Chapter 4
Native Peoples' Relationship to the California Chaparral

M. Kat Anderson and Jon E. Keeley

Abstract Ethnographic interviews and historical literature reviews provide evidence that for many tribes of California, chaparral plant communities were a rich source of food, medicines, and technologies and that they supplemented natural fires with deliberate burning of chaparral to maximize its ability to produce useful products. Many of the most important chaparral plant species used in the food and material culture have strong adaptations to fire. Particularly useful were many annual and perennial herbs, which proliferate after fire from seed and bulb banks, shrub resprouts that made superb cordage and basketry material, as well as animals that were more readily caught in postfire environments. The reasons for burning in chaparral are grouped into seven ecological categories, each relying on a known response to fire of the chaparral community. The authors posit that tribes employed intentional burning to maintain chaparral in different ages and size classes to meet diverse food and material needs, tracking the change in plant and animal abundance and diversity, and shifts in shrub architecture and habitat structure during the recovery of the chaparral community. Areas were burned in ways designed to create a mosaic of open grassland and recently burned, young and mature stands of chaparral with different combinations of species and densities. This management conferred on chaparral plant communities a degree of spatial, structural, successional, and biotic diversity that exceeded what would have been the case in the absence of human intervention. These impacts are still evident on contemporary landscapes.

Keywords California Indians · Chaparral · Ethnobiology · Fire ecology · Fire management · Indian burning · Native Americans · Tribes · Type-conversion · Vegetation patterns

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4.1 Introduction

Although plant communities we would recognize as chaparral have been present in western North America for at least 10 million years (Keeley et al. 2012), it is impossible to fully understand the ecology, composition, and distribution of this vegetation without reference to how it has been impacted, at the very tail end of this long history, by humans. People of mostly western European extraction have indeed heavily influenced California chaparral during the past 200 years by clearing chaparral for agriculture, mining, rangeland, and residential and industrial development, by altering fire regimes, and by changing the global climate, but chaparral in California was shaped by human activities in ways equally profound, though less evident, well before the Gold Rush or the establishment of the missions in Spanish colonial times. These vegetation-altering activities were carried out, of course, by the Native peoples of California, who, not long after their arrival ~12,000 years ago, developed a relationship with chaparral based on both using its resources extensively and carefully managing them.

For many of the tribes of California, chaparral plant communities were a rich source of food, medicines, and materials for baskets, ceremonial items, clothing, living structures, tools, and other items of technology. Exploiting these resources over long periods of time, the Indians who lived in and near chaparral zones learned through observation, trial-and-error experimentation, and accidental discovery that many of the chaparral-based resources they found most valuable could be sustained by judicious harvest methods and enhanced, in quality or quantity, by certain kinds of manipulation. For example, replanting the bulblets of the checker lily and wild onion bulbs harvested for food could insure the availability of bulbs in subsequent years. Saving the seeds of red maids (*Calandrinia ciliata*) and scattering them where they had not grown before could expand the populations and thus the harvests of these food plants. Pruning flannelbush (*Fremontodendron californicum*) in a certain way would rejuvenate older shrubs and encourage the growth of shoots ideal for cordage manufacture.

These management techniques were all important, but by far the most consequential was the use of fire. Done properly, burning areas of chaparral could yield multiple and long-lasting beneficial effects by creating diverse landscape mosaics of chaparral and herbaceous communities. Tribes discovered that if you burned the chaparral at the right time of year and at the right frequency, you could simultaneously open up the habitat for ease of movement and hunting, increase its ability to support deer and small mammals, increase the productivity of the plants used for food and medicine, encourage shrubs to produce shoots ideal for basketry, and reduce the vulnerability of villages to out-of-control, lightning-ignited summer wildfires (Timbrook et al. 1982; Lewis 1993; Shipek 1993; Keeley 2002; Anderson and Rosenthal 2015).

Native peoples in California applied fire and other management techniques to chaparral to achieve specific, relatively short-term, and human-centered results, but over the many thousands of years during which this management regime was practiced (and undoubtedly refined), its consequences reached deeply into the foundation of what defines chaparral: the distribution, interactions, and genomes of its constituent species. We will likely never know the exact extent to which Indian management of chaparral in the pre-historic era altered the distribution and ecology of the chaparral plant community, but the evidence indicates that it almost surely did. The implications for present-day management of chaparral are considerable. Our goal in this chapter is to present the foundational knowledge and evidence that need be taken into account when considering how management and use of chaparral by the first peoples of the state could inform today's management of chaparral dominated lands.

4.2 Native Peoples' Use of the Chaparral Community

Colonization of what is now California by Europeans completely disrupted Native peoples' lifeways, including their harvesting of plants and animals from the environment (Anderson 2005a). Infectious diseases brought by the early explorers and Spanish missionaries spread through villages in wave after wave beginning in the 1600s, decimating many populations, even among tribes living far from Spanish influence (Preston 1996, 2002). Using methods of both persuasion and coercion, the padres brought surviving Indians to the missions to work the fields, make adobe blocks, process livestock skins for leather, and perform the many other tasks that kept the missions' economies running (Costo and Costo 1987). As a result of these processes, the traditional subsistence and management practices of the tribes in the chaparral zones of the central and southern Coast Ranges dwindled in many areas by the end of the eighteenth century (Castello 1978). In the chaparral zones of the Sierra Nevada foothills and northern California, tribes kept traditional practices going into the nineteenth century despite demographic disruption, but then the massive influx of whites that came during and after the Gold Rush drastically curtailed them (Mason 1881; Holliday 1999). Within a few decades, appropriation of land, violent repression, genocide, disease, and legal strictures had severely limited Native harvesting of chaparral resources in the foothills and northern regions and supplanted Native management with neglect and sometimes wanton destruction (Anderson 2005a; Madley 2016).

By the early twentieth century, when trained scientists began serious study of California's vegetation and anthropologists began to document elements of Native cultures, the reciprocal relationship that California Indians had established with chaparral was only a memory in many Native families. The extensive and regular use of fire as a management tool in chaparral had waned in most regions. Few Indians existed entirely apart from the emerging industrial economy, and what traditional practices remained were isolated remnants of the former lifeways.

Fortunately, we know how Native peoples in California used resources from the chaparral community in the times pre-EuroAmerican colonization, through evidence in varying forms, ranging from observations recorded more than 200 years ago to pollen grains buried in lake sediments. Archaeological sites yield clues to the importance of chaparral in the form of charred fruits, seeds, and bulbs from cooking hearths, and bone, antler, and hide remains of terrestrial mammals. In museums and other repositories, plant foods, baskets, and other artifacts, collected by anthropologists and others before the vast curtailment of traditional practices, tell us what plants and animals had importance in indigenous economies, as do the written accounts of missionaries and early settlers. Remarkably, some Native people today still practice gathering and hunting traditions and remember what their grandparents told them about former indigenous burning and other chaparral management techniques, and they hold knowledge passed along by their ancestors about the plants and animals of the land. In addition, the anthropologists, ethnographers, and naturalists who studied the partially intact Native cultures that still existed around the turn of the twentieth century were tenacious and thorough in their search for authentic examples of the former lifeways and left us a rich record of documentation. These forms of evidence, combined with data from growth rings, pollen deposits, soil, and charcoal deposits, allow us to form a rough picture of the role of plants and animals of the chaparral in the pre-historic cultures of California.

As we explore the different plant and animal species of the chaparral that helped support tribes' subsistence economies and supplied much of their physical cultures, it is important to keep in mind that the chaparral plant communities that existed in California pre-EuroAmerican contact were somewhat different from what we see today. Why this would be so is the subject of discussion later in this chapter. For now, it suffices to recognize that the pre-EuroAmerican contact chaparral was, at least in some locations, more spatially heterogeneous than what exists today. Its different successional stages formed mosaics of shrublands mixed with open grasslands and woodlands. This structural complexity, with its greater vegetational diversity and ecotonal area, translated into greater floristic and habitat diversity and an abundance of different niches for wildlife (Verner and Boss 1980). Simply put, the chaparral in much of pre-EuroAmerican contact California was species-rich in a way that a contemporary person struggling through a sea of chamise (*Adenostoma fasciculatum*) or contemplating a hillside of seemingly pure buckbrush (*Ceanothus cuneatus*) would find difficult to appreciate.

In pre-historic times the heterogenous chaparral zones of California supported populations of mule deer, grizzly and black bears, mountain lions, various smaller mammals, and numerous species of birds, reptiles, and insects, many of which were taking advantage of this fire-prone landscape (White et al. 1980; Quinn 1990). Mule deer (*Odocoileus hemionus*) fed on the herbaceous plants at the edges of brush land and browsed the young, tender sprouts of recently burned chaparral shrubs such as, mountain mahogany (*Cercocarpus betuloides*) (plant nomenclature according to Baldwin et al. 2012), Utah service-berry (*Amelanchier utahensis*), and chamise (*Adenostoma fasiculatum* var. *fasciculatum)*. Bears (*Ursus americanus* and *U. arctos*) feasted on the berry bushes along chaparral borders, rooted up bulbs from dense Mariposa lily (*Calochortus* spp.) patches, and denned in dense thickets of chaparral. Mourning doves (*Zenaida macroura*) fed on the jet-black seeds of *Calandrinia ciliata* growing in fire-created openings and tortoiseshell butterfly larvae (*Nymphalis californica*) partook of young *Ceanothus cuneatus* seedlings. Small mammals such as voles, moles, ground squirrels, and rabbits hid in the shrub cover and became meals for various raptors. The high diversity and abundance of insects fed larger predatory reptiles, birds, and mammals.

Fig. 4.1 Estefana Salazar, Tubatulabal, with tobacco (*Nicotiana attenuata*) leaves gathered from a patch in Weldon, Kern County, California. *Nicotiana attenuata* was widely used by tribes for ceremonial and medicinal purposes, and clearing areas and enhancing *N. attenuata* patches was one of the most commonly recorded reasons for burning in chaparral. Museum number 15-10544, courtesy of the Phoebe A. Hearst Museum of Anthropology, and the Regents of the University of California. Photo by E.W. Voegelin, July 1932

Chaparral and its ecotonal margins supported a diversity of shrubs, herbs, and grasses that as a group ranked among the most useful and most needed of food and non-food plants. Annuals such as *Calandrinia ciliata*, chia (*Salvia columbariae*), and perennial grasses such as blue wild-rye (*Elymus glaucus*) produced edible seeds. Shrubs and perennial grasses such as sumac, also known as sourberry (*Rhus aromatica*), *Ceanothus cuneatus*, deerbrush (*Ceanothus integerimus*), redbud (*Cercis occidentalis*), and deer grass (*Muhlenbergia rigens*) yielded prized basketry materials. A few special shrubs and perennials like cascara sagrada (*Frangula purshiana*), yerba santa (*Eriodictyon californicum*), California lomatium (*Lomatium californicum)*, and jimsonweed (*Datura wrightii*), and annual herbs such as tobacco (*Nicotiana attenuata* and *N. quadrivalvis*), provided materials for medical and ceremonial use (Fig. 4.1) (Goddard 1903; Lake 1982). Many species that today might be difficult to find growing in a chaparral community were more abundant and more widespread. The native people of California made wide use of these and other chaparral plants and animals, as we detail in the following pages.

4.3 Useful Chaparral Plants

The indigenous people of California were fortunate to have a great diversity of plants to draw from in the chaparral. More than 400 species that make up the chaparral plant community are known to have been used in some manner by at least one tribe. Together, these plants furnished an essential portion of the subsistence economy of tribes that had access to chaparral dominated lands.

