end of the sea are no more than 50 m above sea level. The jagged Peninsular Ranges to the west and higher ground to the east (e.g., Mesa Andrade, the Chocolate Mountains) naturally funnel birds into the Salton Sink that were not deterred when reaching land at the head of the gulf. Furthermore, an abundance of water along the Río Hardy, the Río Colorado, and in large bodies, such as at Campo Geotérmico Cerro Prieto (lying in the bed of former Volcano Lake) or Laguna Salada (when flooded), is conducive to "leapfrog" movements through the Río Colorado delta into the Mexicali and Imperial Valleys. Lastly, the "thermal-rich environment of the coastline in the Sonoran Desert" is conducive to birds soaring at great heights (Anderson et al. 1977). Birds reaching the northern end of the Salton Sink will inevitably find the Salton Sea, not only because of the vast area the sea covers but also because the geography of the area further pinches inward, tightly narrowing the funnel. The rugged Santa Rosa Mountains sweep eastward, skirting the northwestern edge of the Salton Sink. Similarly, the Orocopia Mountains sweep westward, nearly merging with the Little San Bernardino Mountains (Fig. 10).

In the northern part of the Salton Sink, the north end of the Peninsular Ranges (i.e., the San Jacinto Mountains) meets the central Transverse Ranges (i.e., the San Bernardino Mountains) to form the formible San Gorgonio, which rises from 50 m below sea level to over 650 m above sea level in a stretch of only ±50 km. This great, narrow pass is one of the deepest rifts in the Americas, as it separates Mount San Jacinto (3,225 m) and Mount San Gorgonio (3,464 m), the apices of which are a mere 34 km apart. Most waterbirds moving northward in spring through the Salton Sink are funnelled through this pass, making it one of the most important migratory corridors in the West (see below).

Wind patterns play a significant role in influencing bird movements at the Salton Sea, and again establish a tight link between the sea and gulf (Anderson et al. 1977, Patten and Minnich 1997). Wind flow in the summer months (May through September) is primarily from the south, with prevailing flow stopping at the San Gorgonio Pass (prevailing winds north of the pass are always from the north). During other months monsoon flow breaks down and winds are primarily from the north, sweeping southward from the San Gorgonio Pass through the Salton Sink (Fig. 11; Blake 1923). These wind patterns are strongly associated with the dispersal of numerous seabirds from the Gulf of California to the Salton Sea. Species include regular visitors such as the Brown Pelican and Yellow-footed Gull, which occur in the 1000s and have been increasing (Anderson et al. 1977, Patten 1996), and unusual strays such as the astounding 30+ records of eight species of highly pelagic Procellariiforms (i.e., albatrosses, petrels, and shearwaters; Patten and Minnich 1997).

Concomitant with the southerly winds in summer is an increase in sea surface temperatures off western Mexico. During the winter months, the gulf is normally much warmer than the oceanic waters off of western Mexico, effectively isolating the gulf from the surrounding seas. Warming of waters during summer brings temperatures off western Mexico to nearly the same as in the gulf, creating a more uniform environment. The break down of the temperature gradient barrier facilitates dispersal of seabirds into the Gulf of California (Patten and Minnich 1997), aided by the monsoon winds.

Vegetation and Habitat

To aspects of biogeography and macroecology are especially important to a consideration of the distribution and abundance of organisms. The first is the actual geography and topography of the region in question. As noted above, the strong relationship between the Salton Sink and the Gulf of California exerts a powerful influence on bird distribution in the region. The other major influence is vegetation and habitat, which are directly related to geography and climate of a region but which shape animal distributions in an entirely different way. Obviously, if favorable habitat does not exist for a particular species to survive and reproduce, that species will not occur there regularly.

The dry, hot environment of the western Sonoran Desert is undeniably harsh, exacting a heavy toll on plants that grow there. A particularly harsh climate exists in the Salton Trough, which holds the dubious distinction of being one of the hottest locales in all of North America, the others being Death Valley and the head of the Gulf of California (Schmidt 1989). Furthermore, even though soils are mainly alluvial deposits from the Colorado River, with some gravel and sand along the western and eastern shorelines and a fine sandy loam in portions of the Coachella Valley (a residual of Lake Cahuilla), most are highly alkaline. Lastly, annual rainfall is exceedingly low, averaging <4 cm throughout the region. Vegetation is therefore clumped around alternate water sources, such as the Whitewater River (draining the south slope of the San Bernardino Mountains), Salt Creek (draining the Orocopia Mountains), the Alamo and New Rivers (diffluents of the Colorado Rivers), a myriad of washes that carry occasional flash

floods, and various lakes, ponds, marshes, and irrigation ditches. The searing heat, combined with low annual rainfall and highly alkaline soils, exclude many plant species that are otherwise common and widespread in the deserts of western North America. Visitors who expect a multitude of cacti and other succulents will be sorely disappointed.

