Chapter 3

Oak Woodlands as Wildlife Habitat

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This chapter provides local planners and policymakers with information on the diversity and abundance of oak woodland wildlife, wildlife habitat needs, and how local planning activities can influence wildlife abundance and diversity. Federal and state laws, particularly the federal and California Endangered Species Act and the California Environmental Quality Act (CEQA), require local governments to include wildlife needs in land-use planning. Increasingly, local governments must account for the impacts of their activities on wildlife. The future of oak woodland wildlife depends on how we plan and manage oak woodlands in the face of increasing pressure from recreation and development.

> Man is that uniquely conscious creature who can perceive and express. He must become the steward of the biosphere. To do this, he must design with nature.
> —Ian McHarg

Habitat offers resident wildlife food, cover, water, and living space. California's oak woodlands are some of the richest wildlife habitat in the state. Of the 632 terrestrial vertebrates (amphibians, reptiles, birds, and mammals) native to California, over 300 species use oak woodlands for food, cover, and reproduction, including at least 120 species of mammals, 147 species of birds, and approximately 60 species of amphibians and reptiles. Each species of wildlife has different habitat requirements. For example, the band-tailed pigeon *(Columba fasciata)* consumes acorns and leaf buds, while the blue-gray gnatcatcher *(Polioptila caerulea)* gleans insects from oak twigs and foliage. The mule deer *(Odocoileus hemionus)* requires about a thousand acres of oak habitat to satisfy all its food, water, and cover needs, but the California mouse *(Peromyscus californicus)* uses less than an acre. Habitat needs of wildlife may also change with the seasons. The acorn woodpecker *(Melanerpes formicivorus)* eats acorns during fall and winter, but must forage for insects in spring to feed its nestlings. Similarly, the cover needed by wildlife during the summer may be much different than that required to survive in winter.

Habitat Structure

Habitat components found in oak woodlands are distributed both horizontally and vertically across the landscape. For instance, across the countryside, varying proportions of rock outcrops, shrubs, trees, and watercourses create a horizontal landscape mosaic of habitat patches of varying sizes, referred to as *horizontal structure*.

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Within an oak woodland patch, several vertical layers of vegetation—canopy, shrub, and herb ground layers—are referred to as *vertical structure*.

Horizontal and vertical structure influences the kinds and numbers of animals that occur in oak woodlands. Generally, an oak woodland habitat with complex or well-developed horizontal and vertical structure supports a greater diversity of wildlife. Complex habitat structure increases the options available to animals. The wrentit *(Chamaea fasciata),* for example, feeds and nests in the shrub layer, and a woodland without a shrub layer will not support wrentits.

Horizontal Structure

Various land uses can alter the food, cover, water, and spatial components of habitat that wildlife require for survival. Many land-use practices and natural disturbances that alter the horizontal structure of habitat can lead to fragmentation when patches of habitat are created that differ from the surrounding habitat. The concept of habitat fragmentation comes from research conducted in eastern deciduous forested landscapes where two centuries of agricultural clearing and residential development have opened up (or fragmented) the once continuous forest canopy (fig. 3.1). In contrast, oak woodland is naturally patchy, and the classic concept of habitat fragmentation should be only loosely applied. The key element, however, is that oak woodlands can be altered in many ways, and the consequences for wildlife can be similar to what has occurred in eastern deciduous forests. Fragmentation that is caused by the construction of homes, road building, tree thinning, and heavy grazing in California oak woodlands can lead to invasion and population increases of undesirable non-native species such as the rock pigeon *(Columba livia),* English sparrow *(Passer domesticus),* and European starling *(Sternus vulgaris),* all introduced from Europe, as well as increases in native animals such as mule deer and raccoon (*Procyon lotor*) that often increase when open habitats predominate or when human presence increases.

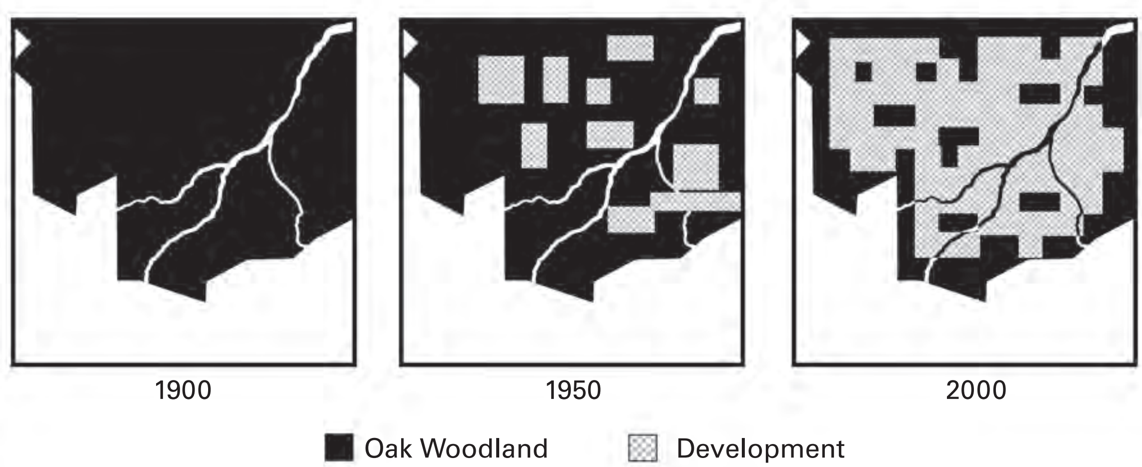

Figure 3.1. Hypothetical habitat fragmentation of an oak woodland patch over time (1900–2000) due to urbanization. The residual habitat mosaic in 2000 is greatly altered from the habitat of 1900.

Agricultural and residential development in oak woodlands does not always affect wildlife equally. Each species responds differently to changes in habitat, and regardless of the type of change, some species will benefit and others will suffer. For example, a study that sampled birds in oak woodland of northern-coastal California in three levels of development (ranchette, suburban, and relatively undisturbed rangeland) concluded that overall numbers and diversity of birds did not change, but

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bird composition (that is, the suite of species present) did (Merenlender et al. 1998). Specifically, the study demonstrated that more non-native species were found in the more intensively developed habitat, which likely reflected the change in vegetation (more non-native landscaping) and other elements of human presence such as roads, houses, pets, and noise. Presumably, a similar reduction within the other groups of vertebrates (small mammals, amphibians, and reptiles) that were not specifically assessed also occurred. Because these animal groups are, overall, less mobile than birds and more subject to the deleterious effects of roads, pets, and landscaping and garden poisons, we assume that numbers of individuals and the diversity of native species were reduced, similar to what occurred among the birds. Data from undeveloped blue oak–coast live oak woodland in coastal-central California support this supposition. Species diversity of small mammals, amphibians, and reptiles was greatest in the patches of woodland with high levels of vertical diversity (i.e., well-developed ground, shrub, and canopy layers; see Tietje et al. 1997).

