Stanford News (http://news.stanford.edu/)

OCTOBER 9, 2017

Stanford research finds that diversity of large animals plays an important role in carbon cycle

With abundant data on plants, large animals and their activity, and carbon soil levels in the Amazon, Stanford research suggests that large animal diversity influences carbon stocks and contributes to climate change mitigation.

BY TAYLOR KUBOTA

Trees in tropical forests are well known for removing carbon dioxide from the air and storing the potent greenhouse gas as carbon in their leafy branches and extensive roots. But a new analysis led by Stanford University researchers finds that large forest animals are also an important part of the carbon cycle.

Go to the web site to view the video.

The findings are based on more than a million records of animal sightings and activity collected by 340 indigenous technicians in the Amazon during more than three years of **environmental surveys (http://news.stanford.edu/news/2011/october/amazon-indigenous-technicians-111311.html)**, coordinated by ecologist Jose Fragoso and supported by biologist **Rodolfo Dirzo (https://profiles.stanford.edu/rodolfo-dirzo)**, who were working together at Stanford at the time. The team found that places where animals are most diverse correlate with places that have the most carbon sequestered in the soil.

“It’s not enough to worry about the trees in the world holding carbon. That’s really important but it’s not the whole story,” said Fragoso. “We also have to worry about maintaining the diversity and abundance of animals, especially mammals at this point, in order to ensure a well-functioning carbon cycle and the retention of carbon in soils.”

Although scientists have long understood that animals – through ingestion, digestion, breathing and decomposition – are part of the carbon cycle, the work, published Oct. 9 in **Nature Ecology and Evolution (https://www.nature.com/articles/s41559-017-0334-0)** is the first to suggest the importance of animal biodiversity rather than just animal numbers in the carbon cycle.

If we want to increase carbon sequestration, we have to preserve not only high numbers of animals but also many different species, the authors said.

Mining an unprecedented data source

The inspiration for this work came from a conversation during a Biology Department happy hour years ago. The scientists knew that an ecosystem with more species generally functions better, which they assumed should include the carbon cycle. Proving the relationship between animal diversity and carbon, however, was not so straightforward.

"It is a very difficult idea to test regarding vertebrates in a real-world system such as the Amazon," said Mar Sobral, lead author of the paper, who was a postdoctoral researcher in the **Dirzo Lab (https://dirzolab.stanford.edu/)** during this research. "The amount of data needed to test such an idea is massive and the type of data is a big challenge. The economic resources, time and logistics involved in our project are unprecedented."

Members of the soil sampling teams, made of up indigenous Wapishana people. *(Image credit: Jose Fragoso)*

In order to collect these data, people from the indigenous Makushi, Wapishana and Waiwai nations trekked through the Amazon, noting the number, diversity and potential carbon storage of trees – using size and rainfall estimates – and the presence and activities of vertebrate animals, including large mammals, birds, reptiles and amphibians. Over a three-year period, they saw 132,995 individual vertebrate animals and recorded signs of an additional 190,369, representing 218 species. There was evidence of 43,448 feeding events, and for each one technicians recorded what was eaten. These data sets were cross-referenced with carbon levels that came from 825 soil samples taken in the final six months of the fieldwork.

The researchers found that soil had the highest carbon concentrations where they saw the most vertebrate species. When they looked for a mechanism that could explain this relationship, it turned out that the areas with highest animal diversity had the highest frequency of feeding interactions, such as animals preying on other animals or eating fruit, which results in organic material on and in the ground. The researchers suggest that these meal remnants bump up diversity and abundance of soil microbes, which convert the remains into stored carbon.

"Traditionally, it is plant biologists who have been asking questions about carbon stocks, and plants are the acceptable organisms to work with," said Kirsten Silvius, a senior research associate at Virginia Tech and co-author of this paper. "I hope this research will encourage a more holistic view of communities and a better understanding of large vertebrates as full participants in ecosystem function rather than as somewhat removed beneficiaries of that ecosystem function or victims of the loss of function."

Credit where credit is due

Fragoso, who has recently left Stanford for the California Academy of Sciences, Silvius and Sobral plan to return to the Amazon to further test their hypothesis, along with Dirzo and others. They want to know more about the soil microbes and are curious whether certain key species in the environment are critical for soil carbon rather than animal biodiversity.

The researchers will also test a new technique they hope will allow them to measure diversity through DNA collected from mosquitos and flies.

Fragoso said the indigenous people they worked with were critical for collecting such high quality data. In any given month, there were at least 70 technicians collecting data. Relying on their knowledge and local skills and bolstered by training in techniques to measure animal abundance, they were able to identify species by eye and other signs of their presence, including tracks, burrows and scat.

“Without the indigenous people, it would have been completely impossible to do this,” Fragoso said. “My graduate students and postdocs would not have had the skills to walk into and detect animals in these remote, often mountainous or swampy tropical rainforest sites.”

He also emphasized the importance of compensating indigenous people fairly for their work and for maintaining the forest and the animals within it.

Additional co-authors on this work are Han Overman, State University of New York College of Environmental Science and Forestry; Luiz F. B. Oliveira, Museu Nacional/UFRJ Rio de Janeiro, Brazil; and Ted K. Raab, Carnegie Institution for Science. Dirzo is also a is a senior fellow at the **Stanford Woods Institute for the Environment (https://woods.stanford.edu/)**.

This research was funded by the National Science Foundation, the Gordon and Betty Moore Foundation and Stanford University.

Media Contacts

Taylor Kubota, Stanford News Service: (650) 724-7707, **tkubota@stanford.edu (mailto:tkubota@stanford.edu)**

(mailto:?subject=An%20interesting%20article%20from%20Stanford%20News&body=I%20want%20to%20share%20t