

As Seen from Above

I looked out into the river canyon and then quickly down at the tablet showing the drone heading out-of-range. I sprinted 30 m along the ridge to get a better view of what was unfolding. I was still able to make it out in the distance, some 100 m away, as it buzzed over a grove of cypress trees planted half-way up the canyon. The forceful 30 mph westward gusts were bending the tops of the trees. I returned to the screen and watched with panic as the distance reading continued to climb up to 200 m, then 300. Up and up it went. I hit the automatic Return-to-Home button repeatedly as if the more times I pressed it, the harder the drone would fight against the seemingly gale-force winds. Soon, I lost sight of it. Now I was forced to depend exclusively on the tablet and remote controller to try to understand its location and heading. The live video feed showed it spinning wildly. The battery level was dropping quickly, so I decided to turn off the onboard camera to save as much power as possible. I finally gave up on the idea of bringing it back and decided to try an emergency landing. I pushed the control stick all the way down and the altitude reading on the screen began to decrease. The battery level was critically low at this point. Finally, the screen froze. The onboard battery had died, abruptly cutting off the transmission of data regarding its whereabouts. The drone had disappeared.

Thus was one of our first experiences with a camera-equipped, radio-controlled quadcopter purchased by Nectandra Institute (NI) earlier this year in order to help us document our forest conservation and restoration work from the air. One of its first flights also turned out to be its last. A search and rescue mission spanning two days and lasting more than eight hours did not turn up the drone or even its remains, considering it fell from 300 m when it ran out of power. If anyone has seen it since, it is most likely a dairy cow grazing on the steep pasture that together with intermittent patches of riparian forest make up the river canyon the drone was flying through.

Undeterred, we invested in a replacement drone which has fared much better than its predecessor. The second quadcopter has enjoyed multiple successful flights over some of the regenerating forest on lands purchased by NI's

community partners with our eco-loans. Thanks to the drone's high quality video and photo imagery, we have better documentation of the progress being made on these protected lands. Using orthophotos (non-distorted aerial images) acquired in 2005, we have created a reference forest map for each restoration property for analyses of tree growth succession. At different stages of a growing forest, we previously classified (*i.e.*, zoned) land area into grassland, shrubland, young forest, and mature forest using aerial photos obtained in piloted small plane flights. The task is now made easier. With the drone, we can readily obtain real-time aerial photos needed to rezone the properties at regular intervals to track plant growth since 2005. We no longer have to purchase expensive orthophotos (last updated in 2005, jointly by NASA and a Costa Rican agency) or depend on lower resolution (albeit free) Google maps satellite images. In addition, the resolution of the drone images is such that identification of specific types of trees and other plants may soon be possible. The drone will help in other ways too. For example, trees can be counted in defined sample plots to estimate the tree number and density for an entire property. This sort of work would be much more time consuming and labor intensive if it had to be done in the field. Semi-annual aerial photos coupled to ground photos taken from fixed vantage points will additionally create a highly informative photographic record of the ecological restoration process.



Manrique Esquivel, Nectandra Institute's biologist, launches the drone for a flight over a 250-acre property undergoing restoration

An aerial photography platform provides more complete coverage and opens up visual access to areas that are difficult to get to on foot. The drone can help us detect previously unknown, interesting features of the restoration lands. For example, upon reviewing recent aerial video of one protected property, we noticed a small area of wetlands that no one knew existed before. Additionally, the drone can be flown within the forest, not just above it, in order to get to hard to reach areas, include the underside of the canopy. For example, we can fly it up along the

trunks and branches of trees in order to inspect the variety of epiphytic plants high above-the-ground surfaces. Height-loving orchids, bromeliads, and bryophytes can now be viewed through the drone's camera lens. Compared to the under-story, the mid-story and canopy are rarely explored parts of the forest, and a drone makes it easier to get acquainted with them. This is especially exciting with regard to tropical cloud forests, given the hundreds of plant species growing on individual trees in these highly diverse ecosystems.