California oak woodlands and associated animal species that are likely to be most affected by development as predicted by the habitat fragmentation model are those that most resemble well-structured Eastern deciduous forest, such as closed-canopy California coast live oak woodland, black oak woodland on moist sites, or oak riparian forest. These forests contrast with open-canopied blue oak woodland or valley oak savanna where the habitat fragmentation model may be less applicable. The model also applies better to areas with more intensive land use. Taken together, these results point to the importance of giving special attention in the planning process to coastal oak woodlands where pressures for development are especially great and where a new threat—sudden oak death—poses yet another concern.

Important landscape-level considerations when identifying features of oak woodland habitat that are often altered by land use include the number and size of habitat patches, the amount of edge, the continuity and configuration of habitat corridors, and barriers.

Patch size

Habitat occurs in what landscape ecologists refer to as patches. A patch is simply a distinct piece of habitat of a particular vegetation type and size. When habitat is modified by home building, vineyard development, or extensive firewood cutting, the number, size, and spatial arrangement of habitat patches on the landscape change. The residual patches have been likened to “islands” in a sea of development (see fig. 3.1). They may be too small or too isolated to provide resident wildlife the food, cover, water, and living space they need. The types of wildlife living in a patch are at least partly a function of how the habitat is altered as a consequence of land-use practices.

Edge

An edge occurs where two or more vegetation types meet. An example of a natural edge is the transition between woodland and grassland. The transition between woodland and an urban landscape or a vineyard would be an induced edge. A natural edge may result from gradients in soil type or topography, or from a fire or a windstorm. Induced edges result from land-use practices such as woodcutting, agricultural clearing, and residential development. Much study has addressed the effects of edges on wildlife in temperate deciduous forests of the eastern United States, where extensive clearing of the original contiguous forest has resulted in high edge densities. In eastern deciduous forests, there is greater light penetration and more human activity in forest edges than in forest interiors (i.e., away from edges). As a result, the understory is denser near edges and has a different composition of plant

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species than in interior contexts. Also, increased human disturbance results in edge effects that are usually deleterious to native wildlife.

Unlike eastern deciduous forest, California oak woodland is naturally patchy and edges are common even in the absence of human influence. While the primary constraint on vegetative development in eastern deciduous forest is light penetration, rainfall often limits plant growth in California oak woodlands. Because rainfall is similar across a patch, edges and interiors of oak woodlands in California are similar in vegetation structure and plant species composition (Vreeland and Tietje 2004). It therefore appears unlikely that natural edges in oak woodland have deleterious edge effects on wildlife.

Human disturbances, however, are similar in eastern forests and California oak woodlands. Agricultural and residential development in oak woodland results in the following induced edge effects:

- Increased human activity at edges increases fire probability.
- Dogs and cats kept as pets or released to become feral in wildland areas are harmful to native wildlife.
- Nest predators and species that thrive with human influence (such as raccoons and starlings) increase in edge habitat with deleterious effects on other animals.
- Weedy species of plants from agricultural fields, yards, and landscaping are carried into wildlands by wind, humans, pets, livestock, and wildlife. These invasive plants may displace native vegetation and eliminate habitat for native animal species.

For these reasons, land-use planning should seek to minimize the density of induced edges while maximizing undeveloped wildland habitat.

Corridors and connectedness

Strips of habitat that connect patches are called corridors. A corridor can be a strip of habitat that remains after disturbance, such as planting a vineyard, building a housing development, or cutting trees. Corridors may also be created by retaining or planting a strip of natural vegetation along a roadway or a greenbelt through a developed area. Some corridors occur naturally, such as the habitat along a stream or river (a riparian corridor).

Some wildlife species require habitat that cannot be met in a single patch of oak woodland and may depend on corridors in the landscape to connect several patches. Corridors can be crucial in maintaining interconnectedness between wildlife populations and providing suitable habitat for animals during migration. For example, mule deer in Northern California move in the fall from high-elevation foraging areas to lower-elevation foothill woodlands. It is essential that the deer have travel lanes of habitat (corridors) for protection and food during their journey. Some species are reluctant to enter or cross habitat that exposes them to predators or other hazards. Even a few oak trees connecting patches of oak woodland facilitate the movement and dispersal of some bird species, such as the oak titmouse *(Baeolophus inornatus)*. In some cases, maintaining even a few trees helps prevent the isolation of populations.

A connection between habitat patches can turn an otherwise isolated, unused patch into usable, occupied habitat. Although mountain lion *(Felis concolor)* populations in Southern California typically require approximately 625 square miles (1,600 sq km) of continuous habitat, the availability of connecting corridors allows lions to move into and between habitat patches that are small and therefore would not be used if not interconnected by the corridors. The connected patches can be sufficient cumulatively to maintain a lion population in an area where the large,

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continuous tracts of habitat have been fragmented by land use (Beier 1993). Oak woodland wildlife with large home ranges, such as gray fox *(Urocyon cinereoargenteus),* and bobcat *(Felis rufus),* also use corridors to move safely between habitat patches in search of food and water. The identification and conservation of corridors should be given careful consideration in the land-use planning process to minimize the adverse impacts of altering or fragmenting the oak woodland landscape.

Barriers

The opposite of a corridor is a barrier. Developments as seemingly harmless as a dirt road can disrupt the natural migration and dispersal patterns of animals. Unimpeded animal movements are important for the survival and reproduction of individuals as they seek food and mates. They are necessary to maintain the genetic health of populations. While dirt roads may sometimes be barriers, paved roads, especially major highways, definitely act as barriers. Highways and other roads with high traffic volume are significant sources of mortality and can serve as complete barriers to movement for many wildlife species. Several European countries have had great success with "greenways" that provide strips of continuous habitat either in underpasses or overpasses to facilitate movements and reduce mortality across large roadways.

