Ben Wilder
Current Research Overview for 6&6

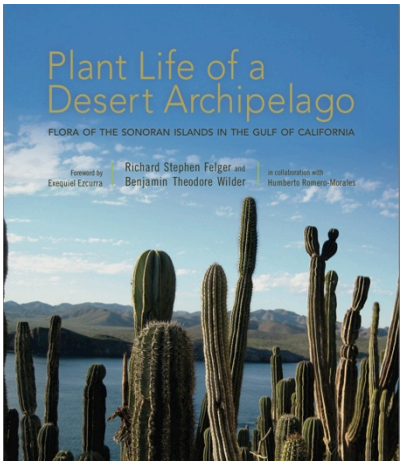
Disciplines:
Biogeography, Botany, Conservation, Natural History, Plant Ecology
Regions:
Baja California, Borderlands, Gran Desierto, Gulf of California, Midriff Islands, Seri
Website: http://ezcurralab.ucr.edu/bwilder/bwilder.html

My research is broadly focused in desert ecology and botany. I utilize multiple approaches and time scales to establish baselines to better understand modern biodiversity and connect science to conservation.

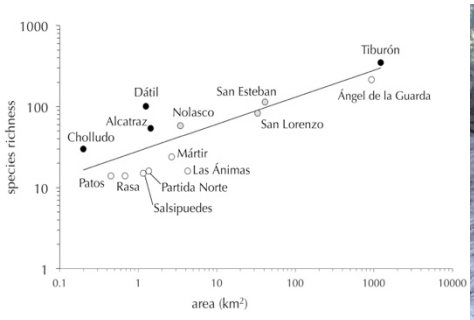
I earnestly began to discover the desert after a fortuitous trip to the Gulf of California and shores of the Seri region opposite Isla Tiburón in the fall of 2004. At that moment, the uninterrupted coastal bajada of Tiburón and the desert-sea interface nestled in my heart and brain. I had recently begun to focus on plants due to their awesomeness and early inspiration from botanists I worked with at the Desert Lab at Tumamoc Hill. Questions about the plants on the island and how they differed from the mainland directly led to the great botanist Richard Felger. In short order, Richard proposed that we do the flora of Tiburón. As Ray Turner told me, this was the opportunity of a lifetime. In 2005 we began a collaboration that has allowed me to learn from Richard's expertise, explore, and learn from not just the islands but also the Comcaac (Seri People).

The eastern bajada of Isla Tiburón from Punta Chueca, Sonora. October 2004.

Our work with Seri botanical expert Humberto Romero Morales led to multiple co-authored papers on island floras and our book published in 2012 by the University of Arizona Press, *Plant Life of a Desert Archipelago: Flora of the Sonoran Islands in the Gulf of California*. I wasn't ready to leave the islands yet (I do not think I ever will be). I continued to be intrigued by the patterns in the distributions of the plants on the various islands and between Baja California and mainland Sonora. The observations and data gathered during the production of the flora became the root for my dissertation.



I obtained my PhD under the guidance of Dr. Exequiel Ezcurra at UC, Riverside in December 2014. My dissertation, Historical Biogeography of the Midriff Islands in the Gulf of California, Mexico, (http://escholarship.org/uc/item/1987n0j6#page-1) focuses on three case studies (island biogeography, bighorn sheep on Tiburón Island, and the enigmatic occurrence of the crucifixion thorn on the high elevation of Isla Tiburón) to better understand the origin of the Sonoran Desert we see today.



Chapter 1
Revisiting Island Biogeography to Establish Ecological Baselines in the Gulf of California
Paper in Prep.

Chapter 2
Local Extinction and Unintentional Rewilding of bighorn sheep on a desert island.
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0091358

Chapter 3
Tracking the Desert's Edge with a Pleistocene Relict
Paper in Prep.

Most of my current research projects continue to revolve around the Gulf of California. All of the projects below are in the early stages.

