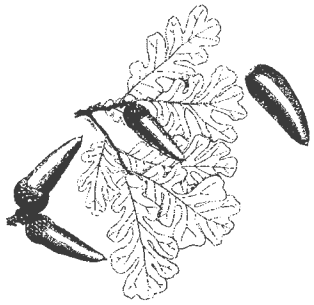
Guidelines for Managing California's Hardwood Rangelands



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ON THE COVER: Oaks on a foggy morning — Murphy's Laurelwood Ranch, Sonoma County, California. Photograph courtesy of Michael Brigham, Photographix, 131 E. First Street, Cloverdale, CA 95425. Inside photographs by Michael Brigham, Richard B. Standiford, and Douglas R. McCreary.

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Preface

California's hardwood rangelands cover estimated 11 million acres in the state. This area is characterized by an overstory canopy of at least ten percent cover of hardwood tree species, predominantly in the oak genus (*Quercus*), with an understory of annual grasses, forbs and occasional native perennial grasses. There are an additional 2.5 million acres of oak savannah, with less than a 10 percent oak canopy cover. Since European settlement of California, hardwood rangelands have been managed primarily for livestock production. These areas have taken on a new importance because of the recognition that they are one of the richest wildlife habitats in the state, with at least 313 terrestrial vertebrate species relying at least partly on hardwood rangelands for habitat. Other public values provided by these areas include water quantity and quality, erosion and sediment control, outdoor recreation, and aesthetics. Management decisions by landowners and managers are important, since over 80 percent of California's hardwood rangelands are in private ownership.

The purpose of this book is to help landowners and managers of hardwood rangeland properties develop management plans that maintain the profitability of their properties, while at the same time sustaining the ecological values provided by their land. There is no one best management system or one best set of guidelines. These guidelines will lead the reader through a close evaluation of their goals and objectives for their personal lives and their properties, and present a variety of management strategies to achieve these goals and objectives. This book is a revision of *The Preliminary Guidelines for Managing Hardwood Rangelands*, released in 1986 by the University of California. It incorporates nine additional years of research and experience developed by the University's Integrated Hardwood Range Management Program and other universities and agencies.

This book consists of three parts. Part I (The Hardwood Rangeland Resource) presents a framework upon which sustainable management is built. Setting conservation, economic, and quality of life goals, and assessing your resources are prerequisites for both economic success and success in maintenance of land values. Part I concludes with a chapter on oak woodland wildlife ecology and habitat relationships.

Part II (Hardwood Rangeland Management) presents four chapters on enterprises that can contribute to the economic and quality of life goals. First, the livestock enterprise on hardwood rangelands is examined, including relationships of oaks to forage production, grazing management, animal health issues, and predator management. Livestock grazing is still the major economic use of hardwood rangelands, with over two-thirds of the total acres grazed by domestic livestock. Fee hunting and other forms of outdoor recreation are discussed in this section, and how these enterprises allow owners to capture economic benefit. A chapter on open space values shows how owners can receive economic benefit from amenity values, which previously had been provided for free. A chapter is also presented on firewood utilization and other specialty wood products.

Part III (Sustaining Hardwood Rangelands) addresses management of hardwood rangelands to sustain their long-term economic and ecological values. Hardwood conservation is discussed at the regional and local level and at the individual tree and watershed level. Evaluations of the the relationships of fire and erosion to the long-term sustainability of hardwood rangelands conclude Part III.

With past wise stewardship of these lands by the owners and managers, hardwood rangelands continue to be a rich source of ecological value. As pressures for competing uses for these lands intensifies in California due to rapid urban population expansion into areas that were previously rural, it is important to ensure the economic well-being of the owners. The most cost-effective form of conservation of hardwood rangelands is maintaining sustainable economic enterprises. With rising public concerns about conservation of hardwood rangelands, there is an increased interest in the development of management practices and local guidelines for different areas of the state. This book is written for California's hardwood rangelands as a whole, and not for those in one particular region or county. It is hoped, however, that the general information, the processes described, and the references provided can help landowners, and resource management professionals develop site specific management recommendations and policies suited for local conditions.

A prudent approach to all decisions on hardwood rangelands is: preserve your options. Oak trees are long-lived because they are adapted to wide fluctuations in climatic conditions, periodic insect and disease outbreaks, and relatively benign but persistent human land uses. However, oak trees on hardwood rangelands are sensitive to drastic changes in land management, and once the trees are killed or removed, they are difficult to replace. *Preserving your options* helps to ensure that decisions you make today do not adversely affect your options in the future.

Chapter One
Setting Goals for Hardwood Rangeland Management

Primary authors: Richard Standiford , Univ. of California, Berkeley; and Melvin George, Univ. of California, Davis

This chapter will help you through the process of critically assessing your goals for a hardwood rangeland property. What are you trying to achieve with your hardwood rangeland property and how do you plan to use your time, effort, money, and management skills to accomplish this? A systematic evaluation of these questions helps determine your management goals. Management is simply an activity directed toward attainment of your goals. Therefore, the goals you set will provide direction to all your management efforts. Worksheet 1-1 will help you to develop the goals for your hardwood rangelands.

Types of Goals

All of us have goals that we work toward over many years - goals such as debt-free ownership of a farm or ranch, or "burning" the mortgage on the family home. Some goals require a lifetime to achieve. Others can be attained in a year, a few years, or a decade. Goals are typically written as action statements. " To complete ... " or "To earn ..." or other action statements are often used to introduce a goal. Shown below are three broad categories of goals – namely *conservation goals, economic and production goals, and quality of life goals* – which will greatly influence how you manage your hardwood rangelands.

Conservation Goals - What are your general goals for the long-term conservation of the resources on your property? In this book, we take the view that there are minimum levels of resource protection that individuals should attain through their management activities. However, many hardwood rangeland owners have conservation goals that exceed these minimum threshold values. They actively promote the concept of resource stewardship, whereby owners look at themselves as stewards of the broad array of market and non-market resources found on a property. Some of the general conservation goals for a property might include:

- *Sustain existing resources* - This would include sustaining the existing diversity of biological organisms on a property. It also seeks to maintain the ecological processes and habitat characteristics on hardwood rangelands at a variety of scales ranging from the individual tree to the watershed level.

- *Enhance or improve resources* - Owners may wish to improve the general condition of the natural resources on their hardwood rangeland property. This may involve planting oaks on areas where they once stood, or improving riparian habitat to enhance wildlife values and improve water quality.

- *Improve water quality and quantity* - Hardwood rangelands are under the auspices of various state and federal water quality programs. Landowners often wish to go beyond these minimum standards and reduce erosion from road networks or locate the source of gully erosion and adopt practices to reverse these processes. Landowners may also wish to enhance the water supply from their land for livestock and wildlife use.

- *Maintain aesthetic values* - In a recent survey of landowners asking why they were interested in the oaks on their property, one rancher replied, "Because the oaks make my property look like a ranch, and not a farm." Most owners are concerned with the consequences of their management activities on the appearance of their land. The beauty of hardwood rangelands helps maintain aesthetic and economic values of the property.

Economic and Production Goals - The setting of economic goals may involve sitting down and evaluating the economic needs of your family. How willing is the family to accept risk? What kind of cash flow is needed to provide for your family's basic needs? When do you need capital to purchase new equipment, or to send your children to college, or to take a vacation? Careful evaluation of each item listed below will help you to set these goals.

- *Risk* - How much risk are you willing to accept? How many years can an enterprise lose money? How much of a savings cushion is there? How heavily leveraged is the enterprise? Landowners may be willing to invest a certain percentage of their assets in more risky investments once their basic living expenses are ensured because of possible high rates of return. A general rule of thumb is that investments with high rates of return often have high risk.

- *Cash flow* - How often are returns required? Is this the sole income source for the family? Are there special upcoming expenses (i.e. college, new home, etc.)? How much reserve is needed for unanticipated expenses (medical needs, etc.)? Carefully evaluate your cash flow needs.

- *Profit* - What rate of return on invested capital is needed? How does this stack up with other investment opportunities available? Is it better to invest your money in a new enterprise on your hardwood rangeland property, or to take that money and put it into the bank or a mutual fund?

- *Estate planning* - How interested are your heirs in managing hardwood rangeland property? How do estate taxes figure into long-term sustainability? Hardwood rangeland owners need to carefully consider the value of their estate, and plan to find ways to reduce the impact of estate taxes on the continued ownership and production.

Quality of Life Goals - Each person is unique in the kind of lifestyle they desire for themselves and their family. What kind of person are you and how can your management activities help support the quality of life you desire for yourself or your family? How interested are you in working with other people? Are you comfortable with the idea of supervising labor or do you want your property to be a strictly family-run business? Do you enjoy working outdoors doing manual labor or do you prefer to spend your time on business and marketing activities?

- *Preservation of lifestyle* - Many ranchers own hardwood rangelands and desire to preserve a lifestyle that previous generations of ranchers have established. These individuals must carefully evaluate management alternatives and economic enterprises that may influence how they and heir children will live upon their rangelands.

- *Personal contact with others* - Some people enjoy owning hardwood rangeland because of the peace and solitude it offers. Others like working with people and providing a service to them. You need to carefully consider your aptitude and interest in working with people, as that will impact the kinds of management activities and enterprises that will be most appropriate for your situation.

- *Marketing skills* - Many hardwood rangeland enterprises require a great deal of effort to develop markets for the products or services provided. How willing are you to work on marketing? Do you have the skills or interest to develop new markets? There are lots of opportunities to expand the economic base of hardwood rangeland properties for individuals who have a keen interest in developing markets. However, if that is an area you are not comfortable with, you would be better to stick to enterprises that have well-developed markets.

- *Labor relations* - Do you intend to hire outside labor to carry out the enterprise, or is this to be only a family business? Is the necessary skilled labor available in your family, or do you need to hire help?

Assessing Your Goals

Worksheet 1-1 gives you some guidance in evaluating the goals for your hardwood rangeland property. Plan on sitting down with all members of your family who have an interest in your hardwood rangeland property, and systematically determining your goals. This process may take several meetings until everyone is comfortable with the ranch goals. You should first have each person complete this worksheet individually. Then, you can be-

gin the process of combining these goals into a working foundation for managing your hardwood rangeland resource.

Once you have gone through the process of systematically evaluating your goals, determine what types of enterprises are consistent with them. Table 1-1 shows a matrix of several conservation, economic and production, and quality of life goals. This shows what types of enterprises are worth considering in more detail as you go through the process of developing a management plan. For example, if your quality of life goals are such that you do not desire to have much contact with the public, then enterprises such as hunt clubs, recreational enterprises, and using your property as conservation land, are likely to be enterprises that will not be satisfying for you. The results of this assessment of your goals will help you decide which of the ideas and enterprises discussed in the following chapters are worth looking at more closely.

Table 1.1. Matrix of goals and management enterprises. Use results from Worksheet 1-1 to help evaluate possible resource management enterprises.

Enterprise	Conservation goals				Economic and production goals				Quality of life goals			
	Sustainable Manage-ment	Improve Resources	Water Quality	Aesthetics	Risk	Cash Flow	Estate planning	Profit	Preserva-tion of Lifestyle	Personal Contact	Marketing	Labor Relations
Livestock grazing **Chapter 5**	Simulate natural role of grazing in ecosystem	Grazing as a manage-ment tool	Protect riparian zones	Depends on aesthetic values desired	Moderate - periodic fluctuations in prices	Annual	Genetic stock, fencing, structures	Variable - usually low	High - traditional product	Low - does not require great contact with others	Low -Existing market structure	Variable - Depends on size
Hunt club **Chapter 6**	Can broaden economic base	Can help pay for restoration projects	Take care with roads and other improve-ments	Depends on aesthetic values desired	Low - usually involves long-term contracts	Annual	Client list, habitat improveme nt(water, lodge, etc.)	Moderate - high demand for recreational hunting	Variable - sometimes must deal with people having different values	High - requires contact with people	Moderate - will be start-up marketing; can contract	Variable - Depends on size; guides, hired hands
Recreation or tourism **Chapter 6**	Can broaden economic base	Can help pay for restoration projects	Take care with roads and other improve-ments	Depends on aesthetic values desired	High - uncertain markets in some areas	Annual	Client list, improve-ment	Moderate - depends on location, services	Variable - sometimes must deal with people having different values	High - requires contact with people	High - will require marketing skills	High - Usually involves outside labor
Conser-vation land **Chapter 7**	Can broaden economic base	Value enhanced through improve-ment	Can enhance through manage-ment	Depends on aesthetic values desired	High - markets beginning to develop in some areas	Variable - lump sum payments or annual rent	May affect title for land, future permissible enterprises	Variable - depends on location	Variable - depends on terms of conserva-tion easement	High - Will involve contact with variety of people	High - New concept, will require work to develop	Low - Once started, little hired labor needed
Wood products **Chapter 8**	Harvest only what can be grown; ensure regenera-tion present	Can use to thin and accomplish stand structure goals	Protect riparian zones	May be unsightly without tight supervision	Moderate - low short-term risk; long-term future uncertain	Variable - Dependent on product	Seedlings and saplings required for the future	Low - Depends on terrain, distance to market	High - depending on long-term wood-cutting effects	Low - little involved	Moderate - high - dependent on product	Moderate - high - dependent on product

Worksheet 1-1: Goals for Managing Hardwood Rangelands

Conservation Goals

Over the next five to ten years, what do you think will be the most important conservation goal?

What are the next most important conservation goals over the next five to ten years?

What are the most important conservation goals in the next year or two?

Shown below are several possible conservation goals for your property. Place a check mark by the ones that you feel are important to your situation. If you have other goals that don't appear, add them to the list.

- ❑ To maintain a mosaic of oak-woodland, shrub, and open grassland
- ❑ To stabilize the streambanks along _____ and increase stream shading
- ❑ To encourage a diversity of wildlife resources
- ❑ To reduce wildfire hazard
- ❑ To establish new oaks in _____ .
- ❑ To develop new water sources in _____ .

Other Goals:

- ❑
- ❑
- ❑
- ❑

Worksheet 1-1: Goals for Managing Hardwood Rangelands (cont.)

Economic and Production Goals

Over the next five to ten years, what do you think will be the most important economic goal? (record on these lines)

What are the next most important economic goals over the next five to ten years?

What are the most important economic goals in the next year or two?

Shown below are several possible economic goals for your property. Place a check mark by the ones that you feel are important to your situation. If you have other goals that don't appear, add them to the list.

- ❑ To pass on the ranch as an operating unit to be managed by the next generation
- ❑ To earn $ ____ annually from ranch enterprises
- ❑ To earn a ___ % return on invested capital
- ❑ To have $ ____ in savings to be used ____ years from now for ____
- ❑ To provide for adequate retirement income starting in _____

Other Goals:

- ❑
- ❑
- ❑
- ❑

Worksheet 1-1: Goals for Managing Hardwood Rangelands (cont.)

Quality of Life Goals

Over the next five to ten years, what one quality of life goal will be the most important? (record on these lines)

What are the next most important quality of life goals over the next five to ten years?

What are the most important quality of life goals in the next year or two?

Shown below are several possible quality of life goals for your property. Place a check mark by the ones that you feel are important to your situation. If you have other goals that don't appear, add them to the list.

- ❑ To preserve the existing quality of life associated with ranching.
- ❑ To maintain a level of living similar to friends/family living in towns
- ❑ To lead a quiet life away from urban influences
- ❑ To find new ways to develop new market products
- ❑ To interact frequently with people
- ❑ To maintain the beauty of my property
- ❑ To work outdoors and remain active
- ❑ To hire others to maintain the property

Other Goals:

- ❑
- ❑
- ❑
- ❑

Chapter Two
Oaks and Habitats of the Hardwood Rangeland

Primary authors: Barry Garrison, Calif. Dept. of Fish and Game; Greg Giusti, Univ. of California, Mendocino Co.; and Richard Standiford, Univ. of California, Berkeley

The main focus of these guidelines is on hardwood rangelands in California with at least a 10 percent canopy cover. These areas are also referred to commonly as oak woodlands. Both terms will be used interchangeable throughout these Guidelines. Eight major oak species occur on California hardwood rangelands. Blue oak, valley oak, Oregon white oak and Engelmann oak are all deciduous and members of the white oak group. Coast live oak, interior live oak, and canyon live oak are three important evergreen oaks. California black oak is a deciduous oak in the red oak group. Table 2-1 briefly describes the general characteristics of these important oak species. Figure 2-1 illustrates the typical leaf and acorn for each species, although these show great variation throughout the state.

