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Ecology, Management, and Utilization of California Oaks

June 26-28, 1979, Claremont, California

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CONTENTS

Quercus douglasii

Livestock Utilization of California's Oak Woodlands[1]

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Abstract: California's oak woodlands are important to the range livestock industry. Among interactions between oaks and livestock are effects of grazing on oak regeneration and the canopy effect of oaks on the herbaceous understory. Oak leaves and acorns vary in value according to species and other factors, as browse and food for livestock and wildlife.

Key words: Oak woodlands, livestock utilization, browse, mast, range livestock

INTRODUCTION

The oak woodlands of California are an important source of range forage for the State's livestock industries, even though the oaks themselves play a minor role. It is estimated (Biswell 1956) that out of the 17.5 million acres which provided 80 percent of the forage for domestic livestock raised on California wildland, 7.5 million acres were woodland-grass. In addition, some 3 million acres of woodlands are usually dominated by oaks. The total of more than 10 million acres of oak woodlands, a figure which corresponds to other estimates in the literature (Wieslander and Jensen 1946), include the foothills, which have been referred to as "the most important range area within the State" (Bentley and Talbot 1951).

The San Joaquin Experimental Range (Madera County) includes areas typical of much of the California oak woodlands, which have been described as being "in the lower portion of the woodland zone between the treeless plains below and the higher brushy and timbered belts" (Hutchison and Kotok 1942). It is "open and everywhere accessible to livestock...with scattered trees and bushes, and occasionally dense clumps of shrubs. The lower ground cover, consisting chiefly of annual grasses and herbs...is made up of a large number of different species." This description applies to much of the California oak woodlands.

The oak woodlands have been historically linked with California's vast livestock industry. The early Spanish missions and rancheros were often located in the oak woodlands of the Coast Range. After the discovery of gold in the western Sierra foothills, the oak woodlands again supported an expanding livestock industry to supply meat to the miners, as homesteads and ranch developments spread throughout the State.

REGIONAL DIFFERENCES

A recent treatment of California's oak woodlands by Griffin (1977) provides an excellent summary of knowledge of the area and its regional differences. Earlier, based on the "plant communities" of Munz and Keck (1959), Griffin and Critchfield (1972) identify three oak woodland associations--foothill woodland, northern oak woodland, and southern oak woodland. The northern oak woodland of the north Coast Ranges is characterized by the presence of the Oregon white oak (Quercus garryana), with an associated livestock industry comprised of both sheep and cattle

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producers operating the year around. At the other end of the State, the southern oak woodland is characterized by the presence of the Engelmann oak (Q. engelmannii) and coast live oak (Q. agrifolia) and much of it is not grazed. The relatively small livestock industry is mainly beef cattle production including both year-round cow-calf and seasonal stocker operations.

The foothill woodlands are more extensive and cover a vast area of the great Central Valley and lower elevations of the Coast Range. Blue oak (Q. douglasii) and digger pine (Pinus sabiniana) characterize the community, with neither species ranging far beyond this particular type (Griffin and Critchfield 1972). There are many other species of oaks present, including the valley oak (Q. lobata) and interior live oak (Q. wislizenii) in the north, coast live oak in the south coast, and California black oak (Q. kelloggii) at higher elevations. The livestock industry in the south Coast Ranges is centered around beef cattle production involving both year-round, cow-calf, and seasonal stocker operations. The foothill woodlands of the western Sierra foothills have historically been used on a seasonal basis rather than for year-round operations. These have been heavily used during the winter and spring flush of growth; the cattle have been moved to the upper elevations, mostly on Federal grazing permits, or to irrigated and dryland pastures down in the Central Valley. Livestock production, again, is primarily beef cattle, with more stocker cattle present in the southern foothills than in the north. Another distinctive type of livestock operation occurs in the northern and northwestern foothills of the Sacramento Valley. Both sheep and cattle are grazed in this area during the winter and spring growing season. The livestock are transported to southern Oregon or to the Sierra-Cascade mountain ranges during the summer and early fall.

Although cattle are now the most important, other species of livestock also use California's oak woodlands. Many of the horses in California are in the oak woodlands area; they are used in livestock operations and, increasingly for pleasure. In swine production, acorns were utilized until economic factors curtailed this type of extensive management. The Madera County Historical Society (1968) notes, "At the time placer mining first penetrated the area, farming and ranching were already becoming established. Hogs evidently were more important than cattle until barbed wire was available in the mid-1870's, making large cattle herds more practical. Sheep, however, were more numerous than cattle through the 1880's." Now wildhog hunting ranks second in popularity among California's big game animals. Wildhog habitat is often associated with the oak woodlands (Barrett 1978). Of a relatively small number of range goats in California (Spurlock and others 1978), there are probably more in the areas of heavy brush than in the oak woodlands.