Outside of our community partners' protected areas, the drone will also help us better understand the land-use panorama around the various stream sampling sites in the upper Balsa River watershed, NI's priority action. Since 2009, we've been monitoring the water quality at more than 20 stream locations in the watershed. By flying the drone above each stream sampling point, we will get a much better look at the surrounding uses of land. Discharges from dairy farms and pesticide-laced runoff are two major sources of stream contamination. Water quality scores for sampling sites downstream from croplands or dairy farms are generally lower than those of stream sites flowing through forest-covered land. We will study the aerial imagery against the water quality scores for each sampling site in order to tease out any possible correlations between land-use and water quality. We will also be able to use the drone footage to create an interactive map online that will allow the public to take virtual aerial tours of the various stream monitoring sites in the watershed.



The clearly drawn line between competing uses of land in Costa Rica's upper Balsa River watershed

Of the many ways we can take advantage of drone technology to further NI's mission of promoting cloud forest conservation, perhaps the most important is simply to highlight for people the fragility of the forest. When looked at from above, scattered around what seems to be an ever-expanding agroscape, the relatively small fragments of forest in places such as Costa Rica's upper Balsa River, almost seem out of place. This is a strange

thing to say about a country that just a few decades ago was 80% covered in forest. This number dropped to a low of 21% in the late 1980s, and although public and private efforts have managed to bring it back up to around 50% currently, there is still palpable pressure on the forest by competing land uses, particularly agriculture and cattle ranching. Aerial drone images bring this conflict squarely into focus. Just as this aerial perspective gives us a clearer understanding of the degree of forest connectivity on the lands, it also provides a dramatic, unobstructed view of the agricultural encroachment of forests. And in doing so, it can serve as a check on our collective conscience, showing us the clearly drawn line where our insatiable appetite for land confronts the edge of the forest. For our community partners and us, the view from above is eye opening, and it inspires us to push onward in defense of nature.

To view a short video shot with Nectandra Institute's drone, go to the following link:

<https://youtu.be/KEzCPF4GV38>

— Luis Villa —

The Osa Peninsula and Alvaro Ugalde

The bonding between Alvaro Ugalde, the late president of our Institute, and the Osa Peninsula occurred many years ago, when Alvaro was nineteen. He had been an apprentice worker in Georgia for a year and was flying home to Costa Rica, with no plans for the immediate future. As fate would have it, a conversation with two fellow passengers landed him a paying job even before he plane touched ground. To his own astonishment, Alvaro was hired to lead a two-man gold mining expedition in Osa. He was put in charge of chartering a small plane and of outfitting the venture. He bought gear ranging from gold pans to nuts—including a revolver, to boot! Alvaro described his meteoric rise and fall as a gold miner with much humor in our archived NI newsletter March 2004-1. This was Alvaro's indelible first introduction to his beloved Osa.

Eleven years later in 1976, Alvaro was back in Osa thick in negotiation with 166 families of gold miners and squatters, trying to convince them to vacate the newly designated Corcovado National Park (NP). He hiked days to reach the many subsistence farmers, ranchers and miners scattered over a 160 sq. mi area. He talked with them, ate with them and even slept with their pigs. He learned first hand about their living conditions and listened to their angst. Then when the time came, he meted out the decisions firmly, but, he hoped, fairly. His heartfelt impression of the people, the place and the historical context, all is recorded and transcribed in his oral [history](#) posted on our NI website. It is from this experience that Alvaro forged his guiding principle as a career

