

Lebl, K., Bieber, C., Adamík, P., Fietz, J., Morris, P., Pilastro, A. and Ruf, T. 2010. Survival rates in a small hibernator, the edible dormouse: a comparison across Europe. – *Ecography* 33: xxx–xxx.

Supplementary material

Appendix 1

Density estimation

Different survival rates between areas could be caused by density differences. Populations at higher densities can suffer from increased mortality rates, which may be due to intrinsic (e.g. increased intraspecific competition) as well as extrinsic (e.g. higher predation risk) factors (Sinclair and Pech 1996).

To compare the abundance of edible dormice at the different study areas, we estimated population size separately for each study site and year using the closed capture approach implemented in MARK (White and Burnham 1999). We only used capture occasions from the 2nd to the 4th month in the active season, since at the beginning and towards the end of the active season not all dormice are active. We used linear models to test for area differences and to find out if there are density differences between RY and NRY.

Due to the differences in the data collection it is difficult finding a satisfying density estimator which allows comparing the abundance of edible dormice at the five study areas. We compared the estimated population size regarding 1) the number of nest-boxes and 2) the size of the area and number of nest-boxes (only Czechia, Germany and Italy, since in those areas the nest-boxes were arranged in a grid pattern) (Table A1-1). The number of

dormice per nest-box differed between the areas and was highest in Austria and Italy ($p < 0.001$, $F_{4,34} = 36.833$). However, comparing the number of animals per nest-box and size [ha] showed no differences between the areas ($p = 0.468$, $F_{2,20} = 0.789$). The density was not affected by reproductive years (N per NB: $p = 0.686$, $F_{1,33} = 0.166$; N per nest-box and ha (Czechia, Germany and Italy): $p = 0.168$, $F_{1,19} = 2.057$).

The high number of dormice per nest-box in Austria and Italy most likely indicates a shortage of alternative nesting and breeding sites rather than density differences, since the occupancy can depend on the availability of natural nesting sites and the number of nest-boxes in the direct neighbourhood (Juškaitis 2006). We found no evidence for different abundances in the number of animals per nest-box and ha in our study (at least for Czechia, Germany and Italy), therefore it is very unlikely that density differences are the cause for the observed survival differences between the areas.

References

- Juškaitis, R. 2006. Nest-box grids in population studies of the common dormouse (*Muscardinus avellanarius* L.): methodological aspects. – *Pol. J. Ecol.* 54: 351–358.
- Sinclair, A. R. E. and Pech, R. P. 1996. Density dependence, stochasticity, compensation and predator regulation. – *Oikos* 75: 164–173.
- White, G. C. and Burnham, K. P. 1999. Program MARK: survival estimation from populations of marked animals. – *Bird Study* 46: 120–138.

Table A1-1. Different approaches to estimate density of edible dormice at the five study areas. N is the mean estimated population size over the study period, using the closed capture approach, NB is the number of nest-boxes and ha the size of the study size in hectares. Nest-boxes in Austria and England were not arranged in a grid-pattern, which makes it inappropriate to relate the population size to an area.

| | Austria | Czechia | England | Germany | Italy |
|-----------------------------------|---------|---------|---------|---------|----------|
| N | 624.12 | 143.45 | 79.71 | 76.68 | 345.90 |
| (sd N) | (50.05) | (30.61) | (50.11) | (20.97) | (132.61) |
| NB | 197 | 100 | 135 | 126 | 100 |
| ha | 1860 | 23 | 50 | 12 | 60 |
| $N \times NB^{-1}$ | 3.168 | 1.435 | 0.590 | 0.609 | 3.459 |
| $N \times ha^{-1}$ | – | 6.237 | – | 6.390 | 5.765 |
| $N \times NB^{-1} \times ha^{-1}$ | – | 0.062 | – | 0.051 | 0.058 |

Appendix 2

Separate models for each area

We calculated models for each study area separately following the procedure described in the Methods. The general model for the areas England, Germany and Italy was $[(\text{Sex} \times \text{Month} \times \text{Repr}) p(\text{Sex} \times \text{Month} \times \text{Repr})]$, and for the areas Austria and Czechia it was $[\Phi(\text{Sex} \times \text{Month}) p(\text{Sex} \times \text{Month})]$, as we had reproductive years only in these areas. In addition, to check for temporal trends, we used the model $[\Phi(\text{Sex} \times \text{Month} \times \text{Year}) p(\text{Sex} \times \text{Month} \times \text{Year})]$ as a starting point as well (England, Germany and Italy only, as we did not consider it meaningful to check for long term effects in datasets less than four three). The only difference to the procedure described in Methods was that, since there was one parameter less ('Area'), we could estimate the best estimates for survival and recapture probabilities in one step.

