

BIRDS OF THE CALIFORNIA DESERT

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INTRODUCTION

The term, "California desert", as used herein, refers to a politically defined region, most of which is included in the California Desert Conservation Area (CDCA) designated by the Federal Land and Management Act of 1976 (FLPMA). Of the 25 million acres in the CDCA, about one-half are public lands, most of which are managed by the Bureau of Land Management (BLM) according to the 1980 California Desert Conservation Area Plan mandated by FLPMA. The California desert encompasses those portions of the Great Basin Desert (east of the White and Inyo Mountains and south of the California-Nevada border), the Mojave Desert, and the Colorado Desert which occur within California; it does not include areas of riparian, aquatic, urban, and agricultural habitats adjacent to the Colorado River. (Also see chapters on *Geology* by Norris and *Bioclimatology* by Rowlands).

Birds¹⁴ are the most conspicuous vertebrates found in the California deserts. Records exist for at least 425 species (Garrett and Dunn 1981) from 18 orders and 55 families. These counts far exceed those for mammals, reptiles, amphibians and fish, and they are similar to totals for the entire state -- 542 species from 20 orders and 65 families (Laudenslayer and Grenfell 1983). These figures may seem surprisingly similar considering the harsh, arid climates often believed characteristic of desert environments. However, habitats found in the California desert range from open water and marshes at the Salton Sea to pinyon-juniper woodland and limber pine/bristlecone pine forests on a few mountain ranges. Between these extremes are numerous shrub-dominated communities, wash habitats, and riparian areas. This variety of habitats supports a greater number of bird species than would be expected if the entire area were the stereotypic barren desert.

ADAPTATIONS TO DESERT ENVIRONMENTS

The size and varying topography of the California desert encompass a diverse array of climates. Summers on valley floors, bajadas, and low elevation mountain ranges can be extremely harsh. Air temperatures in Death Valley and the Salton Trough can exceed 50°C (120°F) with soil surface temperatures over 70°C (160°F). On the same summer day, at upper elevations in the New York, Clark, Panamint, and Inyo Mountains, temperatures may approach only 25°-30°C (75°-85°F). During winter, sub-freezing temperatures occur regularly at night in the Mojave and Great Basin Deserts, and in most winters the crests of the higher northern mountain ranges are capped with snow. Freezing temperatures are rare in the Colorado Desert, and winter daytime temperatures are commonly 20°-30°C (70°-85°F).

Rainfall patterns also vary considerably. The Great Basin and Mojave Deserts are characterized by wet winters and relatively dry summers sporadically interrupted by thundershowers. The Colorado Desert typically receives rainfall regularly in both winter and summer. However, rainfall patterns throughout the deserts are erratic and unpredictable. Many lowland areas average less than 13 cm (5 in) of precipitation per year, while forest and woodland habitats in the higher mountain ranges average up to 30 cm (12 in) total precipitation per year.

14. Scientific and common names are from American Ornithologists' Union Checklist of the Birds of North America (AOU 1983, 1989).

Most birds found in the California desert avoid the hotter and drier habitats of the desert environment, at least during the summer months. Some, however, such as the Common Poorwill (*Phalaenoptilus nuttallii*) are crepuscular, that is, they are active only during early morning and late evening. During the winter when food is scarce, some poorwills go into periods of torpor during which body temperature is lowered and caloric requirements are reduced (Jaeger 1961; Stebbins 1964).

Some species may be found in the lowlands only during winter months when temperatures are low and water is more available. Others are restricted to the relatively lush areas adjacent to springs and streams. These riparian habitats are oases where food supplies are greater and more diverse, and where water is easier to find than in desert scrub habitats on valley bottoms, bajadas, and low-elevation mountains. Few species breed in these scrub habitats. Of 274 birds breeding in California (Small 1974), only 40 were identified by Miller (1951) as occurring in the desert scrub ecological formation; 23 of these were listed as exhibiting primary preference for another formation.

Birds that occur in lowland habitats during the late spring and summer generally do not use the typical mammalian strategy (a nocturnal activity pattern coupled with diurnal retreat to relatively cool moist burrows to cope with high temperatures and restricted water availability). Instead, birds depend upon their mobility, a relatively greater ability than mammals to tolerate heat, and several other avian behavioral and physiological characteristics that "pre-adapt" them to arid environments.

Desert-dwelling birds must balance water availability with water demands for use in body functions, including evaporative cooling. Birds breeding in lowland scrub habitats have primarily insectivorous and carnivorous diets. These foods are higher in water content than the typically granivorous diets of many doves and sparrows. The Black-throated Sparrow (*Amphispiza bilineata*), a common breeding bird in scrub habitats, adopts a primarily insectivorous diet during the spring and early summer (Smyth and Bartholomew 1966). In Arizona, Ohmart (1969) found that insects in the diet of Rufous-winged Sparrows (*Aimophila ruficeps*) provided adequate water throughout the year. Black-throated Sparrows (Smyth and Bartholomew 1966) and Gambel's Quail (*Callipepla gambelii*) (Gullion 1960; Hungerford 1960; and others) acquire additional water from succulent vegetation when it is available.

Surface water is extremely important to many desert birds, including species that breed only in riparian habitat, and several species that regularly fly long distances to reach water. The best known examples in the California desert are Mourning Dove (*Zenaida macroura*) and White-winged Dove (*Z. asiatica*). Their diets consist primarily of dry seeds, and daily trips to water may be a necessity during hot summer months. In the summer, when succulent vegetation and insects are less abundant, many species are forced toward a seed-dominated diet, and surface water becomes important to species such as Gambel's Quail (Elder 1956) and Black-throated Sparrow (Smyth and Bartholomew 1966). Smyth and Coulombe (1971) observed 21 resident bird species using a desert spring during the summer in Riverside County, California. Of these, only the five granivorous species drank regularly from the spring.

Survival in the harsh summer environment of desert lowlands requires efficient use of the water that is available. Several physiological mechanisms common to most birds aid in water conservation. Nitrogenous waste is excreted in the form of uric acid, a compound that precipitates out of solutions at low concentrations and is voided as a semi-solid. This requires less than one-tenth the water used by mammals to excrete the same amount of nitrogen in urea molecules (Dawson and Bartholomew 1968). The Roadrunner (*Geococcyx californianus*) possesses a nasal salt gland used to excrete excess salts with small quantities of water (Ohmart 1972, 1973; Ohmart et al 1970). This gland has also been found in the Desert Partridge (*Ammoperdix heyi*) and Ostrich (*Struthio camelus*) which occupy arid areas of Africa (Schmidt-Nielsen et al 1963), but is not found in most birds inhabiting the deserts of the southwestern United States (Dawson and Bartholomew 1968).

Body temperatures of birds are generally higher than those of most mammals, and most birds are also able to tolerate a daily $2^{\circ}\text{--}3^{\circ}\text{C}$ ($3.6^{\circ}\text{--}5.4^{\circ}\text{F}$) shift in body temperature (Bartholomew and Dawson 1958). This combination reduces the volume of water that birds require to maintain an appropriate body temperature. Birds can wait longer before they must begin evaporative cooling and can store some heat during the day and passively dissipate it at night when ambient temperatures drop (Dawson and Bartholomew 1968). To further reduce the need for evaporative cooling, desert-dwelling birds greatly curtail their activity during midday, reducing metabolically-produced heat (Calder 1968; Dawson 1954). They also move to cooler, shaded retreats where escape from direct insolation reduces heat loads (Bartholomew and Cade 1957; Dawson 1954).

The reproductive efforts of birds in the California desert undoubtedly vary with rainfall. However, no research has been conducted to test this relationship. Jaeger (1955) suggested that in years of low rainfall, and therefore low productivity, nesting activity is lower and fewer eggs are laid. Ohmart (1973), in a study of Roadrunners in the Sonoran Desert of Arizona, found a bimodal nesting pattern with larger egg clutches following the more productive summer rains than in the spring after a normal winter.

In summary, topographic and climatic diversity of the California desert combine to produce a variety of habitats. During the summer months, lowland habitats can be among the harshest in the world, and relatively few birds live under these conditions. Most species are restricted to higher elevations or to moist riparian habitats, or are present only during the fall and winter when conditions ameliorate. Birds that breed in North American deserts during harsh summer conditions generally have not developed special physiological capabilities. Instead, they rely on the general avian characteristics of high and labile body temperature, as well as the ability to travel long distances to water combined with behavioral and dietary patterns that allow them to maintain a delicate balance between water demands and availability.

MIGRATION

Seasonal movements of birds found in the California desert range from nonexistent for apparently sedentary populations to the transients en route to and from breeding areas during migration. Spring migration begins in March and early April, peaks during late April and early May, and ends with the passage of passerines continuing into early June (Jehl et al 1977; Small 1974). Fall migration begins soon afterward as the first shorebirds begin returning from their breeding grounds in late June and July. Southward movement of shorebirds continues during August and September, then declines. Fall migration of land birds occurs from August through October (Jehl et al 1977; Small 1974).

