

# Ecosystems not searching for balance

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On these rocks the research took place.

Species abundances in natural ecosystems may never settle at a stable equilibrium. Biologists from the University of Amsterdam (The Netherlands), Leigh Marine Laboratory (New Zealand) and Cornell University (USA) report that species in one of the world's oldest marine reserves showed chaotic fluctuations for more than 20 years. The species replaced each other in cyclic order, yet the exact timing and abundances of the species were unpredictable. The results are published in the *Proceedings of the National Academy of Sciences (PNAS)*.

The new study describes a rocky coast in New Zealand, where species

show striking ups and downs for at least 20 years. In some years the rocks are covered by barnacles, in other years mussels or algae dominate. The species display a cyclic succession. First, bare rock is colonized by barnacles. The barnacles are invaded by crustose algae, which are in turn overgrown by a dense mussel carpet. After the [barnacles](#) are killed, the mussel carpet breaks off and is washed away, and the cycle starts anew. The rates of these species replacements depend on the seasonal temperature variation. Hence, the resulting pattern is erratic. The order of species replacement is cyclic, but the species abundances vary chaotically.

## **Natural harmony**

Since ancient times, it is often argued that external disturbances are responsible for changes in species abundances. According to this world view, species in undisturbed ecosystems will reach a [stable equilibrium](#), in which species abundances are maintained at constant numbers. Yet, over recent years more and more evidence has accumulated that this "balance of nature" does not exist. Mathematical models predict that species can sustain chaotic fluctuations that appear just as erratic as the stocks on the financial market. These predictions are supported by lab experiments with plankton and insects, and also infectious diseases are known to display chaotic dynamics.



This research provides the first field evidence for chaos in a real multi-species ecosystem. The work suggests that chaotic fluctuations are common in nature. A major implication of chaos in ecosystems is that species abundances are predictable in the short term (a few generations) but unpredictable on the long run.

The data were gathered by Dr. Bill Ballantine, who monitored the [species](#) composition and weather conditions on a monthly basis for more than 20 years. His data illustrate the value of long-term field studies, and hopefully will inspire others to protect marine ecosystems and to conduct similar long-term field studies.

**More information:** "Species fluctuations sustained by a cyclic succession at the edge of chaos." *Proceedings of the National Academy of Sciences USA*, [DOI: 10.1073/pnas.1421968112](https://doi.org/10.1073/pnas.1421968112)

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