Life on the move

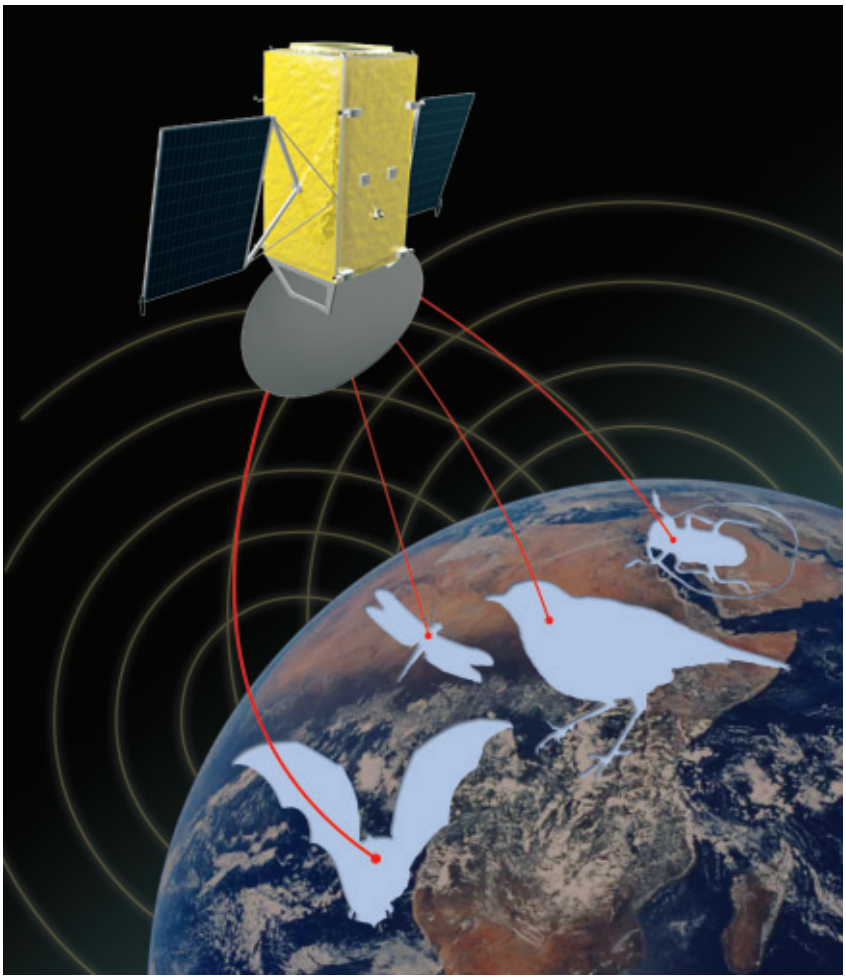
Studying animal movements to understand the 'Pulse of the Living Planet'…

Animal movements are both essential and dangerous for humankind, and yet we lack the technology to understand, predict and ultimately conserve them.

'Panta rei' (Ancient Greek) means life is moving. Around the globe, as we speak, billions of animals are roaming wildly. They connect the most remote places on Earth and in the oceans, and could be our sensors, our eyes, ears and noses for the health of our planet.

Migrating animals provide some of the most important ecosystem services for people: salmon and sardines serve as food, fruit bats pollinate mangos and disperse tree seeds every night across fragmented African landscapes, and songbirds control plant pests that otherwise threaten crops. At the same time, animals may massively harm us: billions of desert locusts and African quelea birds destroy crops, bats and birds spread harmful viruses such as Ebola, Nipah and West Nile, and wild relatives of domesticated mammals harbour viruses that threaten human livelihood, such as foot and mouth disease. Ideally, we should precisely know where our friends and foes are moving to and what they are doing – but we can't yet, in most cases.

While we are able to study and predict weather, plant growth and atmospheric chemistry around the globe, scientists have an exceedingly difficult – and often impossible – time to even observe moving animals. Some whale species disappear for much of the year into unknown corners of the ocean, billions of songbirds vanish every year without a trace and us knowing where and how they die. Unexpectedly, invasive species magically appear in new

