

# A Comparison of Management Strategies in the Oak Woodlands of Spain and California<sup>1</sup>

Lynn Huntsinger James W. Bartolome Paul F. Starrs<sup>2</sup>

**Abstract:** The characteristics, uses, and management of oak woodlands and savannas in California and southern Spain are compared. There are many similarities between the Spanish dehesa and the California oak woodland. Both are located in Mediterranean climate zones, and are used predominantly for livestock grazing. However the Spanish dehesa is a more diverse and long-standing system of management. Products include cork, acorn-fattened hogs, charcoal, milk, mushrooms, and lucrative hunting. Analysis of this system offers insight into the role of ecological and economic diversity in sustainable resource use for California.

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This paper compares the characteristics, uses, and management of oak woodlands and savanna in California and southern Spain (table 1). Although the two woodlands have much in common, the ecological dynamics and hence appropriate management techniques vary in some important ways. Similarities outweigh differences, however, and methods for long-term, sustained management of the Spanish dehesa provide contrast to hardwood woodland management in California.

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## CHARACTERISTICS

California's oak woodland and savanna covers approximately 3 million hectares of what is generally rolling foothill topography (Ewing and others 1988). The overstory is dominated by one or a combination of five oak species and their hybrids: blue, coast live, interior live, valley, and Engelmann oaks (*Quercus douglasii*, *Q. agrifolia*, *Q. wislizenii*, *Q. lobata*, and *Q. engelmannii*). In southern Spain and Portugal, oak woodland overstory is predominantly one or a combination of two oak species, holm oak (*Quercus ilex*<sup>3</sup>), and cork oak (*Quercus suber*). These two species together cover about 5.5 million hectares in southern Spain and Portugal, including the Andalusian uplands, and extending north toward Madrid and Lisbon (Marañon 1988; Campos 1984; Ruiz 1986).

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<sup>2</sup>Assistant Professor and Professor, Department of Forestry and Resource Management; Lecturer, Department of Geography, University of California, Berkeley.

<sup>3</sup>Sometimes considered a separate species, *Quercus rotundifolia*.

In both Spain and California, oak woodland soils tend to be shallow and infertile, unsuitable for intensive crop production. In Spain, soils are limestone or granitic. In California, the woodland soils are of metamorphic and sedimentary origins. Climate in the woodlands of California and Spain is typical Mediterranean, with the California woodlands typically having a slightly warmer and drier summer.

The majority of Spanish and Californian oak woodlands are in private ownership - 82 percent private in California (Ewing and others 1988) and 98 percent private in Spain. About half of California's land is public, while in all of Spain, less than 2 percent of the land is public. Population growth is rapid in both areas. Patterns of urban and suburban development appear to differ, however, with a less sprawling, more concentrated pattern of growth in Spain.

In California, the characteristic oak savanna understory is annual grasses and forbs, most of which have emigrated from other Mediterranean regions, including Spain (figure 1). The oak savanna type is considered a stable community that, in the absence of human intervention, changes slowly or not at all (Griffin 1977). Without direct human intervention, the understory of Spanish oak savanna is rapidly invaded by aggressive shrubs, most commonly dominated by rockrose (*Cistus*) species (figure 2). The oak savanna that seems like a natural part of the landscape in Southern Spain is in fact an unstable assemblage carefully maintained by land managers. Oak woodlands are managed to maintain an open savanna understory as part of the silvo-pastoral system known as the "dehesa" (Marañon 1988). In Portugal the term "montado" is used. Spanish oak woodland ranches, or fincas, are sometimes themselves called dehesas.

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## USES

In California, oak woodlands produce about a third of the total rangeland forage supply. Cattle consume about 86 percent of that forage, sheep most of the rest (Ewing and others 1988). In Spain, about 50 percent of the grazing is done by *Retinto* cattle, 42 percent by *Merino* sheep, 6 percent by goats and 2 percent by domestic Iberian pigs (Marañon 1988). Meat products and wool are produced in both countries. In Spain, milk from sheep and goats is also an important product.

The California mast or acorn crop is harvested primarily by wildlife, as much as 2 tonnes/ha in some cases (Passof and others 1985). The California acorn crop is probably more variable over the state as a whole than the Spanish crop, as greater variation in