Man's search for desirable places to live is probably the greatest constraint on use of the oak woodlands for livestock production. The climate and scenic beauty of the oak woodlands make them highly attractive for human habitation. It is estimated that Madera County has lost at least 10 percent of its oak woodlands to subdivisions (McDougald 1979). As one travels the central coast or the Sierra foothills, this settlement pattern is seen repeating itself. Many other land uses (military reservations, water storage, natural preserves, etc.) limit opportunities for grazing on the oak woodlands.

Most quantitative information relating livestock production to the oak woodlands comes from three experimental areas. The oldest is the San Joaquin Experimental Range which was established in 1934 by the Forest Service, U. S. Department of Agriculture. The University of California, Division of Agricultural Sciences, operates the Hopland Field Station, established in 1951, and the Sierra Foothill Range Field Station, established in 1964. Summaries of the livestock research and a list of publications for the San Joaquin Experimental Range are found in Wagnon and others (1959) and Duncan (1975), and for Hopland in California Agriculture (Univ. Calif. Agric. Exp. Stn. 1976).

OAKS AND LIVESTOCK

Oaks and livestock affect each other's welfare in many ways. For example, oaks serve as a source of shade for domestic livestock during hot weather. The need for shade is well known (McDaniel and Roark 1956), but is difficult to quantify in terms of animal production and will not be discussed here.

Regeneration

The browsing of young trees by livestock has often been cited as the cause of poor or no oak regeneration. Exclusion of cattle in several instances for a rather long period did not bring about any instant oak

regeneration, however. A considerable increase in digger pine and buck brush (Ceanothus cuneatus) was noted in the Natural Area at the San Joaquin Experimental Range, which has been protected from grazing and fire since 1934, (Woolfolk and Reppert 1963), but no increase in oaks was reported. Photographs indicated extremely little change in older blue oaks over periods of more than 20 years. In another paper in this Symposium, Griffin noted exclusion of cattle on the U. C. Hastings Natural History Reservation in Monterey County did not result in oak regeneration.

In discussing lack of the blue oak seedlings and young trees in Kern County, Twissleman (1967) reasoned that poor oak reproduction was probably a combination of drought, livestock browsing, and the inability of young seedlings to compete with introduced annual plants. He suggested prolonged drought might be the most significant of the above factors.

The effect of combined sheep and deer use on oak regeneration at the Hopland Station was discussed by Longhurst and others (1979). After only 5 years of protection 554 oak seedlings were counted per acre, compared to none in the grazed area. The authors conclude that "with virtually no replacement of oak stands under the combined weight of deer and sheep use, this important source of browse and mast will gradually be reduced as trees mature and die."

There is no doubt that consumption of acorns by domestic livestock and many species of wildlife greatly reduces the number of acorns that might possibly become trees. In addition to acorn use by domestic animals, which will be discussed in more detail, acorns are very important diet items for quail and ground squirrels (Glading and others 1940, Shields and Duncan 1966, Schitoskey and Woodmansee 1978).

Observations of recent events on the San Joaquin Range provide an example. A severe drought in 1977 resulted in scanty forage, but blue oaks produced a good crop of acorns. Ground squirrels were repeatedly seen securing acorns up in the oaks in an ungrazed area; the few acorns that reached the ground were consumed by deer. Although the following year was wet, few seed were left for oak regeneration.

Canopy Effect on Forage

In many foothill areas in central California, the difference in amount and kind of herbaceous vegetation under the canopy of oaks, especially blue oak, is readily apparent even to the casual observer, especially in the winter and early spring. The canopy effect of the various oaks of course varies regionally, and definitely is influenced by the density of the oak trees. A summary of work in northern California, noting that removal or reduction of blue oaks increased forage production, is presented by Kay and Leonard in a paper in this Symposium. A discussion of the effects of blue oak on forage production and nutritional quality in central California may be found in the Symposium papers of Holland, and Holland and Norton, and the picture is quite different from areas studied by Kay and Leonard. In earlier reports, Holland (1973, 1976), noted that in central California herbaceous vegetation production was 40 to 100 percent greater under blue oaks than in open grasslands. Many of the data in Holland's reports were collected on the San Joaquin Experimental Range in Madera County. In a severe drought year on the Experimental Range considerably more herbage was noted under the blue oak canopies than in open areas (Duncan and Reppert 1960). This was confirmed over a period of seven years, and herbage growth was observed to begin earlier, and plants to stay green longer, underneath blue oaks (Duncan 1967). Also, observations and utilization records showed that cattle preferred forage under blue oaks, both in green and dry seasons. Discussion with ranchers indicate that in some other areas of the State, cattle apparently do not show this preference.

