

# Human hunting mortality threshold rules for extinction in mammals (and fish)

Eric L. Charnov<sup>1,2</sup> and Wenyun Zuo<sup>1</sup>

<sup>1</sup>Department of Biology, The University of New Mexico, Albuquerque, New Mexico, USA and

<sup>2</sup>Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon, USA

---

## ABSTRACT

**Question:** Are there general life-history rules for exploitation-caused extinction of mammal populations?

**Mathematical methods:** A population of size  $N$  faced with the added mortality of human exploitation will deterministically go extinct if its per-capita birth rate can no longer match its per-capita mortality rate as  $N$  approaches zero. We develop exploitation-extinction theory for a mammal life history using  $R_0 < 1$  as  $N$  goes to zero, and combine the criterion with several facts about mammal life histories.

**Conclusions:** Extinction results if the ratio of the instantaneous mortality rate caused by hunting ( $F$ ) divided by the adult instantaneous mortality rate ( $M$ , for the unexploited population) exceeds a critical value ( $F/M > C$ ). The  $C$  value is determined mostly by the level of recruitment compensation as  $N$  declines, and  $C$  is likely very similar for different sized mammals. We use existing mammal life-history data to estimate  $C$  (~0.5). We then estimate the threshold of instantaneous mortality rate,  $F$ , as a function of adult body mass,  $W$ ; it's a  $-0.25$  power allometry. Finally, we extend the model to fish.  $C$  is expected to vary a lot between fish species, mostly because fish are expected to have much larger recruitment compensation than mammals, the recruitment may correlate with body size, and immature fish are often not exploited. We show how to combine these to predict  $C$ .

**Keywords:** exploitation-caused extinction, fisheries-extinction, life span allometry, mammals, population recruitment.

## INTRODUCTION

Animal populations may be driven extinct by human exploitation even in the absence of other forms of habitat degradation. This simply requires that the added fishing/hunting mortality overpower the added recruitment normally present as  $N \rightarrow 0$ . Fishery scientists have studied this, theoretically and empirically, for many years (e.g. Myers and Mertz, 1998; Myers *et al.*, 1999; Myers and Worm, 2005). In general, if a fishing fleet exploits several populations

---

Correspondence: E.L. Charnov, Department of Biology, The University of New Mexico, Albuquerque, NM 87131, USA. e-mail: rlc@unm.edu

Consult the copyright statement on the inside front cover for non-commercial copying policies.

---



[www.evolutionary-ecology.com](http://www.evolutionary-ecology.com)

***Evolutionary Ecology Research* is delighted that you wish to consult one of its articles.**

You may if your library or laboratory subscribes.

Did you know that EER invented the idea of posting final drafts of mss as soon as they are accepted?

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:

- Was the first journal in the world to allow e-only subscriptions while maintaining a traditional print edition, too.
- 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 so you can use your web browser to find any article, author, title word or keyword in any article that *EER* has ever published. (Forget 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, keyword or author in any article *EER* has ever published.
- Provides its own **new** search filter that allows you instantly to compile a hot-linked list of articles according year, issue, author, title word or keyword (as you prefer).

*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](#)**