Mathematical Applications for Conservation Ecology: The Dynamics of Tree Hollows and the Design of Nature Reserves

Ian R Ball

Submitted in partial fulfilment of the requirements of a PhD.

University of Adelaide,
Department of Applied Mathematics

Table of Contents

Part 2: The Nature of Reserve Design and the Design of Nature Reserves

Bibliography

Abstract

The first part of this thesis describes a deterministic computer model for simulating forest dynamics. The model predicts the long term dynamics of hollow bearing trees which occur in a single species (monotypic) forest stand under an array of different timber harvesting regimes over a time scale of centuries. It is applied to a number of different timber harvesting scenarios in the mountain ash (*Eucalyptus regnans* F.Muell.) forests of Victoria, south-eastern Australia. The results have far-reaching implications for forest management. These include: 1) When the harvest rotation time is 100 years or less, a supply of trees with hollows cannot be ensured by only retaining trees which already have hollows; and 2) When some retained trees are lost through logging related mortality, the effect on the number of trees with hollows is exaggerated. For instance if half of the retained trees are lost via logging related mortality, it is not sufficient to double the number of trees retained in order to maintain the same number of hollow bearing trees.

The second part of the thesis looks at a number of new mathematical problems in the design of nature reserve systems. The basic problem is to select a set of sites from a list to try to meet the representation requirements of a set of species which occur on these sites for as small a cost or number of sites as possible. After comparing a number of methods for solving basic problems a number of new problems are introduced. These include: Fixing the cost or size of the reserve system and then trying to maximise species coverage; Building a reserve system up in stages with species requirements incremented - this is another way of controlling the size or cost of the reserve system and also allows the cost - biodiversity trade-off to be examined; Controlling fragmentation of the reserve system by trying to minimise the boundary length as well as the size of the reserve; and introducing spatial requirements for each species. These requirements are that individual patches with the species be large enough to be viable on their own, as well as having some patches separated by a great enough distance that they are not all likely to be destroyed in a local catastrophe.