Gauging the key role animals can play in monitoring climate change

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Credit: Max Planck Institute

The world's scientists rely on an elaborate network of satellites, ocean buoys, weather stations, balloons, and other technologies to help predict the weather and assess the global effects of climate change on terrestrial landscapes, oceans, and the atmosphere.

But they are overlooking some of the most sensitive and informative instruments of all—the world's animals—argue researchers at Yale's Center for Biodiversity and Global Change (BGC Center) and the Max Planck Institute of Animal Behavior.

Equipping fish, birds, seals, and other creatures with sophisticated sensors, the researchers say, can offer localized and timely data on environmental conditions impacted by climate change that current technology cannot.

"We can literally turn animals into flying, swimming, and walking weather stations,"' said Diego Ellis-Soto, a Ph.D. student in the lab of Walter Jetz, professor of ecology and evolutionary biology in Yale's Faculty of Arts and Sciences and director of the BGC Center. "Animals equipped with modern sensors could be seen as the 21st-century version of the canary in the coal mine."

Ellis-Soto is the lead author of a perspective piece published Sept. 18 in the journal *Nature Climate Change* that describes the shortcomings of current methods of collecting weather and climate data—and the benefits of equipping animals with sensors. By tagging animals with such technologies, they say, scientists can improve their measurements of air temperature, ocean salinity, and air pollution as well as the animals' own metabolism.

In doing so, the authors say, animals can help scientists fill critical data gaps, particularly in remote parts of the planet.

The authors identify several examples of how such an animal-based monitoring system might work. For instance, while satellites can record temperatures atop the canopy of a cloud-covered jungle they are not able to measure conditions on the ground. But a monkey equipped with modern GPS-tracking sensors can. In addition, the sensors can also

monitor changes in the animal's stress levels as a result of warming temperatures.

Moreover, while most weather stations are built on flat landscapes and in developed areas of the world, they are seldom placed in remote mountain regions, including in areas that are among the world's most affected by climate change, the researchers say. However, mountain goats or birds moving up and down steep mountainous terrains are able to characterize the temperature profile in great detail.

And over the Atlantic Ocean, Ellis-Soto said, sophisticated weather balloons offer pilots warnings of turbulence on their routes. But "flying from Japan to Chile there is little to no such information available," he noted.

That, he said, is why the Japanese government has begun to equip high-flying seabirds with sensors to gauge windspeed strength at a variety of altitudes and integrates ocean measurements collected from technology-equipped turtles into oceanographic models for weather forecasts.

"Animals can be our fine-tuned biological weather stations," said Martin Wikelski, director of the Max Planck Institute of Animal Behavior and co-author of the perspective piece.

The Max Planck Institute of Animal Behavior has already equipped thousands of birds and animals with sensors designed to track where wildlife is thriving—and where it is struggling—along migratory routes affected by climate change. While these sensors are designed to track biodiversity, they can also be used to help predict weather and the effects of extreme weather events such as heat waves on animals.

There are other examples of how animal tagging is helping to provide a living measure on the impacts of climate change itself in near real time.

For instance, tagged elephant seals already provide 80% of data on ice depth and ocean salinity in Antarctica, which is helping scientists predict sea level rise under current and future climate change, Ellis-Soto said.

Land animals equipped with sensors are not only able to report on under-sampled areas, researchers say, they are able to do so at fine spatial detail.

"They are just a tremendous complement to Earth-orbiting satellites, by offering a biological lens that tunes into fine-scale conditions of habitats," said Jetz, senior author of the study.

Using animals to monitor conditions also offers the opportunity to collect data that is more localized and comprehensive. Satellites, for instance, can give a rough approximation of conditions in sub-Saharan Africa at a resolution of one square kilometer.

"[But] a white stork with sensors can give us a bird's eye view of conditions on the ground in seconds," Ellis-Soto said.

And benefits are not limited to purely wild areas of the world, researchers say. With many regions enduring extreme heat this summer, carrier pigeons helped identify dangerous urban heat islands—urban areas that are significantly warmer than surrounding regions—and air pollution levels in heavily populated areas.

"It is an untapped gold mine of detailed meteorological information with relevance for weather forecasting and biology alike," concluded Ellis-Soto.

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