One reason why the number of chaparral plants documented as useful is so high is that Native people could find uses for just about any plant. If it did not produce fruit, seeds, shoots, or below-ground parts that could be eaten or used for medicine, then its stems or roots might have been fibrous enough to be used for cordage or basketry, or perhaps they contained compounds that could be extracted as dyes. If none of these uses seemed to be possible, then the stems or branches could at least be used for structures like summer houses or hunting blinds, or the branches and trunks could be burned as cooking or heating fuel.

David Prescott Barrows (1967), an anthropologist, took note of this ability to see and find uses in plants. "There are few plants in Indian country," he wrote, "that have not been experimented with by its native inhabitants." At the time, he was speaking of the Cahuilla, with whom he had conducted field work in the 1890s, but his statement would apply to all of the tribes of California. The Cahuilla's use of so many plants from the chaparral and other plant communities for such an enormous variety of purposes shows "how diligent and acute…the investigation for useful things has been" (Barrows 1967).

Native people gathered native plants from every type of chaparral, from the lower elevation chaparral on the slopes of the coastal mountains to the montane chaparral higher up and in the Sierra Nevada. In the chamise chaparral, the Luiseño cut the branches of *Adenostoma fasciculatum* to form the rough coiled structures of the acorn granary and used the young shoots to form the foreshafts of arrows (Sparkman 1908; Beemer 1980). In the mesic scrub oak chaparral on north-facing slopes, the Cahuilla plucked acorns of scrub oak (*Quercus berberifolia*) for food (Bean and Saubel 1972). On the lower slopes of the San Gabriel and San Bernardino Mountains, the Tongva broke off the carbohydrate-rich young flowering stalks of chaparral yucca (*Hesperoyucca whipplei*) for baking in an earth oven and collected the leaves of ephedra (*Ephedra* spp.) for tea (Johnston 1962). The Kawaiisu gathered the edible seeds of the dominant bush poppy (*Dendromecon rigida*) in the desert chaparral of the Coast Ranges bordering the San Joaquin Valley (Zigmond 1981). In the red shanks (*Adenostoma sparsifolium*) chaparral of southern California the Kumeyaay harvested the wood and roots of *Adenostoma sparsifolium* for firewood (Hinton 1975). In the higher-altitude montane chaparral of the Cascades, the Wintu collected the tasty fruits of *Amelanchier utahensis* (Du Bois 1935).

Of all the native chaparral plants, perhaps the many species of manzanita (*Arctostaphylo*s spp.) are the most emblematic of the chaparral's cultural importance. Indians used the leaves, bark, and berries of *Arctostaphylos* spp. for various medicines and transformed its bark and wood into arrow straighteners, awl handles,

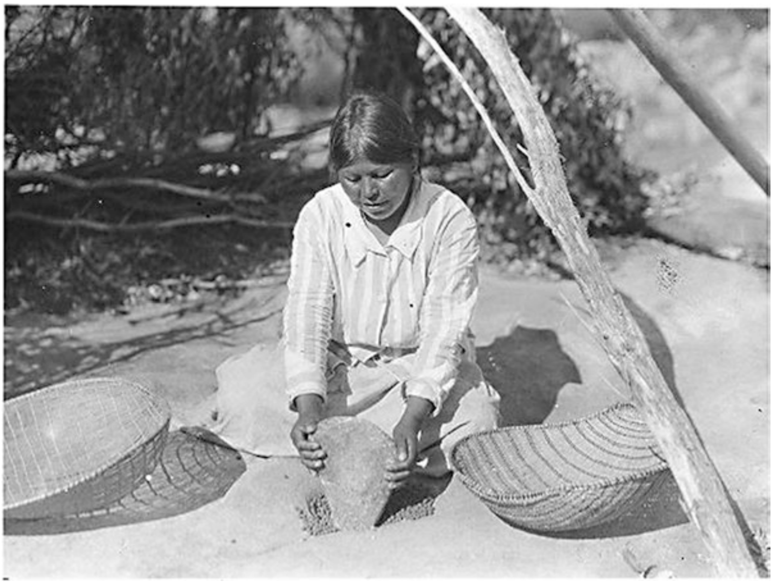

Fig. 4.2 Mollie Cheepo, North Fork Mono, pounding the berries of manzanita (*Arctostaphylos* spp.) in a bedrock mortar, a major step in processing the fruits for cider. Tasineu Village, North Fork. Museum Number 15-6227, courtesy of the Phoebe A. Hearst Museum of Anthropology and the Regents of the University of California

digging sticks, canes, brooms, reels for string, containers, firewood, house construction, pipes, mush paddles, and ear- and nose-piercing sticks. Because the wood of *Arctostaphylos* spp. burned so hot and made excellent coals, the Mono, Coast Miwuk and other tribes preferred it for heating rocks for cooking acorn mush and parching seeds and other foods (Collier and Thalman 1991; Anderson 2009). A vitamin-rich cider-like drink unique to the tribes of California was made from the fruits of *Arctostaphylos* spp. (Fig. 4.2). So important was this drink that it typically accompanied foods such as venison and acorn mush or soup, and it was mixed with foods such as ground *Salvia columbariae* seeds and yellowjacket larvae, and moistened other foods such as wildflower seeds that were crushed and pressed into balls. "[I]n color and flavor," wrote ethnographer C. Hart Merriam in 1902, this beverage was "like the very best apple cider…cooling and delicious" (Merriam 1902). Since any particular locality supported only a few of the 14 species of *Arctostaphylos* utilized in California chaparral,[1] each tribe had its own local cider reflecting that particular *terroir* (Anderson and House 2012). The berries of *Arctostaphylos* spp. are one of the most common paleoethnobotanical remains in archaeological sites located in chaparral habitat (Wohlgemuth 2004), indicating the plants' importance to tribes.

[1] *Arctostaphylos canescens, A. glandulosa, A. glauca, A. manzanita, A. mewukka, A. myrtifolia, A. nevadensis, A. parryana, A. patula, A. pumila, A. pungens, A. tomentosa, A. uva-ursi,* and *A. viscida.*

4.3.1 Plants for Food and Medicine

Ethnographers working with California Indian tribes in the late 1800s and early 1900s noted their uniformly sweet breath, teeth with no decay, clear eyes, and the rarity of obesity (Hudson 1901a; Powers 1976). Good health was partially a result of a very diverse diet of plants, animals, fish, shellfish, red meat, and mushrooms, and for many tribes much of this diet came from chaparral. The variety of edible chaparral plants in the traditional diet is impressive and includes four plant-part categories: potato-like under-ground stems (called bulbs, corms, and tubers); seeds, grains and nuts, leaves; stems and flowers for greens; and the fleshy fruits (the pomes, drupes, and berries).

Edible chaparral plants were important parts of the maintenance of social relations, being offered as gifts and offerings. The berries of *Arctostaphylos* spp., for example, were brought as a present to a Foothill Yokuts mother's ceremony after childbirth and were scattered as offerings during Nisenan healing ceremonies (Hudson 1902; Gayton 1948a). Today various foods and drinks made from chaparral plants, such yerba buena tea, sumac berries, ephedra tea, Sierra mint tea, manzanita cider, and gray pine nuts, are given to friends and guests at major social events and offered as snacks and refreshments at Indian homes. They are extremely important in maintaining ethnic identity (Anderson 2005a).

Annual cycles of food-gathering were closely tied to the phenology of chaparral plants. Particularly important were the plants with edible under-ground storage organs, called *geophytes* by botanists and ecologists and *Indian potatoes* or *root foods* by Native Americans. Indians dug these bulbs, corms, and tubers for food with digging sticks in disturbed, open ground of chaparral and they were eaten raw or boiled, baked in an earth oven, or roasted in coals. Perhaps the most widely dug geophytes in the chaparral were soap plants (*Chlorogalum pomeridianum*), Gairdner's yampah (*Perideridia gairdneri*), and blue dicks (*Dichelostemma capitatum*). The tremendous diversity of geophtyes available for harvest is illustrated by the large number of species utilized in the *Brodiaea* complex. The corms of at least five kinds of brodiaeas (harvest brodiaeae [*Brodiaea elegans*] subsp. *elegans*, California brodiaeae [*B. californica*], crown brodiaeae [*B. coronaria*], dwarf brodiaeae [*B. minor*], and Kaweah brodiaeae [*B. insignis*]), all species of *Dichelostemma* (ookow [*D. congestum*], roundtooth snakelily [*D. multiflorum*], and twining snakelily [*D. volubile*]), and four species of *Triteleia* (largeflower triteleia [*Triteleia grandiflora*], white brodiaeae [*T. hyacinthine*], pretty face [*T. ixioides*], and common triteleia [*T. laxa*]) were dug and eaten (Dixon 1905; Brubaker 1926; Barrett and Gifford 1933; McMillin 1956; Duncan 1964; Powers 1976; Latta 1977; Eastwood n.d.; Howell n.d.; Hudson n.d.). To the north, important chaparral root foods included pussy ears (*Calochortus tolmiei*) bulbs, yellow fritillary (*Fritillaria pudica*) bulbs, and hairy brackenfern (*Pteridium aquilinum* var. *pubescens*) rhizomes (Fowler 1986; Goddard 1903; McMillin 1956; Knudtson 1977). In southern California common goldenstar (*Bloomeria crocea*), *Calochortus concolor*, and Palmer's mariposa lily (*Calochortus palmeri* var. *palmeri*) were valued (Sparkman 1908; Voegelin 1938; Bean and Saubel 1972). The contribution of these and other root crops to the subsistence economies of tribes was substantial (Anderson and Lake 2016).

In addition to gathering the carbohydrate-rich geophytes growing in early successional chaparral, Native Americans gathered many plant foods that grew aboveground: sprouts, young stems, fleshy fruits, and seeds. Seasonally abundant, easily harvested in large quantities, rich in vitamins and phytonutrients, and easily dried or prepared for storage and trading, the above-ground plant foods from chaparral plants were an essential dietary component for many tribes.

While many of the above-ground plant foods gathered in chaparral could be found in other vegetation types, chaparral and openings in chaparral were favorite gathering spots. These habitats supported a great variety of edible species and produced abundant and predictable crops. Green vegetables gathered from chaparral included the sweet raw shoots of whitehead mule-ears (*Wyethia helenioides*), the tender tops of horseweed (*Erigeron canadensis*), the stems of different kinds of thistles (*Cirsium* spp.), the young leaves of docks (*Rumex* spp.), phacelias (*Phacelia* spp.), fiddlenecks (*Amsinckia* spp.), and buckwheats (*Eriogonum* spp.), mature stems of common cowparsnip (*Heracleum maximum*), and young fiddleheads of bracken ferns (*Pteridium*). The young flower stalks and basal portions of mature stalks of the *Hesperoyucca whipplei* were eaten after being roasted in a pit oven with hot stones (Voegelin 1938; Gayton 1948a).