OAKS AS BROWSE AND MAST

It is difficult to estimate the value of the oak species as browse. Sampson and Jespersen (1963) pointed to the difficulty of identifying the oak species of primary browse importance because grazing animals in different situations vary in their choice of species. Interior live oak, California scrub oak (Q. dumosa), blue oak and California black oak were seen as being the more palatable in most situations, however. Listed as secondary are the Oregon white oak, canyon live oak (Q. chrysolepis) and huckleberry oak (Q. vaccinifolia). The food value of coast live oak and valley white oak is probably mainly in the acorns. Browse ratings of several oak species are listed for domestic livestock and deer (table 1).

An estimated 1 to 2 percent of the forage utilized by domestic livestock year after year was obtained from all browse plants on the San Joaquin Experimental Range (Hutchison and Kotok

Table 1--Summary of browse ratings of oak species for domestic livestock and deer[1/]

Species (Quercus)	Common Name	Overall Browse Value[2/]				
		Cattle	Horses	Sheep	Goats	Deer
Q. agrifolia	Coast live oak	5	5	4-5	4-5	3-4
Q. chrysolepis	Canyon live oak	5	5	5	5	3-4
Q. douglasii	Blue oak	4	4-5	3-4	3-4	1-2
Q. dumosa	California scrub oak	4-5	5	4	2-4	1-2
Q. garryana	Oregon white oak	4-5	5	4-5	4-5	2-3
Q. kelloggii	California black oak	2-4	4-5	3-4	3-4	1-2
Q. lobata	Valley white oak	4	5	4-5	4-5	3-4
Q. vaccinifolia	Huckleberry oak	4-5	5	4-5	4-5	3-4
Q. wislizenii var. frutescens	Scrub interior live oak	4	5	3-5	3-4	1-2

1/ Adapted from Sampson and Jespersen 1963.

2/ Overall rating symbols are: 1 = excellent, 2 = good, 3 = fair, 4 = poor, 5 = useless.

1942). These species do provide some green material as a source of protein, phosphorus, and possibly vitamin A during the summer when the herbaceous forage is mainly dry. The species most commonly browsed are the California blue oak, interior live oak, and California buckeye (Aesculus californica), in that order.

Hopland Field Station sudies (Van Dyne and Heady 1965) with sheep and cattle during the months of July, August, and September indicated that more than 5 percent of the field-harvested forage in late summer was fallen leaves and acorns of Quercus species, which occurred in 60 percent or more of the animal diets and composed 4 to 12 percent of the diet by weight. Sheep diets in the late summer frequently contained newly-fallen acorns, and field observations indicated that both cattle and sheep browsed on the low-hanging branches and on fallen twigs and leaves. The Hopland pastures had been grazed by sheep for several years, so that there was a browse line at approximately 4 feet. Thus, it would appear that more browse was available to cattle than to sheep, but on the average cattle and sheep selected about the same amount.

Also reporting on work at the Hopland Station, Longhurst and others (1979) presented findings on the use of oak mast and leaves by the range herbivores, on mast production, and the effect of the grazing animals on oak regeneration. In general, they found deer consumed more acorns and relied more on browse than sheep. For a 5-year period, average acorn production from blue oak trees was about 13 lb/per tree/per year, and the amount of acorns by year varied from less than 2 lb to over 55 lb/per tree. Similar wide variations in acorn production have been observed by workers at the San Joaquin Experimental Range. More detailed treatments of mast production and/or animal use are presented by Menke and Fry, and by Graves in other Symposium papers. Barrett (1978) lists acorns as the most important food item of feral hogs inhabiting oak woodland in the Sierra foothills.

