Tag number 3473, one point nine feet,” calls the measurer from his contorted position kneeling on the rainforest floor. After scanning the data sheet on her clipboard for the tag number, the recorder answers, “Another one that’s barely grown! It was one point six feet in 1965.” The recorder writes the new measurement next to the original record on the data sheet, and nonchalantly flicks away the leech that has inched up her leg.

Our field team repeated a similar version of that call-and-response for almost 20,000 plants last year, during the fiftieth-anniversary census of one of the world’s longest-running rainforest dynamics projects. We worked at two plots in Australia: one just south of Brisbane, in Lamington National Park, and the other at Davies Creek National Park, southwest of Cairns. Both plots were set up—and the first large trees were tagged—in 1963 by Joseph H. Connell, now Professor Emeritus at the University of California, Santa Barbara (UCSB). About ten members of our team spent two weeks at each plot, extending Connell’s legacy to five decades of research. With each new round of field observations we better understand these forests’ diversity and dynamics.

The way Connell tells it, once UCSB gave him tenure he was keen to spread his wings and explore. Australia was irresistible as a research destination in the early 1960s—biologically a bit exotic, English-speaking, and unlike several tropical countries at the time, politically stable. Connell’s initial research had been in marine ecosystems, and he spent a year in Australia in 1962 setting up permanent monitoring quadrats (small sampling areas) on Heron Island, determined to study the processes that maintain the diverse community of corals that occurs there. It wasn’t long, however, before the parallels with rainforests became obvious: like corals, rainforest plant communities contain a high diversity of sessile organisms, so the fates of individuals can be tracked over time. Connell returned to Australia in 1963, and with the help of colleagues John G. “Geoff” Tracey and Leonard “Len” J. Webb (from Australia’s Commonwealth Scientific and Industrial Research Organisation, or CSIRO), he laid out what is now known as the Connell Plots Rainforest Network.

Connell [see photograph on this page] wanted to better understand the processes that maintain species diversity in natural communities. Do ecological mechanisms prevent common species from monopolizing all available resources? Do rare species sometimes have an advantage over the common ones, so that the balance among species shifts over time?

Connell, Tracey, and Webb chose the roughly four-acre tropical site at Davies Creek because it had never been logged; instead, the Queensland Forestry Department set it aside in 1951 as a reference site against which the effects of silvicultural treatments at other rainforest sites nearby could be compared. Logging was still widespread in north Queensland at the time, and Connell remembers hearing the buzz of chainsaws when he first visited the site. The grounds for choosing the other site, the subtropical location near O’Reilly’s Rainforest Retreat (an inholding, or privately owned enclave, within Lamington National Park), might have been a bit more prosaic: apparently Mrs. O’Reilly’s roast lamb at lunch convinced Connell this was an ideal site for long-term research.

Both the Davies Creek and O’Reilly’s plots have been closely monitored ever since. Every few years, teams of hardy field workers brave the stinging trees, ticks, leeches, and biting flies to record the fates of thousands of tagged plants. The value of these long-term demographic data sets—records of birth, growth and mortality—increases with age. When those data are collected at multiple time points (“censuses”), they reveal the temporal patterns of population change. Accordingly, a collection of demographic data sets for the various species that inhabit a natural community provide valuable insights into the patterns of change for the whole community. We’ve accumulated a lot of information over...
repeated censuses in five decades of research: for the plots combined, our databases contain records for about 300,000 individual plants in about 300 species.

Many plots exist throughout the tropics that follow the fates of individual trees. Most of those plots are smaller than the Connell Plots at Davies Creek and O’Reilly’s (one-quarter of an acre and two-and-a-half acres are standard sizes), and a few plots are substantially larger (a few dozen sixty-plus-acre plots exist, including a relatively new one at Robson Creek, about six miles away from the Davies Creek plot). Where multiple small plots scattered across a landscape are useful for understanding geographic patterns of distribution, large plots are invaluable for understanding a forest’s internal dynamics (births, deaths, and growth of individual stems). Within this mix, the unique value of the Davies Creek plot is its age and inclusion of the smallest tree size classes right from the beginning.