The results of the models for each area were very similar to the best model in the general analysis (Table A2-1): In all areas we found a strong seasonal pattern with low survival in early summer, higher rates in late summer and the highest survival rates in winter (Fig. A2-1). For all populations experiencing RY as well as NRY the factor reproduction was also present in the candidate models, and survival was higher in NRY compared to RY. The factor sex was included in all areas, except for the population in Czechia. However, as the effect size for this factor was rather small and this was the population with the smallest sample size, it is possible that the missing sex effect was due to the sample size.

The best models with the factor year instead of RY/NRY all included the three factors year, season and sex (Table A2-2). We found no evidence for any long-term trend of survival rates in any population, but in all but the German population several parameters could not be estimated due to sparseness of data in individual areas. As an example, parameter estimates for the German population are shown in Fig. A2-2.

Table S2.1 Models for survival and recapture estimates, computed separately for each area. Models are ranked according to their QAICc, only models ranked 1–7 are shown. np number of estimated parameters; QAICc quasi-likelihood corrected AICc; Δ QAICc difference between the QAICc and the minimum QAICc; Model likelihood relative strength of evidence for a model within the set of models computed. Best models (models within a Δ QAICc < 2 from the model ranked first) are marked in bold.

| parameters | np | QAICc | Δ QAICc | Model likelihood | Deviance |
|---|----|----------------|----------------|------------------|----------------|
| Austria (N=1070; \hat{c} =1.1826) | | | | | |
| Φ(Season \times Sex) p(Month \times Sex) | 20 | 3799.03 | 0.00 | 0.57 | 995.71 |
| Φ(Season + Sex) p(Month \times Sex) | 17 | 3800.77 | 1.74 | 0.24 | 1003.57 |
| Φ (Season) p(Month \times Sex) | 16 | 3801.18 | 2.15 | 0.19 | 1006.02 |
| Φ (Month) p(Month \times Sex) | 18 | 3813.71 | 14.68 | <0.001 | 1014.47 |
| Φ (Month + Sex) p(Month \times Sex) | 19 | 3814.85 | 15.82 | <0.001 | 1013.57 |
| Φ (Month \times Sex) p(Month \times Sex) | 24 | 3820.79 | 21.76 | <0.001 | 1009.26 |
| Φ (Season) p(Season \times Sex) | 12 | 3838.68 | 39.64 | <0.001 | 1051.64 |
| Czechia (N=304; \hat{c} =1.1094) | | | | | |
| Φ(Season) p(Month \times Sex) | 16 | 962.19 | 0.00 | 0.43 | 278.22 |
| Φ(Month) p(Month \times Sex) | 18 | 963.06 | 0.87 | 0.28 | 274.82 |
| Φ (Season + Sex) p(Month \times Sex) | 17 | 964.31 | 2.12 | 0.15 | 278.21 |
| Φ (Month + Sex) p(Month \times Sex) | 19 | 965.19 | 3.00 | 0.10 | 274.80 |
| Φ (1) p(Month \times Sex) | 13 | 968.47 | 6.27 | 0.02 | 290.85 |
| Φ (Season \times Sex) p(Month \times Sex) | 20 | 968.80 | 6.61 | 0.02 | 276.25 |
| Φ (Sex) p(Month \times Sex) | 14 | 970.49 | 8.29 | 0.01 | 290.76 |
| England (N=473; \hat{c} =1.0701) | | | | | |
| Φ(Repro \times Sex + Season) p(Month \times Repro \times Sex) | 29 | 4128.79 | 0.00 | 0.51 | 2815.90 |
| Φ (Month + Repro \times Sex) p(Month \times Repro \times Sex) | 31 | 4131.40 | 2.61 | 0.14 | 2814.31 |
| Φ (Repro + Season + Sex) p(Month \times Repro \times Sex) | 28 | 4131.48 | 2.69 | 0.13 | 2820.68 |
| Φ (Repro \times Season + Sex) p(Month \times Repro \times Sex) | 30 | 4132.34 | 3.55 | 0.09 | 2817.35 |
| Φ (Repro + Season \times Sex) p(Month \times Repro \times Sex) | 31 | 4132.40 | 3.61 | 0.08 | 2815.31 |
| Φ (Month + Repro + Sex) p(Month \times Repro \times Sex) | 30 | 4134.42 | 5.63 | 0.03 | 2819.44 |
| Φ (Repro \times Season \times Sex) p(Month \times Repro \times Sex) | 36 | 4137.20 | 8.41 | 0.01 | 2809.57 |
| Germany (N=619; \hat{c} =1.1391) | | | | | |
| Φ(Repro + Season + Sex) p(Month \times Repro \times Sex) | 28 | 4244.59 | 0.00 | 0.19 | 2561.33 |
| Φ(Repro \times Season + Sex) p(Month \times Repro \times Sex) | 30 | 4244.64 | 0.05 | 0.19 | 2557.26 |
| Φ(Repro \times Sex + Season) p(Month \times Repro \times Sex) | 29 | 4245.20 | 0.61 | 0.14 | 2559.88 |
| Φ(Month + Repro + Sex) p(Month \times Repro \times Sex) | 30 | 4245.87 | 1.28 | 0.10 | 2558.49 |
| Φ(Season + Sex) p(Month \times Repro \times Sex) | 27 | 4245.91 | 1.32 | 0.10 | 2564.70 |
| Φ(Month + Repro \times Sex) p(Month \times Repro \times Sex) | 31 | 4246.54 | 1.95 | 0.07 | 2557.11 |
| Φ (Month + Sex) p(Month \times Repro \times Sex) | 29 | 4246.60 | 2.01 | 0.07 | 2561.28 |
| Italy (N=1229; \hat{c} =1.3707) | | | | | |
| Φ(Repro \times Season) p(Month \times Repro \times Sex) | 25 | 7659.68 | 0.00 | 0.36 | 3758.49 |
| Φ(Repro \times Season + Sex) p(Month \times Repro \times Sex) | 26 | 7660.21 | 0.53 | 0.27 | 3756.99 |
| Φ (Month \times Repro) p(Month \times Repro \times Sex) | 27 | 7662.43 | 2.76 | 0.09 | 3757.18 |
| Φ (Month \times Repro + Sex) p(Month \times Repro \times Sex) | 28 | 7662.69 | 3.01 | 0.08 | 3755.40 |
| Φ (Repro + Season) p(Month \times Repro \times Sex) | 23 | 7664.70 | 5.02 | 0.03 | 3767.57 |
| Φ (Month + Repro) p(Month \times Repro \times Sex) | 24 | 7664.88 | 5.20 | 0.03 | 3765.72 |
| Φ (Repro \times Sex + Season) p(Month \times Repro \times Sex) | 25 | 7665.35 | 5.67 | 0.02 | 3764.16 |