Not surprisingly, extensive cultivation has drastically altered the natural vegetation of the region. Nevertheless, native plant species affinities in the Salton Sink are predominantly transmontane (meaning the other side of the mountains, relative to the ocean), not cismontane (meaning the same side of the mountains as the ocean). As aptly noted by Parish (1914), "a student of the flora of the Colorado Desert speedily discovers evidences of migratory movement from the south and east." The Colorado Desert flora is the western fringe of the arid flora of Sonora, Arizona, and New Mexico (Turner et al. 1995), but the xerophytic (dry tolerant) vegetation of the Salton Sink is mainly differentiated by the preponderance of saltbush (*Atriplex* spp.) and other halophytes (salt tolerant plants; Parish 1914). Considering purely native plants, a typical cross-section of the Salton Sink, from west to east, moves from pinyon-junipers woodland on the dry eastern slopes of the Peninsular Ranges through rich *Yucca*-cholla (*Opuntia* spp.)-Ocotillo (*Fouquieria splendens*) vegetation in the Anza-Borrego and edge of the Pattie Basin, Creosote (*Larrea tridentata*) scrub at lower elevations, mesquite (*Prosopis* spp.) bosques on low-lying sandy soils, to saltbush flats characterizing the Salton Sink (Fig. 12; Parish 1914, Wilke 1978). Climbing eastward out of the sink leads through a similar transition, until one reaches the extensive mesquite-willow (*Salix* spp.)-Fremont Cottonwood (*Populus fremontii*) association of the lower Colorado River Valley.

Vegetation associations in the Salton Sink can be divided into eight principal formations or types, five of them native. Such divisions are artificial to some degree, as many vegetation communities grade into one another. Nevertheless, naming these formations provides an important shorthand for discussing avian habitats in the region. The first five native formations were recognized by Parish (1914). Their descriptions herein are largely summaries of his early report, but are updated with current nomenclature and taxonomy (Hickman 1993, Turner et al. 1995) and modifications to accommodate recent knowledge. Human-modified habitats comprise the last three vegetation "formations." Obviously such associations are artifical, so speaking of them as communities is meaningless. Nonetheless, each provides habitat for numerous species, as does the open water of the Salton Sea itself.

HYDROPHYTIC FORMATION. Truly aquatic plants are poorly represented in the Salton Sink. The duckweed *Ruppia cirrhosa* is the only prevalent representative. It occurs sparingly on fresh-water marshes and some ditches that have sufficiently clear water to allow growth.

HELIOPHYTIC FORMATION. In contrast to aquatic plants, sun-tolerant, shallow-water plants are fairly well represented in the Salton Sink, mainly at the edge of marshes, ponds, and lakes and along rivers and ditches (Fig. 13). Dominant species are two cattails, *Typha domingensis* and *T. latifolia*, various bulrushes but especially *Scirpus americanus* and *S. maritimus*, the reed grass *Phragmites australis*, rushes such as *Juncus cooperi*, and the saltgrass *Distichlis spicata*. The non-native saltcedar *Tamarix ramosissima* was become a significant component of this community in the past half-century. *Typha* is especially common in marshes and around river mouths, but salt cedar and *Phragmites* dominate along rivers and ditches and lake edges.

MESOPHYTIC FORMATION. Riparian forest and similar mesophytic formations are generally only moderately represented in the Salton Sea. They are found exclusively along the rivers, around seeps, and near lakes and large ponds. Although the extent of riparian habitat has undoubtedly decreased over the past century, historical accounts (e.g., Mearns 1907) suggest that it was never abundant in the region. Salt cedars (*Tamarix ramosissima* and *T. aphylla*) now dominate this habitat. Portions of the Whitewater, New, and Alamo Rivers support the Fremont Cottonwood and Goodding's Black Willow (*Salix gooddingii*; Fig. 14) and patches of these trees occur around some lakes and marshes. Aside from salt cedar, the most numerous shrub element is the Arrowweed (*Pluchea sericea*). In stark contrast to the Mojave Desert, well-wooded oases are rare in the western Sonoran Desert (i.e., the Colorado Desert) and especially so in the Salton Sink. A prominent tree of oases in the Colorado Desert is the fan palm *Washingtonia filifera*, but it occurs commonly only at Dos Palmas and is otherwise rare along the rivers.

HALOPHYTIC FORMATION. Given the highly alkaline soils of the Salton Sink, it should come as no surprise that halopytic (salt tolerant) plants are well represented. The salt cedar *Tamarix ramosissima* is the dominant plant species along the fringe of the Salton Sea and in river bottoms and other wetlands. Where understory vegetation grows it is often nothing more than a mat of the salt grass *Distichlis spicata* and where salt cedar does not occur at the edge of the sea the dominant plant is generally the Iodine Bush (*Allenrolfea occidentalis*; Fig. 15). Away from the edge of the sea, various recessions of Lake

Cahuilla and initial recession of the Salton Sea exposed alkaline flats that were readily occupied by halophytes (MacDougal 1914), forming the saltbush scrub that characterized much of the pre-irrigation Salton Sink (Fig. 16). Dominant plants are the saltbushes *Altriplex lentiformes*, *A. polycarpa*, and *A. canescens*. Other common shrubs and subshrubs in this formation are the Bush Seepweed (*Suaeda moquinii*), the goldenbush *Isocoma menziesii*, Western Sea Purslane (*Sesuvium verrucosum*), and Alkali-Mallow (*Malvella leprosa*). In more mesic areas the heliotrope *Heliotropium curassavicum* and salt grass are common elements of the ground cover.