Another important source of food, particularly in areas around villages, was patches of chaparral shrubs with edible fruits. Many different kinds of fruits, most of them berries, were dried and soaked in water to re-constitute them before being eaten. Dried berries were also made into cakes and fruit leathers. The chaparral shrubs producing edible berries are numerous: lemonade berry (*Rhus integrifolia*), sumac, or *Rhus aromatica*, sugar bush (*Rhus ovata*), *Arctostaphylos* spp., blue elderberry (*Sambucus mexicana*), bitter cherry (*Prunus emarginata*), western chokecherry (*Prunus virginiana* var. *demissa*), Sierra plum (*Prunus subcordata*), holly-leaf cherry (*Prunus ilicifolia*), spiny redberry (*Rhamnus crocea*), gooseberry (*Ribes amarum*, *Ribes menziesii*, *Ribes quercetorum*, and other spp.), *Amelanchier utahensis* and other *Amelanchier* spp., *Heteromeles arbutifolia*, California blackberry (*Rubus ursinus*), barberry (*Mahonia* spp.), snowberry (*Symphoricarpos albus* var. *laevigatus*), rose (*Rosa* spp.), whitebark raspberry (*Rubus leucodermis*), California wild grape (*Vitis californica*), California juniper (*Juniperus californica*), western juniper (*Juniperus occidentalis*), nightshade (*Solanum xanti*), ninebark (*Physocarpus capitatus*), and mission manzanita (*Xylococcus bicolor*) (Timbrook 2007; Anderson and Rosenthal 2015). Some of these fruits are still gathered today and eaten raw or made into jams, jellies, cakes, and pies.

Many kinds of sun-loving wildflowers including *Salvia columbariae*, *Calandrinia ciliata*, California compassplant (*Wyethia angustifolia*), common madia (*Madia elegans*), valley popcorn flower (*Plagiobothrys canescens*), western buttercup (*Ranunculus occidentalis*), farewell-to-spring (*Clarkia* spp.), and whitestem blazingstar (*Mentzelia albicaulis*) were harvested for their edible seeds in the open patches of chaparral (Barrett and Gifford 1933; Voegelin 1938; Anderson et al. 2012). The seeds of forbs and grasses were important enough to be stored in their own granaries or baskets separate from acorns (Barrett and Gifford 1933). Seeds were roasted, baked into bread, or boiled into mush or soup. A favored seed collection method was to beat the inflorescences of wildflowers and grasses with a seed beater, a shallow basket with a handle, so that the seeds would fall into a wider-mouthed basket or burden basket.

In open areas in and around chaparral grew many kinds of wildflowers, as well as various native grasses that were valued for their edible grains. These included California brome *(Bromus carinatus*), *Elymus glaucus*, and slender hair grass (*Deschampsia elongata*) (Duncan 1964; Powers 1976; Bunnell 1980; Anderson et al. 2012). Seeds of subshrubs and shrubs such as white sage (*Salvia apiana*), black sage (*Salvia mellifera*), *Ceanothus cuneatus* and deer brush (*Ceanothus* spp.) were important too (Dixon 1905; Miller 1928; Anderson et al. 2012; Hudson n.d.). The Serrano gathered the seeds of *Salvia apiana* and ate them raw and also peeled and ate the new stems (Lerch 2002). The Chumash gathered the seeds of at least two kinds of salvias: *Salvia columbariae* and *S. carduacea* (Timbrook 2007). The Mono mixed the seeds of *Ceanothus cuneatus* with the pupae of the California tortoise-shell butterfly, and the Konkow soaked *Ceanothus* spp. seeds and then scorched them to remove the bitterness. They were pounded into flour, sifted in a winnowing basket, and then eaten plain or mixed with acorn mush, meat, or other foods (Duncan 1964). The nuts of various kinds of trees that occur in chaparral were gathered for food as well. The most important were the oaks such as canyon live oak (*Quercus chrysolepis*), blue oak (*Q. douglasii*), coastal scrub oak (*Q. dumosa*), Engelmann oak (*Q. engelmannii*), Oregon white oak (*Q. garryana* var. *semota*), turbinella oak (*Q. turbinella*), and interior live oak (*Q. wislizeni*). Also important were California buckeye (*Aesculus californica*), California bay (*Umbellularia californica*), and gray pine (*Pinus sabiniana*) (Fig. 4.3) (Beals 1933; Bean and Saubel 1972; Clark 1987; Anderson 1988).

Fig. 4.3 Elizabeth Enos, Nisenan Maidu, peeling California buckeye (*Aesculus californica*) nuts for food. Museum number 25-5034, courtesy of the Phoebe A. Hearst Museum of Anthropology and the Regents of the University of California. Photo taken by Samuel A. Barrett, 1983

California tribes living in chaparral not only gathered food plants but also plants with medicinal properties. Indigenous pharmacopeias contained hundreds of plant species that could be collected in the chaparral plant community. Each plant or plant part was designated for very specific treatments such as curing fevers, reducing internal pains, tonifying vital organs, alleviating colds and coughs, or healing stomach troubles. Many medicinal plants were taken internally in some form: the Shasta chewed the roots of chaparral clematis (*Clematis lasiantha*) for colds (Holt 1946), tribes up and down California boiled the leaves of *Eriodictyon* spp. and made a tea used as a cough medicine (Anderson 2016), the Kawaiisu made an infusion of the leaves of pallid silk tassel bush (*Garrya flavescens*) and drank it to cure stomach aches (Zigmond 1981).

A wide variety of chaparral herbs were also made into salves or poultices and applied topically for skin, muscle, and eye problems and some were collected for baths to treat aching and sore muscles, arthritis, bruises, cuts, sores, wounds, and sore eyes. The Konkow applied the milky juice of purple milkweed (*Asclepias cordifolia*) externally for warts and other skin problems such as skin cancer (Duncan 1964). The Nisenan mashed the root of narrow petal wakerobin (*Trillium angustipetalum*), cooked it, and applied it as a poultice for toothaches, stiff necks, and sore throats, and in powdered form it was applied to small cuts (Duncan 1964). The Paiute and Shoshoni made a decoction of the plant Scouler's St. John's wort (*Hypericum scouleri*) and used it to bathe aching feet (Train et al. 1941). The Southern Sierra Miwuk put mugwort (*Artemisia douglasiana*) leaves in bathwater to sooth aching bones (Anderson 1988).

The Kawaiisu, Sierra Miwuk, and Luiseño, each separated by other tribal territories and speaking mutually unintelligible languages, all used different species of a chaparral spurge (*Chamaesyce*)[2] applied as a poultice to draw out the poison of rattlesnake bites and reduce the swelling (Sparkman 1908; Barrett and Gifford 1933; Zigmond 1981). That three different tribes would have discovered this plant's effectiveness for snakebite, attests to the proficiency of Indian healers and their exhaustive experimentation with chaparral plants.

Many chaparral plants were so effective in treating ailments that they were adopted by the Franciscan missionaries as they came into contact with the Indians. The padres gave several of these plants names that included the words *sagrada* (sacred) and *santa* (holy or saint). Later, some of these chaparral plants were used by American doctors and became part of American medical care. Their official listing in the US Pharmacopeia by the medical establishment[3]—and the present-day use of a few, such as *Frangula purshiana*, attests to their efficacy (Voegel 1970).

[2] *Chamaesyce albomarginata* for the Kawaiisu; *Chamaesyce ocellata* and *C. serphyllifolia* for the Sierra Miwok; and *Chamaesyce polycarpa* var. *polycarpa* for the Luiseño.

[3] In the first US Pharmacopeia issued in 1820, almost half of the substances were native plants used by American Indians.

Fig. 4.4 Justin Farmer, Ipai, splitting a managed branch of sumac (*Rhus aromatica*) into three pieces to be used as sewing strands or weft in baskets. Young growth is what weavers prefer as it is flexible, long, without side-branching and no insects or diseases. This desirable shrub architecture and quality are created through deliberate Indian burning and pruning in chaparral areas. Photo by Kat Anderson

4.3.2 Plants as Raw Material for Technologies

If the chaparral plant community could be considered a grocery store and pharmacy because of the abundance of its edible and medicinal plants, then it was also the Indians' hardware store, home building center, tobacco shop, and craft supply store. Like aboriginal people anywhere, the people of California made a variety of items and structures necessary for human survival and comfort, including cordage, baskets, mats, shelters, clothing, weapons, and tools, and for many tribes much of the raw material for these items came from chaparral (Figs. 4.4 and 4.5). The diverse properties of the wood and fiber from chaparral plants and shrubs are what made the chaparral such an important source of raw material for technologies. The exceptional hardness of *Cercocarpus betuloides* wood, for example, made it ideal for spears and digging sticks, similarly because the wood of *Arctostaphylos* spp. had "the same hardness all the way through" (Gayton 1948a) it was perfect for making pipes.

This section addresses five primary cagories: basketry, cordage, clothing, utensils, tools, weapons, and structures and fencing. Baskets, which served many different functions, were among the most important items of technology for all tribes in

Fig. 4.5 Justin Farmer, Ipai, pointing out the tiny knot, also called a "dimple" that forms where the lateral branch grows from the main stem on older-growth sumac (*Rhus aromatica*) making it unsuitable for basketry material. Photo by Kat Anderson

California. They held drinking water, stone-boiled foods, trapped fish, transported commodities, winnowed seeds, and stored household items. Many parts from chaparral plants were used to make baskets: leaves of *Hesperoyucca whipplei*, branches and roots of *Pinus sabiniana*s, flower stalks of *Muhlenbergia rigens*, stems of rushes, and young shoots of *Cercis occidentalis*, *Rhus aromatica*, *Ceanothus* spp., *Ceanothus cuneatus*, *Vitis californica*, bush penstemon (*Keckiella breviflora*), wild mock orange (*Philadelphus lewisii*), pink honeysuckle (*Lonicera hispidula*), ocean spray (*Holodiscus discolor*), and *Fremontodendron californicum* (Merriam 1902; Goddard 1903; Merrill 1923; Brubaker 1926; Voegelin 1938; Goodrich et al. 1980; Bates 1982; Hedges and Beresford 1986).

Thousands of young shoots of chaparral shrubs were gathered by each weaving family every year to make burden baskets, seedbeaters, cradleboards, winnowers, sifting baskets, rough work baskets, and many other kinds (Barrett and Gifford 1933; Duncan 1964). Such large quantities of basketry materials were needed that a typical Indian house might be filled with bundles of straight sticks of *Ceanothus* spp., *Cercis occidentalis*, *Ceanothus cuneatus*, *Rhus aromatica*, and *Prunus emarginata*, with coils of *Pinus sabiniana* root hanging from ceilings, hung on walls, or stored in baskets (Barrett and Gifford 1933; Neely 1971; Chesnut 1974; Heizer 1978; Bates 1982; Bethel et al. 1984; Anderson 1988). The Southern Sierra Miwuk considered *Ceanothus cuneatus* to be the "strongest basket material" and used it to make cooking pots, drying baskets to hold acorns and fruit, and bath tubs (Hudson 1901a; Merriam 1955). Basketweaver Norma Turner Behill, Mono/Dumna (pers. comm. 2006) described the extensive use of this chaparral shrub, "The whole rods are used for winnowing baskets. The two year old ones are split for lacing and go around seed beaters, the tops of the burden baskets and the tops of baby baskets. They use those little fine sticks to make those little fine baskets".

