

A GUIDE TO WILDLIFE
HABITATS OF CALIFORNIA

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Vegetation

Structure.—Generally these woodlands have an overstory of scattered trees, although the canopy can be nearly closed on better quality sites (Pillsbury and De Lasaux 1983). The density of blue oaks on slopes with shallow soils is directly related to water stress (Griffin 1973). The canopy is dominated by broad-leaved trees 5 to 15 m (16 to 50 ft) tall, commonly forming open savanna-like stands on dry ridges and gentle slopes. Blue oaks may reach 25 m (82 ft) in height (McDonald 1985); the tallest tree, found in Alameda County, measured 28.7 m (94 ft) high and had a crown spread of 14.6 m (48 ft) (Pardo 1978). Shrubs are often present but rarely extensive, often occurring on rock outcrops. Typical understorey is composed of an extension of Annual Grassland vegetation.

Composition.—Blue oak is the dominant species, comprising 85 to 100 percent of the trees present. Common associates in the canopy are coast live oak in the Coast Range, interior live oak in the Sierra Nevada, valley oak where deep soil has formed, and western juniper in the Cascade Range. In the Tehachapi and Paiute Ranges in Kern County, this habitat mixes with species from east of the mountains—California juniper and single-leaf pinyon. In interior sections of the southern Coast Range, as in San Luis Obispo County, it mixes with California juniper (V. L. Holland, pers. comm.). Associated shrub species include poison-oak, California coffeeberry, buckbrush, redberry, California buckeye, and manzanita spp. The ground cover is comprised mainly of annuals, such as bromegrass, wild oats, foxtail, needlegrass, filaree, fiddleneck, and others. Comprehensive descriptions of different BOW's can be found in White (1966), Griffin (1977), Baker et al. (1981), and Pillsbury and De Lasaux (1983).

Other Classifications.—The habitat is referred to as Foothill Woodland by Munz and Keck (1959), Blue Oak Phase of the Foothill Woodlands by Griffin (1977), Blue Oak Series by Paysen et al. (1980), Blue Oak Savanna by Verner and Boss (1980), and Blue Oak Community by Parker and Matyas (1981). BOW's and Blue Oak-Digger Pine Woodlands are considered a single habitat in Küchler's (1977) Blue Oak-Digger Pine Forest (25) and in the Blue Oak-Digger Pine (250) type of the Society of American Foresters (Eyre 1980).

Habitat Stages

Vegetation Changes 1;2-5:S-D.—Details of successional trends in this habitat type are poorly known. Succession presumably proceeds directly from annual grasslands to tree stages. Most stands of BOW exist as medium or large tree stages with few or no young blue oaks present (White 1966, Holland 1976, Griffin 1977, Baker et al. 1981). Therefore, only structural classes 3-5:S-D are likely to be found. Few areas can be found in California where successful recruitment of blue oaks has occurred since the turn of the century (Holland 1976). This may be due to changes in land use; increased consumption or damage of acorns and seedlings by insects, livestock, and native animals; competition between seedlings and introduced annuals for available soil nutrients and moisture; and the absence of appropriate climatic conditions. Where germination of acorns occurs, survival and growth of the seedlings typically fail. Probably in the drier savanna-like stands, the grassland openings will simply become larger as older trees die. Griffin (1977) suggests that live oaks may replace deciduous oaks in some areas, because their seedlings are more browse resistant. Many authorities question whether conditions will ever again support the recruitment of blue oaks needed to maintain these important woodlands.

Duration of Stages.—Valid generalizations about the duration of various successional stages leading to mature stands of BOW are not possible, because adequate quantitative studies have

never been done. The successional sequence probably takes at least 50 years, even on good sites. Age studies in the Coast Range (White 1966, Pillsbury and De Lasaux 1983) and the southern Sierra Nevada (Brooks 1969) indicate that most blue oak stands are currently 80 to 120 years in age. Blue oaks are relatively slow-growing, long-lived trees. Large blue oaks range in age from 153 to 390 years (White 1966). Estimation of tree age based on dbh measurements is risky, however, because the dbh relationship varies tremendously depending on site quality. Moreover, height growth is extremely slow or even ceases after trees reach 65 cm (26 in) in dbh (McDonald 1985).

Biological Setting

Habitat.—This type usually intergrades with Annual Grasslands or Valley Oak Woodlands at lower elevations and Blue Oak-Digger Pine woodlands at higher elevations.

Wildlife Considerations.—The importance of oak habitats to wildlife in California has recently been reviewed by Barrett (1980) and Verner (1980), but they give few details relevant specifically to BOW's. Verner and Boss (1980) give data on wildlife use in blue oak savannas of the western Sierra Nevada. They indicate that 29 species of amphibians and reptiles, 57 species of birds, and 10 species of mammals find mature stages of this type suitable or optimum for breeding, assuming that other special habitat requirements are met. Griffin (1971) concluded that acorns buried by scrub jays, yellow-billed magpies, western gray squirrels and California ground squirrels are more likely to germinate because they root better and are less likely to be eaten. Although many wildlife species benefit from the use of oaks and even enhance oak germination, additional information is needed on many aspects of oak-wildlife relationships before this habitat can be properly managed.

