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Source: *The Southwestern Naturalist*, Vol. 14, No. 2 (Oct. 10, 1969), pp. 149-155
Published by: Southwestern Association of Naturalists
Stable URL: http://www.jstor.org/stable/3668869
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THE SOUTHWESTERN NATURALIST 14(2):149–156 OCTOBER 10, 1969

SURVIVAL OF *QUERCUS TURBINELLA* AND *Q. EMORYI* SEEDLINGS IN AN ARIZONA CHAPARRAL COMMUNITY

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ABSTRACT. Naturally occurring seedlings of shrub live oak (*Quercus turbinella*) and Emory oak (*Q. emoryi*) are uncommon, but a moderate population was observed in August 1963 on chaparral strips burned 1 and 2 years previously. Ninety-four shrub live oak and 47 Emory oak seedlings were tagged. After 3 years, survival of shrub live oak seedlings was 26 percent, and Emory oak, 27 percent. Nearly all mortality was attributed to drought. It is hypothesized that rainfall is suitable for oak seedling germination and establishment only 1 year in 10. Critical moisture values suggested are 15 inches or more of October-March precipitation, followed by 10 inches or more of July-September rainfall.

Shrub live oak (*Quercus turbinella* Greene) is the most characteristic shrub of the chaparral in central Arizona, where it is commonly the dominant shrub on all sites and exposures (Shreve, 1942). Emory oak (*Q. emoryi* Torr.) is a common associate, but is usually found on the deeper soils and more mesic sites, where it may occur as groves of small to medium size trees. On poorer sites it occurs as scattered individuals, scarcely tree-like.

Both species sprout readily after fire, and are highly resistant to damage by browsing, pests, and disease. They appear to live to considerable age, resprouting after infrequent fires sweep over them (Cable, 1957). Mortality of each species in stable communities is low, as indicated in the few studies made of individual plants. Thus, few seedlings are needed to replace the occasional decadent individuals. In fact, seedlings of shrub live oak under natural conditions are rare in

[1] Forest Service, U. S. Department of Agriculture, central headquarters maintained at Fort Collins, Colorado, in cooperation with Colorado State University. The research reported here was conducted at Tempe, Arizona, in cooperation with the Arizona State University.

[2] Cooperative goat range study, 1939. Data on file at Rocky Mountain Forest and Range Experiment Station, Tempe, Arizona.

most years (Saunier, 1964), a condition shared with the closely related *Quercus dumosa* Nutt. of the California coastal chaparral (Horton and Kraebel, 1955). Conditions for establishment of Emory oak seedlings are probably less critical, as occasional seedlings are observed on favorable sites in most years (Pase, 1965).

A large number of shrub live oak and Emory oak seedlings emerged on a burned chaparral study area on the Sierra Ancha Experimental Forest in August 1963, and provided a long-sought opportunity to observe initial survival and establishment of these ubiquitous plants. Shrub live oak seedlings were not encountered on the intervening unburned strips, but occasional widely scattered Emory oak seedlings were found. Intensive searches on the burned strips in 1962, 1964, 1965, and 1966 failed to discover shrub live oak seedlings, although occasional Emory oak seedlings were observed.

STUDY AREA AND METHODS. The study area was located on the Sierra Ancha Experimental Forest, a field unit of the Rocky Mountain Forest and Range Experiment Station. The Forest lies along the crest of the Sierra Ancha, about 35 miles north of Globe, Arizona. Elevation of the study site was 5,500 feet.

The area, formerly in dense *Quercus-Cercocarpus* chaparral, had been recently burned (half in 1961, half in 1962) as part of a study to determine feasibility of fall burning chaparral, and its effect on plant succession, shrub recovery, and erosion. Preburn shrub canopy cover was 64.6 percent. Shrub live oak and true mountain mahogany (*Cercocarpus montanus* Raf.) were codominants, with canopy cover values of 20.0 and 18.8 percent, respectively. Twenty species of shrubs and half-shrubs made up the remaining 25.8 percent canopy cover.

Soils are coarse textured, low in organic matter, and almost structureless. The shallow A and B horizons quickly grade into heavily weathered diabase, which extends to at least 10 feet.

