Appendix I

Descriptions of Habitat Types Likely To Occur in or Adjacent to Proposed Program Activities

Riverine

William E. Grenfell Jr.

General Description

Structure-- Intermittent or continually running water distinguishes rivers and streams. A stream originates at some elevated source, such as a spring or lake, and flows downward at a rate relative to slope or gradient and the volume of surface runoff or discharge. Velocity generally declines at progressively lower altitudes, and the volume of water increases until the enlarged stream finally becomes sluggish. Over this transition from a rapid, surging stream to a slow, sluggish river, water temperature and turbidity will tend to increase, dissolved oxygen will decrease and the bottom will change from rocky to muddy (McNaughton and Wolf 1973).

Aquatic Environment

Composition-- The majority of fast stream inhabitants live in riffles, on the underside of rubble and gravel, sheltered from the current. Characteristic of the riffle insects are the nymphs of mayflies, caddisflies, alderflies, stoneflies; and the larva and pupae of true flies. In pools, the dominant insects are burrowing mayfly nymphs, dragonflies, damselflies and water striders. Water moss and heavily branched filamentous algae are held to rocks by strong holdfasts and align with the current. Other algae grow in spheric, or cushionlike colonies with smooth, gelatinous surfaces. Algae growth in streams often exhibits zonation on rocks, which is influenced by depth and current.

With increasing temperatures, decreasing velocities and accumulating bottom sediment, organisms of the fast water are replaced by organisms adapted to slower moving water. Mollusks and crustaceans replace the rubble-dwelling insect larvae. Backswimmers, water boatmen and diving beetles inhabit sluggish stretches and backwaters. Emergent vegetation grows along river banks, and duckweed floats on the surface. Abundant decaying matter on the river bottom promotes the growth of plankton populations that are not usually found in fast water.

Other Classifications-- Other classification systems of rivers and streams are: Riverine (Cowardin et al. 1979); Streams-10.2, Rivers-10.3 (Cheatham and Haller 1975) and Proctor et al. (1980).

Aquatic Zones and Substrates

The riverine habitat exists in structural classes 1;24:0-B. Open water (1) is defined as greater than 2 meters in depth and/or beyond the depth of floating rooted plants, and does not involve substrate. Small rivers and streams may not have an open water zone. The submerged zone (2) is between open water and shore. The shore (4) is seldom flooded (except for wave wash or fluctuations in flow) and is less than 10 percent canopy cover. For shorelines with 10 percent canopy cover or more, use a terrestrial habitat designation.

The rate at which a stream erodes its channel is determined by the nature of the substrate, composition of the water, climate and the gradient. The greater the slope, the greater the capacity to transport abrasive materials through increased velocity (Reid 196)

Most natural riverine systems are relatively stable over long periods of time as long as there is no human interference. The building of dams and the dredging and straightening of stream channels are in the most important factors controlling the duration of stream and river types.

Biological Setting

Habitat-- Riverine habitats can occur in association with many terrestrial habitats. Riparian habitats are found adjacent to many rivers and streams. Riverine habitats are also found contiguous to lacustrine and fresh emergent wetland habitats.

Wildlife Considerations-- The open water zones of large rivers provide resting and escape cover for many species of waterfowl. Gulls, terns, osprey and bald eagle hunt in open water. Near-shore waters provide food for waterfowl, herons, shorebirds, belted-kingfisher and American dipper. Many species of insectivorous birds (swallows, swifts, flycatchers) hawk their prey over water. Some of the more common mammals found in riverine habitats include river otter, mink, muskrat and beaver.

Physical Setting

Streams begin as outlets of ponds or lakes (lacustrine), or rise from spring or seepage areas. All streams at some time experience very low flow and nearly dry up. Some streams, except for occasional pools, dry up seasonally every year.

The temperature of the riverine habitat is not constant. In general, small, shallow streams tend to follow, but lag behind air temperatures, warming and cooling with the seasons. Rivers and streams with large areas exposed to direct sunlight are warmer than those shaded by trees, shrubs and high, steep banks.

The constant swirling and churning of high-velocity water over riffles and falls result in greater contact with the atmosphere-and thus have a high oxygen content. In polluted waters, deep holes or low velocity flows, dissolved oxygen is lower (Smith 1974).

Distribution

Rivers and streams occur statewide, mostly between sea level and 2438 meters (8000 fl).

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Montane Riparian

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Vegetation

Structure-- The vegetation of montane riparian (MRI) zones is quite variable and often structurally diverse (Marcot 1979). Usually, the montane riparian zone occurs as a narrow, often dense grove of broad-leaved, winter deciduous trees up to 30 m (98 ft) tall with a sparse understory. At high mountain elevations, MRI is usually less than 15 m (49 ft) high with more shrubs in the understory. At high elevations, MRI may not be well developed or may occur in the shrub stage only.

Composition-- In northwest California along streams west of the Klamath Mountains, black cottonwood is a dominant hardwood. In some areas, it is codominant with bigleaf maple. In either case, black cottonwood can occur in association with dogwood and boxelder. At high elevations black cottonwood occurs with quaking aspen and white alder (Parker and Matyas 1979). In northeastern California, black cottonwood, white alder and thinleaf alder dominate the montane riparian zone. Oregon ash, willow and a high diversity of forbs are common associates. In the Sierra Nevada, characteristic species include thinleaf alder, aspen, black cottonwood, dogwood, wild azalea, willow and water birch (southern Sierra east of the crest), white alder and dogwood (north Sierra). In the southern Coast Range as well as Transverse and Peninsular ranges, bigleaf maple and California bay are typical dominants of montane riparian habitat. Fremont cottonwood is the most important cottonwood in the Sierra below 1524 m (5000 ft), much of the Coast Ranges and the Transverse and Peninsular ranges.

MRI habitats can occur as alder or willow stringers along streams of seeps. In other situations an overstory of Fremont cottonwood, black cottonwood and/or white alder may be present.

Other Classifications-- Montane riparian habitats are also described as riparian (Laudenslayer 1982), riparian deciduous (Verner and Boss 1980, Marcot 1979), bigleaf maple, alder, maple-alder-dogwood, white alder, willow and alder-willow series (Parker and Matyas 1979), mixed riparian woodland -6.21, willow thickets - 6.24 and red alder groves - 6.22 (Cheatham and Haller 1975)
.

Habitat Stages

Vegetation Changes-- 1;2-5:S-D;6. Definite successional stages are not described in

the literature. Many montane riparian stages may prevail indefinitely, climax or subclimax. Shrub-type stages should be evaluated as size/age class 1 or 2. Overstory trees such as cottonwood, maple and alder may range up to size/age class 6.

Duration of Stages-- Montane riparian habitats within given watersheds tend to maintain the same mosaic of stages. However, the location of these stages may vary as a result of periodic torrential flows. Riparian Systems can be damaged by debris, sedimentation, or uprooting of entire plants which are redeposited further downstream (Campbell and Green 1968).

Biological Setting

Habitat-- The transition between MRI and adjacent non-riparian vegetation is often abrupt, especially where the topography is steep. This habitat intergrades with montane chaparral, montane hardwood, montane hardwood/conifer, lodgepole pine, red fir and wet meadow habitats.

Wildlife Considerations-- All riparian habitats have an exceptionally high value for many wildlife species (Thomas 1979, Marcot 1979, Sands 1977). Such areas provide water, thermal cover, migration corridors and diverse nesting and feeding opportunities. The shape of many riparian zones, particularly the linear nature of streams, maximizes the development of edge which is so highly productive for wildlife (Thomas 1979).

The range of wildlife that uses the MRI habitat for food, cover and reproduction include amphibians, reptiles, birds and mammals. The southern rubber boa and Sierra Nevada red fox are among the rare, threatened or endangered wildlife that use MRI habitats during their life cycles.

Physical Setting

Riparian areas are found associated with montane lakes, ponds, seeps, bogs and meadows as well as rivers, streams and springs. Water may be permanent or ephemeral (Marcot 1979). The growing season extends from spring until late fall, becoming shorter at higher elevations. Most tree species flower in early spring before leafing out.

Distribution

Montane riparian habitats are found in the Klamath, Coast and Cascade ranges and in the Sierra Nevada south to about Kern and northern Santa Barbara Counties, usually below 2440 m (8000 ft). The Peninsular and transverse ranges of southern California from about southern Santa Barbara to San Diego Counties also include MRI habitat. MRI subtype, consisting mostly of red alder, is found from northern San Luis Obispo to Del Norte Counties along the immediate coast (Cheatham and Haller 1975).

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Valley Foothill Riparian

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Vegetation

Structure-- Canopy height is approximately 30 m (98 ft) in a mature riparian forest, with a canopy cover of 20 to 80 percent. Most trees are winter deciduous. There is a subcanopy tree layer and an understory shrub layer. Lianas (usually wild grape) frequently provide 30 to 50 percent of the ground cover and festoon trees to heights of 20 to 30 m (65 to 98 ft). Herbaceous vegetation constitutes about one percent of the cover, except in openings where tall forbs and shade-tolerant grasses occur (Conard et al. 1977). Generally, the understory is impenetrable and includes fallen limbs and other debris.

Composition-- Dominant species in the canopy layer are cottonwood, California sycamore and valley oak. Subcanopy trees are white alder, boxelder and Oregon ash. Typical understory shrub layer plants include wild grape, wild rose, California blackberry, blue elderberry, poison oak, buttonbrush, and willows. The herbaceous layer consists of sedges, rushes, grasses, miner's lettuce, Douglas sagewort, poison-hemlock, and hoary nettle.

Other Classifications-- Other classification schemes that describe VRI habitats are Cottonwood and California Sycamore (Parker and Matyas 1981), Central Valley Bottomland Woodland 6.11, Southern Alluvial Woodland - 6.31 (Cheatham and Haller 1975), Wild Rose Alder, Cottonwood, Sycamore, Willow (Paysen et al. 1980), Riparian Forest - 28 (Küchler 1977) and Forested Wetland -61 (Anderson et al. 1976).

Habitat Stages

Vegetation Changes-- 1;2-5:S-D. Cottonwoods grow rapidly and can reach WHR size/age class 5 in about 20 to 25 years. One specimen measuring 92 cm (36 in) (inside the bark) showed an age of 29 years (Sudworth 1908). This secondary succession to climax could occur as rapidly as 25 to 30 years in VRI habitats dominated by cottonwood. One valley oak tree 54 cm (21 in) in diameter (WHR size/age class 4) showed an age of 57 years. Valley oak dominated riparian systems would probably take 75+ years to reach climax/maturity. Some VRI types consisting of only a shrub layer (VRI 1;2: S-D) (willows, wild rose, blackberry) may persist indefinitely.

Duration of Stages-- Shrubby riparian willow thickets may last 15-20 years before being overtopped and shaded out by cottonwoods. Cottonwood or willow tree

habitats close to river channels that receive a good silt infusion, without major disruptive flows, tend to be self perpetuating (R. Holland pers. comm.).