In summary:

- Maintain large tracts of continuous oak woodlands (fig. 3.2A). Large tracts of woodland provide a variety of habitat elements and large populations of particular species; large populations are less likely to be extirpated than small populations. Large patches also minimize the amount of edge (fig. 3.3).
- A single large habitat patch is usually superior to several smaller patches, especially for vertebrate species with large territories or home ranges (fig. 3.2B). The importance of a variety of habitats for some woodland birds may argue for benefits of having many small fragments, but reproduction is often poor in small fragments because of predation by edge species of wildlife such as crows, raccoons, house cats, and skunks.
- To the extent possible, retain natural population levels of large carnivores in the system (fig. 3.2C). There is compelling evidence that coyotes *(Canis latrans)*, bobcats, and mountain lions limit numbers of smaller non-native predators such as house cats and red foxes *(Vulpes vulpes)* that prey on ground-nesting birds.
- Minimize human disturbance (fig. 3.2D). Excessive numbers of trails and roads through oak woodlands accelerate the invasion of weedy species and serve as barriers for some animals.
- Maintain or develop corridors to link habitat patches (fig. 3.3E). Corridors can ameliorate the deleterious effects of habitat fragmentation.

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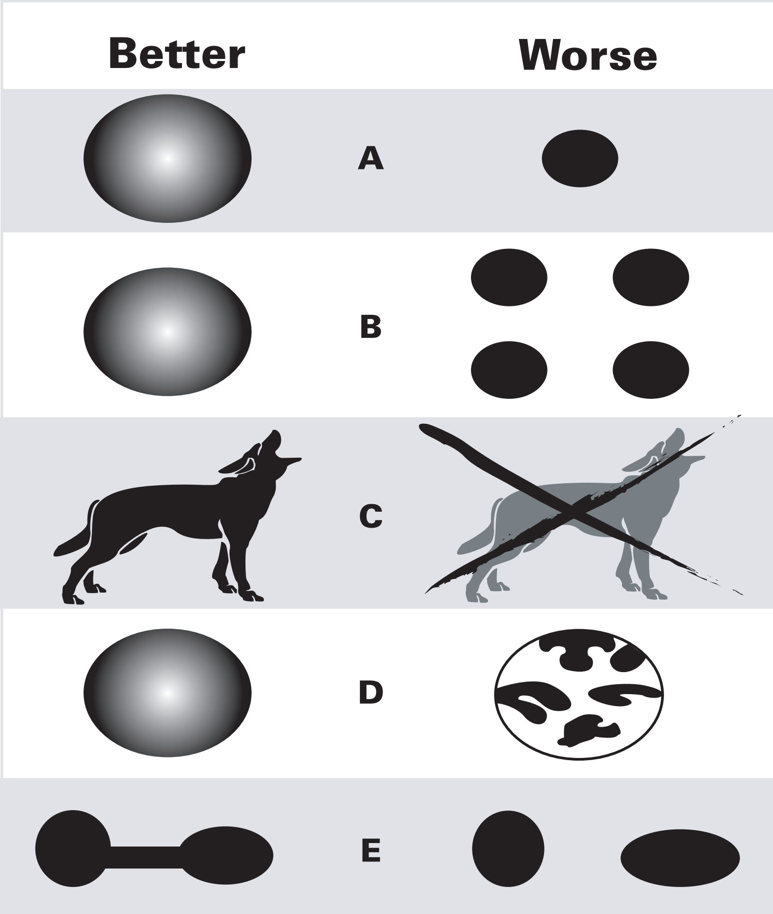

Figure 3.2. Summary of guidelines for maintaining horizontal habitat structure in oak woodland. *Source:* Adapted from Soulé 1991.

Vertical Structure (Structural Complexity)

Vertical structure in a woodland stand is made up of mature tree canopy, snags (dead standing trees), shrub layers, herbaceous ground cover, and downed wood. As more habitat elements are added to woodland, animal species diversity generally increases. Imagine looking into woodland from its edge. Woodland with only grasses on the woodland floor and large, living, mature oak trees of one species in the canopy is structurally simple. This same site, but with an additional species of tree in the canopy and with a few snags and a few pieces of downed wood, has more vertical structure, which encourages more animal species to use that area. Adding more layers of vegetation, especially several species of native shrubs (some producing berries), younger trees that are shorter than mature trees but taller than the shrubs, and more downed wood and snags in different decay states greatly increases the structural complexity of this woodland. Animals that require those habitat elements would correspondingly increase in abundance. Below are some important elements of horizontal and vertical structure and brief descriptions of how they influence wildlife.

Riparian habitat

Riparian habitat provides many of the needs of wildlife in a relatively small area. Water supports lush, diverse plant growth that provides food sources for herbivores and supports an abundant and diverse insect community. These vegetative and insect foods support species that eat them, which in turn support predators. Vegetation density and structure afforded by the trees and shrubs that grow in riparian areas provide protective cover. As a result, riparian areas are warmer in winter and cooler in summer than surrounding uplands. Riparian habitat also provides hiding and nesting cover for wildlife and corridors for safe daily and seasonal movements. For these reasons, oak-woodland riparian areas usually harbor greater numbers and kinds of wildlife than upland areas.

Land-use planners can maintain the wildlife values of riparian habitats by identifying these areas and protecting them with buffers along their edges. Because of the multiple ecological and political variables involved, it is unlikely that we will soon have a prescription for optimal riparian width. The width of the distinctive woody riparian vegetation serves as a guideline for determining buffer width. In riparian areas where the woody vegetation has been eliminated, the vegetation should be allowed to recover through protection and natural regrowth or restoration. Construction activities should be prohibited in riparian areas, and recreation, livestock grazing, tree cutting, and other possibly damaging activities managed conservatively.