Precipitation since 1914 at the Sierra Ancha climatic station, ¾ mile east and 400 feet lower, has averaged 24.7 inches, of which 8.6 inches (35%) fell in July, August, and September. August was the wettest months, with median precipitation of 3.33 inches. June was the driest month, with median precipitation of only 0.19 inch.

Mean annual temperature since 1935 has averaged 59.8°F. July, the hottest month, has a mean of 78.2°. January, the coldest month, has a mean of 42.3°. Highest daily maxima usually occur toward the end of the spring-early summer drought period in June and July. This is a critical period for shallow-rooted plants, and particularly so for seedlings.

In mid-August 1963, recently emerged shrub live oak and Emory oak seedlings were observed on chaparral study plots burned the previous two autumns. Several were excavated to determine the depth to which the acorns had been planted presumably by scrub jays, *Aphelocoma coerulescens*, which had been observed feeding on and caching acorns in the area. Ninety-four shrub live oak and 47 Emory oak seedlings were tagged. Survival was observed twice a year for 3 years: once in May or June, and once in October or November. Where possible, cause of mortality, such as rodents or insects, was determined. Extreme dryness of the soil to the rooting depth of the very young seedlings, and the absence of visible disease symptoms, suggested drought as the cause of death of those seedlings without visible mechanical damage.

At the end of 3 years, seedling height was measured, and a number of seedlings were excavated to determine depth and extent of rooting.

Excavation of a limited number of seedlings shortly after germination indicated that they had been "planted" at a uniform depth of 1.5 to 2.0 inches, almost all as single acorns. Burned strip widths on which the seedlings grew varied from 70 to about 200 feet; hence, the nearest mature shrubs with acorns would have varied from a few feet to as much as 100 feet from the more-or-less randomly-located seedlings. Distribution of the seedlings over the entire disturbed area, rather than concentrated near mature acorn-producing shrubs, plus the uniform depth at which the acorns were found, suggest that most acorns were planted by scrub jays. This habit has also been observed with California (scrub) jays in oak communities in California (Grinnell, 1936). When multiple seedlings did occur, they tended to be in groups of from 10 to 20 or more, suggesting rodent caches; clusters such as these were not included in the study.

RESULTS. Mortality was highest in the first spring drought period after germination; 53 percent of the shrub live oak and 48 percent of the Emory oak seedlings died before the following summer rainy period. The survival curve for shrub live oak appeared to flatten by the third year after germination, while this tendency was less obvious for Emory oak (Figure 1).

Major cause of death was apparently drought; only 1 out of 69 shrub live oak seedling deaths was attributed to rodents. Of 34 Emory oak seedlings that died, one was killed by rodents, one probably by insects, and 32 by drought.

Top growth of surviving plants was surprisingly low. At the end of 3 years, shrub live oak seedlings averaged 2.9 inches and Emory oak

only 3.3 inches high. Most seedlings of both species had from 5 to 10 leaves similar in size and shape to mature plants.

Root elongation was much more rapid than top growth. After 3 years, shrub live oak roots had penetrated 21 inches and Emory oak 20