XEROPHYTIC FORMATION. Being in a desert environment, one expects xerophytic (dry tolerant) plants to be well represented in the Salton Sink. Exclusive of cacti and true succulents, xerophytic plants are indeed common. However, true desert scrub, though well developed, is now confined to the fringes of the sink. It is especially common along the eastern edge, on the gentle slope that climbs to the Orocopia and Chocolate Mountains and the Algodones Dunes, and on the western edge as the halophytic scrub of the sink merges with the relatively lush desert scrub of the Anza-Borrego region. On sandier soils the common plant is *Larrea tridentata*, the Creosote. It is especially common along the eastern edge of the cultivated portion of the Imperial Valley. Desert scrub in the sink is otherwise characterized by lower shrubs and subshrubs, such as the Brittlebush (*Encelia farinosa*), Turtleback (*Psathyrotes ramosissima*), the dyeweed *Tiquilia plicata*, the locoweed *Astragalus limatus*, and Burrowweed (*Ambrosia dumosa*; Fig. 17). Patches of both Honey and Screwbean Mesquites, *Prosopis glandulosa* and *P. pubescens*, form dense stands, especially in parts of the southern Coachella Valley, eastern Imperial Valley, and western Mexicali Valley and along San Felipe Creek (Fig. 18). Unfortunately, mesquite is now much rarer in the Salton Sink than it was formerly. Based on Mearns (1907) descriptions of vegetation along the New and Alamo Rivers in 1894, mesquite was the dominant tree. It dominates in few locations today. The mistletoe *Phoradendron californicum*, which grows mainly on mesquite in the region but also uses the Fremont Cottonwood as a host, provides important habitat and food for frugivores. In addition to mesquite, washes draining into the sink, particularly along the western edge, support stands of the Blue Palo Verde (*Cercidium torreyanum*), Ironwood (*Olneya tesota*), and Smoketree (*Psorothamnus spinosus*). Although characteristic of drainages in many parts of the Sonoroan Desert, the Desert Willow (*Chilopsis linearis*) is scarce in the Salton Sink.

SUBURBIA, PARKLANDS, AND RANCH YARDS. In the desert Southwest, wooded suburbia, parks, and ranch yards now act as a surrogate for many erstwhile riparian species (Rosenberg et al. 1987). Large broadleaf trees, ranging from the native Fremont Cottonwood to non-native *Eucalyptus* spp., were heavily planted throughout the settled portions of the valleys. Planted pines (*Pinus* spp.) are prevalent in the larger towns, as are a multitude of deciduous trees such as elms (*Ulmus* spp.), mulberries (*Morus* spp.), the myoporum *Myoporum laetum*, and sycamores (*Platanus* spp.), and numerous shrubs. Extensive planting has created a lush artificial habitat that is now important for many species, whether resident (e.g., Inca Dove, Gila Woodpecker, Northern Mockingbird), breeding visitors (e.g., Black-chinned Hummingbird, Hooded Oriole), or migrants.

ORCHARDS. Cultivated orchards are another important artificial habitat in the Salton Sink. The southern Coachella Valley supports a myriad of vineyards and date palm and citrus orchards. These habitats in turn support a myriad of bird species that are generally associated with wooded habitats elsewhere (e.g., Common Ground-Dove, Lark Sparrow). Orchards are less common in the Imperial and Mexicali Valleys (especially in the former), but nonetheless provide habitat for birds in the region.

AGRICULTURAL FIELDS. As noted above, the Coachella and Imperial Valleys are among the most important agricultural regions in the United States and the Mexicali Valley is one of the most important in Mexico (Steer 1952, Putnam and Kallenbach 1997). A wide variety of crops are cultivated in these valleys, but land use patterns differ widely between them. The Coachella Valley largely supports orchards and vineyards; open agricultural land generally is dominated by sod farms, with little devoted to vegetable or textile crops. Far fewer orchards exist in the Imperial and Mexicali Valleys. Instead, cultivated lands are devoted to grains, alfalfa, sugar beets, vegetables, cotton, and many other crops. Rotation of farming creates an everchanging matrix of fallow or weedy fields. Fields not farmed in a particular year provide habitat for numerous wintering birds, ranging from Northern Harriers and Short-eared Owls to Western Meadowlarks and various sparrows. Burning of harvested fields is a common practice in both the southerly valleys; such burns may provide critical habitat for wintering Mountain Plovers and frequently support large numbers of wintering Horned Larks and American Pipits. Nearly 95% of birds feeding or roosting in agricultural fields during a recent study (Shuford et al. 2000) occurred in fields with three broad cover types. Fields supporting grasses host more birds (39%) than do field