Demography of the enigmatic low phase in a cyclic lemming population

Supplementary material

Appendix. Details on the live-trapping protocol, sample sizes, and tables and figures presenting additional results.

Details of the live-trapping protocol

We used four primary periods (i.e. mid June, early July, late July, and mid August) and up to ten secondary periods (i.e. visits of traps every 12 h) in 2004-2007. In 2008, we reduced the number of primary periods to three (i.e. mid-June, mid-July, mid-August) and the secondary periods to six. Within primary periods our live-trapping design, secondary periods consisted of visiting traps every 12 h for three to five consecutive days depending on the year. For the first primary period, traps were set in the grids for ~24 h in the locked-open mode (i.e. lemmings could enter without activating the trap). Then, traps were activated with a piece of apple (2004-2015) or with both a piece of apple and a small grape-sized ball of peanut butter mixed with oat and flour (2016-2019). Each lemming trapped was identified to species, sex, weighed, and marked with a PIT-tag or an ear-tag. Ear-tags were used to reduce costs but were employed only during the last primary period of 2016-2019 to avoid false mortalities or emigration due to loss of tags. Inter-annual recaptures are extremely rare due to most lemmings living less than a year (Fauteux et al. 2018b). Recaptured lemmings were once again weighed, their reproductive condition was noted, and the tag number was noted. We assigned individuals to age classes (juveniles or adults) based on their body mass, with adult female lemmings being ≥28 g and adult males being ≥30 g

(Fauteux et al. 2015). Traps were then left continuously in the locked-open mode between primary periods. Number of individual lemmings trapped over the years are presented in Table S1.

Table S1. Number of individual brown lemmings captured per year for each sex and age group. Lemmings from all primary periods and trapping grids have been pooled to simplify the table.

Year	Adult females	Adult males	Juvenile females	Juvenile males
2004	19	47	11	28
2005	13	8	2	3
2006	5	5	1	13
2007	2	10	2	8
2008	56	60	25	57
2009	4	7	2	3
2010	83	114	19	49
2011	169	142	38	61
2012	1	9	4	1
2013*	0	0	0	0
2014	181	186	47	62
2015	98	101	57	62
2016	48	66	26	22
2017	3	12	5	4
2018	1	1	0	0
2019	43	53	19	40

*No brown lemming was captured in 2013 even if the exact same trapping protocol as the other years was applied.

Table S2. Model selection for the survival analysis of brown lemmings on Bylot Island conducted with E-SURGE. The most parsimonious model and the next two best models are presented.

φ	*K*	Deviance	ΔAICc
year.*t*+AgeSex.*t*+grid	**51**	**1951.02**	**0.00**
year+AgeSex.*t*+grid	36	1987.87	5.92
AgeSex.*t*+grid	23	2025.02	16.51

year: annual variation; *t*: monthly variation (between primary periods within year); AgeSex: categorical variable with four values (adult females, adult males, juvenile females, juvenile males); grid: categorical variable with four values (wet tundra grid, mesic tundra grid 1, mesic tundra grid 2, predator exclosure).

Table S3. Ranking of negative binomial models for the analysis on maximum and average distances between the initial capture and recaptures based on the second order Akaike's information criterion. The model selected for the results presented in the manuscript is in bold. Models shown are those with a ΔAICc<4 and the following one. All models included an offset based on the log-transformed number of recaptures. For each model, the number of parameter (*K*), the log-likelihood (*LL*) and the dispersion parameter for negative binomial models (θ) are also shown.

Movements	Model	*K*	Log-likelihood	ΔAICc	θ
Maximum distance	**density+sex*age**	**6**	**-5773.70**	**0.00**	**0.467**
	density*age+sex	6	-5774.79	2.19	0.467
	density+sex+age	5	-5775.97	2.51	0.466
	density*sex*age	9	-5772.68	4.05	0.468
Average distance	**density+sex*age**	**6**	**-5453.47**	**0.00**	**0.441**
	density*sex*age	9	-5452.19	3.53	0.442
	density+sex*age+grid	9	-5452.22	3.58	0.442
	density*age+sex	6	-5455.60	4.27	0.444

Table S4. Ranking of logistic mixed-effects models testing the relationship between the proportions of adult females in reproductive condition (i.e. perforate vagina, lactating or pregnant) and population density. All models with a ΔAICc <4 and the following one are listed. The selected model is in bold.

Model	*K*	Log-likelihood	ΔAICc
D+period+grid	**8**	**-439.49**	**0.00**
period+grid	7	-441.57	2.13
D+grid	6	-444.55	6.05

Table S5. Model coefficients (β) and 95% confidence intervals (CI) for the analysis of the relationship between the proportion of reproductive adult females and population density for each lemming group. Significant relationships are in bold.

Covariate	β	95% CI
D	**-0.087**	**[-0.170, -0.004]**
periodPP2	**0.690**	**[0.243, 1.154]**
periodPP3	0.282	[-0.190, 0.760]
grid LG2	**-0.820**	**[-1.275, -0.401]**
grid LX1	**-0.952**	**[-1.572, -0.396]**
grid Exclosure	**1.448**	**[0.832, 2.130]**

Table S6. Ranking of models testing the relationship between daily change in body mass and ontogenical, seasonal, and density-dependent factors based on the Akaike's information criterion. All models with a ΔAICc <4 and the following one are listed. The selected model is in bold.

