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Seeing Through Sonar: Detecting the Amazonian Manatee

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Daniel Gonzalez-Socoloske, *as told to* **Isabella Koh**

All photos courtesy of Daniel Gonzalez-Socoloske

Have you ever wondered how to study something you can't see?

If I took you to the habitat of the Amazonian manatees for an entire year, you'd be lucky to spot one at all. They live in the almost entirely dark, murky water of rivers, lakes and flooded forests, migrating in and out of them between high and low water seasons. Despite the characteristic white patches on their belly, their black skin blends them into their habitat completely. We know the manatees exist, but beyond that, almost everything else is a big mystery.

And that's where my work comes in.

AS AN ECOLOGIST, I'M INTERESTED in the interaction of species and conservation efforts for them. I'm specifically interested in how species adapt to the various environments they live in and how those adaptations change when there are human-induced environmental changes. A lot of people ask me: why manatees? The truth is, I'm interested in a lot of animals. I ended up serendipitously working with manatees during my master's program when a research project about them opened up in Honduras. During that project, I quickly learned how hard it is to detect wild manatees outside of the clearwater habitats. It was due to that project that I tested side-scan sonar as an alternative way of detecting manatees for the first time, focusing on the West Indian manatee, which is a species living in coastal areas from Florida all the way down to Brazil. Thus began an almost multi-decade journey of experimentation and discovery using sonar to study manatees.

I felt there was more to discover, however, and in 2020, I was privileged to be awarded a Fulbright U.S. Scholar Award for my continued research in manatee detection. Later, in 2022, I became a National Geographic Explorer and was awarded a grant to support an official research trip. Because of the highly competitive nature of both awards, I was surprised and honored to have been recognized. Both were an important part of my sabbatical period last semester, when I spent five months in Brazil to continue studying alternative detection techniques on Amazonian manatees.

LEFT: *Sonar image from the multibeam sonar tested in both Peru and Brazil*
ABOVE: *Three Amazonian manatees wait until their enclosure is cleaned and refilled at the Amazon Rescue Center (CREA) in Iquitos, Peru, where experiments were conducted.*

My current project utilizes a new device called multibeam sonar for detecting manatees in their natural environment. This new research technique directly expands on the work I've done with side-scan sonar and allows us to capture videos, rather than still images, which changes the game entirely. In addition to distinctly identifying the manatees, multibeam sonar operates at a frequency well above their hearing range and doesn't seem to have any behavioral effect on the organisms themselves. There are exciting ways we could use this technology in the future, including population counts, studying behavior and viewing interactions between species.