Biological Setting

Habitat-- Transition to adjacent non-riparian vegetation is usually abrupt, especially near agriculture (Cheatham and Haller 1975). The Valley-Foothill Riparian habitat is found in association with Riverine (RIV), Grassland (AGS, PGS), Oak Woodland (VFH) and Agriculture (PAS, CRP). It may intergrade upstream with Montane Riparian.

Wildlife Considerations-- Valley-foothill riparian habitats provide food, water, migration and dispersal corridors, and escape, nesting, and thermal cover for an abundance of wildlife. At least 50 amphibians and reptiles occur in lowland riparian systems. Many are permanent residents, others are transient or temporal visitors (Brode and Bury 1985). In one study conducted on the Sacramento River, 147 bird species were recorded as nesters or winter visitants (Laymon 1985). Additionally, 55 species of mammals are known to use California's Central Valley riparian communities (Trapp et al. 1985).(No 1985 cites for Brode and Bury, Laymon, and Trapp et al. in habitat Lit Cite. I used 1984 cites for all 3 in Lit Cite at end.)

Physical Setting

Valley-foothill riparian habitats are found in valleys bordered by sloping alluvial fans, slightly dissected terraces, lower foothills, and coastal plains. They are generally associated with low velocity flows, flood plains, and gentle topography. Valleys provide deep alluvial soils and a high water table. The substrate is coarse, gravelly or rocky soils more or less permanently moist, but probably well aerated (Cheatham and Haller 1975). Average precipitation ranges from 15 to 76 cm (6-30 in), with little or no snow. The growing season is 7 to 11 months. Frost and short periods of freezing occur in winter (200 to 350 frost-free days). Mean summer maximum temperatures are 24 to 39 C (75 to 102 F), mean winter minima are 2 to 7 C (29 to 44 F) (Munz and Keck 1973). VRI habitats are characterized by hot, dry summers, mild and wet winters. Coastal areas have a more moderate climate than the interior and receive some summer moisture from fog (Bailey 1980). Potential evaporation during the warmest months is often greater than precipitation. Low rainfall and streamflow result in water scarcity in many parts of the area.

Distribution

Valley-foothill riparian habitats occur in the Central Valley and the lower foothills of the Cascade, Sierra Nevada and Coast ranges. They are also found in lower slopes at the bases of the Peninsular and Transverse ranges. A few lower elevation

locations are on the desert side of the southern California mountains. VRI habitats range from sea level to 1000 m (3000 ft), fingering upward to 1550 m (5000 ft) on south-facing slopes.

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Annual Grassland

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Vegetation

Structure. Annual Grassland habitats are open grasslands composed primarily of annual plant species. Many of these species also occur as understory plants in Valley Oak Woodland (VOW) and other habitats. Structure in Annual Grassland depends largely on weather patterns and livestock grazing. Dramatic differences in physiognomy, both between seasons and between years, are characteristic of this habitat. Fall rains cause germination of annual plant seeds. Plants grow slowly during the cool winter months, remaining low in stature until spring, when temperatures increase and stimulate more rapid growth. Large amounts of standing dead plant material can be found during summer in years of abundant rainfall and light to moderate grazing pressure. Heavy spring grazing favors the growth of summer-annual forbs, such as tarweed and turkey mullein, and reduces the amount of standing dead material. On good sites, herbage yield may be as high as 4900 kg/ha (4400 lb/ac) (Garrison et al. 1977).

Composition. Introduced annual grasses are the dominant plant species in this habitat. These include wild oats, soft chess, ripgut brome, red brome, wild barley, and foxtail fescue. Common forbs include broadleaf filaree, redstem filaree, turkey mullein, true clovers, bur clover, popcorn flower, and many others. California poppy, the State flower, is found in this habitat. Perennial grasses, found in moist, lightly grazed, or relic prairie areas, include purple needlegrass and Idaho fescue. Vernal pools, found in small depressions with a hardpan soil layer, support downingia, meadowfoam, and other species (Parker and Matyas 1981). Species composition is also related to precipitation (Bartolome et al. 1980). Perennial grasses are more common on northern sites with mean annual rainfall greater than 150 cm (60 in). Soft chess and broadleaf filaree are common in areas with 65-100 cm (25-40 in) of rainfall, and red brome and redstem filaree are common on southern sites with less than 25 cm (10 in) of precipitation (Bartolome et al. 1980).

Other Classifications. Annual Grassland habitat has been described as Valley Grassland (Munz and Keck 1959, Heady 1977), Valley and Foothill Grassland (Cheatham and Haller 1975), California Prairie (Küchler 1977), Annual Grasslands Ecosystem (Garrison et al. 1977), Brome grass, Fescue, Needlegrass, and Wild Oats series (Paysen et al. 1980), and Annual Grass-Forb series (Parker and Matyas 1981).

Habitat Stages

Vegetation Changes 1-2:S-D. Annual Grassland habitats occupy what was once a pristine native grassland. The native grassland likely consisted of climax stands of perennial bunchgrasses, such as purple needlegrass, on wetter sites (Bartolome 1981, Bartolome and Gemmill 1981), with annual species existing as climax communities on drier alluvial plains (Webster 1981). Today, plant succession in the classical sense does not occur in Annual Grassland habitats. However, species composition is greatly influenced by seasonal and annual fluctuations in weather patterns. Annual plants germinate with the first fall rains that exceed about 15 mm (0.6 in), growing slowly during winter and more rapidly in spring (Heady 1977). Botanical composition changes throughout the growing season because of differences in plant phenology (Heady 1958). Most annuals mature between April and June (Heady 1977), although some species, such as tarweed and turkey mullein, continue to grow into summer. Fall rains that encourage germination, followed by an extended dry period, favor the growth of deep-rooted forbs (Duncan and Woodmansee 1975), but continuing rainfall favors rapidly growing grasses (Pitt and Heady 1978). Livestock grazing favors the growth of low-stature, spring-maturing forbs, such as filaree (Freckman et al. 1979), and summer annuals, such as turkey mullein (Duncan 1976). Because these are important food plants for many wildlife species, proper levels of livestock grazing are generally beneficial in this habitat. In the absence of livestock, Annual Grassland habitats are often dominated by tall, dense stands of grasses such as ripgut brome (Freckman et al. 1979) and wild oats.

Duration of Stages-- Although Annual Grassland habitats consist largely of non-native annuals, these effectively prevent the reestablishment of native perennials over large areas and now comprise climax communities (Heady 1977). Introduced annuals should be considered naturalized plant species and so managed, rather than as invading species characteristic of poor range sites.

Biological Setting

Habitat. Annual Grassland habitat is found just above or surroundingValley Foothill Riparian (VRI), Alkali Desert Scrub (ASC), Fresh Emergent Wetland (FEW), Pasture (PAS) and all agricultural habitat types, and below Valley Oak Woodland (VOW), Blue Oak Woodland (BOW), Blue Oak-Foothill Pine (BOP), Chamise-Redshank (CRC), and Mixed Chaparral (MCH) habitats. Annual Grassland habitat also borders Coast Oak Woodland (COW), Closed Cone-Pine-Cypress (CPC), Coastal Scrub (CSC), and Eucalyptus (EUC) habitats.

Wildlife Considerations. Many wildlife species use Annual Grasslands for foraging, but some require special habitat features such as cliffs, caves, ponds, or habitats with woody plants for breeding, resting, and escape cover. Characteristic reptiles that breed in Annual Grassland habitats include the western fence lizard, common garter snake, and western rattlesnake (Basey and Sinclear 1980). Mammals typically found in this habitat

include the black-tailed jackrabbit, California ground squirrel, Botta's pocket gopher, western harvest mouse, California vole, badger, and coyote (White et al.1980). The endangered San Joaquin kit fox is also found in and adjacent to this habitat (U.S. Fish and Wildlife Service 1983). Common birds known to breed in Annual Grasslands include the burrowing owl, short-eared owl, horned lark, and western meadowlark (Verner et al. 1980). This habitat also provides important foraging habitat for the turkey vulture, northern harrier, American kestrel, black-shouldered kite, and prairie falcon.

Physical Setting

Annual Grassland habitat occurs mostly on flat plains to gently rolling foothills. Common soil orders include Entisols and Alfisols (Garrison et al.1977). Entisols are often found at lower elevations on flood plains and swales that receive periodic deposits of alluvium (U.S. Soil Conservation Service1975), and are characterized by little or no pedogenic horizon development. Alfisols occur at higher elevations above the valley floor (Garrison et al.1977). Some Annual Grassland habitats can be found in the drier portion of the southern San Joaquin Valley on Aridisols (Garrison et al. 1977). Climatic conditions are typically Mediterranean, with cool, wet winters and dry, hot summers. The length of the frost free season averages 250 to 300 days (18 to 21 fortnights) (Garrison et al. 1977). Annual precipitation is highest in the north (Redding, 960 mm (38 in)) and north coast (Ukiah, 909 mm (36 in)), decreasing to the south (Sacramento, 430 mm (17 in); Stockton, 339 mm (13 in); Fresno, 259 mm (10 in)), and reaching a minimum in the southern San Joaquin Valley (Bakersfield, 150 mm (6 in)) (Major 1977).

Distribution

Annual Grassland habitat occurs in patches of various sizes throughout the state

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Blue Oak-Foothill Pine

Jared Verner

Vegetation

Structure-- This habitat is typically diverse in structure both vertically and horizontally, with a mix of hardwoods, conifers, and shrubs. The shrub component is typically composed of several species that tend to be clumped, with interspersed patches of Annual Grassland. Woodlands of this type generally have small accumulations of dead and downed woody material and relatively few snags, compared with other tree habitats in California. Most existing stands of this type are in mature stages, with canopy cover ranging from 10 to 59 percent, and dbh ranging from 2.5 to 30 cm (1 to 12 in). Size class 6 depends on a sparse overstory of foothill pine above a lower canopy of oaks, as canopies of blue oak seldom exceed 15 m (50 ft) in height. Individual trees seldom exceed 125 cm (49 in) dbh, and exceptionally may reach 30 m (100 ft) in height.

Composition-- Blue oak and foothill pine typically comprise the overstory of this habitat, with blue oak usually most abundant. Stands dominated by foothill pine tend to lose their blue oak, which is intolerant of shade (P. M. McDonald, pers. comm.). In the foothills of the Sierra Nevada, tree species typically associated with this habitat are interior live oak and California buckeye. In the Coast Range, associated species are the coast live oak, valley oak, and California buckeye (Griffin 1977). Interior live oak sometimes dominates the overstory, especially in rocky areas and on north-facing slopes at higher elevations (Neal 1980).

At lower elevations, where blue oaks make up most of the canopy, the understory tends to be primarily annual grasses and forbs. At higher elevations where foothill pines and even interior live oaks sometimes comprise the canopy, the understory usually includes patches of shrubs in addition to the annual grasses and forbs. Shrub species include Ceanothus spp. Mariposa manzanita, whiteleaf manzanita, Parry manzanita redberry, California coffeeberry, poison-oak, silver lupine, blue elder, California yerba-santa, rock gooseberry, and California redbud.

