Modelling chamois population trends in the Swiss National Park from 1994 to 2022

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Background

- Abundance of all animal populations fluctuate over the years. These fluctuations can be described by the population growth rate.
- Population growth rate itself is a function of vital rates, e.g., survival, fecundity, or sex ratio.
- Integrated Population Models (IPM) combine data from population counts and marked animals to improve estimates of vital rates and population size.

Questions

- What processes are responsible for the population trends of chamois in the Swiss National Park (SNP)?
- Which vital rate contributed the most to the population growth rate?
- What happened in years with low vital rates and low population growth rates?

Method

- An IPM was fitted to 30 years of data from chamois counts (state-space model) and observations of marked animals (Cormack-Jolly-Seber model).
- Yearly estimates of vital rates were parametrized as random effects around a mean vital rate.
- A half-normal detection model accounted for years with poor observation conditions.
- A transient life table response experiment (tLTRE) revealed how changes in each vital rate contributed to changes in population growth rate.

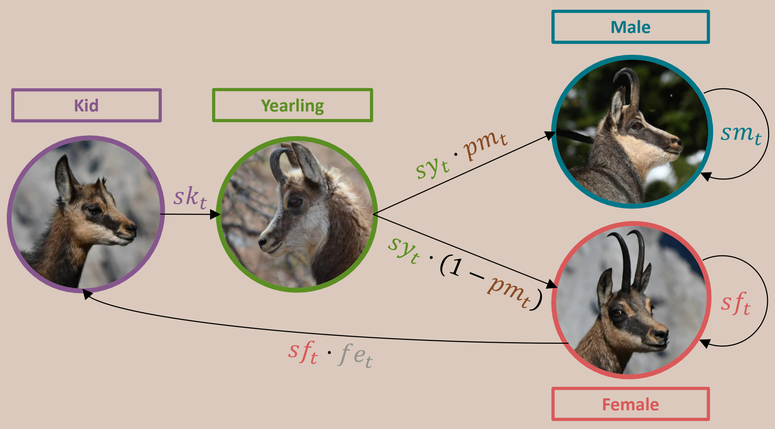

Fig. 1: Stage structured population model describing how each stage contributes to the stages in the following year.

Estimated population parameters (vital rates):

- sm: survival probability of males
- sf: survival probability of females
- sy: survival probability of yearlings
- sk: survival probability of kids
- fe: fecundity (number of juveniles per female)
- pm: sex ratio (proportion of male yearlings)

Results

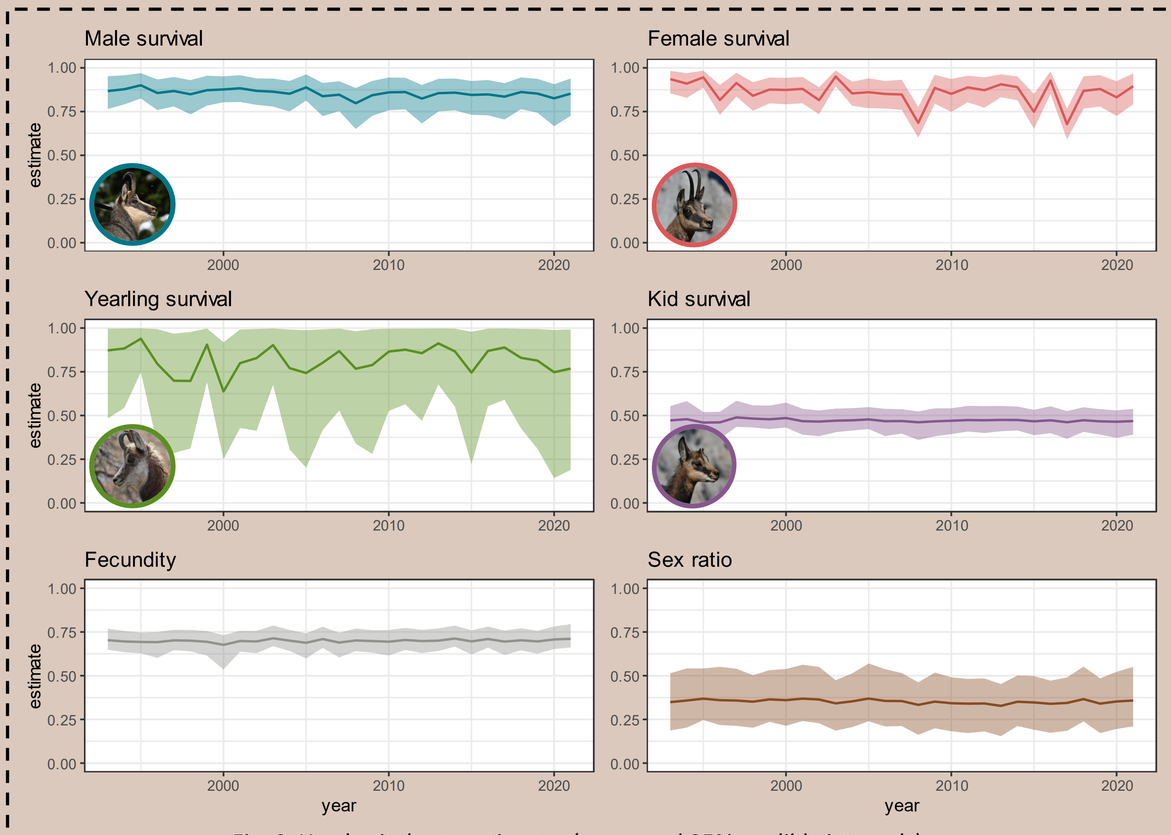

Fig. 2: Yearly vital rate estimates (mean and 95% credible intervals)

- Most vital rates were constant over the years. In some years female survival was notably lower than on average.
- Female survival was sensitive to chamois abundance. It was high when abundance was low, dropped as abundance increased, and recovered as abundance decreased.
- Changes in female survival contributed the most to changes in the population growth rate.

