THE FUTURE OF CALIFORNIA ISLANDS CONSERVATION IN A CHANGING WORLD

Denise Knapp[1], Donaxi Borjes-Flores[2], Peter Dixon[3], William Hoyer[4], John Knapp[5], Luciana Luna-Mendoza[6], Kathryn McEachern[7], Julio Hernández-Montoya[6], Bryan Munson[4], Paula Power[8], y John Randall[5]

The Islands of the Californias are precious gems strung along the coast of western North America—stunningly beautiful, rich in cultural history, and home to plants and animals found nowhere else in the world (Knapp and Randall, Guilliams et al., this issue). Managed primarily for biodiversity conservation, they provide an opportunity to demonstrate what is possible with vision and a dedicated, sustained effort. As contained systems, they are also important laboratories for learning and innovation.

What does global change have in store for these gems? Drought, warmer temperatures, precipitation extremes, ocean warming and acidification, and sea level rise (IPCC 2014) are all occurring at accelerated rates. Decreasing fog frequency (Johnstone & Dawson 2010) will hurt plants that rely on this vital moisture source, such as the Bishop pine (*Pinus muricata*) (Carbone et al. 2013). Habitats already rare on the islands—such as dunes, coastal bluff scrub, and coastal marshes—will shrink. It is predicted that up to 66% of California's endemic plant taxa will experience range reductions within a century (Loarie et al. 2008). Invasive species will likely be favored over natives (Sandel and Dangremond 2012). Sensitivity to climate change may be higher on the coast than in inland areas (Ackerly et al. 2015), and animals on the Channel Islands may be even more vulnerable than their coastal mainland counterparts (Bova et al. 2012).

These changes are happening, and while the islands have made remarkable progress (Munson et al., Oberbauer et al., this issue), they haven't completely recovered from the introduced ungulates that overgrazed and browsed them for over a century (McEachern et al., this issue). Fewer, smaller rare plant populations with reduced genetic diversity are hindered in their ability to attract pollinators and reproduce, and are less able to adapt to environmental changes. Our goal has been to reverse these human-caused changes and give plants a fighting chance at survival so that their biodiversity can provide the islands resistance to invasion, resilience to disturbance, and adaptation to future environments.

Thankfully, innovative and inspiring restoration is happening on the California Islands (Mazurkiewicz et al., this issue). Efforts should continue to be strategic and data-driven, prioritizing the restoration of ecological function. For example, the interconnections of food and pollinator webs should be carefully considered. Ongoing restoration of dense mosaics of diverse habitat will reduce fragmentation and favor native wildlife over invasive species such as Argentine ants and rats. By continuing and strengthening biosecurity measures, we will protect these systems from future invasions. Restoration and reintroduction projects should be used as experiments wherever possible—taking plants out of their presumed range limits, for instance, to learn more about their requirements. Finally, we suggest storing funds in order to respond quickly to wildfires or take advantage of high rainfall years for planting.

Changes, both good and bad, are being felt and observed on California's Islands. As stewards, we can be flexible with our goals and targets and practice adaptive management while using the best available data and modern tools. Techniques such as structured decision making and risk assessment may be used to balance trade-offs and ambiguities. Working together, we can continue to harness our passion for island restoration and find efficiencies by sharing knowledge. Our Botanical Collaborative (Hoyer et al. in review) is being strengthened and archipelago-wide goals formalized. We are working to combine information across climate, geology, and land use gradients, which will help us to understand the limits of rare, endemic, and invasive species' environmental tolerance and show us ways forward.