Physical Setting

BOW's are usually associated with shallow, rocky, infertile, well-drained soils from a variety of parent materials (McDonald 1985). Blue oaks are well adapted to dry, hilly terrain where the water table is usually unavailable (Griffin 1973). The climate is Mediterranean, with mild wet winters and hot dry summers. Climatic extremes are relatively great in these woodlands, because they have a considerable geographic and elevational range. Average annual precipitation varies from 51 to 102 cm (20 to 40 in) over most of the blue oak's range, although extremes are noted from 25 cm (10 in) in Kern County to 152 cm (60 in) in Shasta County (McDonald 1985). Blue oaks have an unusual tolerance of severe drought, even shedding their leaves during periods of extreme moisture stress. This survival trait contributes to its pattern of distribution, as it competes most successfully with other tree species on drier sites (McDonald 1985). Mean maximum temperatures are from 24 to 36°C (75 to 96°F) in summer, and minima are from -2 to 6°C (29 to 42°F) in winter. The growing season ranges from 6 months in the north to the entire year in the south, with 175 to 365 frost-free days (Burcham 1975).

Distribution

BOW's occur along the western foothills of the Sierra Nevada-Cascade Ranges, the Tehachapi Mountains, and in the eastern foothills of the Coast Range, forming a nearly continuous ring around the Central Valley. The habitat is discontinuous in the valleys and on lower slopes of the interior and western foothills of the Coast Range from Mendocino County to Ventura County. It is generally found at elevations from 152 to 610 m (500 to 2000 ft) at the northern end of its range and on the western slopes of the Sierra Nevada, from 76 to 915 m (250 to 3000 ft) in the central Coast Range, and from 168 to 1370 m (550 to 4500 ft) in the Transverse and Peninsular Ranges (Sudworth (1908).



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 broadleaved, 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 nonriparian 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.

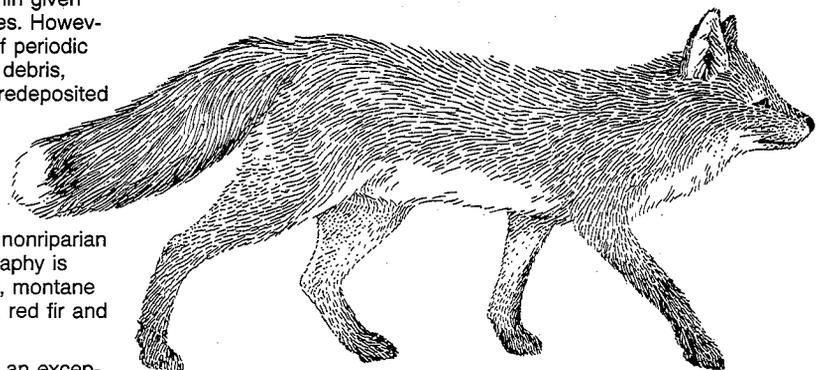
The southern rubber boa and Sierra Nevada red fox are among the rare, threatened or endangered wildlife that use MRI habitats during their life cycles.

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).



Sierra Nevada Red Fox (*Vulpes vulpes necator*)



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 nonriparian 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).

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.



Ringtail (*Bassariscus astutus*)



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), Bromegrass, 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 surrounding Valley Foothill Riparian (VRI), Alkali Scrub (ASC), Fresh Emergent Wetland (FEW), Cropland (CRP), Orchard-Vineyard (OVN), and Pasture (PAS) habitat types, and below Valley Oak Woodland (VOW), Blue Oak Woodland (BOW), Blue Oak-Digger 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.

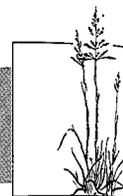
Wildlife Considerations.—Many wildlife species use Annual Grasslands for foraging, but some require special habitat features such as cliffs, caves, ponds, or habitats with woody plants for breeding, resting, and escape cover. Characteristic reptiles that breed in Annual Grassland habitats include the western fence lizard, common garter snake, and western rattlesnake (Baisey 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 Service 1975), 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 throughout the central valley of California, in the coastal mountain ranges as far north as Men-



Vegetation

Structure.—Fresh Emergent Wetlands are characterized by erect, rooted herbaceous hydrophytes. Dominant vegetation is generally perennial monocots to 2 m (6.6 ft) tall (Cheatham and Haller 1975, Cowardin et al. 1979). All emergent wetlands are flooded frequently, enough so that the roots of the vegetation prosper in an anaerobic environment (Gosselink and Turner 1978). The vegetation may vary in size from small clumps to vast areas covering several kilometers. The acreage of Fresh Emergent Wetlands in California has decreased dramatically since the turn of the century due to drainage and conversion to other uses, primarily agriculture (Gilmer et al. 1982).

Composition.—On the upper margins of Fresh Emergent Wetlands, saturated or periodically flooded soils support several moist soil plant species including big leaf sedge, baltic rush, redroot nutgrass and on more alkali sites, saltgrass. On wetter sites, common cattail, tule bulrush, river bulrush, and arrowhead are potential dominant species (Cheatham and Haller 1975, U.S. Army Corps of Engineers 1978, Wentz 1981).

Other Classifications.—Other names for Fresh Emergent Wetland habitats include riverine, lacustrine and palustrine emergent wetland (Cowardin et al. 1979); alkali marsh - 5.23 and fresh water marsh - 5.24 (Cheatham and Haller 1975); tule marsh - 37 (Küchler 1977) and cattail-sedge (Parker and Matyas 1981). The U.S. Fish and Wildlife Service summarizes several Fresh Emergent Wetland classifications according to their occurrence in certain terrestrial habitats (Proctor et al. 1980).

Habitat Stages

Vegetation Change 1:2:S-D.—It is commonly thought that as depressions or shoreline areas that support Fresh Emergent Wetlands (FEW) accumulate silt, marsh communities are replaced by upland communities. This process is slow unless erosion, either natural or man caused, is accelerated (U.S. Army Corps of Engineers 1978). Fresh emergent wetland habitats may exist in any of the structural classes 1-2:S-D. In areas with relatively stable climatic conditions, fresh emergent wetlands maintain the same appearance year to year (Cowardin et al. 1979); however, where extreme climatic fluctuations occur, they may revert to an open water phase in some years (Stewart and Kantrund 1971).