The number of birds crossing the desert during spring migration is thought to be considerably higher than in fall. Climatic differences between these periods may be an important factor contributing to this apparent pattern. During early spring, mountains may still be snow-covered and sub-freezing temperatures are common at night. At the same time, temperatures on the desert floor are relatively mild, productivity is high, and food and water are relatively easy to obtain. In the fall, mild temperatures and relatively high productivity are found in the mountains and along coastal areas while temperatures in the desert are high, water is limited, and food is difficult to find (Jehl et al 1977; Small 1974).

California geography also may contribute to the differences between the number of birds present during fall and spring migrations. However, the study of bird migration is difficult, and it is hard to demonstrate conclusively the existence of definite migration routes. Several authors (Howell 1923; Jehl et al 1977; Miller 1957; Small 1974) believe that birds traveling north in the spring across mainland Mexico, the Gulf of California, and Baja California are funneled through the Imperial and Coachella Valleys and riparian habitats along the Colorado River. Small (1974) indicates that there is

virtually no northward coastal movement of birds in spring and that land birds reaching the coast have arrived via a westerly or northwesterly route, implying the importance of inland habitats. Birds traveling to some coastal and montane habitats may use San Geronio Pass as a route to breeding areas (Miller 1957). A number of normally pelagic seabirds have been observed either at, or west of, San Geronio Pass, including Laysan Albatross (*Diomedea immutabilis*) (Dunn and Unitt 1977), Magnificent Frigatebird (*Fregata magnificens*) (Bleich and Blong 1978; Small 1961), and Blue-footed Booby (*Sula nebouxii*) (McCaskie 1970b). Cajon Pass and Garlock Fault also have been suggested as influencing migration pathways (Miller 1957). North of the Coachella Valley and northwest of the Colorado River, no obvious physical features exist to direct migrants and movement probably occurs over a broad front (Howell 1923; Jehl et al 1977).

On the southward migration, Small (1974) suggests some western species migrate primarily west of the desert and are concentrated in coastal areas where the southern California coastline curves toward the southeast. Land birds migrating through the desert in the fall apparently are not concentrated in any particular geographical area or habitat type (e.g., American Redstart (*Setophaga ruticilla*), McCaskie 1970a). However, southward movement occurs over a longer period than spring migration and is therefore more difficult to track. Oases scattered across the deserts are important resting areas for individuals that find them, but Jehl et al (1977) believe there is little evidence to support a theory that migrants oasis-hop as they cross the desert. Many species are capable of flying non-stop over the desert and may use this strategy to avoid this inhospitable environment in the fall (Jehl et al 1977). Miller and Stebbins (1964) suggest that some land birds follow ridges southward, but evidence for this theory is also lacking (Jehl et al 1977). Records for many fall migrants, including vagrant eastern species, are primarily of juvenile birds. Jehl et al (1977) believe this suggests the California desert is not an important fall migration route.

In contrast to the normal southward migration in fall, a few species disperse north to the Salton Sea after breeding in and around the Gulf of California. Wood Storks (*Mycteria americana*) breed on mainland Mexico and annually wander north to the Salton Sea from July through early September. The Magnificent Frigatebird, Roseate Spoonbill (*Ajaia ajaja*), and Blue-footed Booby undertake a similar movement, but occur in low number and may not be seen in most years. Brown Pelican (*Pelecanus occidentalis*), Laughing Gull (*Larus atricilla*), Heermann's Gull (*Larus heermanni*), and Yellow-footed Gull (*Larus livens*) breed on islands in the Gulf of California and regularly move north to the Salton Sea in late summer and early fall.

HABITAT USE

Prior to the early 1970s, little quantitative data had been gathered on birds using desert habitats in California. The Bureau of Land Management, through the California Desert Plan Program and Riverside District Office, began collecting quantitative information in 1975-76 during the inventory phase of the East Mojave Unit Resource Analysis and Sun Desert Nuclear Powerplant Environmental Impact Statement. Data gathering efforts increased during 1977-78 while the BLM conducted inventories for the preparation of the California Desert Plan. A total of 59 permanent study plots were censused by BLM employees and contractors during the breeding and/or winter seasons using the international spot mapping and winter bird-population sampling techniques. Seven additional plots had been studied prior to 1977 by non-BLM personnel. Results of all 66 plots were published as breeding bird surveys and winter bird-population studies in *Audubon Field Notes* and *American Birds* (see chapter on *CDCA Data Base* by Berry et al).

These 66 plots surveyed were distributed among 21 broad habitat types falling into four general habitat structural classes -- woodland, riparian/wash, desert scrub with overstory, and desert scrub (Table 1). During the breeding season, woodland and riparian/wash habitats clearly averaged

higher "Bird Species Richness" (BSR) and higher abundances than either desert scrub habitats or desert scrub habitats with overstory (Table 2). Desert scrub with an overstory similarly averaged a higher BSR and abundance than desert scrub (Table 2).

Habitat-use patterns were similar during the winter (Table 2). Riparian/wash habitats were used by more species at higher abundance than any other structural class. Bird abundance in woodland habitats was substantially higher than desert scrub habitats with or without overstory. Bird Species Richness in the woodlands was comparable to desert scrub with overstory. In the winter, desert scrub habitats without overstory supported bird abundances comparable to desert scrub habitats with overstory, but had a lower average BSR.

The significance of avian habitat use patterns in the California desert is evident when the availability of each habitat structural class is considered. The riparian/wash class has the richest avifauna, but is the rarest of the four classes in the California desert. Woodland and desert scrub with overstory habitats occupy a greater portion of the California desert, but are still rare to uncommon when compared to the total area supporting desert scrub without overstory. The concentration of birds in these habitats does not imply that desert scrub is unimportant. Species composition of the avifauna using each vegetation class was not considered in this overview. Some species of birds are found only in desert scrub habitats with or without overstory and occur infrequently in riparian and woodland vegetation. Examples include the Rock Wren (*Salpinctes obsoletus*), Brewer's Sparrow (*Spizella breweri*), and Sage Sparrow (*Amphispiza belli*).

SPECIAL HABITATS

The California desert encompasses a variety of habitat types, each with its own composition of bird species and numbers. Several of the habitats that support the greatest diversity of birds are discussed in this section. When quantitative habitat use data exist for a particular habitat type, comparisons are made to results for habitats falling within either desert scrub with overstory or without overstory (Table 2). The amount of quantitative information available for most habitats in the California desert is small, and some comparisons will undoubtedly change as more data become available.

JOSHUA TREE WOODLAND

Joshua tree woodland is found primarily in the Mojave Desert. It is a relatively uncommon habitat with a patchy distribution. The northern limit is in Wyman Canyon in the White Mountains and the southern limit is in the Little San Bernardino Mountains. This habitat usually is found at elevations between 700 m (2,300 ft) and 2,000 m (6,600 ft) (P.G. Rowlands, pers. comm.). Some of the best developed stands of this habitat can be found in the following areas: Joshua Tree National Monument; near Yucca Valley and Twentynine Palms; near Victorville and Hesperia; in the eastern Mojave Desert on Cima Dome and in northern Lanfair Valley; and on the desert slopes of the southern Sierra Nevada and San Bernardino Mountains.

Structurally, Joshua tree woodland is similar to habitats with Mojave yucca (*Yucca schottigera*) and ocotillo (*Fouquieria splendens*). Each habitat type has a low-growing desert shrub layer and an additional foliage layer above the shrub canopy. The addition of the overstory provides nesting, perching, and singing sites for birds which require taller vegetation. Examples include "Gilded" Northern Flicker (*Colaptes auratus mearnsi*), Ash-throated Flycatcher (*Myiarchus cinerascens*), Bendire's Thrasher (*Toxostoma bendirei*), Loggerhead Shrike (*Lanius ludovicianus*), and Scott's Oriole (*Icterus parisorum*).

During the breeding season, Bird Species Richness is three times higher in Joshua tree woodland than in desert scrub vegetation (Cardiff 1978b, Cardiff and Cardiff 1979; Carlson and Newberger 1979a, 1979b; Dock 1978b; Landry 1979b; Robert 1967; Zembal 1974). Data from winter surveys reveal no appreciable difference in Bird Species Richness between desert scrub and Joshua tree woodland (Cardiff 1979; Dock 1979a; Fees 1976; Herring 1976; Landry 1974, 1979a; Remsen et al 1976a).

MONTANE ISLANDS

In California, montane island habitats include pinyon-juniper woodlands and white fir forests found at higher elevations on a few desert mountain ranges. These sites are relatively small and widely dispersed. Pinyon-juniper woodland is found on desert mountain ranges above approximately 1,800 m (5,900 ft), as in the New York Mountains (Vasek and Thorne 1988), and on the Old Woman Mountains, Granite, New York, Providence, Clark, and Kingston Mountains in San Bernardino County, and several ranges in Inyo County. White fir forests are rarer and smaller in area than pinyon-juniper woodlands and are located only in the Kingston, New York, and Clark Mountain ranges. The largest white fir population is on Clark Mountain and includes about 1,000 trees covering about 65 ha (Vasek and Thorne 1988).

