

## **Podcast Interview: Scott Fitzpatrick, Alvaro Castilla-Beltrán, Simon Haberle, Kelsie Long, Kristina Douglass, Rebecca Hamilton, and Michael-Shawn Fletcher**

**PNAS:** Welcome to *Science Sessions*, the podcast of the *Proceedings of the National Academy of Sciences*, where we connect you with Academy members, researchers, and policymakers. Join us as we explore the stories behind the science. I'm Matthew Hardcastle, and this is the second part of a two-part podcast on, "Tropical Forests as Key Sites of the Anthropocene," a collection of articles published as a special feature. In part one, we heard about the various ways humans have shaped tropical environments, not just in the recent past, but for thousands of years. In this part, we'll focus on tropical islands, which arguably represent the most vulnerable ecosystems in the Anthropocene. We'll also hear why it is essential to incorporate indigenous voices into conservation policies. In one article in the collection, Scott Fitzpatrick, an archaeologist at the University of Oregon, and colleagues outlined the importance of a model for holistically understanding the ways Indigenous peoples used both terrestrial and marine resources on islands. The authors used the archipelagoes of Palau in Micronesia and the Lesser Antilles in the Caribbean as case studies. Fitzpatrick explains.

**Fitzpatrick:** Palau, like many other Pacific Island groups, have different conservation ethics that had been recorded historically. We have this really interesting and unique change in settlement patterns in Palau, where we know people are modifying landscapes pretty significantly in the form of terrace formations; we call them earthworks. What's interesting about this is that we see this happening 3,000 or so years ago, and then people begin to move pretty intensively to the coast. Over the 25 plus years that I've worked in Palau, it sort of dawned on me that there probably is a connection that goes back in time of these current conservation strategies that could have essentially been rooted in this movement where people are recognizing that inland occupation and forest clearance are leading to sedimentation that are choking coral reef systems, which are a really important part of Palauan food systems.

So in the Lesser Antilles, we see kind of an inverse of what we see in Palau, in that coastal settlements seem to be initially more important and then people began to move inland, and they move away in some cases from more intensive marine exploitation. People seem to be practicing marine resource harvesting in some ways that are very sustainable but in some ways that are becoming unsustainable. And in a number of islands where we've tested this by measuring thousands and thousands of shells and seeing how those compare over time, in some cases they're getting larger or they're staying the same. So this seems to be a case of sustainable exploitation. In other cases, peoples are harvesting lots of land crabs and things early on, and those become a case of unsustainable harvesting, and then they move to exploiting more marine resources. And so we see kind of an ebb and flow in the Caribbean, compared to Palau.

**PNAS:** In another article, ecologist Alvaro Castilla-Beltrán of the University of La Laguna in Spain and colleagues looked at the Canary Islands and Cabo Verde as case studies for the impact of human habitation on forested islands.

**Castilla-Beltrán:** Our study was a comparative view of how different forested ecosystems had changed through time after humans arrive to these islands. The Canary Islands have a prehistoric occupation period. This is a period in which prehistoric societies were present for

around 2,000 years. Cabo Verde was only discovered by Portuguese sailors 500 years ago. Our main results highlight that forested landscapes were changing from minute one, in a sense, from when humans arrive to the islands.

We are studying forested landscape changes in the highlands of different islands, and this allows us to focus out of particular sites and start to contrast different trends of change. For instance, we have, both in the Canary Islands and in Cabo Verde, a type of forested landscape called thermophilous forest. And they are iconic due to the presence, for instance, of Dragon trees; in Cabo Verde, the presence of ficus trees. And what we were able to see is that human occupation was especially devastating for these types of forests, mainly due to the fact that humans in the Canary Islands, for instance, very much occupy this ecological zone within the islands, and in Cabo Verde due to the fact that there are few other sources of materials, such as wood. One of the main striking conclusions is that this forest was very much impacted in both archipelagos in a similar way.

**PNAS:** Some of the effects humans have had on tropical islands are recent. Simon Haberle, a paleoecologist at the Australian National University, and colleagues studied the health of the Lake Kutubu wetland ecosystem in Papua New Guinea.

**Haberle:** The kind of study we do in wetlands is to take cores from the lake sediment bed, and these sediments that have accumulated slowly over time actually hold a record of the state of the lake at any time in the past. And what we found was quite a remarkable and relatively stable ecosystem over a number of decades prior to industrialization and mining appeared in the region. And what we saw was quite dramatic and significant changes had occurred in the last two or three decades.

These various indicators suggest that there were changes afoot as early as the mid-1980s. And this is a period when there was not so much mining going on, but people were beginning to migrate into this region. And then as soon as we moved into the 1990s and up into the 2000s, when there was much more industrialization in terms of the kind of mining exploration and setting up of oil and gas extraction areas, as well as quite extensive road building activities, as well as many, many more people migrating to this region, and that clearly has had a major impact on the wetland ecosystems.

**PNAS:** Kelsie Long, an archaeologist at the Australian National University and another author on the article, explains the potential impact of land use changes on fish and plant communities in Lake Kutubu.