Duration of Stages.—Fresh Emergent Wetlands are relatively stable successional (U.S. Army Corps of Engineers 1978) but are transitory in a geological time frame (Odum 1971). Fire, flooding, and draining, maintain shallow basins where Fresh Emergent Wetlands prosper (Odum 1971); but conversion to uplands, which may take from decades to centuries, is the climax. The time this process takes depends on wetland size, rate of sedimentation, frequency of flooding and drainage, and the rate of increase in organic matter. Few studies estimate the time frame of long term wetland succession, but a wetland studied by McAndrews et al. (1976) had a history of 11,000 years and was still present.

Biological Setting

Habitat.—Fresh emergent wetland habitats may occur in association with terrestrial habitats or aquatic habitats including Riverine (RIV), Lacustrine (LAC) and Wet Meadows (WTM). The upland limit of Fresh Emergent Wetlands is the boundary

between land with predominantly hydrophytic cover and land with primarily mesophytic or xerophytic cover or the boundary between hydric and nonhydric soils (Cowardin et al. 1979). The boundary between fresh emergent wetlands and deep water habitats (e.g., Lacustrine or Riverine) is the deep water edge of the emergent vegetation. It is generally accepted that this demarcation is at or above the 2 m (6.6 ft) depth (Cowardin et al. 1979, Zoltai et al. 1975). The 2 m (6.6 ft) lower limit for emergent wetlands was selected because it represents the maximum depth to which emergent plants normally grow (Welch 1952, Sculthorpe 1967).

Wildlife Considerations.—Fresh emergent wetlands are among the most productive wildlife habitats in California. They provide food, cover, and water for more than 160 species of birds (U.S. Comptroller General 1979), and numerous mammals, reptiles, and amphibians. Many species rely on Fresh Emergent Wetlands for their entire life cycle. The endangered Santa Cruz long-toed salamander and rare black toad require ponded water for breeding, while the rare giant garter snake use these wetlands as its primary habitat. The endangered Aleutian Canada goose, bald eagle, and peregrine falcon use Fresh Emergent Wetlands as feeding areas and roost sites (Calif. Dep. Fish Game 1980).

Physical Setting

Physical Setting.—Fresh emergent wetland habitats occur on virtually all exposures and slopes, provided a basin or depression is saturated or at least periodically flooded. However, they are most common on level to gently rolling topography. They are found in various landscape depressions or at the edge of rivers or lakes (Wentz 1981). Fresh emergent wetland vegetation zones characteristically occur as a series of concentric rings which follow basin contours and reflect the relative depth and duration of flooding. If the bottom of the wetland is very uneven, vegetation zones may be present in a patchy configuration rather than the classic concentric ring pattern (Millar 1976). Soils are predominantly silt and clay, although coarser sediments and organic material may be intermixed (Cowardin et al. 1979). In some areas organic soils (peat) may constitute the primary growth medium (U.S. Army Corps of Engineers 1978). Climatic conditions are highly variable and range from the extreme summer heat of Imperial County to the Great Basin climate of Modoc County where winter temperatures often are well below freezing (Cheatham and Haller 1975).



Vegetation

Structure.—Saline Emergent Wetlands (SEW) are characterized as salt or brackish marshes consisting mostly of perennial graminoids and forbs, the latter often succulent and suffrutescent, ranging in height from 0.2 to 2 m (0.7-6.6 ft) or more (Munz and Keck 1973, Cheatham and Haller 1975, Küchler 1977), along with algal mats on moist soils and at the base of vascular plant stems (Küchler 1977, Zedler 1982). The component plants occur sometimes in zones but more often in patches or as a sequence of overlapping species along an elevational gradient (Vogl 1966, Macdonald 1977a, Zedler 1982). Vegetational coverage is complete or nearly so except where creeks and ponds are present or following disturbance (Pestrong 1972, Küchler 1977, Zedler 1982). Vertical stratification occurs in all but the lower, outer zone.

Composition.—Characteristic or distinctive vascular plant species ranging from lower saline sites to higher or brackish sites are cordgrass, pickleweed, Humboldt cordgrass, glasswort, saltwort, jaumea, California seablite, seaside arrowgrass, alkali heath, sea-shore saltgrass, spearleaf saltweed, shoregrass, the endangered birdsbeak, common glasswort, sea-lavender, brass-buttons, salt-marsh dodder, gumweed, salt rush, tufted hairgrass, Pacific alkali bulrush, Olney bulrush, tule bulrush, California bulrush, common cattail, tropical cattail, cinquefoil, and coast carex (Macdonald and Barbour 1974, Cheatham and Haller 1975, Macdonald 1977a, Zedler 1982, U.S. Fish and Wildlife Service 1983a, Spicher and Josselyn 1985). Algae include greens, bluegreens, and diatoms (Zedler 1982).

