Arctic engineers develop innovative radar method to detect polar bears

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Riding through Canadian polar bear country in a Tundra Buggy—essentially a monster truck that keeps riders safely distanced from wildlife—a BYU engineering capstone team scoured the landscape

with sharp eyes. When they finally spotted their first polar bear of the day, they ecstatically sent its GPS coordinates to the helicopter above. (The polar bear, enjoying a nap, remained unmoved by the sight of them.)

Locating a bear in the vast terrain had been tough, but the students' real work would begin back at BYU, where they'd determine whether they could see that same polar bear again, this time in the radar images taken from the helicopter. Their goal was to discover if radar can feasibly track the bears aboveground. If so, the team's work would mark a significant step forward in scientists' ability to track mother polar bears during winter, when they den and give birth to their cubs beneath dense snowpack. Locating and protecting bear dens is important for conservation efforts.

"Polar bears have become the symbol for climate change, and looking across the board, biologists have put together a chilling tale of the future of these bears," said BYU plant and wildlife sciences professor Tom Smith. Smith serves on the advisory board of the capstone team's sponsor, Polar Bears International, a group based in Churchill, Canada, that is committed to ensuring polar bears' survival in the Arctic. "We want to do something, anything, to try to stop that decline. The students bring the skills that we need to try out this new technology, synthetic aperture radar (SAR)."

SAR offers an alternative to infrared, the current method used for identifying dens, which is often ineffective because the bears are so well insulated that their heat can't penetrate the snowpack. The theory behind SAR is that, with long wavelengths, radar will penetrate the snow and send back a "signature" of a polar bear—data that can be processed mathematically to reveal a picture of what's beneath the surface.

The students hoped the aboveground radar images they were gathering in

Churchill could later be used as a guide to see through the snow and identify polar bears in images taken. They worked under the guidance of Smith, electrical and computer engineering professor David Long and mechanical engineering professor Terri Bateman, their capstone coach.

"It was amazing to see these large polar bears just walking around in their habitat, waiting for the sea ice to form so they can hunt," said engineering student Lucas Stock. "It's an experience I'll probably never have again. I think a lot of my friends are annoyed at this point, how much I bring up polar bears."

Before getting in the Tundra Buggies, the team had designed helicopter flight paths over areas with high-density bear populations. For each of the 21 bears they saw, the BYU students communicated the coordinates to students from Simon Fraser University in the helicopter, who then flew over the bear several times to gather radar images and camera photos.

Once back on campus, Stock worked with fellow students McKay Formica, Brent George and Nicholas Hilke to process and analyze over a thousand images, identifying bears in photos and trying to match them to bright spots in the corresponding grayscale radar images. "We spend a lot of time trying to decide, is this a rock? Is this a bear?" Stock said.

The experiment was a lesson in patience and perseverance. "We weren't sure if the radar would even show a polar bear on the images," Bateman said. "The students had a tough time figuring out how to analyze the images, and they were often frustrated, but they didn't give up. They learned how to find polar bear signatures, and it was impressive."

Ultimately, the students were able to identify six polar bears, which Stock considered a success. "With our results, we're optimistic that you can find a bear signature, but it needs more testing, which is exciting for

future projects."

The students are putting their new knowledge to use by sharing their findings with Polar Bears International and writing a paper for potential publication in an engineering or wildlife journal. They will also approach their future careers with a broader perspective.

"Before, my image of engineering work was just sitting in a lab, working on a computer," Stock said. "But in this project we worked with the life sciences and learned that engineering's really interdisciplinary. It was inspiring to see all the different people coming together to try to improve the world, and it made me want to look around for different ways to use my engineering skills."

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