

Table S1. Summary climate statistics for all 12 elk calf survival study areas.

Study area	year	Weather station	Adult female condition Winter severity (Dec-Mar)		Adult female condition Summer previous year (May-Aug)		Calf condition Spring current year						
			mean min T (C)	total snow (cm)	mean max T (C)	total precip (cm)	Mar mean max T (C)	Apr mean max T (C)	May mean min T (C)	Mar total precip (cm)	Apr total precip (cm)	May total precip (cm)	June total snow (cm)
OR													
SW	2002	Toketee Falls	-0.67	0.00	26.22	14.76	10.84	16.68	4.89	10.31	8.41	3.10	0
	2003		1.21	49.53	25.85	11.25	11.22	11.96	5.45	20.68	13.34	3.02	0
	2004		0.89	42.16	26.80	14.73	15.61	18.98	6.11	6.40	9.60	13.23	0
	2005		0.00	60.96	24.99	24.51	13.12	14.71	7.37	14.99	12.34	19.96	0
OR													
Blue Mnt	2002	Wallowa	-5.24	50.04	27.21	9.75	8.94	15.24	2.69	3.73	2.87	1.75	0
	2003		-2.18	137.41	26.16	9.70	12.03	15.43	3.92	8.48	3.61	3.96	0
	2004		-4.59	17.27	28.20	9.32	14.18	18.28	5.06	1.65	3.23	8.74	0
	2005		-4.32	50.04	25.80	22.63	12.99	15.11	5.54	2.57	4.62	9.96	0
	2006		-5.63	41.15	26.93	15.21	9.46	15.52	4.21	3.53	7.01	8.26	0
	2007		-4.94	131.57	27.70	16.66	14.21	16.15	3.83	2.54	1.91	2.41	0
WA													
Blue Mtn	1993	Daytona	-3.99	22.54	26.90	14.10	10.79	15.18	9.59	4.93	9.17	6.50	0
	1994		-0.34	6.10	24.90	15.42	14.93	17.98	8.35	2.08	2.44	2.77	0
	1995		-0.55	8.38	27.34	7.98	12.49	15.22	7.56	5.92	4.55	3.15	0
	1996		-2.19	21.34	25.56	17.50	10.73	16.94	6.24	3.28	9.93	4.42	0
	1997		-0.62	19.05	25.39	8.74	12.08	14.78	9.25	8.97	6.20	3.05	0
ID													
NFL	1973	GMU 12 Fenn	-3.51	57.91	27.91	18.80	11.08	16.35	3.87	6.96	3.28	5.13	0
	1974		-3.35	81.28	27.28	21.62	10.27	15.39	4.81	14.88	11.38	7.39	0
	1975		-3.43	184.15	27.30	22.23	8.67	12.07	4.19	8.69	12.90	10.06	0
	1976		-3.47	162.56	25.55	35.74	8.44	15.89	4.94	9.73	8.00	7.09	0
	1977		-3.46	92.71	25.63	36.47	8.35	20.46	5.61	9.93	1.98	13.08	0
	1978		-1.81	151.13	26.11	37.72	13.73	15.29	5.72	8.46	7.06	13.54	0
	1979		-4.33	217.42	24.70	32.26	10.64	14.76	6.04	7.62	8.94	6.91	0