On the San Joaquin Experimental Range, cattle definitely do browse to some extent on the oaks, and seem to prefer blue oak to interior live oak. Observations by the senior author indicate the opposite preference is shown by deer. Hutchison and Kotok (1942) and Wagnon and others (1959) have surmised browsing of oaks and other woody vegetation results in adequate provision of vitamin A even in periods when there is no green herbaceous material available.

In the central part of the State's oak woodlands, both domestic livestock and many species of wildlife consume acorns when available. Considerable attention has been

paid to acorn use by cattle because of an abnormal congenital condition, described by Hart and others (1932) which has existed in cattle on the foothill ranges for many years. The deformity is more common in the oak belt, and usually occurs in poor feed years; the name "acorn calves" for deformed animals originated from the general impression that the deformities resulted from the dams' consuming excessive amounts of acorns during the gestation period. In describing early acorn-feeding trials at the San Joaquin Experimental Range, Wagnon and others (1942) stated their preliminary results indicated acorns were not the primary factor in causing "acorn calves".

In a bulletin entitled "Acorn Calves", Hart and others (1947) reported on long-term studies and said the name was incorrect. They concluded that examination of fifteen years of data on acorn calves showed the condition is nonhereditary, and that it is due to maternal nutritional deficiency, probably occurring between the third and sixth month of gestation. They also stated the specific deficiency or deficiencies involved had not been ascertained. Since the acorn calves had occurred without the dams' having access to acorns, it was evident that their ingestion was not the direct causative agent. They concluded by stating, "Acorns may be a contributing factor, however, when they are the main ingredient of the diet, by preventing the formation or utilization of some dietary essential. A consistent, constructive policy of livestock management, with supplemental feeding that will enable the breeding cows to produce maximum percentage calf crops and calves of optimum weaning weight, can be counted on practically to eliminate acorn calves."

Reporting on early acorn-feeding trials at the San Joaquin Experimental Range, Wagnon and others (1942) noted marked differences in the palatability of acorns from different live oak trees in 1936. In August, consumption of acorns was 3 or 4 pounds per day, and by September, cows were eating 14 to 18 pounds per head daily. Consumption increased to as much as 37 pounds per day for one cow. In describing the reasons for a series of studies on acorns as cattle feed Wagnon (1946) noted that of the various species of trees on California rangelands oaks are easily the most abundant, and the occasional large crops of acorns are readily eaten by range cattle. These years of heavy mast have been of concern to many stockmen, and among the deleterious effects attributed to heavy feeding on acorns are deformed calves, abortions, death from impaction, and weight losses. Wagnon noted, however, that some cattlemen claim that the cattle gained weight. Usually the greatest weight losses occurred in cattle consuming acorns just prior to the onset of winter, when feed conditions were poor. He summarized the chemical content of acorns of several oaks (table 2), and his studies demonstrated that heavy ingestion of low-protein acorns when the

Table 2--Chemical analysis of acorns from five different species of oak[1/]

	Blue oak *Quercus douglasii*	Live oak *Quercus wislizenii*	Black oak *Quercus kelloggii*	Valley oak *Quercus lobata*	Scrub oak *Quercus dumosa*
	Percent				
Moisture	40.75	29.80	37.60	40.57	44.58
Crude Protein	3.03	3.08	3.43	2.82	2.29
Crude Fiber	7.08	11.24	14.07	7.84	7.96
Fat	4.77	14.47	11.05	4.25	3.42
Nitrogen-free Extract	43.39	40.40	32.71	43.44	40.65
Ash	0.98	1.01	1.14	1.08	1.10
Calcium	0.08	0.09	0.09	0.08	0.09
Phosphorus	0.04	0.05	0.06	0.06	0.05
Tannins	3.61	4.60	1.81	3.85	5.15

[1/] From Wagnon 1946.

forage was dry and also low in protein resulted in rapid weight loss. However, providing a protein supplement counteracted any ill effects and promoted gains when the forage was poorest. When green forage was available, acorns gave good results. He summed up his results as, "Thus with adequate supplemental feeding, acorns can become a very important feed resource instead of a decided liability."

Wagnon (1960) described a series of studies in which cattle were fed oak leaves in addition to acorns, to gain insight into the old question and differences of opinions among stockmen whether acorns were harmful or good cattle feed. Results were not conclusive, but providing a protein supplement to range cows grazing on dry forage and eating blue oak acorns resulted in weight gains as he had reported earlier (Wagnon 1946) and cows receiving no supplement lost weight.

