

## Table S1 ó Definitions

Model variables and parameters: names, definitions, dimension.

Class	Variable name	Variable definition
<b>Morphology</b>	Body size	Snout-vent length (SVL) to the nearest mm
	Body mass	Total mass to the nearest dg
	Body condition	Residuals of a linear regression of body mass against body size.
<b>Reproduction</b>	Sexual maturation	Immature or sexually mature (first obvious signs of reproduction)
	Reproductive status	Non reproductive or reproductive (pregnant or post-pregnant)
	Clutch size	Total number of eggs produced in the laboratory or palpated in the abdominal cavity at the end of gestation, including all reproductive items
	Clutch mass	Mass loss during parturition measured as the difference between body mass measured at least one day before and a few hours after parturition.
	Residual clutch mass	Residuals of a linear regression of clutch mass against body mass after parturition
	Litter success	Proportion of healthy embryos in the clutch
	Litter mass	Total mass of healthy embryos
<b>Transition and growth</b>	Recruitment probability	Probability to become sexually mature at a given age
	Annual mass loss	Loss of body mass from before vitellogenesis to after parturition
	Annual mass change	Change of body mass during a year
	Annual growth	Change of body size (SVL) during a year
	Survival probability	Annual survival probability conditional on current reproductive status
	Transition probability	Probability to shift between reproductive statuses conditional on annual survival

## Tables S2 to S4 ó Mark recapture models

*Table S2. Mark-recapture models for age at first breeding.* Multi-state mark-recapture models for capture, survival, and first-breeding probabilities between 4-6 years old for female based on recapture data until the age of 7 years old. Three successive steps of model selection were conducted (see legend for a, b and c). The table gives information on model name, AICc,  $\Delta AICc$  (difference in AICc with the best model), AICc weight (model likelihood relative to all models), model likelihood, rank (number of estimated parameters), deviance and identification number. At each step, the most informative models according to the AICc are indicated in bold when  $\Delta AICc < 2$ . Notations used in all models:  $\phi$ =first-breeding probability,  $\psi$ =survival probability,  $p$ =capture probability, +=additive effects, a=linear age effect, a3=three age classes (age 4, 5 and 6 years old), ct=age constant, and hab=habitat effect.

Model name	AICc	$\Delta AICc$	AICc_w	Likelihood	Rank	Deviance	Number
<b>(a) Variation in capture probabilities</b>							
<b>(a3+hab) (a) p(a)</b>	<b>489.05</b>	<b>0</b>	<b>0.98</b>	<b>1</b>	<b>8</b>	<b>169.47</b>	<b>1</b>
(a3+hab) (a) p(ct)	497.11	8.06	0.02	0.02	7	179.70	2
<b>(b) Variation in survival probabilities</b>							
<b>(a3+hab) (ct) p(a)</b>	<b>487.75</b>	<b>0</b>	<b>0.66</b>	<b>1</b>	<b>7</b>	<b>170.34</b>	<b>3</b>
<b>(a3+hab) (a) p(ct)</b>	<b>489.05</b>	<b>1.30</b>	<b>0.34</b>	<b>0.52</b>	<b>8</b>	<b>169.47</b>	<b>2</b>
<b>(c) Variation in first-breeding probabilities</b>							
(ct) (ct) p(a)	<b>483.03</b>	<b>0</b>	<b>0.59</b>	<b>1</b>	<b>4</b>	<b>172.00</b>	<b>4</b>
(ct+hab) (ct) p(a)	485.12	2.09	0.21	0.35	5	171.99	5
(a3) (ct) p(a)	485.87	2.83	0.14	0.24	6	170.60	6
(a3+hab) (ct) p(a)	487.75	4.72	0.06	0.09	7	170.34	3

**Table S3. Mark-recapture models for breeding probabilities and survival costs of reproduction.** Multi-state mark-recapture models for capture, transition and survival probabilities of adult female vipers. Three successive steps of model selection were conducted (see legend for a, b and c). Model selection procedures and terms were similar than in Table S2. Notations used in all models: =transition probability, =survival probability, p=capture probability, +=additive effects, \*=interactive effects, b=breeding status (breeder versus non-breeder), hab=habitat effect, and ct=time constant.

