Wildlife Biology

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Appendix 1

Table A1. Timeline of fence construction dates and configuration-switching of the study fences.

Fence	Period	Configuration
Red Deer	Prior to 22 June 2015	No fence
	23 June 2015 to 21 May 2018	Construction*
	22 May 2018 to 30 July 2018	Wildlife-permeable
	31 July 2018 to present	Bison-deflection
Panther	Prior to 15 June 2015	No fence
	16 June 2015 to 22 April 2016	Construction*
	23 April 2016 to 28 July 2018	Wildlife-permeable
	29 July 2018 to 3 August 2018	Bison-deflection
	4 August 2018 to 31 August 2018	Wildlife-permeable
	1 September 2018 to present	Bison-deflection
Dormer	Prior to 5 June 2018	No fence
	6 June 2018 to 16 June 2018	Construction*
	17 June 2018 to 3 October 2018	Wildlife-permeable
	4 October 2018	Bison-deflection
	5 October 2018 to present	Wildlife-permeable
Tyrrell	Prior to 24 June 2015	No fence
	25 June 2015 to 3 August 2018	Construction*
	4 August 2018 to 15 August 2018	Bison-deflection
	26 August 2018 to 11 September 2019	Wildlife-permeable
	12 September 2019	Fence removed

* Partial fence under construction omitted from local-scale analysis.

Table A2. Remote camera effort for each fence design at each location. Days represent active camera days, and are adjusted to account for times when cameras were non-operational. Designs are displayed sequentially (left to right) as they were tested. Note that many cameras captured both a wire and a rail fence design simultaneously, and so in these cases the total number of days for all designs will exceed actual camera deployment time.

Camera	Design 1	Days	Design 2	Days	Design 3	Days	Design 4	Days	Design 5	Days
Red Deer 1	5-wire	226	4-wire-no-top	70	2-wire	865				
Red Deer 2	5-wire	166	4-wire-no-top	70	2-wire	716				
Red Deer 3	5-wire	279	3-rail	279	4-wire-no-top	28	2-rail	28	2-wire	729
Red Deer 4	2-wire	826								
Red Deer 5	3-rail	295	2-rail	949						
Red Deer 6	5-wire	185	3-rail	118	2-rail	874	4-wire-no-top	71	2-wire	736
Red Deer 7	5-wire	211	3-rail	59	2-rail	948	4-wire-no-top	36	2-wire	760
Red Deer 8	5-wire	118	2-wire	672						
Red Deer 9	5-wire	226	4-wire-no-top	70	2-wire	761				
Red Deer 10	5-wire	225	3-rail	193	2-rail	744	4-wire-no-top	70	2-wire	642
Red Deer 11	2-wire	102								
Tyrrell 1	5-wire	81	4-wire-no-bottom	140	2-wire	712				
Tyrrell 2	3-rail	55	2-rail	1004						
Tyrrell 3	3-rail	55	2-rail	1000						
Tyrrell 4	5-wire	221	3-rail	77	2-rail	853	2-wire	611		
Panther 1	5-wire	115	4-wire-no-bottom	29	4-wire-no-top	917				
Panther 2	5-wire	118	4-wire-no-bottom	65	4-wire-no-top	595				
Panther 3	3-rail	124	2-rail	782						
Panther 4	2-wire	789								
Panther 5	5-wire	224	3-rail	41	2-rail	1030	4-wire-no-top	847		
Panther 6	3-rail	124	2-rail	971						
Panther 7	5-wire	209	3-rail	1020	2-wire	756				
Panther 8	5-wire	183	4-wire-no-top	39	2-wire	720				
Panther 9	4-wire-no-top	789								
Panther 10	2-wire	789								
Panther 11	2-wire	789								
Panther 12	2-wire	789								
Panther 13	2-wire	524								
Ya Ha Tinda 1	4-wire-no-top	112	2-rail	112	5-wire	67	3-rail	67		
Ya Ha Tinda 2	2-rail	156	4-wire-no-top	156						
Ya Ha Tinda 3	4-wire-no-top	134	5-wire	20						
Ya Ha Tinda 4	4-wire-no-top	156	2-rail	156						
Ya Ha Tinda 5	4-wire-no-top	4	2-rail	4						
Ya Ha Tinda 6	4-wire-no-top	28								
Total Days	**5-wire:** 2874	**4-wire-no-top:** 4192		**4-wire-no-bottom*:** 234		**2-wire:** 13288	**3-rail:** 2507	**2-rail**: 9611		

* This design (4-wire-no-bottom) was not used in the overall crossing success analysis due to small sample size, but was included in generalized design categories for subsequent analyses (e.g. crossing method and age-sex effects).