Studies in eastern California and southern Nevada have documented the bird species found in montane islands of pinyon-juniper woodland and white fir forest (Johnson 1965, 1973; Johnson and Garrett 1974; Remsen et al 1978). These habitats have approximately the same breeding Bird Species Richness (Cardiff 1978a; Woodman 1978b) and wintering Bird Species Richness (Campbell and Woodman 1978; Remsen, Wessman and Berry 1976) as desert scrub with overstory. However, there are differences in species composition. Pinyon-juniper woodland does not support many of the low-desert scrub species such as thrashers, Black-throated Sparrows, and Horned Larks. Instead, birds such as Pinyon Jay (*Gymnorhinus cyanocephalus*), Plain Titmouse (*Parus inornatus*), and Bushtit (*Psaltirius minimus*) are regular nesting species (Remsen et al 1978). White fir forests in the desert of California support several bird species found more commonly only in habitats outside California. Examples include Virginia's Warbler (*Vermivora virginiae*), Painted Redstart (*Myioborus pictus*), Hepatic Tanager (*Piranga flava*), and "Gray-headed" Dark-eyed Junco (*Junco hyemalis*) (Remsen et al 1978; Small 1974).

OAK WOODLAND

Oak woodland habitat is relatively rare in the California desert. It is restricted to enclaves between desert and coastal climates along western margins of the desert and to small enclaves in the eastern Mojave Desert where it is found in association with pinyon-juniper woodlands in the Granite, Providence, and New York Mountains. Oak woodland habitat provides an overstory not available in low-growing, shrub-dominated desert scrub habitats, and adds broad-leaf foliage and the coniferous foliage present in adjacent pinyon-juniper woodland. These characteristics support a different and large assemblage of bird species and a greater number of individuals than desert scrub habitats with or without an overstory (Remsen 1976).

During a survey of birds in the BLM's East Mojave planning unit, Remsen (1976) observed several species in the oak-pinyon-juniper habitat in the Granite, Providence, and New York Mountains. Hammond's Flycatcher (*Empidonax hammondi*) and Wilson's Warbler (*Wilsonia pusilla*), among others, were rated as common. Seasonal status of these species included 14 permanent residents, 12 summer residents, 6 winter residents, and 19 migrants.

Data from breeding (Jehl 1978) and wintering (Bond 1979) bird surveys in an oak-chaparral habitat in southwestern Imperial County further illustrate the importance of this habitat to birds. A comparison of their findings with results from desert scrub with overstory habitats indicates that the Bird Species Richness in oak-chaparral is approximately 1.7 times higher in both the breeding and winter seasons.

RIPARIAN HABITATS

Riparian habitats occur where water is permanently at or near the surface and therefore vegetation is generally taller and denser than in adjacent areas. As a result, this habitat is extremely important to many forms of wildlife, including birds (Hubbard 1977). Unfortunately, riparian habitats are declining in quantity and quality at a rapid rate throughout the southwestern United States. Several types of riparian habitats occur in the California deserts; each has a small distribution and all are heavily used by birds; all are very important and all are rare. The importance of palm oases, marshes, washes, and streamside riparian habitats to birds is addressed in England et al (1984) and discussed below.

Palm oases are characterized by the presence of the Washington fan palm (*Washingtonia filifera*) and usually include a number of large, shrubby plant species. In California, the distribution of this habitat is restricted to moist areas in and around the Salton Sink (Burk 1988). Most palm oases are found in mountains adjacent to the Imperial and Coachella Valleys, and in the Indio Hills where underground water emerges to form seeps and springs along the San Andreas fault (Burk 1988; Vogl and McHargue 1966). Breeding surveys (Koopman 1979a, 1979b, 1979c, 1979d) indicate that the Bird Species Richness in palm oases is approximately half that of desert scrub with overstory, but the number of visiting species and overall abundance in palm groves is several times higher. Wintering birds find palm oases even more attractive than desert scrub with overstory; the BSR is approximately three times higher in palm oases.

Marshes are also few in number and widely dispersed in the California desert. They are generally restricted to the margins of lakes, such as Salt Lake in Saline Valley and Deep Springs Lake in Deep Springs Valley, and are found intermittently along a few perennial watercourses, such as the Amargosa and Mojave Rivers, the unlined Coachella Canal, and San Felipe Creek. Desert marshes are characterized by the presence of cattails (*Typha* spp.), reed (*Phragmites communis*), and sedges (*Carex* spp.), and support many avian species found nowhere else in the desert. Bird Species Richness in desert marshes is similar to those of the palm oases but different species are found in each habitat (Weinstein and Berry 1978). During the winter, BSR in desert marshes is approximately twice that of desert scrub with overstory (Weinstein 1979).

Streamside riparian habitats include various combinations of willow (*Salix* spp.), Fremont cottonwood (*Populus fremontii*), tamarisk (*Tamarix* spp.), and other trees and shrubs found along watercourses with water permanently on or near the surface. These habitats are greater in number and expanse than palm oases or marshes but are still rare in the California desert. Examples of these habitats are found along streams in ranges such as the Inyo and Panamint Mountains, along the Mojave and Amargosa Rivers, and at large springs such as Big Morongo Canyon and Fort Piute. Breeding bird surveys in willow riparian (Dock 1978a; Evens 1979a; McKernan 1978; Remsen 1977; Woodman 1978a) and mixed tamarisk habitats (Cardiff et al 1978a, 1978b) and wintering bird surveys in the same study areas (Cardiff and Cardiff 1979a, 1979b; Dock 1979b; Evens 1979b; Remsen and Berry 1976; Stewart 1979; Woodman 1979) indicate that Bird Species Richness in riparian habitats is about twice as high as desert scrub with overstory habitats.

High bird population densities have been documented in riparian habitats elsewhere in the Southwest (Anderson and Ohmart 1976b, 1977; Carothers et al 1974). Ohmart et al (1977) have described the history of riparian habitat along the lower Colorado River from the 1600s to the

present. Demands for firewood, the occurrence of heavy floods during 1905 and 1907, introduction of tamarisk, construction of dams, and stream channelization have contributed to declines of riparian habitat. Cottonwood communities had been reduced from an estimated 2,000 ha (5,000 ac) in the 1600s to probably 1,100 ha (2,800 ac) by 1976 (Anderson and Ohmart 1976b), and pure stands of cottonwoods had been reduced to less than 200 ha (500 ac) by 1977 (Ohmart et al 1977). Riparian habitats in the California desert have undergone similar declines as a result of overgrazing, recreational use, reduction of water flow caused by groundwater pumping, diversions, dams, and natural causes, such as drought. The future of these habitats is bleak (Fox 1977); however, several government agencies and individuals in the southwestern United States are working to conserve this extremely important habitat.

WASHES

Desert wash habitats occur along watercourses that are dry most of the year but carry water following winter rains or summer thundershowers. Vegetation along washes in the Great Basin and Mojave Deserts generally consists of robust examples of shrubs found in surrounding habitats. Large mesquites (*Prosopis glandulosa* and *P. pubescens*) are frequently found in these washes. In contrast, Colorado Desert washes support numerous shrubs and one or more medium-sized, 2-6 m (6-20 ft) tall, tree species usually not found in adjacent habitats. These trees include palo verde (*Cercidium floridum*), desert ironwood (*Olneya tesota*), and smoketree (*Dalea spinosa*). Some of the best developed examples of Colorado Desert washes are Chemehuevi Wash in San Bernardino County, and Milpitas and Indian Washes, both in Imperial County.

The total area occupied by washes is greater than riparian habitats but is relatively small compared to the vast expanse of the desert scrub vegetation. Bird Species Richness in wash systems is approximately 1.5 times as many breeding species (Daniels and Boyd 1979a, 1979b; Kubik and Remsen 1977, Tomoff 1977) and about twice as many wintering species (Daniels 1979a, 1979b; Henderson 1979; Remsen et al 1976b; Tomoff 1979a, 1979b, 1979c) than in desert scrub with overstory. The results of these surveys demonstrate that wash systems support a greater diversity of species than do the more common desert scrub with overstory habitats. However, washes are subjected to heavy recreational use by campers and offroad vehicle enthusiasts. Both activities cause considerable disturbance to wildlife and lead to habitat degradation.

SALTON SEA

The Salton Sea provides a variety of habitats rarely found in the California desert, including marshes along the shore and a large expanse of open water. The Sea lies in the large Salton, or Cahuilla, Sink which is about 80 m (270 ft) below sea level at its deepest point. Prior to the construction of flood control facilities along the Colorado River, portions of the sink were flooded occasionally by water from the river. The current Salton Sea formed when the Colorado and Gila Rivers flooded during the winter of 1904-05 and the summer of 1905. Waters entered the sink through an irrigation channel headworks located near Yuma, Arizona. The break was repaired in 1907, returning the flow of the Colorado River into the Gulf of California but leaving behind an inland sea covering 1062 km² (410 mi²) and up to 25 m (83 ft) deep (Carpelan 1961). (Also see Norris chapter on *Geology*).

