Supplementary material
Supplement 2. Matrices composing the multi-event model

Reproductive parameters were calculated using an underlying population model that can be characterized by transition matrices. The initial vector defined the initial proportion of females genetically identified at the first event of capture (C: currently) or later (L: later):

$$\boldsymbol{\pi} = \begin{pmatrix} \pi_{\mathrm{L}} & \pi_{\mathrm{C}} \end{pmatrix} \tag{1}$$

Another initial matrix distributed the individuals according to their maturity at first encounter (I: immature or M: mature):

$$\boldsymbol{\pi} = \begin{pmatrix} \pi_{\mathrm{I/L}} & 0 & \pi_{\mathrm{M/L}} & 0 \\ 0 & \pi_{\mathrm{I/C}} & 0 & \pi_{\mathrm{M/C}} \end{pmatrix} \tag{2}$$

A last initial matrix distributed the mature individuals according to their initial breeding status (NB: non-breeder or B: breeder). Then genetic identification can be done previously (P), currently (C) or later (L). In subsequent occasions, we will have individuals identified earlier. Columns 3 and 6, unused here, are placeholders for these future states:

$$\boldsymbol{\pi} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & (1-\pi_{\mathrm{B}}) & 0 & 0 & \pi_{\mathrm{B}} & 0 & 0 \\ 0 & 0 & 0 & 0 & (1-\pi_{\mathrm{B}}) & 0 & 0 & \pi_{\mathrm{B}} & 0 \end{pmatrix} \tag{3}$$

The survival (s) matrix **S** described mortality until the beginning of the next season (I: immature, NB: mature non-breeder, B: mature breeder and D: dead) as a function of the 2 age classes:

$$\mathbf{S} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & s & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & s & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & s & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & s & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & s & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & s & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \tag{4}$$

Then the matrix **T** described the sex status (previously, currently or yet to be identified). The only parameters to be estimated concern the transitions from yet to be identified to currently identified:

$$\mathbf{T} = \begin{pmatrix} (1-t) & t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & (1-t) & t & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & (1-t) & t & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \quad (5)$$

The **A** matrix described the age (a) of the individual:

$$\mathbf{A} = \begin{pmatrix} (1-a) & 0 & 0 & a & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & (1-a) & 0 & 0 & a & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & (1-a) & 0 & 0 & a & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \quad (6)$$

Then the transition matrix **B** described the breeding (b) success. It is followed by the transition matrix, which describes the passage to the new breeding status at $t + 1$ (column status) as a function of the status at t (in row):

$$\mathbf{B} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & (1-b_{\mathrm{NB}}) & 0 & 0 & b_{\mathrm{NB}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & (1-b_{\mathrm{NB}}) & 0 & 0 & b_{\mathrm{NB}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & (1-b_{\mathrm{NB}}) & 0 & 0 & b_{\mathrm{NB}} & 0 \\ 0 & 0 & 0 & (1-b_{\mathrm{B}}) & 0 & 0 & b_{\mathrm{B}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & (1-b_{\mathrm{B}}) & 0 & 0 & b_{\mathrm{B}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & (1-b_{\mathrm{B}}) & 0 & 0 & b_{\mathrm{B}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \quad (7)$$

Eventually, the **P** matrix of event probabilities (p) relates the status (in row) to the event at $t + 1$ (in column):

$$\mathbf{P} = \begin{pmatrix} (1-p_1) & p_1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ (1-p_1) & p_1 & 0 & 0 & 0 \\ (1-p_1) & p_1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ (1-p_1) & p_1 & 0 & 0 & 0 \\ (1-p_2) & 0 & p_2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ (1-p_2) & 0 & p_2 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{pmatrix}$$