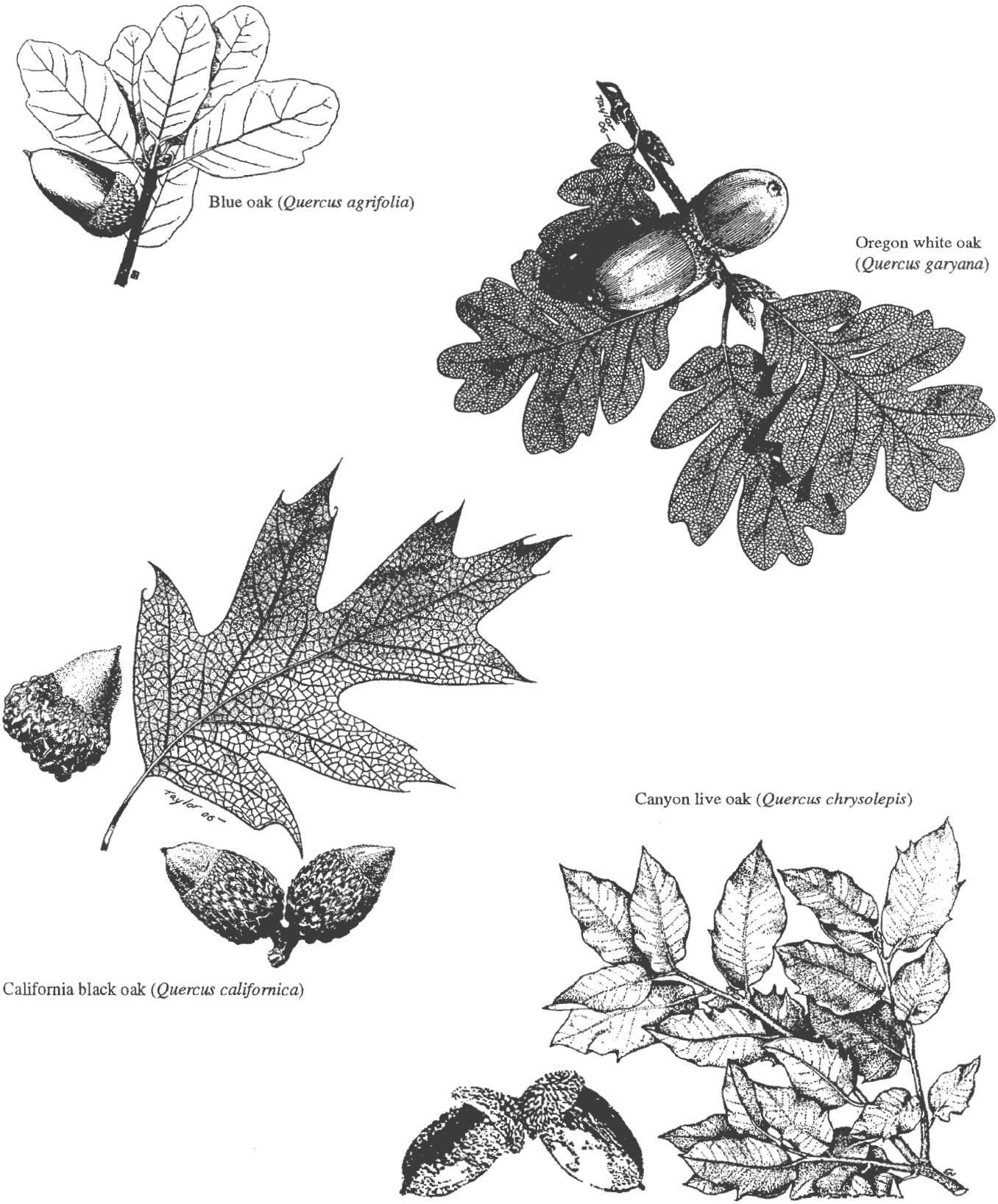
Types of Oak Woodlands

The distribution, density, and abundance of these oak species, together with other tree, brush, and herbaceous species, forms the basis for evaluating the potential of a hardwood rangeland site for providing economic and ecologic value and benefits. Although there are numerous ways to classify California's oak-dominated woodlands, the five vegetation types used in the California Wildlife Habitat Relationships System (CWHR) will be used in these guidelines. The CWHR types are based on the dominant tree species, and include Valley Oak Woodland, Blue Oak Woodland, Blue Oak-Foothill Pine Woodland, Coastal Oak Woodland, and Montane Hardwood Forest.

A list of some of the common names and associated Latin names for some of the tree and brush species used in the woodland type descriptions are provided at the end of this chapter.

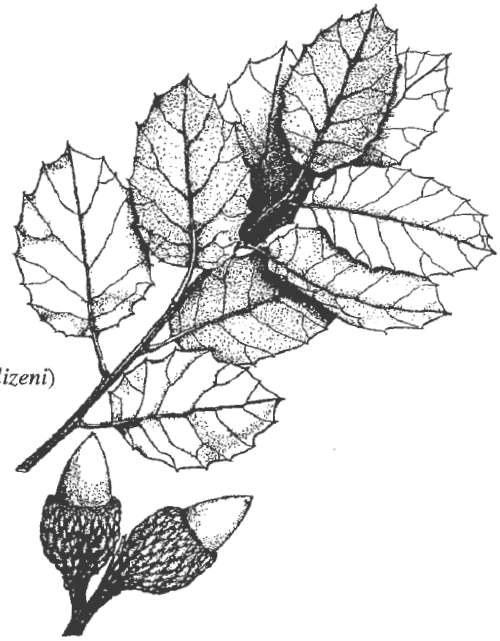
A recent assessment of California by the California Department of Forestry and Fire Protection found approximately 11 million acres of the five types of hardwood rangeland habitats (Table 2-2). This assessment involved 54 of California's 58 counties, which were then placed into one of six geographic regions. Montane Hardwood and Blue Oak Woodland are the most abundant with 4.1 and 3.6 million acres, respectively. Valley Oak woodland was the least abundant, with only 76,450 acres identified. The North Coast and Southern California regions had the least amount of hardwood rangeland habitat types, with 834,800 and 520,000 acres respectively.

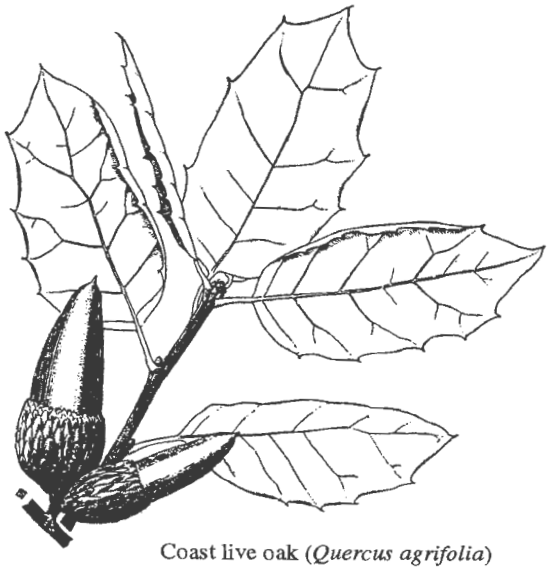
Fig. 2-1. Line drawing of acorns and leaves of California's eight major hardwood rangeland oak species.



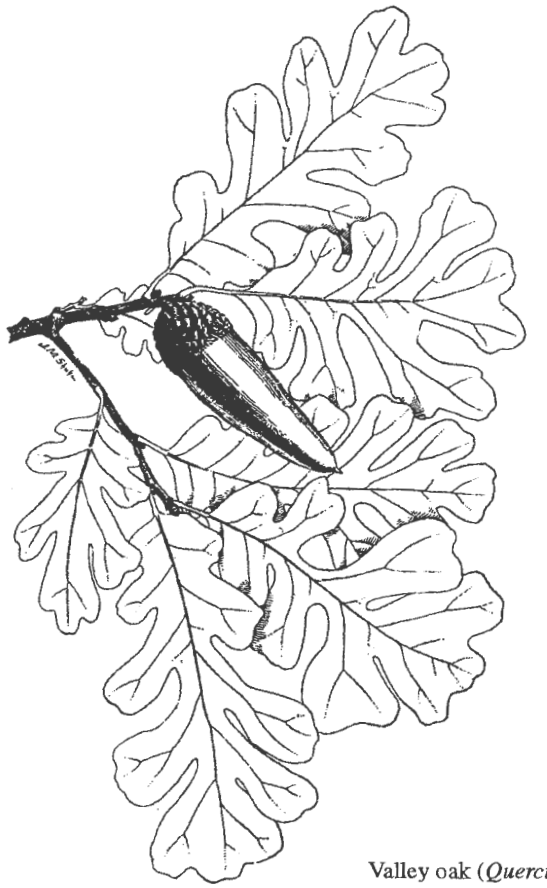
Engelmann oak (*Quercus engelmanni*)

Interior live oak (*Quercus wislizeni*)





Coast live oak (*Quercus agrifolia*)



Valley oak (*Quercus lobata*)

Table 2-1. General characteristics of California's important hardwood rangeland oak species.

Characteristics	Blue Oak	Interior Live Oak	Coast Live Oak	Valley Oak
Scientific name	*Quercus douglasii* Hook. & Arn.	*Quercus wislizenii* A. DC.	*Quercus agrifolia* Nee	*Quercus lobata* Nee
Common names	blue, white, mountain, rock, iron, post, jack, Douglas	Interior live oak, highland live oak, Sierra live oak	Coast live oak, California live oak, encina	Valley, white, California white, mush, water, swamp, roble
Height	Usually 20-60 ft.; tallest over 90 ft.	Usually 30-75 ft.; shrub form 8-10 ft.	Usually 20-40 ft.; may reach 80 ft.	40-120 ft.
Mature Tree DBH (Diam. at Breast Ht.- 4.5 ft. above ground)	Less than 1 ft., up to 2 ft.; largest over 6 ft.	1-3 ft.	1-4 ft.	1-4 ft.; largest over 8 ft.
Longevity	Long-lived, 175-450 yrs.	150-200 yrs.	Long-lived, 125-250 yrs.	Long-lived, 200-250 yrs.
Sprouting	Variable sprouter; not vigorous on dry sites	Very vigorous sprouter	Very vigorous sprouter	Not a vigorous sprouter
Acorn	Matures first year; variable in shape; warty scales; Cup very shallow	Matures second year; very slender, pointed, 1 in. long; cup over half the nut	Matures first year; 3/4 to 2-3/4 in.; cup over 1/3 of nut and not warty	Matures first year, variable but large and tapered, cup over 1/3 of nut and warty
Foliage	Deciduous; blue-gray color; smooth or slightly to deeply lobed edges; 1-3 in. long and 1/2-2 in. wide	Evergreen with smooth to very spiny-toothed; dark green above and lighter below with waxy/shiny surface; 1-4 in.; flat	Evergreen; 1-3 in.; roundish; dark and shiny above with gray or rusty fuzz underneath; cupped or spoon-shaped	Deciduous; leaves leathery with shiny, dark green-yellow above and grayish below; deep irregular lobes; 2-4 in.
Shade Tolerance	Seedlings not tolerant	Somewhat shade tolerant	Shade tolerant throughout life	Seedlings somewhat tolerant, mature trees intolerant
Fire Tolerance	Tolerates grass fires; not hot brush fires	Not very tolerant, but sprouts well after fire	Very tolerant of hot fires due to thick bark	Not tolerant of fires
Elevation	500-2000 ft. in north; up to 5000 ft. in south	Below 2000 ft. in north and above 6200 ft. in south	Below 3000 ft. in north and up to 5000 ft. in south	500-800 ft. in north; up to 5600 ft. in south
Associates	Grades into open valley oak stands at low elevations; blends into denser live oak stands at higher elev.; foothill pine common	In pure stands or mixed with blue and/or coast live oak, and valley oaks in So. California	Forms pure stands; also grows with interior live oak and coast live oak	Blue and Oregon white oak; sometimes interior live oak
Sites	Hot, dry sites with rocky soils, 12-40 in. deep; can't compete with live oak on better sites	Wide range, from valleys to foothills; moister areas than blue oak	Common on valley floors or not-too-dry fertile slopes	Prefers fertile, well-drained bottomland soils, streambeds, and lower foothills
Notes	Confused with valley oaks when leaves are dusty	Confused with coast live oaks; distinguished by flat leaves	Confused with interior live oak but rounded and cupped leaves	Confused with Oregon white oak but acorns pointed with warty cups

Table 2-1. (cont.)

Characteristics	Engelmann Oak	California Black Oak	Oregon White Oak	Canyon Live Oak
Scientific name	*Quercus engelmannii* Greene	*Quercus kelloggii* Newb.	*Quercus garryana* Dougl.	*Quercus chrysolepis* Liebm.
Common names	Engelmann, mesa	Black, California black oak	Garry oak, white oak, Oregon oak	Canyon live oak, canyon oak, gold cup oak, live maul, maul oak, white live oak
Height	20-50 ft.	60-90 ft.	50-80 ft.	60-80 ft.
Mature Tree DBH (Diam. at Breast Ht.- 4.5 ft. above ground)	1-2 ft.	1-4 ft.	2-3 ft.; largest over 5 ft.	1-4 ft.; largest over 5 ft.
Longevity	100-200 yrs.	100-200 yrs., occasionally up to 500 yrs.	100-200 yrs.	Up to 300 yrs.
Sprouting	Variable sprouter	Excellent sprouter	Excellent sprouter	Variable sprouter
Acorn	Matures first year	Matures second year; 1-1/2 in. long; thin cup over half the nut	Matures first year; 1 in. long with shallow cup	1-1/2 in. long; thick, shallow cup,
Foliage	Considered deciduous but foliage may persist during winter; similar to blue-gray color of blue oak	Deciduous; 5 in. long; 5-7 lobed; spiny leaf tips; dark yellow-green above and pale yellow-green below	Deciduous; 4-6 in. long; evenly and deeply lobed with rounded leaf tips; lustrous dark-green and shiny above and pale green below	Evergreen; 3 in. long; persist 3 or 4 seasons on tree; usually not lobed; leathery
Shade Tolerance	Seedlings tolerant, mature trees intolerant	Intermediate tolerance as seedling and intolerant as tree matures	Intermediate tolerance as seedling and intolerant as tree matures	Tolerant of shad
Fire Tolerance	Very tolerant of hot fires	Very sensitive to cambium being killed in hot fires	Maintained in open stands by regular, low-intensity fires	Sensitive to hot fires
Elevation	Under 4000 ft.	200-6000 feet	500-3000 ft.	300-5000 feet
Associates	In pure stands and with coast live oak	Most common with tanoak, madrone, mixed conifer forest species;, also with coast live oak, interior live oak, and blue oak	Douglas-fir and mixed evergreen forests; Pacific madrone and tanoak	Found with mixed conifer, chaparral, and woodland species; tanoak, Douglas-fir, Pacific madrone, coast live oak
Sites	Warm, dry fans and foothills	More common on forest sites; found on moister hardwood rangelands; well-drained soils	Cool humid sites near coast to hot, dry sites inland	Most widely distributed oak on CA.; sheltered north slopes and steep canyons
Notes	Very limited range in southern California makes protection a high priority	Protected by Forest Practice Act on timberlands; commercial properties for finished lumber	Protected by Forest Practice Act on timberlands	Both a shrubby and tree form; very dense wood

Table 2-2. Acreages of California hardwood rangeland habitat types from the California Department of Forestry and Fire Protection database.

Habitat Type (CWHR)	Central Coast (acres)	San Joaquin Valley/ Eastside (acres)	Sac. Valley-North Interior (acres)	Central Sierra (acres)	North Coast (acres)	So. California (acres)	TOTAL (acres)
Blue oak woodland	1,096,990	1,078,080	945,170	365,920	75,900	34,000	3,596,060
Blue oak-foothill pine woodland	283,180	332,090	458,620	230,530	0	0	1,304,420
Valley oak woodland	54,600	16,870	1,760	0	2,230	1,000	76,450
Coastal oak woodlands	1,277,630	24,710	20,790	0	217,650	399,000	1,939,770
Montane Hardwood	632,880	775,450	1,087,910	1,019,910	539,020	86,000	4,141,170
TOTAL	3,345,270	2,227,200	2,514,240	1,616,360	834,800	520,000	11,057,870

Description of regions:
Central Coast: Alameda, Contra Costa, Lake, Marin, Monterey, San Benito, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, Ventura counties
San Joaquin Valley/Eastside: Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, Tulare counties
Sacramento Valley/North Interior: Butte, Colusa, Glenn, Lassen, Modoc, Plumas, Sacramento, Shasta, Sierra, Siskiyou, Solano, Sutter, Tehama, Trinity, Yolo, Yuba counties
Central Sierra: Amador, Calaveras, Eldorado, Mariposa, Nevada, Placer, Tuolumne counties
North Coast: Del Norte, Humboldt, Mendocino counties
So. California: Imperial, Los Angeles, Orange, Riverside, San Diego, San Bernardino counties

Valley Oak Woodland

Vegetation Composition and Structure: These widely scattered but sparsely occurring woodlands are dominated by valley oaks. Associated tree species in the Central Valley include California sycamore, California black walnut, California boxelder, Oregon ash, interior live oak, California buckeye, and blue oak. In the Coast Range, foothill pine and coast live oak occur in valley oak woodlands, while California black oak occurs with valley oaks at higher elevations. At low elevations close to water, valley oak is associated with Fremont cottonwood and tree willows. Valley oak woodlands vary from open savannahs to closed canopy forests. Dense stands occur along natural drainages in deep soils. Tree density tends to decrease as one moves from lowlands to uplands. The understory shrub layer can be dense along drainages and very sparse in uplands. Understory grasses and forbs are mostly introduced annuals. Mature valley oaks have well-developed crowns and reach maximum heights of 50 to 120 ft. The massive trunks (often up to 6 feet DBH) and branches of mature trees dominate valley oak woodlands.