The Salton Sea and adjacent marsh and agricultural habitats support more bird species and larger numbers than any other area in the California deserts. A checklist for the area published by the U.S. Fish and Wildlife Service (USFWS 1970) included 302 species of birds; 258 were regular visitors and 44 were casual or accidental species. Based on these figures, approximately 71% of the bird species recorded from the California desert have been observed at the Salton Sea on one or more occasions. This percentage is a low estimate since ornithologists and birdwatchers visiting the

Sea have observed additional species not included on the 1970 checklist. Several species recorded from the California desert generally have been observed only in habitats associated with the Salton Sea. Examples include Black Skimmer (*Rynchops nigra*), Wood Stork, Gull-billed Tern (*Sterna nilotica*), and Blue-footed Booby.

The Salton Sea is an important breeding area for many waterbirds; a minimum of 63 species have been recorded by the U.S. Fish and Wildlife Service (1970). Shoreline habitats provide nesting areas for large numbers of Black-necked Stilt (*Himantopus mexicanus*) and recently for an increasing population of Black Skimmer. Tamarisk and mesquite thickets along the shore and dead snags in the Sea are nesting areas for large numbers of egrets and herons. Marshes around the periphery of the Sea and along watercourses in the vicinity of the Sea provide most of the "California" Black Rail (*Laterallus jamaicensis coturniculus*) and "Yuma" Clapper Rail (*Rallus longirostris yumanensis*) habitat found in the California desert. Additional populations of both subspecies are found along the Colorado River (Gould 1975; Jurek 1975; Repking and Ohmart 1977; Smith 1974).

The Salton Sea is used by large numbers of waterbirds during the winter and migration periods, including the Snow Goose (*Chen caerulescens*), Canada Goose (*Branta canadensis*) and Ross' Goose (*Chen rossii*), which regularly winter at the Sea. State and Federal Wildlife Refuges have been established at the south end of the Sea to manage the flocks and to regulate hunting. In addition to ducks and geese, large numbers of shore- and waterbirds occur on the Sea during the winter and in migration. McCaskie (1970c) lists 82 species of shorebirds and waterbirds, exclusive of swans, ducks, geese, and rails, that have been found at the Salton Sea.

BIRDS OF SPECIAL INTEREST

Each of the bird species recorded in the California desert has its own habitat requirements, seasonal movement patterns, food preferences, water requirements, and other ecological and physiological characteristics that warrant special discussion. However, only a few species can be mentioned here. The species discussed below have been chosen to highlight the variety of species present, special management problems, changing population and distribution patterns, and observations of special scientific interest. Unless otherwise noted, data presented apply only to occurrence within the California deserts.

RARE, THREATENED AND ENDANGERED SPECIES

Fourteen species or subspecies recorded from the California deserts have been listed officially as Threatened or Endangered by the California Department of Fish and Game (1990a,b) or the U.S. Fish and Wildlife Service (1990) (also see Table 3). The purposes of the endangered species programs are to identify species and populations undergoing declines that could lead to extinction, to take management actions to halt downward trends, and to facilitate recovery to a point where the protection afforded by listing is no longer necessary to ensure survival.

1. Brown Pelican (*Pelecanus occidentalis*). Uncommon, post-breeding summer visitor to the Salton Sea. Most observations are of immature birds from July through October (McCaskie 1970c; Anderson, DeWeese & Teller 1977). Observations in the desert away from the Salton Sea are rare.

2. "Aleutian" Canada Goose (*Branta canadensis leucopareia*). Accidental winter resident at south end of the Salton Sea. Six individuals recorded December 3, 1975 (McCaskie 1976a) and 2+ during the winter of 1977-78 (Garrett and Dunn 1981).

3. Bald Eagle (*Haliaeetus leucocephalus*). Rare winter resident primarily at Salton Sea. Occasionally observed during winter at bodies of water elsewhere in the California desert.

4. Swainson's Hawk (*Buteo swainsoni*). Rare summer resident and uncommon migrant. Since 1950, breeding has been reported in Joshua tree woodland habitats near Cima Dome and Lanfair Valley, San Bernardino County (McCaskie 1968c, 1978b; P. Bloom 1980; A.S. England, per obs.); in riparian vegetation at Oasis Ranch, Mono County (McCaskie 1969c, 1974b); and in unidentified habitat type near Lancaster, Los Angeles County (McCaskie 1978b). Formerly bred in Joshua tree woodland habitat near Victorville and Adelanto, San Bernardino County; egg collected in 1932 and 1946 in collection at Western Foundation of Vertebrate Zoology. Reported to be declining throughout its range (Arbib 1978). Grinnell and Miller (1944) reported the decline of populations as early as 1943. Bloom (1980) documented a significant decline in numbers throughout most of California.

5. Peregrine Falcon (*Falco peregrinus anatum*). Rare migrant. Most observations at Salton Sea. Possible rare summer visitor at Salton Sea (Garrett and Dunn 1981).

6. "California" Black Rail (*Laterallus jamaicensis coturniculus*). Rare resident. Known to be year-round resident on lower Colorado River (Repking and Ohmart 1977). In California, distribution is restricted to marshes adjacent to the Salton Sea, between the Coachella and Highline Canals, at Carrizo Marsh in Anza Borrego Desert State Park. Preferred habitat on the lower Colorado River is stands of three-square bulrush (*Scirpus olneyi*) with shallow water, gently sloping shorelines, and minimum fluctuation in water levels (Repking and Ohmart 1977).

7. "Yuma" Clapper Rail (*Rallus longirostris yumanensis*). Uncommon resident. Restricted to marshes adjacent to Salton Sea and between the Coachella and Highline Canals. Observed at Harper Lake, San Bernardino County, June 4-7, 1977 (Henderson 1977; McCaskie 1977b), but probably not a breeding location (LeValley 1978). In Arizona, favors marshes dominated by cottonwood (Smith 1974).

8. "Western" Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*). Rare summer resident. Breeding occurs along Amargosa River south of Tecopa, Inyo County (Gaines and Laymon 1984; Laymon and Halterman 1987). Potentially suitable habitat along Mojave River appears to be unoccupied (Laymon and Halterman 1987). Occasionally reported as a migrant in other desert oases. Preferred habitat is riparian vegetation over 90 m (300 ft) wide, 10 ha (25 ac) in extent, and dominated by willows, thick understory vegetation and frequent cottonwood trees (Gaines 1974, 1978; Grinnell and Miller 1944).

9. Elf Owl (*Micrathene whitneyi*). Formerly a breeding species at Cottonwood Spring, Joshua Tree National Monument and at Corn Spring in the Chuckwalla Mountains, Riverside County (Cardiff 1978c). Last observation in California desert in 1976 at Corn Spring (McCaskie 1978c). Requires nest cavity in tree for reproduction and to escape daytime heat (Ligon 1968). Requires cottonwood trees at Cottonwood Spring, heavy recreational use at both former nesting sites, competition with introduced European Starlings (*Sturnus vulgaris*) and several native species for nesting sites may have contributed to the observed decline (Cardiff 1978c). Field studies in 1978 (Cardiff 1978c) and 1987 (Calif. Dept. Fish and Game 1988) failed to find Elf Owls in the desert away from the Colorado River.

10. Gila Woodpecker (*Melanerpes uropygialis*). Rare permanent resident. Formerly common in cottonwoods around farmhouses in the Imperial Valley (Remsen 1978). Decline attributed to destruction of riparian habitat along the lower Colorado River and to competition with European Starlings for nesting cavities (Calif. Dept. Fish and Game 1988; Remsen 1978).

11. "Gilded" Northern Flicker (*Colaptes auratus chrysoides*). Rare resident in Joshua tree woodland on Cima Dome. Population levels have always been low (Johnson et al 1948), but McCaskie (1977a) states that "this form is becoming decidedly scarce in California". Five individuals may be the highest number recorded in a single day (McCaskie 1967b), and Remsen (1978) estimated only one or two breeding pairs. Requires Joshua tree for cavity nest. Habitat destruction, recent invasions by European Starlings, overgrazing, and hybridization with "Red-shafted" Northern Flickers (*C. auratus cafer*) could all be factors contributing to decline (Remsen 1978).

12. Willow Flycatcher (*Empidonax traillii*). Extremely rare breeding species; fairly common migrant. One desert breeding record at Morongo Valley oasis in 1981 (McCaskie 1981).