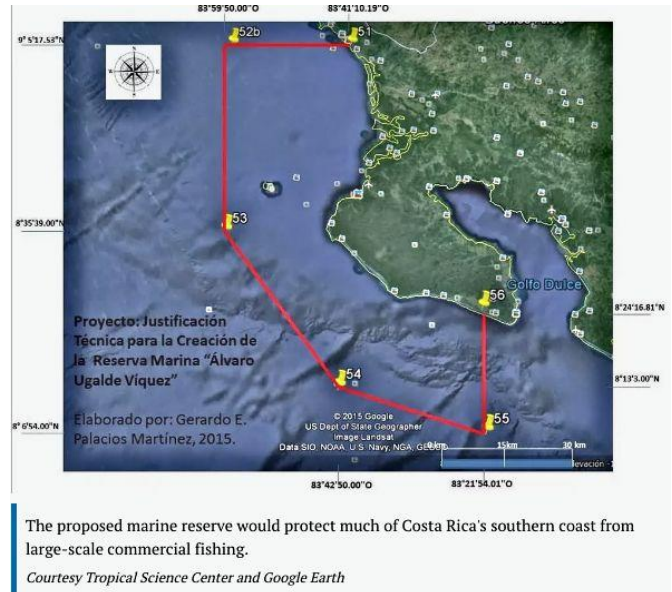
conservationist — that “There is no conservation without justice”. The Corcovado NP is today the second largest (106,000 acres) of the Costa Rica system of 28 national parks.

Corcovado National Park has had its ups and down over the intervening years in terms of governmental support. By 2000, it was at its worst in spite of increased tourism. The park had only a handful of park rangers to patrol and protect the vast area from illegal poaching and gold mining. Alvaro watched the neglect from the sideline and agonized until he couldn’t bear it. Once more, he returned to the trenches as Director of the Osa Conservation Area. During those three years (before becoming the full time president of the Nectandra Institute) he raised enough funds and attention to reverse Osa’s plight and to restaff the emaciated system.

In the end, as he requested, Alvaro’s ash was interred in Osa under “his” beloved giant Ajo tree. There, his spirit shall rest and watch over Osa for eternity.

Alvaro’s empathy for his fellow beings, humans and otherwise, was his single most important asset. His straight shooting may not have earned everyone’s affection, but even his opponents recognized his selflessness and dedication to nature and biodiversity. The combined personal traits formed the secret arsenal to achieve his remarkable accomplishments. Together with Mario Boza, the two helped conserve 4% of the *global* biodiversity. In the process, Alvaro earned the reverence of all, and above all, the affection of his park rangers. At his memorial service, his “men” took turn to stand by his side in silent vigil throughout the night and day — to pay personal tribute to their comrade-in-chief.

It is no surprise, then, to learn that two former comrades, Mario Boza and Miguel Madrigal, spearheaded an initiative through Congress to create the Alvaro Ugalde Viquez Marine Reserve: 1,000,000 acres of the Pacific ocean off the Osa Peninsula coast (see map). The proposed reserve will be contiguous with the Bellena Marine National Park (13,500 ha to the north) and the Térraba-Sierpe National Mangrove Wetlands (66,800 acres to the east). Close by will also be the Pejeperro Wildlife Refuge (1089 acres) and finally the Corcovado National Park. The complex will form a vast sea-land biological corridor, covering more than 1,187,000 acres.



Within this corridor are the main winter residences of a large number of cetaceans, including the humpback and Bryde’s whales, the Pilot whale, dwarf sperm whale, Costa Rican spinner dolphin, Fraser’s dolphin, bottlenose dolphin, rough-toothed dolphin and pan-tropical spotted dolphin. Each summer, many of the above make their epic migration to their favorite tropical feeding and mating ground. Also located within the proposed reserve’s borders is the San Josecito de Osa Coral Reef, the food source for hawksbill turtles, and not to mention the home of incalculable invertebrates and vertebrates.

The bill is winding its way through the Congress at the moment. It has the support of multi-agencies and organizations—the Ministry of Environment Energy (MINAE), the National System of Conservation Areas (SINAC), but also Friends of the Sea Club (PROMAR), a non-profit marine conservation organization. The Alvaro Ugalde Viquez Marine Reserve, as proposed, will be managed jointly by MINAE and SINAC and will be supported in part by fishing licenses. Under the proposed bill, artisanal and sport fishing are allowed, but industrial fishing and fishing practices involving longlines, bottom trawls and drift gillnets are prohibited.