Gordon and Sampson (1939) noted that the crude protein content of blue oak leaves on the San Joaquin Experimental Range varied from 30 percent for young leaves to 10 percent for mature leaves. However, Sampson and Jespersen (1963) assigned the blue oak a "poor" browse rating for cattle. No ill effects from feeding blue oak leaves were reported by Wagnon (1960), but he noted that the study animals would not eat the leaves from certain trees. Similarly, they ate acorns from some trees readily, but not those from others.

In a comprehensive report on the behavior of beef cows, Wagnon (1963) noted they spent about 18 percent of the feeding time beneath canopies, as compared to 60 percent on open slopes and 22 percent in swales. He determined that browsing was of practically no importance when green forage was abundant and of minor importance as a source of feed the rest of the year. Animals spent less than 4 percent of the total feeding time browsing.

MANAGEMENT IMPLICATIONS

In addressing the question, Can California's oak woodlands be managed for sustained yield?, in this paper, we must look at the sustained yield in terms of livestock utilization of the oak woodlands. There is seldom a simple answer to a complex biological/sociological/economic question, and blanket statements can always be picked apart. In general, however, livestock use of California oak woodlands can probably continue at today's levels without jeopardizing the oak stands. And, with present technology, livestock production could probably be increased. Overall production of livestock in the area probably is, and will be, decreased more by loss of grazing lands to other land uses than by overutilization by domestic livestock and wildlife.

The exclusion of grazing on many acres of the oak woodlands calls attention to one good effect of livestock utilization that is commonly overlooked. This is the reduction of the fuel build-up. Those of us who live in the tinder-dry foothill areas every summer shudder at the idea that the mass of herbage that grows each year should not be used by livestock. The problem of fuel build-up has become more noticeable in recent years as increasing acreage in the oak woodlands has been sold, subdivided, or otherwise removed from grazing. More and more people are moving into areas where more and more fuel is available to carry wildfires.

The effect of oak tree canopy has been treated briefly here. The decision to remove, or thin, or leave oaks undisturbed depends on the objectives of the landowner or manager, and the particular combination of climatic, edaphic, and vegetative features of each individual area. Economic considerations usually enter the picture. But, one thought should be kept in mind--removal of an old oak tree, though perhaps not permanent, has long-lasting effects on the people and all other organisms in the immediate vicinity.

The sustained yields of the oaks themselves are covered only indirectly in this paper. Perhaps the "whys" of little or no oak regeneration in some areas have been brought into focus by this Symposium. Hopefully the interchange of facts, ideas, and opinions will help us make better informed decisions leading to more rapid strides in gaining a realistic understanding of the problem, what is causing it, and in developing ways of obtaining oak regeneration where desired.

California's oak woodlands have been, are, and probably will continue to be an important area in which the range livestock industry can, under proper management, produce a considerable proportion of the food and fiber products needed to meet the demands of the population of the State.

LITERATURE CITED

Barrett, Reginald H.
1978. The feral hog on the Dye Creek Ranch, California. Hilgardia 46(9):283-355.

Bentley, J. R., and M. W. Talbot
1951. Efficient use of annual plants on cattle ranges in the California foothills. USDA Circ. 870. 52 p.

Biswell, H. H.
1956. Ecology of California grasslands. J. Range Manage. 9(1):19-24.

Duncan, Don A.
1967. Blue oak canopy effect on herbage yield on central California foothill rangeland. Abs. Papers 20th Annu. Meet. Amer. Soc. Range Manage., Seattle, Wash. Feb. 14-17. p. 61-62.

Duncan, D. A.
1975. Comprehensive network site description San Joaquin. Grassl. Biome, US/IBP. Tech. Rep. No. 296. 153 p. Natural Resource Ecol. Lab., Fort Collins, Colo.

Duncan, D. A., and J. N. Reppert
1960. A record drought in the foothills. USDA Forest Serv. Misc. Pap. 46, 6 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

Glading, Ben, H. H. Biswell, and C. F. Smith
1940. Studies on the food of the California quail in 1937. J. Wildl. Manage. 4(2): 128-144, illus.

Gordon, A., and A. W. Sampson
1939. Composition of common California foothill plants as a factor in range management. Calif. Agric. Exp. Stn. Bull. 627. 95 p.

Griffin, James R.
1977. Oak woodland. In Michael G. Barbour and Jack Major, eds. Terrestrial vegetation of California. John Wiley and Sons, New York. p. 383-415.

