

Digging into the past to find the future

Palaeo-ecology meets restoration biology

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Ecological restoration projects in the Hawaiian lowlands have little to go on in terms of intact coastal forest ecosystems to serve as models. Nevertheless, a program of palaeo-ecological research has led to some unique restoration initiatives by the National Tropical Botanical Garden on Kauai. For instance, palaeo-botanical evidence from a cave site a few miles from NTBG's southshore gardens has given scientists their most detailed evidence yet for how coastal vegetation before humans would have looked. As it turns out, the list of species in coastal dry forests was quite long and included many endangered taxa that are represented in the wild today only by a few individuals at remote inland sites, or that are extinct on the island but have survived on a neighbouring island.

On both the north and south shores of Kauai, NTBG has several exciting new restoration projects with ties to palaeo-ecology and archaeobotany. These include a project along the coast fronting the Allerton Garden, an area called Lawai Kai, which was initiated by grants from the US Fish & Wildlife Service and the Natural Resources Conservation Service (USDA). In the more inland parts of the Lawai Valley, NTBG's McBryde Garden has new restoration projects underway aimed at protecting rare plant species adapted to dry upland conditions on the island's leeward slopes. Initial funding of the project in McBryde was made possible through NTBG Fellows, a major support group of the organization. NTBG's Limahuli Garden on the north shore has restored traditional Polynesian pondfields and other dramatic landscapes through careful attention to the details of local oral traditions and data from adjacent archaeological sites.

A key link in the process of finding the successful path to restoration against the

odds posed by aggressive alien plants and animals has been that NTBG staff pay close attention to ecological history in planning its restorative efforts. Hawaiian oral traditions, early historical accounts, and particularly information from archaeological and palaeo-ecological sites near the restorations have provided useful evidence concerning the site's potential for restoration, serving as reference systems or restoration targets for various projects.

At Makauwahi Cave on Kauai's spectacular Mahaulepu coast, our research group has excavated more than 200 m³ of sediment from a sinkhole palaeolake in the centre of the cave system, yielding a 10,000-year record of changes in sea level, environmental conditions and biota. The fossil-rich mud of this site has yielded about 45 species of fossil birds, for instance, as well as more than a dozen types of extinct land snails, and a rich record of early Polynesian diet and lifestyles. Most germane to the question of what types of vegetation grew there in the past and could be targets for future restorations, of course, were abundant well-preserved fossil spores and pollen, seeds and fruits, and even leaves, twigs and whole tree trunks.

This material showed that, for thousands of years before human arrival, the site was surrounded by a woodland dominated by a small-fruited native loulou palm (*Pritchardia* cf. *aylmer-robinsonii*) and a wide array of trees and shrubs. This remarkable vegetation included plenty of kou (*Cordia subcordata*), a species formerly believed by most botanists to have been brought to the islands by Polynesians. Our radiocarbon dating shows clearly that this tree, as well as hala (*Pandanus tectorius*), were part of the indigenous flora.

◀ Volunteers remove invasive grasses and plant native strand plant along the beach at Lawai Kai in the historic Allerton Garden.



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Armed with this kind of information from the past, NTBG embarked last year on the ambitious restoration of the spectacular beach and adjacent coastal forest at Lawai Kai. The project's first goal was to remove the exotic grasses from the beach strand, which had crowded out most native strand plants and hardened the beach's substrate so that the Hawaiian green sea turtle or honu (*Chelonia mydas*) had stopped nesting there. Additional challenges were to create a vegetation barrier to ameliorate the effects of marine overwash (the structures on the site had been damaged previously by a tsunami and two hurricanes), while retaining the ocean view. Add to this the need to remove aliens, which made up much of the plant biomass, and create stable habitat for a wide array of highly endangered endemic plants, and the order is tall indeed.

A plan was developed in late 2003 that addressed these requirements and deliberately followed the fossil and historical evidence to design a vegetative landscape aimed at mimicking the kind of plant assemblage that would have been there about a millennium ago – shortly after Polynesian arrival. Evidence from excavations at Makauwahi as well as 6000-year sediment cores from Lawai Kai's own estuary and about a dozen other palaeoecological and archaeobotanical sites around Kauai were combined with present and historical records for plants to generate a very long species list. Many of those plants, including rare palms, trees and shrubs endemic to the island, now thrive on the three-acre restoration.

Similarly, at Limahuli Garden on the north shore, ancient oral traditions have guided the reconstruction of taro pond-fields in the lowermost parts of the valley. Higher up, a three-man restoration team battles exotic weed trees and plants out hundreds of natives grown in NTBG nurseries. Nearby, a sediment core from a coastal fen contained a 9,000-year record of sedimentation in a windward, high-

rainfall area, including evidence for megatsunamis and flood events.

NTBG has been able to spread this successful approach, utilizing a deep-time perspective to guide ecological restoration efforts, in collaboration with other landowners on Kauai. The restoration activities on the 15 acres surrounding the Makauwahi Cave was made possible by the cooperation of Grove Farm Company, which leased the land to the research group. Similarly, our 7,000-year sediment cores from the Bette Midler Trust property in the Kawaihau Wetlands on Kauai's east coast provided a pollen and spore record to guide restoration planning there in cooperation with the Natural Resources Conservation Service (USDA). Similar collaborations with the State of Hawaii and US Fish & Wildlife Service may help in the effort to re-establish rare Hawaiian plant species on Lehua, a small islet and seabird colony just offshore from the nearby island of Niihau. These and other NTBG projects and collaborations may be the best chance for many rare Hawaiian plant species to have any sort of future at all.

There is a supreme irony in this turn of affairs. In order to provide some plants with a future, we must look to the past. In a sense NTBG's mission has grown to embrace an exciting new concept in conservation – an approach that holds out the possibility of staving off extinction by consulting with the ancestors, especially those of the plants themselves!

National Tropical Botanical Garden

is a non-profit institution, dedicated to tropical plant conservation and research and to sharing what is learned. *For more information, please visit our website at www.ntbg.org <http://www.ntbg.org/> or contact us at (808) 332-7324.*

▼ **Nursery Manager Bob Nishek growing native plants for the Dry Forest Restoration Project in NTBG's McBryde Garden. Paleoeological studies of leeward areas of Kauai have shown that, before their destruction in recent centuries, dry forests were remarkably diverse.**



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