

The lowland rainforest canopy tends to be uneven, as frequent natural disturbances such as subsidence, fallen trees, and tropical storms disrupt it. Six diverse lowland rainforest types are spread about the Solomon Islands, resulting from a forest's location on the northern or western side of an island, its elevation, and the local level of disturbance.

A variety of common tree species exist here; among the most common are penaga (*Calophyllum kajewski*), kamani (*C. vitiense*), the fruit-bearing sumac (*Camptosperma brevipetiolata*), sea bean (*Maranthes corymbosa*), beabea (*Schizomeeria serrata*), elephant apple (*Dillenia solomonensis*), the deciduous whitewood (*Endospermum medullosum*), and the eucalypt black wattle (*Gmelina mollucana*). Other important plants include the many endemic orchid and palm species.

### Fauna

As true oceanic islands, the Solomon Islands are home to a high number of endemic vertebrates. The rainforests have fewer mammals than other nearby regions, such as New Guinea to the west, but there is a large gallery of bats here. The Solomon Islands rainforests are thought to contain fewer than 50 mammal species. At least half of these are endemic to the biome, including nine rodent species; 15 species of family *Pteropodidae*, or old-world fruit-eating bats; a free-tailed bat of genus *Molossus*; and the Solomons horseshoe bat (*Anthops ornatus*).

A similar pattern holds with avian species: relatively low diversity but high rate of endemism. The Solomon Islands rainforests are a haven to more than 40 families and subfamilies of birds, with perhaps 200 species. More than one-third of these are endemic to this ecosystem, a factor making the Solomon Islands rainforests a critical global area for bird conservation.

Among the endangered rainforest bird species found here are Woodford's rail (*Nesoclopeus woodfordi*), Makira moorhen (*Gallinula silvestris*), chestnut-bellied imperial pigeon (*Ducula rubricera*), white-eyed starling (*Aplonis brunneicapilla*), and imitator sparrowhawk (*Accipiter imitator*).

### Environmental Threats

Direct human alteration of riverine and coastal areas, along with typically poor soils in some areas, have contributed to the depletion of lowland Solomon Island rainforests, and fragmentation of remnant coastal swamp vegetation and pandanus thickets. Some of the outlying coral atolls of the archipelago are in better native condition than the larger islands.

The rainforests are subject to tropical cyclones from November to April; these storms have proved to be sources of natural disturbance to flora and fauna, as have extreme droughts, which occur with some regularity, generally on a six- to 20-year cycle. However, climate change impacts upon this region, already prone to major storms and droughts, could push some habitats here beyond tipping points that have evolved over thousands of years.

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### Further Reading

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## Sonoran Desert

**Category:** Desert Biomes.

**Geographic Location:** North America.

**Summary:** Bracketed by temperate regions to the north and the tropics to the south, the Sonoran Desert is home to a biota with high levels of biodiversity from distinct backgrounds.

About 60 million years ago, what is now the southwestern United States and northwestern Mexico contained a relatively wet forest that was composed of both tropical and temperate species. Deserts were nowhere to be found. However, when conditions gradually shifted from wet to dry about 30 million years ago, some species adapted to these changing conditions toward what would later make up the Sonoran Desert biome of today.

### Climate and Origins

The connection of desert species to the temperate and tropical forests from which they originally evolved is clearly visible in the flora of the Sonoran Desert. The five species of columnar cacti that impart much of the character of this region, for example, originated in tropical latitudes, in the remarkable Tehuacán valley of central Mexico. Additionally, more than half of the plants that currently exist in the desert are annuals. Annuals are plants that complete their life cycle in one year and take advantage of temporary resources, and here in the arid Sonoran Desert climate, that especially means rain. These species are about equally divided between those of temperate origin, which emerge in winter, and those of tropical origin, that emerge during summer. Yet, it took millions of years of evolution and shifting climatic conditions for the formation of the desert that we know today. In fact modern desert communities did not appear until just 8,000 years ago. The Sonoran Desert is a new thing in geologic terms.