Other Classifications.—Other names for Saline Emergent Wetlands include coastal salt marsh (2-Munz and Keck 1973, 5.21-Cheatham and Haller-1975, 3-Thorne-1976, 38-Küchler-1977, Macdonald 1977a, Zedler 1982); tidal marsh-3a, salt-flat succulent-3b (Thorne 1976); saltwater marsh, saltwater coastal flat (U.S. Army Corps of Engineers 1978); pickleweed-cordgrass, pickleweed, cattail-sedge, sedge-rush (Parker and Matyas 1981); cordgrass, pickleweed, suaeda, saltgrass, bulrush (Paysen et al. 1980); estuarine intertidal emergent wetland (Cowardin et al. 1979, Jones and Stokes Assoc., Inc. 1981); intertidal estuarine zone-emergent vegetation-2.1.2 C, above tide estuarine wetland zone: diked marsh-2.1.3.A (Proctor et al. 1980); regularly folded saltmarshes-18, irregularly flooded salt marshes-17, salt meadows-16, salt flats-15 (Martin et al. 1953); salt marsh, brackish marsh (Mason 1957, Faber 1982); salt-water marsh, seasonally salt-water marsh (Mason 1957); coastal brackish marsh-5.22 (Cheatham and Haller 1975); tule marsh-37 (Küchler 1977).

Habitat Stages

Vegetation Changes 1-2:S-D.—Saline Emergent Wetland becomes established as low marsh on intertidal flats and advances seaward as plant detritus and sediments accrete, gradually causing a change to high marsh (Macdonald 1977a). Conversely, high marsh can extend landward as sea level rises (Atwater et al. 1979, Krone 1982, Josselyn 1983). This habitat may exist as any of classes 1-2:S-D. Plant height is greater in the outer, lower zone, ranging from 1 to 1.5 m (3.3-4.9 ft) if cordgrass is present (Purer 1942, Zedler 1982). At higher elevations, height generally varies from 0.2 to 0.7 m (0.7-2.3 ft) (Purer 1942), but barren flats may occur in the south (Macdonald 1977a). In brackish marshes, height ranges up to 2 to 4 m (6.6-13.1 ft) (Cheatham and Haller 1975, Josselyn 1983).

Duration of Stages.—Many parts of present day Pacific Coast salt marshes are believed to be of relatively recent (100 years) origin (Macdonald and Barbour 1974). However, high marsh has remained stable for periods of at least 770 years in Oregon, and comparable marshes existed along the coast during the Pleistocene (Macdonald 1977b). Influencing factors are sedimentation

rates and coastal submergence or emergence rates (Macdonald 1977a,b, Zedler 1982). Sedimentation rates have increased from 0.1 cm (0.04 in)/yr before European settlement to 0.2 to 0.5 cm (0.08-0.2 in)/yr in the 1900's because of greater human-induced erosion of uplands (Macdonald 1977a, Zedler 1982). For the last several thousand years, submergence rates from the rise in sea level in the San Francisco Bay Area have averaged 0.1 to 0.2 cm (0.04-0.08 in)/yr (Josselyn 1983).

Other factors affecting wetland duration are diking, ditching, dredging, filling, hydraulic mining, and diversion or impoundment of water upstream, trampling, and pollution (U.S. Fish and Wildlife Service 1979, Atwater et al. 1979, Zedler 1982).

Biological Setting

Habitat.—Saline Emergent Wetlands occur above intertidal sand and mud flats (Küchler 1977) and below upland communities not subject to tidal action (Macdonald 1977a). The upper part of estuaries grade into brackish and freshwater marshes (Cheatham and Haller 1975, Macdonald 1977a, Josselyn 1983).

Wildlife Considerations.—Saline Emergent Wetlands provide food, cover and nesting and roosting habitat for a variety of birds, mammals, reptiles, and amphibians (Macdonald 1977b, Zedler 1982). Endemic subspecies of birds include the endangered California and light-footed clapper rails, California black rail, salt marsh yellowthroat, Belding's Savannah sparrow and three subspecies of the song sparrow at San Francisco Bay (California Department of Fish and Game 1980, U.S. Fish and Wildlife Service 1983a, Josselyn 1983). Other bird species that feed or roost in these wetlands are herons, egrets, ducks, hawks (including the northern harrier), Virginia rail, American coot, shorebirds, swallows, and marsh wren. Some species are residents; others are migrants or winter visitants (Macdonald 1977b, Springer 1982, Zedler 1982, Josselyn 1983). Characteristic mammals are species of shrews, bats, and mice, including the endangered salt marsh harvest mouse endemic at San Francisco Bay, as well as the raccoon, mink, river otter, and harbor seal (Macdonald 1977b, Hall 1981, Springer 1982, Zedler 1982, Josselyn 1983). A number of species from adjacent uplands visit the wetlands to feed (Macdonald 1977b). Several species of lizards and snakes frequent the edge of the high marsh, whereas the Pacific treefrog and western toad occur in slightly brackish marsh or after heavy rains (Macdonald 1977b, Zedler 1982).

Physical Setting

Saline Emergent Wetlands occur along the margins of bays, lagoons, and estuaries sheltered from excessive wave action (Macdonald and Barbour 1974). At their lower margin they are exposed once every 24 hours; whereas, at their upper margin, submergence is short and infrequent, followed by weeks or months of continuous exposure (Macdonald 1977a). Soil salinity varies from that of seawater (35 ppt) or greater (60 ppt up to 145 ppt) because of lagoon closure and evaporation, particularly in the south, to brackish (<5 ppt) at sites influenced by heavy precipitation and run-off (Macdonald 1977a, Zedler 1982, Josselyn 1983). Soils consist of thin veneers (0.2 to 1.8 m, or 0.7-5.9 ft) of fine silts (<4 microns in diameter), clays, and scattered plant remains. Grain size increases at higher elevations in the south. Soil moisture decreases with increasing elevation; whereas soil organic content appears to increase in the north and decrease in the south (Macdonald 1977a, Zedler 1982). Average rainfall ranges from 20 cm (8 in) in the extreme south (Zedler 1982) to 200 cm (80 in) in the extreme north (Proctor et al. 1980). Seasonal and diurnal temperatures fluctuate little, with mean summer maxima of 16 to 22°C (61-72°F) and mean winter minima of 4 to 8°C (39-47°F). Frost-free days range from 330 to 365 (Munz and Keck 1973).