Ecological Processes. In many areas, there is little valley oak recruitment to replace mature tree losses due to both natural and human causes. This is presumed to be related to moisture competition with grasses and forbs, wild and domestic animals feeding on acorns and seedlings, and flood control projects. Also, fire suppression has encouraged live oak and pine invasion in upland valley oak sites. Valley oaks tolerate flooding and young trees will sprout when damaged by fire. Valley oak woodlands should be able to maintain themselves with natural disturbances such as fire and flooding. However, suppression of fire and flooding has adversely affected sustainability of valley oak woodlands.

Locational Characteristics: Valley oaks are endemic to the state, meaning that they are found only in California. They occur in a patchy distribution throughout most major lowland valleys including the Sacramento-San Joaquin and those valleys occurring in the Coast Range and Transverse Range. Many valley oak woodlands occur as isolated stands in areas where surrounding habitats have been modified by agricultural, urban, and suburban activities. Annual grasslands, riparian forests, and other oak woodland types occur adjacent to valley oak woodlands. Conversion of valley oak woodlands to irrigated agricultural land uses has had the largest effect on the acreage decline of this type.

Physical Characteristics: Valley oak communities generally occur on deep, well-drained alluvial soils found in valleys and foothills below 2,400 feet. However, valley oaks can occur up to 5,600 feet as components of other vegetation types in the south Coast Range and Tehachapi Mountains.

Blue Oak Woodland

Vegetation Composition and Structure: Blue oak woodlands are highly variable with blue oak comprising 80-100 percent of the trees present. Foothill pine, California buckeye, valley oak, interior live oak, coast live oak, canyon live oak, and California black oak are common associates of blue oak. The overstory of blue oak woodlands range from sparsely scattered trees on poor sites to nearly closed canopies on good quality sites. Annual grasses form most of the understory in open woodlands. Characteristic shrub species in this community include poison-oak, California coffeeberry, and several species of ceanothus and manzanita.

Ecological Processes: Blue oaks are relatively slow-growing, long-lived trees. Most blue oak stands exist as groups of medium to large trees with few or no young oaks. This may or may not indicate there is a regeneration problem (see chapter 9). However, there is concern that in areas of poor regeneration, blue oak woodlands may be slowly changing into savannas and grasslands as trees die and are not replaced. Since young, vigorous blue oaks can stump sprout readily, while older, decadent trees cannot, younger stands are more likely to regrow after fires. Poor blue oak recruitment from acorns occurs for several reasons. Introduced annual grasses out-compete blue oak seedlings for soil moisture. In addition, acorns and seedlings are eaten or damaged by insects, domestic livestock, and wildlife. Blue oak is also somewhat intolerant of shady conditions, and is unable to survive under dense overstory canopies. Disturbances with small openings may be needed for seedlings to survive and grow sufficiently to promote a broader age class distribution. Furthermore, reduction in annual grass biomass through fire, limited grazing, or weeding may increase seedling growth and survival.

Locational Characteristics: Blue oak woodlands form a nearly continuous band along the Sierra Nevada-Cascade foothills of the Sacramento-San Joaquin Valley. They also occur along the western foothills of the Tehachapi Mountains and eastern foothills of the Coast Range. Typically, blue oak woodlands are found below 3,000 to 4,000 feet, but this elevational threshold drops to around 2,000 feet in the northern range, and rises to around 5,000 feet in the southern range. At lower elevations on gentle slopes, blue oak woodlands typically occur as large blocks with highly variable canopy cover. On steeper ground, blue oak woodlands occur in small patches interspersed with other habitats such as annual grasslands, chaparral, riparian forests, and other types of oak woodlands.

Physical Characteristics: Blue oak woodlands occur on a wide range of soils which are often shallow, rocky, infertile, but well-drained. Blue oak woodlands occur in dry, hilly terrain where the water table is usually unavailable to trees. Over the range of blue oaks, there is considerable climatic variation, with rainfall ranging from 10 to 60 inches annually.

Blue Oak-Foothill Pine Woodland

Vegetation Composition and Structure: Blue oak-foothill pine woodlands have a diverse mix of hardwoods, conifers, and shrubs, and widely variable overstories. Foothill pine (formerly known as digger pine) and blue oak typically form most of the overstory of this highly variable habitat type. Blue oak usually most abundant, although foothill pine is taller and dominates the overstory. Stands dominated by foothill pine have low blue oak density because of its shade intolerance. In the Sierra Nevada foothills, interior live oak and California buckeye are often associated with this type. Interior live oak becomes more abundant on steeper slopes, shallower soils, and at higher elevations. Coast live oak, valley oak, and California buckeye occur with this community in the

Coast Range. In the southern Coast Range and Tehachapi Mountains, California juniper also occurs. Shrub associates include several ceanothus and manzanita species, poison-oak and California redbud, and are usually clumped in areas of full sunlight.

Ecological Processes: Blue oak and foothill pine are relatively long-lived, but foothill pine tends to grow faster than blue oak. Historically, fires occurred every 5 to 25 years in this vegetation community. Regeneration is generally thought to be infrequent throughout California. Following fire, young, vigorous blue oaks sprout well, but older, more decadent trees do not. Therefore, younger stands are more likely to replace themselves after fires. Foothill pine is susceptible to severe damage to fire. This is due to the thin bark of young trees and high resin content in the sap. Furthermore, foothill pine does not reproduce by sprouting, so fire management as a tool should be carefully considered.

Locational Characteristics: Blue oak-foothill pine woodlands are found on steeper, dryer slopes with shallower soils than blue oak woodlands. At lower elevations on gentle slopes, these two communities intermix with grasslands. At higher elevations on steeper slopes, the communities are mixed with grasslands and shrublands. Riparian woodlands may bisect these mosaics along permanent and intermittent watercourses. Blue oak-foothill pine woodlands are found throughout the range of blue oak and form a nearly continuous band along the Sierra Nevada-Cascade foothills of the Sacramento-San Joaquin Valley, except for a gap in Tulare and southern Fresno counties. Elevation ranges from 500 feet in the north to 3000 feet in the south.

Physical Characteristics: This woodland type occurs on a variety of well-drained soils. Terrain is hilly and generally dry, and water is unavailable for much of the year.

Coastal Oak Woodland

Vegetation Composition and Structure: Coastal oak woodlands are highly variable because of their wide distribution along California's coast. Three oak species dominate the range of coastal oak woodlands: coast live oak throughout the central and southern range; Engelmann oak in a small area in southern California; and Oregon white oak in the moister, northern range of this community. Trees associated with Oregon white oak include California black oak, canyon live oak, Pacific madrone, and interior live oak. Species associated with coast live oak on moister sites are Pacific madrone, California bay, tanoak, and canyon live oak, while coast live oak occurs with valley oak, blue oak, and foothill pine on drier sites. In southern California, coast live oak is associated with interior live oak, valley oak, California black walnut and Coulter pine. Where Engelmann oak dominates, it may occur with coast live oak or in almost pure stands. Overstories range from open conditions to nearly closed canopies, resulting in a variable density of understory shrubs, grasses, and forbs. Annual grasses form most of the understory in open woodlands, but are almost non-existent in very dense woodlands. Coastal oak savannas typically occur adjacent to grassland habitats. Shrubs in closed canopy situations tolerate shade, and include toyon, poison-oak, California coffeeberry, and several species of ceanothus and manzanita.

Ecological Processes: Coast live oak, Oregon white oak, and Engelmann oak are relatively long-lived, slow-growing trees, requiring 60 to 80 years to mature to tree size under good conditions. Historically fires frequently occurred in these woodlands. Engelmann and coast live oaks are relatively resistant to low-intensity ground fires, while some mortality occurs to seedlings and saplings. Since coast live oak is fairly resistant to grazing pressure, it appears to be replacing the less resistant deciduous oaks in areas with intense grazing. Coast live oaks regeneration is generally good. However, adequate regeneration of Engelmann oak is not occurring for many of the same reasons affecting blue oaks. In Oregon white oak stands without frequent fires or other disturbances, Douglas-fir and other conifers may grow in the understory and eventually overtop the oaks.

Locational Characteristics: Coastal oak woodlands occur along California's coastal foothills and valleys. Elevations range from sea level to around 5,000 feet. On steep slopes, coastal live oak woodlands occur as relatively small woodland patches in mosaics with annual grasslands, shrublands, and riparian habitats. Blue oak woodlands and montane hardwoods are found with the more interior and higher elevation coastal oak woodlands.

Physical Characteristics: Soils and its underlying rock parent materials are extremely variable. Coastal oak woodlands typically occur on moderately to well-drained soils that are moderately deep and have low to me-

dium fertility. As with other hardwood-rangeland communities, considerable climatic extremes exist.

Montane Hardwood Forest

Vegetation Composition and Structure: Montane hardwood forests are perhaps the most variable of any California hardwood type. The dominant oak species vary by topography, soils, and elevation. Montane hardwood forests typically lack blue oaks and valley oaks. The characteristic oaks are canyon live oak, interior live oak, California black oak, and Oregon white oak. Many montane hardwood forests are located on fairly productive forest soils, and are not truly "hardwood rangelands", but commercial hardwood forests under the jurisdiction of the California Forest Practices Act (FPA). However, pure stands of black oak, tanoak, and madrone with no evidence of conifer associates are exempt fro the FPA at this time.

Canyon live oak often forms almost pure stands on steep canyon slopes and rocky ridge tops throughout the Coast Range, Klamath Mountains, Sierra Nevada, and Transverse and Peninsular Ranges. They have tremendously variable growth forms, ranging from shrubs with multiple trunks on rocky, steep slopes, to 60 to 70 foot tall trees on deeper soils in moister areas. Throughout the same range, California black oak tends to dominate on gentle topography at higher elevations. It grows to heights of 70 to 80 feet at maturity, with long, straight trunks in closed canopy situations. In open forests, California black oak has larger, spreading branches. Canyon live oak and California black oak are widely distributed and form the montane hardwood habitats throughout much of California's mountain areas. However, these two species are usually not associated with hardwood rangeland sites.

Interior live oak occurs with canyon live oak or alone on steep canyon slopes and rocky, steep slopes throughout the North Coast and Sierra Nevada. Its growth form varies much like canyon live oak. Both of these evergreen oaks have dense canopies. Oregon white oak dominates small amounts of montane hardwood types along the northern Coast Range and northern Sierra Nevada and Cascades. Oregon white oak grows to a height of 50 to 80 feet at maturity, with rounded crowns in open conditions and rather narrow crowns in closed conditions.

Associates of montane hardwood communities at higher elevation, good quality sites include ponderosa pine, Douglas-fir, Pacific madrone, Jeffrey pine, sugar pine, incense-cedar, and white fir. At lower elevations and poor soils with steep slopes, associates include foothill pine, knobcone pine, tanoak, and Pacific madrone. In southern California, many of the same species are found, as well as coulter pine and bigcone douglas-fir. Blue oak and valley oak can be associates at lower elevations. Understory shrub species include poison-oak, ceanothus, manzanita, mountain-mahogany, coffeeberry, wild currant, and mountain misery. Forbs and grasses are not as prevalent as on lower elevation hardwood rangeland types. Montane hardwood forests have a pronounced hardwood tree layer with poorly developed shrub and herbaceous layers.

Ecological Processes: Since oaks of montane hardwood communities are long-lived, the community is rather stable and persistent without stand replacing disturbances. Trees are initially established by acorns, and dispersal by animals plays a major role in planting and survival. Once established, the four dominant oaks - canyon live, interior live, California black, and Oregon white - can sprout vigorously from stumps, allowing rapid re-establishment after a fire. Frequent fires over relatively small areas result in a variety of age classes across the landscape. The large number of hardwood and conifer species allows this type to occupy many environments and locations. The general inaccessibility of these habitats have protected them from many of the human-induced disturbances such as intensive agricultural, residential and commercial development, grazing, and wood cutting.

Locational Characteristics: Montane hardwoods range throughout California from 300 feet near the coast to almost 9,000 ft in southern California. Surrounding habitats include conifer-dominated types, chaparral types, blue oak and valley oak woodlands, and exotic annual grasslands.

Physical Characteristics: A wide range of physical characteristics affect montane hardwood forests. Slopes range from gentle to steep. Soils are mostly rocky, coarse, and poorly developed. However, relatively large California black oak stands occur in mountain valleys on alluvial soils. Exposures tend to be south, west, and east, while conifers tend to dominate on northern exposures. Climates are typically Mediterranean but extremely variable given the wide distribution of this type. Average summer temperatures are moderate, while average winter temperatures range from near freezing to the mid-40's. Snow occurs in the winter at higher elevations, but does not remain as long as on adjacent conifer-dominated habitats.

List of Common and Scientific Names for Plants Used in This Chapter

Bigcone Douglas-fir (*Pseudotsuga macrocarpa*)
Blue oak (*Quercus douglasii*)
Brome (*Bromus* spp.)
California bay (*Umbellularia californica*)
California black oak (*Quercus kelloggii*)
California black walnut (*Juglans hindsii*)
California boxelder (*Acer negundo*)
California buckeye (*Aesculus californica*)
California coffeeberry (*Rhamnus californica*),
California juniper (*Juniperus californica*)
California redbud (*Cercis occidentalis*)
California sycamore (*Platanus racemosa*)
Canyon live oak (*Quercus chrysolepis*)
Ceanothus (*Ceanothus* spp.)
Coast live oak (*Quercus agrifolia*)
Coulter pine (*Pinus coulteri*)
Douglas-fir (*Pseudotsuga menziesii*)
Engelmann oak (*Quercus engelmannii*)
Foothill pine (*Pinus sabiniana*)
Fremont cottonwood (*Populus fremontii*)
Incense-cedar (*Calocedrus decurrens*)
Interior live oak (*Quercus wislizenii*)
Jeffrey pine (*Pinus jeffreyi*)
Knobcone pine (*Pinus attenuata*)
Madrone (*Arbutus menziesii*)
Manzanita (*Arctostaphylos* spp.).
Mountain mahogany (*Cercocarpus betuloides*)
Mountain misery (*Chamaebatia foliolosa*)
Oregon ash (*Fraxinus latifolia*)
Oregon white oak (*Quercus garryana*)
Pacific madrone (*Arbutus menziesii*)
Poison-oak (*Toxicodendron diversilobum*),
Ponderosa pine (*Pinus ponderosa*)
Sugar pine (*Pinus lambertiana*)
Tanoak (*Lithocarupus densiflorus*)
Valley oak (*Quercus lobata*).
White fir (*Abies concolor*)
Wild currant (*Ribes spp.*)
Wild oats (*Avena* spp.)
Willow species (*Salix* spp.)

Chapter Three

Resource Assessment and General Hardwood Rangeland Values

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General Assessment of Property

Once you have completed an assessment of the goals for your hardwood rangeland property, it is necessary to assess the various resources to determine if it is possible to accomplish these goals, and where management activities should be directed. In this chapter, we will present two general worksheets. Worksheet 3-1 gives a framework for evaluating the overall hardwood rangeland property, while worksheet 3-2 will help you assemble basic information about your hardwood stands. Most of the information for 3-1 is easily available from a general reconnaissance of the property, as well as an evaluation of maps and aerial photos. The section on sources of assistance gives advice on ordering maps and photos if you do not already have these. You should plan on completing this entire resource assessment exercise because it can provide a foundation upon which sound land management actions may be built. This is a good activity for all family members or parties interested in a particular property to participate in together. The information gained in this exercise will ensure that everyone has a common base of knowledge about the existing resources on a property.

Stand Level Assessment

Once you have completed the general property assessment in Worksheet 3-1, take a look at the information in table 3-1 for some general resource enterprises that may work on your property. These possible enterprises can be compared with those which fit in with your goals developed from the worksheets in chapter 1, to decide on the management potential for your hardwood rangeland property. Then you will be able to direct your attention to detailed discussions in chapters 4 through 9 of this book on various hardwood rangeland enterprises. You may need to collect additional information for a detailed assessment of the individual enterprises. This should help guide your decision about which types of management activities will be best for your situation.

Seen at left is a large madrone tree located on a ranch in Sonoma County. In the background are black oak trees. Madrone trees frequently occur on montane hardwood rangelands.