Other Classifications-- This type is referred to as Blue Oak-Foothill Pine by the Society of American Foresters (Eyre 1980) and Parker and Matyas (1981), and as Blue Oak-Foothill Pine Forest by Küchler (1977). Neal (1980) gives an excellent, short description of the type, and a more complete description can be gleaned from Griffin (1977) in his discussion of California's oak woodlands.

Habitat Stages

Vegetation Changes-- 2-5:S-D;6. Succession presumably proceeds from annual grasslands directly to tree stages at lower elevations, where a shrub layer is usually sparse or absent. At higher elevations, shrubs and trees regenerate together.

Duration of Stages-- Secondary succession beginning with disturbed soil is rapid during early stages, with annual grasslands giving way to shrubs within 2 to 5 years. However, stands of mature shrubs adequate to provide habitat for those wildlife species requiring them take longer to develop approximately 10 to 15 years. The conifers grow more rapidly than the hardwoods, maturing into relatively large trees even within 30 to 40 years, judging from the photo series taken at the San Joaquin Experimental Range in Madera County (Woolfolk and Reppert 1963). Most of the meager information on growth rates of blue oaks comes from sites in northern and central California. They generally grow slowly at all ages. Blue oaks in Nevada, Shasta, and Placer Counties showed little or no growth in height after they reached 65 cm (26 in) dbh (McDonald 1985)(No McDonald 1985 in Habitat Lit Cite.). The age at which they normally begin producing acorn crops is unknown (M. McClaran, pers. comm.), but it likely takes several decades. Concern has been expressed for the long-term existence of this habitat (Holland 1976), because "little regeneration has occurred since the late 1800s, as livestock, deer, birds, insects, and rodents consume nearly the entire acorn crop each year. Of the few seedlings that become established a large proportion are eaten by deer" (Neal 1980:126). Furthermore, the absence of grazing livestock does not generally result in regeneration (White 1966), because many other animals eat acorns and seedling oaks. Moreover, introduced grasses are subject to burning, may compete directly with seedling oaks for light and nutrients, and may be allelopathic to the oaks. The general absence of secondary successional stages of these woodlands has precluded detailed study of their composition or rates of change.

Biological Setting

Habitat-- As Griffin (1977:386) points out, "oak woodland seldom forms a continuous cover over large areas. It is a major item in a mosaic including valley grassland...and chaparral...with strips of riparian forest." This mosaic is reflected in the character of the understory in stands of BOP woodlands. At lower elevations, these woodlands merge with Annual Grasslands, Blue Oak Woodlands, and Valley Oak Woodlands. The Annual Grasslands actually extend into the woodlands as a ground cover where not shaded by shrubs. The Blue Oak Woodlands differ from the BOP type in lacking a conifer component and usually in lacking a shrub component.

At upper elevations, BOP habitats merge with extensive stands of Mixed Chaparral in most localities, although in some places the Ponderosa Pine type grows at an elevation low enough to form a mixed ecotone with Mixed Chaparral and BOP.

Wildlife Considerations-- BOP woodlands provide breeding habitats for a

large variety of wildlife species, although no species is totally dependent on them for breeding, feeding, or cover. In the western Sierra Nevada, for example, 29 species of amphibians and reptiles, 79 species of birds, and 22 species of mammals find mature stages of this type suitable or optimum for breeding, assuming that other special habitat requirements are met (Verner and Boss 1980).

Most species breed during late winter and early spring a factor to consider when planning management activities. Snags are less common, and hence less critical to wildlife, in this than in other forest types. Most species of cavity-nesting birds, for example, use living oaks. The cavities are often in scars where limbs have broken from the trunk or a main branch and have developed a level of decay that makes them more easily excavated by primary cavity nesters.

According to Olson (1974), blue oaks produce an abundant seed crop every 2 to 3 years and bumper crops every 5 to 8 years; however, McClaran (pers. comm.) questions that such a clear cycle of acorn production has been confirmed. In any case, acorns are an important food resource for many species of birds (Verner 1980a.) and mammals (Barrett 1980).

Physical Setting

The habitat occurs in a typically Mediterranean climate hot, dry summers and cool, wet winters. Most precipitation falls as rain from November through April, averaging from 51 to 102 cm (20 to 40 in) within the primary range of blue oak (McDonald 1985). The frost-free growing season ranges from 150 to 300 days, with January minima averaging 1 C (30 F) and July maxima averaging 32 C (90 F) (McDonald 1985). Soils are from a variety of generally well-drained parent materials, ranging from gravelly loam through stony clay loam. Soils rich in rock fragments are typical (McDonald 1985).

Distribution

The range of this habitat (well described by Neal, 1980) generally rings the foothills of the Central Valley, between 150 and 915 m (500 and 3000 ft) in elevation. The Pit River drainage in the Cascade Range and the foothills of the Klamath Mountains mark the approximate northern limit. The habitat is nearly continuous in the western foothills of the Sierra Nevada, except for a gap of 96 km (60 mi) between the Kings and Kern Rivers, where foothill pine is missing. The distribution extends south into the Liebre Mountains of northern Los Angeles County and the drainages of Piru Creek and Santa Clara River in Ventura County. It is discontinuous in the Coast Range west of the Central Valley from Ventura to Mendocino Counties. And it extends westward to within 16 km (10 mi) of the coast in a few places (Griffin 1977, Neal 1980).

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Douglas-Fir

Martin G. Raphael

Vegetation

Structure-- This habitat forms a complex mosaic of forest expression due to the geologic, topographic, and successional variation typical within its range (Sawyer 1980). Typical aggregations include a lower overstory of dense, sclerophyllous, broad-leaved evergreen trees (tanoak, Pacific madrone) up to 35 m (114 ft) tall, with an irregular, often open, higher overstory of tall needle-leaved evergreen trees (Douglas-fir) up to 90 m (295 ft) (Marcot 1979, Sawyer 1980, Franklin et al. 1981, Thornburgh 1982). A small number of pole and sapling trees occur throughout stands (Thornburg 1982). On wet sites, shrub layers are well developed, often with 100 percent cover. Cover of the herbaceous layer under the shrubs can be up to 10 percent. At higher elevations, the shrubs disappear and the herb layer is often 100 percent. Typical mesic habitats have a poorly developed or non-existent shrub and herb layer. Dry habitats have greater cover of shrubs and especially grasses (Franklin and Dyrness 1973, D. A.Thornburgh, pers. comm.). On steeper (> 75%), drier slopes with shallow soils, the shrub and herb layer is poorly developed, represented mainly by moss-covered rocks (Sawyer et al. 1977). Diameter of overstory Douglas-fir ranges up to 450 cm (1140 in) and averages 150 to 220 cm (360 to 560 in) on better sites (Franklin and Waring 1980). Density of Douglas-fir decreases with stand age from about 400 stems >2 m tall/ha (160/ac) in 100-year old stands to 290 stems/ha (116/ac) in 250-year-old stands; density of other species increases from 765 to 1212 stems/ha (306 to 490/ac) M. G. Raphael, unpublished data). In a study of similar forests in Oregon, overstory foliage biomass was similar in young (37-year-old) stands, but understory biomass was nine times greater in the older stand (Grier et al. 1974). Mature overstory Douglas-fir trees have a typically cylindrical crown beginning at 20 to 40 m (66 to 131 ft), composed of irregularly scattered branches (Franklin et al. 1981). Diversity of tree size typically increases with stand age, as does tree spacing (Franklin et al. 1981). Young stands have closely spaced and uniformly distributed trees, whereas older stands show a more patchy stem distribution. Snags and downed logs, an important structural component of this habitat, increase in density or volume with stand age (Franklin and Waring 1980, Raphael and Barrett 1984).

Composition-- Overstory composition varies with soil parent material, moisture, topography, and disturbance history. Dry steep slopes on metamorphic and granitic parent materials are dominated by canyon live oak. Less rocky, dry soils support Douglas-fir, tanoak, and Pacific madrone in association with sugar pine, ponderosa pine, black oak, and canyon live oak. Deep mesic soils support an overstory of Douglas-fir with a tanoak-dominated understory. Wettest sites include Pacific yew and, less

consistently, Port-Orford cedar. On ultrabasic derived soils, Douglas-fir attains less dominance and is replaced by Port-Orford cedar on mesic sites to the extreme northwest (Stein 1980a) and open stands of Jeffrey pine, incense cedar, sugar pine, knobcone pine, and western white pine on more xeric sites (Whittaker 1960, Whittaker 1961, Rockey et al. 1966, Mize 1973, Sawyer et al. 1977). In the southern and eastern extent if the type, ponderosa pine becomes a major codominant with Douglas-fir, and cover of black oak increases (Waring and Major 1964, Sawyer et al. 1977). In the absence of fire or other disturbance, western hemlock may occur as a codominant with Douglas-fir and tanoak at the western extent of the type in areas transitional to redwood forest (Sawyer et al. 1977). The shrub layer is typically composed of canyon live oak, Oregon-grape, California blackberry, dwarf rose, and poison-oak (Franklin and Dyrness 1973). Mesic sites support vine maple, California hazel, salal, and Pacific rhododendron (Sawyer et al. 1977). On sedimentary soils, the principal understory shrubs are California huckleberry, snowbrush ceanothus, salal, and Oregon-grape. Ultrabasic soils support a shrub layer of huckleberry oak, shrub tanoak, California-laurel, California buckthorn, and Brewer oak (Whittaker 1960). Forbs and grasses include Pacific trillium, western swordfern, insideout flower, broad-leaf starflower, deervetch vanillaleaf, American deervetch, princes pine, common whipplea, California honeysuckle, American trailplant, whitevein shinleaf, western rattlesnake plantain, Sierra fairy bells, bracken fern, western fescue, common beargrass, and hartford oniongrass (Franklin and Dyrness 1973, Sawyer et al. 1977). Mize (1973), Simpson (1980), and Laidlaw-Holmes (1981) discuss understory composition in relation to parent material and soil moisture.

Other Classifications-- Other names for Douglas-fir habitat include Douglas-fir-Tanoak-Madrone, Douglas-fir-Pine-Madrone, Douglas-fir Series (Parker and Matyas 1981), Port-Orford-Cedar-231 (Stein 1980a), Douglas-fir-Tanoak-Pacific Madrone -234(Sawyer 1980), Western Hemlock Forest -8.22, and Douglas-fir Forest -8.24 (Cheatham and Haller 1975), Douglas-fir Forest -13(Munz and Keck 1959), Evergreen Forest Land -42 (Anderson et al. 1976), Mixed-Evergreen Zone (Franklin and Dyrness 1973), Pseudotsuga-Hardwood Forest (Sawyer et al. 1977), Mixed Evergreen Forest with Chinquapin, and Mixed Evergreen Forest with Rhododendron (Küchler 1977), and Mixed Evergreen Forest(Marcot 1979).