For a variety of logistical reasons, more effort has been put into the Davies Creek plot than the O’Reilly’s plot. The initial plot census yielded 550 individual trees larger than four inches in diameter in nearly 160 species. A few species were common, but most species were rare. Some species are only represented on the plot by one or two individuals. For example, the Lunch Tree—the tree that serves as the team’s assembly point for beginning a day’s work, having lunch, or preparing to walk back to the vehicles—is the only individual of its species on the plot. This magnificent specimen is a 115-foot-tall northern brush mahogany (Geisoris biagiana), with large buttresses and sinuous roots that extend several yards in all directions from its base. Not all species were well known to science, and in fact the most common species on the plot, a member of the genus Niemeyera, in the plant family Sapotaceae, remains undescribed by taxonomists.

In 1965 Connell and his colleagues laid out several transects across the research plot to facilitate a census of the seedlings and small saplings. This early addition to the project added another fifty species to the plot’s species list, and has proven especially valuable now that nearly five decades of records have accrued for seedling and small-sapling dynamics. The forest is sharing its otherwise well-kept secrets through patterns revealed by statistically analyzing the long-term data set. For example, the data clearly show that recruitment—

Measurements made of modest growth in the forests (Davies Creek, top; O’Reilly’s, bottom). The measuring tape held side by side (bottom) shows the heights of “Tag 3403” (a steelwood tree, Sarcopterix stipata) in 1965 (left) and in 2013 (right).
the production and germination of seeds, and the establishment of seedlings—is localized and sporadic for most species. At one extreme lies satin sycamore (Celtis occidentalis) —magnificent, flaky-barked coniferous canopy trees—have produced only about two dozen new seedlings. The long-term data yield many stories like this, and in an effort to understand this
to ground level at most locations in the forest. Many plants that were one or two feet tall in 1965 are only a few feet taller now, and age estimates using these growth data indicate that seven-foot-tall saplings of many species could be eighty to one hundred years old. It seems that light is so limiting that rates of photosynthesis are barely greater than rates of respiration. The canopy giants of these shade-tolerant species must be truly ancient. On the other hand, there is a smaller group of light-demanding species whose seeds are able to reach light gaps created by the death and toppling of large trees. Over the decades we have tracked the recruitment of seedlings and their transitions into reproductively mature adults of the white basswood, or pencil cedar (Polysais mucupis), in a large gap near the center of the plot. Unlike the “slow and steady” persistence of the shade-tolerating species, these white basswoods have lived comparatively fast and died comparatively young, having enjoyed several good years of reproduction through the 1990s and early 2000s. The infamous gympie stinger (Dendrocnide moroides) is another fast-growing but short-lived species at Davies Creek, and the very large light gaps it requires to establish have been uncommon on the plot. As a consequence, plants of this species have been comparatively rare—fortunately for us, since to slip and be stung while tagging one can be excruciatingly painful!

Elsewhere in north Queensland, cyclones are recognized as a key driver of forest dynamics, but one feature of the Davies Creek plot has been its relative lack of disturbance. The death of large trees sometimes creates canopy gaps, but the plot has survived unscathed by powerful cyclones that have otherwise created large disturbances in rainforests up and down the Australian Wet Tropics over recent decades, notably Cyclones Winifred and Arthur in 1986, Justin in 1997, Rona in 1999, Larry in 2006, and Yasi in 2011.

The monitoring tools and methodology used on the Connell Plots Rainforest Network have barely changed in fifty years. One curious feature of the Network is the units used for measuring distance, height and tree girths. Because the original Queensland Forestry plot at Davies Creek had been set up using the Imperial system of measurement (inches, feet, and chains), Connell decided to maintain this system when he established his plot on top of it in 1963—with one exception. Instead of feet and inches, or inches and eighths of inches, Connell used a hybrid of the Imperial and metric systems in which decimal fractions were applied to Imperial units. He lived in Baton Rouge, Louisiana.

Christian ZieGler

Peter T. Green is a professor in the Department of Biological Sciences at Louisiana State University. His research interests include the processes that shape the diversity and dynamics of tropical rainforests and subtropical pine savannas. He lives in Baton Rouge, Louisiana.

Kyle E. Harms is a professor in the Department of Biological Sciences at Louisiana State University. His research interests include the processes that shape the diversity and dynamics of tropical rainforests and subtropical pine savannas. He lives in Baton Rouge, Louisiana.

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