Chaparral plants were an important source of the fibers used to make cordage. The bast fibers of dogbane (*Apocynum* spp.) were employed in constructing fences for deer and rabbit drives and also for fishnets and fishing line (Duncan 1964). The stem bast fibers of *Asclepias cordifolia*, showy milkweed (*Asclepias speciosa*), and narrow-leaf milkweed (*A. fascicularis*) were used in many parts of California and made into string for bows, sling-shots, belts, carrying straps, net bags, hairnets, fishing lines and nets, and for lashing mush-stirrers and binding dwelling frames and posts (Barrett and Gifford 1933; Gayton 1948a; Duncan 1964; Eastwood n.d.). Clothing, regalia, and jewelry were sewn with milkweed thread. *Fremontodendron californicum* branches were a major tying material in the central foothills of California and throughout southern California, they were split into thin strips to make ties for house frames, rafter bindings, thatch bindings, and lashings for acorn granaries. In addition the outer bark of the branches was stripped off for use in making tumplines and fiber rope for ferrying things across streams (Barrett and Gifford 1933; Voegelin 1938; Gayton 1948a; Bethel et al. 1984; Hudson n.d.). In southern California, the fibers extracted from the leaves of Mohave yucca (*Yucca schidigera*) were used for bowstrings, netting, strings for shell money, ropes, mats, and coiled rope soles for sandals (Bean and Saubel 1972). Cordage was particularly important to tribes because of its central role in the technology used for hunting and fishing. Knowledge of string-making and its application in a great variety of hunting equipment, such as nets, snares, and spears, enabled tribes to tap the rich animal resources of the chaparral.

Most tribes wore clothing including accessories like earrings, belts, bracelets, and purses that derived in part from chaparral plants. The Sierra Miwuk wore sleeveless buckskin clothing belted with *Adenostoma fasciculatum* (Hudson 1901a). Similarly, the deerskins worn by Nisenan women were often sewn with *Adenostoma fasciculatum* (Hudson 1902). The Maidu made rod armor for warfare using *Cercocarpus betuloides* sticks (Kroeber 1976). Indian children in different tribes were swaddled with the shredded bark of *Fremontodendron californicum* or the stems of soft rush (*Juncus effusus*) (Hudson n.d.). Ohlone women wore skirts and aprons woven with the leaves of *Eriodictyon* spp. (Bocek 1984). Hupa women wore aprons under their skirts consisting of many long strands of knobcone pine (*Pinus attenuata*), nut shells strung on twine, and adorned themselves with necklaces made with the black fruits of oval-leaved viburnum (*Viburnum ellipticum*), and hair ties made of the sprigs of yerba buena (*Clinopodium douglasii*) (Goddard 1903).

A great variety of utilitarian items such as utensils for cooking and eating, tools for gathering, hunting, construction, and materials processing, and weapons for defense, were made from the wood, leaves, and bark of various chaparral shrubs and trees. Indians combed their hair with *Chlorogalum pomeridianum* brushes or with combs made of small sticks of *Cercocarpus betuloides* tied with milkweed string (Barrett and Gifford 1933; Voegelin 1938). The needles of gray and other pines scattered in chaparral were used for thatching, bedding, and floor covering (Neely 1971). *Muhlenbergia rigens* leaves were sat on while playing gambling games and game pieces consisted of chaparral plants (Goddard 1903; Anderson 1994). Pipes for pleasure smoking were made of *Sambucus* spp., *Arctostaphylos* spp., or *Cercocarpus betuloides*. Canes made of California-nutmeg, silk tassel bush (*Garrya elliptica*), or *Cercocarpus betuloides* aided walking (Hudson 1902; Goddard 1903; Gifford 1932). Kitchens were stocked with soup paddles and stirrers made of *Ceanothus cuneatus*, *Arctostaphylos* spp., *Fremontodendron californicum*, *Quercus douglasii*, or *Pinus sabiniana*, rocks were fetched from the fire with tongs made of *Quercus douglasii*, *Cercocarpus betuloides*, or *Fremontodendron californicum*. Floors were swept with brooms of *Cercocarpus betuloides* or *Ceanothus* spp. twigs, and axes for chopping firewood had *Ceanothus cuneatus* handles (Hudson 1902; Barrett and Gifford 1933; Voegelin 1938; Gayton 1948b; Bethel et al. 1984; Goode 1992).

Tools for gathering plant parts such as knocking sticks to knock down acorns and retrieve firewood from tree canopies, digging sticks for prying bulbs and corms from the earth, and sickles to cut grasses and forbs, were frequently made of chaparral plants. The twigs and leaves of naked buckwheat (*Eriogonum nudum*) formed brushes to clear the ground under *Arctostaphylos* spp. bushes before knocking off berries, and *Cercocarpus betuloides* brushes tied with *Fremontodendron californicum* fiber were used to sweep under oaks before knocking the acorns (Barrett and Gifford 1933, Ruby Pomona, North Fork Mono, pers. comm. 2006). Two essential pieces of equipment that formed fire-making kits—drills and hearth plates—were often made of *Sambucus* spp., *Aesculus* spp., *Arctostaphylos* spp., or desert almond (*Prunus fasciculata*). A Sierra Miwuk hunter in the early 1800s carried a foxskin quiver full of arrows made from *Sambucus* spp. with *Adenostoma fasciculatum* foreshafts, each arrow fitted with the feathers of a red-tailed hawk (*Buteo jamaicensis*) or roadrunner (*Geococcyx californianus*) (Barrett and Gifford 1933; Clark 1987; Hudson n.d.). On the north coast, Yuki women and children would pry mussels off rocks with a fire-hardened stick of *Garrya elliptica* (Merriam 1967).

Indian homes were well supplied with a wide assortment of substances made from chaparral plants that aided in running the household. *Chlorogalum pomeridianum* bulbs and pitch from *Pinus sabiniana*, Coulter pine (*Pinus coulteri*), or Torrey pine (*Pinus torreyana*) were used to make adhesives, while acorns and the wet inner bark of white alder were used to make dyes for coloring basketry material, bows, and ceremonial paraphernalia. Indian men and women washed their bodies and hair with the mashed bulbs of *Chlorogalum pomeridianum* or the pulverized roots of California goosefoot (*Chenopodium californicum*) and applied the leaves of *Rhus aromatica* as an underarm deodorant (Barrett and Gifford 1933; Voegelin 1938; Melba Beecher, Mono, pers. comm. 2008). Sprigs of *Umbellularia californica* were lit on fire, purifying the air in homes (Duncan 1964).

All manner of structures such as shade ramadas, acorn granaries, dwellings, and sweathouses, were built with chaparral plants. Branches and trunks of *Quercus wislizeni* formed platforms for acorn granaries, frames of houses, and roof beams of sweat houses (Gayton 1948a, R. Pomona and N. Turner Behill, Anderson unpublished field notes 2006). Mono lean-tos were made of willow, *Umbellularia californica*, and *Cercocarpus betuloides* with roofs of *Vitis californica* (Gladys McKinney,

Fig. 4.6 Chaparral brush was used extensively for different types of structures and fencing. One example is the building of shade structures such as this brush structure designed to shield North Fork Mono women from the sun as they pounded acorn and other foods in mortar holes in a granite outcrop, North Fork, Madera County, California. Museum Number 15-6221, courtesy of the Phoebe A. Hearst Museum of Anthropology, UC Berkeley

Mono, pers. comm. 1992). The Tubatulabal made deer hunting blinds of *Quercus berberifolia* (Voegelin 1938). Shade ramadas made of *Ceanothus cuneatus*, *Adenostoma fasciculatum*, *Quercus berberifolia*, and *Umbellularia californica* were built over grinding rocks to shield women from the sun as they pounded acorns into flour (Fig. 4.6) (Voegelin 1938; Bethel et al. 1984; Theodoratus et al. 1985; Anderson unpublished field notes 2006). The Sierra Miwuk made acorn granaries that were covered with *Ceanothus* spp. (Tadd 1988). Golden-fleece (*Ericameria arborescens*) was also used to make Mono granaries and the cross-sticks were of *Cercocarpus betuloides* (Clines 1997 unpublished field notes; Anderson 2009).

Deerweed (*Acmispon glaber*) was an important thatch material for Ohlone and Chukchansi structures and Mono acorn granaries (Bocek 1984; Hudson n.d.; N. Turner Behill, Anderson unpublished field notes 2004). The Chukchansi used Spanish clover as a thatch for structures and Foothill Yokuts used brush of an unidentified species for thatching dwellings (Gayton 1948a; Hudson n.d.).

Drift fences were built of *Adenostoma fasciculatum* or unidentified brush from chaparral in the Sierra foothills. The Mono built a drift fence of brush in the shape of a "V," with each wing about a kilometer long. About 30 people would drive mountain quail (*Oreortyx pictus*) to the fence, and the birds would run along it looking for openings in which the Mono had put snares equipped with nooses made of milkweed. The Sierra Miwuk made a drift fence of *Adenostoma fasciculatum* 1 km

(0.6 mile) long in thick brush for hunting quail. Nets for hunting rabbits were 274–366 m (300–400 yards) and held in place by forked *Adenostoma fasciculatum* sticks (Barrett and Gifford 1933; Aginsky 1943).

4.4 Useful Animals of the Chaparral

The chaparral of California occupied a central place as hunting terrain for birds, reptiles, and both large and small mammals (Wallace 1978; Anderson 2009). Black-tailed deer, black bears, grizzly bears, and mountain lions were often hunted in chaparral or the grassland at its margins (Loud 1918; Anderson 2009). Hunters might stalk them with bows and arrows or set up different types of snares, deadfalls, or pitfalls to capture the animals.

California Indians were particularly fond of eating venison and hunted deer with bows and arrows or spears. In addition to meat, these animals provided many kinds of products: skins for clothing, tallow for paint, medicine for dressing wounds, antlers for glue and pressure flaking tools, the liver and blood for arrow poison, bones for fish hooks, fish spear tips, and basketry awls, sinew for bows, and brains for tanning hides (Gifford 1932; Barrett and Gifford 1933; Voegelin 1938; Gayton 1948a, b; Latta 1977). Bears hibernating in dense chaparral were roused and killed by Native American hunters to provide food, skins for blankets, capes, and sandals (Gifford 1932; Barrett and Gifford 1933; Gayton 1948a, b; Kroeber 1976; Librado 1979). Some tribes, such as the Sierra Miwuk, ate the meat of grizzly bears and used the claws as a charm in ceremonies (Barrett and Gifford 1933; Hudson n.d.). Mountain lions (*Puma concolor*) were valued for their meat, their skins were made into clothing, blankets, and quivers and their bones were used in gambling games (Barrett and Gifford 1933; Voegelin 1938; Gayton 1948a; Latta 1977).

All of these large mammals relied strongly on the chaparral and the ecotones between chaparral and oak woodland and chaparral and grassland, as habitat. Deer found many of their favored foods in the young chaparral vegetation, black bears and grizzly bears often used the chaparral for denning, and mountain lions prowled chaparral for prey.

A number of other, smaller mammals that live in the chaparral were valued by many tribes. The fur of gray fox (*Urocyon cinereoargenteus*) was used for quivers, breech clouts, cloaks, and blankets, and the meat was eaten (Hudson 1901a; Goddard 1903; Gayton 1948a, b; Merriam 1967; Latta 1977; Librado 1979). The Sierra Miwuk ate the meat of coyotes (*Canis latrans*) and used their skins for pillows, quivers, and blankets (Barrett and Gifford 1933; Voegelin 1938). The Yokiah Pomo made bags for carrying *Nicotiana* spp. out of skins of long-tailed weasels (*Mustela frenata*), which used chaparral of the Coast Ranges as habitat (Merriam 1955). Audubon's cottontail (*Sylvilagus audubonii*), brush rabbits (*Sylvilagus bachmani*), and black-tailed jack rabbits (*Lepus californicus*), all denizens of chaparral, were hunted and trapped to provide food, skins for blankets and clothing, bones for whistles, and toes and claws for charm necklaces (Barrett and Gifford 1933; Drucker

1937; Voegelin 1938; Gayton 1948a, b; Merriam 1967; Librado 1979). Foothill Yokuts, Mono, and Tubatulabal people ate the meat of dusky-footed woodrats (*Neotoma fuscipe*) (Voegelin 1938; Gayton 1948a, b) and the Foothill Yokuts ate the meat of Botta's pocket gophers (*Thomomys bottae*) (Gayton 1948a; Kroeber 1976) and California ground squirrels (*Spermophilus beecheyi*) (Gayton 1948a, b; Kroeber 1976; Theodoratus and Parsons 1980). The Mono ate the meat of American badgers (*Taxidea taxus*) and the Sierra Miwuk used badger skins for quivers in ceremonial dances (Barrett and Gifford 1933; Gayton 1948a).