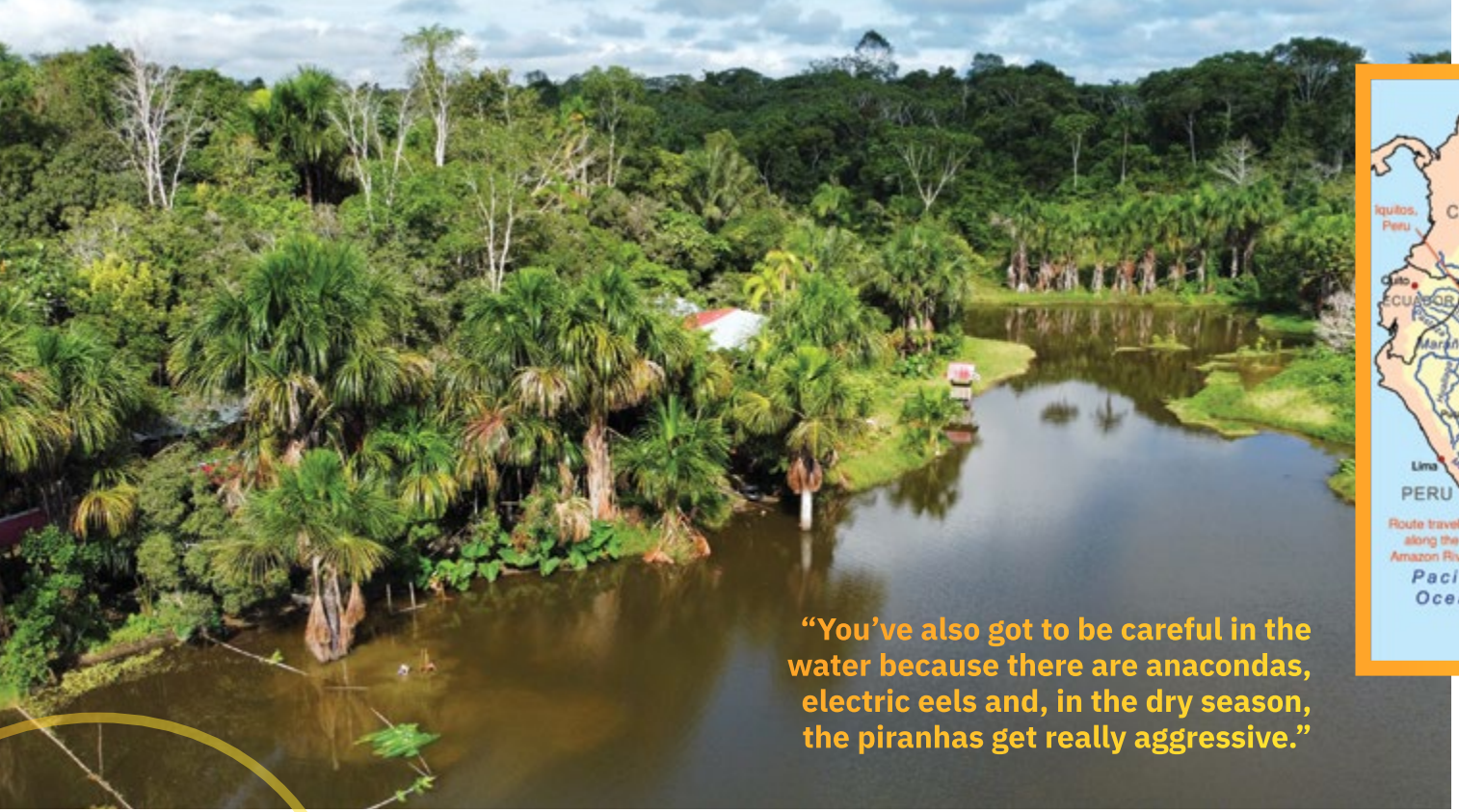

IMAGE CREDIT: https://commons.wikimedia.org/wiki/File:Amazonriverbasin_basemap.png | *locations added*

BEFORE THE PROJECT BEGAN, A LOT OF preliminary outreach, meetings and logistical work happened to get people on board, simply because so much money and time were invested. Multiple collaborators, both old and new, supported me on this project. My main colleague in Brazil, Miriam Marmontel, PhD, is an expert in the aquatic mammals of the Amazon. She's been working with dolphins, otters and manatees for more than 30 years. I've collaborated with her on this particular project since 2017, when our paths crossed due to shared interests in both manatee conservation and sonar detection.

Another member of the team, Jason Gulley, PhD, is a professional freelance photographer, geologist at South Florida University and fellow National Geographic Explorer. When he found out about our project, he contacted us with a personal interest in documenting the manatees, asking if he could be a part of our team. He's the one who took the photographs that you can see in our National Geographic article. It's been a very fruitful partnership.

Most recently, I brought Gordon Hastie, PhD, into the fold. He is a professor at the University of St. Andrews in Scotland and he uses multibeam sonar in his work with gray seals. He had cited some of my papers on side-scan sonar in his research, so I took a chance and emailed him, asking him if he'd be interested in collaborating and lending us one of his devices. For reference, consumer level side-scan sonar devices cost from $1,500 to $2,000, while the multibeam sonar costs around $50,000. Although the equipment is much more expensive, it is also much more technical and allows for movement detection, which is a key element in our project. I met with Gordon in Scotland in May of 2022, and after talking over the plan, he agreed to come on board and lend us the equipment. These partnerships were an important step forward in what is now an 18-year-long project using sonar to detect manatees.

One thing I didn't appreciate initially, but walked away feeling incredibly moved by, was the importance of the incorporation of local community members, specifically local hunters, into our project. The institution I collaborated with has a really good rapport with the local people, which helped lay some of the groundwork, but the relationships I was able to forge with the local hunters really blossomed through our time spent together. That was a highlight of the trip for me.

ABOVE: *Small lake outside of Iquitos, Peru, where several Amazonian manatees are kept; team member Antonio (bottom left) installs the sonar while photographer Jason captures the moment.*
RIGHT: *Daniel Gonzalez-Socoloske and Gordon Hastie at the Scottish Oceans Institute*

WHEN I ARRIVED IN BRAZIL IN MAY, my main project was based in Tefé, in what's considered the central Amazon. To get there, I took a boat from Manaus down the Solimões River (Amazon River) to my destination. My study site was at Lake Amanã, where we worked at one of the rivers connected to it that is a known passageway for migrating manatees. For a biologist, the experience was a sensory overload. It wasn't my first time in an environment like that, but it was the longest prolonged time I'd ever spent in the jungle in such a remote area. There were macaws flying over and I could routinely see wildlife and find jaguar tracks all around us. We ate local food, fished for red-bellied piranhas and had to be wary of the various caiman species. It was a remarkable, almost untouched habitat, which was really cool to see.

No day was the same. Most of my time was split between doing data collection in the field and then prepping for it when I was off-site. Sometimes when I was in the field there were preparatory things that needed to be done, like testing the equipment, making the floating base to house the equipment while we weren't there, refurbishing, painting and working with local individuals. There was no pattern and every day was chock-full. I found myself always running up against deadlines to make sure everything worked correctly.

We ran into some unique challenges right away. One of those involved hauling the multibeam sonar device and the large heavy 12V deep cycle batteries through thousands of kilometers of Amazon, from Manaus to Tefé and from Tefé to Iquitos, Peru. That's a massive stretch of river, which crosses a couple of international borders. You've got to go from Brazil to Colombia to Peru. It was quite the journey. The logistics of working in these remote areas presents a challenge because if any piece of software or something breaks, it's difficult to get a replacement in a timely manner. When you're working out there and something goes wrong, it can lead to weeks or months of delay.

