

12 inches results primarily from absorption by roots and subsequent evaporation (transpiration) from leaves.

## WIND

Wind velocity in deserts seldom exceeds that in the surrounding areas, but the wind has a more pronounced impact because it is less impeded by vegetation. In deserts near mountain ranges, winds tend to alternate directions between night and day. At higher elevations, the air cools more rapidly in the evening, becomes heavier, and descends. During the day, the air at lower elevations warms first, becomes lighter, and sweeps upward. Desert winds are often erratic and occasionally violent. Sandstorms scour the surface of rock structures, create drifts around shrubs, bury vegetation, and form unstable dunes. Dust storms frequently blacken the sky for miles, and cyclonic dust devils dance across the desert landscape, tearing at the vegetation in their path. The greatest impact of wind in the desert ecosystem is that it increases water evaporation from the soil and transpiration from leaf surfaces. But more obvious is its effect on vegetation by shaping plants and by the movement of silt and sand. The desert is indeed a place of shifting, whispering sand.

## VEGETATION

### Interaction Among Plants

It seems logical that with so little available soil moisture, competition among plants for this limited resource would be strong. The density of desert annuals, however, normally much greater under the canopy of large shrubs, suggests a lack of competition. The explanation is simple: the various plant species use water stored at different levels in the soil. Fast-growing ephemerals, annuals, and herbaceous perennials use water stores between 4 and 12 inches. On the other hand, shrubs draw their water mainly from stores below 12 inches. These deeper stores are only slightly affected by evaporation and are thus more stable. Two or more inches of rainfall in a short period of time is required to replenish water stores deeper than 12 inches. Therefore, the drier the climate and the more unpredictable the precipitation, the greater the proportion of annuals.

So competition does exist between plants rooted at similar levels and is responsible for the even-spacing of dominant shrubs over the desert landscape. The small amount of competition between the dominant shrubs and the shallow-rooted ephemerals is insignificant compared to the benefits the latter group of plants gains from the association. The shrub canopy moderates temperature and reduces evaporation and transpiration under it. This extends the time period of accessible moisture. Also, shrubs enhance microbial activity and increase soil fertility. Thus desert annuals ride on the coattails of plants like creosote bush.

### Species Diversity

As in any biome, the diversity of species in deserts depends on the diversity of available resources. As environmental variability increases, so do the number of available niches. And the greater the number of niches, the greater will be the number of species whose resource requirements will be met. Also, as noted above, competition is primarily among species that share the same habitat and have the same resource

heterogeneous as a result of variation over space, the variation expressed in terms of soil chemistry and texture, topographic features, precipitation patterns, temperature, groundwater, and various disturbances. So deserts have a rich assortment of life forms with alternative ways of coping with drought, including annuals, herbaceous perennials, shrubs, small trees, succulents, and so on. Coupled with the variability of life forms is a high degree of species diversity. The Sonoran Desert is especially rich in life forms and species because of the biseasonal precipitation pattern. But whether it's the Sonoran or any other North American desert, most visitors will be impressed by the diversity, abundance, and sheer beauty of wildflowers when the deserts are in bloom.

### Desert Dominants

The dominant plants of any community are those that have the greatest impact on other plants and animals in the community and the most profound effect on the ecosystem as a whole. They achieve dominance through size, distribution, and abundance. The major dominants have been noted in the discussion of the respective deserts and have been identified by a symbol (✱) and given special consideration, including distribution maps, in their respective families.

## ADAPTATIONS

Desert plants must be adapted to survive drought, and the adaptations take a multitude of forms, both physiological and morphological. Routinely, plants are categorized according to their strategy of dealing with drought. Plants can be grouped simplistically as drought escapers, drought avoiders, and drought endurers.

### Drought Escapers

Drought escapers are annual plants that grow rapidly, completing their entire life cycle during or following a rainy period. The cells of the leaves are of a type and orientation that maximize photosynthesis, and the first priority of photosynthetic energy is the development of reproductive structures. For these plants it is essential that the seeds can remain dormant for many years and will not germinate unless there is sufficient moisture to ensure reproductive success. It is critical that the plants are in tune with the environment. In many species, the seed coats contain inhibitors, which must be leached out before the seeds will germinate. The amount of rain required to leach the inhibitors should be sufficient to jump-start the plant's life cycle. Other seeds run on poorly understood "internal water clocks," limiting germination to conditions favorable to seedling survival.

Still, on occasion the drought escapers will be tricked by environmental vagaries, so it is important that the seeds of a species are sufficiently heterogeneous that they don't all germinate at the same environmental signal. An entire species' population could be wiped out if conditions fall short of adequate for completion of the life cycle. Once these annuals embark on life's journey, there is no turning back; the next generation depends on the success of their brief and frenetic existence.

### Drought Avoiders

Most desert perennials fall into the general category of drought avoiders. These plants don't avoid the drought as such but survive it by avoiding the deleterious effects of drought. Most of the water lost by plants is by transpiration—evaporation from the