Griffin, James R., and William B. Critchfield
1972. The distribution of forest trees in California. USDA Forest Serv. Res. Pap. PSW-82, 114 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

Hart, G. H., H. R. Guilbert, and H. Goss
1932. Seasonal changes in the chemical composition of range forage and their relation to nutrition of animals. U. C. Agric. Exp. Stn. Bull. 543. 62 p.

Hart, G. H., H. R. Guilbert, K. A. Wagnon, and H. Goss
1947. "Acorn calves." A nonhereditary congenital deformity due to maternal nutritional deficiency. U. C. Agric. Exp. Stn. Bull. 699. 24 p.

Holland, V. L.
1973. A study of soil and vegetation under Quercus douglasii H. & A. compared to open grassland. Ph. D. dissertation. Univ. of Calif., Berkeley. 369 p.

Holland, V. L.
1976. In defense of blue oaks. Fremontia 4(1):3-8.

Hutchison, C. B., and E. I. Kotok
1942. The San Joaquin Experimental Range. Calif. Agric. Exp. Stn. Bull. 663. 145 p.

Longhurst, William M., Guy E. Connolly, Bruce M. Browning, and Edward O. Garton
1979. Food interrelationships of deer and sheep in parts of Mendocino and Lake Counties, California. Hilgardia 47(6): 191-247.

Madera County Historical Society (in coop. Madera Co. Diamond Jubilee Comm.)
1968. Madera: the rich, colorful and exciting historical heritage of that area now known as Madera County, California. Charles W. Clough (publ.). 96 p.

McDaniel, A. H. and C. B. Roark
1956. Performanace and grazing habits of Hereford and Aberdeen-Angus cows and calves on improved pastures as related to types of shade. J. Anim. Sci. 15(1):59-63.

McDougald, Neil K.
1979. Walt Ellis Ranch coordinated resource plan. Madera Co. Coop. Ext. Serv. mimeogr. pap. 7 p.

Munz, P. A., and D. D. Keck
1959. A California flora. Univ. Calif. Press, Berkeley. 1681 p.

Sampson, Arthur W., and Beryl S. Jespersen
1963. California range brushlands and browse plants. U. C. Man. 33. 162 p.

Schitoskey, Frank, Jr., and Sarah R. Woodmansee
1978. Energy requirements and diet of California ground squirrel. J. Wildl. Manage. 42(2):373-382.

Shields, Paul W., and Don A. Duncan
1966. Fall and winter food of California quail in dry years. Calif. Fish and Game 52(4):275-282.

Spurlock, G. M., R. E. Plaister, W. L. Graves, T. E. Adams, and R. B. Bushnell
1978. Goats for California brushland. Univ. Calif. Agric. Ext. Serv. Leafl. 21044. 30 p.

Twisselmann, Ernest C.
1967. A flora of Kern County, California. Wasmann J. Biol. 25(1 & 2):1-395.

University of California Agricultural Experiment Station
1976. Special Issue, Hopland Field Station, 25 years of research. Calif. Agric. 30(7): 1-31.

Van Dyne, G. M., and H. F. Heady
1965. Botanical composition of sheep and cattle diets on a mature annual range. Hilgardia 36(13):465-492.

Wagnon, K. A.
1946. Acorns as feed for range cattle. West. Livest. J. 25(6):92-94.

Wagnon, Kenneth A.
1960. Cattle feeding trials with acorns and oak leaves indicate need for supplementing dry range forage. Calif. Agric. 14(11):10-11.

Wagnon, Kenneth A.
1963. Behavior of beef cows on a California range. U. C. Agric. Exp. Stn. Bull. 799. 58 p.

Wagnon, K. A., H. R. Guilbert, and G. H. Hart
1942. Experimental herd management. In The San Joaquin Experimental Range (C. B. Hutchison and E. I. Kotok eds.). U. C. Agric. Exp. Stn. Bull. 663. p. 50-82.

Wagnon, K. A., H. R. Guilbert, and G. H. Hart
1959. Beef cattle investigations on the San Joaquin Experimental Range. Calif. Agric. Exp. Stn. Bull. 765. 70 p.

Wieslander, A. E., and Herbert A. Jensen
1946. Forest areas, timber volumes and vegetation types in California. Calif. For. and Range Exp. Stn., For. Surv. Release No. 4. 66 p.

Woolfolk, E. J., and J. N. Reppert
1963. Then and now: changes in California annual-type vegetation. USDA Forest Serv. Res. Note PSW-24, 9 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.