Model name	AICc	AICc	AICc_w	Likelihood	Rank	Deviance	Number
<b>(a) Variation in capture probabilities</b>							
<b>(hab*b) (hab*b) p(hab+b)</b>	<b>774.42</b>	<b>0</b>	<b>0.45</b>	<b>1</b>	<b>11</b>	<b>580.29</b>	<b>1</b>
<b>(hab*b) (hab*b) p(b)</b>	<b>774.66</b>	<b>0.23</b>	<b>0.40</b>	<b>0.89</b>	<b>10</b>	<b>582.69</b>	<b>2</b>
(hab*b) (hab*b) p(hab*b)	776.55	2.13	0.15	0.35	12	580.25	3
(hab*b) (hab*b) p(ct)	804.05	29.63	0	0	9	614.23	4
(hab*b) (hab*b) p(hab)	804.77	30.35	0	0	10	612.81	5
<b>(b) Variation in transition probabilities</b>							
<b>(hab*b) (hab*b) p(hab+b)</b>	<b>774.42</b>	<b>0</b>	<b>0.50</b>	<b>1</b>	<b>11</b>	<b>580.30</b>	<b>6</b>
<b>(b) (hab*b) p(hab+b)</b>	<b>775.97</b>	<b>1.55</b>	<b>0.23</b>	<b>0.46</b>	<b>9</b>	<b>586.15</b>	<b>7</b>
(hab+b) (hab*b) p(hab+b)	776.73	2.31	0.16	0.32	10	584.76	8
(ct) (hab*b) p(hab+b)	778.40	3.98	0.07	0.14	8	590.71	9
(hab) (hab*b) p(hab+b)	779.31	4.88	0.04	0.09	9	589.48	10
<b>(c) Variation in survival probabilities</b>							
<b>(hab*b) (ct) p(hab+b)</b>	<b>769.21</b>	<b>0</b>	<b>0.45</b>	<b>1</b>	<b>8</b>	<b>581.52</b>	<b>11</b>
<b>(hab*b) (b) p(hab+b)</b>	<b>770.22</b>	<b>1.01</b>	<b>0.27</b>	<b>0.60</b>	<b>9</b>	<b>580.40</b>	<b>12</b>
(hab*b) (hab) p(hab+b)	771.34	2.13	0.15	0.34	9	581.51	13
(hab*b) (hab+b) p(hab+b)	772.37	3.16	0.09	0.21	10	580.40	14
(hab*b) (hab*b) p(hab+b)	774.42	5.22	0.03	0.07	11	580.29	15

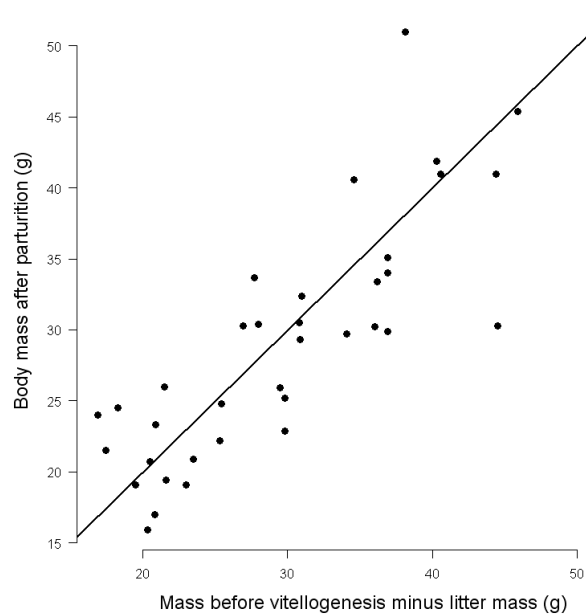
**Table S4. Mark-recapture models for survival effects of post-parturition body condition.**

Multi-state mark-recapture models for capture, transition and survival probabilities of adult female meadow vipers for which post-parturition body condition was calculated in the laboratory and three years of subsequent capture data were available to analyze a full breeding cycle (n=72). Model selection was done starting from the best model obtained in Table S3 including a potential difference in survival between the year following parturition and subsequent years. Due to a more restricted sample size than in Table S3, the spatial variation was not significant in this analysis and we also fitted an intermediate model without habitat effects for capture and transition probabilities. Terms and notations were similar than in Table S3, except for t=time variation between year 1 and subsequent years and PBC=post-parturition body condition.

Model name	AICc	AICc	AICc_w	Likelihood	Rank	Deviance	Number
<b>(a) Full model</b>							
<b>(hab*b) (t) p(hab+b)</b>	<b>230.99</b>	<b>0</b>	<b>0.49</b>	<b>1</b>	<b>9</b>	<b>211.05</b>	<b>1</b>
<b>(hab*b) (t*PBC) p(hab+b)</b>	<b>231.97</b>	<b>0.98</b>	<b>0.30</b>	<b>0.61</b>	<b>10</b>	<b>209.57</b>	<b>2</b>
(hab*b) (ct) p(hab+b)	233.45	2.46	0.14	0.29	8	215.92	3
(hab*b) (PBC) p(hab+b)	235.31	4.32	0.06	0.12	9	215.37	4
<b>(a) Model without spatial variation</b>							
<b>(b) (t) p(hab+b)</b>	<b>229.48</b>	<b>0</b>	<b>0.44</b>	<b>1</b>	<b>6</b>	<b>216.60</b>	<b>5</b>
<b>(hab*b) (ct) p(hab+b)</b>	<b>230.65</b>	<b>1.17</b>	<b>0.25</b>	<b>0.56</b>	<b>5</b>	<b>220.03</b>	<b>6</b>
(hab*b) (t*PBC) p(hab+b)	230.91	1.43	0.22	0.49	7	215.73	7
(hab*b) (PBC) p(hab+b)	232.67	3.20	0.09	0.20	6	219.80	8