Habitat Stages

Vegetation Changes-- 1; 2-5:S-D;6. After a major disturbance, Douglas-fir habitats can proceed through structural classes 1-5, although the sequence is often truncated on poorer sites. Stage 6 stands occur when periodic disturbance leads to a multi-aged stand or a shade tolerant understory develops. This habitat can exist as any of the canopy closure classes S-D, although class D is most frequent. After logging or intense fire, tanoak regenerates by sprouting and Douglas-fir by seeding. Good seed years are irregular, with peaks at about seven-year intervals (Thornburg 1982). Tanoak sprouts grow faster than Douglas-fir seedlings and initially dominate along with various shrubs and herbs. Tanoak can form a nearly solid canopy for 60 to 100 years until natural mortality allows Douglas-fir to become dominant. In mixed stands of tanoak and

Douglas-fir, the latter overtops tanoak in 15 to 30 years on mesic sites (Thornburgh 1982). On xeric sites, hardwoods dominate longer. Thus, abundance and growth of tanoak sprouts depends on the structure of the previous stand and on available soil moisture. Over the course of succession, grasses, herbs, and shrubs are most abundant in the seedling tree class, least abundant in pole and small tree classes, and moderately abundant in the medium/large tree class. Snag and log volume also increase with stand age.

Duration of Stages-- Because of frequent fires, typical climax Douglas-fir habitat is rare (Thornburgh 1982). In the absence of disturbance, such stands develop in 80 to over 250 years, depending on site quality (McArdle 1961, Lang 1980). Individual Douglas-fir trees can live to 1250 years; ages in excess of 750 years are common (Franklin and Waring 1980). Following disturbance, the seedling tree class persists for 5 to 20 years, depending on site quality. The sapling tree class can be 5 to 60 years old the pole-tree, small tree, and medium large tree classes can be 20 to 130, 35 to over 130, and 80 to over 250 years, respectively (McArdle 1961, Lang 1980, Franklin et al. 1981). Multilayered (class 6) stands probably develop over the same time period as medium/large tree stands.

Biological Setting

Habitat-- Douglas-fir occurs at low to moderate elevations in juxtaposition with a number of other habitats. Redwood (RDW) occurs at lower elevations to the west, and Mixed Conifer (MCN) occurs to the east and at higher elevations within the range of Douglas-fir. To the north, especially in more mesic sites, this habitat is bounded by hemlock and sitka spruce zones of Franklin Dyrness (1973)(No 1973 cite. Only a 1969 Cite. Not placed in Lit Cite at enc.). More xeric sites to the south are bounded by and interspersed with Valley-Foothill Hardwood (VFH) and Valley-Foothill Hardwood-Conifer (VHC). ther habitats, such as Montane Hardwood (MHW), Montane Hardwood Conifer (MHC), Montane Riparian (MRI) and Montane Chaparral (MCP) form a complex mosaic with Douglas-fir at similar elevations (Sawyer et al.1977).

Wildlife Considerations-- This habitat supports a high abundance of wildlife species. Weins (1975)(Not in Habitat Lit Cite.) reported that northwest coastal coniferous forests supported a higher average bird density than any other forest type in North America. Bird species typical of this habitat include spotted owl, western flycatcher, chestnut-backed chickadee, golden-crowned kinglet, Hutton's vireo, solitary vireo, hermit warbler, and varied thrush. Among amphibians and reptiles, the distributions of northwestern salamander, Pacific giant salamander, Olympic salamander, Del Norte salamander, black salamander, clouded salamander, tailed frog, and northwestern garter snake are largely coincident with the distribution of Douglas-fir habitat. Although not restricted to this habitat, the ensatina is its most abundant amphibian. Typical mammals include fisher, deer mouse, dusky-footed woodrat western redbacked vole, creeping vole, Douglas' squirrel, Trowbridge's shrew, and shrew-mole.

Physical Setting

Climatically, this habitat experiences hot, dry summers and cool, mild, wet winters. Mean July temperatures range from 14 to 22 C (57-72 F). Average January temperatures range from 0 to 8 C (32-46 F) (Proctor et al. 1980). Annual precipitation varies from 60 to 170 cm (24-27 in), generally less than 15 percent falling during summer. Precipitation increases inland and at higher elevations. Snowfall ranges from 3 to 80 cm (2 to 31 in) and rarely persists later than June (Proctor et al. 1980). Topography is characterized by rugged, deeply dissected terrain and steep slopes (Franklin and Dyrness 1973), especially toward the south. Major soil types are based on sedimentary granitic, and ultramafic parent materials of gabbro, peridotite, and serpentine (Whittaker 1960).

Distribution

Douglas-fir habitat occurs in the north Coast Range from Sonoma County north to the Oregon border and in the Klamath Mountains of California and Oregon. This habitat usually occurs at elevations from 150 to 600 m (500 to 2000 ft) in the Coast Range and from 300 to 1200 m (1000 to 4000 ft) in the Klamath Mountains. It can occur at higher elevations if plentiful precipitation is present (Sawyer 1980).

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Klamath Mixed Conifer

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Vegetation

Structure. Klamath Mixed Conifer (KMC) habitat is typically composed of tall, dense to moderately open, needle-leaved evergreen forests with patchesof broad-leaved evergreen and deciduous low trees and shrubs (Küchler 1977). On favorable mesic sites with little disturbance, the habitat is dominated by tall evergreen conifers up to 60 m (200 ft) in height with a rich shrub layer and well-developed herbaceous layer (Sawyer and Thornburgh 1977). On more xeric sites, the habitat is generally open, but very diverse forest land (Sawyer and Thornburgh 1977) having a well developed shrub layer.

Composition. The overstory layer is characterized by a mixture of conifers. Dominant conifers in the western portion of this habitat are white fir and Douglas-fir. In the east, dominant conifers are white fir, Douglas-fir, ponderosa pine, incense cedar and sugar pine. Other conifers in the overstory layer include Shasta red fir, Sierra lodgepole pine, mountain hemlock, western white pine, knobcone pine, Jeffrey pine and Brewer spruce. In a few isolated stands, other relic conifers include Pacific silver fir, subalpine fir, Port-Orford-cedar, Alaska-cedar, and Engelmann spruce. Occasional broad leaved trees include Sierra chinquapin, canyon live oak and California black oak. Pacific yew occurs as a small tree in the understory (D.A. Thornburgh, Dept. of Forestry, Humboldt State University, Arcata, Calif., pers. comm.; Parker and Matyas 1981)

At higher elevations, red fir and mountain hemlock are more prevalent with occasional whitebark pine and foxtail pine (D. A. Thornburgh, pers.comm.). At lower elevations or on more xeric sites, ponderosa pine becomes more prevalent and white fir and Douglas-fir are reduced. Jeffrey pine is the principal overstory species found on ultramafic soils and serpentine outcrops (Küchler 1977, Sawyer and Thornburgh 1977).

Dense forests have a very rich shrub layer which can include Sierra laurel, Sadler oak, dwarf rose or western thimbleberry. In open-to-moderately dense forests, shrub-size plants in the subcanopy include small individuals of overstory species, especially Shasta red fir and white fir, as well as bitter cherry, Sierra chinquapin, pinemat manzanita, squawcarpet, huckleberry oak, Oregon-grape, greenleaf manzanita, dwarf rose, snowberry, and juneberry (Küchler 1977, Parker and Matyas 1981). The herbaceous layer is well developed and includes twinflower, American trailplant, queencup beadlily, western rattlesnake plantain, sweet-scented bedstraw, chimaphila spp., Idaho fescue, and tufted pinegrass (Sawyer and Thornburgh 1974).

Additional detailed information about the species composition in this habitat is contained in Sawyer and Thornburgh (1974).

Other Classifications. Other names for Klamath Mixed Conifer habitat include Mixed Conifer-Klamath Enriched Series (Parker and Matyas 1981), Klamath Montane Forest with Yellow Pine and Klamath Montane Forest with Douglas Fir (Küchler 1977), and Enriched Conifer Forest (Thorne 1976). It is included in the Red Fir Forest by Munz and Keck (1973) and in the Mixed Evergreen Zone by Proctor (1980). Cheatham and Haller (1975) further divide Klamath Mixed Conifer Forest into Siskiyou Enriched Conifer (8.541) and Salmon-Scott Enriched Conifer Forest (8.542). Sawyer and Thornburgh (1977) include Klamath Mixed Conifer habitat in the category of Abies magnifica Zone and in the upper elevations of the Abies concolor Zone of the"Klamath Montane Forests".

Habitat Stages

Vegetation Changes 1;2-5:S-D;6. Sawyer and Thornburgh (1977) indicate that the early successional stage is usually dense montane chaparral which originates from buried seed. This chaparral is dominated by manzanita, huckleberry oak, golden chinquapin, tobaccobrush and bitter cherry. This shrub stage is followed by a dense young growth conifer forest. According to Proctor (1980), the Klamath-enriched mixed conifer habitat goes through different successional stages following disturbance or manipulation. In general, these types presented by Proctor are early seral grassland, early seral shrub, young or second growth (conifer) forest and mature or old growth (conifer) forest. Sawyer and Thornburgh (1974) have identified several plant communities within the Klamath-enriched mixed conifer habitat that are considered to be potential or climax plant communities. They indicate that in some of these potential communities successful reproduction of most of the overstory species occurs in the understory indicating that the communities are perpetuating themselves.

Duration of Stages. Whittaker (1960) indicates that some forest trees in the Siskiyou Mountains are several centuries old. His studies also indicate that frequent fires were common, with older trees surviving intensive burns and continuing to dominate the upper levels of the tree strata. He concludes that portions of this habitat are stable for several centuries before natural disturbance restarts the process of succession. He further concludes that many vegetative units exhibited stability in spite of frequent fires and should be regarded as fire-adapted vegetation of a summer-dry climate. Commonly the plant communities in this habitat are 200 years old or younger. Often these communities have old growth conifers with deep fire scars, indicating the ability to persist in spite of fires. The mixed conifer communities of the eastern Klamath region are stable, with frequent light fires. The mixed conifer communities of the western Klamath region are usually burned enough to revert to the montane chaparral type (D. A. Thornburgh, pers. comm.).

Biological Setting

Habitat. Klamath Mixed Conifer habitat is bounded by many other wildlife habitats. At the lower, westernmost elevations, it intergrades with Montane Hardwood- Conifer (MHC) and Montane Hardwood (MHW) habitats. Numerous but small meadows and seeps occur throughout this habitat, contributing greatly to wildlife diversity. At lower elevations on its eastern border, Klamath Mixed Conifer interfaces with Sierran Mixed Conifer (SMC), Ponderosa Pine (PPN), Montane Hardwood-Conifer (MHC) and Mixed Chaparral (MCH). On drier or very rocky sites or on rock outcrops, Montane Chaparral (MCP) occurs at the same elevation as Klamath Mixed Conifer. This habitat interfaces with the Subalpine Conifer (SCN) habitat at its uppermost elevations.