Vegetation

Structure.—Pasture vegetation is a mix of perennial grasses and legumes that normally provide 100 percent canopy closure. Height of vegetation varies, according to season and livestock stocking levels, from a few inches to two or more feet on fertile soils before grazing. Old or poorly drained pastures may have patches of weeds in excess of two feet in height.

Composition.—The mix of grasses and legumes varies according to management practices such as seed mixture, fertilization, soil type, irrigation, weed control, and the type of livestock on the pasture. Plant species seeded in pastures also vary with geographic area. In southern California, Bermuda grass is prevalent. In northern California, ryegrasses, tall fescue, Dallisgrass, Ladino clover, Salina strawberry clover, and trefoils are preferred (George et al. 1980). Many California farmers include irrigated pasture in their crop rotation system (Raguse et al. 1967).

Other Classifications.—Most vegetation classification systems include irrigated pasture in more general categories, such as Agriculture (California Department of Fish and Game, 1966), Urban/Agriculture (Parker and Matyas. 1981).

Habitat Stages

Vegetation Changes.—Height and density of vegetation in irrigated pastures depends on cultural and grazing management practices. Length of growing season, soil type, seedbed preparation, seed mix, fertilization, drainage, manure spreading, mowing, and weed control; all influence the composition, density and height of irrigated pasture vegetation. Also the type of livestock, stocking rates and duration of grazing impact the composition, density and height of irrigated pasture vegetation.

Duration of Stages.—Irrigated pastures are often a permanent agricultural habitat, established on soils not suitable for other crops and where an ample water supply is available. It is recommended that seeding to establish or re-establish irrigated pastures be done in the fall; however, spring plantings are sometimes made. Re-establishment intervals vary with the management. With proper management, irrigated pastures will remain productive for over 30 years.

Biological Setting

Habitat.—Pastures often occur in association with agricultural habitats (CRP and OVN). Moreover, irrigated pastures can be found adjacent to habitats such as Valley Foothill Riparian (VRI), Mixed Chaparral (MCH), Coastal Scrub (CSC), Fresh Emergent Wetland (FEW), Annual and Perennial Grassland (AGS, PGS), eastside habitats such as Sagebrush (SGB) and Bitterbrush (BBR) as well as various desert habitats.

Wildlife Considerations.—Pastures are used by a variety of wildlife depending upon geographic area and types of adjacent habitats. Ground-nesting birds, including waterfowl, pheasant, and sandhill crane, nest in pastures if adequate residual vegetation is present at the onset of the nesting season. Some of the highest pheasant counts by Department of Fish and Game biologists have been recorded in irrigated pastures in Stanislaus County. Flood irrigation of pastures provides feeding and roosting sites for many wetland-associated birds, including shorebirds, wading birds, gulls, waterfowl, and raptors. Antelope, deer, and elk also graze these pastures when they provide adequate, adjacent escape cover. The endangered Aleutian goose in Del Norte County and the Sacramento and San Joaquin valleys requires pastures that are sufficiently grazed to keep them low and open. In the Grasslands Resource Conservation District of Merced County, cultural methods are commonly modified so that pasture can be

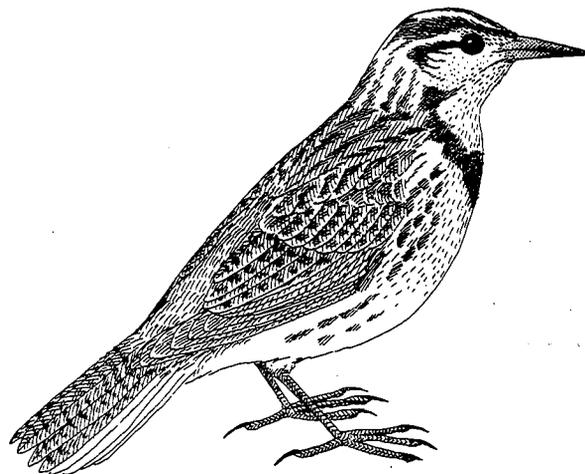
flooded in fall and winter for waterfowl hunting and grazed in summer by livestock.

Physical Setting

Pastures are planted on flat and gently rolling terrain. Flat terrain is irrigated by the border and check method of irrigation, except on sandy soils or where water supplies are limited. Pastures established on sandy soils or hills are sprinklered. Hilly lands also use wild flooding; that is, ditches that follow the grade along ridges and hillsides, where water is released at selected points along the ditch. Climate influences the length of growing season. For example, pastures at higher elevations or in the north have a shorter growing season.

Distribution

A total of 1.1 million acres of irrigated pasture were listed in the County Agricultural Commissioner's Annual Reports for 1983, as compiled by the California Crop and Livestock Reporting Service. These pastures are in every county in California except San Francisco. Imperial County has the greatest acreage, followed by Siskiyou, Merced, Stanislaus, and Modoc counties. Coastal counties contained 5.6 percent and Central Valley counties 52 percent of the pastures in the State. Pasture occurs below sea level in the Imperial Valley and above 4500 feet in Modoc County. In recent years, small pasture have increased due to small acreage lot development (George et al. 1980).



Western Meadowlark (*Sturnella neglecta*)



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;2-4:0-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 1966).

