**Scalability in Ecology and Ecotoxicology**

The issue of scale is a pervasive and perhaps inescapable one at every level of ecotoxicology. Effects scale temporally from the acute to the chronic to the background, studies constrain themselves through their examination of effects at the small scale – which is of questionable real-world application – and the large scale – which is virtually irreproducible. Overcoming one obstacle to reliable, valid science seems inevitably to place another barrier to a study’s application.

Negative though the tone of this introduction is, it is important to recognise that this is not the death of research. Imperfect science has led to many mistakes – but it has also taken men to the moon, developed crop varieties that have saved billions of lives from extinction, and brought us into an age where we understand more than ever before about the nature of the universe that we call home.

**Scaling in Ecotoxicology: Theory, Evidence and Research Needs**

Johnson and Rodgers, 2005

* Scale can be broken down into two sub-categories:
  + Extent, which refers to physical or temporal size
  + Grain, which refers to observation or modelling resolution
* There is no inherently right scale – scales must be carefully selected after analysis of the problem
* Toxicological and ecological parameters often scale allometrically (that is, with body mass)
* Fractals???
* When scaling between cosms, attributes may or may not be scalable
* Considering scale in ‘cosm design is essential for producing valid data
* Extrapolating from smaller models to large ones is problematic not only for reasons of physical scaling
* The paper provides a number of guidelines for scaling:
  + As much attention should be payed to scaling of exposure as of measurements
  + Physical modelling can be useful
  + A variety of theoretical and empirical approaches can be used in scaling?
  + Scaling relationships can be linear or non-linear, continuous or discontinuous
* And similarly a number of research needs:
  + A rigorous assessment of the applications/limitations of allometric scaling in ecotoxicology is needed
  + Greater focus is needed on identifying non-linearities and thresholds in empirical and theoretical scaling relationships
  + Attention should be directed toward integrating spatial and temporal aspects of scaling
  + There is a need for more experimental studies specifically designed to manipulate scale as a controlled treatment variable