Wildlife Considerations. Klamath Mixed Conifer covers a moderately large area in northwestern California. Extensive glaciation combined with complex geology has led to highly diverse vegetation,soils and wildlife habitats. A wide array of nesting and feeding opportunities and thermal cover for wildlife has resulted. Proctor (1980) lists the wildlife species that use this habitat at various successional stages. Rare, threatened or endangered wildlife in this habitat include spotted owl, peregrine falcon, wolverine, and Siskiyou Mountains salamander,

Physical Setting

The Klamath-enriched mixed conifer habitat occupies a complex of mountain ranges in northern California which are characterized by rugged, deeply dissected terrain with steep slopes due to extensive glaciation. This area has a considerable amount of ultramafic parent material and soils with scattered areas of serpentinitic soils; it also overlays a very old and complex geological structure. Average slopes are 60 percent or more and valleys are narrow. Soils found at higher elevations are predominantly Xerochrepts and Xerumbrepts and are generally very gravelly or cobbly. There are scattered areas of shallow unproductive soils such as Xerochrepts, or Xeralfs overlying peridotite and serpentine rock formations (Proctor 1980). There are also extensive areas of more productive Alfisols (B. Adamson, Shasta-Trinity National Forest, Redding, Calif., pers. comm.).

Climatic conditions include warm, wet winters and hot dry summers Mean monthly temperatures during the hottest month of the year range from 14 to 22 C (57 to 72 F). During the coldest month of the year temperatures range from 10 to 8 C (15 to 46 F). Mean annual temperature is approximately 11 C (52 'F) (Proctor 1980). Precipitation varies from 177 cm (69 in) on the western (maritime) side to 60 cm (24 in) on the eastern (continental) side.Most of the precipitation occurs during winter with generally less than 15 percent of precipitation falling during summer. Snowfall is moderate, ranging from 3 to 150 cm (2 to 60 in), with large amounts of snowfall occurring at the middle and high elevations where this habitat occurs. In years of heavy snowpack, the snow field may remain through the summer on north- and east-facing slopes above 1850 m (6160 ft) (Sawyer and Thornburgh 1974, Proctor 1980).

Distribution

The Klamath-enriched mixed conifer habitat is located within the Klamath Region, a geologically defined area in northwestern California comprised of a complex of mountain ranges including the Scott, Salmon, Marble, and southern Siskiyou Mountains, and the Trinity Alps. This habitat is normally found between 1350 2100 m (4500 - 6900 ft) and is restricted to the Klamath Region of northern California and southwestern Oregon.

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Lodgepole Pine

James W. Bartolome

Vegetation

Structure-- Lodgepole pine typically forms open stands of similarly sized specimens in association with few other species and with a sparse understory (Rundel et al. 1977). On fertile sites, trees can reach a height of 40 m (130 ft), but typically a stand consists of groups averaging 15 to 20 m (40 to 65 ft) in height. Nine stands in Sequoia National Park (Van Kat and Major 1978, cited in Rundel et al. 1977) averaged 56 percent crown cover, 3390 trees per ha (1370 per ac), and 58 sq m (625 sq ft) of basal area per ha (2.5 ac). Mature Sierran stands often contain significant seedlings and saplings, in contrast to the even aged character of stands in the northern Cascades and Rocky Mountains (Critchfield 1980).

Composition-- Lodgepole pine overwhelmingly dominates the habitat. Occasional associates include aspen and mountain hemlock. The amount of understory is weakly correlated with overstory density (Bartolome 1983). The understory may be virtually absent, consisting of scattered shrubs and herbs, or a rich herbaceous layer at meadow margins. Many lodgepole stands are associated with meadow edges and streams, where the understory consists of grasses, forbs, and sedges. In the southern Sierra and mountains of southern California, understory shrubs such as huckleberry and mountain heather may be common (Cheatham and Haller 1975).

Other Classifications-- Lodgepole Pine habitats form an easily distinguishable subdivision of the mixed conifer forest. Other classifications are Lodgepole Pine (U.S. Forest Service 1981) and Lodgepole Forest (Munz and Keck 1949). Classifications based on potential vegetation may not include a lodgepole pine type, considering it successional to other forest types.

Habitat Stages

Vegetation Changes-- 1;2-5:S-D. Three major disturbances affect lodgepole pine in California: fire, insects, and logging. These disturbances create openings of various sizes that lodgepole pines rapidly recolonize (Lotan and Perry 1983). The stages of vegetation change are primarily the result of increased tree density, canopy cover, and size.

A short period of herbaceous productivity precedes closure of the tree canopy on productive sites. The prolific seed output, establishment, and seedling growth of

lodgepole pine makes the period of herbaceous production short.

Continued recruitment into stands produces overstocking and slow growth of the overcrowded trees. This overcrowding may make them susceptible to insects (Lotan and Perry 1983), although others have argued that the more vigorously growing trees are more likely to be attacked. Beetle infestation creates large quantities of fuel that increase the probability of wildfire.

Many Sierran meadows have been invaded over the last few centuries by lodgepole pine (Benedict 1982); creating new dense stands. Although the understory persists, productivity is lowered (Bartolome 1983). The causes of this invasion remain poorly understood. Repeated episodes of tree invasion and subsequent reestablishment of meadows have occurred since the most recent glaciation.

Duration of Stages-- Young pines establish very rapidly and become reproductive; five year-old lodgepole pines are capable of producing cones (Critchfield 1980). Within 20 years, the canopy closes and understory productivity becomes negligible (Basile 1975 (Not in Hab Lit Cite)). Duration of the type thus depends on subsequent longevity of the trees. Stand persistence appears inversely related to site productivity (Lotan and Perry 1983); highly productive sites in Washington and Idaho were reported to start losing trees at 80 to 100 years. The upper limit of tree age seems about 400 years, although Critchfield (cited in Rundel et al. 1977) estimated one tree in the Sierra to be at least 600 years old.

Biological Setting

Habitat-- Typically the lodgepole pine zone is found above red fir and below the other subalpine conifer habitats (Rundel et al. 1977). Although the boundaries between lodgepole pine and meadow are dynamic, they are easily differentiated in classification of the existing landscape. Lodgepole pine most closely associates with the red fir habitat of lower elevations. Although lodgepole pine is widespread, it is generally a minor forest element in other habitats. At the upper elevation limits of lodgepole pine in southern California, the trees may adjoin alpine habitats.

Wildlife Considerations-- Lodgepole pine stands have low structural diversity and are relatively low in animal species. Many species found in lodgepole pine stands are associated with the meadow edge. The Lodgepole habitat provides suitable habitat for 6 reptiles and amphibians, 49 birds, 35 mammals (Verner and Boss 1980). These species include wolverine (rare), goshawk (sensitive), bald eagle (endangered), and prairie falcon (sensitive).

Physical Setting

Lodgepole pine occupies an array of landscape units within its zone of adaptation.

Areas of lodgepole pine in the red fir habitats are characterized by poor drainage and often a cooler microsite. Lodgepole pine is commonly associated with meadows (Rundel et al. 1977). Although lodgepole pine has well developed water regulation mechanisms, it typically occupies areas with at least seasonally wet soils. Annual precipitation in the lodgepole pine zone averages from 750 to 1000 mm (30 to 40 in) annually, mostly as snow. The growing season is short, averaging 2 to 3 months (Rundel et al. 1977).

Distribution

Lodgepole Pine habitats are scattered throughout the state, but concentrated in the Sierra Nevada and southern Cascades. Significant stands, however, occur in the higher mountains of southern California (Griffin and Critchfield 1972). Well developed lodgepole pine habitats are found above 1800 m (5900 ft) elevation in the northern Sierra and above 2400 (7900 ft) in the south.

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Montane Chaparral

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Vegetation

Structure-- The growth form of montane chaparral species can vary from treelike (up to 3 meters) to prostrate. When mature, it is often impenetrable to large mammals. Its structure is affected by site quality, history of disturbance (e.g., fire, erosion, logging) and the influence of browsing animals. For example, on shallow granitic soils in the Sierra Nevada, low dense growths of pinemat manzanita and huckleberry oak characterize an edaphic climax community, associated with scattered conifers and much exposed granite. Following fire in the mixed conifer forest habitat type, whitethorn ceanothus-dominated chaparral may persist as a subclimax community for many years. Montane chaparral is characterized by evergreen species; however, deciduous or partially deciduous species may also be present. Understory vegetation in the mature chaparral is largely absent. Conifer and oak trees may occur in sparse stands or as scattered individuals within the chaparral type.

Composition-- Montane chaparral varies markedly throughout California. Species composition changes with elevational and geographical range, soil type, and aspect. One or more of the following species usually characterize montane chaparral communities: whitethorn ceanothus, snowbrush ceanothus, greenleaf manzanita, pinemat manzanita, hoary manzanita, bitter cherry, huckleberry oak, sierra chinquapin, juneberry, fremont silktassel, Greene goldenweed, mountain mahogany, toyon, sumac and California buckthorn. As one or more of these species become dominant under various environmental regimes, further subclassification of the montane chaparral series is possible (Krebs 1972, McNaughton 1968).

Other Classifications-- Montane chaparral has been broadly described as chaparral (Munz and Keck 1973, (Küchler 1977) or mountain shrub (USDA 1977). Subclassifications based upon predominant species composition have also been described as montane mixed shrub series, huckleberry oak/pinemat manzanita series, bush chinquapin series, greenleaf manzanita series, tobacco brush series, mountain whitethorn series (Parker and Matyas 1981); upper montane chaparral, lower montane chaparral (Cheatham and Haller 1975).

Habitat Stages

Vegetation Changes-- 1;2-4:S-D. Montane chaparral in California occurs in

gradations between two characteristic successional sequences: The first sequence is associated with poorer, typically shallow soils (in early stages of development), often overlying fractured bedrock. Here, chaparral species may predominate to form an edaphic climax community.

In the second sequence, chaparral is a secondary succession following disturbance on deeper forest soils. After disturbance (logging, fire, erosion) chaparral proliferates and may exclude conifers and other vegetation for many years. However, chaparral may facilitate the germination of red fir seedlings (Barbour 1984) and other shade tolerant conifers by providing a protective cover, moderating microclimate, and improving soil conditions. Chaparral shrubs may be an essential link in forest succession by building up soil nutrient levels, especially nitrogen, to the point where trees can survive (Zavitovski and Newton 1968). In mature timber stands, chaparral species may senesce due to insufficient light through the canopy and are only present as a sparse understory. Thus, silvicultural practices have a strong influence on the structure of montane chaparral.

Most montane chaparral species are fire adapted. Mature plants sprout back from the root crown. Some species require scarification of the seed for germination and may produce numerous seedlings after a fire (Gratkowski 1961). However, if fires are too frequent, these species may be eliminated (Biswell 1969) changing the subsequent structure of the community. Deer and livestock foraging on sprouting chaparral may also have a significant effect on its rate of development, structure, and ultimate species composition (Biswell and Gilman 1961, Davis 1967). The forage yields of most sprouting shrubs are reduced for the first few years after a fire, but rapidly regain their original status. Burned areas commonly produce new shrub growth high in protein and are a preferred food source for herbivores (Einarsen 1946, Swank 1956).

Duration of Stages-- Following fire, herbaceous plants may dominate for up to 5 years. Usually within 7 to 9 years the brush overstory is fully developed (Sweeney 1956, Sampson 1944). Chaparral may persist for up to 50 years or longer before conifer development begins to significantly reduce the shrub growth through shading (Lyon 1969, Sweeney 1968). Where chaparral types occur as an edaphic climax (i.e., on poor, rocky soils, fractured bedrock or lava caps), growth rates may be rather slow, growth form is usually small and stunted, and individuals may be quite old. Development of montane chaparral at high elevations is often slowed by cold temperatures, snow cover and a short growing season (Barbour and Major 1977). However, at lower elevations, burned or logged areas may sprout new growth by the next growing season.

