

LEARNING FROM THE PAST TO

Save Plants FOR THE FUTURE

David A. Burney and Lida Pigott Burney

“Our modus operandi is to create on the Makauwahi Cave property six distinct management units and make them demonstration and experimental areas for innovative horticultural and agricultural techniques for saving rare native plants and beautifying a unique landscape.”

Behind spectacular sea cliffs on Kauaʻi’s south shore, there is a huge oval hole in the ground, over 100 feet across. Unlike most such holes in Hawaii, Makauwahi Cave is not a volcanic crater. It is a sinkhole in ancient eolian calcarenites, the result of strong groundwater flow eating out the bottom of a fossilized dune field. Stone archways lead off to cave passages with stalactites, and the subterranean ecosystem includes invertebrate grazers and a big blind cave spider.

A 15-year-long scientific study of the sediments in the caves and sinkhole has yielded the most detailed history of prehuman Hawaii of any available, revealing which plants and animals dominated the landscape for millennia, and perhaps what happened to them after human colonization. Bones, shells, seeds, pollen, wood, and a host of other types of fossil

evidence have permitted us to begin visualizing what the area would have looked like more than a thousand years ago. We can now imagine what the first Hawaiians would have seen.

Vision for the Makauwahi Cave Reserve

We are now turning our “time machine” around to gaze into an equally murky future. After theoretically reconstructing what the past landscape looked like, we are creating a native plant restoration project on the 17 acres surrounding the sinkhole. We are gradually supplanting the dozens of invasive non-native plants with native plants: a few of which still persist tenuously in remote stretches along the coast; others which grew here as recently as two centuries ago; and still



Oblique aerial view of the Makauwahi Sinkhole. Note the rare *Pritchardia* palms growing in the “Sunken Garden” at the bottom.



ALLEN COULOMBE



Native plants inside Makauwahi Sinkhole look especially green from the deep darkness of the huge South Cave.



Flowers of the native shrub *Hibiscus waimeae* growing in an abandoned agricultural field at Makauwahi Cave Reserve

ALEC BURNEY



A panoramic view of Unit 2 of the Makauwahi restorations taken in November 2006.

more that are known only from the fossil record.

The project site is spectacularly beautiful with limestone cliffs, arching cave entrances, and dunes overlooking a coast pictured in movies from *Raiders of the Lost Ark* to *Six Days Seven Nights*. Overrun by a handful of aggressive weed species, including thorny kiawe trees introduced from the neotropics, head-high Guinea grass from Africa, and a host of aggressive vines and weeds from Australia, Asia, and the Americas, our first challenge was to remove these latecomers before we could reintroduce or enhance natives.

Among the collaborators on the project are Grove Farm, Inc., that gave us a lease on the property and the National Tropical Botanical Garden

(NTBG), the source for many of the native plants.

Our project has to be large enough in scale to reclaim the vicinity for natives and diverse enough to host populations of rare natives that could be part of stable communities to the degree possible with a viable component of each species' genetic diversity. The landscape-level native restoration also needs to be large enough to help stave off the mass extinction on Kaua'i that is not just a catastrophe documented in the fossil record, but a continuing and accelerating conservation challenge in the present day. The NTBG is a leader in the fight to save Hawaii's rare plants. Of the thousand-odd flowering plant species indigenous to the Islands, nearly half are either Federally designated as Threatened or Endangered, or should

be. So whatever we did had to be done fast, and on a scale big enough to plug the leak for at least some of these species.

With these goals in mind, the cave project has a certain advantage in this task over more formal botanical gardens, in that much of the work is admittedly experimental and may take some time to look good enough for public display. Our *modus operandi* is to create on the Makauwahi Cave property six distinct management units. Each serves as a demonstration and experimental area for innovative horticultural and agricultural techniques in saving rare native plants and beautifying a unique landscape.

All management units have unique goals, challenges, and methods, from

erosion control along the stream banks with native plantings, to reclamation of old mine-spoil piles with hardy native dune plants.

Digital Landscaping

In Management Unit #2, we have taken an abandoned field used for decades for growing sugar cane and corn and converted it into a reforestation project. The place was more than head-high with grass, weeds, and gnarly shrubs when we began. We used a big tractor mower to shred the field two years ago, then disc-plowed it several times. Timing plowing with the onset of dry weather killed most of the weedy cover, although the seed bank of invasive weeds and one common native came on with a vengeance afterward. By planting the introduced natives in rows, like a “crop” composed of a mixture of native trees, shrubs, palms, grasses, sedges, and forbs, and using a giant rotary tiller mounted behind a two-wheel modular tractor to agitate the intervening spaces and dry out the re-sprouting weeds, the weed onslaught was kept away from the natives without resorting to herbicide. Adjacent to the plants, hoeing and hand-weeding during the establishment phase give the newcomers a chance to outstrip the competing weeds.

After establishing this grid of plants and successfully controlling the weeds, we began filling in the paths between the rows with additional species of partial sun and shade-loving plants compatible with the emerging canopy and under story. The result can be some surprisingly natural-looking plant group-

ings and vegetative layers—an ad-hoc system for establishing a lot of plants quickly and tending them efficiently that we have come to refer to as “digital landscaping.” Each plant and intervening spaces can be thought of as a unit in a computer raster file or digital photo, in which each plant and intervening spaces are “pixels” and every plant location has a unique pair of numbers that are its coordinates in the created grid. This approach greatly facilitates relocating any particular plant from our database. No GPS locations are required; each row has a permanent tag number, and each plant a unique numerical position in the row.

