

1 **Supplementary Information**

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3 **Table S1.** Periods for culling policy signals in both states, derived from (12, 39), ESA
 4 sec. 10(a)(1)(A) and Humane Society of the U.S. et al. v. Jewell (U.S. District Court,
 5 D.C., 1:13-cv-00186-BAH Document 52, 2014.

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Period start (dd/mm/yyyy)	Period end (dd/mm/yyyy)	Federal status	Culling**
15/04/1994	31/03/2003	Listed as endangered	not allowed
01/04/2003	30/01/2005	Down-listed to threatened	allowed
31/01/2005	31/03/2005	Relisted	not allowed
01/04/2005	13/09/2005	Sub-permit for culling issued	allowed
14/09/2005	23/04/2006	Sub-permit rescinded	not allowed
24/04/2006*	31/07/2006	Sub-permit for culling issued	allowed
01/08/2006	11/03/2007	Sub-permit rescinded	not allowed
12/03/2007	28/09/2008	Delisted	allowed
29/09/2008	03/05/2009	Relisted	not allowed
04/05/2009	30/06/2009	Delisted	allowed
01/07/2009	26/01/2012	Relisted	not allowed
27/01/2012	14/04/2012	Delisted	allowed

7 *States identical except sub-permit issuance on 6 May 2006 to Michigan instead of
 8 issuance on 24 April 2006 to Wisconsin (12).

9 ** Killing a wolf that posed a threat to human safety was always allowed under ESA
 10 sec.11(a)(3)

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Table S2. Prior and posterior values for all model parameters.

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Prior choice	Posterior distribution	
	Median \pm SD	95% credible interval
<i>Population dynamic</i>		
$\sigma_{proc} \sim \text{unif}(0,0.5)$	0.06 \pm 0.02	0.03 – 0.1
$\gamma \sim \text{Norm}(\mu = 1.06, \tau = 14)$	1.06 \pm 0.07	0.92 – 1.19
$\beta_0^{rW} \sim \text{Norm}(\mu = 0, \tau = 10^{-6})$	0.16 \pm 0.02	0.12 – 0.2
$\beta_0^{rM} \sim \text{Norm}(\mu = 0, \tau = 10^{-6})$	0.14 \pm 0.02	0.1 – 0.18
$\beta_1^r \sim \text{Norm}(\mu = 0, \tau = 10^{-6})$	-0.03 \pm 0.03	-0.1 – 0.04
$\sigma_{Nobs}^{\min} \sim \text{unif}(0,100)$	3.82 \pm 3.39	0.19 – 12.63
$\sigma_{Nobs}^{\max} \sim \text{unif}(0,100)$	4.72 \pm 4.5	0.23 – 16.78
$o_{MIN} \sim \text{Norm}(\mu = 1, \tau = 10^{-6})$ $o_{MIN} \in [0,1]$	0.97 \pm 0.02	0.93 – 1
$o_{MAX} \sim \text{Norm}(\mu = 1, \tau = 10^{-6})$ $o_{MAX} \in [1,10]$	1.03 \pm 0.02	1 – 1.08
<i>Density dependence on pack size</i>		
$\beta_0^p \sim \text{Norm}(\mu = 0, \tau = 10^{-6})$	1.17 \pm 0.03 *	1.1 – 1.23
$\beta_1^p \sim \text{Norm}(\mu = 0, \tau = 10^{-6})$	0 \pm 0	0 – 0
$\sigma_{Pobs} \sim \text{unif}(0,1)$	0.17 \pm 0	0.16 – 0.17

