APPENDIX 1

Candidate Models

Variables that appear in multiple equations are only defined once, at their first appearance.

1. *Linear model*

The linear model is a simple relationship with two parameters, given as:

$$y = b_0 + b_1 x,$$

where y = the response variable, b_1 = rate of change, x = age (number of days since hatch), and b_0= initial value at hatch. Linear models are often applied to specific parts of the growth curve (i.e., "linear growth rate"; Coulson & Porter 1985, Nisbet 1978), and may be especially useful for measures of structural growth such as wing or tarsus length.

2. Quadratic model

The quadratic model consists of three terms and can be defined as:

$$y = ax^2 + bx + c,$$

where a is the quadratic coefficient, b is the linear coefficient, and c is the constant (i.e., free term). The quadratic model is not a typical growth curve model but was considered because the stereotypical pattern of puffling mass gain may visually resemble some aspects of a quadratic curve.

3. Logistic model

The logistic growth model contains three parameters, and is given as:

$$y = \frac{K}{1+e^{-r(x-x_i)}},$$

where K = asymptotic body mass, e = Euler's number (~2.718), r = the growth rate constant, and x_i = the age at the inflection point. This model has a fixed inflection point at 50% of the upper asymptote (Ricklefs 1968).

4. Gompertz model

The Gompertz model also consists of three parameters, and is usually given as:

$$y = Ke^{-e^{-r(x-x_i)}}.$$

Like logistic growth, this model has a fixed inflection point, but it is lower at 36.79% of the upper asymptote (Ricklefs 1968).

5. Extreme value function (EVF) model

The EVF model also consists of three parameters, and can be given as:

$$y = K\left(1 - e^{-e^{r(x-x_i)}}\right).$$

This model has a fixed inflection point higher than that of logistic growth, at 63.21% of the slope. While the EVF model is not commonly used to describe offspring growth, it behaves similarly to the logistic and Gompertz functions and, as such, can be easily compared to these models. The EVF was found to best represent tarsus growth of African black oystercatchers *Haematopus moquini* in Tjørve & Tjørve (2010), and thus may be particularly useful for skeletal measurements.

6. von Bertalanffy model

The von Bertalanffy model contains three parameters, and is given as:

$$y = K(1 - e^{-r(x+x_0)}),$$

where x_0 is a starting point on the x-axis for the curve, at $r = -x_0$. Because the curve has a starting point on the x-axis, it does not have a lower asymptote, unlike the previous three models. The inflection point on this model is the lowest of the considered models at 29.63% of the upper asymptote. While this model is no longer commonly used to describe chick growth, it is still considered one of the classic models (Ricklefs 1968).

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