## Figure S1 ó Body mass dynamics during a breeding year

The body mass after parturition on the  $y$  axis was compared to the body mass before vitellogenesis minus the litter mass on the  $x$  axis (see Methods section and Table S1 for details on calculation of each variable). Assuming that females do not store income resources during gestation and that stored body mass before vitellogenesis is converted into litter mass, we should observe that  $y < x$  for all individuals given the growth cessation during breeding. Yet, we found several individuals for which  $y > x$  suggesting that some females can store some income resources during gestation.



## Appendix S1 ó Life history model

Using an optimisation approach, we constructed a matrix population model to evaluate how variation in transitions between breeding states influences fitness. The model is structured by age and stage and parameterised with our empirical estimates of fecundity and survival rates of the female portion of the population in a pre-breeding census. The model divides the population into seven age classes and assumes that reproduction starts at age four followed by transitions between breeding (R) and non-breeding (NR) states conditional on survival. The transition rates from R to R and from NR to NR are treated as free parameters in the model; they describe the strategy of intermittent breeding: (1, 0) is perfect continuous breeding, whereas (0,0) is perfect biennial breeding. Before reproduction, females grow and survive according to the growth curves and the best fit of survival functions reported in Baron *et al.* (2010a; 2010b). Juvenile survival (from birth to age 1) increases with offspring body mass, which is determined by litter size and maternal size; in sub-adults (from age 1 to age 4), the annual probability of survival is constant (Baron *et al.* 2010a). According to the data reported in this study, adult females stop growing during breeding years due to a trade-off between reproduction and growth, and grow during non-breeding years; the annual probability of survival for adult females is constant; and fecundity increases with body size.

The fitness of the breeding strategy is the asymptotic growth rate of the population in which the strategy is expressed; this growth rate is given by the dominant eigenvalue of the transition matrix. We calculated fitness numerically and plotted fitness landscapes using Mathematica® software. We searched for the optimal life history strategy under alternative physiological scenarios of resource allocation between growth, fecundity, and survival. Regarding growth, we relaxed the assumption of a trade-off between growth and breeding by

assuming that females could grow during a breeding year in the same manner as they would during a non-breeding year in the field. Regarding fecundity, we assumed that fecundity (litter size times juvenile survival) decreases after two consecutive breeding years due to allocation constraints (see our Figure 4 in the main text). The baseline fecundity was altered by a discount factor to model this effect. Likewise, we included the possibility that adult survival decreases between consecutive breeding events. The baseline survival was affected by another discount factor to model this effect.

### **References listed**

- Baron, J.-P., Le Galliard, J.-F., Tully, T. & Ferrière, R. (2010a) Cohort variation in offspring growth and survival: prenatal and postnatal factors in a late-maturing viviparous snake. *Journal of Animal Ecology*, 79, 640-649.
- Baron, J.-P., Tully, T. & Le Galliard, J.-F. (2010b) Sex-specific fitness returns are too weak to select for non random patterns of sex allocation in a viviparous snake. *Oecologia*, 164, 369-378.

## Figure S2 ó Optimisation of breeding frequencies

Fitness landscapes for the breeding strategy given by the state transition rates from breeding to breeding ( $x$  axis) and from non-breeding to non-breeding ( $y$  axis). Fitness (asymptotic population growth rate) was calculated from a stage-age-structured matrix population model parameterised with the life history data of *V. u. ursinii* at Mont Ventoux. The optimal strategy is given by a maximum of fitness for a given combination of transition rates. Upper row, left to right, baseline model assuming a fecundity discount during successive breeding years of 0%, 40% and 80%, respectively. Middle row, left to right, baseline model assuming a survival discount during successive breeding years of 40%, 80%, and 40% together with a 40% discount on fecundity. Lower row, left to right, baseline model assuming no growth cessation during breeding years and, respectively, a fecundity discount during successive breeding years of 40%, a survival discount during successive breeding years of 40%, and both discounts.