The Sonoran Desert exists in a continuum of rainfall seasonality, with two peaks of rain: one in the summer and one in the winter. Winter precipitation comes to the region from the Pacific Ocean, which brings cool, soaking rains. The amount of winter rain tends to be modulated by the La Niña and El Niño oceanic-driven climatic cycles, with more winter rain during the warm El Niño phase than in the cool La Niña period.

In the summer, the heating of the land that occurred during the late spring draws in moisture from the Gulf of California, which creates huge, powerful thunderstorms with bursts of rain and lightning that can cool a hot summer day in minutes. This summer rain system is called the Mexi-

can monsoon. Additional but less reliable summer rain comes in the form of tropical hurricanes in the eastern Pacific that form off the west coast of southern Mexico.

### Biotic Response

Throughout the year, this seasonality is vividly apparent. Summer rains bring a flush of activity to species that originated in tropical latitudes. Cacti release their crowns of multicolored flowers, which are visited by pollinating bats. Elephant trees and various legume trees and shrubs set forth beautiful displays of foliage and flowers. Frogs dormant the rest of the year are awoken by ephemeral pools of water; they fill the desert night with a chorus of croaking.

But on a cool winter day after a gentle rain, none of what comes to life in the summer is visible. Now it is the species of temperate origins that capture the attention. Ferns that in the dry months are mysteriously absent emerge from rocky cracks and blanket previously barren slopes with a bright green.

Unexpectedly cold winter nights bring freezing temperatures that once every few decades are severe enough to kill back vast numbers of tropically derived species, keeping the balance between the temperate and tropical nature of the desert. Spring seasons following fortuitous winter rains erupt in fields of wildflowers that carpet the desert floors in yellow, blue, pink, and white. It is this climatic complexity that makes the Sonoran Desert a composition of such divergent life forms and leads to high levels of biodiversity.

### Regional Habitats

The Sonoran Desert is not a uniform landscape; it is composed of several distinct regions. The saguaro-palo verde studded landscape defines the northern Sonoran Desert. The Lower Colorado Valley in the vicinity of the Colorado River and its delta is the most arid corner of North America. The diminished Colorado River Delta still serves as critical habitat for many migrating birds, although the human diversion and reduction of freshwater flow has severely degraded this once great ecosystem.

Just west of the delta, the Gran Desierto hosts the largest complex of sand dunes on the conti-

## 1162 Sonoran Desert

nent, remnants of the land forms that used to fill the Grand Canyon. Here too, the Pinacates resembles a lunar-like landscape of lava flows and massive craters formed by relatively recent localized volcanic activity, 1.7 million to 16,000 years ago.

The western coast of Sonora, Mexico, is heavily influenced by the buffering maritime influence of the Gulf of California and unpredictable, scant rainfall. A landscape of tall cacti and succulent trees with swollen trunks, and a low layer of shrubs interspersed at regular intervals, hugs the coast for miles and is the vegetation found on the individually unique and pristine islands of the Gulf of California.

Inland of this coastal fringe, the plants become denser and are characterized by a multitude of semi-deciduous tree species and various columnar cacti. Further east or south, the vegetation thickens progressively until the flat, arid valleys



A close-up of the hot pink blossoms of the beavertail cactus (*Opuntia basilaris*) in the Sonoran Desert. Many types of cacti bloom in the desert from March to June. (Thinkstock)

of bare ground, occasional shrubs, and scattered stands of trees fade away entirely. Instead, on the eastern side of the state of Sonora is the towering Sierra Madre Occidental and its deep *barrancas*, or canyons, filled with lush tropical vegetation, here at its northernmost extent in the New World.

