Caching in or falling back at the Sevilleta

Sora Kim[1] and Justin Yeakel[1]
[1]*School of Natural Sciences, University of California, Merced, Merced, CA 95340, USA*

I. MODEL DESCRIPTION

We constructed a two-site stage-class model that tracked shark population dynamics over time, where one site was designated the nursery. We considered four key dynamics to characterize changes in population size for both sites: reproduction, somatic growth, mortality, and migration. Vital rates controlling these dynamics were site- and temperature-specific, where temperatures oscillated annually.

Reproduction: The per-capita reproductive rates $r_{\mathrm{n,a}}$ are assumed to differ between the nursery (n subscript) and adult (a subscript) site. We set the reproductive rate at the adult site $r_{\mathrm{a}} = 0$, whereas the reproductive rate at the nursery was scaled to seasonal ocean temperature, such that $r_{\mathrm{n}} = 0.47 \times 10^{-7}$ female pups per second during the warmest part of the year, and 1/2 that during the coldest.

Somatic growth: Partitioning of metabolism B between growth and maintenance purposes can be used to derive a general equation for both the growth trajectories and growth rates of organisms ranging from bacteria to metazoans [1–5]. This relation is derived from the balance condition $B_0 m^\eta = E_m \dot{m} + B_m m$, [1–5] where E_m is the energy needed to synthesize a unit of mass, B_m is the metabolic rate to support an existing unit of mass, and m is the mass of the organism at any point in its development. This balance has the general solution [5**?**]

$$\left(\frac{m\,(t)}{M}\right)^{1-\eta} = 1 - \left[1 - \left(\frac{m_0}{M}\right)^{1-\eta}\right] e^{-a(1-\eta)t/M^{1-\eta}}, \quad (1)$$

where, for $\eta < 1$, $M = (B_0/B_m)^{1/(1-\eta)}$ is the asymptotic mass, $a = B_0/E_m$, and m_0 is mass at birth. We now use this solution to define the timescale for reproduction and recovery from starvation (Fig. **??**; see [2] for a detailed presentation of these timescales). The time that it takes to reach a particular mass ϵM is given by the timescale

$$\tau\,(\epsilon) = \ln\left[\frac{1-(m_0/M)^{1-\eta}}{1-\epsilon^{1-\eta}}\right]\frac{M^{1-\eta}}{a\,(1-\eta)}, \quad (2)$$

where ϵ is used to partition growth into discrete size classes.

Mortality:

Migration:

[1] G. B. West, J. H. Brown, and B. J. Enquist, Nature **413**, 628 (2001).

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