**ECOLOGY**

**War halts animal tracking project**

As space station antenna goes silent, ICARUS seeks new ways to collect animal GPS data

By Elizabeth Pennisi

The past 2 weeks have been very good—and very bad—for Martin Wikelski and Walter Jetz. In a key proof of principle of their space-based wildlife tracking project, they published a paper tracing the travels of 15 species, including the meanderings of an endangered saiga antelope across Central Asia and the marathon flights of cuckoos from Japan to Papua New Guinea. But the very same week, their data stream from an antenna on the International Space Station (ISS) dried up, likely because data were relayed through a Russian ground station.

The war in Ukraine appears to have grounded their project, the International Cooperation for Animal Research Using Space (ICARUS), just as it was getting off the ground. “This will ruin all the efforts of a great many scientists,” says ecologist Nyambayar Batbayar, director of the Wildlife Science and Conservation Center of Mongolia, whose team has used ICARUS to track snipes and cuckoos. New studies of pinyon jays and robins are on hold because researchers don’t want to burden animals with tags whose data may not be retrievable.

Wikelski, an ornithologist at the University of Konstanz and the Max Planck Institute of Animal Behavior, and Jetz, a Yale University ecologist, say they are now fast-tracking planned efforts to put up other space-based receivers. But scientists who were already skeptical about ICARUS’s goals say its future is in doubt. “I’ve seen a lot of ambitious attempts, but ambition doesn’t always lead to success,” says ecologist Greg Breed of the University of Alaska, Fairbanks.

To understand animal behavior and how humans are influencing it, researchers have increasingly put GPS tags on animals and tracked them with hand-held or ground-based receivers. But tagged animals often move out of range, and the tags were expensive, so few individuals could be tracked. ICARUS, founded in 2002, aimed to lift tracking into space and develop cheaper tags, affordable by researchers worldwide. By expanding the number—and sizes—of tagged animals, and tracing their complete journeys, Wikelski and his colleagues hoped to see how both the environment and human influences shape their survival.

It was such a grand vision that Breed and others were skeptical it would come to pass. NASA initially spurned Wikelski’s attempts to collaborate, so he partnered with the German and Russian space agencies; they and the Max Planck Society have funded the project with €30 million to date. In 2019, a German-built antenna was unfurled on the Russian module of the ISS. By the end of last year, scientists had deployed tags on animals at 91 sites around the world, 21 in Russia.

Each time the space station passes over a tagged individual, its tag turns on and uploads stored data. Those data are transmitted to a ground station in Russia and automatically entered into Movebank, a public repository of animal movement information.

The tags have provided new and sometimes surprising insights, Jetz, Wikelski, and colleagues reported on 8 March in *Trends in Ecology & Evolution* (TREE). The technology traced animals’ entire journeys, not just the end points, yielding clues about why some birds are declining.

Take the mountain plover, a short-grass prairie native about the size of a bluejay, which has declined by 80% since the 1960s. ICARUS data on 17 birds tagged last year showed that when the plovers left their breeding grounds in Colorado, “they all went to different places,” mostly in eastern Colorado, Kansas, and Oklahoma, says co-author Roland Kays, an ecologist at the North Carolina Museum of Natural Sciences. Then they moved on to diverse wintering grounds farther south and into Mexico (see map, left). The finding adds to evidence that migrants don’t always head back and forth between two fixed points, but instead follow food and avoid floods, fires, and other disturbances. Data like these are “changing
the whole picture of [the] animal migration phenomenon as we know it,” Batbayar says.

The tags revealed some plovers are dying at the midpoint stopovers, says the project’s director, Michael Wunder, a quantitative ecologist at the University of Colorado, Denver. “Once you get [this] ‘where’ you can try to figure out what’s contributing to the mortality” says Georgetown University ecologist Peter Marra.

Ecologists are also enthusiastic about the project’s GPS tags, developed with a company, which at 4 grams and $300 apiece are far lighter and cheaper than most. ICARUS “is making technology available to researchers in countries where we don’t have the means to buy other types of tags” says behavioral ecologist Adriana Maldonado-Chaparro of Del Rosario University in Bogotá, Colombia.

In the TREE paper, Jetz and colleagues propose expanding ICARUS to 100,000 animals that could act as Earth’s “sentinels” in the same way that smartphone data on the movements and speeds of individual cars have revolutionized traffic prediction. Tracking data on seabirds, for example, have shown they alter their courses in anticipation of brewing typhoons.

But shortly after the war in Ukraine began last month, all data downloads from the space station stopped. No one knows exactly why, although Wikelski presumes it’s because the German and Russian space agencies no longer collaborate.