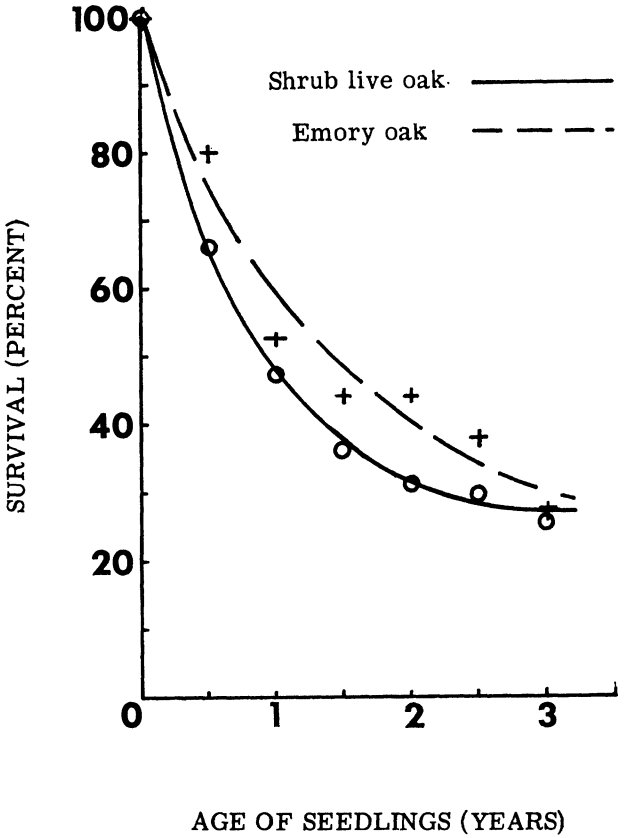

Fig. 1. Percent survival of shrub live oak and Emory oak seedlings in a burned *Quercus-Cercocarpus* chaparral community.

inches. There was little branching until roots were 12 inches or more deep (Figure 2).

DISCUSSION. Infrequency of oak seedling establishment suggests that unusually favorable conditions are required. One of these obviously must be an adequate supply of seed. Shrub live oak and Emory oak acorn production is heavily dependent on previous winter precipitation. While a total acorn crop failure is rarely encountered in the type, acorn production on upland sites in the study area is limited when

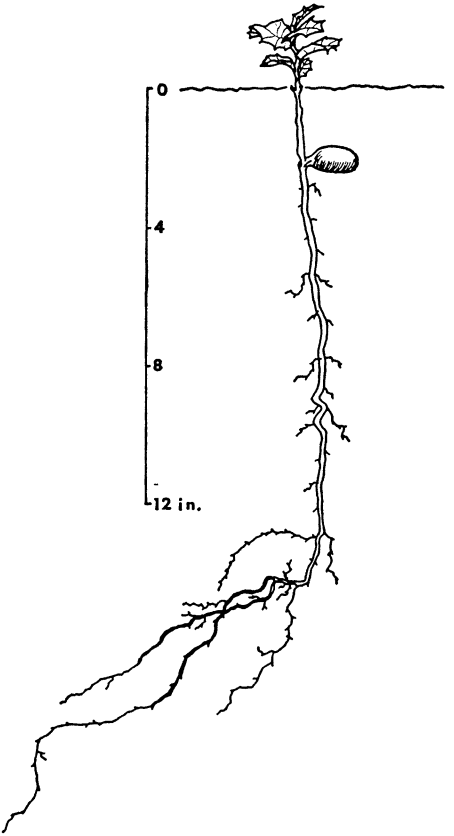

Fig. 2. Depth of planting and rooting characteristics of a 1-year-old shrub live oak seedling.

October-March rainfall drops below 15 inches. Of 34 years of record in the study area, 16 years have had more than 15 inches winter precipitation, and 18 years have had less.

Acorns commonly germinate during the summer rainy season shortly after they mature. No ripening period is needed for the two species studied; in fact, it is difficult to keep stored acorns from germinating. Because of their shrot period of viability, as well as insects, rodents, birds, deer, and other wildlife, there is probably a negligible carryover of seeds from one year to the next. In the study area, germination and emergence has been observed only from late July to mid-September. July-September rainfall, therefore, appears to be another key item in successful germination and early survival. Summer annuals successfully establish in abundance when summer rainfall ex-

ceeds 10 inches. For purposes of this discussion, 10 inches is also assumed to be adequate, with well-spaced storms, for germination of acorns.

The necessary combination of conditions (high summer rainfall following winter precipitation of 15 inches or more) probably occurs about 1 year out of 10. This combination has occurred in 3 of the past 34 years of record, in 1914, 1943, and 1963 (Figure 3). Observations