Biological Setting

Habitat-- Montane chaparral adjoins a variety of other wildlife habitats, including montane riparian (MRI), mixed chaparral (MCH), and perennial grassland (PGS). It becomes established in disturbed coniferous habits such as ponderosa pine (PPN), mixed conifer (SMC), Jeffrey pine (JPN), red fir (RFR) and lodgepole pine (LPN). At high elevations in the southern Sierra, it may occur with a sparse juniper overstory. At the lower extent of its elevational range, montane chaparral may intergrade with mixed

chaparral, a very similar habitat type.

Wildlife Considerations-- Montane chaparral provides habitat for a wide variety of wildlife. Numerous rodents inhabit chaparral (Wirtz 1974). Deer and other herbivores often make extensive use of chaparral. Throughout the west slope of the Sierra and south through the Transverse Range, deer are strongly associated with chaparral communities. Montane chaparral provides critical summer range foraging areas, escape cover and fawning habitat. In the Sierra, fawning areas are frequently found where the chaparral lies adjacent to or contains an interspersion of perennial grass or meadow-riparian habitat (Ashcraft 1975, Dasmann, 1971, Ashcraft 1976, Pacific Gas and Electric 1981). Some small herbivores use chaparral species in fall and winter when grasses are not in abundance. Rabbits and hares eat twigs, evergreen leaves and bark from chaparral. Shrubs are important to many mammals as shade during hot weather, and moderate temperature and wind velocity in the winter (Loveless 1967). Many birds find a variety of habitat needs in the montane chaparral. It provides seeds, fruits, insects, protection from predators and climate, as well as singing, roosting and nesting sites (Verner and Boss 1980), Storer and Usinger 1970).

Physical Setting

Montane chaparral can be found on shallow to deep soils, on all exposures, and from gentle to relatively steep slopes. It may dominate on more xeric sites, but occurs locally throughout the coniferous forest zone. Generally, climate is like that associated with the coniferous forest zone, cold winter temperatures with substantial precipitation. Summers are typically hot and dry (Barbour and Major 1977). In the northern portion of the state, montane chaparral is found between 914 to 2743 m (3000-9000 ft). In southern California this type occurs above 2134 m (7000 ft).

Distribution

Montane chaparral is associated with mountainous terrain from mid to high elevation at 914 to 3047 m (3000-10,000 ft). It occurs in southern California above 2134 m (7000 ft) in the Transverse Range of Los Angeles, and in San Bernardino, Riverside and San Diego counties; from Siskiyou to Kern counties in the Cascade and Sierra Nevada mountains; as a minor type from Tehama to Lake counties; and in Del Norte, Siskiyou, Trinity, and Shasta counties in the North Coast Ranges and Klamath mountains (Barbour and Major 1977). As a successional stage following disturbance, its distribution coincides with the ponderosa pine and mixed coniferous forest habitat types (Barbour and Major 1977).

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Montane Hardwood

Philip M. McDonald

Vegetation

Structure-- A typical montane hardwood habitat is composed of a pronounced hardwood tree layer, with an infrequent and poorly developed shrub stratum, and a sparse herbaceous layer. On better sites, individual trees or clumps of trees may be only 3 to 4 m (10 to 13 ft) apart. On poorer sites, spacing increases to 8 to 10 m (26 to 33 ft). Where trees are closely spaced, crowns may close but seldom overlap. Living crowns on mature canyon live oaks occupy about 60 percent of the bole on typical sites and up to 80 percent on poor sites. Tree heights tend to be uniform at most ages in mature stands where hardwoods occur, but subordinate to conifers. Mature oaks on better sites and in canyons range between 17 and 30 m (56 and 98 fl) tall and up to 150 cm (59) in) dbh. On poorer sites, mature trees typically are 10 to 15 m (33 to 49 ft) tall with boles up to 65 cm (26 in) in dbh, with dome-shaped crowns almost as wide as the trees are tall. On rocky summits, canyon live oak is a shrub of small diameter, usually less than 4 m (13 ft) in height. Snags and downed woody material generally are sparse throughout the montane hardwood habitat.

Composition-- In the Coast Range and Klamath Mountains, canyon live oak often forms pure stands on steep canyon slopes and rocky ridge tops. It is replaced at higher elevations by huckleberry oak (Parker and Matyas 1980)(No 1980 Lit Cite only 1979 and 1981.). At higher elevations, it is scattered in the overstory among ponderosa pine, Coulter pine, California white fir, and Jeffrey pine, the latter on serpentine and peridotite outcrops. Middle elevation associates are Douglas-fir, tanoak, Pacific madrone, California-laurel, California black oak, and bristlecone fir. Knobcone pine, Digger pine, Oregon white oak, and coast live oak are abundant at lower elevations. Understory vegetation is mostly scattered woody shrubs (manzanita, mountain-mahogany, poison-oak) and a few forbs.

In the Transverse and Peninsular ranges of southern California, overstory associates at middle and higher elevations are Jeffrey pine, ponderosa pine, sugar pine, incense-cedar, California white fir, bigcone Douglas-fir, California black oak, and Coulter pine. At lower elevations, associates are white alder, coast live oak, bigleaf maple, California-laurel, bigcone Douglas-fir, and occasionally valley oak, Digger pine, and blue oak (Cheatham and Haller 1975, McDonald and Littrell 1976). Understory shrub species are manzanita, poison-oak, coffeeberry, currant, and ceanothus.

In the southern Cascade and Sierra Nevada ranges, steep, rocky south slopes of major river canyons often are clothed extensively by canyon live oak and scattered old-growth Douglas-fir. Elsewhere, higher elevation overstory associates are typical mixed conifer and California black oak; lower elevation associates are Digger pine, knobcone pine, tanoak, Pacific madrone, and scrubby California-laurel. Associated understory vegetation includes Oregon-grape, currant, wood rose, snowberry, manzanita, poison-oak, and a few forbs and grasses.

Other Classifications-- In southwest Oregon, the species is part of the mixed evergreen (Pseudotsuga-sclerophyll) zone and to a lessor extent the conifer forest zone on drier areas (Franklin and Dryness 1969). These classifications are pertinent to California as well. In California, canyon live oak occurs in 12 of the 17 forest communities described by Munz and Keck (1968)(No Munz and Keck 1968 in Hab Lit Cite.), in 8 dominance types in the Sierra Nevada (Myatt 1980), and in 6 ecological provinces (Parker and Matyas 1980). Cheatham and Haller (1975) place canyon live oak in 8 minor subdivisions of 2 habitat types. Canyon live oak is recognized as a forest cover type by the Society of American Foresters and is an associate species in eight other types (Eyre 1980).

Habitat Stages

Vegetation Changes-- 1;2-5:S-D. Initial establishment of canyon live oak is by acorns, most of which do not move far from beneath tree crowns. Wider dissemination of acorns and seeds of associate species is by birds and mammals. After establishment, canyon live oak sprouts vigorously from the root crown. Most hardwood associates also sprout prolifically. Rapid sprout growth enables the hardwoods to capture most of the favorable micro sites, forcing the conifers to invade harsher sites, or those made harsh by hardwood roots below ground and hardwood shade above. Delayed establishment, slow growth, and sparse or clumpy distribution of conifers often results. In most instances, succession is slow. Seldom is canyon live oak a pioneer species, but occasionally it invades and becomes established on alluvial soils (Heady and Zinke 1978). Canyon live oak has loose, dead, flaky bark that catches fire readily and burns intensely (Plumb 1980). Occasional fire often changes a stand of canyon live oak to live oak chaparral, but without fire for sufficient time, trees again develop. Where fire is frequent, this oak becomes scarce or even drops out of the montane hardwood community.

Duration of Stages-- A type more stable than Montane Hard wood is difficult to envision. The large number of species in the type, both conifer and hardwood, allow it to occupy and persist in a wide range of environments. Good soils and poor, steep slopes and slight, frequently disturbed and pristine all are at least adequate habitats for one or more species. Longevity (at least 300 years for some species), and large size help to ensure dominance. Seed and sprout reproductive modes assure both wide spread and stationary reproduction, and consequently several age and size classes usually are present in most areas. Growth of most hardwoods, especially canyon live oak, generally

is slow and depends on depth and rockiness of soil, slope, and possibly length of time for roots to reach groundwater (Myatt 1980)

Biological Setting

Habitat-- At lower elevations, neighboring habitats are Valley foothill Hardwood-conifer (VHC) and, to a lesser extent, Closed cone Pine Cypress (CPC). At low and middle elevations, Mixed Chaparral (MCH) interfaces with Montane Hardwood. Wildlife habitats at middle elevations, often overlapping above and below, are Montane Hardwood-conifer (MHC), Mixed Conifer (MCN), Douglas-fir (DFR) and, to a lesser degree, Pine-juniper (PJN). At higher elevations, Montane Hardwood is neighbor to Eastside Pine (EPN), Jeffrey Pine (JPN), and Montane Chaparral (MCP).

Wildlife Considerations-- Bird and animal species characteristic of the Montane Hardwood habitat include disseminators of acorns (scrub and Steller's jays, acorn woodpecker, and western gray squirrel) plus those that utilize acorns as a major food source wild turkey, mountain quail, band-tailed pigeon, California ground squirrel, dusky-footed woodrat, black bear, and mule deer. Deer also use the foliage of several hardwoods to a moderate extent. Many amphibians and reptiles are found on the forest floor in the Montane Hardwood habitat. Among them are Mount Lyell salamander, ensatina, relictual slender salamander, western fence lizard, and sagebrush lizard. Snakes include rubber boa, ,western rattlesnake, California mountain kingsnake, and sharp tailed snake.

Physical Setting

Canyon live oak and associates are found on a wide range of slopes, especially those that are moderate to steep. Soils are for the most part rocky, alluvial, coarse textured, poorly developed, and well drained. Soil depth classes range from shallow to deep. L Canyon live oak, incense-cedar, and a few other associates are also found on ultrabasic soils. Mean summer temperatures in the Montane Hardwood habitat vary between 20 and 25 C (68 and 77 F) and mean winter temperatures between 3 and 7 C (37 and 45 F). Frost-free days range from 160 to 230 (Thornburgh 1986)(No Thornburgh 1986 in Habitat Lit Cite.). Annual precipitation varies from 2794 mm (110 in) in the northern Coast Range to 914 mm (36 in) in the mountains of southern California.

