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Maximum Entropy and the Inference of Pattern and Dynamics in Ecology

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Constrained maximization of information entropy yields least biased probability distributions. From physics to economics, from forensics to medicine, this powerful inference method has enriched science. Here I apply this method to ecology, using constraints derived from ratios of ecological state variables, and infer functional forms for the ecological metrics describing patterns in the abundance, distribution, and energetics of species. I show that a static version of the theory describes remarkably well observed patterns in quasi-steady-state ecosystems across a wide range of habitats, spatial scales, and taxonomic groups. A systematic pattern of failure is observed, however, for ecosystems either losing species following disturbance or diversifying in evolutionary time; I show that this problem may be remedied with a stochastic-dynamic extension of the theory.