Model	*K*	Log-likelihood	ΔAICc
initial mass*sex*period+grid	**13**	**58.72**	0.00
initial mass*sex*D*period+grid	21	63.83	6.84

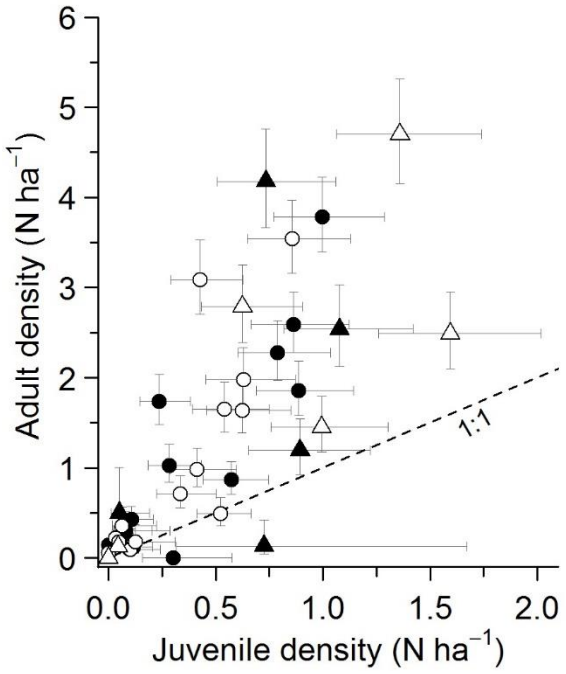
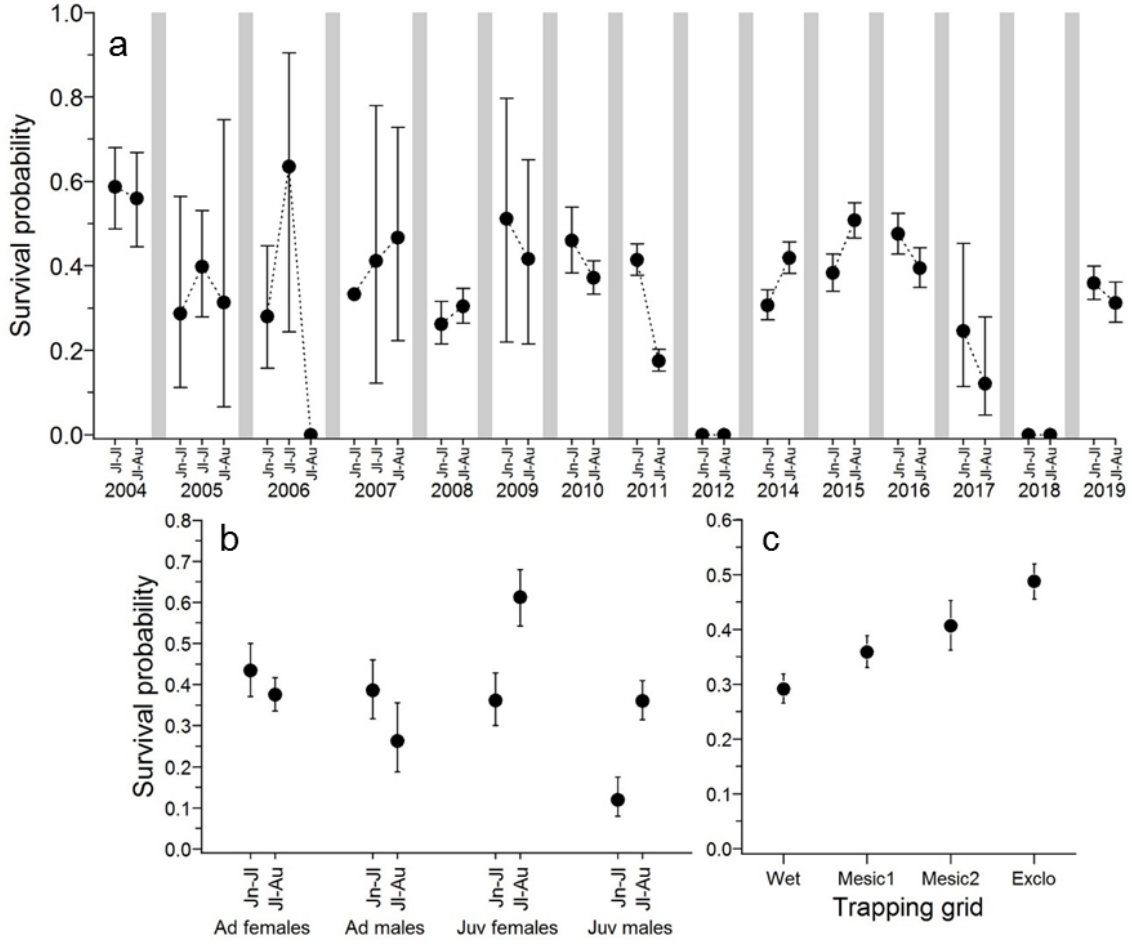


Figure S1. Age-ratio (adult females, ≥28 g; adult males ≥30 g) on Bylot Island, 2004-2019. Black circles: wet meadow trapping grid 1; white circles: mesic trapping grid 1; black triangles: mesic trapping grid 2; white triangles: predator exclosure trapping grid. The dashed line is a visual guideline and represents a 1:1 ratio.



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67 **Figure S2.**