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## Appendix 3.3

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**The following material is Appendix 3.3 for Chapter 3 of: Fowler, C.W. 2009. Systemic Management: Sustainable Human Interactions with Ecosystems and the Biosphere. Oxford University Press**

### **1 Selective evolution between two categories**

Consider  $N_1$  and  $N_2$  as the number of species in two categories. The rate at which species evolve from the first category to the second is defined as  $p_1N_1$ . The term  $p_1$  represents the per-species rate of pseudo-extinction within the first category and is a probability or relative rate. The comparable rate of evolution from the second category to the first is defined as  $p_2N_2$ . Then the respective rates of change (as numerical rates, or absolute rates, not relative rates) for each group will be  $dN_1/dt$  and

$dN_2/dt$  defined in terms of the relative rates and species numbers as

$$dN_1/dt = -p_1N_1 + p_2N_2$$

and

$$dN_2/dt = -p_2N_2 + p_1N_1$$

When equilibrium is reached in the ratio of one category to the other, both rates will be zero and therefore equal:

$$\begin{aligned} dN_1/dt &= -p_1N_1 + p_2N_2 = dN_2/dt \\ &= -p_2N_2 + p_1N_1 = 0 \end{aligned}$$

or

$$p_1N_1 = p_2N_2$$

which means that the ratio  $N_1/N_2$  is determined by the ratio of the rates of speciation ( $p_2/p_1$ ) because:

$$N_1/N_2 = p_2/p_1$$