Table A2-2. Models for survival and recapture estimates, starting from the general model [$\Phi(\text{Sex} \times \text{Month} \times \text{Year}) p(\text{Sex} \times \text{Month} \times \text{Year})$], separated for each area. Models are ranked according to their QAICc, only models ranked 1–7 are shown. np number of estimated parameters; QAICc quasi-likelihood corrected AICc; ΔQAICc difference between the QAICc and the minimum QAICc; Model likelihood relative strength of evidence for a model within the set of models computed. Best models (models within a $\Delta\text{QAICc} < 2$ from the model ranked first) are marked in bold.

| parameters | np | QAIC | ΔQAIC | Model likelihood | Deviance |
|---|-----|----------------|---------------------|------------------|----------------|
| England (N=473; $\hat{C}=1.2455$) | | | | | |
| $\Phi(\text{Season} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 41 | 3542.70 | 0.00 | 0.60 | 2380.97 |
| $\Phi(\text{Month} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 43 | 3544.98 | 2.29 | 0.19 | 2378.98 |
| $\Phi(\text{Season} \times \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 44 | 3545.99 | 3.29 | 0.12 | 2377.84 |
| $\Phi(\text{Season} + \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 40 | 3549.12 | 6.42 | 0.02 | 2389.52 |
| $\Phi(\text{Season} + \text{Sex}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 29 | 3549.44 | 6.74 | 0.02 | 2413.08 |
| $\Phi(\text{Month} \times \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 48 | 3550.32 | 7.63 | 0.01 | 2373.58 |
| $\Phi(\text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 38 | 3551.05 | 8.35 | 0.01 | 2395.71 |
| Germany (N=619; $\hat{C}= 1.0000$) | | | | | |
| $\Phi(\text{Season} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 41 | 4875.89 | 0.00 | 0.38 | 2902.29 |
| $\Phi(\text{Season} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} \times \text{Year})$ | 147 | 4876.87 | 0.98 | 0.23 | 2670.70 |
| $\Phi(\text{Month} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 43 | 4877.25 | 1.35 | 0.19 | 2899.48 |
| $\Phi(\text{Month} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} \times \text{Year})$ | 149 | 4878.75 | 2.85 | 0.09 | 2667.94 |
| $\Phi(\text{Season} \times \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 44 | 4880.17 | 4.28 | 0.04 | 2900.32 |
| $\Phi(\text{Season} \times \text{Sex} + \text{Year}) p(\text{Month} \times \text{Sex} \times \text{Year})$ | 150 | 4881.33 | 5.44 | 0.03 | 2668.21 |
| $\Phi(\text{Season} + \text{Sex} \times \text{Year}) p(\text{Month} \times \text{Sex} + \text{Year})$ | 53 | 4882.95 | 7.06 | 0.01 | 2884.23 |
| Italy (N=1229; $\hat{C}=1.3311$) | | | | | |
| $\Phi(\text{Season} + \text{Year}) p(\text{Month} \times \text{Year})$ | 44 | 7332.73 | 0.00 | 0.27 | 3278.00 |
| $\Phi(\text{Season} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Year})$ | 45 | 7333.34 | 0.60 | 0.20 | 3276.54 |
| $\Phi(\text{Season} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Year} + \text{Sex})$ | 46 | 7334.34 | 1.60 | 0.12 | 3275.48 |
| $\Phi(\text{Season} + \text{Year}) p(\text{Month} \times \text{Year} + \text{Sex})$ | 45 | 7334.50 | 1.76 | 0.11 | 3277.70 |
| $\Phi(\text{Month} + \text{Year}) p(\text{Month} \times \text{Year})$ | 45 | 7334.79 | 2.06 | 0.10 | 3278.00 |
| $\Phi(\text{Month} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Year})$ | 46 | 7335.40 | 2.66 | 0.07 | 3276.54 |
| $\Phi(\text{Month} + \text{Sex} + \text{Year}) p(\text{Month} \times \text{Year} + \text{Sex})$ | 47 | 7336.40 | 3.66 | 0.04 | 3275.48 |

