THE STRUGGLE FOR RECOVERY

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Some of the traits that make the flora of the 18 California Islands so distinctive and remarkable also make it highly vulnerable to extinctions (Guilliams et al, this volume). We have compiled a list of more than 100 plants that are now rare on the islands, ranging from species formerly widespread and dominant to those that have always been rare and specialized. In most instances these species were reduced to a handful of populations, and in a few cases, only one to five individuals through the direct and indirect effects of grazing, browsing, and other land uses. Although some of these species are on trajectories that suggest recovery is occurring, others continue on a slow slide towards extirpation from their islands, and even extinction.

The threatened taxa include a variety of growth forms and variability of life histories. Each of the California Islands has a suite of vulnerable species, regardless of how long it has been since conservation management began. Our islands are not alone as others worldwide have some of the highest known extinction rates for both plants and animals (Courchamp et al. 2003, Ricketts et al 2005, Reaser et al. 2007). Plants on islands have no escape from land use pressures because there are no nearby source populations to "rescue" failing populations through dispersal of seeds or pollen, and some endemics have low genetic diversity or slow growth rates to maturity that limit their ability to respond to rapid environmental change. Essentially, the self-help options are constrained by environmental change, low population numbers, and an innately poor capacity to deal with rapid change.

Through surveys and research studies, we have been working to identify the plant species that are at the greatest risk of near-term extirpation and extinction in order to actively manage for their survival. Of particular concern are species that persist as only a few individuals or in small and isolated populations and those that are vulnerable to extinction by catastrophic events like landslides, flash flooding, or climate change. The

Above: Ken Niessen surveys the rolling hills of Santa Rosa Island, where recovery projects are rebuilding island oak (*Quercus tomentella*) habitat. Photo by Michael Kauffmann.

1. U.S. Geological Survey (USGS)
2. Catalina Island Conservancy (CIC)
3. San Diego State University Research Foundation
4. U.S. Navy, Naval Facilities Engineering Command Southwest (NAVFAC SW)
5. Santa Barbara Botanic Garden (SBBG)
6. The Nature Conservancy (TNC)
7. Grupo de Ecología y Conservación de Islas (GECI)

Some islands still have feral animals. For example, Santa Catalina Island still has introduced mule deer and bison, with some clear patterns in species recovery when compared to islands that have been feral vertebrate free for even a short period of time. Feral vertebrates disproportionately impact certain endemic insular taxa, often those that would be dominant in the absence of these herbivores. On Santa Catalina these effects are illustrated by the genera *Eriogonum* (e.g. *E. giganteum* var. *giganteum*), *Ceanothus* (*C. arboreus*), and *Cercocarpus* (*C. traskiae*), which are preferentially browsed and generally scarce outside of feral animal exclosures. Photo by Amy E. Catalano.

good news is that by sharing field observations, expert knowledge, and research results across the islands we are better able to identify problems these species are experiencing and thus tailor recovery plans accordingly. The bad news is that some actions are expensive in the long-term and funding for this work is a struggle. Thus, we are devising creative ways to streamline costs by sharing workloads and nursery facilities while forming partnerships to share the workload. What follows are examples of some plants in need of stewardship, their vulnerabilities, and how plant lovers can help.

Island mallow (*Malva assurgentiflora*) once dominated stands of vegetation on four of the California Islands, but is now reduced to just a few small populations that survived in places inaccessible to feral animals. Photo by Morgan Ball.

The stories that species on the California Islands tell are compelling. Take island mallow (*Malva assurgentiflora*), which occurs naturally four islands. It is a beautiful shrub with juicy stems, palatable leaves and large showy pink flowers that attract diverse pollinators. Once a dominant member of the island floral community, it is now reduced to only a handful of small isolated sites such as offshore rocks that have remained inaccessible to goats. Populations are often so isolated that there is no cross-pollination which results in low genetic diversity and seed production with limited population expansion. Island mallow is easy to grow in protected experiments and botanic gardens. The key to recovery, then, is to understand patterns of extant genetic diversity so plants can be bred and reared for out-planting on the islands to repatriate lost territory. With careful management, the reestablishment of island mallow could bring a host of other species to similar recovery. If the hands-on recovery success of the related Santa Cruz Island bush-mallow (*Malacothamnus fasciculatus* var. *nesioticus*) is an indicator (Mazurkiewcz, this volume) there are good prospects

TABLE 1 Island Plant Vulnerabilities Across the California Islands Archipelago

Species with innate issues that limit population growth: slow growth to maturity, naturally low reproductive rates, genetic limitations on seed production.

