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3.6 Foraging time and predation risk

The food consumption prediction relationship in Eq. 52 (see Predicting consumption) contains two parameters that directly influence the time spent feeding and the predation risk that feeding may entail: a_{ij} and v'_{ij}. To model possible linked changes in these parameters with changes in food availability as measured by per biomass food intake rate $c_{it} = Q_{it} / B^{it}$ (*i*=juvenile index *J* or adult index *A*), we need to specify how changes in c_{it} will influence at least relative time spent foraging.

Denoting the relative time spent foraging as T_{it}, measured such that the rate of effective search during any model time step can be predicted as $a_{jit} = T_{it} a_{ji}$ for each prey type *j* that *i* eats. Further, we assume that time spent vulnerable to predation, as measured by v'_{ij} for all predators j on i, is inversely related to *T'it*, i.e., $v'_{ij}t = v'_{ij} / T_{it}$. An alternative structure that gives similar results is to leave the a_{ij} constant, while varying the v_{ij} by setting $v_{ijt} = T_{jt} \cdot v_{ij}$' in the numerator of Eq. 52 in Predicting Consumption and $v_{ijt} = T_{it} \cdot v_{ij}$ in the denominator.

For convenience in estimating the a_{ij} and v'_{ij} parameters, we scale T_{it} so that $T_{i0} = 1$, and $v'_{ij} = v_{ij}$. Using these scaling conventions, the key issue then becomes how to functionally relate T_{it} to food intake rate c_{it} so as to represent the hypothesis that animals with lots of food available will simply spend less time foraging, rather than increase food intake rates.

In Ecosim a simple functional form for *T'it* is implemented that will result in near constant feeding rates, but changing time at risk to predation, in situations where rate of effective search a_{ji} is the main factor limiting food consumption rather than prey behaviour as measured by v_{ji}. This is implemented in form of the relationship:

$$T_{i,t} = T_{i,t-1} \cdot \left(1 - a + \frac{a \cdot c_{i,opt}}{c_{i,t-1}}\right) \quad \textbf{Eq. 65}$$

where, a is a user-defined Feeding time adjustment rate [0, 1] on the Ecosim Group info form; $c_{i,opt}$ is the (internally computed) feeding rate that optimizes feeding rate versus mortality risk for *i*; $c_{i,t-1}$ is the consumption/biomass ratio in the previous time step for the group. The time spent feeding is constrained by a user-defined value (Maximum relative feeding time on the *Group info* form with default of two times the feeding rate in the Ecopath base model).

The relationship between foraging time, consumption and predator biomass is illustrated in Figure 3.4.

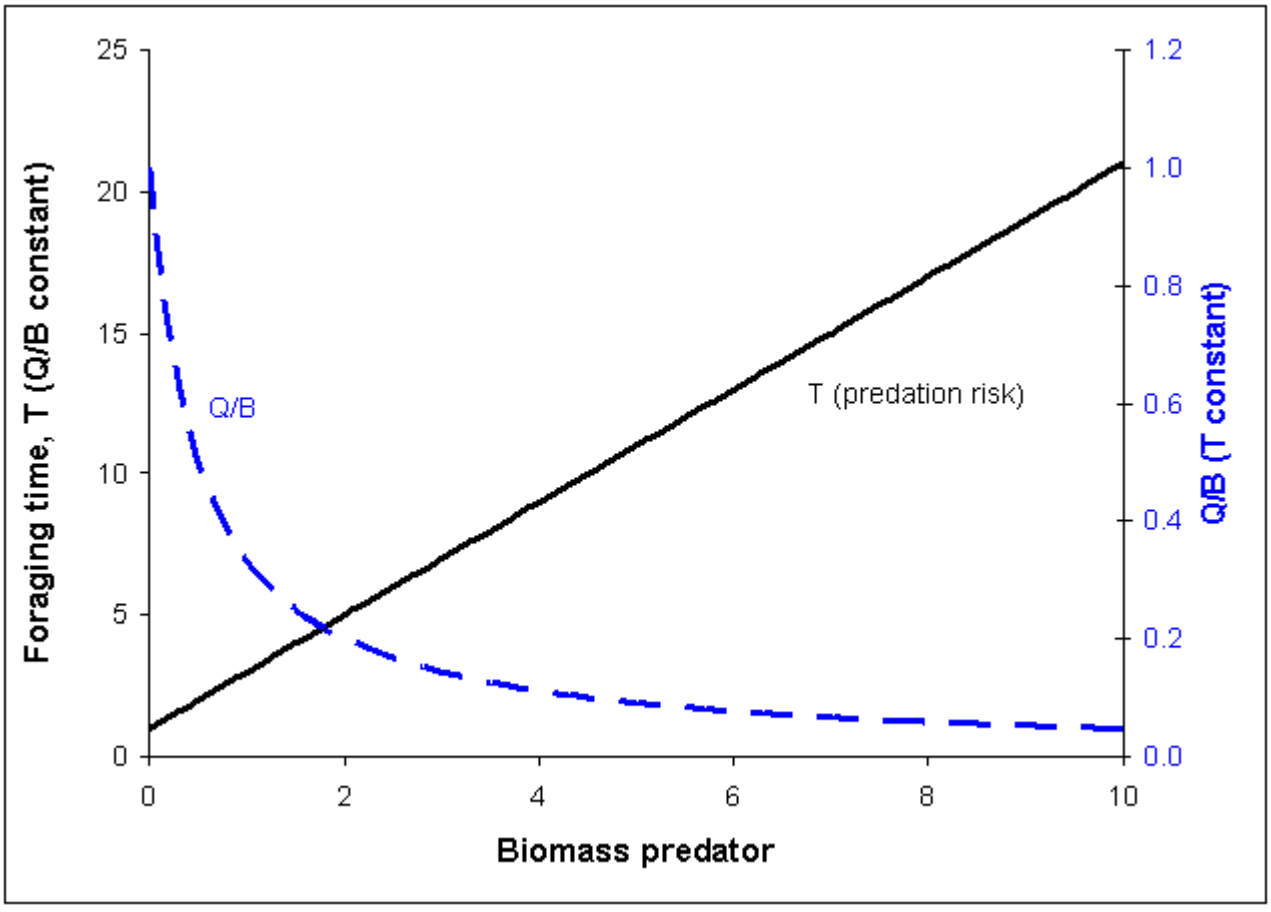

Figure 3.4 Relationship between relative foraging time (*T*), *Q/B* and predator biomass. If *Q/B* is held constant the foraging time (and hence predation risk) is a linear function of the predator biomass (solid line). If *T* is held constant the *Q/B* will decrease asymptotically with predator biomass (stippled line).