Water Conservation

We also set up a cheap, simple temporary irrigation system on this unit that involves pumping water from a nearby irrigation ditch, filtering and tanking it, then delivering it to each native plant with a set up modeled on the low-pressure drip irrigation systems developed on the Israeli kibbutz farms many years ago. With a homespun but effective system of line taps and manifolds, we can water our now more than 2,000 plants in this field with a flick of the wrist. We can also tailor separate areas to differing water regimes. After surviving two dry seasons, the plants are gradually weaned off the supplemental water. Every few months we “fertigate” by dripping diluted fertilizer and mycorrhizal cocktails on the plants through the automated irrigation system.

The Subterranean Ecosystem

In Management Unit 5, we are growing natives that will undoubtedly send their roots down into the cave passages below. Dr. Frank Howarth of the Bernice P. Bishop Museum has recommended native plants that his research has shown form the base of the subterranean food chain that the blind cave invertebrates occupy. Directly over the “headprint” of the cave, we have planted these recommended species including *maiapilo*, the Hawaiian capers (*Capparis sandwichi-ana*); *a’ali’i*, with its showy pinkish hop-like fruits (*Dodonaea viscosa*); and ‘uhaloa (*Waltheria indica*). Nutritious exudates from these plants feed bacteria and fungi that in turn feed the blind arthropods and isopods that live in the cave’s eternal darkness. This is a case where an ecological restoration and native landscaping have been chosen precisely to aid a subterranean ecosystem of blind white troglobites!

Others Join the Battle

The experimental practices demonstrated on the landscape at Makauwahi Cave Reserve have taken root in many locations on Kaua`i and throughout the Hawaiian Islands. At NTBG visitors can see a range of community-level restoration projects in which the emphasis is on creating new populations of native species in situations where the plants can reproduce. In lower Lawai Valley on Kaua`i’s south shore, native plant restorations are growing near the ocean at Lawai-kai in the Allerton Gardens as well as along Lawai Stream up through Allerton and

A panoramic view nine months later.

PHOTO-MOSAICS BY ALEC BURNLEY

"A 15-year-long scientific study of the sediments in the caves and sinkhole has yielded the most detailed history of prehuman Hawaii of any available, down to which plants and animals dominated the landscape for millennia, and perhaps what happened to them after human colonization."

McBryde Gardens. In the upper part of McBryde, there are more than two acres of Kaua'i natives in the Lawai Forest Restoration and many rare dry forest species in the Lawai Cliffside Restoration. Limahuli Garden and Preserve, on the island's north shore, features centuries old stone terraces that have been restored to traditional taro farming. Native plant restorations range all the way up the valley to a remote and relatively pristine Upper Valley Preserve, accessible only by helicopter.

An outgrowth of the Makauwahi Cave collaboration with Grove Farm and NTBG is the Grove Farm Ecological Restoration Project at 'Iliahi House, Grove Farm's upscale conference center on the flank of Kilohana Crater in eastern Kaua'i. Here we created a two-acre reforestation project, featuring dozens of species of native trees and shrubs, with all the Boy Scouts and Girl Scouts on the island to help. As their Camporee project, the nearly 200 Scouts planted almost 1,000 native trees in a single day.

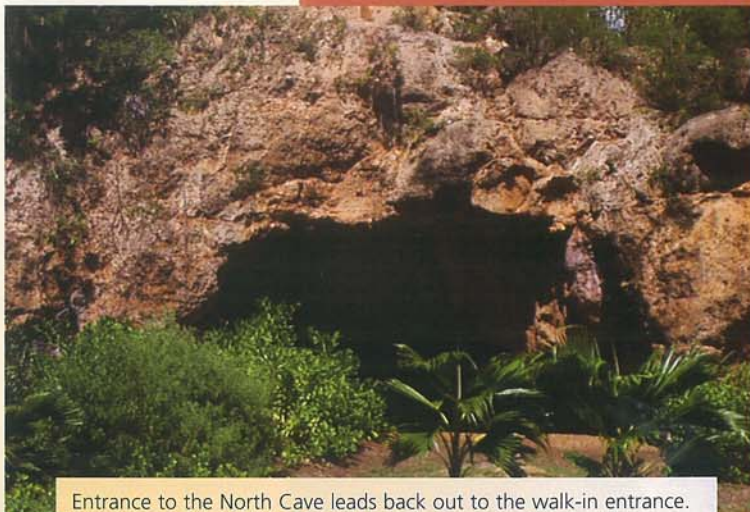
On remote, uninhabited Lehua, an islet off the north shore of Niihau, Kaua'i's island neighbor, a collaboration between NTBG and Federal and state agencies hopes to reestablish a community of natives on this 248-acre island covered with nesting seabirds. At Hawaii Mahogany, Inc., a local tree farm, we are working on plans for a 25-acre native tree restoration.

Where to go from here

After three decades of research on how species become endangered and eventually become extinct, we finally came to the point of daring to try something new: If we can understand how human carelessness leads to species extinction, can we develop programs to stop this senseless waste of biodiversity? Can we find clues in the past to make a better future for some Hawaiian plant species, and can we do it fast enough and on a sufficiently large scale?

We don't know for sure, but we think that we may find some of the answers at Makauwahi Cave where we are striving to bring the past and future together.

David A. Burney, Ph.D., is the Director of Conservation and Director of Living Collections & Horticulture at the National Tropical Botanical Garden; he can be contacted at dburney@ntbg.org. Lida Pigott Burney is the Manager, of the Makauwahi Cave Reserve and can be contacted at makauwahi@gmail.com.



Entrance to the North Cave leads back out to the walk-in entrance. Visitors pass through the North Cave before entering the "Sunken Garden" of native plants well represented as fossils at the site.

DAVID BURNEY



Girl Scouts planting native trees at the Camporee, sponsored by Grove Farm, Inc. Using techniques perfected at Makauwahi, about 200 Scouts planted two acres in a single day.

DAVID BURNEY