Trees and shrubs with low genetic diversity, low seed numbers

Berberis pinnata var. *insularis* – SCI, SRI, AI

Malva assurgentiflora – All islands except SCI and SRI

Lycium brevipes ssp. *brevipes* – SNI, SClem

Dioeceous species with limited gene flow

Baccharis emoryi – SBI

Juniperus californicus – GUA

Populus balsamifera ssp. *trichocarpa* and ssp. *fremontii* – SCI, SRI, SCat

Recent colonists, or species at the limits of their ranges

Arbutus menziesii – SCI

Bergerocactus emoryii, Cylindropuntia prolifera, Vitis girdiana – SCat

Euphorbia misera – SCI, SCat

Species in such altered habitats that they cannot recruit new individuals; viable seeds are produced but the seedlings die.

Trees and shrubs living in altered habitats

Lyonothamnus floribundus ssp. *floribundus* and ssp. *aspleniifolia* – SCI, SRI, SCat, SClem

Arctostaphylos confertiflora – SRI

Acmispon argophyllus var. *adsurgens* – SClem

Herbaceous perennials and annuals

Castilleja mollis – SRI

California macrophylla – SCat, SCI

Species with specialized and rare habitats that have always been rare, now made more rare because their habitats have been greatly altered or reduced, limiting opportunities for expansion on the landscape.

Rock outcrops, canyons, thin soils

Boechera hoffmannii – SCI, SRI

Pentachaeta lyonii – SCat

Cistanthe guadalupensis – GUA

Sibara filifolia – SCI, SCat, SClem

Species of streams, springs and seeps

Anemopsis californica – SCI, SNI, SCat, SClem, Cedros

Epipactis gigantea, Holodiscus discolor – SCI, SCat

Salix exigua – SNI, SCat

Marsh inhabitants

Batis maritima, Jaumea carnosa, Pluchea odorata, Spergularia marina – SCat

Atriplex watsonii, Salicornia virginica and *subterminalis, Suaeda taxifolia* – SNI, SCat

Dune plants

Abronia umbellata – SRI, SNI, SCat

Calystegia soldanella – SNI, SCat

Species that rely on certain ecosystem properties or interactions that are now impaired or missing.

Fire-following herbs

Acmispon grandiflorus var. *grandiflorus* – SCI, SRI, SCat, GUA

Eremalche exilis – SCI, SBI, SCat, SClem, Todos Santos, San Benito, Natividad

Papaver californicum – SCI, SRI

Phacelia grandiflora, Mentzelia spp. – SCat

Fire-adapted shrubs

Arctostaphylos catalinae – SCat

Eriodictyon traskiae – SCat

Solanum wallacei – SCat, GUA

Lacking fire and pollinators or seed dispersers

Malacothanmus fasciculatus vars. *nesiotucus, catalinae, clementinus* – SCI, SCat, SClem

Dendromecon harfordii – SCI, SRI, SCat, SClem

Changed fog regime

Pinus muricata – SCI, SRI

Pinus radiata – Cedros, GUA

Quercus tomentella – AI, SCI, SRI, SCat, SClem, GUA

Changed rainfall regime resulting in altered germination cues

Gilia tenuiflora ssp. *hoffmannii* – SRI

Malacothrix indecora – SCI, SRI

Phacelia insularis – SRI, SMI

Island abbreviations: San Miguel Island, SMI; Santa Rosa Island, SRI; Santa Cruz Island, SCI; Anacapa Island, AI; San Nicolas Island, SNI; Santa Barbara Island, SBI; Santa Catalina Island, SCat; San Clements Island, SClem; Isla Guadalupe, GUA; Isla Cedros, Cedros; Islas Todos Santos, Todos Santos; Islas San Benito, San Benito; Isla Natividad, Natividad

for stopping the island mallow extinction as well.