ID													
NFL	1997		-5.64	406.40	21.48	21.31	7.27	9.93	3.07	14.83	12.50	6.02	0
	1998	GMU 10	-4.13	157.23	22.14	31.22	7.72	15.44	3.99	10.41	8.74	18.59	0
	1999	Head-	-4.65	342.90	23.53	38.38	7.27	11.68	0.68	13.56	8.74	5.54	0
	2000	quarters	-4.03	283.21	21.25	17.81	8.60	15.35	3.07	9.22	6.65	9.50	0
	2001		-6.37	217.17	21.68	19.86	9.23	10.68	1.86	9.17	8.23	9.86	0
	2004		-5.32	276.86	23.47	15.01	11.31	14.98	1.64	4.83	6.02	23.19	0
ID													
SF	1997		-3.28	119.38	23.24	20.29	10.31	11.85	6.20	7.26	14.17	6.22	0
	1998		-3.14	56.95	23.67	36.20	10.29	14.11	5.38	2.11	8.86	10.46	0
	1999		-3.25	119.38	24.65	32.94	9.27	12.35	3.26	7.06	6.35	6.25	0
	2000	Grange-	-2.41	61.77	23.25	19.13	11.14	17.67	5.48	5.08	3.78	11.00	0
	2001	village	-3.96	124.46	25.01	19.02	11.24	12.56	5.54	5.64	8.53	5.18	0
	2002		-3.86	96.52	26.14	12.52	7.12	14.28	4.08	5.99	3.53	4.19	0
	2003		-2.00	49.53	25.06	18.82	9.18	12.63	4.97	9.12	9.07	7.77	0
	2004		-2.98	149.86	23.89	17.98	12.83	15.46	4.89	2.46	5.23	16.54	0
ID													
SAL	2005	salmon	-6.47	35.23	24.45	20.24	11.22	15.09	4.23	0.94	1.09	5.92	0
	2006		-7.90	38.79	24.70	14.50	8.86	15.28	4.82	1.04	5.21	1.63	0
MT			-										
GAR	2002		13.55	48.26	24.35	21.77	1.47	11.02	-1.52	1.50	0.10	4.57	2.54
	2003		-9.03	91.44	15.18	17.65	5.67	12.98	0.14	3.96	2.97	3.15	0
	2004	Ovando	-										
		9SSE	11.20	68.58	17.23	11.38	9.75	15.76	-0.31	1.70	0.76	5.64	0
	2005		10.76	35.56	21.80	18.75	7.92	11.32	0.63	1.07	4.32	5.66	0
	2006		-										
			11.87	7.62	11.16	17.73	4.77	12.78	-0.22	1.14	5.26	3.00	0
MT		W	-										
GAL	2005	Yellow-	16.07	232.16	19.68	29.26	3.80	8.61	-0.47	3.56	2.16	6.53	6.35
WY			-										
JH1	1990		14.41	44.45	21.92	20.17	6.45	12.13	-0.86	1.88	7.34	4.50	0
	1991	Moran 5	-										
		WNW	15.93	37.91	22.36	16.31	4.89	7.18	-0.45	7.65	5.28	9.47	0
	1992		-										
			14.63	17.34	21.47	25.91	8.78	12.85	1.31	1.83	8.48	2.34	0

WY			-										
JH2	1997		13.52	121.16	21.96	22.56	5.47	7.21	-0.50	7.37	5.97	7.87	0
			-										
	1998		13.87	66.36	21.31	32.51	3.94	9.72	-0.86	6.99	5.21	8.38	0
			-										
	1999		13.60	111.76	21.59	25.78	5.56	7.59	-2.38	2.79	5.08	4.83	0
WY			-										
YNP	2003		14.45	130.05	22.63	18.26	5.48	11.39	-2.60	4.17	4.24	4.24	0
		Tower	-										
	2004	Falls	13.53	137.92	23.51	11.07	8.94	13.78	-0.72	0.79	1.93	4.98	0
			-										
	2005		13.36	134.62	21.02	22.99	5.57	10.37	-0.88	1.60	1.22	3.51	0

Table S2. Original and categorized mortality causes for neonatal elk in the Northwest during summer, 1973-2007.

Original mortality cause	Cougar	Ursid	Coyote	Wolf	Other
Black bear		222			
Grizzly bear		41			
Bear spp		17			
Coyote			37		
Wolf				24	
Canid					1
Cougar	226				
Bobcat					2
Golden eagle					1
Wolverine					1
Hunter					2
Unknown predator					73
Disease/Infection					22
Starvation					9
Abandoned					23
Accident					10
Drowned					3
Unknown					37
Other					5
Total	226	280	37	24	189

Table S3. Neonatal elk calf survival summary statistics for all study areas, including sex ratio, capture dates, birth date, capture age, and capture weights.