Land-Sea interface ecology and conservation

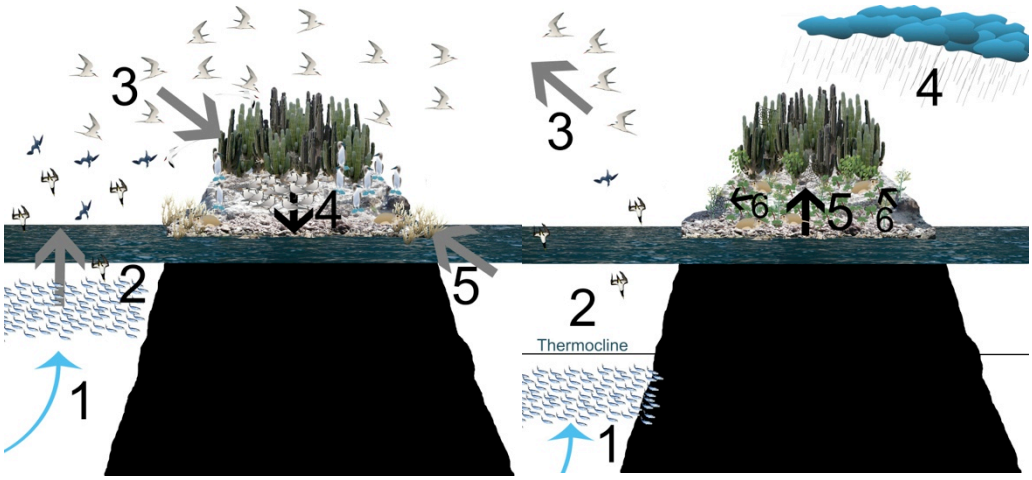
I am currently engaged in two distinct projects that investigate the porous boundary between the arid lands and diverse sea of the Gulf of California.

Seabird Islands

Small oceanic islands support immense seabird rookeries in the Gulf of California. The waters of the Gulf have globally high levels of productivity, which fuels a diverse and multi-stepped trophic web. This marine food web is connected to land by the birds that nest on the predator free islands. The birds deposit massive amounts of guano, high in nitrogen and phosphorus that limit the plant species that can establish – making these islands significantly impoverished in plant diversity. However, those that can tolerate these nutrient loads (primarily cacti and amaranths) occur in remarkable abundances.

Isla San Pedro Mártir after a warm season rain. Cardones (*Pachycereus pringlei*) surrounded by the annual cucurbit vine *Vaseyanthus insularis*
Photo, J.A.Soriano / Grupo de ecología y Conservación de Islas archive

Fascinatingly, these ecological connections are dictated by year-to-year variations in El Niño (warm waters) and La Niña (cool waters). The life and ecology of these islands dramatically change based on these oceanographic conditions. Observations of the bird and plant life of these small islands in the middle of the Gulf of California are predictive factors on the state of the oceans. Current work is focused on gathering quantitative data for these ecological connections.

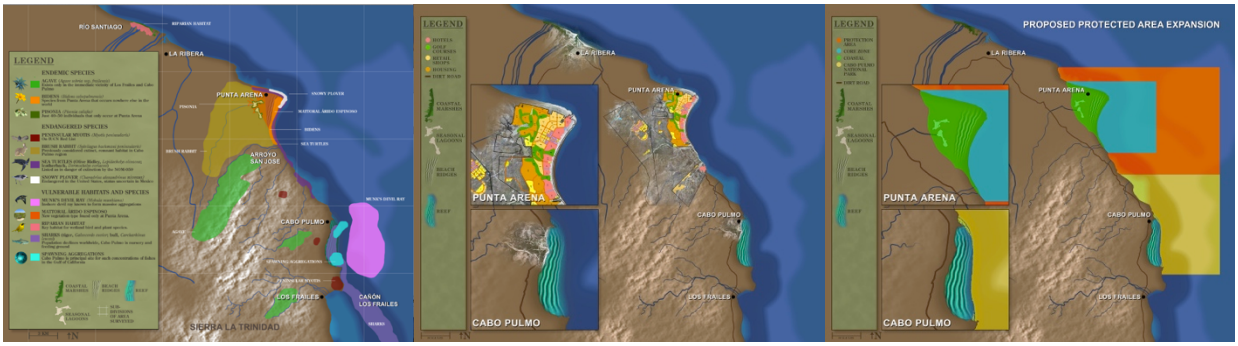


Conceptual model of small bird islands in the Gulf of California. For full figure caption see page 57 of my dissertation.