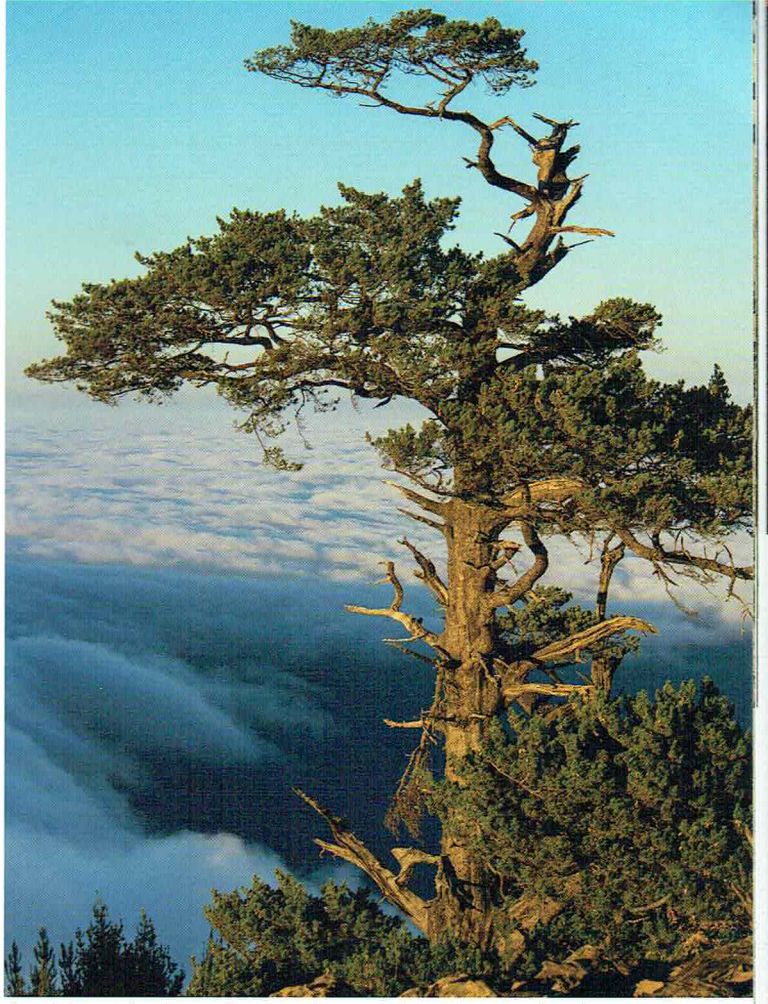
Several other island plants tell a story similar to the beautiful island mallow. The Cedros and Guadalupe Island pines (*Pinus radiata* var. *binata*); California juniper (*Juniperus californica*) and Guadalupe Island cypress (*Hesperocyparis guadalupensis*) on Guadalupe Island; island oak (*Quercus tomentella*) on five of the six islands where it occurs; island ironwood (*Lyonothamnus floribundus*) on the four largest US islands; felt-leaf ceanothus (*Ceanothus arboreus*) on the three US islands are all now very rare where they were more widespread.

At the opposite end of the spectrum, San Clemente Island woodland star (*Lithophragma maximum*) is an example of an endemic, perennial herb with a rare and specialized habitat that has become more isolated and scarce over the last 150 years. San Clemente is one of the driest islands, except in the deep, shaded, east-side canyons where trees create moist microclimates. Fog drip is common, the habitat is more mesic, and covered with mosses and lichens. This is all quite different from the vegetation on the rest of the island. The woodland star exists in small, isolated patches in seven of these remote canyons, requiring many hours to reach a single population. The total number of known plants fluctuates between dozens to the low hundreds of plants across all populations each year.

This woodland star exemplifies the challenges facing other island specialists: there are fewer places now that retain the habitat characteristics within which specialists evolved. Microsites are more isolated in the island landscape because the territory in between is inhospitable and places that look like they might be good habitat do not currently support the plant.