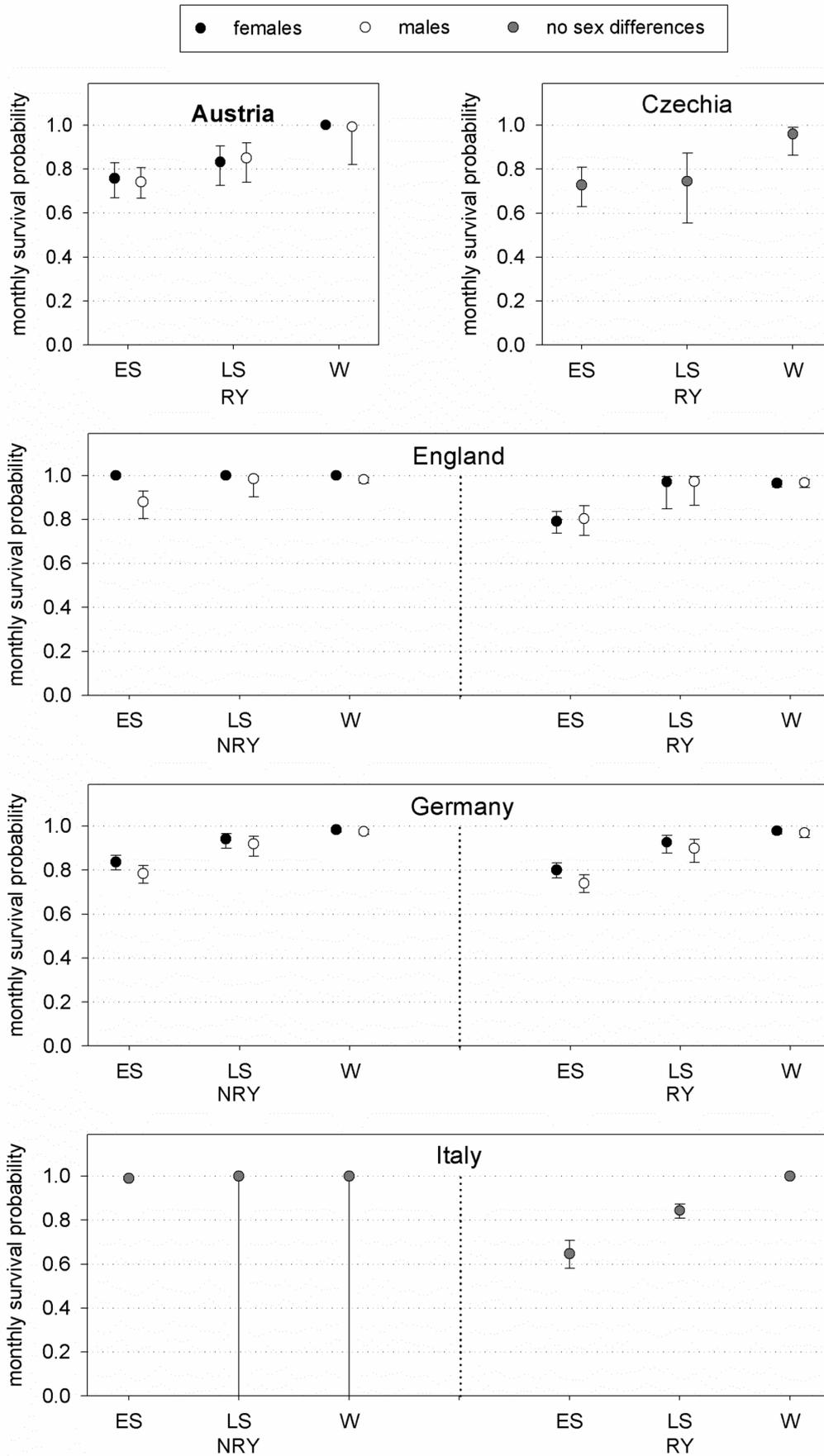


Figure A2-1. Local monthly survival probability \pm 95% CI at the five study areas depending on the season (ES – early summer, LS – late summer, W – winter), sex and differentiated by reproductive (RY) and non-reproductive years (NRY), estimated separately for each area from the model ranked first. Note that in Austria and Czechia only reproductive years occurred during the