Site-specific results

Table A3. Model selection results for crossing success. For each model, we report degrees of freedom (df), Akaike's information criteria (AIC), AIC difference versus top model (Δ AIC), and Akaike weight (W_i). Explanatory variables were fence design (5-wire, 4-wire-no-top, 2-wire, 3-rail, 2- rail-no-top) and guild (bighorn sheep, carnivore, elk, mule deer, white-tailed deer). Reference variables were 5-wire and mule deer. Parameters abbreviated for clarity.

Parameters	df	AIC	Δ AIC	W_I
Fence design × Guild [1]	24	6169.3	0	1.00
Fence design + Guild	10	6343.1	173.8	0.00
Guild	6	6617.7	448.5	0.00
Fence design	6	6676.2	506.9	0.00
Null	2	6950.7	781.4	0.00

[1] Excludes 3 rail * elk interaction (0 successful crossings, n= 51) and 3 rail * bighorn sheep interaction (n=5)

Table A4. Model selection results for crossing method (over or under/through). For each model, we report degrees of freedom (df), Akaike's information criteria (AIC), AIC difference versus top model (Δ AIC), and Akaike weight (W_i). Explanatory variables were fence material (wire, rail), fence height (full height = 5-wire, 4-wire-no-bottom, 3-rail; reduced height = 4-wire-no-top, 2-wire, 2-rail-no-top), and guild (bighorn sheep, elk, mule deer, white-tailed deer). Carnivores were excluded from this analysis. Reference variables were wire, full height, and mule deer. Parameters abbreviated for clarity.

Parameter	df	AIC	Δ AIC	W_I
Fence material + Guild	6	710.7	0	0.88
Fence material × Guild	9	714.7	4.0	0.12
Fence height × Guild	9	732.0	21.2	0.00
Guild	5	738.1	27.3	0.00
Fence height + Guild	6	739.6	28.9	0.00
Fence material	3	1024.9	314.1	0.00
Fence height	3	1030.3	319.6	0.00
Null	2	1030.6	319.8	0.00

Table A5. Model selection results for elk crossing success. For each model, we report degrees of freedom (df), Akaike's information criteria (AIC), AIC difference versus top model (Δ AIC), and Akaike weight (W_i). Explanatory variables were age-sex class (adult female, antlered male*, juvenile**), fence height (reduced height = 4-wire-no-top, 2-wire, 2-rail; full height = 5-wire, 4-wire-no-bottom, 3-rail), and fence material (rail, wire). Reference variables were adult female, reduced height, and rail. Parameters abbreviated for clarity.

Parameters	df	AIC	Δ AIC	W_I
Age-sex class × Fence height + Fence material [1]	9	1781.9	0	0.91
Age-sex class + Fence height + Fence material	6	1786.5	4.6	0.09
Age-sex class	4	1851.2	69.3	0.00
Fence height	3	1862.9	81.0	0.00
Fence material	3	1878.9	97.1	0.00
Null	2	1898.6	116.8	0.00

*Antlered male defined as adult male outside of pedicled period (15 March to 15 May for elk).
** Juvenile defined as animal classified as subadult, yearling, or young-of-year.
[1] Excludes antlered male * full height interaction (0 successful crossings, n= 16).

Table A6. Model selection results for mule deer crossing success. For each model, we report degrees of freedom (df), Akaike's information criteria (AIC), AIC difference versus top model (Δ AIC), and Akaike weight (W_i). Explanatory variables were age-sex class (adult female, antlered male*, juvenile**), fence height (reduced height = 4-wire-no-top, 2-wire, 2-rail-no-top; full height = 5-wire, 4-wire-no-bottom, 3-rail), and fence material (rail, wire). Reference variables were adult female, reduced height, and rail. Parameters abbreviated for clarity.

Parameters	df	AIC	Δ AIC	W_I
Fence material	3	634.0	0	0.60
Age-sex class + Fence height + Fence material	6	635.1	1.1	0.34
Fence height	3	640.1	6.1	0.03
Age-sex class × Fence height + Fence material	9	641.1	7.1	0.02
Null	2	641.7	7.7	0.01
Age-sex class	4	643.3	9.3	0.01

* Antlered male defined as adult male outside of pedicled period (15 February to 15 April for mule deer).
** Juvenile defined as animal classified as subadult, yearling, or young-of-year.

Table A7. Model selection results for white-tailed deer crossing success. For each model, we report degrees of freedom (df), Akaike's information criteria (AIC), AIC difference versus top model (Δ AIC), and Akaike weight (W_i). Explanatory variables were age-sex class (adult female, antlered male*, juvenile**), fence height (reduced height = 4-wire-no-top, 2-wire, 2-rail-no-top; full height = 5-wire, 4-wire-no-bottom, 3-rail), and fence material (rail, wire). Reference variables were adult female, reduced height, and rail. Parameters abbreviated for clarity.