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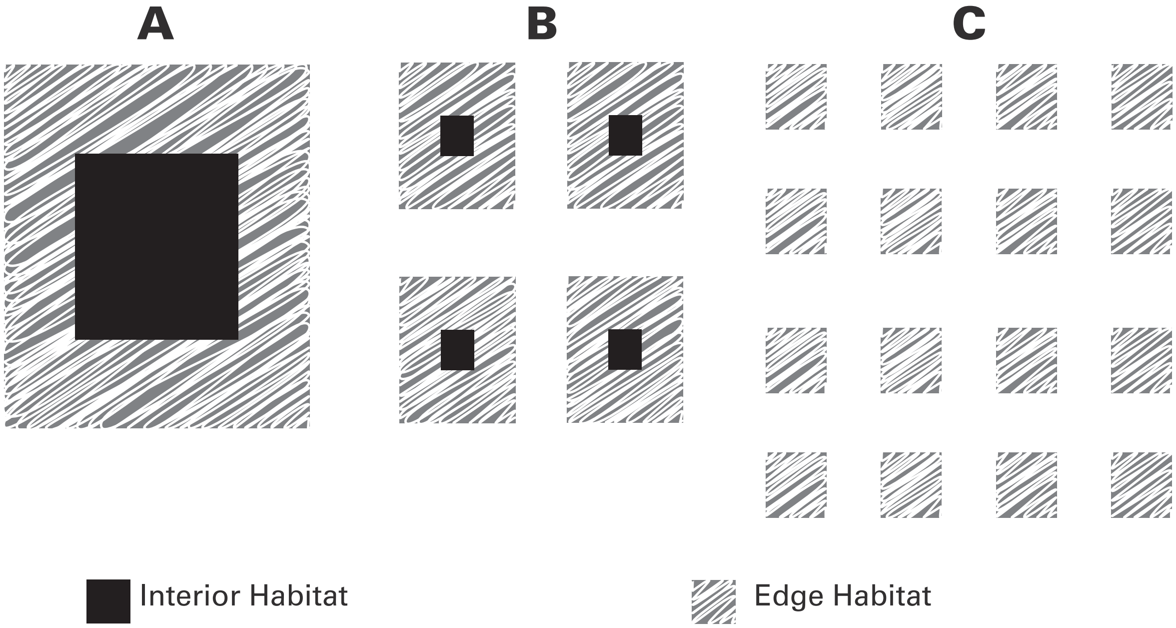

Figure 3.3. Breaking up large patches of woodland increases the relative amount of edge habitat. Here, a hypothetical woodland patch of 16 acres (6.5 ha) (A) was divided into 4 smaller patches of 4 acres each (B), and then subdivided into 16 1-acre patches (C). The relative amount of edge increases dramatically until the patch becomes all edge. *Source:* Adapted from Soulé 1991.

Fishes in Oak Woodlands

> It is a little-known fact that fishes grow on trees.
> —Pacific States Marine Fisheries Commission

Oaks and other tree species play an important role in controlling stream conditions necessary for native fish species to flourish (fig. 3.4).

Trees in riparian, or streamside, areas work to stabilize stream banks. Riparian trees shade streams, keeping water cooler; and masses of roots, called root wads, that emerge from the bank provide hiding places for juvenile and adult fish. This adds structure to a stream, creating pools of slower water where flow is blocked. These are important to many fish species, including migrating salmon and steelhead that need resting areas. Coarse woody debris can also add structure to riffle areas where active mixing brings oxygen into the aquatic environment.

Tree distribution in the landscape can influence the way streams cut through canyons and valleys, creating pools that give migrating or resident fishes a respite from rapid-flow areas. Healthy forests and woodlands in watersheds reduce sedimentation, which can affect fish negatively by reducing water clarity and degrading gravel stream-bottom habitat that is necessary for the successful development of eggs, especially of salmon and trout species. Removal of trees from a landscape alters watershed conditions.

The main factors that determine which fish live where are water temperature, gradient, and flow, along with the ecological history of the region. Oaks are found in a wide variety of geographic situations, including mountain canyons, valley floodplains, and coastal areas. A variety of fish species can be found in the lakes and streams that occur throughout the oak woodlands of California. In the Central Valley, the pikeminnow-hardhead-sucker assemblage of fishes occurs in foothill oak woodlands, where high-quality water flows through deep, rocky pools and wide, shallow riffles found in meandering, tree-lined streams. This ecological group of fishes is dominated by the Sacramento pikeminnow *(Ptychochelius grandis)*, the Sacramento sucker *(Catostomus occidentalis)*, and hardhead *(Mylopharodon conocephalus)*. Tule perch *(Hysterocarpus traski)*, speckled dace *(Rhynichthys osculus)*, California roach *(Lavinia symmetricus)*, riffle sculpin *(Cottus gulosis)*, and rainbow trout *(Oncorhynchus mykiss)* are also found (Moyle 2002).

Southern California streams have variable flows influenced by intense winter storms and spring snowmelt. Areas with warmer water can host California killifish *(Fundulus parvipinnis)*, threespine stickleback *(Gasterosteus aculeatus)*, arroyo chub

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(Gila orcutti), and Santa Ana sucker *(Catostomus santannae)*. Areas that have cooler water and significant uninterrupted spring flows can play host to spawning runs of steelhead, a sea-run variant of rainbow trout.

Human alterations to streams affect aquatic habitat in ways that are similar to their effect on terrestrial areas. Dams, road crossings, and concrete channels can act as barriers to the upstream and downstream movements of fishes. Changes in land use in the watershed can impact water quality in a myriad of ways, including adding pollutants and changing temperature and sediment regimes. Many streams in California have been affected by the introduction of exotic species of invertebrates, amphibians, and fishes that impact native aquatic animals. Invasive species such as crayfish (Family Cambaridae), African clawed frogs *(Xenopus laevis)*, and bullfrogs *(Rana catesbeiana)* may eat the eggs and larvae of native fishes and amphibians, and their burrows in the stream banks alter the physical environment. Exotic fishes, such as mosquitofish *(Gambusia affinis)*, bass *(Micropterus* spp.*)*, sunfish *(Lepomis* spp.*)*, and carp *(Cyprinis carpio)* can also impact the physical and biological environments. Exotic plants, such as the giant reed *(Arundo donax)*, displace riparian forest. This can greatly impact the aquatic environment, for example, by reducing shade, altering flows, and increasing the risk of fire.

Activities that affect fish habitat are subject to a number of restraints through various environmental laws. If a stream provides critical habitat for an endangered fish, changes in land use within the watershed that cause alterations in flow or water quality may be subject to oversight from the federal or state Clean Water Acts or the federal or California Endangered Species Act. If this is the case, the project may require consultation with the U.S. Fish and Wildlife Service, the NOAA Fisheries, the Army Corps of Engineers, or the California Department of Fish and Game and the local Regional Water Quality Control Board. Activities may also need to be reviewed for compliance with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA),