Worksheet 3-1. Hardwood Rangeland Propety Assessment

General Property Information

Property name _____ Parcel size _____ acres Elevation _____ feet

Describe how property was acquired (date, method acquired, original purchase price/basis)

Current Property Value _____

Nature of ownership

❑ Sole ❑ Joint ❑ Partnership ❑ Other _____

Property location (describe general location of property; use local maps where possible)

Accessibility (describe road access to various parts of the property and locate on map/photo)

Adjacent land uses (describe all adjacent land uses)

❑ Ag./open space ❑ Suburban ❑ Rural Residential ❑ Urban ❑ Public land ❑ Protected Areas

Topography (show on map/photo)

Acres on slopes less than 30% ___ Acres on slopes greater than 30% ___

Distance to markets

Distance to urban areas/clientele base for hunt clubs and customers for firewood: ___ miles

Distance to livestock markets: ___ miles

Other markets: ___ miles

Legal/political/social constraints (list ordinances, deed restrictions, zoning, and neighbor concerns affecting property)

Water

Sources of water (describe all sources of water on property and locate on map/photo where appropriate)

❑ Ponds ❑ Water troughs ❑ Springs ❑ Intermittent streams ❑ Perennial streams

❑ Wells ❑ Irrigation ditch ❑ Municipal water source ❑ Other _____

Water quality concerns (describe and locate areas with specific water quality concerns)

General Vegetation Information

Acres by general vegetation cover types (locate vegetation types on map/photo)

Grassland _____ acres	Oak woodlands _____ acres	Shrubland _____ acres
Irrigated agric. _____ acres	Residential areas _____ acres	Wetlands/riparian zones _____ acres
Other forested type _____ acres	Other ( ) _____ acres	

Worksheet 3-1. Hardwood Rangeland Property Assessment (cont.)

Current Management/Economic Uses

Grazing/livestock (check current enterprises that apply, and general information below)

❑ Cow/calf ❑ Stocker ❑ Sheep; ewe/lamb ❑ Lease grazing to others

❑ Other livestock _____

Current livestock inventory: ____ head on ____ acres

Season of use (check all that apply): ❑ Fall ❑ Winter ❑ Spring ❑ Summer

Other sources of forage: ❑ Public land lease ❑ Private lease ❑ Another ranch ❑ Other _____

Tree harvest (describe current tree harvest and marketing programs)

Type of wood products sold: ❑ Firewood ❑ Sawtimber ❑ Biomass ❑ Other _____

Species of tree sold: ❑ Blue oak ❑ Live oak ❑ Foothill pine ❑ Other _____

Harvest _____ cords every ____ years on _____ acres

Hunt Club (describe any hunt club activities you have)

Game species hunted: ❑ Deer ❑ Turkey ❑ Other gamebirds ❑ Pigs ❑ Elk ❑ Other _____

Lease description (describe hunt club economic arrangement)

List other economic uses of hardwood rangeland property

Capital improvements (list of all capital improvements and show on map/photo)

Buildings	Fencing	Road systems	Other Improvements

Resource Constraints

Soils (list all soil series, general productivity, and constraints)

Erodible areas (list all eroded and erodible areas and locate on map/photo where possible)

Threatened and endangered plant and animal species

Table 3-1. Matrix of resource assessment and management enterprises (for assessment chapter)

Assessment Criteria	Livestock grazing	Hunt club/ recreation	Conservation land	Wood products	Specialty products
Parcel size	>25 acres	>500 ac (deer); >100 ac. (turkeys)	>100 ac.	>100 ac.	Depends on product
Cover type and pattern	Must have patches of open or low density woodlands for forage	Mixture of dense and open woodlands with large patches of dense connected woodlands	Must have some special cover type being lost near property or a highly desirable habitat	Must have stands with over 40 percent cover	Sufficient amount of vegetation type for product
Water	Need water	Need water	May enhance value	Not important	May be important
Access	Not important	Need road system for transport	Not essential unless public access desired	Need road system for hauling	Need access for transportation and management
Adjacent land use	Urban uses may present social conflicts	Urban uses may present social conflicts; Rely on neighbors for some habitat needs	Opportunities are best in areas close to urban/residential areas	Urban uses may present social conflicts	Urban uses may present conflicts or opportunities depending on product
Topography	Most areas <50 pct. slope	Need areas with <50 pct. slope for access	Slope class has little effect	Operate only in areas with <30 pct. slope	Most likely need areas <30 pct. slope
Distance to market	Unlimited with new video marketing sales	Need to be <120 miles	Generally near to urban areas or areas with some adverse impact	<100 miles	Should be <100 miles to market to minimize transportation
Capital improvements	Fences, water facilities	Not critical	Not critical	Depends on product	Depends on product
Legal constraints	Local ordinances, T&E species	T&E species, hunting regulations	Often restricts future land use; may be constraints on compatible enterprises	Local ordinances, T&E species, deed restrictions, Forest Practice Act	Need to check health codes, zoning restrictions, T&E species
Resource constraints	Need residual biomass	Species of interest should be present in sufficient numbers to support harvest (i.e. turkeys, deer, etc.)	Presence of critical habitat or threatened and endangered species may enhance value	Site must be capable of regeneration from seedlings or sprouting	Need to ensure that "product" management does not disrupt site ecological processes

Assessing Legal Concerns

Today's land management must often comply with numerous laws and regulations that are imposed at all levels - local, state, and federal. Federal laws and regulations are implemented by either the federal agency which has jurisdiction, or are delegated to a state agency. State laws and regulations for the most part are the responsibility of the jurisdictional agency, although responsibilities can be delegated to county or district agencies. Local ordinances are implemented by the county or district agency. An important part of an assessment is finding out which of these legal concerns apply to your situation, and what these require you to do. Some of the different types of laws and regulations you should be investigating are described, as well as where you might find more information.

Water: Water rights and water quality are both the responsibility of the California State Water Resources Board, who further delegate the water quality responsibilities to nine Regional Water Quality Control Boards. Federal laws such as the Federal Clean Water Act, Safe Drinking Act, and Coastal Zone Act are tailored for implementation in California by the Porter-Cologne Act. Water rights are involved when considering pond or spring development and diversions for water supplies. Water rights applications and information for land parcels are obtained at the county recorder's office. Stream water diversions require a "1603 permit" from the California Department of Fish and Game. Water quality considerations for hardwood rangelands most often involve nonpoint source pollution factors, including sedimentation, nutrients, and/or pathogens. Riparian vegetation management is frequently considered along with these other nonpoint source pollution factors.

Wetlands: Wetlands jurisdiction is confusing and landowners and managers should check to see what issues are of local concern and which agency is involved. Laws and regulations are under a state of revision. For most agricultural lands, the Natural Resources Conservation Service (NRCS) has the lead role for wetlands management. In some cases, the Army Corps of Engineers, the US Fish and Wildlife Service, or the California Department of Fish and Game may be the lead agency.

Air Quality: Any burning activities are under the jurisdiction of local Air Quality Management Districts (AQMD). Check with your local AQMD to determine an air quality restrictions that would apply to management of your hardwood rangelands.

Wildlife: The County Agricultural Commissioner handles issues related to controlled materials for predator control. The California Department of Fish and Game is responsible for issuing predation permits for some animals (deer, mountain lions, bear, etc.), and for setting regulations over hunting and fishing. Furthermore, the Department protects species listed as threatened, endangered, or protected by state law, and it has general jurisdiction and public trust responsibility for the state's fish and wildlife and their habitats.

Timber: Most tree species on hardwood rangelands are currently not considered "commercial species" and are not subject to the Forest Practice Rules administered by the State Board of Forestry. However, a number of counties and cities have ordinances that affect the harvest of oak trees on rangelands. Several other counties have voluntary oak tree harvesting guidelines and suggested best management practices. Check with local experts to see what local rules and guidelines apply to your area.

Endangered Species: Both federal and state laws list plants and animals that are threatened or endangered. The US Fish and Wildlife Service has jurisdiction over the federally listed species, while the California Department of Fish and Game has jurisdiction of those listed by the state (see Appendix A and B). Specific circumstances may prohibit certain management practices or changes in land use if they affect a listed plant or animal. Check locally with California Department of Fish and Game, U.S. Fish and Wildlife Service, or UC Farm Advisors for the situation in your area. This is discussed in more detail in chapter 4.

Archaeological Sites: There is increasing public concern about preserving historically and culturally significant

sites. The presence of such sites may impact proposed changes in land use or management. County planning, Community Colleges, State Colleges, and local museums are good sources of information on archaeological sites in your area.

Land Use: A number of land use related issues may influence certain management decisions. The California Land Conservation Act (Williamson Act) contracts with certain counties to provide tax relief for agreeing to not develop land for 10 years. County General Plans often have restrictions on parcel size, land use, and zoning. Easements for utilities, conservation, open space, and wildlife habitat are becoming more common. Other laws and ordinances to be aware of are those relating to the right to farm and fence, trespass laws, as well as private property rights laws.

Livestock: There are a number of laws relating to livestock including: animal identification (branding) law; laws relating to diseases such as TB and brucellosis; and laws concerned with the disposal of dead animals. Your local agricultural commissioner can provide information on each of these.

Professional Certification: The State Board of Forestry has the licensing authority over natural resource professionals to protect the natural resources of the state and to protect the public interest by ensuring competent professional work. Designations for Certified Rangeland Managers (CRM) and Registered Professional Foresters are maintained by the State Board of Forestry. Details on qualifications, duties, and a list of certified professionals are available.

Values for Hardwood Rangeland Stands

Worksheet 3-2 helps you to collect basic information on hardwood rangeland cover type, canopy cover, slope class, and associated habitat elements, and will allow you to look up some general ecological and managerial recommendations. Table 3-2 shows how the information on tree cover type and canopy density can be used to refer you to a specific description. For example, if your stand is a blue oak woodland with a 50 percent canopy cover, you would go to the description for site C, found on page 11 of this chapter.

Each of the 12 broad site descriptions gives general recommendations and assessments on four categories: oak cover/forestry; recreation; wildlife diversity; and grazing. These are based on some very broad statewide conclusions from practical experiences and research studies. These descriptions, assessments, and recommendations are intended to guide you through some general ideas on the potential uses for hardwood rangeland stands on your property. As you evaluate these recommendations, the rainfall zone, slope class, and presence of wildlife habitat elements such as snags, riparian zones, or downed woody debris, which you are assessing in worksheet 3-2, will allow you to refine these recommendations. These general recommendations must be followed up with site specific information for your local area. Chapters 4 through 9 will help you develop this site specific information for your property.

Table 3-2. Classification for hardwood rangeland sites based on tree cover type and canopy cover.

Tree Cover Type	Tree Canopy Cover			
	10 - 24%	25 - 39%	40 - 59%	60 - 100%
Blue oak woodland, blue oak-foothill pine woodland	A	B	C	D
Valley oak woodland	E	F	G	H
Coastal oak woodland, montane hardwood	I	J	K	L

Worksheet 3-2. Hardwood Rangeland Stand Assessment

Property name

Location of Stand (describe general location on property, use maps where possible)

Acres in Stand		Elevation	Soil Series	
Aspect	❑ North	❑ South	❑ East ❑ West	
Av. Annual Rainfall	❑ <15"	❑ 15 - 25"	❑ 25 - 35"	❑ >35"
Slope Class	❑ Gentle (<30%)		❑ Steep (>30%)	
Erosion	❑ None	❑ Sheet/rill	❑ Gullies	
Ground cover	❑ <25%		❑ 25 - 50%	❑ 51 - 75% ❑ >75%
Tree Cover Type	❑ Blue oak woodland, Blue oak-foothill pine woodland ❑ Valley oak woodland ❑ Coastal oak woodland, montane hardwood			
Tree Canopy Cover	❑ Minimal (<10%) ❑ Moderate (40 - 59%)		❑ Sparse (10 - 24%) ❑ Dense (60 - 100%)	❑ Open (25 - 39%)
Average Tree Size	❑ Seedling (<1 in. DBH) ❑ Pole (6 - 11 in. DBH) ❑ Med./Large tree (>24 in. DBH)			❑ Sapling (1 - 6 in. DBH) ❑ Small tree (11 - 24 in. DBH) ❑ Multi-layered
Tree Mortality	❑ None		❑ Light (<5 % trees)	❑ Heavy (>5% trees)
Regeneration status (check all that apply)	❑ none evident ❑ Saplings (3 - 10' tall)		❑ Small seedlings (<1' tall)	❑ Large seedlings (1 - 3' tall)
Shrub canopy cover	❑ Minimal (<10%) ❑ Moderate (40 - 59%)		❑ Sparse (10 - 24%)	❑ Open (25 - 39%) ❑ Dense (60 - 100%)
Shrub age class (yrs. since fuel reduction)	❑ <5 years ❑ >25 years		❑ 5 - 15 years	❑ 15 - 25 years
Habitat elements (check all that apply)	❑ Brush piles ❑ Riparian zones		❑ Snags	❑ Dead and down logs
Water sources	❑ None ❑ Springs		❑ Perennial streams ❑ Water developments	❑ Intermittent streams ❑ Other _____

Threatened and endangered plants and animals present:

Site A: Blue oak woodland, blue oak foothill pine woodland; 10 – 24 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 20 to 170 cubic feet per acre, and 10-year growth rate ranges from 2 to 40 cubic feet per acre. These are not good areas for commercial harvesting activities due to very low stocking and low growth rates. Many open blue oak savannahs lack oak regeneration, especially on low elevation and/or low rainfall zones. Managers should compare current levels of mortality to regeneration. In areas where mortality exceeds regeneration, it may be necessary to adopt management procedures to encourage regeneration.

Recreation Assessment:
These areas offer only limited opportunities for hunt clubs in their current condition because of low cover and acorn production. Medium populations of quail can be expected, which can be improved by providing additional water and cover with brush piles. It may be desirable to increase cover if feasible to improve habitat for deer and turkeys.

Wildlife Diversity Assessment:
These open blue oak savannah stands contain both grassland and woodland wildlife species. In general, the habitat is good for open grassland species such as western meadowlark, but marginal for woodland species such as Pacific-slope flycatchers. Habitat elements, such as riparian zones, snags, trees with cavities, and large woody debris, have an important effect on biodiversity by making habitats more complex. More complex habitats support greater numbers of wildlife. According to the California Wildlife Habitat Relationships system (CWHR) there are 21 amphibian species, 33 reptile species, 73 mammal species, and 137 bird species which are predicted to occur in these habitats if various elements occur. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur in these habitats falls to 10 amphibian species, 31 reptiles, 39 mammals, and 101 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species.

Grazing Assessment:
Average forage production capability is 3,000 pounds per acre with a range from 1,500 to 4,500 pounds. In low rainfall areas, the presence of scattered trees has been found to increase overall range forage production. However, thistles and other undesirable plants may occur under the tree canopy, although this is not common. Potential for range improvement through seeding, fertilization, and grazing management may increase productivity where production is currently at the lower end of the scale and available soil and soil moisture is not limiting.

Site B: Blue oak woodland, blue oak foothill pine woodland; 25 – 39 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 170 to 425 cubic feet per acre and the 10-year growth is 25 to 70 cubic feet per acre. These areas are generally not good for commercial firewood harvesting. The existing stocking level is good for diverse resource values, and managers should not take canopy density much lower. Some light thinning may be possible in dense clusters, but avoid using equipment on areas with over 30 percent slope to minimize erosion. Perhaps 40 to 85 cubic feet could be harvested per acre in higher productivity sites every 20 years. Many areas like these have an absence of oak regeneration, especially on low elevation and/or rainfall areas. Managers should assess current levels of mortality and compare this to seedling and sapling regeneration. In areas where mortality exceeds regeneration, it may be necessary to adopt management procedures to encourage regeneration.

Recreation Assessment:
These areas have good overall habitat for mule and black-tailed deer, wild pigs and California quail. Habitat can be improved by enhancing acorn production, planting legumes, and maintaining these through proper livestock and deer management. Any reductions in oak cover will also decrease habitat value for many desired game spe-

cies. Areas with slopes greater than 30 percent will have lower values for hunt clubs because of the difficult access.

Wildlife Diversity Assessment:
These blue oak woodland stands support both grassland and woodland wildlife species. In general, the habitat is fairly good for a large number of wildlife species. The occurrence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 21 amphibian species, 31 reptile species, 64 mammal species, and 128 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur on these habitats falls to 10 amphibian species, 29 reptiles, 30 mammals, and 95 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species.

Grazing Assessment:
Average forage production capability is 3,000 pounds per acre with a range from 1,500 to 4,500 pounds. In low rainfall areas, the presence of scattered trees has been found to increase overall range forage production. However, thistles and other undesirable plants may occur under the tree canopy, although this is not typical. Potential for range improvement through seeding, fertilization, and grazing management may increase productivity where production is currently at the lower end of the scale and available soil and soil moisture is not limiting.

Site C: Blue oak woodland, blue oak foothill pine woodland; 40 – 59 percent canopy cover

Oak Cover/Forestry Assessment:

Oak volumes range from 425 to 1200 cubic feet per acre. Ten year growth ranges from 50 to 130 cubic feet per acre. Firewood harvest potential exists, but avoid using equipment on slopes over 30 percent to minimize erosion.. Harvest levels should approximately equal growth to maintain existing oak cover for diverse resource values. Approximately 85 to 250 cubic feet per acre can be harvested every 20 years from these stands. Ensure adequate oak regeneration after harvest.