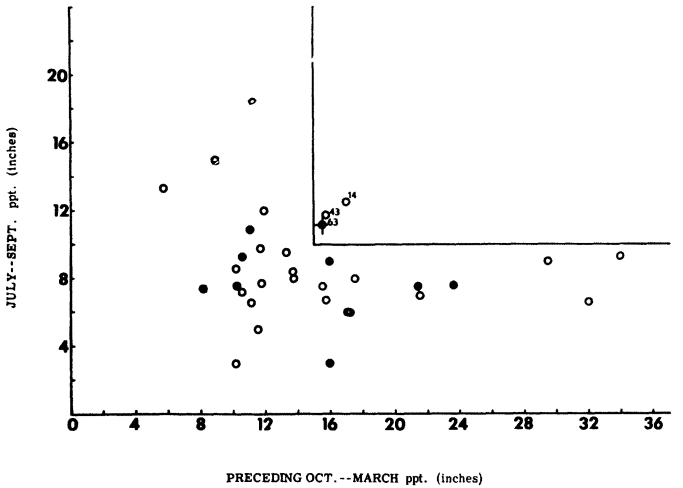

Fig. 3. Scatter diagram of precipitation effectiveness for oak seedling establishment. Points in upper right quadrant are most favorable for seedling establishment. Solid circles are years when seedlings were known to be rare or absent. Open circles represent years without observations on oak seedling occurrence. Circle with cross is year when seedlings were common.

are not available for the first two of these years, but seedlings were fairly common on burned or otherwise disturbed sites in 1963. Oak seedlings were rare or absent for the years 1958 through 1962 and 1964 through 1967. If these critical moisture values are correct, and other factors such as temperature are not limiting, points that fall in the upper right-hand corner of Figure 3 represent years when oak seedlings *could* become established on suitable sites.

No seedlings were observed from acorns lying on or very close to the soil surface; intermittent drying of the soil surface probably restricted germination and establishment. Caching of acorns by jays and rodents at depths of 1½ inches or more provided an ideal opportunity for germination, given adequate rainfall. However, jays and rodents rarely carry heavy seeds great distances, so establishment of new plants would usually be expected fairly close to mature shrubs. Reynolds (1954),

for instance, found Merriam kangaroo rats move mesquite (*Prosopis juliflora* (Swartz) DC.) seeds less than 200 feet from the parent tree. The heavy oak acorns, with their short period of viability, do not lend themselves to effective long-range dispersal; hence, migration of oak communities might be expected to be a very slow process.

SUMMARY. Seedlings of shrub live oak and Emory oak were tagged on strips of *Quercus-Cercocarpus* chaparral burned 1 and 2 years previously. Acorns had germinated in August, 1963 and survival was observed for 3 years. Ninety-four shrub live oak and 47 Emory oak seedlings were tagged. After 3 years, survival of shrub live oak seedlings was 26 percent, and of Emory oak, 27 percent. Total height of 3-year-old shrub live oak adn Emory oak seedlings was 2.9 and 3.3 inches, and rooting depth was 21 and 20 inches, respectively. Acorns had probably been "planted" by scrub jays. It is hypothesized that rainfall patterns and amounts are suitable for oak seedling germination and establishment only about 1 year in 10 in this area. The critical moisture values are suggested as 15 inches of October-March precipitation followed by 10 inches of July-September rainfall.

LITERATURE CITED

CABLE, DWIGHT R. 1957. Recovery of chaparral following burning and seeding in central Arizona. Rocky Mountain Forest and Range Exp. Sta. Res. Note 28, Forest Serv., U. S. Dep. Agr. 6 pp.

GRINNELL, JOSEPH. 1936. Up-hill planters. Condor 38: 80–82.

HORTON, J. S., and C. J. KRAEBEL. 1955. Development of vegetation after fire in the chamise chaparral of southern California. Ecology 36: 214–262.

PASE, C. P. 1965. Shrub seedling regeneration after controlled burning and herbicidal treatment of dense Pringle manzanita chaparral. U. S. Forest Serv. Res. Note RM-56, Rocky Mountain Forest and Range Exp. Sta., Fort Collins, Colo. 2 pp.

REYNOLDS, HUDSON G. 1954. Some interrelations of the Merriam kangaroo rat to velvet mesquite. J. Range Manage. 7: 176–180.

SAUNIER, RICHARD E. 1964. Factors affecting the distribution of shrub live oak, *Quercus turbinella*. M.S. Thesis, Univ. Ariz. 95 pp.

SHREVE, FORREST. 1942. The vegetation of Arizona. *In* Flowering plants and ferns of Arizona. Kearney, Thomas H., and Robert H. Peebles. U. S. Dept. Agr. Misc. Publ. 42. 1069 pp.