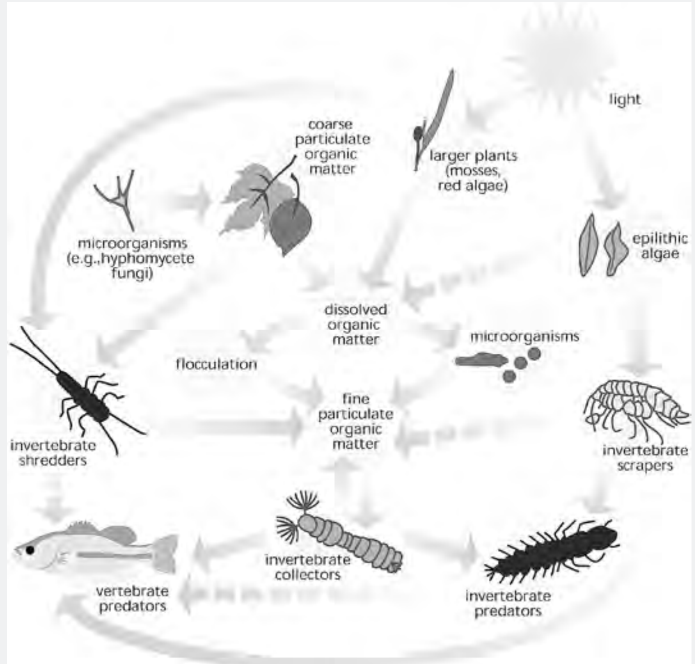

Figure 3.4. Relationships among elements of riparian areas. *Source:* FISRWG 1998.

and may require the submission of a statement of environmental impact. A good resource for information about permitting for any alteration or restoration work in watersheds or streams is the *Guide to Watershed Project Permitting* available from the California Association of Resource Conservation Districts Web site, www.carcd.org.

The presence of fish habitat also provides access to sources of funds and technical assistance. Financial assistance is available from a variety of agencies, including the California Department of Fish and Game, National Fish and Wildlife Foundation (www.nfwf.org) and the National Oceanic and Atmospheric Administration's Community-Based Restoration Program (www.nmfs.noaa.gov/habitat/restoration/community). The California Department of Fish and Game and the California Association of Resource Conservation Districts (www.carcd.org) are good sources of technical assitance, as are your local RCD, NRCS, and Cooperative Extension offices.

Cavity trees

Cavity trees provide shelter and breeding sites for many oak woodland wildlife species. Most cavities in oaks occur in large, living, mature trees and are usually associated with wounds or dead branches. Northern flying squirrels *(Glaucomys sabrinus),* western gray squirrels *(Sciurus griseus),* raccoons, certain owls, bats, and certain amphibians and reptiles use cavities in oaks. A conspicuous group of animals that depends on tree cavities for reproduction are the cavity-nesting birds. These include the western bluebird *(Sialia mexicana),* acorn woodpecker *(Melanerpes formicivorus),* Nuttall's woodpecker *(Picoides nuttallii),* Lewis' woodpecker *(Melanerpes lewis),* Bewick's wren *(Thryomanes bewickii),* oak titmouse, tree swallow

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(Tachycineta bicolor), violet-green swallow *(T. thalassina),* and ash-throated flycatcher *(Myiarchus cinerascens).* Some of these (the woodpeckers) are termed "primary cavity nesters" because they excavate their own cavities; the others, "secondary cavity nesters," use existing cavities (either excavated or naturally occurring crevices, holes, and hollows in trees).

Most excavated cavities are constructed in deciduous oaks such as blue oak, valley oak, and California black oak. Valley oaks, possibly because of their softer wood, seem to be preferred where they occur. In contrast, naturally occurring cavities, for example, those formed when the stub of a broken branch rots out and creates a hole in the trunk, are most abundant in the evergreen oaks (coast live oak, canyon live oak, and interior live oak). Older and larger oaks generally have more cavities than smaller or younger trees and therefore should be maintained to provide habitat for species that use cavities. Careful land-use planning is required to ensure a continued supply of trees with cavities. We recommend that unless they create a safety hazard, dead branches of live trees not be sawed off, as they may be important entry points for disease and fungi that facilitate excavation of nesting cavities.

Snags

Snags are trees that have died but remain standing. A host of different animals use snags. Snags are used as perching sites by raptors and other smaller birds. Reptiles, especially lizards, may use snags as basking sites in the summer and seek refuge under their bark in the winter. Crevices and rotting wood of snags are reservoirs for wood-eating insects, which are valued food items for many songbirds. If a snag has bark that is loose and sloughing off, bats, swallows, salamanders, and lizards can use the spaces between the bark and the trunk as roosts and hibernacula. For cavity-nesting birds, however, snags in oak woodland may be less important. In a recent survey, of 567 cavity nests of 10 bird species in blue oak woodland in Madera County, only 8 percent were in snags (Purcell 1995).

Downed wood

Downed wood is most important as resting and reproductive cover for amphibians, reptiles, and small mammals. Amphibians require moist structures and wet areas to keep their skin moist during dry periods. Because downed wood absorbs moisture during the rainy season and retains that moisture longer than smaller sticks, leaf litter, and grass, amphibians will lie against downed wood and wedge themselves between pieces of bark and the ground. Snakes and lizards also use downed wood in this way, as well as for basking sites. Small mammals construct nests in and against downed wood. Woodrats *(Neotoma fuscipes)* will build their houses in larger, hollow pieces of downed wood. Very large pieces of downed wood also can serve as rest and den sites for foxes, coyotes, and black bears *(Ursus americanus)*. Some species of ground-nesting birds, like dark-eyed juncos *(Junco hyemalis),* spotted towhees *(Pipilo erythrophthalmus),* and California quail *(Callipepla californica),* will place their nest against a piece of downed wood to offer more camouflage and greater protection from nest predators. Data from Madera County showed that house wrens *(Troglodytes aedon),* Bewick's wrens, acorn woodpeckers, ash-throated flycatchers, and mourning doves *(Zenaida macroura)* nested in areas with high cover of downed wood (Purcell and Stephens, in press). The two wren species especially appear to prefer areas with more logs for nesting.

Downed wood is mostly lacking over at least half of the oak woodlands in California (Tietje et al. 2002). Development project proponents and landowners should be encouraged to not "clean" woodland by removing all downed wood to create an open, parklike area. Leaving some downed wood provides an important

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habitat element for many kinds of animals. In addition, downed wood serves as a source of nutrients that can be released slowly back to the woodland during decomposition. It also may aid oak regeneration by providing physical protection for an emerging or growing seedling or sapling. Some suggestions include:

- Do not burn the limbs and smaller branches (slash) following firewood cutting. The slash can be piled on the stump or on the remaining large pieces to encourage stump sprouting and seedling recruitment.
- Concentrate removal of downed wood near the vicinity of structures and other buildings as part of a defensible space policy, and concentrate dead and down wood and slash away from roads and dwellings where the opportunity for a fire start is lessened.