Land-Sea interface of Cabo Pulmo

The aim of this collaborative project is to develop a scientific approach to change the paradigm of conservation vs. development towards science guiding future change. Coastal areas in biodiverse regions are often at the center of land use conflicts. The very areas that draw thousands of people due their aesthetic beauty are also often regional or even global biodiversity hotspots. Historically, development has led to economic gains without adequate information regarding the impact on ecosystems and their services. Vast sections of the aesthetically beautiful shorelines of the Gulf of California have not been studied sufficiently. These areas lack the information needed to design land and sea use that protects the economic and ecological viability of the region. The area of Cabo Pulmo in Baja California Sur, Mexico is just such a region.

The story of Cabo Pulmo encompasses the singular coral reef of the Gulf of California, a pioneering community committed to long-term thinking, one of the worlds most successful marine protected areas, proposals for massive tourism and housing developments, and pressure for increased marine tourism. This project will develop a Land-Sea Planning Map to connect science to future land use planning and link the often overlooked interface of the land and sea. Scientific efforts are focused on gathering quantitative data of key habitats and their biological diversity.



Conceptual Model of the Land-Sea Planning Map

Freshwater Islands in a Sand Sea

At the center of the Dry Borders is the largest extent of sand dunes in North America, the *Gran Desierto*. These grains of sand, once the interior of the Grand Canyon, found on both sides of the international border, hold a fossil water aquifer of unknown extent. This ancient water rises to the surface on the coastal edge of the Gran Desierto where artesian pressure brings forth multiple wetlands and *pozos* (fresh water springs) – riparian islands in a sand sea. To augment sparse Colorado River water for agricultural fields in the Yuma and Mexicali Valleys, ground water pumping by the U.S. and Mexico is being undertaken at an increasing rate. In this arid heart of the desert, local and regional resilience is closely associated with availability of water resources. Water extraction activities, border infrastructure, and climate change threaten to strain the capacity of the region and the diverse wetland hotspots. These wetland ecosystems are a prime indicator of borderland ecological health and resilience.


Pozo at La Salina Grande

Baseline study of the pozos, Ezcurra et al. 1988

This research project aims to better understand the shared wetlands and aquifer of the Gran Desierto as an indictor of ecosystem health of the borderlands in the era of climate change and increasing societal demand. Specific goals are to determine the residence time and origin of the water in the Gran Desierto aquifer through isotopic analysis, address how wetland restoration and spring dynamics are affected by ground water pumping, and document change through time and the trajectory of wetland systems through the revision of long-term ecological studies of the pozos.

Knowledge Transfer in Northwestern Mexico: Conservation Ecology Courses to Create Local Leaders Among the Comcaac

There is widespread interest and action in the conservation of unique cultural and biological diversity. However, these actions largely lack local leadership and expertise, and learning opportunities for indigenous students are few. This is true for the Comcaac (Seri people), an indigenous culture that lived off the bounty of the desert and sea of the Gulf of California and Sonoran Desert for millennia. Today, rapid change envelops the Comcaac and their desert nation as outside cultures, paved roads, invasive species, and development pressures increasingly bear down on what was once a remote portion of the Gulf of California. These conservation ecology courses for a cohort of Seri youth will provide the highest level of scientific and conservation education. Specific self-led Comcaac community research teams will address priority topics in connection with the courses to help train the next generation of Comcaac leaders.

This project harnesses the collective energy and interest of the Comcaac, the Next Generation Sonoran Desert Researchers, universities, and the Mexican government in a collaborative framework of education and action. Intensive field- and classroom-based learning will provide foundational teachings on biodiversity and how to conduct a research project from beginning to end. These actions can further land management practices that conserve the priceless natural heritage of the Gulf of California as well as address the needs of the ever-developing Comcaac society.