We may need to act boldly to prevent species collapse in the face of climate change. For instance, a mainland common garden experiment for Torrey pines (*Pinus torreyana*) conducted by U.S. Forest Service botanists on Santa Barbara Botanic Garden property is showing

1. Santa Barbara Botanic Garden
2. Comision Nacional de Areas Naturales Protegidas
3. Catalina Island Conservancy
4. U.S. Navy, Naval Facilities Engineering Command Southwest
5. The Nature Conservancy
6. Grupo de Ecología y Conservación de Islas
7. U.S. Geological Survey, Western Ecological Research Center
8. Channel Islands National Park

that hybrids of the Santa Rosa Island and San Diego subspecies are more robust than both mainland and island individuals. The increased genetic diversity of these hybrids may buffer them from pest outbreaks and climate changes. Taxa like the relict island ironwood (*Lyonothamnus floribundus*) may already be declining beyond our control (see Guilliams, this issue); perhaps this evidence will guide us to manage selected high-profile stands for education and inspiration.

While the islands have been recovering following the removal of introduced vertebrates, many areas like this Island oak (*Quercus tomentella*) grove on Santa Rosa Island still need a lot of help. Photo by Denise Knapp.

In this, the era of big data and advanced technology, we must use such resources to our advantage. Island scientists are actively compiling existing data across the archipelago and collecting the information we will need in the future (Randall et al. in review). We are using and contributing to existing databases, while creating a customized Island Information System that lets us go farther, faster. Let's also (with thought and care) consider bold new approaches such as translocations, biocontrol, and even genome editing to tackle extensive weed populations like crystalline iceplant (*Mesembryanthemum crystallinum*) or fennel (*Foeniculum vulgare*). We are up against a suite of modern forces—let's use modern tools.

Across the island chain, land managers must play to their strengths. For example, although Santa Catalina's greater visibility has made it tougher to remove all the invasive animals, it receives over a million visitors a year. The Catalina Island Conservancy is building a prominent new interpretive center near the island's entrance to educate visitors and enhance their experience. With education, the public will become stewards for the priceless resources of these islands and better understand the threats that they face. Catalina can be the gateway to the archipelago and help us to conserve the island chain as a whole.

To promote the appreciation and conservation of these islands, we all need to get better at telling their stories. We can tell both a human and a botanical story, for example, by re-tracing the steps of early scientists (Junak et al., this issue) as we "re-discover" the islands' plants, animals, and communities.

Let's promote the islands as places of inspiration and hope—with exceptional beauty and uniqueness, and fascinating human and natural history stories. Now more than ever people need meaningful natural experiences to inspire them to conserve and restore special places. Forty years ago, it was hard to imagine just how amazing the recovery of these islands would be. Today, the botanists who saw them in their weakened state are in awe at how resilient native species can be when given a chance to thrive. The islands will continue to offer optimism in a changing world for what is possible if we work together.

REFERENCES CITED

Ackerly, D.D. et al. (2015). A Geographic Mosaic of Climate Change Impacts on Terrestrial Vegetation: Which Areas Are Most at Risk? *PLoS One* 10(6).

Bova, B. et al. 2012. Climate change vulnerability assessments for terrestrial and freshwater vertebrates in the Mediterranean coast network of national parks. UCLA Institute of the Environment & Sustainability.

Carbone, M.S. et al. (2013). Cloud shading and fog drip influence the metabolism of a coastal pine ecosystem. *Global Change Biology* 19(2): 484-497.

Hoyer, W.F. et al. In review. Islas de las Californias /Islands of the Californias Botanical Collaborative: Planning the Future of Botanical Collaboration. Proceedings of the California Islands Symposium 2016.

IPCC, 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Johnstone, J.A. and T.E. Dawson (2010). Climatic context and ecological implications of summer fog decline in the coast redwood region. Proceedings of the National Academy of Sciences of the United States of America 107(10): 4533-4538.

Loarie, S.R. et al. (2008). Climate Change and the Future of California's Endemic Flora. *PLoS One* 3(6).

Randall, J. et al. In review. Informing our successors: What botanical information for Santa Cruz Island will researchers and conservation managers in the century ahead need the most? Proceedings of the California Islands Symposium 2016.

Sandel, B. and E.M. Dangremond (2012). Climate change and the invasion of California by grasses. *Global Change Biology* 18(1): 277-289.

Denise Knapp, DKnapp@sbbg.org