Shrubs

Native shrubs, including toyon *(Heteromeles arbutifolia)*, redberry *(Rhamnus crocea),* manzanita (*Arctostaphylos* spp.), poison oak *(Taxicodendron diversiloba),* ceanothus (*Ceanothus* spp.), and coffee berry *(Rhamnus californica),* are important habitat components in oak woodlands. In addition to young oak trees, shrubs provide another level of vegetation intermediate between mature trees and ground-cover plants. This “understory” vegetation provides songbirds and small mammals protective cover from terrestrial predators like coyotes and bobcats, as well as from aerial predators such as hawks and owls. Woodrats and many species of wildland mice use shrub stems extensively as runways, rather than running along the ground. This provides them additional escape routes from terrestrial predators. Many of these shrubs produce berries that are used by birds and mammals as food. The addition of the extra layer and volume of vegetation also means greater surface area for invertebrates and, consequently, a greater diversity and abundance of songbirds that feed on woodland invertebrates.

Shrub cover is reduced following fire and was probably much reduced in the past in some areas due to burning by Native Americans and later by European settlers. Grazing also appreciably reduces shrub cover. Removing shrubs lowers the habitat complexity of oak woodlands. Animal diversity and abundance in woodlands can be enhanced by leaving and enhancing habitat for existing shrubs, and, if applicable, by planting native shrubs. Most oak woodland shrub species survive better and longer if they grow underneath a canopy of mature oak trees. Planted native shrubs should be given adequate but partial sunlight and room to expand. Watering and controlling competing annual grasses may be necessary for shrubs to become established, but extensive watering in summer may kill shrubs and trees. Obviously, when prescribing a suitable amount of shrub cover, the recommendation must be balanced with other planning considerations such as fuels management. Around a home, a shrub management scenario might include moderately spaced subcanopy plants intermixed with large cleared areas to create defensible space.

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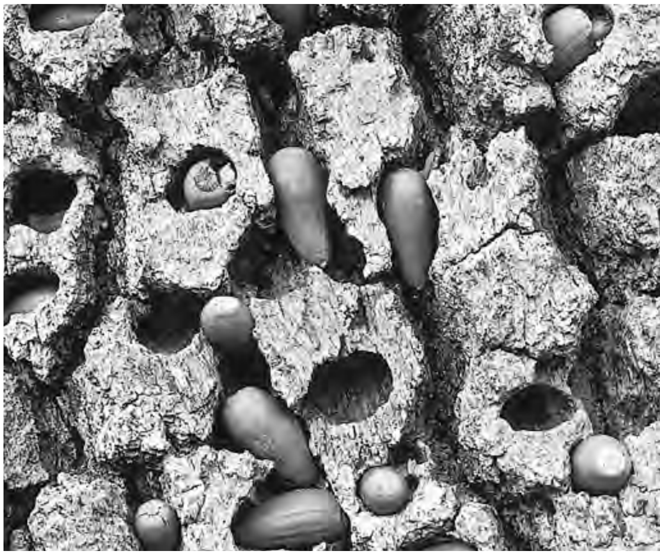
Acorns and acorn trees

All oak species produce flowers during spring. However, some oaks require 2 years to produce a viable acorn while others will produce nuts within 1 year. In both cases, acorns mature by September and October. Acorns are an important food source for many species of vertebrate and invertebrate wildlife. They provide important food resources for at least 45 wildlife species, including mule deer, California ground squirrels *(Spermophilus beecheyi),* western gray squirrels, acorn woodpeckers, western scrub-jays *(Aphelocoma coerulescens),* woodrats, many species of mice, and some insects. In turn, many of these small animals can be important prey for larger predators, including coyotes, bobcats, raptors (hawks, falcons, owls), and gray foxes. Through its effects on the population sizes of prey species, an abundant acorn crop indirectly influences populations of animals that do not directly use acorns.



Oaks, Acorns, and Woodpeckers

W. Koenig, University of California Hastings Natural History Reserve, and associates have published extensively on their work on the behaivor, ecology, and demography of the acorn woodpecker. Information for this sidebar was taken from Koenig et al. 1995.

The acorn woodpecker is a conspicuous resident of California's oak habitats. This bird has the unusual habit of excavating storage holes in old trees, called granaries, and storing large quantities of acorns in these holes in the fall. The woodpeckers then live off these acorns through the winter. Granary trees hold an average of 3,000 acorns, but an exceptional tree in the San Jacinto Mountains was estimated to contain 50,000 storage holes!

The habit of acorn storage goes along with a very unusual and interesting social behavior in this species. Acorn woodpeckers live in groups of up to 15 birds. The adults of a group are divided into breeders and nonbreeding "helpers." All adults generally help with storing acorns, raising the young birds, and defending their granary tree and surrounding territory from intruders.

The welfare of acorn woodpeckers is tied closely to oak trees and annual acorn production, although the birds also rely extensively on insects obtained by flycatching and bark gleaning. The availability of acorns during autumn and the storage capacity of the granary tree determine the winter food supply for the group. If many acorns are stored, survival through the winter is high and production of young in the spring will likely be more successful. Research at the Hastings Natural History Reservation in Monterey County over a 30-year period showed that four times as many groups with acorn reserves remaining in spring successfully raised young, compared to groups that had exhausted their stores. Some acorns are fed to the young birds, but the stores in spring primarily provide a food reserve that enables the adults to forage for insects, which are fed to the nestlings. In this way, the availability of acorns directly determines the number of acorn woodpeckers that occupy the oak woodland.

Few management practices have been developed to increase the production of acorns in the United States, though pruning has been used in Spain for centuries to promote mast production. Cutting trees or shrubs in dense stands of oaks may release suppressed trees and cause them to produce more acorns due to less competition for nutrients and water or better wind pollination. However, an increase in acorn production by a few residual trees may not compensate for the loss of habitat attributes from the trees that were cut.

Anthropogenic Effects on Habitat

Development and other human activities can have negative impacts on wildlife due to changes in the availability, abundance, and juxtaposition of habitat resources. A goal of land-use planning should be to minimize and mitigate these negative impacts.

