LIFE BEYOND THE TIPPING POINT

When conditions change, ecosystems can tip into a new, completely different state. What lies beyond the horizon?

Complex systems are everywhere. Ecosystems are complex by definition, but so are financial markets, for instance. Everything is interconnected. In nature, some species reinforce one another while others interact in a negative way. The strength of those relationships also depends on the circumstances. A robust ecosystem can easily cope with disruptions. But what happens if it is no longer so robust and the limits of its resilience are exceeded? PhD candidate Jelle Lever investigated this future world beyond the tipping point. Well-known examples of tipping points are clear ponds that turn cloudy or landscapes that become degraded.

CRITICAL SLOWING DOWN

But not all ecosystems behave so predictably. When ecosystems with many species that have a relationship with one another pass a tipping point, the new state depends on how the changed circumstances affected the ecosystem. It is not clear beforehand whether the transition will have minor or major effects, nor whether those effects will be positive or negative.

'Complex systems consist of many, many components,' says Lever. 'They all interact with one another positively or negatively.' If that is so, can you ever say anything meaningful about the future? He believes you can. For some complex systems, you can deduce what the future will look like after the transition from the participants' behaviour before the tipping point. That phase is when you see the phenomenon known as 'critical slowing down', when a system takes longer and longer to recover from shocks that disturb the equilibrium.

> **'My theory shows which species do well beyond the tipping point and which do badly'**

That means its resilience is declining. Lever studied models of ecosystems with positive feedbacks that destabilize the system, for example plants and their pollinators. An increase in the number of pollinators causes the number of plants to increase, which in turn has a positive effect on the number of pollinators. The effect reinforces the cause. The reverse is also possible: a decrease in the one leads to a decrease in the other and eventually to the collapse of the system.

PREDICTING THE FUTURE

But not every species reacts to a disturbance with the same lag. Lever showed that differences in behaviour point to what things would look like beyond the tipping point. 'My theory shows what direction the ecosystem will take, and which species do well beyond the tipping point and which do badly, not in absolute numbers but in proportion to one another.' In principle, this gives him an indicator for predicting the future.
'In principle' because so far the proof is purely theoretical. The next step is to test the theory using real data. Ⓡ RK

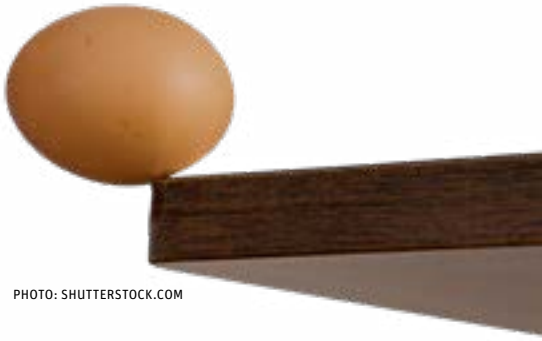

PHOTO: SHUTTERSTOCK.COM