Appendix B

Below are provided two examples of life cycles used in the analysis of the effects of senescence on population dynamics in 58 species of mammals. All other life cycles are available upon request. Models were implemented with the program ULM (Legendre and Clobert 1995) and the popbio R-package (Stubben and Milligan 2007; R Development Core Team 2011). At the end of Appendix B is a table providing time step and matrix dimension for the 58 life cycles.

a. Annual time step: *Desmodus rotundus* (Vampire Bat)

Below is the annual transition matrix for the species (we used a 18×18 matrix for a species with maximum life span L=18 years and an annual time step, see data in Lynch and Fagan [2009]).

s_x is the annual survival rate between ages x and x+1.

LittSize is the annual litter size per female

#litt is the number of litters per year per female

σ is the primary sex-ratio (σ is set to 0.5 in all models)

f is the annual fertility given by f= *LittSize**#litt**σ*s_0

f f f f f f f f f f f f f f f f f f

s_1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 s_2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 s_3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 s_4 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 s_5 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 s_6 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 s_7 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 s_8 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 s_9 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 s_{10} 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 s_{11} 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 s_{12} 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 s_{13} 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 s_{14} 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 s_{15} 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 s_{16} 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 s_{17} 0

Using this transition matrix, the annual growth rate (λ), the per generation deterministic growth rate (R_0) and the generation time (T, in years) were computed (see Caswell 2001).

b. Infra-annual time step: *Peromyscus leucopus* (White-footed Mouse)

Below is the transition matrix for the species. The time step t_s is equal to 0.2 year, which corresponds to the age at female maturity (we used a 15×15 matrix for a species with maximum life span L=3.9 years and t_s=0.2, see data in Lynch and Fagan [2009]).

s_{sx} is the survival rate between time steps x and x+1.

$LittSize_s$ is the litter size per female per time unit

$\#litt_s$ is the number of litters per time unit per female

σ is the primary sex-ratio (σ is set to 0.5 in all models)

f_s is the annual fertility given by $f_s = LittSize_s * \#litt_s * \sigma * s_{s0}$

f_s f_s f_s f_s f_s f_s f_s f_s f_s f_s f_s f_s f_s f_s f_s

s_{s1} 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 s_{s2} 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 s_{s3} 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 s_{s4} 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 s_{s5} 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 s_{s6} 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 s_{s7} 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 s_{s8} 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 s_{s9} 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 s_{s10} 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 s_{s11} 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 s_{s12} 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 s_{s13} 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 s_{s14} 0

Using this transition matrix, the growth rate per time unit (λ_s) and the generation time (T_s, in time units) were computed (see Caswell 2001). The generation time T (in years) and the annual and per generation growth rates λ and R_0 were then approximated to:

$$T = \frac{T_s}{t_s}$$

$$\lambda = \lambda_s^{\left(\frac{1}{t_s}\right)}$$

$$R_0 = \lambda^T$$

c. Time step and matrix dimension for the 58 species

Scientific name	Time step (in years)	Matrix dimension
Pipistrellus pipistrellus	1	8×8
Pipistrellus subflavus	1	10×10
Myotis lucifugus	1	11×11
Plecotus auritus	1	21×21
Peromyscus leucopus	0.2	16×16
Blarina brevicauda	0.125	9×9
Myodes glareolus	0.111	10×10
Zapus princeps	1	7×7
Apodemus flavicollis	0.142	8×8
Desmodus rotundus	1	18×18
Talpa europaea	0.5	11×11
Tamias striatus	0.5	15×15
Spermophilus lateralis	0.25	29×29
Ochotona princeps	1	7×7
Tupaia glis	0.25	13×13
Tamiasciurus hudsonicus	1	6×6

Spermophilus beldingi	1	10×10
Spermophilus armatus	1	5×5
Spermophilus dauricus	1	7×7
Rattus norvegicus	0.25	5×5
Mustela erminea	0.25	5×5
Spermophilus columbianus	1	6×6
Sciurus carolinensis	1	8×8
Sylvilagus floridanus	0.333	10×10
Martes zibellina	1	12×12
Urocyon cinereoargenteus	1	9×9
Marmota flaviventris	1	8×8
Vulpes vulpes	1	6×6
Lynx rufus	1	11×11
Taxidea taxus	0.5	23×23
Propithecus diadema	1	21×21
Capreolus capreolus	1	10×10
Rupicapra rupicapra	1	11×11
Pongo abelii	1	59×59
Pan troglodytes	1	56×56
Callorhinus ursinus	1	24×24
Puma concolor	1	13×13
Aepyceros melampus	1	13×13
Hemitragus jemlahicus	1	13×13
Ovis dalli	1	14×14
Odocoileus hemionus	1	12×12
Ursus americanus	1	19×19
Phacochoerus aethiopicus	1	17×17
Damaliscus lunatus	1	7×7
Ursus arctos horribilis	1	21×21
Rangifer tarandus	1	16×16
Connochaetes taurinus	1	21×21
Tursiops truncatus	1	36×36
Kobus defassa	1	13×13
Sus scrofa	1	10×10
Cervus elaphus	1	16×16
Equus burchelli boehmi	1	21×21
Eumetopias jubatus	1	33×33
Alces alces	1	15×15
Equus caballus	1	24×24
Syncerus caffer	1	19×19
Mirounga leonina	1	24×24
Hippopotamus amphibius	1	44×44

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