Livestock Grazing

Ranching provides a mechanism for maintaining large expanses of wildlife habitat. Livestock grazing, when properly managed, can have far fewer negative effects on habitat than more intensive land management practices. Practices such as denying

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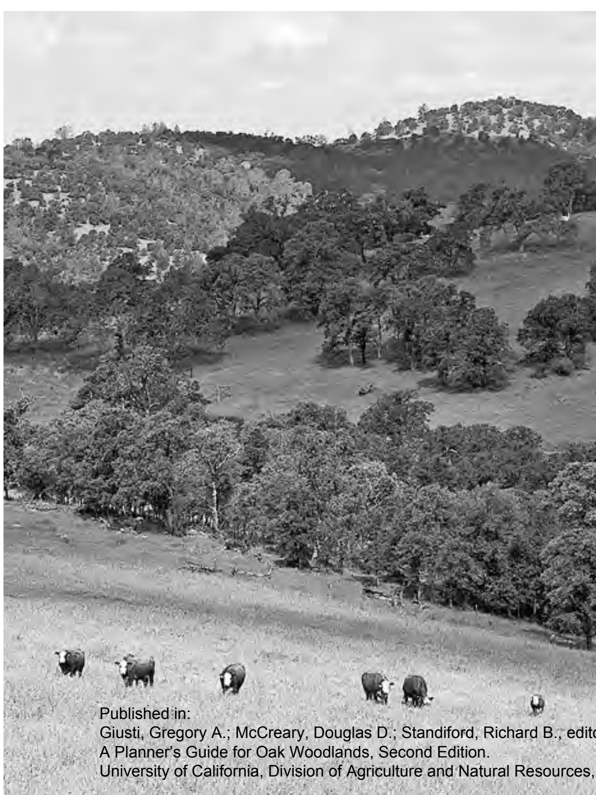
cattle access to riparian areas, making sure water troughs are properly placed and maintained, using weed-free hay when available, and protecting existing oak saplings can help ensure that woodland resources are conserved. When done well, livestock management creates relatively little disturbance to the natural system, yet provides long-term economic benefits to the landowner.

Intensive Agriculture

Intensive agricultural development can seriously impact oak woodlands and the resource values associated with them. Upland parcels, historically considered marginal or off limits for intensive agriculture, became subject to conversion for vineyard and orchard uses in the past decade. Concern about the effects of this type of conversion on the health and sustainability of the woodlands has prompted intensive research and education efforts. (Vineyard development and wildlife habitat management and maintenance are discussed in more detail in chapter 7.)

Urban Development

In California, increased demand for property in rural areas has raised property values and resulted in oak woodland modification or conversion (i.e., complete loss of habitat) to roads, recreational development, or residential use. The Fire and Resource Assessment Program (FRAP) estimates that during the 1990s, approximately 167,000 acres (68,000 ha) of oak woodland were converted from wildland to some level of residential use (1 or more houses per 20 acres). Furthermore, FRAP projects that in the next 40 years approximately 10 percent of California oak woodland (9.7 million acres, or 3.9 million ha) will be developed to some degree. The vast majority of this development has been, and is projected to be, with average lot sizes of 5 to 20 acres (2 to 8 ha) (Fire and Resource Assessment Program 2003). Exotic plants common in suburban and ranchette areas around houses and in residential gardens may not provide the habitat needs of native species. Non-native predators further impact the survival of native species. Bird species preadapted to a higher level of development, such as European starlings and rock pigeons, replace species that require more undisturbed habitat. Retaining large blocks of wild habitat and concentrating residential development in smaller, intensely developed, areas can help minimize the amount of habitat lost to development (see fig. 3.3). It can also make economic sense (see chapter 9).



Fire

For thousands of years, natural and anthropogenic fire have played an important role in oak woodlands of California. Frequent burning by Native Americans before European settlement resulted in low-intensity fires that maintained open stands of large oaks with little shrub cover, creating a fine-grained mosaic of vegetation patches. Following European American settlement in the mid-1800s, ranchers also conducted burns. Fire history studies indicate that average fire return intervals in oak woodlands in the late nineteenth to early twentieth centuries were from 8 to 15 years, at least in some areas. Fire suppression, begun in the 1940s and 1950s, increased surface and crown fuels, invasion of woody vegetation in the understory, and tree density. The effects of past fires are important to consider when making recommendations for wildlife species. Because these conditions existed for such a long time, they represent conditions under which species evolved and to which they are adapted.

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Prescribed fire can be used to reintroduce fire into the ecosystem and to mimic historic fire regimes. Current land ownership patterns complicate prescribed burning plans in many areas, particularly those in urban-wildland interface areas. With careful planning and attention, however, low-intensity prescribed fires can be safely implemented and can achieve the desired results. Moderate- to low-intensity fires rarely kill mature oaks because their thick bark protects them from damage. However, even a low-intensity fire often kills the tops of seedlings, saplings, and small trees, though most will resprout from their base. Most scientific evidence indicates that typical oak woodland understory fires do not adversely affect the majority of terrestrial vertebrate populations. In an experimental fire that burned over approximately 50 percent of 500 acres (200 ha) of mixed blue oak–coast live oak woodland in central coastal California, there was no appreciable loss of canopy cover, shrubbery, or snags (Vreeland and Tietje 2002). Although grass cover was reduced by 70 percent and downed wood and woodrat houses by 30 percent, there were no substantial or long-term negative impacts to over 150 species of birds, small mammals, amphibians, and reptiles monitored 2 years before and 4 years after the fire.

A Fire Effects Information database is available online through the Rocky Mountain Research Station Web site at http://www.fs.fed.us/database/feis/. The database provides up-to-date information about fire effects on almost 900 plant species, approximately 100 animal species, and 16 communities of plants found in North America. The emphasis of each summary is fire and how it affects each species or community.

Wood Cutting

Cutting trees in oak woodland for firewood and to increase grassland area for livestock grazing has occurred since European settlement of California. It is estimated that from 1945 to 1985 firewood cutting and rangeland clearing occurred on 1.2 million acres (485,000 ha) of California oak woodland, mostly in blue oak woodlands. During that period, thinning occurred on nearly 62,000 acres (25,000 ha) annually. Research over the last 20 years has shown that in most oak woodlands, the multiple benefits of improved wildlife habitat, water quantity and quality, scenic watersheds, and increased property values that come with retaining oak trees far outweigh any short-term gains in forage production that may be attained by clearing. As a result, cutting trees for rangeland improvement has largely stopped.

Harvest Effects on Wildlife

Two studies (Garrison and Standiford 1997; Aigner et al. 1998) examined the effects of woodcutting on wildlife species composition and numbers. One of the studies used field data and habitat relationships models to evaluate the effects of firewood cutting. The other study experimentally removed oak trees and evaluated effects on birds using field data collected before and after removal.

