Exercises: Population dynamics

(1) The human population size is currently estimated at 7.4×10^9 individuals. It is growing at an approximate rate of 1.1 per cent per year, which means that the per capita change in the population size over this demographic time period is $\Delta n/n = (w - 1) = 0.011$. Hence, the average fitness of an individual is $w = 1.011$. For this situation:

Determine after how many demographic time periods (how many years) the human population size will have doubled, given the current size is n_0 and assuming constant fitness.

(2) The bacteria *E. coli* divides into two individuals every 20 minutes under ideal conditions: this can be taken as its demographic period. The size of an *E. coli* bacteria is approximately one cubic micrometer, that is, 10^{-18} m^3. Suppose that resources are not limiting and that *E. coli* grows in the absence of density-dependent competition. For this situation:

Determine the time needed for a population founded by a single *E. coli* individual to fill up the volume of the observable universe, which is estimated to be 4×10^{80} m^3.

(3) Suppose that the number of offspring produced by an individual (effective fecundity) follows a Beverton-Holt model of density-dependent competition and that each individual survives with probability s to the next generation, where s is assumed to be density-independent. For this model:

(i) Write down the expression for the fitness of an individual.

(ii) Evaluate the equilibrium population size.

(iii) Does the equilibrium population size increase or decrease with the survival probability s?