Recreation Assessment:
These areas are excellent for medium to large populations of mule and black-tailed deer, squirrel, wild pigs, wild turkeys, mourning dove, and band-tailed pigeons. On areas with less than 30 percent slope, the terrain is excellent for hunter access. Careful tree thinning can complement game habitat. Where controlled fire can be used, it can help stimulate palatable shrub browse. Seeding clover and other legumes and maintaining it through grazing will benefit deer, turkey and quail.

Wildlife Diversity Assessment:
These blue oak woodland stands support a large number of wildlife species. The higher tree density makes these areas less desirable for open grassland species such as western meadowlarks and western kingbirds, but very desirable for woodland species such as Pacific-slope flycatchers and wild pigs. The occurrence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. 19 amphibian species, 28 reptile species, 64 mammal species, and 128 bird species are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or water sources, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur on these habitats falls to 10 amphibian species, 26 reptiles, 30 mammals, and 95 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species.

Grazing Assessment:
Average forage production capability is 2,000 pounds per acre with a range from 1,000 to 2,800 pounds. In areas with less than 20 inches of annual rainfall and during drought years on higher average rainfall areas, range productivity and forage nutritional value is often enhanced by the presence of this level of oak cover. In higher rain-

fall areas, the shading effect of the canopy suppresses total production. Thistles and other undesirable plants may occur under the tree canopy, although this is not typical. Potential for range improvement on slopes less than 30 percent through seeding, fertilization, and grazing management may increase productivity by two- to three-fold where production is currently at the low end of the scale. Tree thinning will increase forage production under the removed canopy in the higher rainfall zones of the state (over 20 inches per year).

Site D: Blue oak woodland, blue oak-foothill pine woodland; 60 – 100 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 1200 to 3800 cubic feet per acre. Estimated growth ranges from 170 to 510 cubic feet per acre over 10 year. Firewood harvest can be carried out to permanently reduce cover and improve habitat for selected wildlife species and range productivity. Areas with less than 30 percent slope are a good place to prioritize for harvesting on the ranch. 500 to 2500 cubic feet per acre can be harvested from these stands to permanently reduce stands to 40 to 60 percent canopy cover after 20 years. If stand openings are absent, you may wish to make some small openings through the firewood operation to encourage blue oak regeneration.

Recreation Assessment:
These areas provide excellent habitat for mule and black-tailed deer, squirrel, wild pig, wild turkey, mourning dove, and band-tailed pigeons. On areas with over 30 percent slope, hunter access is too difficult for commercial operations. Thinning stands back to 50 percent cover in a patchy pattern can enhance deer habitat. Turkeys do best with a dense canopy, and California quail do best with less tree canopy, but both species prefer dense shrub layers and ample water sources.

Wildlife Diversity Assessment:
These dense blue oak woodland stands support a large number of wildlife species, although the higher tree density makes these areas undesirable for open grassland species. A few species such as Cooper's hawks and orange-crowned warblers, actually prefer the dense conditions found in these stands. The occurrence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 19 amphibian species, 25 reptile species, 62 mammal species, and 102 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur on these habitats falls to 10 amphibian species, 23 reptiles, 28 mammals, and 77 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species. Some thinning may help enhance overall biological diversity.

Grazing Assessment:
Average forage production capability is 900 pounds per acre with a range from 500 to 1,500 pounds. The dense tree cover suppresses forage production, leaving less available for livestock operations. Thinning stands on slopes less than 30 percent will increase forage production under the removed canopy for about 15 years by 50 to 100 percent especially on poor sites. After tree thinning, seeding, fertilization, and grazing management may increase forage production. Little improvement potential exists on steeper slopes.

Site E: Valley oak woodland; 10 – 24 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 40 to 340 cubic feet per acre. Growth ranges from 17 to 80 cubic over 10 years. The canopy in these open valley oak savannahs needs to be maintained. These areas are poor candidates for any harvest activity. Managers should encourage the recruitment of young seedlings to sapling size through management activities.

Recreation Assessment:
These areas offer only limited opportunities for hunt clubs in their current condition because of low shrub cover

and acorn production. Medium populations of quail can be expected, which can be improved by providing additional water and cover with brush piles. It may be desirable to increase cover, if feasible, to improve habitat for deer and turkeys.

Wildlife Diversity Assessment:
These open valley oak savannah stands contain both grassland and woodland wildlife species. In general, the habitat is good for open grassland and open woodland species such as western meadowlark, and marginal for woodland species such as Pacific-slope flycatcher. The presence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 19 amphibian species, 32 reptile species, 72 mammal species, and 132 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur on these habitats falls to 8 amphibian species, 30 reptiles, 38 mammals, and 99 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species.

Grazing Assessment:
Average forage production capability is 3,500 pounds per acre with a range from 2,000 to 5,000 pounds. In low rainfall areas, the presence of scattered trees has been found to increase overall range forage production. Thistles and other undesirable plants may occur under the tree canopy, although this is not typical. Potential for range improvement through seeding, fertilization, and grazing management may increase productivity where production is currently at the lower end of the scale and available soil and soil moisture is not limiting.

Site F: Valley oak woodland; 25 – 39 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 340 to 1100 cubic feet per acre. Ten year growth ranges from 60 to 150 cubic feet per acre. Although these are not good areas for commercial harvesting, there is some potential for light thinning due to the relatively high productivity of valley oak stands. It may be desirable to utilize trees being lost to mortality if not needed to provide snags in the stand. Perhaps 40 to 170 cubic feet per acre could be harvested every 20 years on slopes less than 30 percent. The existing stocking level is good for diverse resource values, and managers should not take canopy density much lower. Attempts should be made to encourage recruitment of oak seedlings to sapling size through management practices. Rapid growth of seedlings is possible.

Recreation Assessment:
These areas have good overall habitat for mule and black-tailed deer, wild pigs and California quail. Habitat can be improved by enhancing acorn production, planting clover and other legumes, and maintaining these through proper livestock and deer management, and enhancing shrub cover. Any reductions in oak cover will also decrease habitat value for most commercial game species. Areas with slopes greater than 30 percent will have lower values for hunt clubs because of the difficult access.

Wildlife Diversity Assessment:
These valley oak woodland stands have both grassland and woodland wildlife species. In general, the habitat is fairly good for a large number of wildlife species. The occurrence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 19 amphibian species, 30 reptile species, 71 mammal species, and 128 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur on these habitats falls to 8 amphibian species, 28 reptiles, 37 mammals, and 96 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species.

Grazing Assessment:
Average forage production capability is 3,000 pounds per acre with a range from 1,500 to 4,500 pounds. In low rainfall areas, the presence of scattered trees has been found to increase overall range forage production. However, thistles and other undesirable plants may occur under the tree canopy, although this is not typical. Potential for range improvement through seeding, fertilization, and grazing management may increase productivity where production is currently at the lower end of the scale and available soil and soil moisture is not limiting.

Site G: Valley oak woodland; 40 – 59 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 1100 to 2900 cubic feet per acre. Ten year growth ranges from 120 to 420 cubic feet per acre. Some thinning on a sustainable basis is possible, especially in stands with large numbers of small trees to improve individual tree growth rate. There is some possibility to utilize harvested trees for solid wood products, such as white oak lumber or barrel staves. 170 to 680 cubic feet per acre could be harvested every 20 years on stands with less than 30 percent slope. It is important to ensure that adequate oak regeneration results after the harvest.

Recreation Assessment:
These areas are excellent for medium to large populations of mule and black-tailed deer, squirrel, wild pigs, wild turkeys, mourning dove, and band-tailed pigeons. On areas with less than 30 percent slope, the terrain is excellent for hunter access. Some careful tree thinning can complement game habitat. Where controlled fire can be used, it can help stimulate palatable shrub browse. Seeding clover and other legumes and maintaining these through grazing, as well as increasing shrub cover, will benefit deer, turkey and quail.

Wildlife Diversity Assessment:
These valley oak woodland stands support a large number of wildlife species. The tree density makes these areas less desirable for open grassland species such as western meadowlarks and western kingbirds, but very desirable for woodland species such as Pacific-slope flycatchers and orange-crowned warblers. The occurrence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 17 amphibian species, 27 reptile species, 63 mammal species, and 123 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur on these habitats falls to 8 amphibian species, 25 reptiles, 29 mammals, and 93 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species.

Grazing Assessment:
Average forage production capability is 2,000 pounds per acre with a range from 1,000 to 2,800 pounds. On such sites, the shading effect of the canopy usually suppresses total production. Thistles and other undesirable plants may occur under the tree canopy, although this is not typical. Potential for range improvement on slopes less than 30 percent through seeding, fertilization, and grazing management may increase productivity by two- to three-fold where production is currently at the low end of the scale. Tree thinning will increase forage production under the removed canopy in the higher rainfall zones of the state (over 20 inches per year).

Site H: Valley oak woodland; 60 – 100 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 2900 to 5100 cubic feet per acre. Estimated ten year growth rate ranges from 220 to 420 cubic feet per acre. Harvest could be carried out to increase individual tree diameter and crown growth rate on areas with less than 30 percent slope and high stem density and small diameter trees. This may help improve acorn production and create conditions favorable for seedling establishment. Seedlings are likely to be absent or very slow growing due to little sunlight reaching the ground. Harvest levels of 420 to 1700 cubic feet per acre can be

carried out every 20 years. There is some possibility to utilize harvested trees for solid wood products, such as white oak lumber or barrel staves. It is important to ensure that adequate oak regeneration results after the harvest.

Recreation Assessment:
These areas offer good opportunities for habitat for mule and black-tailed deer, western gray squirrel, wild pig, wild turkey, mourning dove, and band-tailed pigeons. On areas with over 30 percent slope, hunter access is too difficult for commercial operations. Thinning stands to 50 percent cover in a patchy pattern may enhance deer habitat if shrub cover is increased. Turkeys do best with a dense canopy, and California quail do best with somewhat less canopy.

Wildlife Diversity Assessment:
These dense valley oak woodland stands support a large number of wildlife species. The tree density makes these areas undesirable for open grassland species. A few species such as orange-crowned warblers and house wrens, actually prefer the dense conditions found in these stands. The occurrence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 17 amphibian species, 24 reptile species, 61 mammal species, and 96 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur on these habitats falls to 8 amphibian species, 22 reptiles, 27 mammals, and 74 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species. Thinning may enhance biological diversity.

Grazing Assessment:
Average forage production capability is 1,200 pounds per acre with a range from 800 to 1,500 pounds. The dense tree cover suppresses forage production, leaving less available for livestock operations. Thinning stands on slopes less than 30 percent will increase forage production under the removed canopy for about 15 years by 50 to 100 percent at lower levels of current production. After tree thinning, improvement potential through seeding, fertilization, and grazing management may increase forage production. Little improvement potential exists on steeper slopes.

Site 1: Coastal oak woodland, montane hardwood; 10 – 24 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 35 to 250 cubic feet per acre and growth ranges from 17 to 50 cubic feet every 10 years. These areas are not good locations for firewood harvests due to very open stocking. Regeneration concerns are not as pronounced in live oak stands due to rapid resprouting in most areas of the state.

Recreation Assessment:
These areas may offer only limited opportunities for hunt clubs in their current condition because of low tree cover. Medium populations of quail can be expected, which can be improved by providing additional water and cover with brush piles. It may be desirable to increase cover if feasible to improve habitat for mule and black-tailed deer and turkeys. The presence of sprouting live oaks allows greater latitude in quail management than deciduous oaks with similar cover.

Wildlife Diversity Assessment:
These open live oak savannah stands contain both grassland and woodland wildlife species. In general, the habitat is good for open grassland species such as western meadowlark and western kingbirds, and marginal for woodland species such as Pacific-slope flycatcher and western gray squirrels. The presence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 18 amphibian species, 35 reptile species, 74 mammal species, and 135 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush

piles on the site, the number of vertebrate wildlife species predicted to occur on these habitats falls to 7 amphibian species, 33 reptiles, 38 mammals, and 101 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species.

Grazing Assessment:
Average forage production capability is 2,700 pounds per acre with a range from 1,800 to 4,000 pounds. Oak canopy in these lightly stocked areas may enhance forage production in low rainfall areas or during drought years. These low canopy levels have only minimal impact on forage production in higher rainfall zones, although thistles and other undesirable plants may occasionally occur under the tree canopy. Potential for range improvement through seeding, fertilization, and grazing management may increase productivity where production is currently at the lower end of the scale and available soil and soil moisture is not limiting.

Site J: Coastal oak woodland, montane hardwood; 25 – 39 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 250 to 850 cubic feet per acre, with a ten year growth of 50 to 100 cubic feet per acre. Rapid regrowth of stump sprouts and fairly high growth potential of live oaks would allow some commercial harvest to take place. Harvest levels of 85 to 250 cubic feet per acre every 20 years are possible on areas with less than 30 percent slope. It is important to ensure that regeneration from seedlings or stump sprouts is adequate to replace trees being harvested.

Recreation Assessment:
These areas provide good overall habitat for deer, wild pigs and California quail. Habitat can be improved by enhancing acorn production, planting clover and other legumes and maintaining these through proper livestock and deer management, and enhancing shrub cover. Some selective thinning of dense stands may improve habitat for some game species, although leaving some denser areas will maintain habitat values for species using denser cover. If brush is present, brush piles can considerably improve quail habitat. Areas with slopes greater than 30 percent will have lower values for hunt clubs because of the difficult access.

Wildlife Diversity Assessment:
These live oak woodland stands support both grassland and woodland wildlife species. In general, the habitat is fairly good for a large number of wildlife species. The occurrence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 18 amphibian species, 34 reptile species, 74 mammal species, and 131 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur in these habitats falls to 7 amphibian species, 32 reptiles, 38 mammals, and 98 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species.

Grazing Assessment:
Average forage production capability is 2,500 pounds per acre with a range from 1,500 to 3,500 pounds. Tree cover will cause some suppression of winter and spring production except in areas of low rainfall. Thistles and other undesirable plants may sometimes occur under the tree canopy. Potential for range improvement on slopes less than 30 percent through seeding, fertilization, and grazing management may increase productivity by two- to three- fold where production is currently at the low end of the scale. Tree thinning may increase forage production under the removed canopy in the higher rainfall zones of the state (over 20 inches per year).

Site K: Coastal oak woodland, montane hardwood; 40 – 59 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 850 to 2200 cubic feet per acre. Growth rates of 100 to 190 cubic feet per acre are expected every 10 years. These stands are excellent candidates for sustainable wood harvest operation if slopes are

less than 30 percent. There is some potential for utilization of trees for sawtimber in larger straight-stemmed trees. Harvest levels of 170 to 510 cubic feet per acre every 20 years are possible. It is important to ensure that regeneration from seedlings or stump sprouts are adequate to replace trees being harvested.

Recreation Assessment:
These areas are excellent for quail and moderately good for deer, wild pigs, wild turkeys, and band-tailed pigeons. On areas with less than 30 percent slope, the terrain is excellent for hunter access. Some careful tree thinning can complement game habitat, although some dense areas should be left for cover and breeding purposes. If brush is absent, brushpiles can improve quail habitat considerably. If possible, prescribed burning can stimulate shrub layer browse. Seeding clover and other legumes and maintaining it through grazing, and enhancing shrub cover will benefit deer, turkey and quail.

Wildlife Diversity Assessment:
These live oak woodland stands support a large number of wildlife species. The tree density makes these areas less desirable for open grassland species such as western meadowlarks and western kingbirds, but very desirable for woodland species such as Pacific-slope flycatchers and orange-crowned warblers. The occurrence of more complex habitats, through the presence of habitat elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 16 amphibian species, 30 reptile species, 66 mammal species, and 126 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur in these habitats falls to 7 amphibian species, 28 reptiles, 30 mammals, and 95 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species.

Grazing Assessment:

Average forage production is 2,000 pounds per acre, ranging from 1,000 pounds to 2,800 pounds. Forage production is usually suppressed by tree canopy except in low rainfall zones. Thinning may increase forage under some removed canopies by 100 to 200 percent. Brush understory may occur in some locations and is suitable for management burns. Potential for range improvement through seeding, fertilization, and grazing management may increase productivity where production is currently at the lower end of the scale and available soil and soil moisture is not limiting.

Site L: Coastal oak woodland, montane hardwood; 60 – 100 percent canopy cover

Oak Cover/Forestry Assessment:
Oak volume ranges from 2200 to 5100 cubic feet per acre. Growth ranges from 190 to 310 cubic feet every 10 years. These very dense stands could benefit from thinning to improve overall biological diversity, acorn production, and forage yields. Restrict harvest to areas with less than 30 percent slope. Harvest levels of 510 to 1700 cubic feet per acre can be carried out every 20 years. There is some potential to utilize larger diameter logs for sawtimber, especially if boles have few branches. It is important to ensure that regeneration from seedlings or stump sprouts are adequate to replace trees being harvested.

Recreation Assessment:
These areas offer good opportunities for habitat for deer, western gray squirrel, wild pig, wild turkey, mourning dove, and band-tailed pigeons. On areas with over 30 percent slope, hunter access is too difficult for commercial operations. Thinning stands back to 50 percent cover in a patchy pattern may enhance deer habitat if shrub and herbaceous cover are improved. Turkeys do best with a dense canopy, and California quail do best with somewhat less canopy, but both prefer moderately dense shrub layers.