**Long:** They're already feeling a lot of the knock-on effects. And that's increases in the invasive species in the lake, which actually puts a lot of pressure onto the endemic fish. They're losing a lot of the plant communities around the edges of the lake. Potential changes in what's coming into the lake can affect how turbid the lake is, how mixed it is. And this is important at Lake Kutubu because it has a two layer system, where the bottom is very anoxic and the top is very oxygenated, which is where all the fish live. And every now and then they'll have these natural overturning events, which mix the two layers. And usually this happens seasonally in cold, wet weather. But they found that it happens more and more at times when it never happened previously. There's a possibility that these changes at the very base level of the lake could make these overturning events happen more often, cause more fish kill events. But even if that isn't

what happens, and instead we just have these changes in the base communities, then that could have knock-on effects for the food supply for the fish that live in the lake. And so eventually, you could get total ecosystem collapse or changes in the water quality that people are drinking or fishing from. But these are all very tricky areas to predict and to know what would happen. And then you bring climate change on to that as well, and it's a whole other story.

**PNAS:** While there are many examples of the negative effects humans have had on tropical islands, in other cases, researchers have uncovered a long history of sustainable management. Anthropologist Kristina Douglass of Pennsylvania State University explains how she and colleagues analyzed egg shells to learn more about a surprising relationship between Indigenous peoples on New Guinea and cassowaries. Cassowaries are large, flightless birds with dagger-like claws. Although they prefer to avoid people, cassowaries can be formidable. Despite the bird's aggressive reputation, the authors found evidence that humans may have been raising cassowary chicks.

**Douglass:** We basically looked at egg shell development over the course of incubation to see changes in egg shell structure that are linked to growth of the avian embryo. That allows us to then pinpoint about what developmental stage the embryo was at when the egg was broken open. Looking at an archeological assemblage, it allowed us to get an understanding of harvesting practices. And we found that they were timing the harvesting of eggs toward that late part of the development of the embryo. So by the time people were harvesting those eggs, the embryo inside was a fully formed cassowary chick. And so we suggest that one of the possibilities is that people were actually harvesting those eggs, not just to consume the egg, but actually to hatch and rear the chicks. So people must have had a really precise understanding of cassowary nesting behavior and known how to locate those nests and also known how to track how long the male had been sitting on the nest.

Large, flightless birds have disappeared in many parts of the world after humans have arrived on those places, especially large islands. The extinction of moa on New Zealand occurred within a few hundred years, whereas the extinction of elephant birds and other animals on Madagascar may have taken a longer period of time. On New Guinea, cassowaries don't disappear, and people have been in that part of the world for many more thousands of years than on Madagascar and on New Zealand. So it's a really different environmental context and a different cultural one. And people clearly coexisted with cassowaries on New Guinea for many thousands of years.

**PNAS:** Several articles in this special issue highlight how the exploitation of islands and other tropical ecosystems significantly intensified after the arrival of European colonialism. Rebecca Hamilton, a paleoecologist at the Max Planck Institute in Germany, and colleagues explored how modern efforts to conserve tropical ecosystems have often unintentionally perpetuated colonialist ideas and practices. Hamilton explains what it would mean to “decolonize” conservation.

**Hamilton:** So that actually really requires us to remove these ideas of these landscapes being long unpeopled and long unmanaged. And certainly, we need to remove the idea that fencing off these sites and removing indigenous and local peoples from these zones will lead to the best conservation outcomes. And what this really entails is the incorporation of indigenous and local voices in the construction of conservation policy. And that particularly relates to the

construction of conservation policy, often undertaken at global scales, where we have these big sweeping perspectives of how we're going to classify biodiversity hotspots, for instance, without taking into account site-specific parameters of the different hotspot zones that we're classifying.

**PNAS:** Michael-Shawn Fletcher is the director of research for the Indigenous Knowledge Institute at the University of Melbourne in Australia and another author on this article. Fletcher explains why the concept of “wilderness” is flawed.

**Fletcher:** The concept of wilderness, as defined in the Oxford English Dictionary and just the social understanding of the word, means the absence of people or a place characterized by wildlife. So the concept of wilderness is really born from experiencing something out of our norm. And it surged into use when colonial Europeans encountered new places, and what they saw didn't fit what their understanding was of human-impacted landscapes or human-created landscapes. So their base assumption, which carries along with it a whole lot of cultural baggage about what it is and what it isn't to be human and what the progression of human evolution leads to, i.e. the zenith of European-style civilization, it carries with it all sorts of notions about humanity.

The latest wave of the use of “wilderness” is born from the clear recognition that a type of human engagement with the world around us, with the environment, is really negative. There are a whole lot of negative effects of large-scale mining, large-scale clearfelling, large-scale deforestation. All of these kinds of things that are essentially born from the Industrial Revolution out of Europe are really bad for the environment. But the problem is, it loops all humans in this negative narrative. And it's based on essentially a separation between nature and culture that stems from the Enlightenment and the prioritization of reason and the scientific method over all other ways of knowing. And, in doing this, we can develop scientific justifications for the removal of people from landscapes based on these very negative experiences that a type of human activity has in landscapes. But that completely misses that many of the high-value biodiversity landscapes that we recognize today and that we're trying to conserve and preserve are actually the product of long-term human agency. So the perverse outcome of this for conservation, by blanketing all kinds of human activity in this quest to preserve and conserve the natural environment, means that we end up excluding the kind of management that these landscapes require and end up destroying them.

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