Appendices

Appendix A. Including the effectiveness of management actions in deriving the two principles.

The utility function we are seeking to minimize is:

$$U = \sum_{i=1}^{S}(1-\omega_i)\delta_i(n_i)\,, \quad s.t. \quad \sum_{i=1}^{S}\omega_i C_i + n_i M_i \leq B \tag{A.1}$$

where *S* is the number of species considered, ω_i contains a 1 or 0 depending on whether we allocate resources for remedial conservation action or not, δ_i is the probability of decline, n_i is the number of monitoring surveys, C_i and M_i are the cost of taking action and monitoring for species *i*, and *B* is the total budget. By decline we mean that the long-term population trend (over and above variability) is negative, so that a species would eventually go extinct without action to increase numbers over the long term.

Let e_i be the effectiveness of a conservation action for species *i,* or the degree to which a species' rate of decline is reduced (so that e_i = 0 means the conservation action has no impact on reducing the decline, and e_i = 1 means that the decline is completely arrested). Using the same approach as in the main text:

A. Monitor a species i for which management action was planned:

$$E[-\Delta U] = \delta_i \frac{-e_b\delta_b M_i}{C_b} + (1-\delta_i)\left(e_b\delta_b\frac{C_i - M_i}{C_b}\right)$$

$$E[-\Delta U] = e_b\delta_b\left(\frac{C_i}{C_b}(1-\delta_i) - \frac{M_i}{C_b}\right) \tag{A.2}$$

B. Monitor a species i for which no management action was planned:

$$E[-\Delta U] = \delta_i \left(e_i - e_b \delta_b \left(\frac{C_i + M_i}{C_b}\right)\right) + (1 - \delta_i)\left(-\frac{e_b \delta_b M_i}{C_b}\right)$$

$$E[-\Delta U] = e_b \delta_b \left(\delta_i \left(\frac{e_i}{e_b \delta_b} - \frac{C_i}{C_b}\right) - \frac{M_i}{C_b}\right). \quad \text{(A.3)}$$