13. "Least" Bell's Vireo (*Vireo bellii pusillus*). Rare summer resident. Formerly common to abundant locally in suitable riparian habitats in California (Grinnell and Miller 1944). Desert breeding records from Death Valley, China Ranch, and Amargosa Gorge in Inyo County; Mojave River, Big Morongo Canyon, and Little Morongo Canyon, in San Bernardino County; Palm and Andreas Canyons on east slope of San Jacinto Mountains, Riverside County; and San Felipe and Coyote Creeks in San Diego County (Goldwasser 1978; Grinnell and Miller 1944). Population declines throughout the state were reported as early as 1944 (Grinnell and Miller 1944) and have continued (Goldwasser 1978). Since 1970 the only regularly observed breeding population in the California desert has been 2-4 pairs at Big Morongo Canyon (Goldwasser 1978). An extensive survey in 1978 documented approximately 19 territorial males at seven desert locations (Goldwasser 1978). Predation and nest parasitism, the latter by Brown-headed Cowbirds (*Molothrus ater*), are thought to be the major factors contributing to population declines (Goldwasser 1978; Grinnell and Miller 1944).

14. "Inyo" California Towhee (*Pipilo crissalis eremophilus*). Uncommon resident. Subspecies endemic to Argus Range of Inyo County (AOU 1957; Grinnell and Miller 1944). Breeds in riparian vegetation dominated by willows and desert olive (*Forestiera neomexicana*); forages on adjacent open desert hillsides (Cord and Jehl 1979a,b). Total known breeding habitat limited to 8.6 ha (21 ac) of riparian vegetation within a 25,000 ha (62,000 ac) circle (Cord and Jehl 1979a,b). Intensive survey in 1978 indicated a total population of 72-138 individuals (Cord and Jehl 1979a,b). Major threats to subspecies are habitat destruction caused by trampling from recreationists and feral burros, and by groundwater withdrawals for mining and other human uses (Cord and Jehl 1979a,b).

EXTIRPATED AND FORMERLY BREEDING SPECIES

Since the turn of the century, at least three birds have been lost as breeding species in the California desert. Two still occur in the area as non-breeding visitors; one has not been recorded recently from the California desert.

1. American White Pelican (*Pelecanus erythrorhynchos*). Rare winter and uncommon summer visitor on Salton Sea. Fairly common to common during spring and fall migration and may occur on large, temporary bodies of water in the spring (P. Unitt, pers. comm. in Jehl et al 1977). Formerly nested at Salton Sea (Lies and Behle 1966; Thompson 1933); last known nesting in late 1950s (Lies and Behle 1966). Former nesting habitat at the Salton Sea has been covered by rising water.

2. Harris' Hawk (*Parabuteo unicinctus*). Formerly a breeding species in the Imperial Valley, but no nests reported since 1952 (Bancroft 1920; Small 1974). Nesting attempted at south end of Salton Sea in 1976 by captive pair released by the California Department of Fish and Game (McCaskie 1976c). An active program to re-establish breeding population along Colorado River initiated by California Department of Fish and Game in 1979 (R. Schlorff, pers. comm.). Requires

trees or large shrubs for nesting (Bancroft 1920); preferred habitat is deciduous woodland and adjacent open ground of river or delta bottoms (Grinnell and Miller 1944). Habitat destruction, removal of chicks, and pesticide pollution may be contributing to population declines.

3. Laughing Gull (*Larus atricilla*). Common summer visitor (July to November) to the Salton Sea. Formerly nested in small numbers at south end of Sea (McCaskie 1970c; Small 1974). Former nesting habitat has been covered by rising water.

SPECIES WITH RESTRICTED RANGES OR SMALL POPULATIONS

Bird species discussed below have been selected as representatives of many species that have small desert populations and occur in limited areas of the California desert. Several have shown recent population declines either in the desert or over a larger area; others have never been common in the desert and populations may be near historical levels.

1. White-faced Ibis (*Plegadis chihi*). Uncommon resident. Formerly fairly common common breeding species at the Salton Sea. No breeding reported from early 1960s (Small 1977b) through 1976. Three or four pairs nested at the south end of the Salton Sea in 1977 (McCaskie 1977b) and at least 10 pairs nested at the south end in 1978 (McCaskie 1978b). Decreased populations were noted throughout California by Grinnell and Miller (1944). Destruction of marshes has contributed to declines (Grinnell and Miller 1944), but may be only one contributing factor.

2. Northern Harrier (*Circus cyaneus*). Uncommon resident. Uncommon breeding species becoming fairly common during the winter following influx of northern birds. Harper Dry Lake marsh, San Bernardino County, is only recorded breeding location in California desert: nine fledglings observed June 1978 (LeValley 1978); successful nesting confirmed May 1980 (P. Roush, pers. obs.). Birds observed in marsh habitats on May 28, 1979, near Tecopa, Inyo County (R.L. McKernan, pers. obs.) and on June 4, 1977 in Saline Valley, Inyo County (R.L. McKernan, pers. obs.) may be either late migrants or breeding birds. Breeding population declines in California noted by Grinnell and Miller (1944) were thought to result from loss of required marsh habitat.

3. Gull-billed Tern (*Sterna nilotica*). Uncommon summer resident. Nests on low, sandy islets at south end of Salton Sea (Grinnell and Miller 1944). Colony estimated at 500 pairs in 1937 (Grinnell and Miller 1944) and less than 200 in 1976 (McCaskie 1976c) and breeding population has declined; only 17 pairs were found in 1976 (McCaskie 1976c) and breeding may not occur some years (Cogswell 1977; McCaskie 1970c; Small 1974). Higher water levels in the Salton Sea may be disrupting nesting.

4. Short-eared Owl (*Asio flammeus*). Rare resident. Harper Dry Lake marsh, San Bernardino County, is only recorded breeding locality in California desert: three fledglings with observed June 1978 (LeValley 1978); successful nesting confirmed May 1980 (P. Roush, pers. obs.). Wintering populations in California began to decline as early as the 1940s, but were considered common at that time (Grinnell and Miller 1944). Now exceptionally scarce to nonexistent in some winters (McCaskie 1974a, 1975a); factors contributing to declines may include destruction of marsh habitats.

5. Vermilion Flycatcher (*Pyrocephalus rubinus*). Rare summer resident; casual in winter resident. Formerly fairly common in breeding range from Mexican boundary northwest to Imperial and Coachella Valleys at least to Coachella, Riverside County (Grinnell and Miller 1944). Historical breeding records from Camp Cady, San Bernardino County, and Indian Wells Valley, San Bernardino County (Pyle 1953). Only regular breeding locality today at Big Morongo oasis, San Bernardino County (McCaskie 1981; Pyle 1953; Small 1974), but habitat changes have caused the population decline at this site (McCaskie 1974c). Successful breeding pair observed April 4, 1974.

approximately seven miles southeast of Holtville near East Mesa Geothermal Test Well, Imperial County (A.S. England, pers. obs.). Requires desert riparian woodland or thickets near open water (Small 1974), alfalfa fields (McCaskie 1974c) or other open vegetation for foraging. Loss of riparian habitats in the Coachella and Imperial Valleys through receding water table (E. Cardiff, pers. comm.) and destruction of habitat have contributed to population declines.

6. Brown-crested Flycatcher (*Myiarchus tyrannulus*). Rare summer resident. Nesting reported only from riparian habitat at Big Morongo oasis, San Bernardino County (Small 1974). One to three breeding pairs regularly nest at this site (McCaskie 1968c, 1969d, 1970e, 1971b, 1972a, 1973b, 1974c, 1975c, 1976b, 1977a). One to two pairs also reported breeding along the Amargosa River near Tecopa (McCaskie 1982, 1986, 1987). A single bird observed near Victorville, San Bernardino County, and a pair near Mecca, Riverside County, could represent new breeding locations (McCaskie 1978b). Requires nesting cavity in large trees. Use of nest holes by European Starling could disrupt reproduction.

7. Bendire's Thrasher (*Toxostoma bendirei*). Fairly common summer resident. Breeds in valleys and on bajadas adjacent to Granite, Providence, New York, Ivanpah, Clark and Kelso Mountains, and in Lanfair and Shadow Valleys in eastern San Bernardino County (Carlson and Newberger 1979a, 1979b; England and Laudenslayer, 1989; Grinnell and Miller 1944; Johnson et al 1948; Johnston and Foster 1979; Remsen 1976; Small 1974). Also breeds in suitable habitat in Joshua Tree National Monument (England and Laudenslayer 1989; McCaskie 1973a, 1974c, 1978a; Miller and Stebbins 1964), and near Yucca Valley and Twentynine Palms (England and Laudenslayer 1989; McCaskie 1974c). Historical breeding records are known from near Victorville in early 1900s (Pierce 1919, 1920). Most recent evidence of nesting in this area was a bird "seen carrying food near Victorville, San Bernardino County on May 22, (1969)" (McCaskie 1969c), and probable breeding pairs found near Apple Valley and in Sidewinder Mountains in 1986 and 1987 (England and Laudenslayer 1989). Small populations have also been found near Superior Dry Lake north of Barstow, in Kelso Valley on the east slope of the Sierra Nevada, and on Lee Flat east of Lone Pine (England and Laudenslayer 1989). Most commonly found in habitats containing Joshua tree, Mojave yucca and cholla in association with creosote bush (England and Laudenslayer, 1989; Grinnell and Miller 1944; Remsen 1976). Status of current population not well known, but apparently has always been small and scattered (Grinnell and Miller 1944; Pyle 1953; Small 1974).