Alvaro’s legacy is alive and marching on.

— Evelyne Lennette —

Recent News Highlights

January Thirty three students and professors from Texas A&M University studying abroad in Costa Rica [visited](#) the [Nectandra Cloud Forest Reserve](#) (known as the Garden). In recent years, the latter has seen an increase in visitation by groups from U.S. universities. Both the Garden and NI staff welcome the opportunity to teach visitors about the importance for tropical cloud forest conservation, including protection for biodiversity and for nature's provision of environmental services, [such as clean drinking water to local communities](#).

Local youth volunteers once again worked alongside NI staff in the [collection of aquatic macroinvertebrates](#) in creek and rivers of the [upper Balsa River Watershed](#). We have been monitoring these organisms twice a year since 2009 in over 20 stream locations. Some of these organisms are known to be tolerant to organic pollution, while others are not. Each stream sampling point is given a water quality score based on the mix of insects found there.

February Using GPS and GIS technology, Garden and NI staff members jointly mapped the visitor and maintenance trail maps of the reserve. The Garden is a key component of the Institute's education program, serving as a 158-hectare outdoor classroom for teaching young and older members of our partner communities, as well as the public in general, about the rare tropical cloud forest ecosystems and all their biological diversity and ecological importance.

Megan O'Brien and Reagan Murphy, students from the University of Louisville and the University of South Carolina respectively, began volunteering with Nectandra Institute. Our latest University Studies Abroad Consortium volunteers will work on the classification of the [macroinvertebrate specimens collected](#) during the first three months of the year from various locations along creeks and rivers in the upper Balsa River Watershed. Reagan and Megan will also assist in the monitoring of forest restoration progress on protected lands acquired with [eco-loan](#) assistance.

March NI and the water management association for Angeles Norte and Alto Villegas organized [the year's first tree measuring outing](#). Almost 30 community volunteers measured trees planted on 27 acres that the water association purchased almost ten years ago. Of the trees measured in 2014, 9% were 3 meters in height. A year later, that number increased to 22%. And in 2016, 26% of the trees measured were least 3 meters in height. The results for 2017 are still being tabulated.

April School children from the community of San Antonio de Barranca joined NI staff on a [field trip to a](#)

[protected property](#) purchased by the town's water management association in 2011 with eco-loan financing. There are freshwater springs on the land that provides potable water for the people of San Antonio de Barranca. Previously a farmland, the property is now covered in shrubs on its way to being a forest again. The children learned about the important role a forest in protecting springs and rivers, and they were able to see firsthand where the water they use in their homes comes from.

May Our staff biologist prepared and placed several dozen experimental ["seed bombs"](#) in a difficult-to-restore area of the first property purchased with eco-loan. In this 27 acre large property, severe erosion and compacted soil in some places slow forest regrowth. Aggressive exotic grasses also inhibit native seeds germination. The seed bombs contain a mixture of 100-200 native tree species seeds embedded in adobe enriched with nutrients, then shaped into balls ten centimeters across. The balls are planted in the restoration plots with the expectation that viable seeds will germinate in enriched adobe designed to promote the growth of the emerging seedlings.

NI staff worked together with members of the Pueblo Nuevo water association to [map the trails on 150 acres of protected land](#) acquired with an eco-loan. The trails are the primary access to springs that supply clean water to Pueblo Nuevo residents. NI provided GIS technology to create accurate maps of the paths. The Universidad Técnica Nacional will help install interpretive signage to prepare the trails for public education visits.

June Using the Institute's new drone, staff obtained aerial footage of Finca Ocotea, a 250-acre property purchased in 2009 by a local non-profit conservation organization. It is the largest property to date acquired with eco-loan assistance. The drone's aerial photographs allowed us to get information on some of the land features, including a small area of previously unknown wetlands. We shared the [short video](#) with the nonprofit organization during its annual general assembly and highlighted some of the more interesting drone footage.

— Reported by Luis Villa —