Wildlife Diversity Assessment:
These dense live oak woodland stands support a large number of wildlife species. The tree density makes these areas undesirable for open grassland species. A few species such as orange-crowned warblers, actually prefer the dense conditions found in these stands. The occurrence of more complex habitats, through the presence of habitat

elements such riparian zones, snags, trees with cavities, and large woody debris, has an important effect on biodiversity. There are 16 amphibian species, 26 reptile species, 64 mammal species, and 99 bird species which are predicted to occur by CWHR on the most diverse habitats in these stands. If there are no riparian zones or sources of water, no snags or cavity trees, and no large woody debris or brush piles on the site, the number of vertebrate wildlife species predicted to occur in these habitats falls to 7 amphibian species, 24 reptiles, 28 mammals, and 76 bird species. This points to the importance of maintaining diversity in the habitat elements present in the stand to provide for the highest possible diversity of wildlife species. Some thinning may help enhance overall biological diversity.

Grazing Assessment:
Average forage production capability is 900 pounds per acre with a range from 500 to 1,500 pounds. The dense tree cover suppresses forage production, leaving less available for livestock operations. Thinning stands on slopes less than 30 percent will increase forage production under the removed canopy for about 15 years by 50 to 100 percent at lower levels of current production. After tree thinning, improvement potential through seeding, fertilization, and grazing management may also increase forage production. Little improvement potential exists on steeper slopes.

Chapter Four

Oak Woodland Wildlife Ecology, Native Plants, and Habitat Relationships

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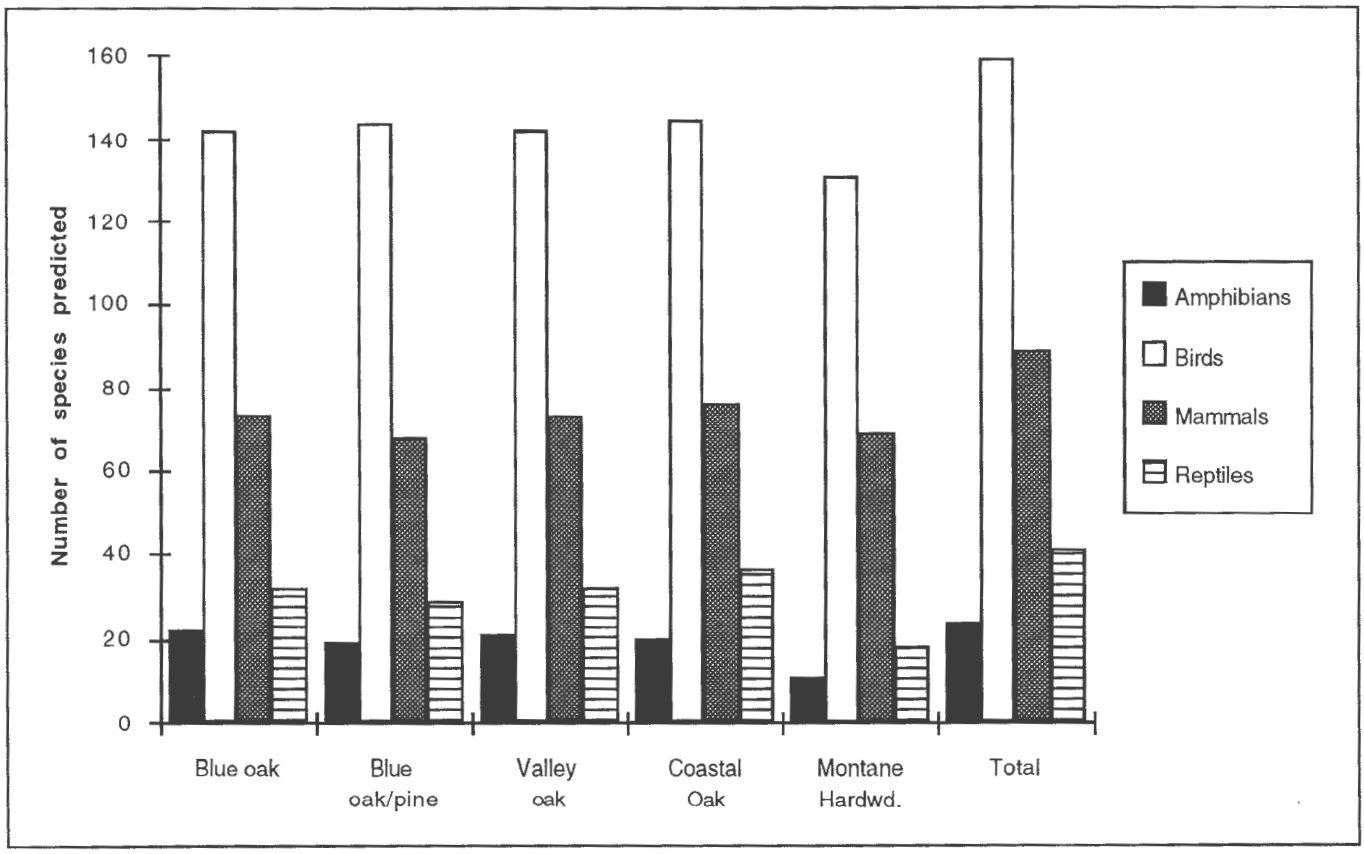
The five habitat types occurring in California's hardwood rangelands (also known as oak woodlands) provide habitat for at least 313 species of birds, mammals, reptiles, and amphibians; more than 2000 plant species; and an estimated 5000 species of insects. Figure 4-1 graphically shows the diversity of vertebrate wildlife species predicted for each of the five major habitat types described in chapter 2. A complete list of all 313 species and their habitat associations is given in Appendix A. The management and long-term sustainability of California's hardwood rangeland habitats will best be served if ecological components and their inter-relationships are recognized and addressed by owners and managers. This chapter provides information on oak woodland ecology

Figure 4-1. Numbers of amphibians, birds, mammals, and reptiles predicted to occur in the five California hardwood rangeland habitats by Version 5.0 of the California Wildlife Habitat Relationships System (CWHR). This list only includes those species in the CWHR System that are predicted to use one or more tree size and canopy cover classes for breeding, feeding, and/or cover.



and wildlife-habitat relationships to serve as a guide for land management activities. The presence and sustainability of specific plant and animal species on hardwood rangeland properties needs to be evaluated with scientific information.

Wildlife Habitat Relationships

Habitats are the specific locations where the factors needed for wildlife survival and reproduction are provided. Successful long-term perpetuation of California's hardwood rangeland wildlife is best achieved by managing habitats because they are the foundation on which wildlife depend. California's five major hardwood rangeland vegetation types (see Chapter 2) and associated riparian types provide habitat for the largest number of vertebrate wildlife species in the state, when compared to habitats dominated by conifers, shrubs, grasses and wetlands. Hardwood rangeland habitats must be able to supply food, water, protection from weather and predators, and locations to reproduce in order to support viable wildlife populations.

In eastern Tehama County, deer use of the lower elevation blue oak and blue oak-foothill pine woodlands are an example of wildlife habitat relationships. These areas are important winter habitat with food and cover for deer that have migrated from higher elevation conifer and meadow habitats around Mount Lassen where they spend the spring and summer to produce fawns. Their autumn migrations take them through montane hardwood habitats where they feed on acorns and browse to gain weight for the strenuous rutting period where bucks (male deer) compete for breeding opportunities. Breeding takes place during the fall and early winter on the lower elevation oak woodlands. Does (female deer) feed on acorns and herbaceous vegetation of oak woodland wintering habitats to provide energy for fawning. These activities are critical and their populations would be dramatically reduced if hardwood habitats failed to provide these key breeding, food, and cover resources.

Habitat Scale Concepts

One way to understand the management complexities of hardwood rangelands is to look at the relationships among its component parts. Wildlife biologists typically evaluate woodland habitats on five levels, providing a convenient system for explaining woodland ecology. Although each level has its applications, it is critical for you to select the management level that is appropriate for your goals. From smallest to largest, these levels are:

1. *Individual*: The interactions of individual plants or animals with their surroundings is the most tangible level of woodland ecology. Survival and reproduction are results that you can observe from the interactions of individual plants or animals.
2. *Population*: The interactions among individuals of the same species and the interactions with their woodland environment form the population level of organization. A population is typically described by the shared characteristics of its individuals, including where they occur, the range of things they eat, when and how they produce young, and how they disperse or migrate. We use this composite picture to define the wildlife habitat relationships between a species and the areas where it occurs. Although this composite picture is somewhat abstract, population data allows biologists to predict the consequences of management activities in woodlands.
3. *Community*: The interactions among species that occur together in a community form the next step in the hierarchy. Species interactions define this level; some species prey on others, some compete with each other for resources, some share resources or recycle nutrients for one another, and some interact in hundreds of other ways. Examples include a deer browsing on oak seedlings, bees pollinating wildflowers, or jays planting acorns. Community interactions are often difficult to detect, and may occur over long time periods.
4. *Ecosystem*: The physical processes and structure that link living things to each other and their ecosystem is the next level of organization. Ecosystems are often defined by their resident or dominant species, such as the hardwood rangeland vegetation types discussed previously. This level of management is somewhat abstract, with boundaries that often blend into adjacent ecosystems.
5. *Landscape*: The geographic patterns of all the other levels creates the landscape level of organization. Some aspects of landscapes are quite tangible, such as the boundaries of a watershed. Others are abstract, such as the patterns of gene flow across the oaks in the coast ranges.

If you protect a 400-year-old oak in your backyard, then you are operating at the individual level of conservation. However, it is often impractical for landowners to manage their woodlands tree by tree. If your goal is to

maintain a specific density or age distribution of oak trees on your property, then you're working at the population level. If you control exotic plants to reduce their effect on oak seedling survival, then you're altering community level interactions among your understory plants. Altering fire frequency to re-establish oak understory would be an ecosystem level of action. Finally, fires burn many different patterns across a landscape, from small patches to catastrophic sweeps of multiple watersheds. Using prescribed burning to create a mosaic of burned and unburned habitats would be a landscape management action.

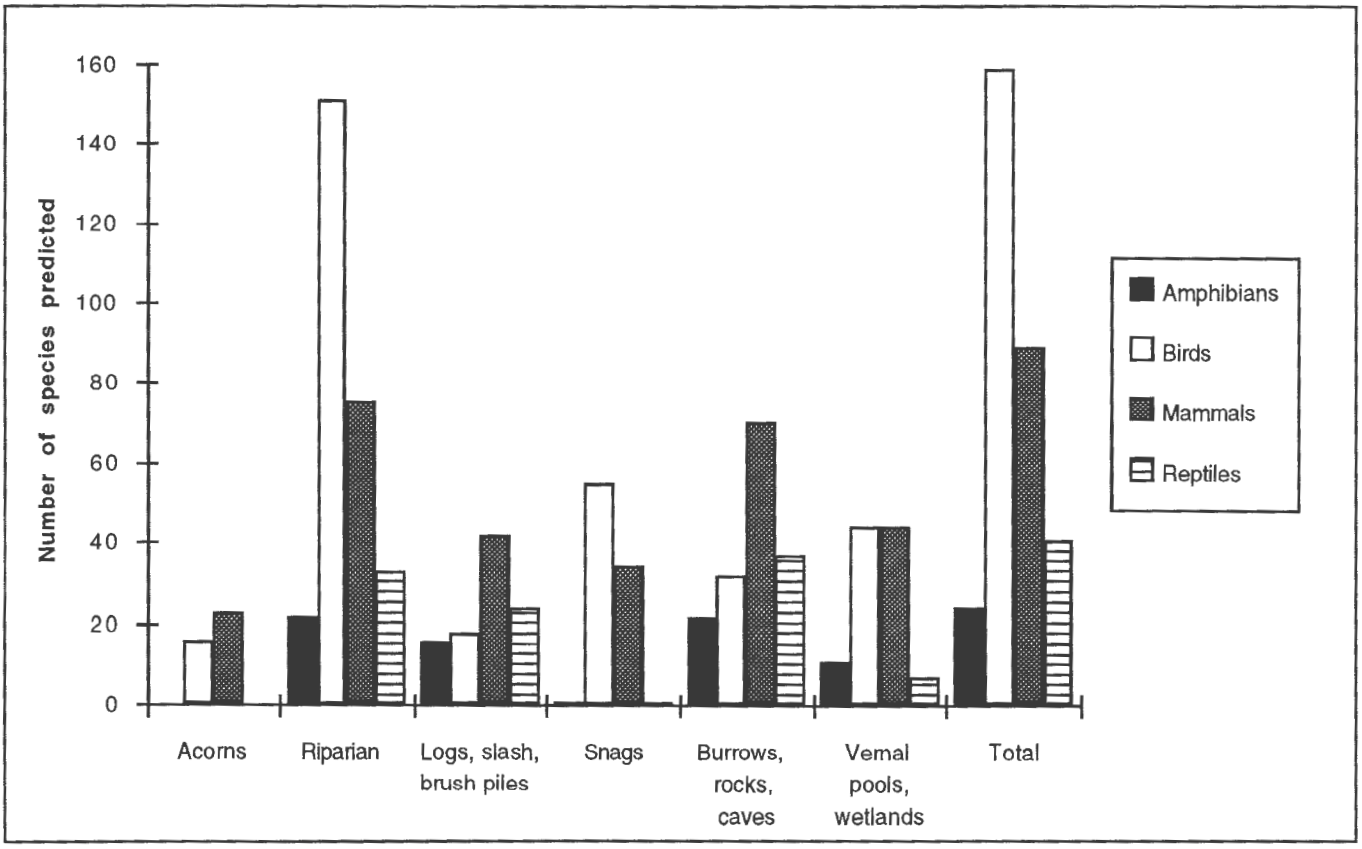
Habitat Structure

Favorable hardwood rangeland habitats supply food, water, and cover to sustain wildlife species. Each habitat element provides unique niches, favoring particular wildlife species. Conversely, the absence of a particular element in a habitat may limit species diversity.

Examples of elements of a hardwood rangeland habitat that are important to consider include riparian zones, vernal pools, wetlands, dead and downed logs and other woody debris, brush piles, snags, rock outcroppings, and cliffs. Figure 4-2 gives the relative number of wildlife species that are predicted to use various elements found on hardwood rangelands. The complete species list in Appendix A shows the specific species that are predicted to use these elements on hardwood rangeland habitats.

Riparian areas are those habitats influenced by the presence of adjacent seasonal or yearlong watercourses. They tend to have a higher biomass level of vegetation due to better water availability throughout the growing season. In general, they have higher tree crown cover, a more diverse assortment of vegetation species, and herbaceous material that stays green later into the summer. As shown, riparian habitat elements are used by almost 90 percent of all hardwood rangeland wildlife species, illustrating the importance of conserving this habitat element where present.

Figure 4-2. Number of amphibians, birds, mammals, and reptiles predicted to use several important habitat elements of California hardwood rangeland habitats by Version 5.0 of the California Wildlife Habitat Relationships System (CWHR). This list includes those species in the CWHR System that are predicted to use one or more of these elements for breeding, feeding, and/or cover.



Over one-third of all bird species on hardwood rangelands make use of snags, or standing dead trees in the stand. This suggests that management strategies to maintain an appropriate number of snags will result in greater wildlife species diversity.

Another important aspect of hardwood rangeland habitat structure is the spatial arrangement of the vegetative cover. The vertical and horizontal distribution of vegetation are both readily visible and easily measured.

Vertical Distribution

Vegetation often occurs in layers from grasses, to shrubs, to trees. This vertical layering affects the duration and intensity of light reaching the ground, which in turn, affects the insects, plants and subsequently those vertebrates dependent on them. Multi-layered habitats provide a diversity of elements offering more niches for wildlife. Most hardwood rangeland species, including California quail, western fence lizards, rufous-sided towhee and acorn woodpeckers, depend on multi-layered vegetation structure. Land managers should consider the consequences of activities that tend to simplify or eliminate vegetation layers.

Horizontal Distribution.

The distribution of different types of habitat or successional stages across a landscape creates diversity in all habitat elements needed for breeding, food and cover. Considering horizontal distribution is important for species that rely on large blocks of land, such as black-tailed deer, mountain lions, and red-tailed hawks.

Alteration of the horizontal distribution of habitats across large landscapes from fire, weather, residential development, rangeland conversion, or oak harvesting, can result in smaller, fragmented habitat patches. Small, isolated patches can eventually become *islands* of habitat that have a similar biological function to oceanic islands. The movement of populations of species isolated on these islands are restricted, so these populations are more susceptible to local extinction than populations which have free access to larger habitat patches. Less mobile species, such as many amphibians, have greater risks of local extinctions than those with greater mobility, such as bird species.

Maintenance of free interaction between reproducing adults is key to the survival of any wildlife species. Connecting patches of habitat through habitat *linkages* or *corridors* improves the interaction of breeding individuals between otherwise isolated populations. These linkages reduce predation and minimize impacts of harsh environmental conditions. Riparian areas often serve as linkages to hardwood rangeland habitats.