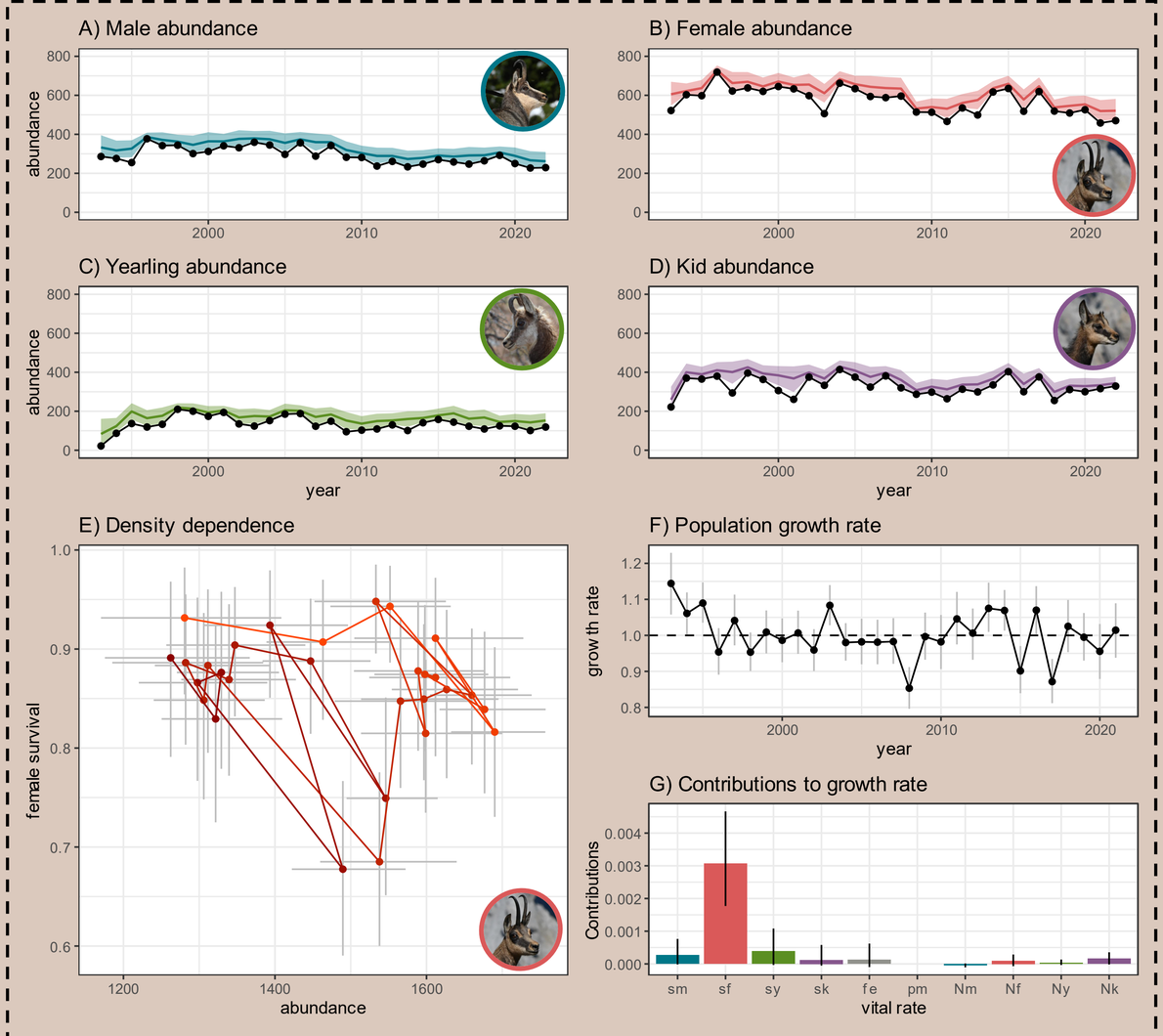

Fig. 3: Abundance of males (A), females (B), yearlings (C), and kids (D) in the SNP. Black dots show the counted number of animals. E) Female survival against chamois abundance. Darker points show later years. F) Change of population growth rate over the years. G) Contribution of the realized temporal variation of the vital rates and of proportional population structure (N) to temporal variability of the realized population growth rates. A-G) Error bars show 95% credible intervals around the mean parameter estimates.

Conclusion

- Female survival is the most important vital rate explaining chamois population trends.
- Female survival is density dependent and reacts strongly to changing environmental conditions.
- Years with low female survival occurred in years with harsh winters (2008/09 and 2017/18) and in a year with a disease outbreak (2015, infective keratoconjuntivitis).

A big thank you goes to the park wardens who have counted and marked ungulates in the park over all the years. Claudio Irniger took the photos. The expertise of Flurin Filli and Pia Anderwald was very helpful in interpreting the results.