**Table 1—Comparison of the oak woodlands of California and southern Spain**

|                           | Spain                                                                                             | California                                                                                                     |
|---------------------------|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Uses:                     |                                                                                                   |                                                                                                                |
| Forage                    | hogs, cattle, goats, sheep                                                                        | cattle, sheep                                                                                                  |
| Mast                      | hogs, wildlife                                                                                    | feral hogs, wildlife                                                                                           |
| Oaks                      | cork, firewood, mushrooms                                                                         | firewood                                                                                                       |
| Wildlife                  | hunting                                                                                           | hunting, recreation                                                                                            |
| Characteristics:          |                                                                                                   |                                                                                                                |
| Understory                | shrubs ( <i>Cistus</i> spp.),                                                                     | annual grass                                                                                                   |
| Overstory                 | annual grass<br>oaks ( <i>Quercus</i> spp.)                                                       | oaks ( <i>Quercus</i> spp.)                                                                                    |
| Soils                     | limestone, granitic                                                                               | sedimentary,<br>metamorphic                                                                                    |
| Topography                | foothill                                                                                          | foothill                                                                                                       |
| Management practices:     |                                                                                                   |                                                                                                                |
| Brush control             | disking, hand clearing                                                                            | control burning,<br>disking                                                                                    |
| Forage improvement        | seeding, fertilization                                                                            | seeding, fertilization<br>overstory thinning                                                                   |
| Grazing systems           | herding, season-long                                                                              | season-long, rotation                                                                                          |
| Wildlife                  | privately owned                                                                                   | publically owned                                                                                               |
| Oaks                      | private reserves, fee per animal<br>high returns<br>cork harvest<br>high interest in regeneration | fee for access<br>marginal returns<br>thinning<br>moderate to low<br>interest in regeneration                  |
| Demographic issues:       |                                                                                                   |                                                                                                                |
| rate of growth            | rapid                                                                                             | rapid                                                                                                          |
| Pattern of growth         | concentrated                                                                                      | sprawl, fragmentation                                                                                          |
| landownership             | 2 percent or less public                                                                          | 50 percent public                                                                                              |
| landownership (woodlands) | 2 percent or less public                                                                          | 20 percent public                                                                                              |
| neighbor conflicts        | arson<br>access for grazing<br>access for hunting<br>envy of hunters<br>foreign investors         | vandalism<br>lifestyles (pets)<br>access for hunting<br>dislike of hunting<br>fond of predators<br>exurbanites |
| Duration                  | 1,000 yrs.                                                                                        | 200 yrs.                                                                                                       |

tree species, environmental conditions, and tree densities is found in California. In Spain the acorn crop is highly valued as fattening feed for Iberian pigs, who commonly harvest 600-700 kg/ha (Parsons 1962). It is from these pigs that "*jamón serrano*," (mountain ham) a gourmet air-cured ham that is the premier Spanish meat, is produced. Iberian pigs are herded through the woodlands in fall and winter to harvest the acorns.

Firewood production is important in both areas, but the means and uses are different. In California entire trees are harvested as part of thinning or clearing operations. It has been estimated that an average of about 24,000 ha per year have been partially or completely harvested recent years, (Bolsinger 1988), and marketed to a growing "recreational wood burning" market, or to foothill residents who use wood as a winter heat source. In Spain firewood is most commonly produced as a side product

from pruning operations. Pruned small branches and some thinned and cleared wood is used to produce charcoal, as well as for firewood. The intensive pruning that some oaks are subject to results in oaks that to Californians look fairly strange. It is in Portugal that pruning seems to reach its most extreme forms. Oaks are pruned both to produce firewood and to enhance acorn and forage production by opening up the canopy. In times of severe drought, livestock may be fed the green branches from oaks as well, although this practice has declined with the availability of modern supplements.

These pruning regimes are representative of intensity of management practices in southern Spain. Trees are managed as individuals, while on California ranches, it is generally the woodland that is managed rather than the tree.

Cork is another important product from Spanish wood-



**Figure 1**—Blue oak woodland with annual grass understory in California's inner Coast Range.



**Figure 2**—Oak woodland with rockrose understory in the Sierra Norte near Seville, Spain.

lands. The typical dehesa has a mixture of cork oak and holm oak. The cork oak bark is harvested every 7 to 9 years (Marañon 1988), resulting in a striking juxtaposition of brilliant red harvested cork oak trunks and grey holm oak trunks in the woodland. Spain and Portugal produce three-quarters of the world's cork (Marañon 1988). Harvesting the cork without damaging the inner layer and hence the tree takes skill. In the Andalusia region, where there is great interest in oak reforestation and the maintenance of dehesa systems, fines are levied for damaging or cutting oaks.

The holm oak is valued for its higher acorn production and "sweeter" acorns, in contrast to the cork oak's larger but more bitter acorns. The higher acorn production of the holm oak partly explains why it is encouraged along with the valuable cork oak, but its high resiliency and resprouting ability also makes it a risk-reducing component in the system. In the event of fire or excessive harvest, perhaps brought about because of drought, the holm oak recovers quickly. It can be used more intensively for livestock forage without risk to the cork crop and without permanent damage to the acorn crop. In addition, oak acorn crops vary highly from tree to tree and year to year and species to species (this is also a well known phenomenon in California). Stands of two species may assure a more consistent acorn crop. Perhaps risk from disease and insects is also reduced.

