



RESILIENCE OF UNIQUE ISLAND VEGETATION

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The Islands of the Californias are well known for their unique vegetation comprised of numerous island specialist (See Williams et al. this issue) including ancient species like Catalina ironwoods (*Lyonothamnus floribundus*) as well as modern insular endemics like manzanitas (*Arctostaphylos*), buckwheats (*Eriogonum*) and tarplants (*Deinandra*). Until a couple of decades ago, these islands harbored only a shadow of their former biodiversity. Nearly all islands suffered century-long overgrazing and browsing which eliminated vegetation and eradicated many of their unique botanical components. The loss of vegetation caused a cascade of destruction including pollinator decline and erosion. Each island shares its own compelling story of the recovery and resilience of native flora and fauna.

THE CHANNEL ISLANDS

In the 1970's the Navy began efforts to remove feral animals on **San Clemente Island**. Before goat

removal for instance, much of the island was denuded of natives or dominated by non-native annual grasses. The lower terraces supported a sparse cover of maritime sage scrub and slopes in the canyons were barren. In 1975, a notable discovery was one San Clemente Island paintbrush (*Castilleja grisea*) on a cliff face in the midst of the protection of cacti. The only populations of San Clemente Island bush-mallow (*Malacothamnus clementina*) were found shielded amongst rusting metal scraps and debris of an old landfill and on an inaccessible cliff in China Canyon. So denuded was the island that there was little, if any, vegetation that could be classified as sage scrub habitat.

The last goat was removed from San Clemente Island in 1991 (Seward 1992), following the removal of feral deer and pigs which was achieved in the 1980's.

Above: By 1888 it is estimated, based on historical records, that there were only 100 Torrey pines (*Pinus torreyana*) on Santa Rosa Island. Today, after herbivore removal, there are over 12,000 trees—one-quarter of which are saplings. Photo by Michael Kauffmann.

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Sheep removal on Santa Cruz Island has greatly affected vegetation as seen in these photos. Before (top) goat removal in early 1980s only a few Coast Live Oak (*Quercus agrifolia*) and Bishop pine (*Pinus muricata*) survive but after (bottom) in 2005 large shrubs like *Ceanothus arboreus* and *Baccharis pilularis* are returning. Photos by Peter Schuyler.

Now, sage scrub vegetation covers the upper terraces of the island and down into the canyons. Maritime desert scrub composed of Box-thorn (*Lycium californicum*) and cacti (*Opuntia littoralis*, *Cylindropuntia prolifera*, and *Bergerocactus emoryi*) has expanded along the lower terraces near the Pacific. New populations of San Clemente Island paintbrush have become a major component of the sage scrub vegetation. Giant coreopsis (*Leptosyne gigantea*) was re-discovered on the island indicating the potential that it could be re-established as a component of the vegetation. Island mallow (*Malva assurgentiflora*) has been planted to mimic its formerly extensive cover while woodlands plants like Catalina cherry (*Prunus ilicifolia* subsp. *hyonii*) and Santa Cruz Island ironwood (*Lyonothamnus floribundus* ssp. *asplenifolius*) have regrown in the canyons. Even the grasslands have shifted composition to include natives like Foothill needlegrass (*Stipa lepida*) and broom baccharis (*Baccharis sarothroides*) where non-native grassland previously dominated the landscape.

Santa Cruz Island was subjected to grazing until 2001 (Van Vuren 2014) with up to 50,000 sheep—nearly one per acre—by the late 1800s in addition to numerous cattle and feral pigs. Root crowns of chaparral shrubs more than half a meter above the existing ground level indicated extreme soil loss and pine logs lay on barren gravel in the 1970s above Prisoners Harbor—providing a hint of the former vegetation.

Beginning in the 1990s with herbivore removal Bishop pine (*Pinus muricata*) began to spread while chaparral shrubs, including island manzanitas (*Arctostaphylos crustacea* subsp. *insulicola*, *A. crustacea* subsp. *Subcordata*, and *A. insularis*), white-haired manzanita (*A. viridissima*), bigpod ceanothus (*Ceanothus megacarpus* var. *megacarpus*), feltleaf ceanothus (*C. arboreus*), and island ceanothus (*C. megacarpus* var. *insularis*) have expanded dramatically. There are now places on the island among the ironwoods where evidence of the introduced vertebrates is all but gone!

Santa Rosa Island, at the start of the 21st century, was mostly devoid of native vegetation due to a suite of introduced vertebrates. The island has seen a progression of herbivore removal initiatives including an early removal of sheep and cattle that remained until 1998. By 2011 all other ungulates including deer, elk, and pigs were removed. In the early days of island occupation when introduced herbivores were present, barren slopes seemed to be the natural environmental state with dry, open canyons lacking any riparian vegetation. Along a southern ridge, a remnant grove of Island oaks (*Quercus tomentella*) appeared to be on stilts with roots exposed two meters above the soil line.

Here too, after the removal of grazing animals, the vegetation has rebounded. Riparian canyons are filled with rushes and sedges (*Juncus* and *Carex*), southern cattails (*Typha domingensis*), arroyo willow (*Salix lasiolepis*) and flowing water. Bishop pine groves on Black Mountain are spreading and Torrey pines (*Pinus torreyana*) which by 1888 were estimated to number around 100 individuals are thriving—with an estimated 12,300 trees, one-quarter of which are saplings. Chaparral shrubs like toyon (*Heteromeles arbutifolia*) and California huckleberry (*Vaccinium ovatum*) have sprouted from rootstocks where no recent vegetation existed. Vegetation has expanded and coalesced, reducing fragmentation and providing habitat for plants that need shrub canopies, like the Coast paintbrush (*Castilleja affinis*) on Carrington Point. The native perennial bunch grass community is also rebounding near Becher's Bay and other locations.