Resources Change Through Time

Important wildlife habitat attributes from oaks such as acorn-producing trees, snags, logs, and large and/or dead branches require considerable amounts of time to develop, even though they may persist for decades once they develop these characteristics. Land use practices that remove these attributes without allowing replacement will negatively alter the wildlife community. For example, it may take almost a century for most oaks to grow from acorn-produced seedlings to mature trees capable of producing abundant acorn crops. Oaks must be mature and several centuries old before they are large enough to have large diameter branches. Also, dead branches often result from heart rot which typically affects older, less healthy trees that are more susceptible to decay agents. An oak tree typically must live its entire life of several centuries before it dies and becomes a snag. Once developed, snags persist for many decades before they fall down and become logs. Logs will persist for many decades until they decay and become part of the soil. Furthermore, individual trees may produce more acorns, have more large branches, and make larger snags and logs than other trees. Therefore, trees with these desirable characteristics should be identified and retained so that wildlife communities will benefit. For example, observing acorn production of individual trees for two or three years over several weather cycles should allow most landowners to identify trees that produce large acorn crops relative to other trees on their lands (see chapter 9).

Habitat Use

The functional relationships among plants, animals and their physical environments are the foundation of ecosystems. Most wildlife species can use a variety of habitat types. The deer mouse is an example of a habitat generalist. It is thought to be the most widely distributed and abundant mammal in North America, and occurs in virtually every terrestrial vegetation type. Deer mice feed on a wide variety of plant and animal materials. They store food for use during periods of shortages, and build nests in almost any form of confined cover, such as rocks, leaves, or logs. The deer mouse can get its water from free water sources, dew, or from its food.

However, some wildlife species are so specialized that they occur in a relatively small number of habitats. The acorn woodpecker is an example of a habitat specialist. Although it has a widespread distribution, its habitat use

patterns are relatively restricted, coinciding with acorn-producing tree and shrub oaks in oak and oak-pine forests and woodlands.

Every wildlife community consists of both habitat generalists and specialists. Habitat generalists are more tolerant of a variety of land use practices than the habitat specialists. The challenge to any manager or landowner is to ensure that habitat needs are provided for all members of the wildlife community. This can be achieved by designing land use activities that ensure the continued presence of habitats and habitat elements needed by all members of the wildlife community.

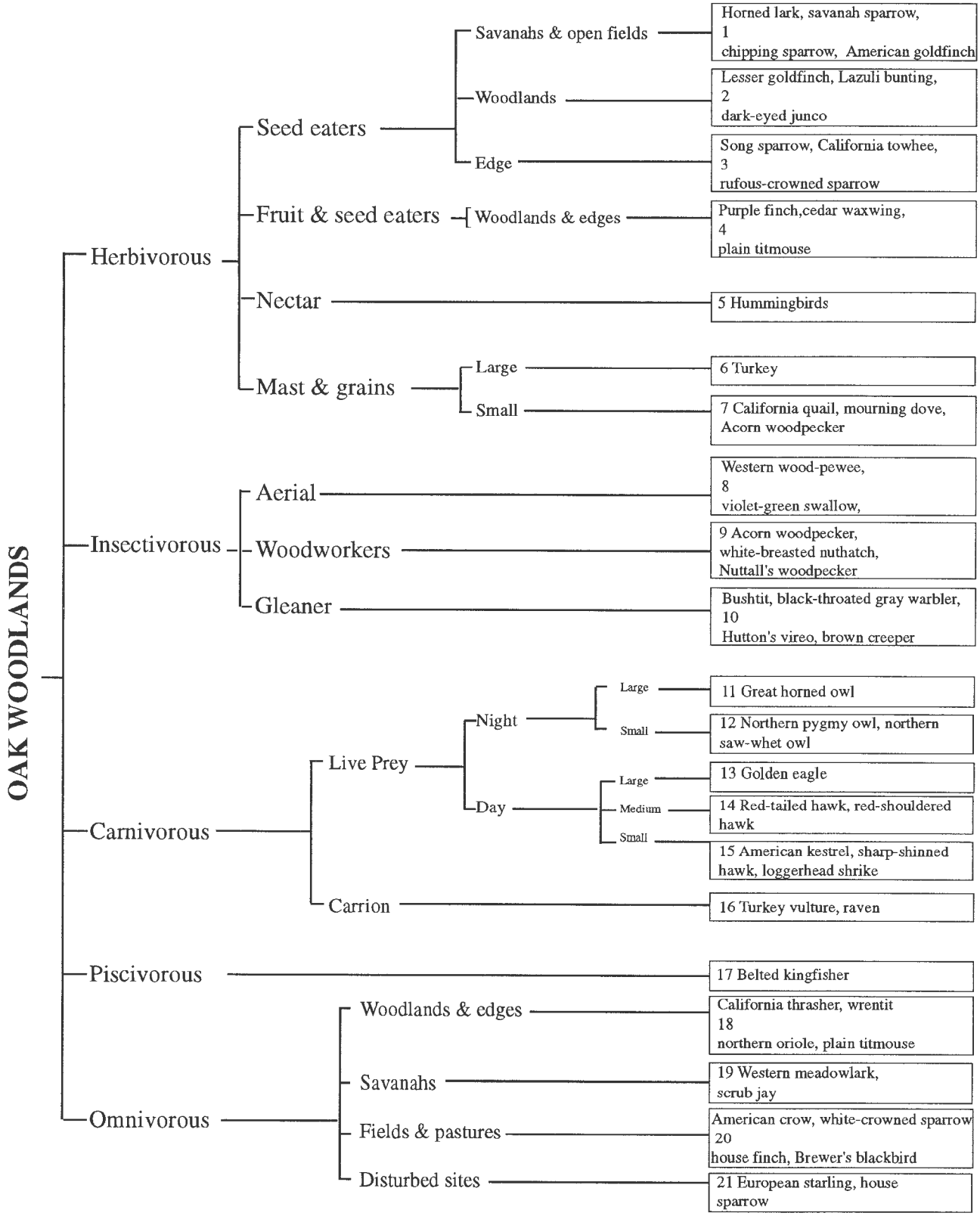
For example, consider a large tract with a mosaic of oak woodlands, brush patches, riparian areas, savannas, pastures and grasslands. Cyclic, seasonal vegetation changes provide a diversity of food resources, including forbs, insects, fruits, and seeds, including acorns, that allow species with differing foraging strategies to co-exist. Birds that frequent oak woodlands throughout the year, both resident and migratory species, will partition these resources to minimize competition for them. If the necessary habitat elements are present, herbivores (plant eaters), insectivores (insect eaters), carnivores (meat eaters), omnivores (plant and meat eaters) and even highly specialized piscivores (fish eaters) can co-exist on this tract because of the way each group selects its food.

Species grouped according to a particular habit are referred to as a *guild*. (see Figure 4-3). For example, herbivorous species that eat seeds and are restricted to habitat edges are in a single guild. This includes song sparrows, California towhees, and rufous-crowned sparrows. If the necessary food and habitat elements are removed from an area, all species associated with this guild will also be removed. Similarly, insectivorous species that forage on wood would be negatively impacted if all standing and dead trees were removed from the site. Pileated woodpeckers, white-breasted nuthatches, and hairy woodpeckers are examples of species in this guild.

Wildlife use habitats at two broad levels usually defined as *macro* and *micro* levels. Management activities must consider both levels to sustain the biological integrity of hardwood rangeland habitats. The *macro*-level consists of all the habitats and their inter-relationships. *Macro*-level characteristics include habitat patch size and shape, edges with other habitats, and adjacent habitats. *Macro*-level features are used over a wide area during a time period that ranges from several weeks to several years.

Micro-level habitat characteristics are more focused on the individual features of the plants and the physical environment within an individual stand of trees. These features include species of plants, snags, rocks, water, acorns and other food items, tree size, and amount of vegetation cover. *Micro*-level elements are items an individual wildlife species uses throughout their daily and yearly cycles for breeding, feeding, and cover.

Fig. 4-3. An example of resource partitioning based on food habits of some land-dwelling birds that are commonly found in oak woodlands throughout California.



Wildlife respond to many different environmental characteristics when they select habitats to use. The three primary characteristics known to be important to many wildlife are: 1) habitat structure (e.g., size, height, amount of vegetation cover); 2) vegetation species composition; and 3) presence of *micro*-habitat elements.

Acorn woodpeckers are a good example illustrating the selection for the three broad habitat characteristics: structure, composition, and elements. They are found almost exclusively in open canopied, tree-sized habitats with substantial numbers of oaks, demonstrating selectivity in the structure and composition of their habitat. Their selection of habitats dominated by tree-sized oaks to provide live trees and snags large enough for granaries and nest cavities, demonstrates habitat selection on the basis of micro-habitat element characteristics. All three characteristics are inter-related to varying degrees, and the overall importance of a particular characteristic varies by season and geographic location.

Studies have also demonstrated the importance of habitat characteristics in California's hardwood habitats to other species. The importance of blue oak woodlands to wintering deer in Tehama County were discussed earlier in this chapter. Black bears showed greater use of habitats dominated by canyon live oak in the San Bernardino Mountains in spring, summer, and fall because these habitats provide cool environments, sufficient water, and low levels of human activity.

Wildlife habitat use changes over time and across landscapes. The migratory and wintering habitat use patterns of deer previously discussed is a good example. Black-tailed deer along the Coast Ranges are year-round residents and do not have pronounced migratory patterns. Yet, these resident deer use many habitats throughout the year, relying on oak-dominated habitats when acorns are available.

Golden eagles display fairly pronounced locational habitat use patterns. In hardwood rangelands, their nesting habitat includes area with large diameter, tall foothill pines with large branches, or tall cliffs with ledges for nests. Therefore, their nesting habitats are typically blue oak woodlands, blue oak-foothill pine woodlands, shrublands, or other habitats located in canyons or along cliffs. However, they feed in grasslands and open oak-dominated woodlands with sufficient populations of prey such as California ground squirrels, black-tailed hares, other medium-sized mammals, and ground-dwelling birds. These different nesting and feeding habitats must occur together over a large area in order to support a pair of nesting golden eagles.

Native Plants within Oak Woodlands

Oak woodlands are a diverse and dynamic ecosystem in California. In fact, for many people, oaks are a symbol of this State. Within oak woodlands, the several species of oak are the most striking plants present. But they represent only a small portion of the plant diversity which occurs in oak woodlands. As stated above, over 2,000 species of California native plants occur in oak woodlands. The scope of this book does not allow for detailed description of the many native plants of oak woodlands. For the more common plants associated with oak woodlands, refer to Appendix C. This section provides information on fundamental habitat relationships of plants that are considered to be sensitive to land use practices in oak woodlands. These species are a small, but special portion of those 2,000+ plant species that coexist with oaks.

Sensitive Plants

There are 130 known sensitive plant species that occur in oak woodlands. Sensitive is defined as plant species that are considered rare, threatened, or endangered within California, whether or not they are state or federally listed.Many of these plants are naturally rare because unique biological needs limit their distribution. Others may have been affected by human activities such that they have become rare, threatened, or endangered within California. Appendix B lists 130 sensitive plant species and their known oak habitat relationships. If a particular oak habitat exists on your property, you may have a particular sensitive plant species depending on the plants' distribution and special habitat relationships (see *Investigating the Occurrence of Sensitive Plants*)

Different Designations of Sensitive Plants

Appendix B designates sensitive species in three categories: federally listed, state listed, and California Native Plant Society (CNPS) categories 1B and 2. Eight oak woodland plant species are federally listed as threatened or endangered, while the State of California has listed 42 as rare, threatened, or endangered. The federal Endangered Species Act establishes protection for federally listed species. Plants state-listed as rare, threatened, or endangered are protected under the Native Plant Protection Act or the California Endangered Species Act. CNPS maintains an inventory that evaluates native plants on their rarity, endangerment, and distribution. This chapter lists only two of their five categories: 1B and 2. Category '1B' is defined as *rare or endangered in California and elsewhere*, while

category '2' is defined as *rare and endangered in California; more common elsewhere.* For a more thorough list of sensitive plant species and a detailed explanation of CNPS's inventory system, you may refer to the electronic or printed California Native Plant Society's INVENTORY of Rare and Endangered Vascular Plants of California (5th. Edition). You may also wish to attain a copy the California Department of Fish and Game's (CDFG) *Special Plants List.*

Investigating the Occurrence of Sensitive Plants

As stated above, the list of plants in Appendix B does not reveal whether a particular plant species does occur on your land. The table does inform you if a particular plant has been found in a particular oak habitat(s). Additionally, the table lists unique ecological characteristics of each plant species. This information is a starting point for you to determine the possibility of one or more rare plants being found on your land. In many cases, the type, periodicity, and intensity of the land use determines whether rare, native plants exist, just as is the case for wildlife.

When determining what plants occur on your land, surveying your land for all plants (*floristic* survey) allows you gain detailed knowledge about the occurrence, distribution, and abundance of all plants, whether they be oaks, common trees, shrubs, grasses, and herbs, or sensitive species. In some cases, plant survey information may already exist for your property. In addition, there are other sources of useful information. These sources would be the local university or college, the regional resource conservation district, individuals or firms involved in biological consulting, your regional CDFG Plant Ecologist or District Biologist, and CDFG's Natural Diversity Database (NDDB). NDDB maintains location information for sensitive plants, animals, and natural communities for all of California. Regional CDFG staff have access to NDDB information, and you may contact NDDB directly if you wish to investigate what is already known about sensitive plants in your area. However, if the NDDB does not include any known records of sensitive plants on your property, this is no guarantee that sensitive plants do or do not occur there. Only plant surveys can determine that.

Management of Lands for Sensitive Native Plants

In a nutshell, there is no recipe for maintaining an area's native flora. For certain species with certain needs, avoidance or minimum activity for a period of time may be crucial (i.e., removing cattle while plants are flowering and setting seed). On the other hand, management for native plants might involve a certain activity for a particular period of time (i.e., prescribed burning to allow seeds to sprout; maintaining grazing so to reduce exotic grasses which in turn allows native species to exist, etc.). Each sensitive plant has specific needs, and it is best to consult with your local botanists, field biologists, and other plant and vegetation experts when deciding on land management activities to meet your needs and the needs of the sensitive plants that may exist on your land.

A Worksheet for Evaluating Woodland Habitat Impacts

There are many ways landowners can manage their oak woodlands for wildlife or to maintain native plants. One can choose to manage on the basis of vegetation composition, percent canopy cover, or even a single wildlife species such as deer. Yet, when assessing various management enterprises, land managers should consider a broad scale approach to management. This *system-wide* management approach considers both ecological and economic effects prior to implementing a management plan. This is really just a new way of saying *"don't put all of your eggs in one basket".*

When evaluating the impacts of various management actions, there are often unforeseen consequences. It is easy to recognize the consequences of harvesting individual oaks (e.g., they become firewood), but more difficult to recognize the potential consequences at the population (e.g. loss of acorn producers), community (loss of bird nesting locations), ecosystem (increased light to forage plants), and landscape (increased edge with grasslands or loss of habitat linkages) levels. Worksheet 4-1 is provided to help assess these broader effects by examining the resources present in the area proposed for management and the anticipated changes of the proposed enterprise to the woodland ecosystem. It is suggested that you work through this process for any enterprise you are considering, to allow you to assess the concepts presented in this chapter.

This worksheet is designed to help assess the impact of the proposed hardwood rangeland enterprise on a particular habitat element. In column one of the worksheet, you should assess the particular habitat element in the area proposed for a particular enterprise. Column two is used to describe how significant that element in the enterprise area is in relationship to the broad region or landscape surrounding the enterprise area. Column three

is used to describe anticipated changes that are expected to occur as a result of the particular enterprise. Column four is used to list the anticipated regional impacts expected as a result of undertaking a specific enterprises. In order to undertake this exercise, you will need a map of your property and basic knowledge of its resources. It is best to have an aerial photograph of your land and the surrounding landscape, but you may use other estimates if a photograph is unavailable. The material you have developed from chapter 3 will help you get started. Instructions on the use of the worksheet and definitions of terms used will follow.

Worksheet 4-1: A checklist for evaluating woodland habitat elements and proposed enterprises.

Landscape Elements (fill out all that apply)	Description of Element in Proposed Area	Anticipated Changes From Proposed Activity	Expected Habitat Impacts
Total Area of Enterprise or Region			
Vegetation Types • oak woodlands • grasslands • shrublands • conifer forest • agriculture			
Patch Size and Linkage • description of woodland patch distribution • average patch size and range • Distance between patches • Linkage between patches			
Surrounding Land Use • Rural residential • Agricultural • Urban			

Ecosystem - Community Elements (fill out all that apply)	Description of Element in Proposed Enterprise Area	Anticipated Changes From Management Activity	Expected Regional Impacts
Vegetation Layers • herbaceous/grassland • only shrubs • canopy and herbaceous • canopy, shrubs, herbaceous • Mixture			
Tree Characteristics • snags • limbs/trunks size distribution • acorns			

Worksheet 4-1: A checklist for evaluating woodland habitat elements and proposed enterprises (cont.)