In California, ranches totalling about 280,000 ha of oak woodland are registered with the state Department of Fish and Game as commercial hunting operations (Ewing and others 1988). There are an unknown number of additional private hunting clubs and ranches. Recent studies have indicated that returns tend to be marginal (Loomis and Fitzhugh 1991; Standiford this symposium), although they can be a significant part of the per hectare value of the woodland, especially when forage values are low, augmenting Net Present Value by about \$180.00 per hectare (Standiford this symposium). Hunting seems under siege in California, with recent legislation preventing the hunting of mountain lions and the number of hunters declining in the state.

Throughout the dehesa, hunting is a popular as well as an elite sport. Hunting expeditions, including four wheel drive transport and overnight accommodations, command high prices. Returns to the landowner can be quite substantial. In contrast to California, where all wildlife is the property of the state, in Spain wildlife is the property of the landowner. Accordingly, instead of the fee for access that is charged by California ranchers, the Spanish dehesa owner most often charges according to the type and sometimes the quality of the animal hunted. The meat from the hunt remains the property of the landowner and is marketed for an additional source of income.

In California, deer, wild pigs, quail, pheasant, and wild turkey are commonly hunted. The Spanish hunt a wide variety of species, including wild boar, deer, several wild cats, and both small and large birds, including song bird species that Americans would not consider game. Hunting is a broadly admired form of recreation in Andalusia, and controversies surrounding it have most to do with the elitism of the sport, and conflicts over access to traditional hunting and grazing grounds. Many of these conflicts stem from the nature of the National Game Law of

1970. This legislation was the first that allowed a landowner to exclude all others from uncultivated land by declaring it a game preserve. As a result, almost every scrap of open land in Andalusia is decorated liberally with the sign "Coto Privado de Caza," or "Private Game Reserve," regardless of whether or not it can support any wildlife at all. Prior to the game law, local villagers had certain usufructuary rights to open land, which might have included access for grazing and firewood collection, for example. A 1929 law allowed closure of lands used for cropping, which may account for the past popularity of understory cropping in Spanish oak woodlands. In fact, understory cereal production in Spain has declined since the passing of the Game Law.

Understory cropping also occurs in California, though not as commonly as in Spain, or with such a variety of species. Wheat, barley, oats, and triticale are among the crops that may be grown on moderately fertile Spanish soils, producing 900-1200 kg/ha (Campos 1984). In Spain, dryland crops are sometimes part of an agro-silvo-pastoral system. In the winter, crops are grown in the understory, while in summer and fall, the understory is grazed. In many areas, crops are grown at 4-6 year intervals (Campos 1984). Mushrooms that grow on the oaks are also becoming an increasingly important side product in Spain.

Aside from their value for firewood and cork, the oak trees in Spain are known to reduce drought stress under the canopy. The soils under the oaks have a higher organic matter content. As a result, perennial grasses such as orchardgrass (*Dactylis glomerata*) and ryegrass (*Lolium perenne*) are more common under the canopy (Escudero and others 1985; Marañon 1986). Recent studies in California have shown higher productivity and nutrient content in herbaceous vegetation under the scattered oaks typical of the savanna (Frost and others this symposium). In the dehesa system, the different soil layers exploited by the oaks and understory are fully taken advantage of. When herbaceous vegetation runs short due to drought, browse can be cut from the trees and acorns still provide feed. In this way water supplies far below the surface are tapped for use in livestock production.

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## MANAGEMENT PRACTICES

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The greatest point of contrast between California and Spain is in the intensity of management. To maintain the open savanna, considerable effort is needed in Spain to control shrubs. Disking is the most common practice. Lands are disked every 4 to 6 years, either solely to control shrubs or as part of periodic crop production. Hand weeding may be used as follow-up control, and intensive livestock grazing may delay the need for the next disking.

Even light grazing and infrequent fires are generally sufficient to repress shrub invasion of California oak savanna. California ranchers commonly use prescribed burning. Done at

a low intensity under controlled conditions, damage to overstory oaks is rare. Burning reduces shrubs and excess dry matter, and may also improve forage. Spanish land managers do not use fire as a tool because they believe that fire will damage cork oaks. Fire is also discouraged because there is a serious arson problem in Spain. Both the elitist nature of hunting and the loss of usufructuary rights have resulted in resentment among local residents. Adding fuel to the fire, so to speak, is the fact that some of the dehesas are owned by foreign investors, and many of the hunters that visit them are also foreigners. Arson is the most common expression of that resentment. The worst recorded wildfire year in Spain so far is 1989.