study period. Due to sparseness of the data not all parameters could be estimated properly (as indicated by estimates of 1 with no CI or CI ranging from 0 to 1).

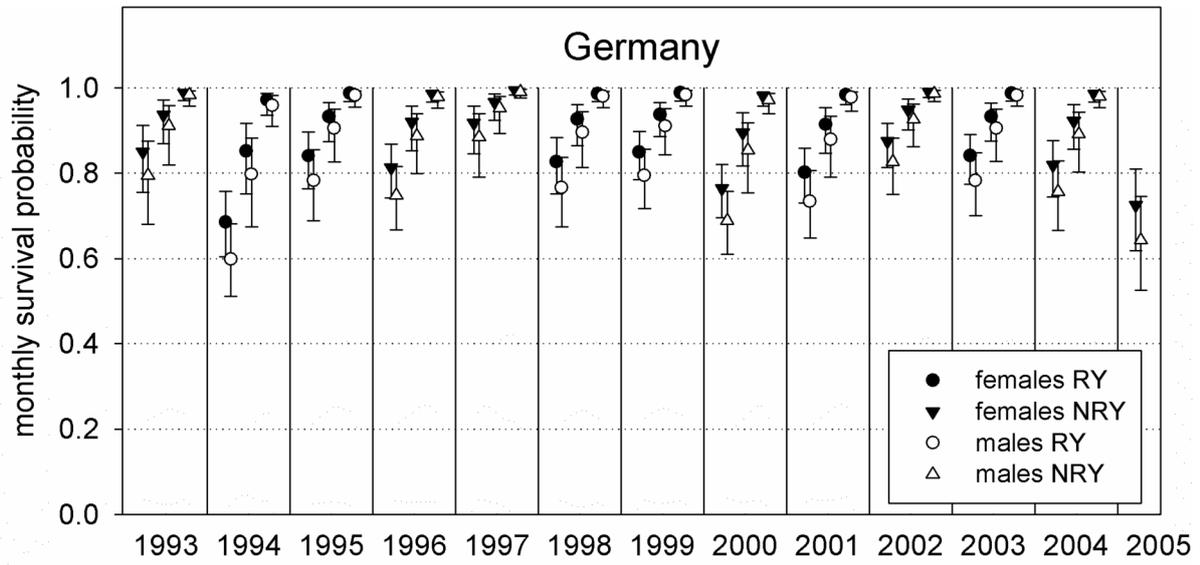


Figure A2-2. Local monthly survival probability \pm 95% CI from the German study area depending on the season (ES – early summer, LS – late summer, W – winter), sex and year, estimated from the model ranked first.