CHAPTER 1

North American Deserts: Environments and Vegetation

1.1 The Deserts of North America

North American deserts range from subtropical thorn scrub to high-latitude steppe to extreme barren desert. The deserts of North America are significantly smaller than those in the Old World, and generally not arid enough to be considered true deserts; North America is thus largely typified by semideserts (Shmida and Whittaker 1979; West 1988). The main determinant of arid climates in western North America is the presence of local mountain ranges creating rain shadows in the Great Basin and Mojave Deserts (the Sierra Nevada-Cascades and Rockies), the Sonoran Desert (the Peninsular Ranges and Sierra Madre Occidental), and the Chihuahuan Desert (the Sierra Madre Oriental and Sierra Madre Occidental). In contrast, most of the world's great arid deserts are created by predictable descending high pressure systems at subtropical latitudes (Shmida 1985). Although a multitude of desert definitions proliferate in the literature, the 120–150 mm isohyet of annual precipitation is generally recognized as the boundary between deserts and semideserts (Shmida 1985) and of arid and semiarid climates (Meigs 1953). Based on this classification, only the western extent of North America's deserts, which lie adjacent to the primary rain shadow of the Sierra Nevada and associated cordillera, can be considered true arid deserts. Shmida (1985) made a further distinction at the 70 mm isohyet between true desert and extreme desert, which corresponds roughly to the boundary between diffuse and contracted vegetation. Only a narrow band from Death Valley in the north to the Gulf of California in the south falls below this 70-mm isohyet and can thus be classified as extreme desert. Many of the North American semideserts are now classified as desert based more on plant physiognomy (desert scrub) than on climate (semiarid). This incongruence between vegetation and climate is almost certainly a function of desertification (Cloudsley-Thompson 1988; Schlesinger et al. 1990), which has been caused largely by overgrazing in concert with climatic drought.

Historically, demarcation of the deserts of North America has relied upon multiple criteria, including climate, vegetation physiognomy, and floristic composition. Although all of these can be used to broadly identify the major continental deserts, strict adherence to any one results in potentially different boundaries. With this caveat in mind, we will briefly describe the deserts of
North America, why they are classified as separate deserts, and what is potentially unique about the climate and vegetation of each desert. For more extensive and detailed discussions, we refer the reader to Shreve (1942a) for the original demarcation of North American deserts, to MacMahon (1979, 1988) and MacMahon and Wagner (1985) for the warm deserts, and to West (1983a,b, 1988) for the cold deserts.

The four primary deserts of North America are the cold desert shrub and shrub steppe (which includes the Great Basin Desert), the Mojave, the Sonoran, and the Chihuahuan (Fig. 1). The four deserts can be climatically demarcated based on latitude (temperature) and longitude (seasonality of precipitation). Fischer and Turner (1978) classified arid and semiarid vegetation into three broad latitudinal zones: (1) savanna (0–20° latitude); (2) transition (20–40° latitude); and (3) steppe (40–50° latitude). They noted that savanna is almost always characterized by dry winters and a wet summer growing season, and that steppe is characterized by cold winters, dry summers, and a spring growing season. In North America, the cold deserts comprise a steppe region, whereas the warm deserts, the Mojave, Sonoran, and Chihuahuan Deserts, are all in the transition region (Fig. 1; the actual boundary between the Great Basin and Mojave Deserts is ca. 37°N). The distinction between “cold” and “warm” is based more on the occurrence of freezing temperatures in the winter (see Sect 1.2.1) than maximum temperatures in the summer.

Within the transition region, seasonal precipitation can occur as winter rainfall, summer rainfall, or bimodal. These patterns, which are related to seasonal airmass dynamics across western North America (Neilson 1987), act to separate the three North American warm deserts. As one moves from West to East (Mojave to Chihuahuan Desert), the ratio of winter to summer rainfall decreases. The Mojave Desert and western Sonoran Desert receive primarily winter rainfall (spring growing season), a majority of the Sonoran Desert has a bimodal rainfall regime (spring and summer growing seasons most years), and the Chihuahuan Desert receives summer rainfall. Although other factors are certainly involved, these differences in seasonal rainfall are sufficient to effect differences in vegetation structure and floristic composition.

The Great Basin Desert is a large (409 000 km²; MacMahon and Wagner 1985), semidesert steppe region that extends from eastern Oregon and southern Idaho in the north (ca. 44°N) to central Nevada in the south (37°N), and from the Wasatch Mountains in the east (ca. 112°W) to the Sierra Nevada/Cascades in the west (ca. 120°W; Fig. 1). Cold-desert vegetation extends beyond these boundaries to the plains of the Columbia River Basin in southeastern Washington and to the Red Desert of southwestern Wyoming. These regions are not considered as part of the desert biome by MacMahon (1979), but we have included them because functionally they do not appear to differ fundamentally from the Great Basin proper, which is a large internal drainage basin (actually a series of many parallel internal drainage basins) that lies between the Sierra-Cascades and the Wasatch Range. When included with the Great Basin, this cold-temperate semidesert ecosystem constitutes the largest desert type in North