Catastrophe Management and Inter-Reserve Distance for Marine Reserve Networks

by

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The design of reserve networks for marine conservation will always be a contentious issue. Many attempts have been made to design networks to deal with the transfer of organisms. These models more often than not fail to deal with the possibility of catastrophe. Inter-reserve distance greatly influences the ability for an organism to be able to recolonise to another viable patch. However for a model, which is affected by some disaster, we must minimize the possibility of the two-patch meta-population becoming extinct.

Initially we consider a Markov Chain model, which uses a Quasi-Stationary Distribution approach to develop policies for reserve management of reserve colonisation and extinction to find an algebraic expression for the optimal spacing for exponentially distributed catastrophe sizes. The analysis relies on finding the eigenvalues and quasi-stationary distributions of the Markov chain meta-population model for the system. This model examines the specific survival of a population which as viable reserve at some suitable distance away.

We further develop the structure of our model to include the possibility of local extinction and colonisation from outside the two-patch system. These two further markov matrices allow us to interpret how the effects of local extinction affect the viability of the second patch. The effect of an external source population might have on the final sustainability of the network can also be considered given this adapted markov chain model.

The results found by analyzing this model use the theory of stationary distributions to show that a viable distance can be found given initial colonisation and extinction probabilities. Our work shows that a possible analytic solution may exist for the placement of reserves with respect to extinction events in Inter-reserve distance problems.