NATURE

50 Years Ago

The Committee on Scientific Research in Schools which was established by the Council of the Royal Society in 1957 has issued a report covering the period November 1, 1959–October 31, 1960. It is stated that interest shown by schools in undertaking research has continued to increase, and the Committee is now administering research projects in 56 schools. Some of these schools have more than one research project under way and a total of 66 separate research projects are now being actively pursued compared with 57 last year ... All research projects with which the Committee is dealing are carried out with the specialist advice and assistance of Fellows of the Society and by others who act as advisers. The Committee invites further requests from school-masters and school-mistresses for assistance in undertaking research.
From *Nature* 4 February 1961

100 Years Ago

Many attempts have been made to synchronise the phonograph or gramophone with the kinematograph, so as to be able to reproduce simultaneously the sounds of the voice, as in singing and speech, while the movements of the face and the bodily gestures of the singer or speaker are depicted on the screen ... The difficulties, however, appear to have been surmounted by M. Gaumont ... The details of the method are not fully developed, but they are to be made public without delay ... We may soon have in our homes the *chefs-d'oeuvre* of our theatres played by our best actors, and even lectures by famous professors may not be restricted to their class-rooms ... Such reproductions are to be called *phonoscenes*.
From *Nature* 2 February 1911

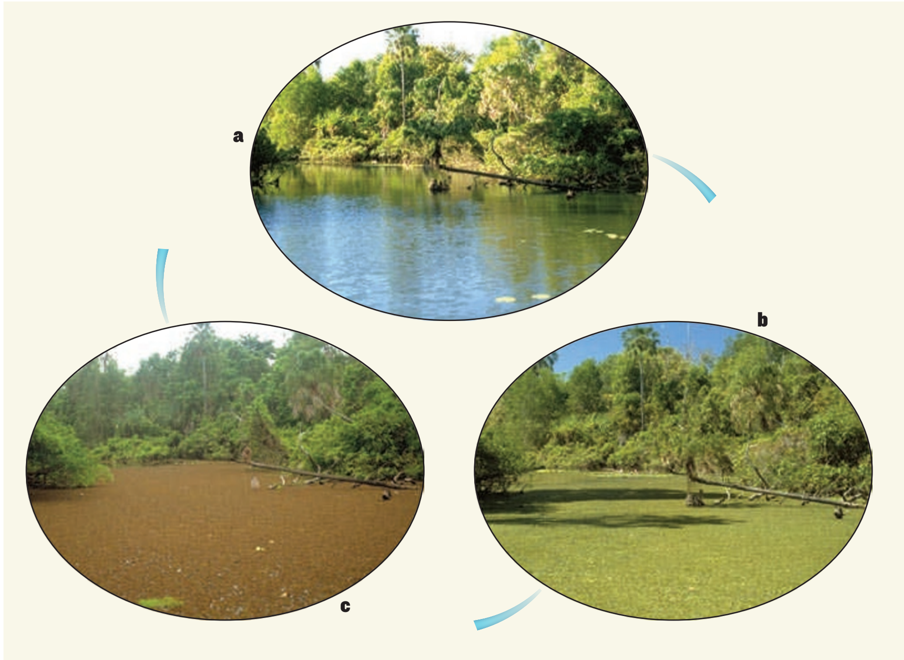

Figure 1 | *Salvinia* infestation of the Howard River, near Darwin, Australia. **a**, The scene before the advent of *Salvinia* in July 1984. **b,** One month later, with *Salvinia* rampant. **c**, February 1985, and the infestation is dying after attack by the weevil *Cyrtobagous salviniae*. Photographs taken by Colin Wilson (at risk of crocodile attack).

introduction of the weevil *Cyrtobagous salviniae*. Unusually, this beetle can feed on *Salvinia* possibly as fast as the weed can grow, causing the latter's dense mats to turn brown through decomposition (Fig. 1). In some cases the weevil can remove 99% of a large-scale *Salvinia* outbreak — which can comprise tens of thousands of tonnes of biomass — within a year.

Schooler *et al.*[1] elaborate on how the annual flooding of the billabongs further complicates the outbreak dynamics. Flooding tends to flush *Salvinia* downstream, allowing the pest to invade other billabongs or to find refuge in terrestrial sites. The ability of *Salvinia* to escape during flooding makes it almost impossible to eradicate the weed, despite the high efficiency of the biological control. Hence outbreaks recur, appearing at erratic and unpredictable intervals as they manage to evade the weevil's stranglehold.

The jumps from periods of control to periods of outbreaks have allowed Schooler *et al.*[1] to draw upon the powerful theoretical framework of alternative stable states, which has proved particularly relevant to those ecosystems in which abrupt changes and catastrophic shifts are intrinsic features[2–4]. The authors were able to formulate the basic structure of a mathematical model that suits the *Salvinia*–weevil system. The nonlinear model has a deterministic 'skeleton' that is driven by environmental stochasticity, and takes into account the observed time-series measurement errors in *Salvinia* and weevil population abundance. But matching the model to the time series proved to be a formidable challenge. The high stochasticity and unpredictability of the billabong system, combined with the complex dynamics introduced by periodic flooding, mean that, using most standard techniques, it is extremely difficult to interpret which of the different states the system is moving towards at any point in time.

Modern time-series analysis came to the rescue. Theoretical ecologists are familiar with the contributions of one of the authors (Ives) to ecological time-series analysis[4,5]; Ives and his Australian co-authors now present[1] further innovation. More specifically, they make use of the (extended) Kalman filter, a statistical technique for which its inventor, engineer Rudolf Kalman, received the US National Medal of Science in 2008. The filter smooths out the system's stochasticity and, in parallel, provides an estimate of the model's statistical likelihood.

With such an estimate, it became possible to fine-tune the model structure by comparing a suite of different possibilities, while fitting the models to the observed billabong data. This allowed determination of the most reasonable model, and homed in on the best-fitting parameter estimates in a statistically rigorous manner. These methods are now finding exciting biological applications[6], but in practice their complexity would normally call for the participation of a versatile mathematician. Hence the importance of multidisciplinary cooperation.

With the final model in hand, Schooler *et al.*[1] initiated a theoretical study of the nonlinear dynamics of its deterministic skeleton and investigated the existence of possible alternative stable states, and the manner in which they depend on control parameters. Two states were