

NATURE IS NOT STATIC

BY GEORGE SUGIHARA

NATURE IS NOT STATIC. This is obvious in the long run, where the birth of species and their extinction are ineluctable facts. However, even with the shorter time-scales (from months to decades) that resource managers and most ecologists work on, the conclusion from actual measurements is that most populations of living things are not in static equilibrium. They are not even fluctuating around an ideal state. In truth, their dynamics are fundamentally unstable and non-stationary. Thus, we see booms and busts in disease outbreaks like measles and pest infestations such as locusts. We also see variations by orders of magnitude in fish stocks such as salmon, squid and sardines. Sedimentary evidence from California's Santa Barbara basin, for example, shows that average sardine abundances over the last two millennia have repeatedly shifted from very low numbers to anomalously high ones, such as those that gave rise to Cannery Row, an industry built precariously on a boom period for sardines.

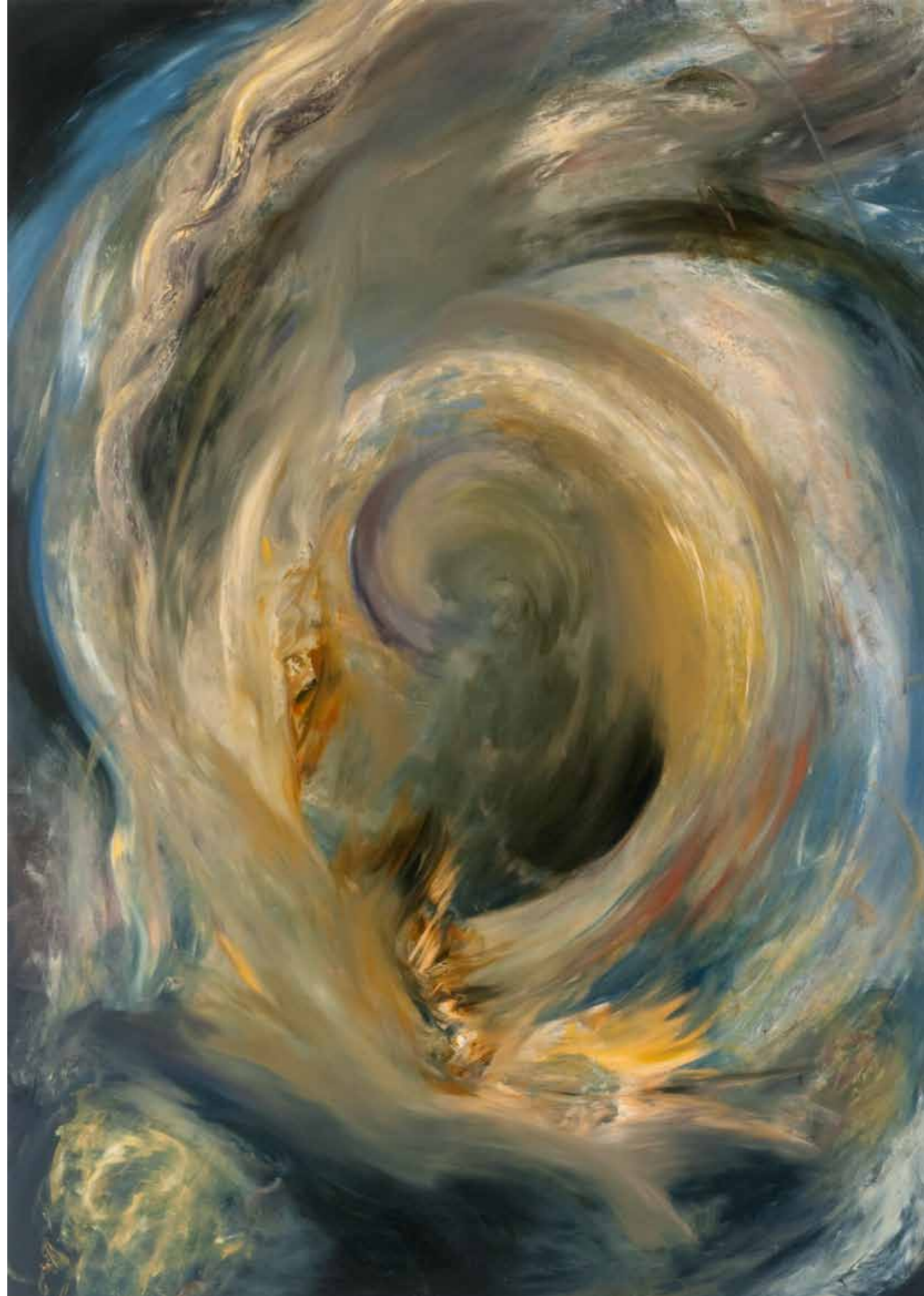
This is very upsetting to most of us, as we like to see the world as being constant in some sense, especially if the preservation of species (and the re-establishment of fixed baselines) is the goal. However, constancy and stability is a fiction, a dangerous approximation in many cases. It is just this kind of wishful thinking that causes us to be constantly surprised and which can lead to systemic mismanagement and collapse. Indeed, this was one of the problems contributing to the recent financial collapse, where measures of default risk based on the most recent decade of data were taken and applied as though the world markets were stable and unchanging fixtures in time.

Statistical methods that assume an unchanging universe can get us into trouble. Thus scientific tools and conceptions built to work well in controlled engineering contexts — involving simple and stable clockwork

mechanical devices — do not work well in natural systems, where nonlinear instability is literally a fact of life. That is, real populations and ecosystems behave in an unstable, non-stationary way so that the rules for change depend on context (“state-dependent dynamics”). Nonetheless, this is not how most of our models work, and it is models that represent our formal conceptions of nature.

Many simple ecological models, physiological models, and even climate and economic models are built by assuming a globally stable equilibrium, with parts that add up linearly. They are easy, but also wrong. Yet we persist in this exercise partly *because we know how* — we have a large battery of tools based on linear systems. Yet sticking with a false scientific paradigm inevitably exacts certain costs, and among these are the mismanagement of our planetary resources, the miscalculation of extreme events, and the hastening of biodiversity loss. To paraphrase Mark Twain, “It ain’t what we don’t know that’s the problem, it’s what we know that ain’t true.”

So where do we turn if the conventional scientific practices (e.g., linear equilibrium models) are at odds with both wisdom and reality, and ideas such as restoration targets based on fixed baselines are therefore illusory? Embracing reality is the essential first step, though not an easy one. Investing more resources toward developing methods and tools that not only acknowledge this complex reality, but which actually exploit it, should follow. Indeed there are already some promising tools out there that do this (e.g., state space reconstruction methods, nonlinear forecasting etc.) so there is good reason for optimism. If education in environmental sciences takes care to be less dogmatic and produces a curriculum that challenges new scientists to tackle complex reality head on, instead of dividing it artificially into bite-sized pieces, we will develop the science needed to become better stewards of the planet. 🐦



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