### Flora and Fauna

Many plants thrive in the Sonoran Desert. The endemic (found nowhere else) saguaro cactus (*Carnegieia gigantea*) is perhaps the best-known plant found here, but others are vital to support local wildlife. Such plants include beavertail (*Opuntia basilaris*), cholla (*Cylindropuntia* spp.), prickly pear cacti (*Opuntia* spp.), legume trees such as iron wood (*Olneya tesota*) and palo verde (*Parkinsonia* spp), diverse grasses, and others. Cacti provide nourishment to many animals and keystone legume trees provide shade to animals and plants alike. From March to June, many cacti produce white, red, pink and yellow flowers, which dot the desert landscape with vivid color.

Other plants of interest include the only regional endemic palm here, the California fan palm, which is found in the Colorado Desert section of the Sonoran Desert and into Baja California. It is also found at several oases, including the one in Joshua Tree National Park.

The Sonoran desert hosts a great diversity of mammals, reptiles, and other animals. The black Mexican king snake, Arizona night lizard, desert iguana, and desert box turtle are among the most widespread reptiles. Coyotes and desert bighorn sheep rank among the hallmark mammal types. Many birds are endemic to the Sonoran Desert, such as the greater roadrunner, Gila woodpecker, and burrowing owl.

### Threats

In the latter half of the 20th century, largely due to intensive irrigation and the widespread use of air-conditioning, the populations of towns in the Sonoran Desert multiplied from a few thousand individuals to form the three major population centers of the region: Phoenix, Arizona, with a population of 4 million; Tucson, Arizona, population 1 million; and Hermosillo, Sonora, population

800,000 (numbers are from 2010). Each of these urban centers continues to expand at nationally high levels, welcoming in new residents from distant regions. The pace of urban growth threatens to undermine the natural infrastructure of the Sonoran Desert biome.

As is expected in a desert where water is the principal and scarcest resource, dramatic hydrological projects of enormous scale have been erected. Vast canal systems channel water from the Colorado River in Arizona and the rivers of the Sierra Madre across the desert to the sprawling cities. Unregulated pumping of the ancient aquifers that lie below the sediment-filled valleys, dating from the prehistoric times when forests grew in the lowlands, fuel continued growth. With the expansion of desert cities comes the loss and fragmentation of habitat due to draw-down of water, construction, pollution, and other collateral effects of urban development.

A related threat to the biodiversity and economic functioning of the Sonoran Desert is an onslaught of exotic plant and animal species that were introduced in the last century, many of which have become invasive, aggressively spreading in recent decades. None seem more threatening than buffelgrass, which introduces a novel fire regime to the previously fire-exempt desert, with deadly consequences for Sonoran Desert plants that are not adapted to survive fire.

The Sonoran Desert relies upon its uniquely consistent precipitation cycle to support the distinct plant and animal biota of the region. Climate change is expected to cause increased warming in this area, with reduced annual precipitation and faster evaporation, but larger and more dramatic pulse type rain events. With increased warming some species, especially those already living at the highest elevations, may have nowhere else to go; if they cannot adapt, they may become extinct. Other species will likely have to adapt to take advantage of the pulses of resources to withstand the longer periods of drought.

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## South China Sea

**Category:** Marine and Oceanic Biomes.

**Geographic Location:** Asia.

**Summary:** Unparalleled biodiversity is the rule here, but there is a race on between fossil fuel extraction, international political tension, and those cooperating to restore, balance, and conserve the ecosystem.

Awash in the waters of the Indian and Pacific oceans, the South China Sea contains up to one-third of the world's marine biodiversity, which gives the region a substantial renewable resource base—but one that by some accounts is slowly crumbling. Sealed below its floor is an unusually large amount of crude oil and natural gas, which has sparked international conflict over extraction rights. Conservation and preservation of the sea's unique and diverse ecosystems may prove to be the key that opens the way for cooperation among the people of the region.

#### Geology and Origins

The South China Basin is the deepest part of the sea in this region. It is surrounded by three significant geomorphologic features: a segment of Eurasia's continental shelf in the west; the Reed Tablemount and Manila Trench to the east; and the Sunda Shelf to the south. Around 30 million years ago, a vast block of rock called the Reed Tablemount slowly separated from the Eurasian