CAREER PROFILES

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Kelly Benoit-Bird

Oregon State University oceanographer Kelly Benoit-Bird uses acoustics to "observe" undersea marine communities

THE SOUNDS OF SCIENCE Kelly Benoit-Bird is a marine scientist at Oregon State University who studies how animals in the vast oceans of the world interact with each other – and she does it most of the time without even looking at them. What Kelly does is use acoustics to bounce sound waves off these marine creatures to determine their size, their movements in the water, and how many of them there might be.

Already in her young career, her studies have taken her around the world. Kelly has studied the voracious Humboldt squid off Mexico, looked at the feeding habits of sea birds and fur seals in the frigid northern waters of the Bering Sea, and analyzed marine communities in a deep undersea fjord off the spectacular coast of New Zealand.

Her experiences are extraordinary considering Kelly is the first member of her family to have attended college. She already has received prestigious awards from the MacArthur Foundation, the White House, the Office of Naval Research and the Acoustical Society of America for her research.

"If you ask my parents, they'll tell you that I knew in elementary school that I would somehow end up doing something that related to oceans," she said with a laugh. "Of course, I had no idea then what a marine scientist was, or whether you could make a career out of it. And the idea of using acoustics to study animals would never have entered my mind."

As it turns out, Kelly Benoit-Bird not only uses sound waves as a tool to study marine creatures, she is very good at it. Two years ago, she developed a technique that would allow scientists aboard a ship to locate squid on sonar, which is a lot more difficult than it sounds. Squid, you see, don't have bones or swim bladders, so there is little for a signal to "bounce off" and create an acoustical image. So Kelly developed a an analysis approach using multiple frequencies or pitches of sound– and it worked like a charm.

Why is that important? For one reason, many whale species love to eat squid, but it had been difficult, if not impossible, to estimate how many squid are in a certain location. And many scientists thought whales couldn't use "echolocation" to hunt for squid for the same reason acoustics had previously failed. Now scientists are looking at how the whales themselves use multiple frequencies to locate prey.

Kelly also has made important discoveries about how spinner dolphins off Hawaii hunt for food, using acoustics to track their movements through the water that are so sophisticated, it would put a synchronized swim team to shame. The dolphins in these groups themselves use sounds higher in frequency than humans can hear to communicate with each other to maintain their elaborate formations and synchronize their feeding behavior.

"Technology is really advancing rapidly," the Oregon State University scientist said, "and it can open up a lot of doors to scientists. Luckily, I'm not intimidated by technology and trying new things. My dad was a mechanic and when I was growing up, I was always in his garage helping him, so I learned how to tinker."

That mechanical ability also encouraged her to use new computer software to track the ballet-like moves of the dolphins and share the information with other scientists and students on her web site. Kelly also has an artistic side, however. She draws her own illustrations of marine creatures for the journal articles and book chapters she writes.

"Everyone should choose a career that they are passionate about," Kelly said. "Being a scientist can be a lot of hard work, but if it's something you love doing, it's worth every minute. For me – it's about the animals. I love learning why they do the things they do and how they survive in a world hidden from our view."