Ecosystem - Community Elements (cont.) (fill out all that apply)	Description of Element in Proposed Enterprise Area	Anticipated Changes From Management Activity	Expected Regional Impacts
Surface Water and Riparian Zones • Ponds • Rivers/Streams • Springs • Wetland Vegetation • Riparian Trees			
Dead Woody Material • stumps • logs • brushpiles			
Rock/substrates • cliffs • outcrops • boulders • caves			
Unique Habitats • rare soils • vernal pools • archaeological sites • others			
Fire • % Currently recovering • Years since last fire • Wildfire or controlled?			

Species Elements (fill out all that apply)	Description of Element in Proposed Enterprise Area	Anticipated Changes From Management Activity	Expected Regional Impacts
Endangered species.			
Habitat Specialists			

Instructions for the Worksheet:

General descriptions of the various categories included in the worksheet are shown below to help you fill out the worksheet for the situations you are interested in evaluating.

Description of element in proposed area (column one): This is the part of your property that will be altered by the enterprise you are considering (i.e., grazing, forest products, recreational development, conservation easements).

Anticipated changes column (column two): This helps compare how the habitat changes in the enterprise area will change general habitat conditions. This should help you create a context of the affect of your activities on the surrounding habitats and to understand the cumulative changes occurring in your region.

Potential change column (column three): List the impacts that are expected to occur as a result of the habitat changes described in columns one and two.

A description of the various habitat elements which may be affected by various enterprises is given below.

Landscape/Ecosystem Elements

Enterprise Acreage: The amount of woodland in your enterprise area defines the kinds of conservation decisions you must make. Large enterprise areas are more likely to alter landscape level habitat elements than smaller areas. The effect of small enterprises usually is incremental and cumulative, so it is best to create a long-term plan for your entire property as you develop each enterprise. You may want to compare notes with your neighbors to see what your region will ultimately look like before you design your enterprise.

Vegetation Types. Express the acreage or percent of the area in various vegetation types to help define the species diversity in your enterprise area.

Patch Size and Linkage — Woodland Distribution. Is the area composed of uniform woodland or divided into discrete patches? Will your enterprise increase or decrease this percentage of woodland in your enterprise area and what changes will occur as a result?

Patch Size and Linkage — Average Patch size. Describe the average and range of sizes (acres) of woodland patches in your enterprise area, as well as the average distance between patches.

Patch Size and Linkage — Habitat Linkages. The dispersal, migration, and movement of individuals are necessary to maintain populations and communities of woodland animals and plants. In the process of converting woodlands into other land uses, the ability of animals to move may be disrupted. Ultimately, natural linkages may be reduced to corridors, which become sensitive to disruption. Are your enterprise area and region still intact natural areas? What percent of the woodlands of each area are linked by multiple corridors, and what percent have only a single corridor? Are there woodlands with only one remaining corridor? Are some woodlands isolated without habitat linkages?

Surrounding Land Use: Calculating the percentage of rural, agricultural and urban areas will help to define the current level of habitat conversion. Urban areas should include houses, commercial buildings, and industrial sites; rural areas should include ranchettes, low density (>5 acre lots) housing, and parks; agricultural areas should include all cultivated crops, pastures, and golf courses. This information is available from your local planning agency.

Ecosystem/Community Elements

Vegetation Layers and Mixtures. Calculate the percent of your enterprise area covered with each vegetation layer and determine whether these layers occur together (integrated) or as discrete patches.

Tree Characteristics. Canopies provide a number of different habitat resources, ranging from insects on leaves to cavities for dens and nests. The size and age distributions of oaks in your woodlands provide key resources to the wildlife present. Snags are a special resource; their centers often rot away leaving cavities for many wildlife

species, and dead and dying branches provide additional cavity substrates. Acorns are important for many wildlife species.

Surface Water and Riparian Zones. Surface water sources increase woodland ecosystem diversity. Riparian areas (streams, creeks and rivers) are found throughout California in a number of oak woodland types. They provide essential habitat for large numbers of plant, vertebrate, and invertebrate species. Every stream influences its surrounding landscape, increasing plant productivity and species diversity in all habitats it flows through. Springs require special consideration because they may be the only water source for a large area, and many species may depend on them.

Dead Woody Material. As a tree ages over its lifetime, it drops branches and eventually collapses onto the ground. As the wood decomposes, it is used by many plants and animal species for nutrients and shelter. Shrubs also die over time, contributing brushpiles to the site.

Rock/substrates. Exposed rock creates a different type of substrate for plants and ground- dwelling species. Are cliffs or caves present in your enterprise area? Estimate the percent of your enterprise area covered with rock outcrops. Will your enterprise change any of these features?

Unique Habitats. Habitats such as vernal pools, limestone caves, serpentine outcrops, and springs result from unique combinations of soils, topography, and climate, and secondarily through biotic interactions. This uniqueness typically results in rarity.

Fire. Fire behavior has a profound affect on woodland habitats. Fires can create a mosaic pattern of vegetation, or may burn off entire regions. One way to calculate fire effects is to estimate the relative proportion of vegetation burned by the most recent fire on your land, and the years since the last fire. Finally you need to consider if fire suppression has left your enterprise area vulnerable to unnatural, catastrophic fires.

Species Elements

Many of the assessments for this section of the worksheet are quite involved, and require the assistance of professional resource managers. You can seek the assistance of California Department of Fish and Game, the Integrated Hardwood Range Management Program, or consulting resource managers to determine some of the information needed for these sections of the worksheet. The information in appendices A and B may help to get you started, as well as your general knowledge of the property.

Threatened and endangered species. You should determine if there are any plant or animal species that have been listed as threatened or endangered by the state or federal governments. Manipulation of habitats supporting these species typically require special permits from state and federal wildlife agencies. Some of these T&E species are naturally rare, while others have suffered widespread population declines. General locations and habitat information for these species are available from local Department of Fish and Game representatives. Appendix A and B give a listing of hardwood rangeland wildlife and plant species that have special status.

Habitat Specialists. List any wildlife species present that would be sensitive to habitat disruptions.

Response of Wildlife to Habitat Change

Once you have worked through this general assessment in the worksheet, the expected regional impacts of any changes in habitat should be evaluated. Consult with local resource management professionals to evaluate these possible impacts. Shown below are some general considerations to help you judge the various impacts.

Landscape Elements

Enterprise area: In general, decreasing woodland acreage creates a risk that the number of plant and animal species living there will decrease as well. Species present in your enterprise area are there in part because the woodland was large enough to support viable populations. Chance events such as droughts, catastrophic wildfires, or disease epidemics, can impact various species. The greatest risk is when small (<20 acre) regional woodlands are altered by large enterprises. Large mammals and raptors are especially sensitive, because these indi-

viduals require large tracts of woodland. Small, isolated woodlands may not be recolonized after a species is wiped out by chance events such as an epidemic. In contrast, if your enterprise area is 3 acres within a 10,000 acre woodland, then the change in your woodland is less likely to have a dramatic affect on species diversity.

Vegetation Types: Conversion from oak woodlands to shrubland or grasslands creates a change in the types of elements available for many species.

Patch Size and Linkage - Woodland Distribution: Fragmenting a large, contiguous woodland into smaller, isolated patches is likely to reduce the number of all woodland species. If your woodlands occur in isolated patches with low crown cover (i.e., 10% cover), where denser canopies previously existed, or in narrow, linear patterns, then they may already have a reduced number of woodland species and a greater number of species that prefer edges. Woodland species in general are more sensitive to landscape alterations than edge-oriented species.

Patch Size and Linkage - Average Patch size and Distance between Patches: Patch size often decides the species diversity and composition. It is difficult to maintain viable breeding populations of many species in small (<25 acre) patches. Decreasing patch size will test the ability of many species to overcome chance events such as epidemics (see above). Increasing the distance between patches strongly influences which species will be able to move among patches and how often they will do it. Making these inter-patch areas inhospitable, with houses or other forms of disturbance, further decreases the likelihood of wildlife movement or plant dispersal.

Patch Size and Linkage - Habitat Linkages: If the area will leave habitat linkages in an area that was previously contiguous woodlands, then these linkages will filter species dispersal, reducing the linkages that occurred before alteration. Corridors should be as wide as possible. Narrow corridors (<100 ft.) are generally less effective than wider corridors. However, if your woodland is already down to narrow corridors, then it is probably already experiencing these filtering effects. At this point, corridor removal may further reduce dispersal, especially if linkages to larger more intact woodlands are cut.

Ecosystem/Community Elements

Vegetation Layers and Mixtures. Removing the tree or shrub layers of a woodland will reduce its use by medium sized mammals, such as the ringtail cat, and 10 to 50 species of woodland birds. A few bird and mammal species use exotic-grass/woodland habitat mix, such as European starlings, western bluebirds, and California ground squirrels, and may increase if the shrub understory is lost. Relatively few woodland vertebrates will remain if both shrub and canopy layers are removed. Reducing shrub or canopy layers increases the amount of sunlight reaching the woodland floor, which heats and dries soils used by herbaceous plants and amphibians. Increased light may benefit growth of the herbaceous layer. Decreased canopy and shrub layers also causes more rapid heat loss from the herbaceous layer, changing plant species composition. Since only a few plant species dominate the shrub layer of most woodlands, it is easier to restore vegetation structure than it is to restore species diversity and composition.

Tree Characteristics - snags: Removing large snags adversely affects arboreal salamanders (primary habitat), acorn woodpeckers (acorn storage), other birds (nesting and roosting), and bats (roost and nursery roosts). Removing small (<6 in) snags is less likely to affect these species, but will reduce the source of dead wood on the ground (see below).

Tree Characteristics - limbs/trunks size distribution: If all large diameter trunks and branches are removed, you will adversely affect Nuttall's woodpeckers and other birds that excavate nest cavities, as well as large-bodied birds which nest on these branches, such as red-tailed hawks. The populations of birds and mammals that forage on tree trunks, such as the white-breasted nuthatch and western gray squirrels, also will be reduced. Larger stems tend to have the best developed cavities and cracks for salamanders, lizards, birds, bats, and rodents.

Tree Characteristics - Acorns: Acorns are key diet items for almost 50 species of birds and mammals, particularly many game species (see Appendix A). Removing trees that produce good acorn crops will adversely affect these wildlife species.

Surface Water and Riparian Zones: Surface water availability has a dramatic effect on plant and animal species. Riparian plants are adapted to various levels of soil moisture and flooding, and changes to either the flow or level of water can kill them. In contrast, most oaks on hardwood rangelands are adapted to drought and have difficulty maintaining root functions if soils become flooded. Surface water is the primary breeding habitat for many amphibians, and alterations of riparian characteristics can dramatically decrease amphibian populations. It can also create problems for birds and mammals, since water for drinking is necessary for many of these species. While these species may be flexible about the source, they often require cover vegetation and are unlikely to use exposed water areas. Birds nesting in riparian woodlands often cannot successfully nest in other habitats. Altering riparian vegetation can alter the volume and seasonal availability of insects for insect-eating bats and birds. Furthermore, standing or moving water is habitat for fish, which are food for several wildlife species such as ospreys, bald eagles, and belted kingfishers.

Dead Woody Material: Wood on the ground in the form of logs and branches is consumed by a number of invertebrates and fungi. It is one of the major sources of nutrients and energy underneath oak canopies. Many wildlife species prey on wood consuming invertebrates, including many salamanders, rodents and birds. Brushpiles provide habitats for ground and low shrub nesting birds, such as the California quail and white-crowned and golden-crowned sparrow, and removal of these reduces habitat value for these and other wildlife species.

Cliffs/Rock Outcrops: Habitats in exposed rock outcrops and cliffs are seldom altered by hardwood range enterprises, except for quarry and mining operations. However, wildlife use of these special habitats can be lessened if fragile soils and rock crevices are disrupted by heavy human-activity. Trails built to boulder piles, outcrops, and cliff tops can increase human activity and lessen their use by nesting birds, such as golden eagles, red-tailed hawks, white-throated swifts, and bats. Furthermore, quarry and mining operations will disrupt these species.

Unique Habitats: Hardwood rangelands often have rare soils, such as the serpentine or limestone formations. Plants adapted to these soils often can grow nowhere else, and can be lost if these areas are disturbed. Fortunately, the conditions that lead to these rare soils are fairly well understood and it should relatively easy to identify their locations and to conduct your enterprise without damaging these plants. Vernal pools create another unique habitat. These pools form during winter rains and can be damaged by disking or other manipulations of their soils. Preliminary results indicate some vernal pools are dependent upon disturbance, such as grazing, to maintain fairy shrimp populations. Enterprises that require substantial activity in meadows may damage the sensitive plants and federally listed-invertebrates that live in vernal pools.

Fire: Decreasing fire frequency increases woody biomass accumulation, and increases likelihood of a catastrophic fire in the future. A fire plan, with a design for a mosaic pattern of burns often reduces the likelihood that a fire will consume all the habitats in your enterprise area.

Example of Using Worksheet

Table 4-1 shows the use of this checklist for a firewood harvesting enterprise on a hardwood rangeland property. It is hoped that this will provide a general thought process for landowners and managers as they attempt to assess the impacts of various resource management enterprises on habitat values. As you investigate the enterprises described in Chapters 5 through 8, you should work through this checklist. If you are unsure about the expected habitat impacts, you should consult with a representative of the California Department of Fish and Game, your UC Farm Advisor, or a consulting biologist.

Worksheet 4-1: A checklist for evaluating woodland habitat elements and proposed enterprises.

Landscape Elements (fill out all that apply)	Description of Element in Proposed Area	Anticipated Changes From Proposed Activity	Expected Habitat Impacts
Total Area of Enterprise or Region	*150 acres*	*remove 20% of the total volume for firewood harvest*	*(see below)*
Vegetation Types • oak woodlands • grasslands • shrublands • conifer forest • agriculture	*80%* *10%* *10%*	*75%* *15%* *10%*	*Little effect is anticipated; Slight increase in grassland type is in small openings within a general woodland matrix*
Patch Size and Linkage • description of woodland patch distribution • average patch size and range • Distance between patches • Linkage between patches	*fairly contiguous block of woodland* *150 acres* *Interconnected* *Large block*	*Small openings created* *2 to 100 acres* *Interconnected* *Matrix of woodland maintained*	*Good retention of landscape features; little impact expected*
Surrounding Land Use • Rural residential • Agricultural • Urban	*Grazing land*	*No change*	*No impacts expected*

Ecosystem - Community Elements (fill out all that apply)	Description of Element in Proposed Area	Anticipated Changes From Proposed Activity	Expected Habitat Impacts
Vegetation Layers • herbaceous/grassland • only shrubs • canopy and herbaceous • canopy, shrubs, herbaceous • Mixture	*Small grassland area* *Small shrub area* *Most woodland area*	*Small grassland area* *Small shrub area* *Most woodland area* *Slight increase in shrub component with canopy reduction*	*Little impact expected*
Tree Characteristics • snags • limbs/trunks size distribution • acorns	*Scattered snags* *Some large limbs, trees 4 to 20" DBH* *Several good acorn trees identified*	*Some reduction in snags* *Similar distribution remaining* *Good acorn trees retained*	*Reduction in cavity nesting species*

Worksheet 4-1: A checklist for evaluating woodland habitat elements and proposed enterprises (cont.)

Ecosystem - Community Elements (cont.) (fill out all that apply)	Description of Element in Proposed Area	Anticipated Changes From Proposed Activity	Expected Habitat Impacts
Surface Water and Riparian Zones • Ponds • Rivers/Streams • Springs • Wetland Vegetation • Riparian Trees	*Only perennial water source a small spring; also an intermittent stream* *Willows in riparian area*	*Buffers will be maintained around spring and riparian areas*	*No changes anticipated; integrity of water supply and structural components of riparian zone maintained*
Dead Woody Material • stumps • logs • brushpiles	*Very low levels of dead woody debris in area*	*Increase in stumps* *Increase in logs* *Increase in brushpiles*	*Improved habitat for reptiles and amphibians; brushpiles improve songbird and game bird habitat*
Rock/substrates • cliffs • outcrops • boulders • caves	*None*	*None*	*No effect*
Unique Habitats • rare soils • vernal pools • archaeological sites • others	*Brush area has serpentine soils*	*Brush area will be avoided by equipment*	*No impact expected*
Fire • % Currently recovering • Years since last fire • Wildfire or controlled?	*None, all mature* *Over 30 years* *Controlled burns*	*Previous owners had regular prescribed burning program, but no fires over past 30 years; brush piles and woody debris may increase probability of wildfire*	*Higher wildfire probability after firewood harvest may lead lead to mortality of mature trees, and lead to type conversion of oak woodland to grassland; may want to consider prescribed burning*

Species Elements (fill out all that apply)	Description of Element in Proposed Area	Anticipated Changes From Proposed Activity	Expected Habitat Impacts
Endangered species.	*Some endangered plants suspected to be present in serpentine area*	*Serpentine area will be avoided; need to positively determine of endangered plants present and ensure survival in future management activities*	*No immediate effects expected*