A number of birds that frequent chaparral were valued by tribes for many uses. Common raven (*Corvus corax*) feathers were used to make cloaks and skirts for ceremonies, doctor's outfits, and headdresses (Hudson 1901a; Barrett and Gifford 1933; Gayton 1948a). The feathers of yellow-hammers formed the headbands of Wappo dancers (Beard 1979). Feathers from greater roadrunners (*Geococcyx californianus*) were used in Sierra Miwuk arrows and Mono headdresses (Hudson 1901b; Barrett and Gifford 1933; Gayton 1948a). The Sierra Miwuk ate the meat of mourning doves and snared large numbers of California quail (*Callipepla californica*) so that they could use their feathers to decorate basketry (Barrett and Gifford 1933; Gayton 1948a; Spier 1978). All tribes ate quail meat, the Miwuk hunted quail during migration and killed enough birds to store them over the winter (Barrett and Gifford 1933). The red-tailed hawk (*Buteo jamaicensis*) was hunted for its valuable feathers, which were placed on arrows, sewn into ceremonial clothing, and assembled into fans for fanning fires (Barrett and Gifford 1933; Gayton 1948a; Latta 1977). The Sierra Miwuk used turkey vulture (*Cathartes aura*) feathers to make head ornaments, cloaks, skirts, and dance sticks, the Foothill Yokuts used them to make fire fans for hunting and for fanning coals under foods being cooked or roasted (Barrett and Gifford 1933; Gayton 1948a). Golden eagle (*Aquila chrysaetos*) down and feathers were used in ceremonial regalia such as belts, plume sticks, and dance skirts (Barrett and Gifford 1933; Voegelin 1938; Gayton 1948b; Hudson n.d.). The feathers fanned fires and were used in war arrows, and eagle bones were used in fish spears and panpipes (Hudson 1901b; Gayton 1948a). Foothill Yokuts groups used golden eagles for a variety of purposes: the feathers were important ceremonially, the leg made a container, leg bones were fashioned into whistles, and the tallow served as a salve and binder for face paint (Gayton 1948b).

Many reptiles that frequent chaparral were useful (Basey and Sinclear 1980). The western rattlesnake (*Crotalus viridis*) provided medicine and food for the Sierra Miwuk, a rheumatism remedy for the Chumash, and arrow poison for the Tongva (Barrett and Gifford 1933; Johnston 1962; Librado 1979). Gopher snake (*Pituophis melanoleucus*) meat was eaten by both the Sierra Miwuk and Chukchansi (Barrett and Gifford 1933; Gayton 1948a). The Wintu removed the bright red bellyskin of a red-bellied snake that inhabits chaparral (probably ring-necked snake [*Diadophis punctatus*]) and wrapped it in a spiral around their bows as a decoration (Merriam 1955).

Insects that live part or all of their life-cycles in chaparral formed an important part of California Indian economies by serving as food. Some of the most important insects used for food were June or rain beetles (*Pleocoma fimbriata*, *P. hoppingi*, *and P. tulerensis*) (Fig. 4.7), tortoiseshell butterflies, sphinx moths (*Hyles lineata*), and

Fig. 4.7 From left to right: male and female rain beetles (*Pleocoma tulerensis*) an important food source of tribes in the central and southern Sierra Nevada that live their entire life cycle in chaparral. Specimens in the Bohart Museum of Entomology, UC Davis collections. Photo by Kat Anderson 2009

red-legged grasshoppers (*Melanoplus femurrubrum*) (Hovore 1979, 1998; Anderson 2005b). Insects formed an ideal supplemental food source because they are high in protein, could be dried and cached over the winter in large quantities, and were considered a delicacy (Barrett and Gifford 1933; Bean and Saubel 1972; Beard 1979).

Insects were especially attractive as a food source because many are relatively easy to capture during at least one of their life history stages: the larval and pupal life stages move slowly or not at all, and the adults of certain species concentrate in large numbers in cyclical events called "outbreaks" (Powell 1972). The adults of some species can be strategically "herded" to a destination by many people sweeping the ground with branches or by setting a fire to direct their course for capture.

Tribes also utilized chaparral insects for ceremonies. One of the most important in this regard was the ceanothus silk moth (*Hyalophora euryalus*) (Peigler 1994; Collins 2011). The inner lining of each moth's cocoon (which protects the pupal life stage) was removed and some small pebbles, sand, or seeds were placed inside the hard outer shell. Several of these cocoons were tied to stick handles to make loud rattles. These accompanied various kinds of ceremonies such as the Bear Dance and the Shamans' Contest and were used in curing illness and pain and to prevent snakebites (Dixon 1905; Gayton 1948a; Kroeber 1976). The chaparral host plants for this moth include *Ceanothus* spp., *Arctostaphylos* spp., *Cercocarpus betuloides*, *Rhamnus crocea*, and California coffee berry (*Frangula californica*) (Tuskes et al. 1996).

4.5 Native Management of Chaparral

The emergent qualities of pre-EuroAmerican chaparral plant communities that made them so important to indigenous subsistence economies and cultures, i.e., their biodiversity, productivity, and abundance, were not merely products of natural ecological processes. Native people deliberately manipulated chaparral to enhance these qualities. They did so because chaparral contained and supported so many useful species, but the converse was in a sense true as well. Chaparral supported an abundance of many useful species *because* of Native management. Through creation of landscape mosaics of chaparral and herbaceous communities, this management conferred a degree of spatial, structural, successional, and biotic diversity that exceeded what would have been the case in the absence of human intervention (Anderson and Rosenthal 2015).

As we noted earlier in the chapter, fire was by far the most important management tool used in chaparral plant communities. Its impacts were spatially widespread, multi-faceted, quickly manifested, ecologically consequential, and probably long-lasting. Further, fire had a disproportionately beneficial effect on the chaparral plant species most useful to Native people. In part, this was due to the adaptations of useful chaparral species to predictable disturbance by fire. Regular burning allowed them to enhance reproduction, reduce competition from other plants, and maintain them in a state of high growth and production postfire. Because of fire's pre-eminent status for Native land managers and because fire is the factor of greatest managerial relevance today, it will receive the most attention in the following discussion of Native management of chaparral.

It is well established by various lines of evidence that Native people did indeed burn chaparral plant communities with regularity and conscious intent. Nevertheless, it is helpful to examine this evidence in depth, because in addition to establishing the use of fire in indigenous management, it informs how, when, why, and where fire was used in California chaparral.

4.5.1 The California Landscape Was Pyrogenic at Euro-American Contact: Archaeological Evidence

We know that California has been peopled for many millennia. Archeological evidence suggests that humans began to occupy certain areas of California more than 12,000 years ago (Erlandson et al. 2011; Rosenthal and Fitzgerald 2012). Shortly after the demise of the North American mega-fauna, evidence for human occupation in California is widespread (Rosenthal and Fitzgerald 2012). The density of pre-Columbian people in California was, as is the case with contemporary populations, many times greater than that of most other parts of the West (Krech 1999). The native population in California is estimated to have been over 300,000 (Cook 1978), much greater than, for example, the 25,000 estimated to have lived in Montana (Baker 2002). Indians were widely dispersed along the California coast and throughout the coastal foothills and valleys, averaging 1–3 persons per km^2 (247 acres) Cook 1951). The regions that are today the best agricultural areas correlate with very high Indian population densities at Euro-American contact. For example, in Courtland, south of Sacramento, there were an estimated 6.4 people per km^2 at contact (Anderson and Wohlgemuth 2012). In the Santa Barbara region the Chumash achieved a density of 7.7 people per km^2 (Milliken 2006; John Johnson pers. comm. 2008). These densities are much higher than those in other areas considered densely populated in pre-historic times, such as the area where the Kongkandji lived in Australia (1.9 people per km^2) and where the Puyallup lived in Washington (also 1.9 persons per km^2). Some California tribes are believed to have achieved, at the time of Euro-American contact, the greatest population densities of any Native group in North America (Ubelaker 2006), and perhaps any hunter-gatherer group on earth (Kelly 1995).

Archaeological evidence suggests that virtually every part of the California landscape was inhabited, at least part of the year, including the Mojave Desert and alpine Sierra Nevada (Jones and Klar 2007). Permanent settlements were typically established in well-watered valleys and along upland rivers and streams with between 10 and 250 individuals (Kroeber 1976; Heizer 1978). In these politically autonomous lineages, families lived in closely spaced houses on cleared sites. Land use was intensive from the valley bottom up to the crest on each side of the drainage (Shipek 1993). Food resources varied from year-to-year in accordance with rainfall and thus families also maintained resource-extraction zones at scattered locations beyond their home valleys but typically within a half-day walk. This "home range" was jealously guarded (Beals and Hester 1974), and inter-tribal conflicts often occurred in accordance with resource fluctuations (McCorkle 1978). Many violent deaths during the late Holocene have been interpreted as resulting from population pressures (Fiedel 1992) and most accounts of warfare list resources as the primary reason for conflict (James and Graziani 1991). It appears that people were living at or near the carrying-capacity of their local environments (Baumhoff 1981).

By the early Holocene, broad-spectrum economies based on the exploitation of large and small mammals, fish, birds, shellfish, and nuts and seeds were widely established throughout California (Rosenthal and Fitzgerald 2012). One archaeological signature of a wide diet breadth is the common occurrence of plant processing tools. Handstones and millingslabs along with a more general set of pounding, chopping, and scraping tools are found at most Early Holocene sites throughout a broad range of environmental settings in western California (Rosenthal and Fitzgerald 2012).

While paleontological, fire scar, and archeological studies suggest that Indians were burning the vegetation to some extent as early as many millennia ago (Stephens et al. 2007; Klimaszewski-Patterson et al. 2015), evidence of technological innovations, greater diet breadth, and increasing complexity of social organization in the late pre-historic sequence makes archaeologists suspect that fire was increasingly used in California as a vegetation management tool, as part of an overall strategy for economic intensification (Hammett 1991; Cuthrell 2013; Lightfoot et al. 2013a, b). Fire scar studies along north-coastal California indicate late Holocene fire regimes with fire-return intervals at a frequency much greater than what would have been possible from lightning-strike ignitions alone (Stephens and Fry 2005; Stuart and Stephens 2006). Abrams and Nowacki (2008) propose that by the time Euro-Americans arrived in the New World, many of the landscapes they encountered were pyrogenic—products of both human- and lightning-caused fires.