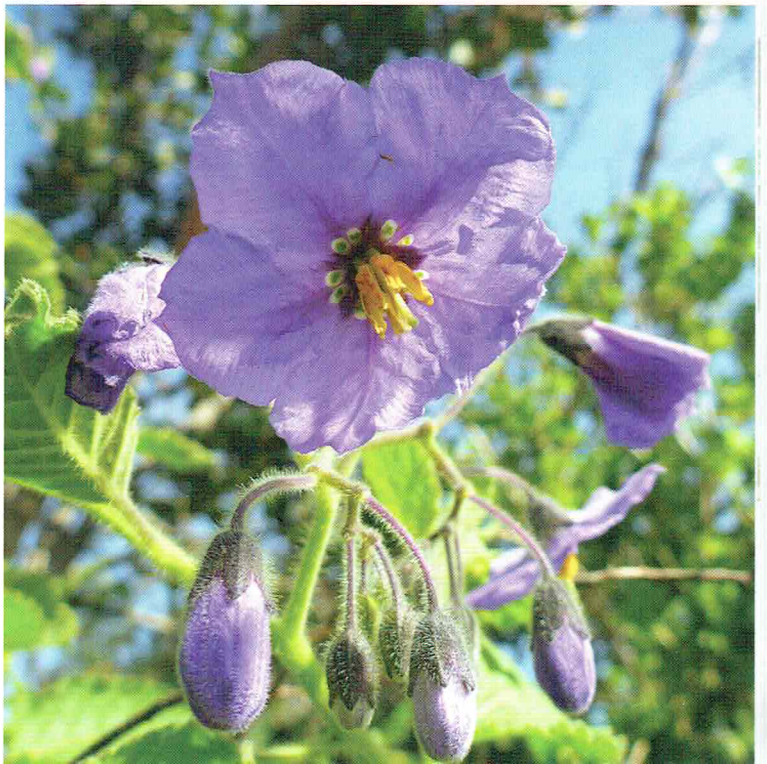
The challenges for island botanists include a lack of information about the relationships among poor seed production, isolation, and low genetic diversity within sites and a lack of information on the range of habitat tolerance. It may be that low genetic diversity leads to poor seed set and limited habitat tolerance. Data do suggest that gene flow is limited in the woodland star. However, it is not clear whether populations are more threatened by low genetic diversity or by insufficient pollination and/or habitat isolation.

Paradoxically, some island species like the endangered two-island endemic Hoffman's rock-cress (*Boechera hoffmannii*), have broader habitat tolerance than is apparent from current distributions. This rock-cress has been found growing in a range of vegetation communities wherever there is sufficient shade and fog for seedlings to survive their first dry summer.



Guadalupe Island pine (*Pinus radiata* var. *binata*) was reduced to a few stands and California juniper (*Juniperus californica*) to just a few individuals by more than a century of goat browsing on Guadalupe Island. Their numbers are so low and their habitats are so changed that they are struggling to recover their former dominance. Photo © J.A. Soriano/GECI archive.

Catalina nightshade (*Solanum wallacei*) is found on Santa Catalina and Guadalupe Islands and the nearby mainland, where it sprouts following wildfire. These islands were so denuded that there was not enough vegetation to carry fire, and the nightshade declined to very few island populations. Photo by Julia Parish.



Channel Islands tree poppy (*Dendromecon harfordii*) sprouts readily after fire, and it has seeds that are dispersed by native ants. This is a plant that has suffered the double challenge of lack of fire and displacement of native ants by invasive predators. Photo by Susan Bloom.

For the woodland star, studies to determine causes of poor seed set and ways to increase seed production are needed, along with experiments testing the potential for population growth in similar habitats. Then, botanists can create recovery plans tailored to the specific issues facing this endemic plant and inform recovery options for similar species.

Recovery actions that can help these plants are best targeted to various levels of ecological organization. Examples of recovery work range from manipulations within populations (informed by genetic studies) to actions taken within and across habitats and landscapes. Often, management actions benefit other species in the local area. Addressing ecosystem-level challenges is more difficult, but we are working to add resilience by cultivating healthy populations and spreading the risk of decline across island environments and across the archipelago.

Here are some of the current recovery actions:

- Adding plants within populations
- Habitat improvement
- Exclosure construction where feral animals are still present
- Pinniped trampling prevention through exclusion fencing and plant population re-location
- Installing fog-capture structures to facilitate seedling and small plant establishment
- Planting groups of flowering plants that are big enough to attract and retain pollinators
- Hand pollination for seed production
- Non-native Argentine ant eradication to increase populations of native seed-dispersing ants
- Eradicating non-native European honey bees and yellow star thistle control to reduce pollen clogging with non-native pollen
- Seed banking to ensure conservation collections exist for rare island natives

Reasons for the lack of spontaneous recovery across the California Islands archipelago are numerous and varied. There are suites of species with similar problems across islands, just as there are similar suites of problems across species. Working together, island botanists are discovering ways to help manage declining species. We are finding that sharing information, techniques, materials, and staff is the most efficient and cost effective way to provide assistance to these most vulnerable island plants across the archipelago.

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