"The Amazon, where I was, fluctuates more than ten meters in water level based on the time of year, and it drastically changes the landscape."

You've also got to be careful in the water because there are anacondas, electric eels and, in the dry season, the piranhas get really aggressive. One of my assistants had his ear bitten pretty badly while he was in the water, but

BELOW: *(L–R) Jeremias, Antonio, Oda, Daniel and Nego on a small floating base used to deploy the multibeam sonar in the Rio Castanho, Amanã Sustainable Development Reserve*
RIGHT, TOP: *Red-bellied piranhas to be cooked*
RIGHT, BOTTOM: *Oda and his Amazonian parrot*

thankfully he didn't lose anything. The transition of the seasons was fascinating to see. I experienced the extent of the high water season and the extreme dry water season. The Amazon, where I was, fluctuates more than ten meters in water level based on the time of year, and it drastically changes the landscape. You have inundated forests and floodplains during the high water season and, in the low water season, access to some areas becomes restricted and you can be isolated for weeks.

One of the hardest parts about this trip was the time spent away from my family. Although I've been on long expeditions before, this was the first time I spent five months away from my wife and kids. That, especially toward the end, was really challenging because I wasn't there to watch them change and grow. It was a huge sacrifice, and I missed them deeply. If I had another way of doing it, where I could have had my family around more, I probably would have. Thankfully, they got to visit me in Brazil after my five months of work and I was able to share the wonders of the Amazon with them.

OVER THE SPAN OF MY VISIT, I WAS able to cover quite a bit of ground, which was really fascinating. For a month, I took time away from the manatees to help out with river dolphin surveys along the Tapajós River. I assisted a big group funded by the World Wildlife Fund in doing standardized dolphin counts. Fourteen of us lived on a large boat in the lower portion of the river. Just four of us in a much smaller boat surveyed the wilder, more remote, upper portion of the river. Each day we had rotating stations of observer and data collector, both in the bow and the stern of the boat. We'd work from sunrise to sunset, then sleep on board. It was pretty exhausting but overall such a cool thing to do, because I've always dreamed of studying dolphins.

Although I wasn't able to interact with many manatees in the wild during my research, even though

ABOVE: *Back in Tefé after several weeks in the field collecting data, Daniel's data processing sessions lasted many hours into the night to ensure having multiple data copies.*
LEFT: *A local transport boat passes by just at sunset in the Amanã Sustainable Development Reserve, state of Amazonas, Brazil.*

RIGHT, TOP: *Daniel with an Amazonian manatee calf being rehabilitated in the Amazon Rescue Center (CREA) in Iquitos, Peru*
RIGHT, BOTTOM: *Daniel recovering a manatee skull with the aid of local hunters*
FAR RIGHT: *Daniel and his research team were invited to assist CREA staff in releasing three rehabilitated manatees at the Amazon Rescue Center.*

"We can't protect something when we cannot ultimately say that their numbers are decreasing, stable or increasing."

we know they were there, I did have the opportunity to finally see one in the wild, with the help of local hunters we collaborated with. Based on the hunters' experience and know-how, they can predict where the animals are going to pop up and have a pretty good track record of sighting them. I also was able to interact with the manatees at the rescue center in Iquitos, and that was wonderful. While visiting, I had the opportunity to bottle-feed the young calves and interact with some of the larger adults. I also participated in the release of three animals back into the wild, which was a really unique experience with our partners in Peru.

By the end of my trip, I was able to capture the first sonar recordings of Amazonian manatees swimming in their natural environment. We first did it in Iquitos, in captivity, to verify proof of concept, and then we applied it during the migration into the lake systems at the start of the low water season. Now that we have that information, the next step, which is where we're at right now, is three-pronged. First, we have to analyze the many hours of data we collected. What can we say about that season's migration? Can we speak to how many manatees went through, detected by the sonar? Second, rather than manually interpreting the imagery, which can be subjective, we are going to create an algorithm that will auto-detect the various manatee signatures. Because some of this work has already been done by Gordon with seals, I'll be visiting Scotland to help reprogram the existing code so it recognizes manatees specifically. Third, to scale things up, we'll place multiples of the sonar setup in key locations, where we know animals are coming through at a particular time in their life cycle. We can then use their migration patterns, along with this software algorithm, to count them.

ONE OF THE PRINCIPAL ASPECTS OF understanding species ecology is to know where the animals are and how many there are. We can't protect something when we cannot ultimately say that their numbers are decreasing, stable or increasing. This project is another step forward in standardizing how we count these mammals. Sonar isn't going to register all of them, but we can use formulas to correct for errors. Then, we can come up with detection probabilities, as well as abundance and trends. We are aiding in the conservation of the species by building a clearer picture of the number of Amazonian manatees and how that abundance changes from year to year. This is a tool to address populational changes in real time. We're really excited about the journey and the potential results of this current study. ■

Isabella Koh, University Communication student writer, interviewed Daniel Gonzalez-Socoloske, professor of biology, in preparation for writing this article.