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

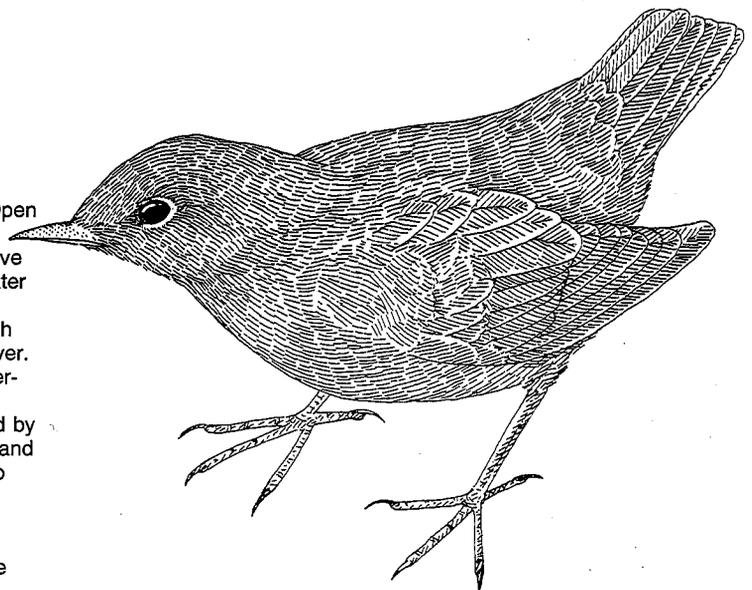
Streams begin as outlets of ponds or lakes (lacustrine), or rise from spring or seepage areas. All streams at some time experience very low flow and nearly dry up. Some streams, except for occasional pools, dry up seasonally every year.

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 ft).



American Dipper (*Cinclus mexicanus*)



General Description

Structure.—Lacustrine habitats are inland depressions or dammed riverine channels containing standing water (Cowardin 1979). They may vary from small ponds less than one hectare to large areas covering several square kilometers. Depth can vary from a few centimeters to hundreds of meters. Typical lacustrine habitats include permanently flooded lakes and reservoirs (e.g., Lake Tahoe and Shasta Lake), intermittent lakes (e.g., playa lakes) and ponds (including vernal pools) so shallow that rooted plants can grow over the bottom. Most permanent lacustrine systems support fish life; intermittent types usually do not.

Aquatic Environment

Suspended organisms such as plankton are found in the open water of lacustrine habitats. Dominant are the phytoplankton, including diatoms, desmids and filamentous green algae. Because these tiny plants alone carry on photosynthesis in open water, they are the base upon which the rest of limnetic life depends. Suspended with the phytoplankton are animal or zooplankton organisms which graze upon the minute plants. Most characteristic are rotifers, copepods and cladocerans (Smith 1974).

The plants and animals found in the littoral zone vary with water depth, and a distant zonation of life exists from deeper water to shore. A blanket of duckweed may cover the surface of shallow water. Desmids and diatoms, protozoans and minute crustaceans, hydras and snails live on the under-surface of the blanket; mosquitoes and collembolans live on top. Submerged plants such as algae and pondweeds serve as supports for smaller algae and as cover for swarms of minute aquatic animals. As sedimentation and accumulation of organic matter increases toward the shore, floating rooted aquatics such as water lilies and smartweeds often appear. Floating plants offer food and support for numerous herbivorous animals that feed both on phytoplankton and the floating plants (Smith 1974).

Other Classifications.—Other names of lacustrine habitats include Lacustrine (Cowardin et al. 1979), Lakes - 10.41, Manmade Reservoirs - 10.42 and Ponds - 10.43 (Cheatham and Haller 1975). The U.S. Fish and Wildlife Service summarizes several lacustrine habitats according to their occurrence in certain terrestrial habitats (Proctor et al. 1980).

Aquatic Zones and Substrates

The lacustrine habitat may exist in any of the structural classes 1:2-4:0-B. The limnetic or open water zone extends from the deepest part to the depth of effective light penetration. The submerged (littoral) zone is shallow enough to permit light penetration and occurs at the edges of lakes and throughout most ponds. Periodically flooded lacustrine habitats should be evaluated only when water is present. This stage usually cannot support fish populations, and therefore will not attract fish predators. To qualify as shoreline, there must be a water border and less than 2 percent vegetation. Shoreline vegetation exceeding 2 percent would fall into the riparian category.

Lakes and ponds are more or less temporary features of the landscape because of a slow siltation process. The time it takes depends on size, rate of sedimentation and the increase of organic matter.

Biological Setting

Habitat.—Lacustrine habitats may occur in association with any terrestrial habitats, Riverine (RIV) and Fresh Emergent Wetlands (FEW).

Wildlife Considerations.—Lacustrine habitats are used by 18 mammals, 101 birds, 9 reptiles and 22 amphibians for reproduction, food, water and cover. This represents about 23 percent of the species in the Wildlife Habitat Relationships data base. The endangered Santa Cruz long-toed salamander and rare black toad require ponds for breeding. The endangered bald eagle feeds on fish and some birds taken from lakes.

Physical Setting

The relatively calm waters of lakes and ponds offer environmental conditions that contrast sharply with those of running water. Light penetration is dependent on turbidity. Temperatures vary seasonally and with depth. Because only a small proportion of the water is in direct contact with the air and because decomposition is taking place on the bottom, the oxygen content of lake water is relatively low compared to that of running water. In some lakes, oxygen may decrease with depth, but there are many exceptions. These gradations of oxygen, light and temperature along with the currents and seiches, profoundly influence the vertical distribution of lake organisms (Smith 1974).

Distribution

Lacustrine habitats are found throughout California at virtually all elevations, but are less abundant in arid regions.