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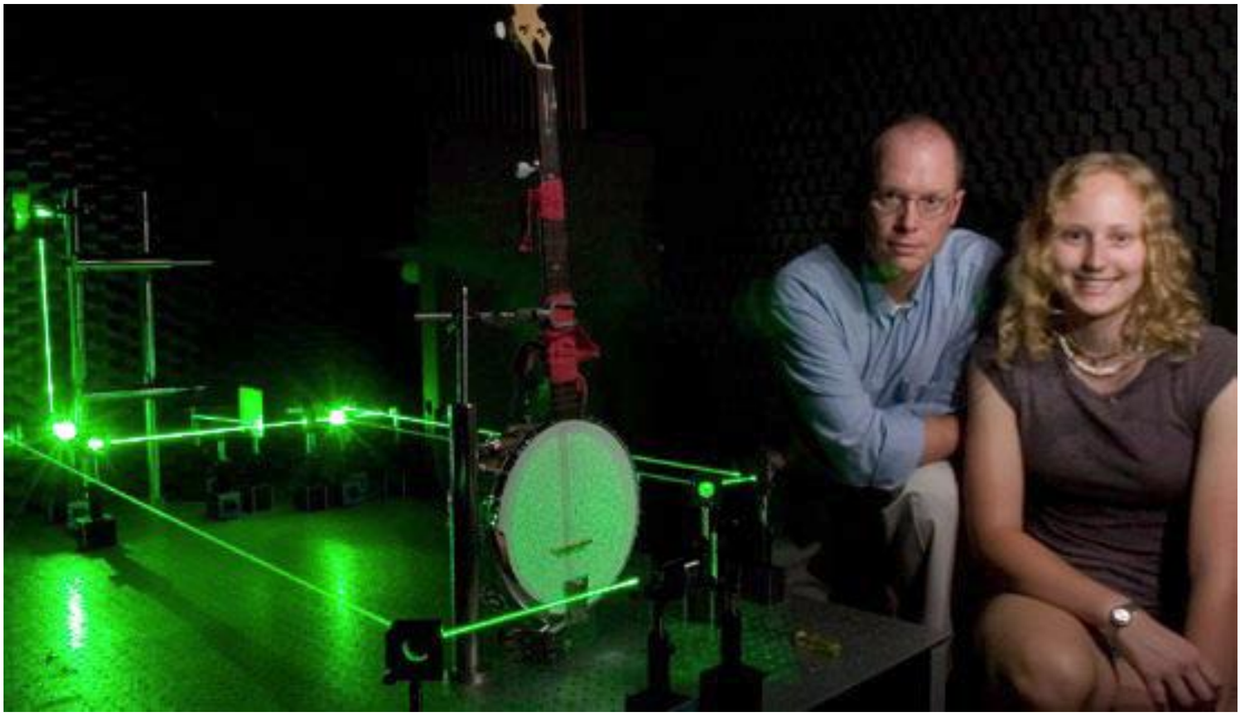

Thomas Moore

Thomas Moore was never a very good student. Not at first. As a child, his father, who was a physicist, taught him to be inquisitive—to think through things as a scientist would and to always ask questions. But while Thom liked this approach, it did not fit into the educational philosophy of the school system. Therefore, he was not very good at his schoolwork and was always just an average student. Now that he is a teacher, he thinks that inquisitiveness is often driven out of students through "too much homework and too little thinking."

Thom eventually received his Bachelors in Physics from Stetson University, and after graduation he joined the Army. He served in the Army for 21 years, during which time he did many of the usual things an Army officer would do, but he also earned a Master's Degree in Nuclear Physics, a Ph.D. in Optics, worked at Lawrence Livermore National Laboratory, and taught physics at West Point. Thom really liked teaching at West Point, and while he was there he began thinking about how science is taught and how students learn. After he retired from the Army he took a job teaching undergraduate physics at Rollins College, where he concentrated on involving his students in original scientific research, because he thinks that a laboratory is a better place for learning than a classroom.

While at Rollins, Thom realized he could not continue his research in the field of nonlinear optics if he wanted to deeply involve his undergraduate students. So he began studying the physics of musical instruments, because he knew that his students would be interested in asking questions about music. Although he eventually became an acoustician, Thom did not stop using optics. Thanks to his background in optics, he has developed new techniques for looking at the vibrations of drum heads, pianos, trumpets, steel drums and more. Most of his experimental equipment is optical, like his electronic speckle-pattern interferometer, and he has developed new and inexpensive techniques to view the vibrations of many musical instruments. These vibrations, which can be smaller than the diameter of a human hair, are what make the music we hear. Thom conducts his research in a laboratory with a special chamber that is isolated from noise, and uses the light from a high power laser to image and measure these small vibrations.

Thom has found his work as an acoustician rewarding, and counts his published articles with undergraduate coauthors as his most important successes. He got even greater satisfaction by publishing an article with both an undergraduate student and a high school teacher as co-authors.

As an active member of both the Optical Society of America and the Acoustical Society of America, Thom has enjoyed getting to meet the people who are making history as scientists. “Anyone, even a student, can go to an OSA or ASA conference and be accepted,” he noted. He remembers speaking with many renowned optical scientists when he was still a student, and now he tries to always be accessible to young acousticians in the same way.

One important reason Thom is a good teacher is that he himself was not a great student, so he understands his students’ frustrations. Thom spent most of his time as a student trying to memorize answers instead of asking questions. But once he became a teacher, and had to anticipate his students’ questions, Thom found that asking questions about the material was the best way for him to learn it. Now he asks simple questions, like “why do I hear bass but not treble from car stereos as they drive by?” In order to learn, you have to stop and listen, and ask a question. Often it is the simple questions have the most interesting and important answers. Even questions as simple as “why is the sky blue?” need to be asked. Thomas Moore knows the answer. Do you?