In California, there is also some hostility toward the Fish and Game commercial hunting program among hunters. Landowners who enroll with Fish and Game under the 1985 Act (AB 580) can gain permission to extend the hunting season or exceed normal bag limits if they have an approved wildlife habitat improvement plan. Landowners then charge a fee for access to the land, which can be high. Greater enforcement of "no trespassing" areas may presumably follow. Some hunters feel that this favors the wealthier hunters. However, by far the greatest conflict about hunting results from the differences between those growing numbers of individuals who believe in no hunting at all and those who hunt. The "Bambi syndrome," as it is derogatorily termed by hunting proponents in California, seems unlikely to have much influence in a country where bullfighting is the most popular spectator sport.

There is little direct wildlife habitat improvement effort among Spanish landowners. A greater tolerance for the shrubby understory may be the major effect of the high returns from hunting. Landowners may be more inclined to leave some shrub covered areas on their properties. Rockrose species, however, are for the most part unpalatable to wildlife, so their main value is as cover. Oak woodland with a shrubby understory is of little use for livestock production of any kind in Spain. In California, thinning of stands, maintaining mosaics of shrub/grassland/oaks, prescribed burning, and construction of quail piles and water tanks are all common wildlife habitat improvement practices. Understory shrubs are more diverse and in some cases may be fair browse for livestock and excellent wildlife browse. A scattering of shrubs is not considered entirely undesirable on a California ranch.

In Spain as well as in California, year-long grazing is the most common practice. Seasonal grazing also occurs, although in Spain as in California, changing land use patterns have limited access to traditional seasonal grazing grounds. Herding of sheep and goats is not uncommon in Spain, but is virtually unknown in California oak woodlands. Mixed species grazing is the norm in Spain, but is also unusual in California. In Spain, cattle may graze the herbaceous understory year-long, with pigs herded through in fall to harvest acorns. Various combinations of sheep, goats, cattle, pigs and even horses may graze the same pasture, either serially or concurrently. This presumably leads to greater homogeneity of pasture utilization. In both Spain and California, plantings of subterranean clover (*Trifolium subterraneum*) and other attempts at forage improvement are occasionally employed.

The intensity of management characteristic of the dehesa system carries over into regeneration practices. Both holm and cork oaks resprout and in most soil conditions produce abundant seedlings from acorns. Seedlings and sprouts that are located in appropriate spots are encouraged to grow to trees. Herders guide animals away from young trees, and may pile branches and brush around seedlings to protect them from browsing. Over time, the dehesa oaks have come to be spaced relatively evenly, far apart enough to allow a tractor pulling a disk to pass between the trees and perhaps to maximize multiple resource use (figure 3). In recent years, however, there has been a shift away from close herding of stock toward extensive pasture grazing and enhanced deer and boar populations. As a result, suppression of seedlings and sprouts due to over-browsing has become a problem in some areas. On California ranches oak distribution is irregular, in some places very dense and in others sparse (figure 4). A variety of factors, including browsing, soil conditions, and changes in the California flora, seem to be affecting the regeneration success of some oak species. Landowner interest in the regeneration of individual trees is limited but there is interest in low cost techniques of enhancing or maintaining woodland regeneration rates overall.

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## CONCLUSIONS

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The ecological dynamics of the oak woodlands of Spain and California are different, and it follows that the management practices employed also must differ. Yet similarities outweigh differences, and there is much Californians can learn about long-term, sustained management systems through study of the Spanish system. The management of the dehesa extends back through Moorish times into the distant reaches of Roman history, at least a thousand years. Cervantes' Don Quixote noted the advantages of eating acorns as the staff of life, and in rare cases today, acorn bread or gruel is sometimes eaten. A popular liquor is brewed from acorns. It is the diversity of the system, both in terms of its vegetation components and the products produced, that makes it so stable and enduring.

In California, we like to think that human intervention in oak woodland ecosystems has been brief, about 200 years. We think of ourselves as interlopers in a pristine system, as exploiters. But we really don't know much about the long term management of California oak woodlands. Acorns were the dietary staple of a large population of Native Americans in California. It is possible that California oaks have been managed for thousands of years, and that the present distribution and abundance of oaks is a function of that management to some degree (Heady and Zinke 1978).

Now we are in the process of re-defining our role in the oak woodlands of California. Are we interlopers—a destructive force driving the woodlands to extinction? Will we simply learn to be good neighbors to the remnants of an ecosystem that is best



**Figure 3**—Holm oak woodland on a Sierra Norte hillside near Seville, Spain. Note the relatively even spacing of trees, mono-specific stand.



**Figure 4**—Blue oak woodland on the west slope of the Sierra Nevada east of Marysville, California. Note uneven tree distribution, mix of digger pine, interior live oak, and blue oak.

off without our intervention? In Spain, the dehesa is renowned as a reservoir of biodiversity, and home to a variety of threatened and endangered species (Marañón 1988). At the same time, it produces a variety of products for human use, and support to rural economies and families. In California, questions that will be resolved in the next few decades include whether we will manage our oaks intensively, extensively, or not at all. A lot depends on how we view ourselves and our role in natural systems.

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