		Overall	OR	WA	ID Cool	ID NF/	ID	MT	MT	WY	WY	WY		
			OR SW	BlueMt	BlueMt	water	Lochsa	SF	Salmon	Garnets	Gallatin	Jackson	Jackson	YNP
												90_92	97_99	
N		2188	156	452	230	139	161	221	112	221	29	165	154	151
Sex ratio (M:F)		0.9:1	1.3:1	0.8:1	0.9:1	1.1:1	1:1	0.8:1	1.2:1	0.8:1	0.6:1	1.2:1	1:1	0.8:1
Count		2188	155	450	230	139	161	221	273	221	29	165	154	151
Julian	Mean	155	158	152	158	155	157	158	158	153	148	154	152	151
	SE	0.14	0.61	0.35	0.61	0.63	0.30	0.25	0.23	0.20	1.08	0.40	0.29	0.56
	Median	154	159	151	157	153	157	158	158	153	146	154	152	152
	Min	130	141	130	144	145	149	147	149	145	138	141	146	140
	Max	199	177	199	182	181	176	167	176	159	160	181	164	161
Actual	Median	6/3	6/8	5/31	6/6	6/2	6/6	6/7	6/7	6/2	5/26	6/3	6/1	6/1
	Min	5/10	5/21	5/10	5/24	5/25	5/29	5/27	5/29	5/25	5/18	5/21	5/26	5/20
	Max	7/18	6/26	7/18	7/1	6/30	6/25	6/15	6/25	6/8	6/8	6/30	6/12	6/9
Count	2008	155	450	50	139	161	221	221	273	221	29	165	154	151
Birth Date	Mean	151	155	149	151	151	153	154	154	150	145	151	149	149
	SE	0.14	0.55	0.35	0.54	0.52	0.31	0.27	0.24	0.22	1.07	0.41	0.28	0.55
	Median	151	155	148	151	150	153	155	154	150	143	150	149	149
	Min	129	140	129	144	142	144	143	144	141	135	140	141	137
	Max	197	175	197	159	173	175	164	175	157	159	176	161	161
Actual	Median	5/31	6/4	5/28	5/31	5/30	6/2	6/4	6/3	5/30	5/23	5/30	5/29	5/29
	Min	5/8	5/20	5/8	5/24	5/22	5/24	5/23	5/24	5/21	5/15	5/20	5/21	5/17
	Max	7/16	6/24	7/16	6/8	6/22	6/24	6/12	6/24	6/6	6/8	6/25	6/9	6/9
Capture Age	Count	2008	155	450	50	139	161	221	112	221	29	165	154	151
	Mean	3	3	4	4	3	4	4	4	4	3	3	3	3
	SE	0.05	0.2	0.1	0.5	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1
	Median	3	3	3	5	1.5	4	4	4	4	3	3	3	3
	Range	0 - 10	1 - 10	0 - 10	0 - 8	1 - 10	0 - 8	0 - 9	0 - 8	0 - 8	0 - 8	0 - 7	0 - 8	0 - 6
Capture Wt	Count	2032	78	438	191	134	159	216	108	211	29	165	154	148
	Mean	21.5	18.7	23.2	28.0	21.4	20.6	21.0	22.1	21.2	19.3	19.8	18.3	17.6
	SE	0.13	0.53	0.29	0.53	0.55	0.43	0.34	0.57	0.25	0.54	0.29	0.27	0.26
	Median	20.4	17.9	21.5	27.3	19.7	20.0	20.2	22.7	20.5	18.8	19.8	18.3	17.1
	Range	6.4 - 50.0	11.3 - 31.8	10.0 - 44.8	11.8 - 50.0	11.3 - 42.2	9.1 - 34.5	9.1 - 34.5	10.0 - 33.7	13.6 - 35.5	12.7 - 27.6	10.5 - 31.9	8.3 - 26.0	6.4 - 27.7

Table S4. Hazard ratios for top 2 models (from the entire 12 study area dataset) of survival of neonatal elk in Jackson Hole, WY dataset. The top model (model 1) describes survival as an additive function of the base model (included sex, birth weight and birth date) and number of predator species and climate covariates. The second ranked model captures similar weak interactive effects between predation and climate as the entire dataset (Table 3). The Jackson Hole studies have data from 1990-1992 when 3 predator species were in the system and 1997 – 1999 when 5 predator species were in the system. The reference values are to the 3 predator system. Note that the hazard ratio for 5 predators is 2.40 (0.84) which is similar to our original hazard ratios 2.39 (1.01) (Table 3) from the entire data set.

Model 1. $\Delta AIC = 0$	Jackson Hole dataset		
Covariate	Hazard Ratio	p	95%CI
Female	0.60 (0.15)	0.05	0.36 – 0.99
Birth weight	0.83 (0.04)	<0.001	0.77- 0.91
Birth date	1.05 (0.03)	0.08	0.99 - 1.10
Prev. summer max temp	1.08(0.56)	0.87	0.64 - 3.49
May precip	1.07 (0.08)	0.27	0.94 – 1.24
4 Predators	N/A		
5 Predators	2.40 (0.84)	0.014	1.19 - 4.74

Model 1. $\Delta AIC = 2.1$	Jackson Hole dataset		
Covariate	Hazard Ratio	p	95%CI
Female	0.61 (0.15)	0.05	0.37– 1.01
Birth weight	0.84 (0.04)	<0.001	0.77- 0.91
Birth date	1.03 (0.02)	0.05	1.00 - 1.06
Prev. summer max temp	1.04(0.62)	0.94	0.33 - 3.34
May precip	1.11 (0.11)	0.29	0.91 – 1.34
4 Predators	N/A		
5 Predators	2.40 (0.84)	0.014	1.19 - 4.74
Mayprcp*5 pred	0.93 (0.12)	0.99	0.71 – 1.22

Table S5. Neonatal elk survival and cause-specific mortality hazard (Standard errors) for first 3 months of life by study areas and major predators. Survival was estimated by Kaplan-Meier methods, and cause-specific mortality hazard was estimated using cumulative incidence function analysis. Non-predators includes mortality caused by non-predators (e.g., starvation, disease, accident, abandoned). Other includes other predators (e.g., bobcat), unknown predators, and unknown causes. Zeros indicate species present with no known mortalities and N/A indicates speceis absent.