Answers:

Treble (higher pitched tones) does not travel through solids, like the car, as well as bass (lower pitched tones). So the bass gets to you but not the treble – unless the windows are down.

The sky is blue because gas particles in the air scatter the blue light from the sun but not much of the other colors. The scattered blue light bounces around the atmosphere and comes to you from all directions making the sky look blue. See www.optics4kids.org/tutorials/whyskyblu

Whitlow Au

Whitlow Au is a Researcher at the Hawaii Institute of Marine Biology, an institute of the University of Hawaii. His research focuses on marine bioacoustics, which covers just about anything in the oceans that you can use acoustics to study.

Whit puts acoustic recorders on the ocean bottom, along the coastline, to measure animal sounds where they occur. These recorders are run by small computers, which run on a “duty cycle” that turns them on and off to save power and collect data for months at a time. As most marine mammals tend to stay close to the coastline, this method works well for capturing the sounds of dolphins, smaller whales, fish, snapping shrimps and other organisms in coral reefs.

How did Whit end up in such a cool job? He studied electrical engineering while an undergraduate at the University of Hawaii, a field that allows for many different careers. He knew he wanted to live in Hawaii and do research, and found that marine bioacoustics would allow him to do just that. It has also allowed him to travel to research and conference locations around the world, including New Zealand, Iceland, the Netherlands, Denmark, Moscow, Rome and Beijing!

In his over 35 years in this field, Whit has discovered a lot about dolphin sounds, and considers his work a continual game, trying to understand dolphin SONAR. He says his most memorable discovery was finding that dolphins produce very high intensity, high frequency (loud, high pitched) sounds in the wild. Because dolphins were previously monitored in tanks, only lower frequencies and amplitudes had been recorded. But Whit's recorders out in the bay were finding unbelievable results that many other scientists had a hard time accepting. In fact, his first paper on dolphin SONAR was rejected.

Reviewers and other scientists thought Whit had measured incorrectly, as his numbers were so surprising. But Whit had stumbled upon a new concept: dolphins adjust their sound's volume and frequency to suit their environment. In fact, the difference in the tank versus the open sea was about 40 decibels, or 100 times louder! So Whit decided to try again, and wrote a paper proving his methodology, making sure to include lots of examples and lab calibration data. He even borrowed a hydrophone from another researcher to show that his results were not due to a problem with his own equipment. The paper was accepted in 1974.

By the time Whit published his book, The SONAR of Dolphins, in 1993, it was widely accepted by scientists. His other professional highlights include winning his first silver medal in bioacoustics, and being elected President of the Acoustical Society of America.

If you want to be a scientist, Whit says, you must like to study! He has had a lot of fun working in a field that encourages you to learn as much as you can. And if you have a high degree of curiosity, you'll have fun as a scientist, and you can take whatever the world throws at you.

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Cindy Moss

Cindy Moss works in a place called the "Bat lab." In the Batlab, her research laboratory at the University of Maryland, Cindy and her graduate and undergraduate assistants are studying the way free-flying animals use echolocation to locate objects in the environment. Sometimes, this means they hang worms from strings for bats to locate and eat as they fly around the room. On other days, when working with a colleague studying hearing in insects, they might put a praying mantis and a bat in the Batlab together to observe their methods of detecting each other!

Observing bats and animals is made easier by the methods Cindy and her team have developed. They placed high-speed cameras and microphones on the walls and floor of the lab, which lets them track the bats in 3D. From the images and sounds recorded in the Batlab, the scientists create animations that they slow down to get insight into the bats' behavior (bats fly at about 3 meters per second). They were able to see that bats aim their "sonar" like a flashlight, beaming it around the room to find their prey.

How did Cindy end up in the Batlab? Her interest in science started when she was very young. She used to explore the woods near her house, and bring home frogs, tadpoles and turtles to observe. As she got older, she was interested in languages and art, too. As an undergraduate at Hampshire College and the University of Massachusetts, she started studying psychology and zoology, and the mix of the two. Her Ph.D. work at Brown University and post-doctorate work in Germany got her more into neurobiology in general and bats in particular. Bat echolocation research has taken her into the study of acoustics.

Her advice to aspiring young students is to imagine that you are a scientist already. Ask questions, then design, plan and carry out projects that will help you find the answers. You may discover interests you didn't even know you had.

You can find Batlab movies and videos at www.bsos.umd.edu/psyc/batlab/movies.html.