4.5.2 Native People Managed Chaparral with Fire: Historical and Anthropological Evidence

Numerous early European explorers took note of the mosaic of grasslands, shrublands, and woodlands they passed through or observed from just offshore, correctly inferring a human influence over its inviting pattern. The coast north of Cape Mendocino featured, according to Vancouver, "a great variety of hills and dales, agreeably interspersed with wood-land, and clear spots, as if in a state of cultivation" (Lamb 1984). Explorers, missionaries, and early white settlers also directly witnessed Indian burning in many California landscapes, either learning from the Indians or surmising that the purpose was to clear the brush (Bolton 1927). "In all of New California from Fronteras northward," Spanish explorer José Longinos Martinez reported in 1792, "the gentiles have the custom of burning the brush" (Simpson 1938).

From the early 1900s to the early 1960s, a string of anthropologists under the tutelage of Dr. Alfred Kroeber and other faculty of the University of California, Berkeley conducted field research with many tribes, recording the widespread practice of Indian burning to reduce the brush, either in current practice or in tribal memory. For example, anthropologist Llewellyn Loud (1918) noted that the grasslands within Wiyot territory in northwestern California were kept open and free of brush with Indian burning, and wrote that the Wiyot's use of fire was of "incalculable value" in encouraging the grasslands to produce not only "vegetable products, but also...game". Anthropologist Omer Stewart's field notes from 1935 have many entries from multiple Pomo consultants who spoke of deliberately setting fires in California's Coast Ranges and valleys for such purposes as encouraging clovers, fostering wildflowers with edible bulbs and seeds, eliminating brush, enhancing grass, and driving game and grasshoppers. Anthropologist Julian Steward (1938) recorded of the Owens Valley Paiute that "The brush in basins in the hills near the winter villages was burned and *Mentzelia* and *Chenopodium* seeds were broadcast. There is no question that this practice was native."

A second wave of anthropologists, ecologists, and ethnobiological researchers conducted interviews in the late 1970s into the 2000s with Native elders who still retained specialized local forms of knowledge about burning practices. They found that in addition to having observed fires being set by their parents or grandparents, often in chaparral, some elders had even burned patches of vegetation on the sly up until recent times. With long-term ties to the ecology of the places they have lived, these indigenous consultants have made a significant contribution to regional fire histories (Knudtson 1977; Peri et al. 1982; Shipek 1981, 1993; Heffner 1984; Anderson 2005a; Lake 2007).

While the majority of the ethnographic evidence of burning in chaparral is from central and northern California, tribes in southern California used many of the same chaparral plants for the same purposes. For example, *Rhus aromatica* for basketry, *Nicotiana* spp. for ceremonies, *Eriodictyon* spp. for medicine, *Acmispon glaber* for thatch, *Salvia columbariae*, *Calandrinia ciliata*, *Dichelostemma* spp., and

Calochortus spp. for food, and *Muhlenbergia rigens* for basketry. It is difficult to imagine these fire-adapted plants yielding sufficient quantities of useful products in the absence of regular burning.

4.5.3 Native Burning Shaped the Distribution of Chaparral on the Landscape: Biogeographic Evidence

Some researchers have concluded that the practice of burning chaparral and coastal sage scrub repeatedly to affect localized type-conversion to grassland and to maintain grass/shrub mosaics was widespread (Knowles 1953; Baumhoff 1981; Anderson 1994; Anderson and Moratto 1996) (Fig. 4.8).

The contemporary pattern throughout the central and southern Coast Ranges of California is a mosaic of chaparral, sage scrub, grassland, and oak woodland. While the boundaries of these vegetations may seem timeless, ecological analyses have concluded that disturbance has played a prominent role in their formation. Specifically, some researchers believe these patterns may have been initiated by Native Americans and perpetuated by Spanish/Mexican and American settlers (Keeley 2002). In general, the vegetation patterns are consistent with the hypothesis that Native Americans utilized high fire-frequency to drive type-conversion from woody shrublands/woodlands to herbaceous associations.

Fig. 4.8 Chaparral burned at short intervals thins out chaparral and increases herbaceous growth, which increases flammability and is conducive to repeat burns before the woody vegetation has had time to recover (photo by Jon Keeley)

Fig. 4.9 Contemporary landscape mosaic of grasslands and chaparral in central Coast Ranges of California. Cooper (1922) hypothesized this pattern derived from repeated burning in the valleys and a diminishing influence of high fire frequency further into the range. Image from Google Earth

Wells (1962) examined the substrate and slope aspect characteristics associated with grassland, shrubland, and woodland vegetation in the San Luis Obispo Quadrangle of the central coast. Grasslands, all of which were dominated by non-native annuals, were well represented on at least half a dozen different substrates and these same substrata also supported abundant woody vegetation. Indeed, he commonly found grassland and shrubland or woodland juxtaposed side-by-side on the same soil type. He hypothesized that some time after humans entered California in the late Pleistocene, their intentional acceleration of fire frequencies initiated a long process of type-conversion of ligneous (woody) associations to herbaceous communities. These conclusions are supported by many other studies, as summarized in Keeley (2002).

Cooper (1922) made some profound observations about vegetation patterns in the Coast Ranges of California (e.g., Fig. 4.9) and ascribed historical Indian burning as the key determinant.

It is worth quoting him at length:

> "[M]ountains are controlled by chaparral and the plains by grasses. The character of the transition zone between the types is as follows: The first hills are as a rule entirely grass covered, though even on these, and occasionally out upon the valley-floor, are patches of chaparral. These show absolutely no correlation with altitude, slope-exposure, or soil type. Their edges are sharp and the shrubs are uniformly developed throughout. They are obviously remnants…. Penetrating farther into the mountain mass, the chaparral patches become more and more numerous…. In short, everywhere near the valleys and plains the hills are grass, while in the depths of the ranges they are covered with scrub. The larger the extent of

> the mountain mass the greater is the central area of chaparral. Conversely, a small isolated area of hills, though of considerable altitude, may have none. This arrangement is so nearly universal where chaparral and grassland meet that specific examples are hardly necessary."

Cooper (1922) concluded that the mechanism driving these patterns was fire. If fire occurred with great frequency, it favored grassland at the expense of the chaparral, and yearly burning would inevitably destroy the brush completely and prevent invasion by it. "The patchy transition between grassland and chaparral is also explained," he wrote, "for fires started in the valleys, where most of the Indian population lived." These Indian-set fires, Cooper surmised, "would spread into the surrounding ranges in various directions and to varying distances. Certain areas would escape, and these would be larger and more mountain systems, where paucity of population would reduce the starting of fires to a minimum" (Cooper 1922).

"The most convincing proofs of former control of present-day grassland by chaparral," Cooper wrote, "are the frequent remnants [of chaparral]." These remnants are "sharply limited patches in the midst of other vegetation, in which *Adenostoma* is usually most prominent." Summarizing the results of using his method, which Cooper claimed "has in some cases been corroborated by historical testimony", he wrote that "it has been possible to demonstrate that dense chaparral once covered extensive areas which are now grassland."

Other early observers noted similar patterns in the northern Coast Ranges (Sterling 1904). In the southern Tehachapi Mountains, Bauer (1930) noted the following: "In the grassland the islands of shrub growth, with sharp boundaries and uniform vegetative composition, indicate a more or less remote fire or fires… It is reported that in aboriginal days the natives intentionally burned the rank herbaceous vegetation yearly."

Working in San Diego County, Dodge (1975) concluded that localities described in the diaries of early Spanish explorers as grasslands are today covered by shrublands, presumably due to the exclusion of Indian burning. Other researchers have reached the same conclusion: Native Americans maintained the southern California landscape in a mixture of grassland and shrubland through repeated burning (Aschmann 1959). Timbrook et al. (1982) came to a similar conclusion about the impact of Chumash Indian burning in the Santa Barbara region.

At the northern end of the central coastal region around the San Francisco Bay there are numerous reports of relatively recent shrub re-establishment into grasslands following the elimination of grazing and burning due to the incorporation of these areas into parks and reserves (McBride and Heady 1968). More vigorous suppression of natural fires is often invoked to explain shrub "invasion," but since natural lightning fires are rare in the region (Keeley 2005), it seems more probable that invasion is due to enhanced prevention of anthropogenic fires. It is likely that much of the grassland in this area originated with Native American burning, as this region was densely populated with over 2000 inhabitants spread across as many as 100 village sites (Cook 1951).

The idea that chaparral and other shrubland vegetation has spread into areas formerly maintained as grassland by Indian burning has gained support in recent decades with the discovery of numerous former Indian habitation sites in areas of dense chaparral. Obscured by the chaparral for more than a century, these sites have been revealed by wildfires burning through the thick chaparral. The 1995 Saddle Fire in Sequoia National Park, the 2003 Cedar Fire in Cuyamaca Rancho State Park, the 2013 Springs Fire in Point Mugu State Park, and the 2016 Scherpa Fire in Santa Barbara, along with others, have all revealed various kinds of archaeological sites, including roasting pits for yucca, milling stations, shell middens, and shell scatters (Nathan Stephenson pers. comm. 1998, Schneider 2009, Barbara Tejada pers. comm. 2016). These sites, located in all types of chaparral terrain, were certainly not established by native people when the immediate surroundings were covered with chaparral vegetation. Tribes must have burned off the chaparral to make suitable conditions for daily activities and living. However, it is likely that patches or tracts of chaparral were maintained nearby, because this vegetational diversity would have maximized the availability of important resources. Once the Native peoples left the sites and regular burning ceased, the nearby chaparral re-invaded.

How much of the vegetation physiognomy was altered by Native American burning? A starting point would be to look at the current distribution of grasslands in the 10 coastal counties from Monterey southward. Today they cover almost two million hectares (~five million acres) or 25% of the landscape. They are dominated almost entirely by non-native annuals, and less than 1% of this grassland landscape has significant patches of native perennial bunchgrass (Huenneke 1989). If we accept the conclusions of Cooper (1922), Wells (1962), and Hamilton (1997) that the origin of much of these non-native grasslands lies in anthropogenic type-conversion from shrubland/woodland, and assume minimal expansion of grassland since EuroAmerican settlement, then perhaps one quarter of the indigenous landscape was altered by fire-driven type-conversion of shrublands and chaparral.

4.5.4 What Native People Desired to Accomplish by Burning Chaparral

We know from the evidence summarized above that Native people began using fire many thousands of years ago to shape the landscape to their advantage not long after their arrival in what is now California. By the time Euro-Americans first arrived, the Natives had been burning chaparral for many centuries, if not longer, in order to intensify their exploitation of its resources. It is useful, then, to explore in greater detail exactly how burning accomplished this overall goal. We can do so by looking at specific resources—the useful chaparral plants and animals described earlier in this chapter—and examining how burning made them more useful by increasing their quantity or enhancing their quality.

Tribes in California were very much aware of the different things fire could do, depending on where, how, and when it was used, and they used this knowledge to achieve specific objectives. The ethnographic and historical literature is full of examples of Indians describing their reasons for burning. For instance, how burning a particular hillside every few years was necessary for maintaining the health of a patch of *Cercis occidentalis*, for example, or that the *Salvia columbariae* would decline if that valley over there was not burned every few years or so. Such evidence indicates that over the many centuries during which they exploited the abundant biotic resources of the chaparral, the indigenous people learned a great deal about the biological needs of the plant and animal species on which they depended, enough to allow them to manage each species with burning and other methods so that it would be available and flourish.