Distribution

The Montane Hardwood habitat ranges throughout California mostly west of the Cascade-Sierra Nevada crest. East of the crest, it is found in localized areas of Placer, El Dorado, Alpine and San Bernardino Counties. Elevations range from 100 m (300 fl) near the Pacific Ocean to 2745 m (9000 ft) in southern California

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Montane Hardwood-Conifer

Richard Anderson

Vegetation

Structure-- Montane Hardwood-Conifer (MHC) habitat includes both conifers and hardwoods (Anderson et al. 1976), often as a closed forest. To be considered MHC, at least one-third of the trees must be conifer and at least one-third must be broad-leaved (Anderson et al. 1976). The habitat often occurs in a mosaic-like pattern with small pure stands of conifers interspersed with small stands of broad-leaved trees (Sawyer 1980). This diverse habitat consists of a broad spectrum of mixed, vigorously growing conifer and hardwood species. Typically, conifers to 65 m (200 ft) in height form the upper canopy and broad-leaved trees 10 to 30 m (30 to 100 ft) in height comprise the lower canopy (Proctor et al. 1980, Sawyer 1980). Most of the broad-leaved trees are sclerophyllous evergreen, but winter-deciduous species also occur (Cheatham and Haller 1975).

Relatively little understory occurs under the dense, bilayered canopy of MHC. However, considerable ground and shrub cover can occur in ecotones or following disturbance such as fire or logging. Steeper slopes are normally devoid of litter; however, gentle slopes often contain considerable accumulations of leaf and branch litter (Cheatham and Haller 1975).

Composition-- Common associates in MHC are ponderosa pine, Douglas-fir, incense-cedar, California black oak, tanoak, Pacific madrone, Oregon white oak, and other localized species. Species composition varies substantially among different geographic areas.

In the north coast, California black oak, Oregon white oak, golden chinquapin, and canyon live oak are commonly found with white fir, Douglas-fir, and ponderosa pine (Parker and Matyas 1981). In the Klamath Mountains and north coast from the Oregon border to Marin County, Oregon white oak, tanoak, Pacific madrone, red alder, Douglas-fir, western red cedar, western hemlock, ponderosa pine, sugar pine, and knobcone pine are common (Küchler 1977, McDonald 1980(Is it a or b Lit Cite), Parker and Matyas 1981). In the northern interior, California black oak, bigleaf maple, Pacific madrone, and tanoak are common with ponderosa pine, white fir, incense-cedar, Douglas-fir, and sugar pine forming the overstory. In the northern Sierra Nevada, common associates include California black oak, bigleaf maple, white alder, dogwood, Douglas-fir, incense-cedar and ponderosa pine. In the southern Sierra Nevada, common associates include California black oak, black cottonwood, canyon live oak, Jeffrey pine, Douglas-fir, ponderosa pine,

sugar pine, incense-cedar, and localized areas of giant sequoia (Küchler 1977, Parker and Matyas 1981). In the central coast, common associates include coast live oak, big leaf maple, Pacific madrone, tanoak, canyon live oak, Coulter pine, coastal redwood and, to a lesser extent, California black oak and ponderosa pine. In the northern central coast, Douglas-fir is found; while in the southern areas, bigcone Douglas-fir occurs. In the Tehachapi, transverse and peninsular ranges of Southern California, common associates include canyon live oak, Pacific madrone, coast live oak and, to a lesser extent, California black oak, ponderosa pine, sugar pine, and incense-cedar (Thorne 1976, Küchler 1977, Parker and Matyas 1981).

Other Classifications-- Montane Hardwood-Conifer is very diverse and has been given a variety of names in the literature including: Mixed Evergreen Forest (Munz and Keck 1973); Mixed Evergreen Zone - Second Growth Forest (Broadleaf 1.1.1H) (Mixed 1.2.31) (Proctor et al. 1980); Mixed Evergreen Forest with Chinquapin, Mixed Hardwood Forest, Mixed Hardwood and Redwood Forest, Oregon Oak Forest, Coulter Pine Forest (Küchler 1977); Mixed Evergreen Forest, Coast Range Mixed Conifer Forest, Santa Lucia Fir Forest, Coast Range Ponderosa Pine Forest, Coulter Pine Forest (Cheatham and Haller 1975); Santa Lucia Fir Series, Bigcone Douglas-fir Series, Madrone Series and Black Oak Series (Paysen 1980)(No Paysen 1980 Lit Cite. There is a Paysen et al. Cite.); Oregon White Oak (Stein 1980); California Black Oak (McDonald 1980); Douglas-fir-Tanoak-Pacific Madrone (Sawyer, 1980); Black Oak Series, Maple-Alder-Dogwood Series, Mixed Conifer-Pine Series, Madrone-Tanoak Series (Parker and Matyas 1981).

Habitat Stages

Vegetation Changes-- 1;2-5:S-D;6. This habitat is climax in most cases; however, it can occur as a seral stage of mixed conifer forests. Vegetation response following disturbance, such as fire or logging, begins with a dense shrubby stage dominated by taller broad-leaved species. The stand gradually increases in height, simultaneously developing into two canopy strata with faster growing conifers above and broad-leaved species below. On mesic sites the conifer component overtakes the hardwood component more rapidly than on xeric sites, where the hardwood component is dominant longer (McDonald 1980).

Duration of Stages-- Secondary succession following disturbance is vigorous, with shrubs and trees regenerating together. The conifer component develops into relatively large, mature trees within 30 to 50 years. The broad-leaved component normally requires 60-90 years. Eventually the conifer component overtakes the broad-leaved component. Successional sequence and timing varies geographically and differs depending on species and environmental factors such as climate, water, and soil.

Biological Setting

Habitat-- Geographically and biologically, Montane Hardwood-Conifer is transitional between dense coniferous forests and montane hardwood, mixed chaparral, or open woodlands and savannahs. MHC merges with many other habitats at its upper and lower ecotones. These habitats include Valley-Foothill Hardwood (VFH), Valley-Foothill Hardwood-Conifer (VHC), Valley-Foothill Riparian (VRI), Closed-Cone Pine-Cypress (CPC), Montane Hardwood (MHW), Mixed Conifer (MCN), Douglas-fir (DFR), Redwood (RDW), Montane Riparian (MRI), Montane Chaparral (MCP), and Mixed Chaparral (MCH). The habitat is an area of vegetational and floristic diversity with large numbers of endemic species (Proctor et al. 1980).

Wildlife Considerations-- Montane Hardwood-Conifer provides habitat for a variety of wildlife species. Mature forests are valuable to cavity nesting birds. Moreover, mast crops are an important food source for many birds as well as mammals. Canopy cover and understory vegetation are variable which makes the habitat suitable for numerous species. In mesic areas, many amphibians are found in the detrital layer. Due to geographic variation in components of Montane Hardwood-Conifer, caution must be exercised when predicting wildlife species use.

Physical Setting

Montane Hardwood-Conifer generally occurs on coarse, well drained mesic soils, in mountainous terrain with narrow valleys. Slopes average approximately 57 percent with all aspects encountered. Winters are cool and wet; summers are hot and dry. Northern California Montane Hardwood-Conifer sites have less rainfall and fog than Redwood (RDW) or Mixed Conifer (MCN) habitats. In southern California, this habitat is found at higher elevations, and in moist canyons. Average rainfall is 60 to 170 mm (25 to 65 in), with some fog. The growing season is 7 to 11 months, with 200 to 300 frost-free days. Mean summer maximum temperatures are 25 to 36 C (75 to 95 F). Mean winter minima are 2 to 4 C (29 to 30 F) (Munz and Keck 1970)(No Munz and Keck 1970 Lit Cite).

Distribution

Montane Hardwood-Conifer occurs throughout California and is somewhat continuous from Santa Cruz County northward through outer coast range into Oregon, usually some distance inland m the coast (Cheatham and Haller 1975). The habitat typically lows the upper and/or inland margins of the coastal redwood RDW) or Douglas fir (DFR) habitats. It can also be found on north facing slopes of the inner north coast ranges, the Santa Lucia Mountains, as well as small patches extending to Santa Barbara County (Cheatham and Haller 1975). Montane Hardwood-Conifer also occurs somewhat continuously down the Sierra Nevada to the transverse ranges. Elevations range from 300 to 10 m (1000 to 4000 ft) in the north to 605 to 1760 m (2000 to 00 ft) in the south. Isolated patches of MHC can be found throughout the transverse and peninsular ranges of southern California.

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Ponderosa Pine

E. Lee Fitzhugh

Vegetation

Structure-- Tree spacing in ponderosa pine stands varies from open patchy to extremely close. On high quality sites, virgin stands may be 46-55 m (150-180 ft) high, with diameters from 0.91.2 m (3-4 ft) (Harlow and Harrar 1950). Typical overstory coverage of all layers may exceed 100% (Vankat 1970). Other conifers, when present, provide denser crowns than do the pine, thus creating habitat diversity. Grasses, shrubs, and deciduous trees may be present or absent. Typical coverage of shrubs is 10-30% and of grasses and forbs is 5-10% (Barbour 1986).

Composition-- The ponderosa pine habitat includes pure stands of ponderosa pine as well as stands of mixed species in which at least 50% of the canopy area is ponderosa pine. Associated species vary depending on location in the state and site conditions. Typical tree associates include white fir, incense-cedar, Coulter pine, Jeffrey pine, sugar pine, Douglas-fir, bigcone Douglas-fir, canyon live oak, California black oak, Oregon white oak, Pacific madrone and tanoak.

Associated shrubs include manzanita, ceanothus, mountain-misery, Pacific dogwood, hairy yerba-santa, yellowleaf silktassel, bitter cherry, California buckthorn, poison-oak, Sierra gooseberry. Grasses and forbs include slimleaf brome, Orcutt brome, carex, smallflower melicgrass, bluegrass, bottlebrush squirreltail, bedstraw, bracken fern, bush morning-glory, rhomboid clarkia, Child's blue-eyed mary, shrubby eriastrum, splendid gilia, Sierra iris, whisker-brush, Inyo bush lupine, summer lupine, purple nightshade, streptanthus, gooseroot violet, and wild iris.

Other Classifications-- The ponderosa pine habitat, as defined here, forms a part of the yellow pine forest of Munz and Keck (1959) and Thorne (1977), the montane forest of Griffin and Critchfield (1976)(No 1976 Lit Cite. There is a 1972 Lit Cite. 1972 Cite not placed in Lit cite at end.), the ponderosa/Jeffrey pine series of Pays More restrictive types which include only a part of the ponderosa pine habitat are Pacific ponderosa pine (245) (Eyre 1980), ponderosa pine (Parker and Matyas 1979 and Barbour and Major 1977), western Sierra ponderosa pine forest (Barry unpublished, cited in Cheatham and Haller 1975), ponderosa pine series of the Sierra montane conifer forest (Pase 1982a), Coast Range ponderosa pine forest and "westside" ponderosa pine forest (Cheatham and Haller 1975), and Sierran yellow pine forest (Küchler 1977). en, et al. (1980) and the mid-montane conifer forest of Barbour (1986). In addition, on those sites where ponderosa pine is dominant, portions of other montane forests (Küchler

1977), and Pacific ponderosa pine-Douglas-fir (Barbour 1986), and mixed conifer (244, 243), (Eyre 1980) are included in ponderosa pine habitat.

Habitat Stages

Vegetation Changes-- 2-5;SD. Most ponderosa pine stands that include other coniferous trees probably are maintained by periodic ground fires. In many of these stands, crown fires result in dense montane chaparral communities (Cheatham and Haller, 1975). Young, dense stands, as in plantations, exclude most undergrowth once trees attain a closed canopy. Prior to that, dense brush is typical, but an herbaceous layer may develop on some sites.