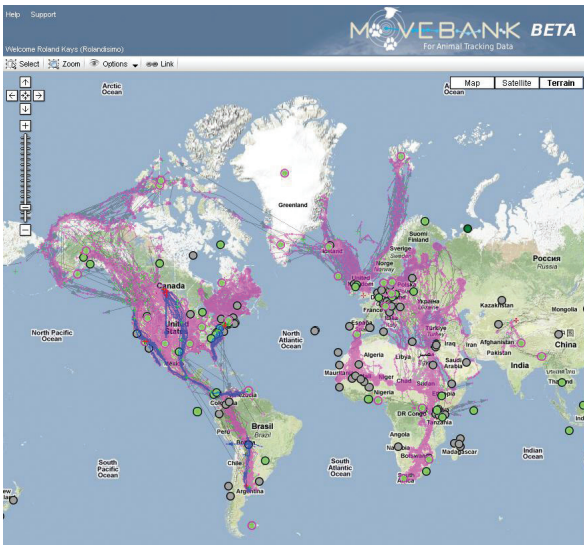


habitats, causing massive harm and long-term damage.

We are now finally in a technological position to propel humankind out of this ignorance about life on the move. We will soon even solve Aristotle's enigma of where an individual swallow flies when it leaves us behind in the cold northern winter. The old Greek philosopher and naturalist thought swallows burrow in the mud during the winter. We now know they don't, but still can't follow the fate of an individual swallow yet, and are far from understanding the dynamic changes in entire swallow populations.

What animal ecologists lack to fulfil their societal role is similar to what meteorologists already have: real-time knowledge about the movement of individual aerial 'particles', information about the inner properties and behaviour of these particles, and a global database and model to predict the future with a certain probability.

The International Cooperation for Animal Research Using Space (ICARUS) has outlined a roadmap to build an 'animal lifecast' for planet Earth. We can soon attach nanosensors with GPS technology to even tiny animals, eventually allowing us to know where they are every few seconds or minutes throughout their life. 3D acceleration sensors provide us with intimate knowledge about the



behaviour of individuals. Physiological sensors give us the internal state of an individual, using heart rate and body temperature to assess its health status. So far we can only read out some of these data from a small number of large animals globally, via the mobile phone system, the satellite phone system, or the French ARGOS satellite system that currently has the widest global coverage and allows for the smallest on-animal tags. In the future, ecologists will have a larger variety of options to listen to and learn from the moment-to-moment decisions of animals. Mobile phone technology will miniaturise further, and new types of global communication systems are being tested and established.

The European Space Agency (ESA), with the help and support of the Russian Space Agency and its transport vehicles, plans to launch an ICARUS receiver system to the International Space Station (ISS) in 2014. This receiver will be able to listen to tiny transmitters on tens of thousands of animals, or other small mobile objects, around the globe. Due to its accessibility and possibility for constant human updates and interventions, the ISS is an ideal development platform to rapidly prototype and advance the engineering of a new global transceiver system under European leadership. ICARUS will be based on the Global Transmission System (GTS) technology developed by the Steinbeis Transfer Centre for Space and supported by the German Air and Space Agency. On the ground, ICARUS will stimulate the advancement of miniaturised sensing and biologging technology, ultimately enabling biomedical research to 'go wild' in their approach to test lab animals in a natural setting.

We also need to develop an archive and real-time database for life on the move, to feed animal movement models and enable predictions. Movebank (www.movebank.org), an international project funded by the US National Science Foundation, the German Science Foundation, the Max-Planck Society and Konstanz University, is starting to provide a global data backbone for animal ecologists. Combined with new data mining methods, geo-visualisation tools and individual-based movement models, Movebank provides a virtual research environment to scientifically understand and publicly communicate information on animal movement. Movebank also allows ecologists to seamlessly link animal movement information with environmental information such as wind, weather, plant growth or environmental disasters.

A vision of the future of life on Earth

We all know that the world has become a small place, individual space is tightening up. The soon-to-be nine billion people need more food and will – because of space restrictions – interact with livestock and wild animals more closely. We will face more zoonotic disease outbreaks and less habitat and corridors for moving animals. To plan for a future in which both human and animal health and movements are ensured, we need better, more precise and real-time information about the movement of animals.

Professor Martin Wikelski, Director

By remotely observing animals around the globe, we will get a good understanding of the 'Pulse of the Living Planet', about the inter-connectedness of life, and its consequences for humankind. The Food and Agriculture Organization (FAO) of the United Nations has already started the OneHealth initiative (www.onehealth-initiative.com). Movebank and ICARUS plan to collaborate with the FAO to strengthen the existing Global Early Warning System (GLEWS, www.glews.net). We will soon be in a situation where we can use the senses of animals around the world to tell us where the Pulse of the Living Planet is out of synchrony. Individual mobile animals around the globe can soon be our 'canaries in the coal mine', and will help us to make the world a better place.

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