8. Virginia's Warbler (*Vermivora virginiae*). Rare summer resident. Known as regular breeding species in open stands of white fir and pinyon pine on Clark Mountain, San Bernardino County, since 1939 (McCaskie 1974c, 1977b, 1978b; Miller 1940; Small 1974). Recently discovered as probable breeding species in similar habitat in Kingston and New York Mountains (Cardiff and Remsen 1981; McCaskie 1977b; Remsen et al 1978). Never an abundant species in California (Grinnell and Miller 1944; Miller 1940).

9. Summer Tanager (*Piranga rubra*). Uncommon summer resident. Breeds in scattered riparian-woodland habitats including Big Morongo Canyon, San Bernardino County (1-6 pairs), and Brock Experimental Ranch, southeast Imperial County (1-2 pairs) (McCaskie 1969c, 1970d, 1972b, 1973b, 1974c, 1975b, 1976c, 1978b, 1979, 1985). Observed sporadically as a breeding species on Amargosa River south of Tecopa, Inyo County (McCaskie 1979b), on Mojave River near Victorville, San Bernardino County (McCaskie 1977b, 1984, 1987), at Fort Piute, San Bernardino County (McCaskie 1984), near Yalermo, Los Angeles County (McCaskie 1986), and at Whitewater Canyon and San Geronio Pass, Riverside County (McCaskie 1971b, 1973b, 1978b, 1985, 1986). Requires riparian-woodland habitat dominated by large cottonwoods and willows (Grinnell and Miller 1944; Small 1974). Considered common in breeding range by Grinnell and Miller (1944); McCaskie (1975c) noted it was "apparently on decline in Calif." Habitat destruction is a major factor for declines along the Colorado River and may also be contributing to declines in California desert.

In contrast to threatened, endangered, and extirpated species, field work has documented breeding attempts by several species or subspecies not recorded among California's breed avifauna by Grinnell and Miller (1944). Painted Redstart, Hepatic Tanager, and "Scott's" Rufous-crowned Sparrow (*Amophila ruficeps scottii*) have colonized, or appear to be colonizing suitable habitat in small numbers, whereas the Cattle Egret (*Bubulcus ibis*) and Black Skimmer now well established and have increased rapidly to form large breeding populations on the Salton Sea. These five species are discussed below. However, birds such as the Whip-poor-will (*Caprimulgus vociferus*) also have been recorded as breeding species in California (Jones 1971), and other birds colonizing the California desert may have gone undetected.

2. Black Skimmer (*Rynchops nigra*). Fairly common summer resident. First California desert record on south end of Salton Sea, July 3, 1968; subsequent nonbreeding records on July 1969 and May 17, 1970 (McCaskie and Suffel 1971), and July 31, 1971 (McCaskie 1971b). California nesting was five nests found on south end of Salton Sea in June and July 1972 (McCaskie 1972b; McCaskie et al 1974). Nesting has occurred annually in increasing numbers since 1972 has occurred at the north and south ends of the sea. Reported nesting records include 10 three nests in 1973 (McCaskie 1973b); 20 birds, at least three nests in 1974 (McCaskie 1974 birds, 9 nests in 1975 (McCaskie 1975c); 100 birds, 25 nests in 1976 (McCaskie 1976c); 500 100+ nests in 1977 (McCaskie 1977b); nested in large numbers in 1978 (McCaskie 1978b); nests in 1986 (McCaskie 1986) and 500+ pairs in 1987 (McCaskie 1987).

4. Hepatic Tanager (*Piranga flava*). Uncommon summer resident. Not recorded in C
desert by Miller (1940), Grinnell and Miller (1944), and D.Johnson, Bryant and Miller (1948),
extensive field work in eastern Mojave Desert. First evidence of breeding at a California

locally (McCaskie 1972b) was two pairs on Clark Mountain, San Bernardino County, May 1973 (Johnson and Garrett 1974). Since then one or three pairs have been reported annually from Clark Mountain (McCaskie 1974c, 1975b, 1976c, 1977b, 1978b, 1984, 1987). Direct and indirect evidence of breeding also reported from New York Mountains and Kingston Range, San Bernardino County, in 1976 and 1977 (Cardiff and Remsen 1981; McCaskie 1976c, 1977b; Remsen et al 1978); recently Hatched Hepatic Tanagers were also found in the white fir grove of the New York Mountains in 1979 (Cardiff and Remsen 1981). Restricted to white fir forests and pinyon-juniper woodlands on Clark Mountain, Kingston Range, and New York Mountains (Johnson and Garrett 1974; Remsen et al 1978).

5. "Scott's" Rufous-crowned Sparrow (*Aimophila ruficeps scottii*). Rare resident. First evidence of breeding included territorial males observed in Keystone Canyon-Live Oak Canyon portion of the New York Mountains, San Bernardino County, May and July 1976, and May and June 1977; one male with enlarged testes was collected (Remsen and Cardiff 1979). One possible previous record of this subspecies from eastern Mojave Desert was a pair observed in Mitchell Caverns State Park in March 1975 (McCaskie 1976c; Remsen and Cardiff 1979). Remsen and Cardiff (1979) cite four lines of evidence suggesting a recent range expansion as opposed to lack of suitable habitat for the limited distribution of this subspecies: 1) extensive work in the eastern Mojave Desert by a number of investigators, 2) absence of this species from apparent suitable habitat, 3) proximity to nearest source population, and 4) evidence of westward and northward expansion by a number of southwestern desert birds (Johnson and Garrett 1974).

HUMAN IMPACT ON BIRDS OF THE CALIFORNIA DESERT

Human activities generally have deleterious effects on bird populations. Negative impacts usually occur in three primary ways: 1) destruction or degradation of habitat, 2) disturbances that interrupt the life cycle of a bird, and 3) direct mortality. Habitat loss usually has the most severe and most long-lasting effects; a bird species will be eliminated from an area if the basic resources it requires are destroyed. Habitat degradation occurs when changes in soil, vegetation, water availability, and other resources cause reductions in population densities or the number of bird species found in a habitat. Habitat degradation frequently causes desirable species to be replaced by undesirable species. Disturbances can reduce breeding success, prevent birds from obtaining essential resources such as water and food, and occasionally will lead to indirect mortality. These deleterious impacts are generally short-term, but can have long-term effects on some species and habitats if the disturbance is too intense, if it occurs during a critical point in a bird's life cycle, or if it is continued for relatively long periods of time. Direct mortality can have severe long-lasting effects on small, declining and isolated populations. However, in larger, more stable populations, direct mortality is usually a short-term impact from which many species quickly recover.

Some human activities also have beneficial effects on wildlife. However, unless they result from a specific wildlife management action, most positive impacts are minor when compared to concomitant losses and generally benefit few native species.

Many demands have been put on the resources of the California desert. Each current and future use or development will have an effect on birds. A few human activities that most directly affect birds are discussed briefly in the following paragraphs.

OFFROAD MOTORIZED VEHICLE USE

The negative effects of offroad motorized vehicle use on birds result primarily from habitat degradation, but also include disturbance effects and direct mortality. When vehicles are restricted to roads, impacts are limited to birds occupying habitats adjacent to the road. If no constraints are

placed upon vehicle use, as in open areas, large numbers of birds and large areas of habitat are likely to be affected. The severity of negative impacts varies with the intensity and type of use, the level of noise produced, and the size and terrain of the area where offroad vehicles are allowed to operate. Deleterious effects are greatest in large, heavily used open areas, but are also substantial along most race courses and in many areas where use is "restricted" to existing vehicle routes.

The effects of noise on birds have been addressed in a number of studies. Marler et al (1973) demonstrated that the hearing abilities of birds can be permanently impaired by noise emanating from motorcycles and dune buggies. Weinstein (1978) and Luckenbach (1978) have documented that birds avoid areas intensively used by offroad vehicles. Harmata et al (1978) documented the reactions of several breeding Prairie Falcons (*Falco mexicanus*) to motorcycles and other vehicles; falcons reacted when vehicles passed at distances as great as 1.3 km (0.8 mi). (Also see Brattstrom and Bondelo chapter on *Desert Sound and Man-made Noise*).