State	Location	Survival	Cause-specific mortality					
			Cougar	Ursid	Coyote	Wolf	Non-predator	Other
OR	SW Cascades	0.75 (0.04)	0.15 (0.04)	0.01 (0.01)	0.00	N/A	0.02 (0.01)	0.07 (0.02)
	NE - Blue Mountains	0.61 (0.03)	0.25 (0.02)	0.07 (0.02)	0.01 (<0.01)	N/A	0.03 (0.01)	0.03 (0.01)
WA	Blue Mountains	0.75 (0.07)	0.13 (0.05)	0.02 (0.02)	0.02 (0.02)	N/A	0.02 (0.02)	0.05 (0.05)
	Lochsa	0.44 (0.05)	0.13 (0.04)	0.32 (0.04)	0.02 (0.01)	0.00	0.02 (0.02)	0.07 (0.03)
ID	Lochsa/North Fork	0.41 (0.04)	0.15 (0.03)	0.26 (0.04)	0.00	0.01 (0.01)	0.08 (0.02)	0.09 (0.02)
	South Fork Clearwater	0.49 (0.04)	0.11 (0.02)	0.18 (0.03)	0.00	0.00	0.11 (0.03)	0.11 (0.02)
	Salmon	0.67 (0.05)	0.03 (0.02)	0.09 (0.03)	0.06 (0.02)	0.08 (0.03)	0.02 (0.01)	0.08 (0.03)
MT	Garnets	0.81 (0.03)	0.03 (0.01)	0.05 (0.02)	0.01 (0.01)	N/A	0.02 (0.01)	0.06 (0.02)
	Gallatin	0.48 (0.09)	0.00	0.42 (0.09)	0.00	0.00	0.00	0.10 (0.06)
WY	Jackson Hole	0.84 (0.03)	0.00	0.08 (0.02)	0.04 (0.02)	N/A	0.05 (0.02)	0.00
	Jackson Hole	0.70 (0.04)	0.01 (0.01)	0.15 (0.03)	0.04 (0.02)	0.00	0.09 (0.03)	0.01 (0.01)
	Yellowstone National Park	0.31 (0.04)	0.01 (0.01)	0.43 (0.05)	0.05 (0.02)	0.09 (0.02)	0.04 (0.02)	0.09 (0.03)
	Overall	0.61 (0.01)	0.11 (0.01)	0.15 (0.01)	0.02 (<0.01)	0.01 (<0.01)	0.04 (0.01)	0.06 (0.01)

Table S6. Result of Pepe-Mori tests of equality in cause -specific mortality between areas with differing numbers of predators. Main event is the mortality cause listed in the first column while competing events are all other competing risks. A significant increase in a specific mortality cause without reduction in the probability of mortality from all remaining causes would denote additive mortality (i.e. Ursid).

Mortality Cause (main event)	Test of difference between 3 to 4 predators		Test of difference between 4 to 5 predators		Test of difference between 3 to 5 predators	
	Main Event	Competing Event	Main Event	Competing Event	Main Event	Competing Event
Cougar	$\chi^2=11.50$ P=0.0007	$\chi^2=18.66$ P=0.00002	$\chi^2=11.95$ P=0.0006	$\chi^2=12.12$ P=0.0005	$\chi^2=103.43$ P<0.00001	$\chi^2=76.776$ P<0.00001
Ursid	$\chi^2= 2.96$ P=0.085	$\chi^2=2.9$ 9P=0.083	$\chi^2=18.62$ P=0.00002	$\chi^2=1.28$ P=0.258	$\chi^2=40.1$ P<0.00001	$\chi^2=0.084$ P=0.772
Coyote	$\chi^2= 1.86$ P=0.173	$\chi^2= 6.14$ P=0.013	$\chi^2= 1.73$ P=0.189	$\chi^2= 4.41$ P=0.036	$\chi^2= 7.09$ P=0.008	$\chi^2= 25.49$ P<0.00001
Wolf	N/A	N/A	$\chi^2= 3.03$ P=0.082	$\chi^2= 4.23$ P=0.040	N/A	N/A