

The Outside Story

Returning Home: Magnetic Homing

By Rachel Sargent Mirus

Every holiday season there is a mass migration of humans towards home and family. We use many tools to help us navigate back to the places we're from – from simple maps to sophisticated GPS – but animals who travel long distances must rely on their own senses. Some of them have a long-range navigational sense called magnetoreception that is like a built-in compass or imprecise GPS.

Earth is surrounded by a magnetic field that is generated by currents in the mixture of molten iron and nickel deep in the heart of our planet. This geomagnetic field exists throughout every environment all the time, making it a uniquely reliable source of information, if an animal can detect it. When some

biologists first suggested animals could sense magnetic fields in the late 1800s, their colleagues were skeptical. Yet behavioral scientists continued to collect observations that some animals would change their movement patterns near magnets.

In the late 1960s, a German researcher showed that migrating birds would cluster at the south end of their windowless roosts but would reverse their choice when surrounded by an artificial magnetic field that was oriented opposite to the Earth's. Around the same time, an American researcher demonstrated that putting magnets on the heads of pigeons interfered with their ability to return home.

Researchers in the 1980s caught male newts, subjected them to the scientific equivalent of being blindfolded and spun in circles, then transported them 10 to 50 km away from their home ponds – 10 to 20 times farther than newts typically travel on their own. The newts adjusted to their new surroundings for several weeks before they were exposed to spring-like temperature changes to stimulate their spring migration instincts. The newts then attempted to travel in the correct direction to return to the ponds they came from, indicating they sensed their position relative to their original pond.

Further research indicates that the newts are detecting the inclination angle, or the angle of the magnetic field lines relative to the Earth's surface. To understand what newts, and animals like them, are sensing, picture the Earth floating in space surrounded by contour lines that map the orientation of its magnetic



field. The lines leave the south pole, rising straight up from the ground, but as they do, they split and curve to the left and right to encircle the planet on each side.

As the field lines curve around the planet, they flatten relative to the surface until they are parallel to the ground at the equator. Continuing around, the lines bend back to re-enter the Earth's surface at the north pole, once again perpendicular to the ground. The magnetic field is stronger at the poles and weaker at the equator. By sensing the inclination angle and the strength of Earth's magnetic field, an animal can infer a "magnetic map" of its location.

Biologists are still researching how magnetoreception works within an animal's body. Currently there are two top theories for terrestrial animals: they are using complex biochemical reactions that are sensitive to magnetic fields or they have magnetite, a magnetic mineral, stored in their bodies. There is mounting evidence that migratory birds use biochemical reactions in their retina to sense the Earth's magnetic field, but those reactions are so complex that many questions remain.

In other animals, biologists have successfully tracked down the location of tiny magnetite crystals; rainbow trout store these crystals in cells in their noses. No one knows yet exactly how the fish use their magnetite, but researchers have recorded signals in the nerves in the fish's nasal tissue. If the crystals can move along with the Earth's magnetic field, they would act like a compass needle that is wired to the fish's nervous system.

Whether you're a trout swimming towards the stream you were born in or hopping on a plane for the holidays, traveling home is a lot of work. Animals migrate because their destination has something favorable: better weather, more food, or ideal conditions to raise offspring. Whatever your reason, there's just something special about going home.

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