On size and extinction: a random walk model predicts the body size of lowest risk for mammals

Oskar Burger¹ and Lev Ginzburg²

¹SWCA Environmental Consultants, Broomfield, Colorado and ²Department of Ecology and Evolution, Stony Brook University, Stony Brook, New York, USA

ABSTRACT

Question: Is the relationship between extinction risk and size in terrestrial mammals described by a peaked function or a monotonic function?

Mathematical method: We develop a population viability analysis model where species take random walks at generational time steps. The model works like the classic gambler’s ruin problem where risky combinations of variance in growth rate, population density, and generation length are eliminated from an evolutionary game.

Key assumptions: Our model ignores speciation. It assumes that the population growth rate at evolutionary time scales is zero. It assumes an unbiased random walk. Chronological time is adjusted for generation length, so that longer-lived species make fewer ‘gambles’ in the same period of time.

Conclusions: Particular combinations of variance in growth rate and average population density yield an extinction function that predicts a size of lowest relative extinction risk for terrestrial mammals. This size is close to the mode of continental body size distributions (at about 0.1 kg). Generation length is a fundamental evolutionary time scale.

Keywords: allometry, Damuth rule, generation time, mammal body size distribution, optimal size, population variability, probability of extinction.

INTRODUCTION

Mammals vary tremendously in size, from shrews to elephants, but the most common size is near 0.1 kg, the modal size for continental body size distributions (Brown et al., 1993; Blackburn and Gaston, 1998; Kozlowski and Gawełczyk, 2002). The modal value is highly consistent across continents (Smith et al., 2004), which has led some researchers to consider the possibility that the modal size is somehow advantageous or optimal. For instance, Brown et al. (1993) developed a model suggesting that the modal size is optimal with respect to allocating metabolized energy to offspring. Other lines of evidence also support the notion that the most typical (modal) size represents some evolutionary or ecological optimum. The island rule for
Evolutionary Ecology Research is delighted that you wish to consult one of its articles.

You may if your library or laboratory subscribes.

Ask your librarian or library committee why your place does not already subscribe to the low-cost journal that is publishing splendid science in a socially responsible manner. EER’s low prices have helped librarians to rein in the indefensible cost increases that have reduced our access to science all over the world! Just ask our partners at SPARC — the Scholarly Publishing & Academic Resources Coalition of the Association of Research Libraries.

Or maybe you should just remind the folks who order your journals to contact us and subscribe! You need — and they should support — the journal that:

- Invented the instant publication of reviewed, revised and accepted e-editions.
- Vests the copyrights of all articles in their authors while preserving the rights of educational and research groups to use its material in classes, seminars, etc. at no additional cost.
- Maintains a unified data-base of articles, thus doing away with your need to worry about issue numbers, author order, and other such impediments to easy access.
- Provides Webglimpse so that you can search any word, place, species, variable, phrase or author in any article EER has ever published.
- Pioneered e-only subscriptions while maintaining, at the same time, a traditional print edition, too.

Some 10,000 readers per week have it right. EER is the place to go for great science, responsible publication policies and easy access!

Click here for the Table of Contents of the most recent issue of Evolutionary Ecology Research

Click here for full access to a sample issue of Evolutionary Ecology Research

Click here for SUBSCRIPTION INFORMATION