If we put the goals of burning that relate to management of plant and animal resources together with those connected to more general goals, such as "to keep down the brush," we come up with seven distinct categories (Anderson and Rosenthal 2015). In using fire, Native people sought to: (1) enhance the growth and production of plants with edible above-ground parts (seeds, greens, and berries), (2) enhance the growth and production of plants with edible below-ground parts (corms, bulbs, tubers, and rhizomes), (3) promote the growth of basket-weaving and cordage materials, (4) maintain in optimal condition the habitats used frequently by game birds and mammals, (5) control pathogens and insect predators of valued plants, (6) increase water resources, and (7) keep areas open to improve accessibility and reduce the chance of catastrophic fire.

Although a single fire might achieve several different objectives at once, and some of the objectives were overlapping in the sense that realizing one necessarily meant realizing another, the evidence indicates that Native people had different and distinct desirable outcomes in mind when they set fires. Below, each of these seven objectives is discussed in turn.

1. Enhance the growth and production of plants with edible above-ground parts (seeds, greens, and berries)

   Certain chaparral lands were cleared by burning the shrubs right down to the ground. With frequent enough burning these areas were type-converted and managed for patches of herbaceous plants used for foods and medicines. For example, many of the edible seed resources used by Native Americans were annuals that were abundant for a short period after fire. These included blow-wives (*Achyrachaena mollis*), *Salvia columbariae*, farewell-to-springs (*Clarkia biloba*, *C. purpurea* subsp. *viminea, C. unguiculata*, *C. rhomboidea*, *C. williamsonii*), *Calandrinia ciliata*, and tarweeds (*Centromadia fitchii*, *Madia elegans*, *M. gracilis*, *M. sativa*).
2. Enhance the growth and production of plants with edible below-ground parts (corms, bulbs, tubers, and rhizomes)

   As good carbohydrate sources that could be stored for long periods of time, "root foods" such as *Dichelostemma* spp., *Calochortus* spp., wild onions (*Allium* spp.), *Chlorogalum* spp., sanicles (*Sanicula* spp.), and *Perideridia* spp., were critical food resources. Burning of the chaparral served these plants well for the same reasons it benefited annuals with edible seeds: it created the open habitat they needed, reduced competition, released nutrients, and encouraged vigorous growth (Anderson and Lake 2016). In addition to using fire where these plants grew, the Native people also harvested the under-ground parts in a way that actively promoted the plants' asexual reproduction and enlarged their populations. The roots or bulbs were dug up with sticks, which loosened the soil. Only the largest and most mature parts were removed for consumption, immature plants, parts of roots and rhizomes, and the asexual propagules of bulbs were left in the soil and often replanted with care, sometimes outside of the established population so that the patch would grow in size. Small trees, shrubs, and other plants that might compete with the food plants were pulled up and removed.

3. Promote the growth of basket-weaving and cordage materials

   Islands of chaparral within grassland and the diverse ecotones between chaparral tracts and grasslands contained *Cercis occidentalis*, *Rhus aromatica*, *Ceanothus integerimus*, *Fremontodendron californicum*, *Prunus virginiana var. demissa*, *Prunus emarginata*, and other shrubs that were managed specifically as sources of wattling material. Fire and pruning encouraged the plants to produce straight and flexible shoot growth, which was used for basketry, cordage, drying racks, fish weirs, housing materials, tools, household utensils, digging sticks, and many other items (Anderson and Rosenthal 2015). Patches of *Muhlenbergia rigens* in chaparral were burned in the fall or winter every 2–5 years to remove dead material and increase flower stalks for the foundations of coiled baskets (Anderson 1996).

4. Maintain in optimal condition the habitats used frequently by game birds and mammals

   Using fire to benefit game animals was always a major part of Native land management, because these animals were so important to Native economies and cultures. Unlike the management of plant-based resources, however, the management of deer, bear, mountain lion, rabbits, quail, mourning doves, and other animals was not direct. Native people aimed at keeping the populations of these animals at optimal sizes and in optimal health by managing the habitats and vegetation on which the animals depended for food, bedding, and cover and by keeping the overall landscape open enough to facilitate their ability to move and migrate. Fire, of course, was the most powerful tool for doing this.

   When Indians set fires to the chaparral lands to manage habitat for game birds and mammals, they actually accomplished three distinct but overlapping goals at the same time. They wanted to make hunting easier by reducing the vegetation that might hide animals or deter the pursuit of wounded prey, they wanted to make the habitats more attractive to the game animals so that they would congregate there more frequently, and they wanted to maximize the amount of food available to the animals so that their populations could be as large as possible.

   The hypothesis that Native Americans utilized fire to open up dense shrublands to increase deer and other animal resources is well supported by contemporary game management practices (Lawrence 1966). We know from studies of deer management that undisturbed stands of chaparral are nearly impenetrable and the new growth in older stands is commonly produced out of reach of deer. Indeed, it was this observation by wildlife managers that led to the widely popular myth that old chaparral becomes senescent (Keeley 1992). Immediately after fire the food available for deer from shrubs increases 40 fold or more (Hendricks 1968) and the majority of species comprising the temporary postfire flora are also important food resources for deer (Cronemiller and Bartholomew 1950). Herds increase several-fold in postfire environments, although the effect is short-lived, as the vegetation closes in after about 5 years (Biswell 1961). Repeated burning produces a mosaic of grassland and shrub patches, which is ideal habitat, and results in a permanent three- to five-fold increase in deer herds (Taber 1956). Other important resources such as California quail, brush rabbits, and mourning doves increase several fold in open brush and grassland mosaics compared to undisturbed chaparral (Biswell et al. 1952). Jack rabbits, which completely avoid dense shrublands, will expand into these the chaparral-grassland mosaics created by burning. Opening up these shrublands would have been crucial to Native American exploitation of these animal resources because approaching prey undetected would have been unlikely in undisturbed shrublands, and lack of maneuverability would have prevented the use of bows and arrows or the boomerang-like throwing stick (McCawley 1996).

5. Control pathogens and insect predators of valued plants

   Many culturally significant plants that occur in chaparral are susceptible to insects and diseases and if attacked are rendered useless for basketry, medicines, cordage and other items (Sinclair et al. 1987). Although native people were not aware of pathogenic microorganisms as such, and may not have completely understood the life cycles of insect "pests," they did know that fire was useful for limiting the damage to valued plants caused by insects and diseases. The ethnographic literature contains many examples of elders claiming that fire or smoke was good for "getting rid of" pests. Modern research corroborates such claims. For example, burning is thought to be an effective control for a pathogen called *Passalora* that blackens the leaves, pods, and stems of showy milkweed, an important plant for cordage, food, and medicine, and for the native pathogen called black knot (*Apiosporina morbosa*) on *Prunus virginiana* var. *demissa*, a plant used for food and basketry (David Rizzo, pers. comm. 2013).

6. Increase water resources

   Vegetation is known to affect the flow, quantity, and recharge of groundwater through various mechanisms. Mature chaparral vegetation, with its deep roots and large leaf surface area, appears to remove more water from the soil through transpirational losses than the types of herbaceous vegetation that would have replaced chaparral in the presence of Indian burning. Native people observed that springs and seeps were more productive when there was less brush. When patches of chaparral were burned off, the water table rose and water sources flowed more strongly or reappeared. This was an important effect of fire because the availability of water affected landscape scale interactions, including where human villages might be located and the migration patterns of large mammals.

   Ethnographic research has found that Central Sierra Miwuk elders remember the connection between available water and burning of brush. "The Indians [Central Sierra Miwuk] used to keep the brush burned off," Miwuk elder Louis Williams told anthropologist Gary Maniery in 1980, "thus making the springs useful and productive" (Maniery 1987). Similarly, North Fork Mono elder Rosalie Bethel (pers. comm. 1991) remembered that "burning brush helped to save water." Experimental research on small chaparral watersheds in Arizona and California show a marked increase in the flow of springs and streams when brush is converted to grassland with controlled burns (Biswell and Schultz 1958; DeBano 1983; Biswell 1989).

7. Keep areas open to improve accessibility and reduce the chance of catastrophic fires

Chaparral was so important to Native people for hunting, harvesting plant food, gathering basketry and cordage materials, and so on that they often chose to live in close proximity to it. Maintaining this kind of close relationship required management focused on the spatial attributes of the vegetation. Native people needed to be able to move through chaparral to hunt and to access its resources, and areas of dense brush could not be located too close to villages because of the danger of out-of-control wildfire. Therefore, chaparral was often burned for the general purposes of keeping it open, maintaining a network of trails, and eliminating the brush that might carry a catastrophic fire. In the ethnographic literature, there are many examples of native informants speaking about burning for the purpose of keeping the landscape open and preventing fires that might burn trees or villages.

North Fork Mono elder Rosalie Bethel explained this rationale for burning to one of the authors in 1991:

> "I'm going by what the elders told me happened in the 1800s. Burning was in the fall of the year when the plants were all dried up when it was going to rain. They'd burn areas when they would see it's in need. If the brush was too high and too brushy it gets out of control. If the shrubs got two to four feet in height it would be time to burn. They'd burn every two years. Both men and women would set the fires. The flames wouldn't get very high. It wouldn't burn the trees, only the shrubs. They burned around the camping grounds where they lived and around where they gathered. They also cleared pathways between camps. They burned in the valleys and foothills" (pers. comm. 1991).

Based on his ethnographic work, Duncan (1964) described what the northern Sierra Nevada foothills may have looked like before the Gold Rush:

> "There was considerably less chaparral and underbrush, due to the Maidu practice of burning off the areas near where they lived each fall and winter. They preferred an open, grassy, oak savannah habitat for several reasons. Open country is much easier to travel in than country with thick underbrush as it is easier to find game and harder for enemies to sneak up on a camp. More bulbs and greens grow in such an environment, and it is easier to gather acorns on bare ground."

4.6 Impacts of Native Use of Fire on Chaparral

While there were a multitude of motivations for Native people to use fire and plenty of evidence for its use, there is some debate on the impact of Indian fire management practices on the distribution of chaparral vegetation. Stewart (1956) was convinced that fires set by Indians were of the utmost importance in determining many landscape patterns throughout the western hemisphere, and many researchers today share his perspective and assert its relevance for understanding chaparral in

California. Indeed, there are reasons to believe that these shifts in fire regimes initiated by the earliest inhabitants in North America were transformative events that greatly altered landscape patterns (Pinter et al. 2011). Representing another side of the debate, Vale (2000) contended that lightning-ignited fires were so frequent in western North America that whatever additional burning was done by Native peoples altered vegetation in only limited areas. This view is supported by Jones and Hadick (2016). What this difference in perspective tells us is that some researchers remain unconvinced that Native people, as opposed to the "natural" force of lightning strikes, could have controlled the fire regime in chaparral.

So let us review what is known about human-versus lightning-caused fire in California. In the absence of human influence, the natural fire regime in California varied both spatially and temporally. The Coast Ranges were ignition-limited and experienced century-long fire-free periods, in contrast to interior montane landscapes where annual lightning ignitions generated more frequent and more predictable fires (Keeley and Safford 2016) (Fig. 4.10). In the central coastal region, modeling studies conclude that fire-return intervals from just natural lightning ignitions were substantially longer before Native Americans arrived on the scene compared to after (Greenlee and Langenheim 1990). Fossil pollen from the central Coast Ranges has also been interpreted as providing evidence for burning by Indians (Mensing 1998; Anderson et al. 2015). Other circumstantial evidence of Native American influence is from charcoal deposition studies that show that the frequency of large fires in the front range of the Santa Ynez Mountains of Santa Barbara County prior to EuroAmerican colonization was similar to the contemporary period (Mensing et al. 1999). Today humans are responsible for the vast majority of ignitions in this region (Keeley and Syphard 2018), suggesting that Native Americans likewise were a dominant source of ignition in pre-history.