Cradles of the Desert: Exploring rain shadow valleys to understand the formation of New World deserts

New World deserts at mid-latitudes (~30º) are expansive biomes that span multiple degrees of longitude. These well-known regions (the Sonoran and Chihuahuan Deserts in North America, and the Monte Desert in South America) digitate into fragmented insular pockets with increasing proximity to the tropics where dryland communities are relegated to small rain shadow valleys. The similarities and differences between North and South America desert communities have fascinated researchers and explorers since the time of Alexander von Humboldt and Charles Darwin. Yet fundamental questions remain. A multitude of desert taxa on both sides of the tropics share close common ancestors, such as mesquites or creosote bushes, while others seem to have been unable to cross the equatorial divide, such as ocotillos and agaves from North America and a rich flora of zygophylls in the Southern Hemisphere. It remains unanswered to what degree these remarkable patterns are the result of past long distance dispersal events ("amphitropical disjuncts") or the actions of convergent evolution.

Valle de Tehuacán, Puebla/Oaxaca, Mexico

AMPHITROPICAL RELATIONSHIPS IN THE FLORAS OF NORTH AND SOUTH AMERICA

By PETER H. RAVEN

Division of Systematic Biology, Stanford University, Stanford

ABSTRACT

Amphitropical distributions of vascular plants in the Western Hemisphere are divided into three groups: bipolar or high-latitude, with about 90 species; temperate, with about 130 species; and desert, with a substantial number. Close relationships of this sort can be explained either by divergence from a common tropical ancestor or by origin on one side of the tropics and subsequent migration to the other. The latter is true for the great majority of groups discussed. These may have crossed the tropics in a single jump or by direct migration. The plant communities involved are relatively recent in origin. The amphitropical disjuncts are drawn from relatively few families and mostly are plants that occur in open habitats such as seasonal or seasonally moist places where establishment would be relatively easy. Woody plants and even herbs of closed communities are scarcely represented. Animals by and large do not have analogous amphitropical distributions as they would be expected to if the plants migrated by a land bridge or mountain chain that took them directly through the tropics. Nearly all of the plants are self-compatible; the arrival of a single seed in a suitable habitat is sufficient for the start of a new disjunct population. Animals, being predominantly bisexual, are not as likely to establish colonies in new areas to which they are rarely dispersed as are autogamous plants. Many of the disjunct patterns correspond with the migration routes of birds, which must occasionally carry seeds between one hemisphere and the other. The floras of extratropical North and South America have been distinct since at least the middle Cretaceous and are still very different at present; the few common or closely similar species are discordant elements superimposed on this pattern. Despite this, in at least 200 species and species-groups of plants, the relationships between North and South American populations are very close. Many of these are annual herbs of rapidly evolving groups in which chromosomal differences often accumulate quickly. Nevertheless, crosses between North and South American plants in several groups have demonstrated a relatively high degree of chromosome pairing and some fertility. The bipolar species mostly come from the Northern Hemisphere; their most likely time of dispersal seems to have been the Pleistocene. About 85 per cent of the temperate species may likewise have come from the north, possibly in the late Pliocene and Pleistocene. A majority of the desert species may have come from the south, possibly as recently as post-Pleistocene time in some cases. Sporadic long-distance transtropical dispersal seems to be the best hypothesis to account for all these facts.

INTRODUCTION

WORKS such as Darlington's *Zoogeography* (1957) have made it abundantly clear that present patterns of distribution can teach us much about the past history of organisms and the lands they inhabited. The patterns must be understood properly, however, if the deductions are to be valid. No comprehensive review of the similarities and differences between the extratropical floras of North and South America has appeared for more than 90 years. During this time, a host of new techniques has been employed to define and interpret taxonomic relationships. Therefore, although every group mentioned in

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Early paper on amphitropical disjuncts by Raven 1963

To untangle this longstanding mystery it is necessary to shift attention from the core desert biomes, well studied by the International Biological Program of the 1970s, and explore the edges of the tropics where dramatic mountains tower above desert islands. These poorly known and underexplored arid pockets harbor the equatorward extent of dryland-adapted communities with disproportionately high levels of endemism, exemplified by columnar cacti. In addition, Miocene and Pliocene mountains ring these valleys, which have buffered them from glacial and interglacial dynamics. As such these desert communities are of great antiquity, which heightens their ability to house the secrets of the past. Initial efforts will consist of basic scientific exploration of desert fringes in Argentina, Peru, and Mexico.