Diverse habitat are needed to preserve diverse species. Nelson's hairstreak (*Mitoura nelsoni*) butterfly relies entirely on *J. occidentalis* and incense cedar as larval hosts.

animals than any other area of North America. Endemic species are those that are found nowhere else and California has roughly as many unique plants and animals as the rest of the 48 contiguous states put together. More than 65 vertebrates, 1,500 plants and thousands of invertebrates are endemic to the state.

California's high number of endemic species is the result of geology and climate, both of which are more complex and variable here than anywhere else in the United States. For example, the precipitation gradient from mountain to desert can range from 2 to 45 inches in less than 10 miles. Such conditions have subjected California's plants and animals to strong evolutionary forces, producing and maintaining new varieties of plants and animals at a rate that is seldom matched in other parts of the continent. Second, a number of the state's plant and animal species have also shown a profound ability to differentiate. We have over 110 species of buckwheat (*Eriogonum*) in California, for instance, with 85 differentiated varieties that may become species in the future.

Third, there are a number of California species that have been able to persist due to the equitable, maritime climates of coastal areas. Southern Arizona, which rivals California's mix of biomes but lacks its equitable climate (characterized by even temperatures and precipitation), has about one-fifth the number of endemic species found in Southern California and about 60 endangered species.

Like many parts of the West, California maintained much of its biodiversity well into the 20th century. Steep topography prevented the wholesale conversion of natural habitats seen in midwestern, southern, and eastern states. California agriculture had to deal with summer drought, steep slopes and thin soils; as a result, much of the state was left relatively untouched. Similarly, the impact of wildland grazing in many of the state's rare habitats was restricted by steep terrain, limited water and poor forage.

Beginning in the 1920s, however, water projects finally allowed people to develop habitats that had remained virtually unchanged since Spanish colonization in the late 1700s. Today, California's biodiversity occurs and must be managed in thousands of pockets of unique habitat that are often unremarkable in their species numbers or scenic beauty. This pattern of scattered pockets has become the crux of our endangered species dilemma: a small change of land use is more likely to harm a rare species in California wildlands than in any other state. Even a small change in land use can harm a rare species or disrupt the physical and biological processes that maintain pockets of endemism.

The broad diversity of local conditions that permit California growers to produce the broadest range of agricultural products anywhere in the United States also yield the nation's richest diversity of insects. While no one has added up the number of known insect species in California and new species are still being discovered, one conservative estimate is that there are about 27,000 insect species in California. That is roughly 30% of the estimated total for all of North America north of Mexico.

California is often likened to a biological island isolated by the Pacific Ocean on the west and by the deserts on the east. High mountain ranges further inhibit animal and plant dispersal into and out of the state. California's complex topography and its climatic gradient — which ranges from the cool, moist north coast to hot, dry southern desert — have subdivided the state into a number of biotic provinces. Each of these provinces has a fauna comprising some widespread species and many of more limited distribution.

Additionally, over geologic time, the state's climate has oscillated between subtropical and glacial extremes, causing repeated redistributions of organisms as they tracked the changing climate zones. Some insect populations adapted to the new conditions, while others became extinct or survived in isolated refugia. As a result, California contains a multitude of insects adapted to narrowly defined local conditions and isolated by geographic and ecological barriers.

Insect diversity is also closely tied to that of plants because about half of all insect species feed on plants. Moreover, many insects depend entirely on just one or a few plant species. Herbivorous insects are often further spe-

**Nation's richest insect diversity in California**

Greg Ballmer

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Reserves in California

Can we maintain ecosystem and evolutionary processes in our biological reserves? Reserves are the linchpins of conservation in California. However, with so many unique habitats and species, we lack the financial and intellectual resources to even locate and select the habitats we should preserve, much less to purchase and manage them.

Despite 50 years of urban planning, we have not succeeded in separating sensitive natural areas from suburbs and land development (fig. 1). It has become painfully obvious that many reserves cannot function because they are isolated and often damaged by outside forces. If futurists are correct, the interface between wildlands and urbanization will continue to grow as California’s economy and infrastructure shift to clusters of small cities and ranchette communities such as Grass Valley in the Sierra foothills and Jamul in San Diego County. As the state’s population doubles to 63 million by 2040, it will take significant energy and resources to protect reserves from the damages of exotic species, recreation seekers, non-point-source pollution, and 8-year-olds with BB guns.

The conservation continuum

Nearly all current models of reserve design include a surrounding buffer zone of low-intensity use by humans as well as habitat linkage among reserves (Dyer and Holland 1991). However, low-intensity buffer zones and linkages are virtually impossible to create in California’s fragmented wildlands. This is exemplified in figure 1, which shows San Diego County wildlands fragmented by urban, suburban, and ranchette development.

In San Diego County and elsewhere, urbanization has moved unevenly into wildlands, creating vast amounts of edge. In San Diego County alone, the edge between wildland and urban areas extends more than 1,400 miles. The same is true for urbanized areas such as Orange County (fig. 2) and San Francisco Bay. The size and quality of wildlands left after land development varies from large tracts of pre-European (nearly native) habitat to small, disturbed patches embedded...