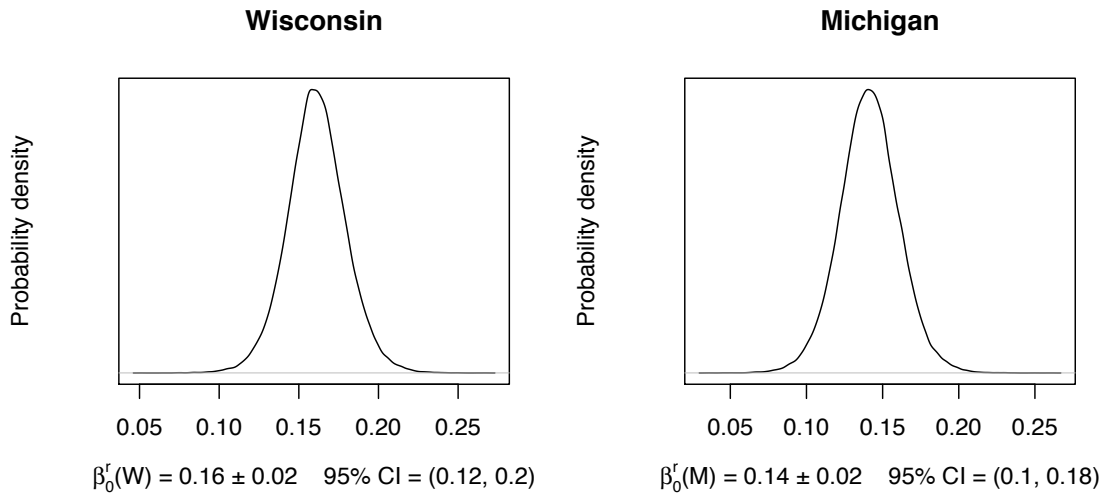
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<i>Density dependence on probability a pack reproduces</i>		
$\beta_0^R \sim \text{Norm}(\mu = 0, \tau = 10^{-6})$	0.39 ± 0.13	$0.14 - 0.64$
$\beta_1^R \sim \text{Norm}(\mu = 0, \tau = 10^{-6})$	0 ± 0	$0 - 0$
<i>Density dependence on area occupied by packs</i>		
$\tau^A \sim \text{T}(\alpha = 10^{-6}, \beta = 10^{-6})$	97 ± 46	$33 - 212$
$\beta_0^A \sim \text{Norm}(\mu = 0, \tau = 10^{-6})$	9.61 ± 0.1	$9.42 - 9.81$
$\beta_1^A \sim \text{Norm}(\mu = 0, \tau = 10^{-6})$	0 ± 0	$0 - 0$

* on the log scale

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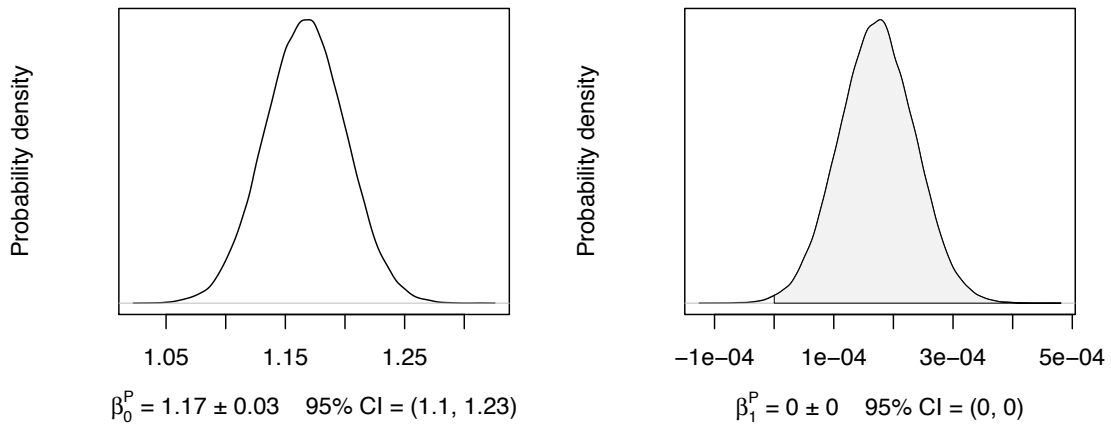
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Figure S1. Posterior density distributions of intercepts β_0^{rW} (Wisconsin, left) and β_0^{rM} (Michigan, right) of population growth rates (without policy signal).

