

**Mark Novak and J. Timothy Wootton. 2008. Estimating nonlinear interaction strengths: an observation-based method for species-rich food webs. *Ecology* 89:2083-2089.**

Appendix A: Derivation of Type II observation-based method.

The derivation of Eq. 3 is analogous to the derivation of the type II functional response itself (Holling 1959, Case 2000). Let an arbitrary amount of time  $T$  be divided into the total time an individual predator spends searching ( $T_S$ ) and the total time it spends handling all consumed prey individuals of its prey species ( $T_H$ ).  $T_{H(i)}$  is thus the total time spent handling all individuals of prey  $i$ , which is the product of the handling time of prey  $i$  ( $h_i$ ) and the number of prey  $i$  individuals eaten in time  $T$  ( $E_i$ ).  $E_i$  is the product of the attack rate constant ( $c_i$ ), the abundance of prey  $i$  ( $N_i$ ), and  $T_S$ . Given a survey of a predator population, the fraction of feeding individuals observed in the act of handling prey species  $i$  will be

$$F_i = \frac{\# \text{ observed feeding on prey } i}{\text{total } \# \text{ observed feeding}} = \frac{T_{H(i)}}{T_H} = \frac{c_i \cdot h_i \cdot N_i \cdot T_S}{\sum_{k=1}^S c_k \cdot h_k \cdot N_k \cdot T_S} = \frac{c_i \cdot h_i \cdot N_i}{\sum_{k=1}^S c_k \cdot h_k \cdot N_k}, \quad (\text{A.1})$$

and the fraction of all sampled individuals observed in the act of handling prey species  $i$  will be

$$A_i = \frac{\# \text{ observed feeding on prey } i}{\text{total } \# \text{ sampled}} = \frac{T_{H(i)}}{T} = \frac{c_i \cdot h_i \cdot N_i \cdot T_S}{T_S + \sum_{k=1}^S c_k \cdot h_k \cdot N_k \cdot T_S} = \frac{c_i \cdot h_i \cdot N_i}{1 + \sum_{k=1}^S c_k \cdot h_k \cdot N_k}. \quad (\text{A.2})$$

Using the two prey species case as an example, solve Eq. A.1 to get  $c_2$  as a function of  $F_1$  and  $c_1$ ,

$$c_2 = \frac{c_1 \cdot h_1 \cdot N_1 + c_1 \cdot h_1 \cdot N_1 \cdot F_1}{h_2 \cdot N_2 \cdot F_1}. \quad (\text{A.3})$$

Substitute Eq. A.3 into Eq. A.2, set  $T$  to unity (since the scale to which time is set is arbitrary), and solve for  $c_1$  to obtain

$$c_1 = \frac{F_1 \cdot A_1}{(F_1 - A_1) \cdot h_1 \cdot N_1}. \quad (\text{A.4})$$

Substitute Eq. A.4 into the Eq. A.3 to obtain

$$c_2 = \frac{(1 - F_1) \cdot A_1}{(F_1 - A_1) \cdot h_2 \cdot N_2}. \quad (\text{A.5})$$

Thus, by iteratively solving and substituting, and because in a system of  $S$  prey species

$F_i = 1 - \sum_{k \neq i}^S F_k$ , it can be shown by induction that Eq. 3 is true for any prey  $i$ .

Eq. 3 works for predators with a diet of a single prey species as well (unless all individuals of the population are observed feeding (i.e.,  $F_i = A_i = 1$ )). Thus the choice of prey species  $x$  is arbitrary. However,  $x$  is preferably the species with the highest  $A_i$  since its proportion is likely to be estimated most accurately.

#### LITERATURE CITED

- Case, T. J. 2000. An illustrated guide to theoretical ecology. Oxford University Press, New York, New York, USA.
- Holling, C. S. 1959. Some characteristics of simple types of predation and parasitism. Canadian Entomologist 91:385-398.