Geophysical Research Abstracts
Vol. 14, EGU2012-4832, 2012
EGU General Assembly 2012

Ecosystem control parameters, scaling relations and complexity thresholds from dimensional constraints.

G. Rowlands (1), S. C. Chapman (1), N. W. Watkins (2,1), A. Clarke (2), and E. J. Murphy (2)

(1) University of Warwick, Physics Dept., Coventry CV4 7AL, UK (s.c.chapman@warwick.ac.uk), (2) British Antarctic Survey, NERC, High Cross, Madingley Road, Cambridge CB3 0ET, UK

We perform a bottom up analysis of an idealized ecosystem using formal dimensional analysis. As a starting point, we assume that observations can characterize the level of ecosystem complexity by some (non- unique) method which can differentiate different functional groups of individuals within the ecosystem. The details of this categorization are not needed for what follows, only that some categorization is possible and is consistently applied across the data. This categorization yields intrinsic macroecological variables such as density, diversity, trophic level, metabolic rate and body size along with characteristic lengthscales for clumping or dispersal of individuals. The possible relationship between these intrinsic macroecological variables, and extrinsic variables such as habitat size and the rate of supply and uptake of resource has a fundamental physical constraint- that individuals in the ecosystem can only, in sum, utilize resource at the rate at which it is taken up by the ecosystem as a whole. This constraint corresponds to an ecosystem which is dynamically balanced, that is, it can respond to exogenous change with endogenous reconfiguration such that the balance between the net rates of uptake and utilization is on average maintained. Quite generally, there are dimensional constraints on how these macroecological variables are related to each other and to the level of complexity of the ecosystem. We perform a formal dimensional analysis to obtain this relationship for a dynamically balanced ecosystem. This yields a control parameter which constrains how complex an ecosystem can be- thus we can identify and parameterize thresholds in the complexity of the system. The relationship that we obtain captures observed macroecological patterns but also suggests dimensionless variables which isolate underlying trends- these are testable predictions which can be used to determine whether an ecosystem is indeed dynamically balanced, or is under rapid change or collapse.