. It is the authors' hope that this "pilot study" will encourage others to further explore this aspect of the oak woodlands on the plateau. Now that the Nature Conservancy has a large sanctuary on the Santa Rosa Plateau, oak studies, as well as other interesting biological problems, will be encouraged.

As a starter for further studies on this problem, one could perhaps consider whether *Quercus agrifolia* is superimposed on *Q. engelmannii* distribution in DOW or whether *Q. engelmannii* only appears to have the ability to invade grasslands and form "savannas."

Snow (1972) has suggested that coast live oak is more closely associated with large rock outcrops than is Engelmann oak. He indicates that seedlings of both oak species are very rare on the Santa Rosa Plateau, except that coast live oak seedlings may survive amid the rocks, due to the water harvest of the rocks and the acorns being buried by ground squirrels in holes around the rocks. Snow (1979) states that coast live oak seedlings are less resistant to fire than Engelmann oak seedlings and the rock outcrops may provide some protection from fire. The protection of oaks by rocks against grazing cattle, which have been in the area continuously for the last 75 years, may explain why seedlings and saplings are not often found away from rock outcrops.

In other oak woodlands in California, Griffin (1971, 1976) has shown that deer, birds, gophers, and insects in the absence of cattle can seriously reduce the establishment of oaks. These short explanations as to why this community is the way it is may form the base for further studies, but at present these explanations are inadequate.

ACKNOWLEDGMENTS

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