Still, he, Kays, and Jetz remain upbeat. They say the ISS antenna was always intended as a temporary measure and they had already planned to expand the number of space-based receivers by flying them on microsatellites called CubeSats (Science, 14 July 2017, p. 118) or by piggybacking them on other satellites. Their efforts have yielded tentative promises from space agencies and satellite companies to get receivers back in space by the end of the year, and more by 2024. And in 2027, a joint NASA and German space agency mission to measure gravity variations, the Gravity Recovery and Climate Experiment, may carry ICARUS receivers.

For the near term, however, Breed and others think ecologists might do better to pin their hopes on more proven technologies. He and Sara Maxwell, a marine sustainability ecologist at the University of Washington, Bothell, suggest the 20,000 animals around the world now wearing GPS tags retrieved locally or, rarely, with private satellites, can already serve as environmental sentinels. Movebank is developing software to pool those data in the future, Kays says.

Wikelski thinks ICARUS has proved itself. He’s not giving up on getting the big picture of animal movement from space—and vows his project will take flight again. □

NEUROSCIENCE

Brain implant enables man in locked-in state to communicate

Despite complete paralysis from amyotrophic lateral sclerosis, person used neural signals to spell out thoughts

By Kelly Servick

In its final stages, the neurological disease amyotrophic lateral sclerosis (ALS) can bring extreme isolation. People lose control of their muscles, and communication may become impossible. But with the help of an implanted device that reads his brain signals, a man in this “complete” locked-in state could select letters and form sentences, researchers report this week.

“People have really doubted whether this was even feasible,” says Mariska Vansteensel, a brain-computer interface researcher at the University of Medical Center Utrecht who was not involved in the study, published in Nature Communications. If the new spelling system proves reliable for all people who are completely locked in—and if it can be made more efficient and affordable—it might allow thousands of people to reconnect to their families and care teams, says Reinhold Scherer, a neural engineer at the University of Essex.

ALS destroys the nerves that control movement, and most patients die within 5 years of diagnosis. When a person with ALS can no longer speak, they can use an eye-tracking camera to select letters on a screen. Later in the disease’s progression, they can answer yes-or-no questions with subtle eye movements. But if a person chooses to prolong their life with a ventilator, they may spend months or years able to hear but not communicate.

In 2016, Vansteensel’s team reported that a woman with ALS could spell out sentences with a brain implant that detected attempts to move her hand. But this person still had minimal control of some eye and mouth muscles. It wasn’t clear whether a brain that has lost all control over the body can signal intended movements consistently enough to allow meaningful communication.

The participant in the new study, a man with ALS who is now 36, started to work with a research team at the University of Tübingen in 2018, when he could still move his eyes. He told the team he wanted an invasive implant to try to maintain communication with his family, including his young son. His wife and sister provided consent for the surgery.

Researchers inserted two square electrode arrays, 3.2 millimeters wide, into a part of the brain that controls movement. When they asked the man to try to move his hands, feet, head, and eyes, the neural signals weren’t consistent enough to answer yes-or-no questions, says Ujwal Chaudhary, a biomedical engineer and neurotechnologist at the German nonprofit ALS Voice.

After nearly 3 months of unsuccessful efforts, the team tried neurofeedback, in which a person attempts to modify their brain signals while getting a real-time measure of whether they are succeeding. An audible tone got higher in pitch as the electrical firing of neurons near the implant sped up, lower as it slowed. Researchers asked the participant to change that pitch using any strategy. On the first day, he could move the tone, and by day 12, he could match it to a target pitch. “It was like music to the ear,” Chaudhary recalls. The researchers tuned the system by searching for the most responsive neurons and determining how each changed with the participant’s efforts.

By holding the tone high or low, the man could then indicate “yes” and “no” to groups of letters, and then individual letters. After about 3 weeks with the system, he produced an intelligible sentence: a request for caregivers to reposition him. In the year that followed, he made dozens of sentences at a painstaking rate of about one character per minute: “Goulash soup and sweet pea soup.” “I would like to listen to the album by Tool loud.” “I love my cool son.”

He eventually explained to the team that he modulated the tone by trying to move his eyes. But he did not always succeed. Only on 107 of 132 days reported in the study could he match a series of target tones with 80% accuracy, and only on 44 of those 107 could he produce an intelligible sentence.

“We can only speculate” about what happened on the other days, Vansteensel says. The participant may have been asleep or simply not in the mood. Maybe the brain
War halts animal tracking project
Elizabeth Pennisi