Duration of Stages-- On sites or areas that are dry or of low quality, significant pine regeneration may depend on concurrent disturbance of chaparral and a good pine seed crop with favorable weather. Thus, it may require 50-100 years for significant pine regeneration in the absence of intervention. Clearcuts with minimal brush control develop a dense stand of pole-size trees in 2030 years, twice the time required when brush is completely removed. Dense brush is typical in young stands and an herbaceous layer may develop on some sites. On drier sites, there is less tendency for succession toward shade-adapted species. Sites disturbed by fire or logging sometimes are converted to dense montane chaparral or mixed chaparral. Moist chaparral areas of higher site quality tend to develop directly into mixed conifer stands. As young, dense stands age and attain a closed canopy, they exclude most undergrowth. When other adapted conifers occur in moist ponderosa pine stands of medium to high site quality, they may form a significant understory in about 20 years in the absence of fire. If allowed to continue, such succession may change the structure and composition of the stand within 40 years sufficiently to favor wildlife adapted to mixed conifer habitats. Most ponderosa pine stands that include other coniferous trees probably are maintained by periodic ground fires (Cheatham and Haller 1975).

Biological Setting

Habitat-- In Northern California, ponderosa pine stands occur above coastal oak woodland, valley oak woodland, blue oak woodland, blue oak-digger pine and below mixed conifer. Montane hardwood stands may be below or interspersed with ponderosa pine. Jeffrey pine stands often occur above ponderosa pine, but may be found on serpentine soils or on harsh sites at lower elevations in the ponderosa pine zone. Farther south, coastal scrub, chamise-redshank, mixed chaparral, or woodland oaks are typical at the lower boundary of the ponderosa pine habitat, with bigcone Douglas-fir or true firs at the upper edge. Dry, rocky sites within the habitat may support montane chaparral, mixed hard wood-conifer or closed-cone pine-cypress. Isolated, small patches of bigcone Douglas-fir may occur in mesic canyons or on north-facing slopes within ponderosa pine stands.

Wildlife Considerations-- Ponderosa pine sometimes is a transitional or migratory habitat for deer and can be extremely important to deer nutrition in migration holding areas. A mixture of early and late successional stages closely interspersed probably will provide good general wildlife habitat but riparian zones, deer migratory routes and holding areas require special consideration during management planning. The California condor uses the ponderosa pine habitat from Madera and Santa Clara Counties southward. Moreover, the Sierra Nevada red fox, Siskiyou mountain salamander and Shasta salamander also are found in the habitat.

Physical Setting

The lower elevational limit of the habitat may correspond to a mean annual temperature less than 13 C (55 F) and precipitation greater than 350 mm (33 in) except in southern California (Barbour 1986). Brown (1982) reported a minimum precipitation level of 635 mm (25 in) annually in the Peninsular Ranges. Ponderosa pine is found on all aspects, depending on soils and location within the local elevational range. Less than one-third of the precipitation is snowfall (Barbour 1986).

Distribution

Ponderosa pine habitat is found on suitable mountain and foothill sites throughout California except in the immediate area of San Francisco Bay, in the north coast area, south of Kern County in the Sierra Nevada and east of the Sierra Nevada Crest. Elevational ranges include 240-180 m (800-5000 ft) in the northern Sierra Nevada and Cascades, 1200-2100 m (3937-6890 ft) in the central and southern Sierra Nevada and 1300-2140 m (4265-7021 ft) in the Transverse and Peninsular Ranges, although it may be found as low as 105 m (3445 ft) in moist south-coastal sites (Rundel et al. 1977, Thorne 1977, Brown 1982 and Cheatham and l Haller 1975). The ponderosa pine habitat is replaced by Jeffrey pine on the Mojave Desert slopes of the Transverse Range and often on the eastern side of the Peninsular and Coast Ranges.

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Sierran Mixed Conifer

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Vegetation

Structure. The Sierran mixed conifer habitat is an assemblage of conifer and hardwood species that forms a multilayered forest. Historically, burning and logging have caused wide variability in stand structure, resulting in both even-aged and unevenaged stands (Rundel et al. 1977). Virgin old-growth stands where fire has been excluded are often two-storied, with the overstory comprised of mixed conifer and the understory white fir and incense-cedar (Tappeiner 1980).

Forested stands form closed, multilayered canopies with nearly 100 percent overlapping cover (Rundel et al. 1977). When openings occur, shrubs are common in the understory (Kosco 1980). Closed canopy stand distribution is both extensive and patchy depending on scale, site, slope, soils,microclimate, and history.

At maturity, the dominant conifers range from 30 to 60 m (100 to 200 ft) tall with a highly variable basal areas of about 17 to 26 sq m (180 - 280 sq ft). Diameter breast height at maturity for pines and Douglas-fir is commonly greater than 1 m (40 in); white fir greater than 0.9 m (35 in) is common (Laake and Fiske 1983b). Fuel loading in stands heavy with pine may reach 27,000 kg/ha (70 to 80 t/ac) in natural stands; whereas fuel loading in stands heavy with fir may reach 16,000 kg/ha (40 to 50 t/ac).

Composition. Five conifers and one hardwood typify the mixed conifer forest white fir, Douglas-fir, ponderosa pine, sugar pine, incense-cedar, and California black oak. White fir tends to be the most ubiquitous species (though most often a minor overstory component) because it tolerates shade and has the ability to survive long periods of suppression in brush fields Douglas-fir dominates the species mix in the north, but is absent south of the Merced River (Tappeiner 1980). Ponderosa pine dominates at lower elevations and on south slopes. Jeffrey pine commonly replaces ponderosa pine at high elevations, on cold sites, or on ultramafic soils (Rundel et al. 1977). Red fir is a minor associate at the highest elevations. Sugar pine is found throughout the mixed conifer type. Black oak is a minor, but widespread, component in mixed conifer stands. Though black oak does best on open sites,it is maintained under adverse conditions such as shade, ridge tops, and south slopes where conifers may regenerate in its shade (Tappeiner 1980). In the central and particularly southern Sierra Nevada, giant sequoia is a striking associate of the mixed conifer type (Rundel et al. 1977). White fir, incense-cedar and sugar pine are associated with the mesic giant sequoia sites (Tappeiner 1980).

Deerbrush, manzanita, chinquapin, tan oak, bitter cherry, squawcarpet, mountain whitethorn, gooseberry, rose, and mountain misery are common shrub species in the mixed conifer understory (Kosco and Bartolome 1983). Grasses and forbs associated with

this type include mountain brome, Carex, bull thistle, iris, Juncus, and needlegrass. In all, over 100 species of grasses, forbs and shrubs contribute to the flora of the mixed conifer habitat (Tappeiner 1980).

Other Classifications.- Other names for the Sierran mixed conifer habitat include yellow pine forest (Munz 1973). Parker and Matyas (1981) divide Sierran mixed conifer into five series: mixed conifer-fir, mixed conifer-pine, ponderosa pine, white fir and Jeffrey pine. Rundel et al. (1977) describes the mixed conifer as part of a White fir-mixed conifer forest and Cheatham and Haller (1975) call this habitat Sierran coniferous forest (8.42), a major subdivision of the lower montane coniferous forest habitat (8.4). Sierran mixed conifer is SAF type 243 (Tappeiner 1980). Where ponderosa pine or Douglas-fir predominates without significant amounts of white fir or incense-cedar, the forest is typed as Pacific ponderosa pine or Pacific ponderosa pine-Douglas-fir (SAF types 245 and 244, respectively) (McDonald 1980).

Habitat Stages

Vegetation Changes 1;2-5:S-D;6. After logging or burning, succession proceeds from an ephemeral herb to perennial grass-herb, through a shrub-perennial grass stage, to conifers (Burcham 1964). In many areas, however, shrubs appear in the first year after disturbance (Kosco 1980). The habitat stages are stage 1, grass-forb, with bedstraw, plantain, mountain brome, and needlegrass as common early succession species; stage 2, shrub-seedling-sapling, characterized by manzanita, Ceanothus, cherry, gooseberry, and mountain misery. In the seedling tree stage through the sapling tree, pole tree, small tree, and medium/large tree stages, the five conifers gain dominance of the site.

Duration of Stages. Stage duration has been described by Verner (1980). The grass-forb stage, generally is short-lived (less than 2 years). The shrub-seedling-sapling stage is usually evident by yr 2 and lasts 10 to 40 yr; this stage is a mixture of shrubs and saplings up to 6 m (20 ft) tall depending on the site, degree, and type of disturbance. If tall shrubs capture the site, it may take 10 to 15 plus yr for trees to dominate the site. The pole-medium tree stage supports trees up to 15 m (50 ft) tall and may last from 15 to 90 yr on poor sites. The mature and overmature stages include stands greater than about 30 m (100 ft) in height.

Biological Setting

Habitat. The type adjoins Ponderosa Pine (PPN) at lower elevations and drier slopes, and White Fir (WFR) and Red Fir (RFR) at higher elevations. Wet Meadow (WTM) and Montane Riparian (MRI) are found within the Sierran Mixed Conifer type. Blue Oak - Foothill Pine (BOP) and Mixed Chaparral (MCH) may adjoin this type at drier, and lower, elevations.

Wildlife Considerations. The mixed conifer forest supports some 355 species of animals (Verner and Boss 1980). Sensitive species inhabiting mixed conifer include spotted owl, fisher and pine marten. Endangered species include bald eagle and peregrine

falcon (Verner and Boss 1980). Variety in plant species composition provides diversity in food and cover. Black oak acorns, berries from a variety of shrubs (e.g., deerbrush), and a great number of grasses and forbs provide the forage resource essential for wildlife (Kosco and Bartolome 1983).

Physical Setting

Soils supporting the Sierran mixed conifer habitat are varied, derived primarily from Mesozoic granitic, Paleozoic sedimentary and volcanic rocks, and Cenozoic volcanic rocks. Serpentine soils, found primarily in the northern mixed conifer zone, support a number of endemic plants. Soils are deep to shallow. Fissures and cracks in granitic parent material often support forest growth, even where soil development is shallow. Temperatures range from 24 to 58 C (40 to 96 F) in summer and 4 to 36 C (10 to 60 F) in winter and decrease with elevation (Major 1977). The growing season ranges between 90 and 330 days in the north with 40 to 200 frost-free days, and 180 to 365 days in the south with 180 frost-free days. Precipitation ranges from 76 to 229 cm (30 to 90 in) per year, from October to May, with increasing snowfall as elevation increases.

Distribution

The Sierran mixed conifer habitat generally forms a vegetation band ranging 770 to 1230 m (2500 to 4000 ft) in the north to 1230 to 3076 m (4000 to 10,000 ft) in the southern Sierra Nevada (Griffin and Critchfield 1972). The Sierra Nevada mixed conifer forest occupies between 1.8 to 3.2 million ha (4.5 to 7.8 million ac) in southern Oregon and California, dominating western middle elevation slopes of the Sierra Nevada. Disjunct populations of mixed conifer are found in the Peninsular, Transverse, and Coast ranges of California.

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