The remarkable recovery of vegetation continues on **San Miguel Island**, which prominent botanist Edward L. Greene called “a huge sand dune” following only 40 years of intensive herbivory. The recovery has been remarkable and can be seen when comparing aerial imagery from 1929 to more recent aerial photos in Johnson (1980) article about erosion on San Miguel Island.

Santa Catalina Island has been exposed to the greatest variety of introduced ungulates, including bison and black buck antelope. After multi-year programs to remove goats and pigs, mule deer and bison are the last remaining large herbivores. However, the potential for recovery is evident. After a fire in a region protected from feral animals, native chaparral endemics such as feltleaf ceanothus, Channel Island tree poppy (*Dendromecon harfordii*), Santa Catalina Island bush-mallow (*Malacothamnus fasciculatus* var. *catalinensis*) and island rush-rose (*Crocantthemum greenei*) emerged from the seed bank.

Early island botanists described Island tree mallow (*Malva assurgentiflora*) as abundant, but it was subsequently eliminated from the main island to only survive on two offshore islets. Yet, when planted and protected with fencing on the main island, this plant responds vigorously. It is interesting that though it has not been recorded from Santa Cruz Island, it is found to the west on San Miguel Island, and to the east on Anacapa Island. This raises the question of whether or not it ever existed on Santa Cruz Island.



On Guadalupe Island, *Senecio palmeri* and *Lupinus niveus* recover on formerly bare slopes after goat removal. Photo by Thomas Oberbauer.



Young Guadalupe cypress (*Hesperocyparis guadalupensis*) recovering on Guadalupe Island. Photo by Thomas Oberbauer.

Santa Barbara Island, one of the smallest islands, hosts giant coreopsis (*Leptosyne gigantea*) which was historically so abundant that on a clear day in spring the island appeared as a yellow hill on the ocean when viewed from the mainland. With the introduction of European rabbits and hares the species declined but since their removal giant coreopsis, Santa Barbara Island buckwheat (*Eriogonum giganteum* var. *compactum*) and Santa Barbara Island dudleya (*Dudleya traskiae*) have rebounded.

MEXICAN ISLANDS

Off the western coast of Mexico, on **Coronado Sur Island**, the endemic Coronado Island dudleya (*Dudleya candida*) and western island mallow (*Malva occidentalis*) have spread since the goats and burros were removed. On **San Benito Oeste Island**, after the removal of goats, burros and rabbits, the endemic San Benito Island tarplant (*Deinandra streetsii*) recovered. The **Todos Santos Islands** were also subjected to the impacts of feral rabbits from the 1970s to 1998 as well as donkeys and cats (Donlan et al. 2003). Though the rabbits and donkeys have been removed, annual grassland composed of non-natives has expanded on both islands due rabbit herbivory but some native vegetation remains on the north island, which is once again a major seabird nesting area.

On **Guadalupe Island**, vegetation communities were decimated due to goats into the early 2000s. Endemic Guadalupe Island pine (*Pinus radiata* var. *binata*), Guadalupe Island palm (*Brabea edulis*), Guadalupe Island cypress (*Hesperocyparis guadalupensis*), and island oaks (*Quercus tomentella*) declined. Chaparral components were non-existent or surviving only on cliffs. Some species, such as the composite Guadalupe Baeropsis (*Baeropsis guadalupensis*) and the endemic Guadalupe Cistanthe (*Cistanthe guadalupensis*) were extremely rare on the main island, surviving on goat-free islets. Reid Moran, the chronicler of the islands flora described the surface as “covered with rocks

that were too big to step over but too small to step around” meaning that the island was difficult to traverse because the surface was covered with ankle turning rocks, devoid of soil.

After only a dozen years, the removal of goats has allowed for tremendous change (Cecena-Sanchez et al. 2016). Three native taxa including the composite Estafiate (*Ambrosia camphorata*), the saltbush Galletilla (*Atriplex barclayana*), and Guadalupe globemallow (*Sphaeralcea sulphurea*) are reestablishing vegetatively. A suite of silver-leaved shrubs including Guadalupe Island ragwort (*Senecio palmeri*), Guadalupe Island rock daisy (*Perityle incana*) and San Clemente Island golden-bush (*Hazardia cana*) as well as the Guadalupe Island silver lupine (*Lupinus niveus*) are reclaiming large areas on the north end of the island. Even species not previously known to occur here, such as feltleaf ceanothus, have become abundant after goat removal.

Overall, the greatest action for the conservation of the California Islands has been the removal of introduced and feral herbivorous mammals. In the absence of these non-native animals each island has demonstrated an unprecedented resilience in vegetation recovery.

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Above: Elephant tree (*Bursera microphylla*) on Cedros Island.
Right: Coastal cholla (*Opuntia prolifera*) on Santa Catalina Island.
Below: Cedros Island Agave (*Agave sebastianiana*) on Cedros Island.
All photos this page by Denise Knapp.





Above: Coronados liveforever (*Dudleya candida*) on South Coronados Island. Photo by Stephen McCabe.

Right: Botanist and botanist-in-training explore El Tigre Ridge on Santa Cruz Island. Photos by Denise Knapp.

Below right: On Santa Cruz Island, Wildlands Conservation Science employee Katrina Olthof is treating a remote population of the invasive carnation spurge (*Euphorbia terracina*) with the aid of helicopter transport. Photo by Morgan Ball.

Below: Federally endangered *Malacothamnus clementinus*, a San Clemente Island endemic, has expanded its range since the 1970s, when feral goats had eliminated all but one population. Photo by Dylan Neubauer.