Field Data and Model Assessment of Firewood Harvest

Impacts to wildlife from woodcutting at 19 sites in blue oak woodland in Shasta and Tehama Counties were assessed from vegetation data collected after the firewood harvest. Although the growth model projected that the average tree diameter at the woodcutting sites would remain approximately the same (10 inches, or 25 cm), tree canopy cover after 50 years would average 16 to 34 percent on the cut sites compared to 53 to 70 percent canopy on the uncut sites (Garrison and Standiford 1997). Given this scenario, habitat relationships models indicated that of 21 vertebrate wildlife species used to evaluate the cutting impacts, 1 species would be negatively affected, 7 species positively affected, and 13 species unaffected. Not surprisingly, species that prefer oak woodlands with more open canopy, such as mule deer, ash-throated flycatcher,

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and western bluebird, were predicted to benefit from the woodcutting. Negative effects of harvest were predicted only when the change in canopy from uncut to cut conditions was substantial. Recommendations to minimize harmful impacts of firewood harvest include the following:

- Cut trees of all sizes and leave disproportionately more large trees.
- Retain 25 to 40 percent canopy cover.
- Allow for tree recruitment through stump sprouting and production of seedlings and saplings.
- Retain habitat elements, especially shrubs, snags, and downed wood.

The authors caution that all predictive models have limitations and results should be tested and judiciously applied.

Effects on Breeding Birds of an Experimental Firewood Harvest

A pre- and post-assessment was conducted of the effects on breeding birds from an experimental removal of approximately 25 percent of the stems and basal area of mature oak trees (mostly blue oak and interior live oak) in low-elevation foothills of the northern Sierra Nevada. Nest cavity and granary trees were retained. Consistent population changes were detected in 12 species in the two seasons after harvest. Of these, 10 increased and 2 decreased: Hutton's vireo *(Vireo huttoni)* and Pacific-slope flycatcher *(Empidonax difficilis)*. Most of the species that increased on harvested study plots responded to the creation of brush piles after the harvest. Two of the others that increased—western kingbird *(Tyrannus verticalis)* and Bullock's oriole *(Icterus bullockii)*—were clearly linked to the more-open stands of oaks that were created by the harvest, while the decrease in numbers of Hutton's vireos and Pacific-slope flycatchers was associated with the reduction of canopy cover. The authors concluded that small-scale firewood harvests with low levels of removal (< 25 percent) and retention of cavity trees would likely have minimal effects on most of the more common breeding birds. Effects on the more rare species could not be determined; further research is needed.

Planning Considerations

Historical records reveal that the first European settlers that viewed California oak woodlands saw a land of abundant wildlife and other natural resources. In spring 1844, John C. Frémont reported that by the Tuolumne River in Tuolumne County the beauty of country "had been increased by the additional animation of animal life; and now it is crowded with bands of elk and wild horses; and along the rivers are frequent fresh tracks of grizzly bear, which are unusually numerous in this country" (Frémont 1970, 661). During the past 150 years, the introduction of exotic plants and animals, agricultural conversions, cutting oak trees for fuel and to increase forage for livestock, suppression of fires, and, especially in the last 25 years, development, have left a landscape much different from that viewed by the first European settlers. Vision and creativity are needed to maintain the economic and ecological viability of remaining landscapes. The remainder of this chapter briefly summarizes several ideas and techniques that may be helpful to integrate wildlife considerations into the land-use planning process.

Species Richness versus Selected Species Considerations

There are two possible approaches in planning for wildlife:

- plan for the habitat requirements of as many species as possible, known as "species-richness planning"
- plan for the habitat needs of particular species, known as "selected species planning."

Here we will focus on planning for species richness. Sources of information on managing for specific wildlife species and ranch management goals are given in the bibliography. Of course, most oak woodland habitat is owned by ranchers who must consider livestock production and other range-management goals in conjunction with maintaining habitat for wildlife.

Wildlife species richness can be promoted by maintaining a range of tree species with differing size and stages of vigor in close proximity. It is important to identify

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and maintain unique and special oak habitat components such as riparian areas, cavity trees, downed wood, and good acorn-producing trees. One should also try to maintain large blocks of contiguous oak habitat where components are represented in sufficient quantities and juxtapositions. The importance of maintaining corridors and connectedness increases as the size of the habitat block decreases. A habitat corridor through a developed area not only increases numbers and kinds of wildlife, it also enhances the aesthetic and economic value of the area. Wildlife professionals can assist in developing specific plans to meet wildlife goals.

Design Considerations: Fitting Development to the Land

Several ideas for designing development on the lot, individual project, and landscape scale are listed below. Some of these design considerations can also benefit crop and livestock production and thus help preserve agriculture and open space which, in turn, may benefit wildlife.

Lot design

Large lot sizes (that is, low density) maintain more habitats for wildlife than small lots. However, even with low lot density, high-density use, such as recreational horse use with accompanying barns and sheds and high animal impacts, may have a greater impact than what was originally planned.

Project design

Cluster development is a form of high-density development that concentrates construction in one portion of the development site, perhaps where adverse impacts on wildlife would be least. In this way, the remainder of the development site can be designated as open space for recreational use and wildlife habitat. For example, a cluster-development design was used to maximize maintenance of open space at a 3,100-acre (1,250-ha) site in oak woodland located near San Luis Obispo. An 800-acre (320-ha) piece was divided for 48 lots. The remaining 2,300 acres (930 ha) were dedicated to ranching, recreation, and other low-disturbance land use with minimal adverse impacts on wildlife.

Another consideration is the shape of a development site. Should it be circular or elongated? Because wildlife moving through woodland or flying over it are more likely to come into contact with a long, narrow development oriented perpendicular to their line of travel, it is generally better to concentrate developments in circular areas. Shape and size of the project are only part of the design considerations. The size of the planned area has traditionally included only the area slated for development. However, several of the larger oak woodland birds and mammals move across thousands of acres in pursuit of their life needs. Chapter 5 examines the nuances of regional and landscape-level planning considerations.

Landscape design

Generally, most land development in oak woodlands has occurred on parcels ranging in size from 1 to 40 acres (0.4 to 16 ha). Management by watershed or landscape units is a more ecologically sound approach. Management at that scale provides a mechanism for local planners to integrate wildlife values with other resource values such as air, water, agriculture, and open space. In this way, areas of adequate size and connectedness can be maintained for all wildlife.

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The political climate in California today and available information technology makes planning for wildlife feasible on a regional or countywide basis. Cumulative effects of many small developments can and must be addressed at the largest spatial scale possible. Examples of how to maintain wildlife in the planning process are given in Adams and Dove 1989.

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