Bald Eagle (*Haliaeetus leucocephalus*)



General Description

Structure.—Estuarine habitats occur on periodically and permanently flooded substrates and open water portions of semi-enclosed coastal waters where tidal seawater is diluted by flowing fresh water (Ellison 1983). This mix of fresh and ocean waters usually forms a horizontal salinity gradient that varies by area and location with seasonal variations in fresh water inflow and tidal action. In California, estuarine habitats include coastal lagoons containing waters of more uniform salinity than true estuaries, or waters with vertical rather than horizontal salinity gradients. Estuarine habitats differ greatly in size, shape, and volume of water flow, based on local topography.

Aquatic Environment

Composition.—The various physiological stresses exerted in the estuarine environment, especially those related to changing salinities, result in natural communities that are low in species richness but high in density. The largest number of estuarine organisms are benthic and include hydrozoans, anthozoans, and annelid worms. Such organisms attach to the bottom substrate, bury in the mud, or live in crevices (Smith 1974). Mollusks, including gastropods and bivalves, also occur in this zone.

The open water is a medium for suspended organisms, such as plankton. Phytoplankton, tiny plants that photosynthesize in open water, are densest near the surface and in low salinity areas in summer. In winter, they are distributed more uniformly throughout the estuarine system. Zooplankton, including many small crustaceans, such as amphipods, decapods, and copepods, are the primary trophic level on which fishes and other vertebrates depend. Aquatic plants other than phytoplankton include green and red algae. In addition, eel grass (a common flowering plant) grows in dense stands in many subtidal estuarine habitats.

Salinity determines species distribution in estuarine habitats. Organisms are primarily marine in origin, except for anadromous fish or wildlife species that can migrate easily to fresh water. Very few purely fresh water organisms are found in estuarine systems.

Other Classifications.—Other names for the estuarine habitat include Bays and Harbors - 1.11, Coastal Estero - 0-1.12, Tidal Flats - 1.21 (Cheatham and Haller 1975); Drowned River Mouth Estuary (Pritchard 1967); Blind Estuary, Estuarine (Cowardin et al. 1979), Estuaries (Ellison 1983).

Estuarine habitats exist in the structural classes 1;2-4:0-B. This habitat extends shoreward to the shallower subtidal zone where light easily penetrates under normal conditions. In the intertidal zone, the substrate is periodically exposed and flooded by tidal action or at times by storm runoff. Shoreline is defined by a water border with less than 2 percent existing as Saline Emergent Wetland (SEW).

Estuarine systems tend to be fairly stable and long lasting. Human impacts such as water diversion (flow reduction) and sedimentation can however, significantly alter or eliminate the estuarine condition. In southern California, diversion, channelization and other developments in the Los Angeles and San Diego drainages have destroyed once viable estuarine systems (Ellison 1983).

Biological Setting

Habitat.—Estuarine habitats may occur in association with Riverine (RIV), Marine (MAR), Saline Emergent Wetland (SEW), and Urban (URB).

Wildlife Considerations.—Estuarine habitats provide for reproduction, feeding, resting, and cover for many species of mammals and birds. These habitats provide shelter for large numbers of water birds, especially during heavy winter storms when open coastal waters become rough. Of great importance are the eel grass beds supported by estuarine subtidal habitats. These areas are critical to the black brant which feeds almost exclusively on eel grass.

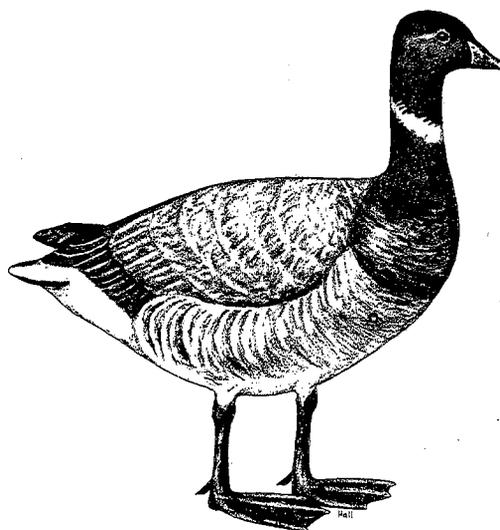
Physical Setting

In general, California's estuarine systems do not conform to the classic description. Exceptions are the Sacramento/San Joaquin River estuary and possibly a few north coast rivers like the Klamath (Ellison 1983). California estuaries are highly variable due to a restricted coastal plain and stream flow regimes characterized by summer drought.

On a seasonal basis the marine influence of many California estuaries is interrupted by the formation of sand bars. When this occurs, considerable movement of water between the estuarine and marine environments may be maintained by infusion. Although marine waters may continue to influence estuary salinities, the movement of most aquatic organisms is severely restricted (Ellison 1983). Permanent blockages, creating lagoon-like situations may drastically change the structure and composition of associated plant and wildlife species.

Distribution

Estuarine habitats commonly occur along coastal California at the drowned mouths of perennial rivers tributary to the Pacific Ocean.



Black Brant (*Branta bernicla*)



Vegetation

Structure.—The structure of urban vegetation varies, with five types of vegetative structure defined: tree grove, street strip, shade tree/lawn, lawn, and shrub cover.

Tree groves, common in city parks, green belts, and cemeteries, vary in height, tree spacing, crown shape, and understory conditions, depending upon the species planted and the planting design. However, they have a continuous canopy. Mature tree groves in San Francisco vary in height from 19.3 m (64 ft) (eucalyptus) to 14.5 m (48 ft) (Monterey cypress). Ground cover in these groves ranges from 0 to 90 percent (McBride and Froehlich 1984).

Street tree strips show variation in spacing of trees, depending upon species and design considerations. Both continuous and discontinuous canopies are observed. Most street tree strips are planted in grass, but other ground covers are not uncommon.

