

### 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  $c_{it} = Q_{it} / B^t$  ( $i$ =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.,  $v_{ij}^? = v_{ij}^? / T_{it}$ . **An alternative structure that gives similar results is to leave the  $a_{ij}$  constant, while varying the  $v_{ij}$  by setting  $v_{jit} = T_{it} \cdot v_{ij}$**  in the numerator of Eq. 52 in [Predicting Consumption](#) and  $v_{jit} = T_{it} \cdot v_{ij}$  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  $v_{jt}$ . This is implemented in form of the relationship:**

[../Resources/Images?/0800002A.png](#) 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.

[../Resources/Images?/0600002B.png](#)

**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).