Vehicular travel and recreation use in desert washes can have serious deleterious effects on birds. Bury et al (1977), in their work in creosote bush habitats of the central Mojave Desert, compared breeding birds at sites with no, moderate, and heavy offroad vehicle use. The site with no use supported five breeding pairs whereas the moderately-used site had three and the heavily-used site had none. Luckenbach (1978) reported over 90% fewer birds in a wash used by vehicles in the Colorado Desert compared with an undisturbed wash nearby. Three major factors contributed to these declines (Luckenbach 1978). First, disturbance effects are large because most desert birds breed during the spring when offroad vehicular use is greatest. Second, damage to vegetation reduces nesting cover and food supplies. Third, offroad vehicle users often ride and camp around desert water sources, preventing birds and other wildlife from gaining access to water. The severity of impact varies with the number of vehicles and recreationists using the wash.

Direct mortality can have negative impacts on birds adjacent to roads. Hodson (1962) reported that birds were killed along roads when foraging for insects or carrion, dust-bathing, ingesting while flying at a low altitude. Vehicle travel on roads can have substantial effects on bird populations. In a non-desert habitat, Robertson (1930) observed 104 road-killed birds along 14.5 km (9 mi) of paved road over a one-year period. This type of mortality undoubtedly occurs in areas where offroad vehicle travel is allowed. Ground-nesting species such as Horned Larks (*Eremophila alpestris*), which prefer relatively open areas as nesting sites, would be subject to greater impacts in areas where offroad vehicle use is allowed.

Vehicular travel, on or off highways, has effects on bird populations. When vehicles are limited to roads, a small portion of the avifauna in a given area is subjected to these effects. However, with unrestricted offroad travel, large portions of the avifauna over large areas are affected and negative impacts rise as vehicle numbers increase, with habitat being degraded or destroyed.

LIVESTOCK, WILD HORSE AND FERAL BURRO GRAZING

Little quantitative information has been collected on the effects on birds by livestock grazing in desert habitats. However, information has been gathered under different climatic regimes. Much of the published information addresses the effects of grazing on game birds and raptors.

Grazing pressure frequently causes changes in the structure and composition of vegetation with reduction of vegetation cover as a common result. Monson (1941) found that greater fox cover on ungrazed plots more than doubled bird populations. Other birds prefer open habitats. Species such as Horned Lark and Bendire's Thrasher may benefit from decreased vegetative cover. However, trampling can destroy nests of species such as Mourning Dove and Horned Lark. In some situations, grazing can stimulate shifts toward shrub often nest on the ground.

vegetation, causing reductions in and loss of grassland nesting species. Changes in the species composition of vegetation can significantly alter the quantity and quality of food available for some species. Removal of seedheads before seedset may be detrimental to granivorous species such as Black-throated Sparrows. In Arizona, food plants important to Montezuma Quail (*Cyrtonyx montezumae*) have been removed through grazing pressures (Gallizioli 1977; Gorsuch 1934). In the Intermountain Region, plant composition shifted to species which were less nutritious and palatable to Sage Grouse (*Centrocercus urophasianus*) (Rasmussen and Griner 1938; Schneegas 1967). Changes such as these may alter the insect populations that support insectivorous birds.

In the desert, cattle (Ames 1977; Kennedy 1977) and burros (Woodward and Ohmart 1976) congregate in riparian and wash habitats to find water, succulent vegetation, and shade. This pattern is especially prevalent during hot, dry summer months. These habitats are among the most productive for birds. Concentrated use causes trampling and overgrazing of these areas when adjacent desert habitats may remain lightly utilized. Resulting negative impacts to birds can be great (Taylor 1986) and many riparian areas in the California desert have been damaged.

In some habitats and under certain conditions, livestock grazing can be beneficial to particular species of birds. Some grazing is desirable to maintain the open areas required by California Quail (*Callipepla californica*) in regions of California where dense chaparral or woodland habitats may develop (Leopold 1977). Grazing may benefit raptors if forage utilization is not so severe that perch sites or prey species are reduced. In areas that have not been damaged by grazing, light to heavy grazing may increase some rodent populations (Dick-Peddie 1976; Phillips 1936; Stoddart and Smith 1943) and provide a better prey base for raptors. In short-grass prairies, Olendorf and Stoddart (1973) found greater rodent abundance on ungrazed or lightly grazed areas, in contrast to heavily grazed areas. Most rangelands in the California desert have been moderately grazed to overgrazed; any benefits to raptors may already have been achieved or exceeded.

Grazing can have different effects on birds depending upon grazing intensity, previous grazing use, and other ecological and management variables. Buttery and Shields (1975) state, "the effects of grazing most often depend on its intensity and localization. High intensity grazing profoundly alters breeding avifaunas from the natural state, generally in the direction of decreased species numbers and complexity." Light to moderate grazing would probably not be detrimental to most rangeland birds (Buttery and Shields 1975; Weins and Dyer 1975). However, even light grazing pressure may be detrimental on ranges previously overgrazed. Well-regulated grazing systems in certain situations may enhance the habitat for some bird species, whereas other species are negatively affected by any grazing pressures. Grazing systems and range improvement techniques must be designed and regulated to provide for bird populations as well as livestock production. (Also see chapter by Rowlands on *Vegetation Dynamics*.)

WATER USE AND AGRICULTURE

In the California desert, dry-land farming is rarely attempted, and agriculture is dependent upon irrigation systems. Water is acquired from two sources, local groundwater pumping from underground aquifers and importation of water from outside the desert. Groundwater wells are the major source of water for agricultural operations in desert areas such as Deep Springs, Mesquite, Fremont and Lucerne Valleys, and the area adjacent to Harper Lake. Imported water, primarily from the Colorado River, is the main source of water for the Coachella and Imperial Valleys.

Both of these methods of water acquisition have negative impacts on birds. Groundwater pumping in excess of replenishment rates lowers the water table, causing declines in natural seeps and springs, and in deep-rooted plants such as mesquite, palm, and cottonwood that obtain water from the vicinity of the water table. As a result, important water sources and highly valuable riparian vegetation may be lost. Establishment of non-native plants such as tamarisk and Russian thistle

(*Salsola iberica*) may be the result of groundwater overdrafts (Harris 1966) and contribute to in native vegetation. Massive removal of groundwater reserves may cause subsidence of soil which may increase soil losses due to wind erosion (Johnson 1978) leading to further degradation of habitat.

Diversion of water from rivers usually requires channelization of streambeds and construction of dams, pipelines, and canals to control, store and transport water. Positive and negative effects of these structures on birds result from increased demands on river water and changes in stream characteristics. Beneficial impacts include creation of new marsh and lake habitats. However, control facilities eliminate periodic flooding and reduce the volume of water in the river. Irrigation practices cause reductions in marshes and riparian habitats. On the Colorado River, reduced flow have caused formerly productive marsh and riparian areas in the river delta and along riverbanks to become dry desert habitat.

Large areas of native habitat in the Imperial and Coachella Valleys and other parts of the California desert have been converted to agricultural uses. As the area used for agricultural purposes increases, populations of many bird species decline as a result of habitat loss. Agriculture is beneficial to avian species that forage in croplands. Wintering flocks, including such as Horned Larks, blackbirds, and many shorebirds, generally obtain the greatest benefit from these changes. Birds such as California Quail, Gambel's Quail, White-winged Dove and others often forage in agricultural fields to take advantage of high seed production. However, some species usually require nesting and roosting sites in native habitats adjacent to foraging areas. Detrimental impacts to some desert nesting species can be reduced if croplands are interspersed with belts of native vegetation.

Agricultural use also affects birds in a number of subtle ways. Brown-headed Nuthatch populations are benefited by many agricultural developments. This species is a nest predator of many vireos and warblers, and populations of host species such as Bell's Vireo and Yellow Warbler (*Dendroica petechia*) have declined or have been extirpated from the Colorado River (Ancient Murrelet 1976a). Declines in the Least Bell's Vireo (Goldwasser 1978) and other species in the California desert may also be partially the result of increased cowbird populations.

The effects of pesticides on birds other than raptors and marine forms are not well known and no studies have been conducted in the California desert. However, in some instances mortality has been attributed to pesticide (Herman and Bulger 1979; Pearce et al 1976). Non-persistent types are highly toxic to birds (Risebrough 1978). Pesticides at less than 1 ppm can have biologically observable effects (Newton 1979). For example, eggshell thinning in birds of species has a high correlation with DDE (dichloro-diphenyl-ethane) levels (Hickey and Newton 1968; Risebrough 1978), and may be a significant factor in the decline of a number of avian species. Application of pesticides to farmlands in the California desert could have similar effects. In addition, desert breeding birds that migrate to wintering grounds in the south may be exposed to pesticides when away from the desert.

Some of the more favorable areas for agricultural development in the California desert are situated adjacent to streams and large springs. These areas have soil conditions conducive to agricultural development and water supplies that are easily tapped, and frequently support native vegetation, mesquite thickets or other highly productive habitats. Agricultural growth is a factor reducing the availability of these rare desert habitats that support many birds, including wintering species.