Shade trees and lawns are typical of residential areas and reminiscent of natural savannas. Structural variation in the shade tree/lawn type is typical when a large number of species are incorporated in the landscape.

Lawns are structurally the most uniform vegetative units of the California urban habitat. A variety of grass species are employed, which are maintained at a uniform height and continuous ground cover. Biomass productivity is greater than natural grasslands because of irrigation and fertilization (Falk 1977).

Shrub cover is more limited in distribution than the other structural types. Hedges represent a variation of the urban shrub cover type. Species, planting design, and maintenance control the structural characteristics of this type. Height ranges from 10 cm (4 in) tall to tree height.

The juxtaposition of urban vegetation types within cities produces a rich mosaic with considerable edge areas. The overall mosaic may be more valuable as wildlife habitat than the individual units in that mosaic.

Composition.—Species composition in urban habitats varies with planting design and climate. Monoculture is commonly observed in tree groves and street tree strips. A survey of tree groves in San Francisco parks showed that three species (eucalyptus, Monterey cypress, and Monterey pine) composed 75 percent of total tree cover (McBride and Froehlich 1984), and these species were almost exclusively planted in pure stands. Climatic variation associated with elevation in California also influences the mix of tree species. For example, in urban areas a comparison of urban forests found a species richness of 7 tree species per hectare ($\approx 3/\text{acre}$) in South Lake Tahoe and 30 tree species/hectare ($\approx 12/\text{acre}$) in Menlo Park. The difference in species richness is due largely to the low winter temperatures in South Lake Tahoe (McBride and Jacobs 1979).

A distinguishing feature of the urban wildlife habitat is the mixture of native and exotic species. Both native and exotic species are valuable, with exotic species providing a good source of additional food in the form of fruits and berries.

Other Classifications.—Detwyler (1972) has classified urban vegetation into four major types: the interstitial forest, consisting of trees growing between man's constructions (buildings, streets, etc.); parks and green zones, existing in blocks or sizable patches that are relatively unbroken by human construction; gardens, in which are green ornamental plants as well as food plants; and lawns, or interstitial grasslands. Clemens et al. (1984) suggest an additional classification unit, demolition sites—those urban lands cleared of structures and supporting spontaneous vegetative cover. Many recent demolition sites in California cities are dominated by annual grasses and pioneer shrub species. The demolition site category also comprises vacant urban lands not supporting native vegetation types.

Some commercial and industrial portions of urban areas are without any vegetative cover. These areas do, however, serve as habitat for a limited number of wildlife species.

Habitat Stages

Vegetation Changes.—Most units of urban vegetation are relatively static in species composition because of maintenance. Unmaintained units often are invaded by exotic and native species. Unmaintained forest groves at the Presidio, San Francisco, have developed locally dense understories of poison-oak or Algerian ivy. Lawns are commonly invaded by Bermuda grass and crab grass as well as broadleaf weeds (i.e., dandelion, English daisy, etc.).

Viewed from early urbanization to the present, urban vegetation appears less static. McBride and Jacobs (1976) describe changes in the preference of Menlo Park homeowners for different tree species over the last 100 years. The California pepper tree and London plane have been supplanted by camphor, Modesto ash, purple plum, and sweetgum. Vegetation structure also changes through time as a result of maturation. Tree and shrub height, and crown closure, increase during this maturation process.

Duration of Stages.—Urban vegetation, especially urban tree cover, is relatively recent — only about 100 years. Many trees remain from presettlement forest or savanna and can be expected to survive for centuries. In contrast, most species in urban tree groves are not long-lived. For example, Monterey pine and Monterey cypress are relatively short-lived species, only 100 to 150 years. Windthrow and wind breakage are common to stands where these species exceed 90 years old (McBride and Froehlich 1984). In older stands in Golden Gate Park, San Francisco, tree defects were observed in 91 percent of Monterey pine and 56 percent of Monterey cypress trees (Smith et al. 1980).

Biological Setting

Habitat.—Urban development has occurred within or adjacent to most other habitats in California, with the highest density at lower elevations. The majority of urban developments exceeding 10,000 in population were developed in grassland or scrub (coastal sagebrush or chaparral) vegetation. Very probably the original vegetation at such locations was modified by agriculture and today most of our cities are surrounded by agricultural and grazing lands rather than natural vegetation.

Wildlife Considerations.—Three urban categories relevant to wildlife are distinguished: downtown, urban residential, and suburbia. The heavily-developed downtown is usually at the center, followed by concentric zones of urban residential and suburbs. There is a progression outward of decreasing development and increasing vegetative cover. Species richness and diversity is extremely low in the inner cover. Rock dove, house sparrow, and starling comprise over 90 percent of all avian density and biomass (Emlen 1974).

The urban residential zone is characterized by a denser and more varied mosaic of vegetation — shade trees, lawns, hedges and planted gardens; approximately 40 percent of the land's surface is covered by impervious material. This region is characterized by a variety of bird species including scrub jay, mockingbird, house finch, (Jaeger and Smith 1966, Smith 1968, Guthrie 1974, Sproul 1975, Williams and Monroe 1976). Associates in the urban residential areas include the raccoon, opossum, striped skunk, (Berry and Berry 1959) and California slender salamander (Stebbins 1972).

Suburban areas with mature vegetation closely approximate the natural environment. In addition to landscaped gardens and lawns, relatively large tracts of adjacent natural vegetation such as chaparral, grasslands, and oak woodland abound. Wildlife diversity increases while species density decreases (Thomas and DeGraaf 1975) and proportionately greater numbers of native species occur. Bird species include wrentits, bushtits, plain titmouse, chestnut-backed chickadee, California quail, (Jaeger and