So, on the chaparral dominated landscapes of central and southern California at least, natural ignitions were few and far between. Further, much of this was a densely populated landscape, far denser than the average Native American density

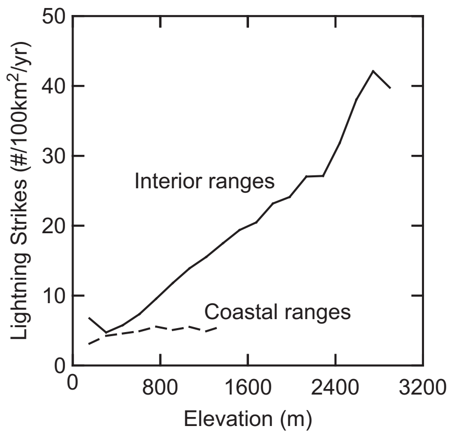

Fig. 4.10 Distribution of lightning strikes in interior versus coastal ranges of California illustrating the ignition-limited characteristic of this landscape dominated by Native peoples (from Keeley 2006)

across western North America. It is very unlikely that California tribes relied solely upon natural fires to generate the postfire herbaceous resources they needed to support this dense population because natural fires in the Coast Ranges occur at long intervals, perhaps only once or twice a century (Keeley and Syphard 2018). Thus, we are confident in arguing that Indian burning significantly decreased the fire-return interval relative to the "natural" background interval, altering chaparral shrublands and associated vegetation. At the same time, we acknowledge that impacts may have varied locally depending on population density, topography, elevation, species composition, tribal culture, access to non-chaparral based food sources like inter-tidal invertebrates, and other factors.

So exactly how did Indian burning alter the chaparral dominated landscapes of California and affect the distribution of chaparral vegetation? In considering this question, it is important to keep in mind that Native people wielded fire with intention, in order to realize specific objectives, and guided their use of this powerful tool with in-depth knowledge about how fire affected plant growth. The many objectives that Native people sought to realize from burning chaparral dominated landscapes indicate that what they wanted to achieve, in terms of overall landscape physiognomy, was a mosaic of open, herbaceous dominated plant communities interspersed with large and abundant patches of woody chaparral vegetation. This type of heterogeneous landscape, with its structural and ecological diversity and large amount of ecotonal boundary, would have maximized productivity and biotic diversity and satisfied native requirements for accessibility and habitability at the same time. This could be achieved only with the skilled use of fire.

Repeated burning by Indians would maintain the herbaceous elements in the area and diminish the capacity of the woody cover to close in, thus placing the vegetation on a trajectory that favored persistence of a strong herbaceous component. Continued burning would produce a new quasi-equilibrium, where shrub re-colonization was slowed by weak seed dispersal or poor seedling establishment in grasslands (Keeley and Brennan 2012). As a consequence, once the stand of chaparral was opened up, less frequent burning would have been needed to preclude shrub recolonization. Thus, Horne's (1981) contention that "annual burning of shrublands" did not occur is almost certainly correct: once localized type-conversion to herbaceous associations was effected, this vegetation was likely stable for a decade or longer without repeated burning. Since the whole point was to create a vegetational mosaic containing significant woody elements, Indian land managers would have wanted to keep the frequency of disturbance low enough to avoid eliminating shrubs altogether and producing a complete type-conversion to grassland.

Careful calibration of fire frequency would have allowed native people to create the optimal mixture of herbaceous and woody elements *and* control the species composition of the woody elements. Frequent fires (e.g., more than one per decade) would extirpate chaparral shrubs that recruit entirely by seed (e.g., many species of *Ceanothus* and *Arctostaphylos*), and thin out facultatively seeding shrubs like *Adenostoma fasciculatum* (Keeley and Syphard 2018). Under such fire frequency, resprouting shrubs would persist as islands in a matrix of herbaceous vegetation and these resprouters include some important Native American food and basketry resources: *Prunus ilicifolia*, *Heteromeles arbutifolia*, *Sambucus* spp., *Ribes* spp., *Rhus aromatica*, other species of *Arctostaphylos*, and *Quercus berberifolia*. There is also value added to this scenario in that these resources are far more accessible when present in isolated island remnants, plus fruit production increases following such stand thinning due to reduced plant competition for soil water resources (Keeley and Keeley 1988). Burning removed dead biomass and encouraged maximal growth of fruit-bearing canes and branches (Anderson and Rosenthal 2015).

The widespread existence of shrub islands and vegetational mosaics is substantiated in Pomo testimony related to Omer Stewart (unpublished field notes, 1935): "When John was a boy the hills were bare from brush—all bald. The brush was much less thick and *Arctostaphylos* spp. was limited to a few spots. The areas where productive brush was located was protected from yearly fires which burned grass and other brush. The grass fires did not bother the big trees. Small trees were burned at time in the hills. This was used for wood. Each fall the whole country was burned. This made the grass grow better."

If humans had not found a way to migrate from Asia to North America and California had remained unpeopled, the Euro-Americans sailing along the coast in the late sixteenth and early seventeenth centuries would have glimpsed a landscape very different from what they actually encountered. Instead of a land "agreeably interspersed with wood-land, and clear spots, as if in a state of cultivation," they would have looked upon hillsides covered in brush, uninviting and difficult to penetrate. Making trails through this dense shrubland, they would have found a less diverse flora and probably less wildlife. Fortunately for these explorers, California was peopled, and the people had worked for perhaps millennia shaping the landscape, especially its chaparral and allied vegetation, into something more productive and diverse than nature alone could accomplish. Although centuries have passed since Indians actively managed the chaparral and other plant communities with fire, we still see the impacts of that early land management.

4.7 A Future for Indigenous Burning?

There is increasing interest among resource managers in incorporating traditional ecological knowledge into land management practices, and there are notable cases where it has played a significant role in understanding contemporary issues. As just one example, the very lethal 1993 Four Corners "Navajo Flu" outbreak was a total mystery to scientists until local medicine men reported that it had been observed several times in the twentieth century and was associated with high rainfall followed by a population explosion of mice. Here was a case where the combination of traditional ecological knowledge and contemporary scientific investigation had a synergistic effect on bringing to light the very serious health issue known as hanta virus, a lethal virus transmitted through mice feces. Undoubtedly there is much to be learned from a fuller understanding of traditional ecological knowledge.

With respect to fire, there is a growing interest in restoring indigenous peoples' fire management practices to forests, savannas, and other landscapes throughout the world (Trauernicht et al. 2015). In California there is a strong case to be made for this in many forested landscapes in the Sierra Nevada and northern California where fire suppression has greatly altered natural fire regimes (Keeley and Safford 2016). On these landscapes not only have traditional burning practices been eliminated but natural lightning-ignited fires have been suppressed (though not always successfully). As a consequence abnormal accumulations of living and dead fuels have made these ecosystems extremely vulnerable to high-intensity crown fires that cause high rates of tree mortality.

Western scientists and resource managers are increasingly recognizing that indigenous burning in various vegetation types contributed not only to community livelihood, but also to many conservation values such as landscape heterogeneity and resiliency (USDA Forest Service 2012). The outcomes that indigenous people were aiming for when burning chaparral, such as increased water flow, enhanced wildlife habitat, and the maintenance of many kinds of flowering plants and animals, are congruent and dovetail with the values that public land agencies, non-profit organizations, and private landowners wish to preserve and enhance through wildland management. As a result, Indian burning is being emulated by some non-Indian land managers. In Whiskeytown National Recreation Area, in chaparral areas most likely traditionally managed with fire by Wintu cultural groups, prescribed burning and brush thinning favors open diverse understories, stimulating the germination and growth of long dormant bulb and seedbanks (Jennifer Gibson, pers. comm. 2016).

For over 20 years, the staff biologists of Occidental Arts and Ecology Center (OAEC), a 28 ha (70 acre) Wildland Preserve in western Sonoma County, have been stewarding 2.8 ha (7 acres) of coastal prairie using guidelines derived from horticultural and traditional practices (Dolman 2016). They are saving the seeds of native bulbs, wildflowers, and grasses, reintroducing frequent low-intensity fire to keep coyote brush and other chaparral species from encroaching, and broadcasting the collected seeds into recently burned areas before major winter rains. The results are markedly heightened patches of native perennial bunchgrasses such as *Elymus glaucus*, California oatgrass (*Danthonia californica*), and purple needlegrass (*Stipa pulchra*), and wildflowers that include indigenous food sources such as multiple species of *Perideridia* spp., *Dichelostemma* spp., *Triteleia* spp., *Brodiaea* spp., and yellow mariposa lily (*Calochortus luteus*) (Dolman 2016).

Fire-based management informed by knowledge of pre-historic practices is also being carried out by Native people themselves. Some tribal elders and indigenous resource managers still retain detailed knowledge of how, why, and when to apply fire to the land. Members of the Amah Mutsun Land Trust, a tribally owned trust, in partnership with Pinnacles National Park, are bringing back onto their traditional lands the practices of burning of *Muhlenbergia rigens* to heighten flower stalk production and burning to keep chaparral from engulfing bunchgrass colonies. Don Hankins, Plains Miwuk, with other Konkow practitioners, and staff and students have been burning since 2010 in oak-chaparral communities in Big Chico Creek Ecological Reserve in Butte County to increase native grass dominance and culturally significant plants, benefit oaks, maintain landscape patchiness and representation of various ecological states, similar to what might have been done under the traditional management of the Konkow (Don Hankins, pers. comm. 2016). In northern California, the Karuk tribe and Orleans/Somes Bar Fire Safe Council have conducted fuel treatments over the past 15 years on the vegetation of Offeld Mountain, which includes chaparral, setting the stage for bringing back the ceremonial use of fire on the mountain. The US Forest Service is working with the Karuk and local communities around Happy Camp to restore controlled burns to high-elevation ridge systems to create landscape scale fuelbreaks.

Southern California chaparral represents a very different situation and one in which restoring traditional fire practices on any significant scale would not improve fire hazard and instead would likely cause ecological damage. The primary reason is that indigenous burning in the region has been replaced by even more anthropogenic burning than Indians ever did.

Some would argue that the problem with today's large catastrophic fires in southern California is the result of not using traditional fire management practices, which would prevent fires from spreading due to a mosaic of different aged fuels. The primary basis for this belief is the idea that large fires in this region are the result of highly successful fire suppression that has resulted in abnormal fuel accumulation (Minnich 1983). However, it is apparent that over the last century on this landscape fire suppression has failed to exclude fire and the region has had an abnormally high fire frequency (Safford and van de Water 2014). So much so that regionally there is no evidence of anomalously high fuel accumulation and that fuel age and continuity have very little control on fire size (Keeley et al. 1999). Rather it has been shown that large fire events are the result of extreme droughts, high temperatures, and high winds (Keeley and Zedler 2009).

Some advocates of restoring Indian burning maintain that we should restore those early landscapes that type-converted shrublands to a mosaic of shrubs, grass, and herbs because of its inherent cultural value. However, these cultural landscapes were comprised of native shrubs and native herbs, but today the herbaceous flora is dominated by non-native species. Repeated burning of chaparral is invaded by these non-native species, greatly diminishing the resource value, and is contrary to conservation goals of maintaining native vegetation. In addition, such type-conversion increases the highly flammable flashy fuels and results in increased ignitions and fire spread into more hazardous chaparral fuels (see Chap. 12).

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