TRANSMISSION LINES AND WIND FARMS

Construction and maintenance of transmission lines affect birds in a variety of ways (Olendorff et al 1981). Habitat is permanently lost to access roads and tower structures, and is temporarily altered during construction through activities as diverse as operation of portable concrete-batch plants, conductor-pulling sites and tower-erection sites. For each 1.6 km (1 mi) of transmission line, about 1.1 ha (2.7 ac) of habitat is lost to access roads and an additional 0.7 ha (1.8 ac) of habitat is temporarily affected (Southern California Edison 1977).

Transmission wires and towers can be hazardous to flying birds, particularly during inclement weather or at night. During one spring, Woodman (pers. comm.) recorded 12 dead birds along 2.2 km (1.4 mi) of transmission line corridor (consisting of one 500 kV and two 220 kV lines) in Ivanpah Valley. Birds found included seven Wilson's Warblers (*Wilsonia pusilla*), two Mourning Doves (*Zenaida macroura*), and one each of Violet-green Swallow (*Tachycineta thalassina*), Black-throated Warbler (*Dendroica nigrescens*) and Lazuli Bunting (*Passerina amoena*).

Raptors have been electrocuted on transmission lines, especially on lower voltage lines where wires are only 1.2-1.5 m (4-5 ft) apart. High voltage lines are farther apart and generally do not cause such problems. Steel lattice towers many extend the range of some raptor species (Hannum et al 1975) by providing roosting and nesting sites (Rue 1957).

TAMARISK INVASION OF DESERT RIPARIAN HABITATS

Tamarisk (or saltcedar) is a complex of exotic plant species that range in form from short shrubs to tall trees. They have been introduced into the United States from the Middle East and have invaded many desert riparian habitats. They generally are able to colonize disturbed areas faster than native plants, and often form dense stands which exclude native vegetation. Since the introduction of tamarisk to the lower Colorado River Valley, virtually every riparian habitat type along the River has been invaded by this exotic; a number of pure tamarisk stands now exist (Anderson and Ohmart 1976a). Tamarisk associations along the lower Colorado River appear to be regularly burned, but are able to regenerate at rates faster than native willows and mesquite; cottonwoods do not regenerate following fire (Anderson and Ohmart 1976a).

Anderson and Ohmart (1976a) and Anderson et al (1977) compared avian use of tamarisk to native plant associations along the lower Colorado River, and Hunter et al (1988) compared the avifauna in tamarisk on several southwestern rivers. Their results indicate that mature tamarisk provides better habitat for birds than smaller tamarisk, and vegetation composed of tamarisk mixed with other shrubs and annuals has a more diverse avifauna than homogeneous stands of tamarisk. Tamarisk in general provides poorer habitat for birds than most native riparian communities.

The impact of these exotic plants on desert riparian areas is still under study. However, the problem is severe and tamarisk continues to increase in the desert. Active management procedures are necessary to reduce the problem, either by eliminating the tamarisk, by introducing and maintaining native plants in tamarisk associations, or by managing tamarisk areas to produce dense, tall stands (Anderson and Ohmart 1976a).

In the early 1980s, the problem was recognized by Bill Neill of the Sierra Club who has undertaken a continuing program in cooperation with the Bureau of Land Management to eradicate tamarisk from the desert riparian areas. An active volunteer group has been established under Neill's leadership and organized efforts at control or eradication are making considerable headway in reducing or eliminating tamarisk at smaller, isolated water sources scattered about the desert where the infestation has not yet become fully established. Both the Bureau and the Anza-Borrego State

Park have separately initiated control programs. Tamarisk is so well established along the Colorado River and in some areas along the Mojave River and around the Salton Sea, that efforts at control or eradication would be impossibly difficult (Neill 1983).

MANAGEMENT CONCERNS

During the preparation of the California Desert Conservation Area Plan in the late 1970s, the Bureau of Land Management carried out intensive research and monitoring during their studies of desert birds, as described above. However, research and monitoring have not continued at the former level and much valuable information has not been collected. Birds are particularly valuable as indicators of the health and productivity of the desert. Longterm research and consistent monitoring are basic to wise management of public lands and are vitally necessary if we are to properly manage and maintain desert birds and other wildlife in the California desert and other public lands.

SUMMARY

In spite of the harsh environmental conditions found in many parts of the California desert, at least 425 bird species have been recorded from the region. Most species have been observed during migration and/or the cooler and moister months. Most of the approximately 175 species that breed in the California desert are found in riparian habitats along water courses or in forests and woodlands at higher elevations where climatic conditions are less harsh than on valley bottoms and bajadas. Yet these dry, lowland scrub habitats support bird species not found elsewhere in California.

Each bird species recorded from the California desert has its own unique set of ecological requirements. The distribution, abundance, and habitat preferences of selected species of special interest is discussed. These include 14 Threatened or Endangered species, three extirpated or formerly breeding species, 10 species with restricted ranges or small populations, and five species with recently expanding ranges.

The California desert is easily damaged and slow to recover from disturbances. Human activities are damaging many rare, sensitive, and highly productive habitats. Impacts include offroad vehicle use, grazing, water development, agricultural growth, establishment of transmission lines, and invasion by exotic plants. If existing trends continue, some of these impacts will contribute to regional extirpation of a number of bird species now using the California deserts.

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Table 1. Habitat distribution of 66 bird survey plots.

HABITAT STRUCTURE		NUMBER OF SURVEYS BY SEASON	
Habitat	Number of Sites	Breeding Bird	Winter Bird
WOODLAND			
Digger pine woodland	1	1	1
Limber pine forest	1	1	1
Pinyon-juniper	2	2	2
Scrub oak woodland	1	1	1
Total	5	5	5
RIPARIAN/WASH			
Palm oasis	2	2	2
Marsh	1	1	1
Cottonwood-willow-riparian	5	5	5
Tamarisk riparian	3	3	3
Mesquite thicket	4	4	4
Ironwood wash	3	3	3
Microphyll woodland/ paloverde wash	6	6	6
Catclaw wash	1	1	1
Total	25	25	25
DESERT SCRUB WITH OVERSTORY			
Joshua tree woodland	10	7	6
Mojave yucca scrub	6	5	2
Ocotillo scrub	3	2	3
Total	19	14	11
DESERT SCRUB			
Creosote bush scrub	8	7	7
Sagebrush scrub	2	2	2
Shadscale scrub	1	1	1
Saltbush scrub	3	3	3
Sand dune scrub	2	2	2
Rabbitbrush scrub	1	1	1
Total	17	16	16
GRAND TOTAL	66	60	57

Table 2. Average bird utilization of four general habitat structural classes based on breeding bird censuses and winter bird-population studies.

UTILIZATION (Average Value)	VEGETATION			
	Woodland	Riparian Wash	Desert Scrub With Overstory	Desert Scrub
BREEDING BIRD SURVEYS				
Breeding species ¹	13.4	12.5	9.6	3.2
Individuals/40 ha (100 ac)	72.2	274.1	35.6	16.0
Visiting species	24.0	39.9	7.9	8.8
WINTER BIRD-POPULATION STUDIES				
Wintering species ¹	13.8	26.4	12.9	9.0
Individuals/40 ha (100 ac)	107.6	523.4	71.1	75.9
Visiting species	7.3	N/A ²	3.5	N/A ²

¹Bird Species Richness (BSR)²No information recorded

Table 3. Threatened and Endangered birds of the California deserts. (U.S. Fish and Wildlife Service 1989, 1990; Calif. Dept. Fish and Game 1991a,b;1992).

Species / Subspecies	Federal Status ¹	State Status ¹
Brown Pelican (<i>Pelecanus occidentalis</i>)	E	E
"Aleutian" Canada Goose (<i>Branta canadensis leucopareia</i>)	T	-
Bald Eagle (<i>Haliaeetus leucocephalus</i>)	E	E
Swainson's Hawk (<i>Buteo swainsoni</i>)	-	T
"American" Peregrine Falcon (<i>Falco peregrinus anatum</i>)	E	E
"California" Black Rail (<i>Laterallus jamaicensis coturniculus</i>)	1	T
"Yuma" Clapper Rail (<i>Rallus longirostris yumanensis</i>)	E	T
"Western" Yellow-billed Cuckoo (<i>Coccyzus americanus occidentalis</i>)	-	E
Elf Owl (<i>Micrathene whitneyi</i>)	-	E
Gila Woodpecker (<i>Melanerpes uropygialis</i>)	-	E
"Gilded" Northern Flicker (<i>Colaptes auratus chrysoides</i>)	-	E
Willow Flycatcher (<i>Empidonax traillii</i>)	-	E
"Least" Bell's Vireo (<i>Vireo bellii pusillus</i>)	E	E
"Inyo" Brown Towhee (<i>Pipilo crissalis eremophilus</i>)	T	E

¹ E = Endangered

T = Threatened

1 = Category 1 - U.S. Fish and Wildlife Service has substantial information on hand to support listing but proposed ruling has been precluded by other listing activity.

FSS = Federal (BLM and USFS) Sensitive Species

SCE = California Candidate for listing as Endangered