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Living sentinels for climate change effects

Migrating birds affected by climate change in the Arctic may have lower survival chances in their tropical habitats

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Humans have long used animals as sentinels for threats to their own well-being. Canaries in coal mines are a classic example. On a global scale, studies of birds were key to detecting environmental problems caused by the excessive use of pesticides (*1*, *2*). The recent loss of up to 98% of some vulture populations highlights the widespread dangerous effects of diclofenac use in cattle (*3*). Bee populations, sentinels for global insect losses, are also declining owing to the combined stress from pesticides and other environmental changes caused by humans, resulting in a widespread loss of pollination services (*4*). On page 819 of this issue, van Gils *et al.* (*5*) highlight another global ecological warning sign, this time linked to Arctic warming. They show that long-term changes in the body architecture of Arctic wading birds can affect their survival in their tropical wintering range.

The authors study red knots (see the photo), which breed in the high Arctic in the summer and migrate to tropical habitats around the world in the winter. They show that juvenile red knots growing up in warm Arctic habitats have shorter bills, which lower their foraging efficiency in the tropical mudflats and may later decrease their survival chances. Thus, changes in one habitat may have important ecological consequences in habitats halfway around the world. Similar to the early warnings regarding DDT use (*1*), these results show that global warming affects life on our planet in unanticipated ways.

The basic data are ingeniously simple. Van Gils *et al.* measured the body size of red knots over 30 years along one of eight major flyways of Arctic birds (see the figure) and linked the annual and long-term changes in body size to the time of snowmelt. Over this time period, the date of the snowmelt advanced by more than 2 weeks, and the birds produced smaller and smaller offspring probably because insect populations peaked earlier than in the past, resulting in limited food resources when the parents arrived from their long-distance migration flights.

Many animal species can compensate for periods of slow growth early in life by growing faster at other times (*6*, *7*), but red knots do not. Possible reasons for the lack in catch-up growth are the need to keep adult metabolic rate low (*6*) and cognitive performance high (*7*). Both can be affected by compensatory growth during early development. Overall, van Gils *et al.* nicely show how important early development is for the entire life history of an organism and how subtle many ecological interactions are. These effects only become evident when one considers the mi-

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gratory connectivity of red knots by following individuals from breeding to wintering (*8*).

The researchers can only determine the "apparent survival" of the birds: Individuals not seen any more are considered dead. This is the accepted standard in field ecology. It is likely that many individuals with short bills die, but some short-billed individuals may identify new foraging grounds and perhaps even establish new, currently unknown migratory populations. Only by tracking the development and morphology of individual birds throughout their life can researchers fully understand the population consequences of environmental change (*8*). One technology that will allow such lifetime tracking of small animals is the satellite-based ICARUS system, which will be installed in early 2017 by the German and Russian space agencies (*9, 10*).

Population-level changes similar to those observed by van Gils *et al.* are currently occurring in many populations of migratory animals throughout the world (*11*). Examples include the loss of more than 400 million songbirds in Europe alone over the past 30 years (*12*). Human societies may soon miss many of the ecosystem services, such as pest control, provided by the masses of migratory species.

The study by van Gils *et al.* beautifully illustrates how simple measures in ecology can alert us to subtle but potentially life-threatening changes in ecosystems around the world. Gaining such understanding requires observing the entire life history of individuals in the wild a task that can only be achieved if biologists around the world work together to link their data sets (*13*). Over the next 10 years or so, the recently formed International Bio-logging Society (*14*) aims to combine observational and satellite data on hundreds of mobile and migratory species marine, terrestrial, and aerial in a global assessment of the health of life on the planet. Once we understand the connectivity and interactions of individual animals, we can capitalize on the superior sensing of the environment that emerges from their collective behavior (*15*). We may then be able to rely on animals to forecast the conditions of life on the planet that we share with them.

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East Atlantic flyways of Arctic birds

Long-distance migrating birds such as red knots link their Arctic breeding areas to distant parts of the globe. Van Gils *et al.* studied the *Calidris canutus canutus* subspecies in its East Atlantic flyway. Flyways from www.caff.is.