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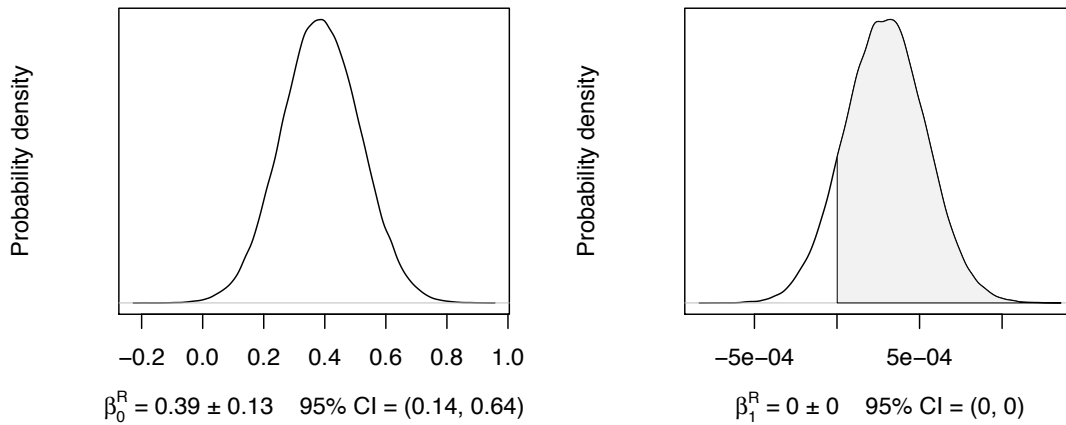
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Figure S2. Posterior density distributions of linear model coefficients (intercept β_0^P and (slope β_1^P) for pack size. The grey area under the curve at right indicates the probability there is no negative density dependence.

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Figure S3. Posterior density distributions of linear model coefficients (intercept β_0^R)

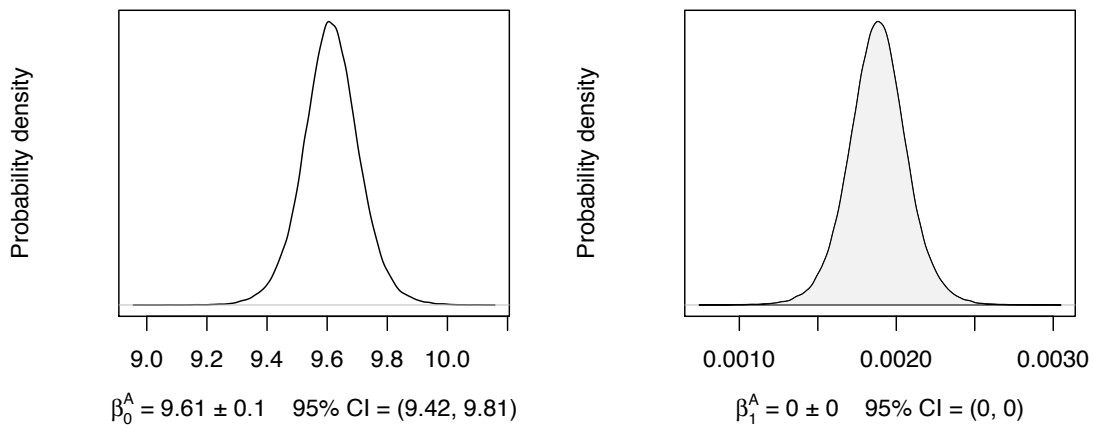
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and (slope β_1^R) for the probability a pack reproduces. The grey area under the curve at

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right indicates the probability there is no negative density dependence.

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Figure S4. Posterior density distributions of linear model coefficients (intercept β_0^A)

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and (slope β_1^A) for area occupied by wolf packs. The grey area under the curve at right

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indicates the probability there is no negative density dependence.

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