Parameters	df	AIC	Δ AIC	W_i
Age-sex class × Fence height + Fence material	9	1955.6	0	0.59
Age-sex class + Fence height + Fence material	6	1956.7	1.1	0.34
Fence height	3	1959.7	4.1	0.08
Fence material	3	2124.5	168.9	0.00
Age-sex class	4	2130.4	174.8	0.00
Null	2	2133.3	177.7	0.00

* Antlered male defined as adult male outside of pedicled period (February 1 to March 15 for white-tailed deer). ** Juvenile defined as animal classified as subadult, yearling, or young-of-year.

Table A8. Results from top age-sex/crossing success logistic regression models for elk, mule deer, and white-tailed deer. We report the beta coefficient estimate (β), standard error (SE), z-statistic (z), and p-value (P). Antlered males were defined as adult males outside of the pedicled period of 15 March to 15 May (elk), 15 February to 15 April (mule deer), or 1 February to 15 March (white-tailed deer). Reference variables were adult female (age-sex), reduced height (height), and rail (material).

	Parameter	β	SE	z	p
Elk	Intercept	-2.03	0.395	-5.135	<0.001*
	Wire	1.39	0.299	4.658	<0.001*
	Full height	-1.01	0.178	-5.689	<0.001*
	Antlered male	0.66	0.325	2.042	0.041*
	Wire	-0.91	0.401	-2.265	0.024*
	Juvenile	-0.56	0.443	-1.255	0.210
	Wire	-0.55	0.473	-1.168	0.243
	Full height	-1.40	0.755	-1.855	0.064
Mule deer	Intercept	-1.63	0.549	-2.961	0.003*
	Wire	1.26	0.453	2.780	0.005*
	Full height	-0.50	0.290	-1.717	0.086
	Antlered male	-0.17	0.261	-0.645	0.519
	Juvenile	-0.35	0.269	-1.301	0.193
White-tailed deer	Intercept	0.11	0.382	0.287	0.774
	Wire	0.22	0.276	0.803	0.422
	Full height	-1.98	0.175	-11.330	<0.001*
	Antlered Male	-0.02	0.335	-0.062	0.951
	Wire	-0.27	0.369	-0.729	0.466
	Juvenile	-0.10	0.393	-0.248	0.804
	Wire	0.11	0.411	0.260	0.795
	Full height	0.69	0.279	2.476	0.013*

* Indicates significance at α = 0.05
** Excludes antlered male/full height interaction (0 successful crossings, n= 16)

Local scale results

Table A9. Results from top-ranked (AIC) logistic regression model for local-scale detection probability. Beta coefficient estimate (β), standard error (SE), z-statistic (z), and significance (p). Reference variables are no fence (configuration), ungulate (guild), and Dormer (location).

Parameter	β	SE	z	p
Intercept	-3.79	0.23	-16.39	0.000*
Bison deflection	0.32	0.08	3.990	0.000*
Wildlife permeable	0.37	0.07	5.638	0.000*
Canid	-0.38	0.05	-7.688	0.000*
Bison deflection	-0.17	0.12	-1.388	0.165
Wildlife permeable	-0.27	0.10	-2.647	0.008*
Felid	-2.15	0.09	-23.50	0.000*
Bison deflection	1.13	0.16	7.284	0.000*
Wildlife permeable	0.40	0.16	2.508	0.012*
Ursid	-1.50	0.07	-21.28	0.000*
Bisondeflection	-0.03	0.17	-0.209	0.834
Wildlife permeable	0.47	0.12	3.827	0.000*
Panther	0.61	0.42	1.444	0.149
Red Deer	1.81	0.43	4.267	0.000*
Tyrrell	2.09	0.75	2.804	0.005*

* indicates significance at α = 0.05

Landscape scale results

Table A10. Results from the top-ranked (AIC) generalized linear mixed models for factors influencing travel speed for wolves and elk at the landscape scale. Beta coefficient estimate (β), standard error (SE), z-statistic (z), and significance (p). Reference variables are *no fence* (configuration) and Panther (location).

	Parameter	β	SE	z	p
Wolves	Intercept	414.0	195.2	2.12	0.033*
	Wildlife permeable	385.1	178.2	2.16	0.031*
	Bison deflection	106.0	184.0	0.58	0.565
	Location Red Deer	348.9	136.7	2.55	0.011*
Elk	Intercept	813.8	65.2	12.5	< 0.001*
	Wildlife permeable	-198.9	74.2	-2.68	0.007*
	Bison deflection	-207.8	58.3	-3.57	< 0.001*
	Location Red Deer	-159.3	64.1	-2.49	0.013*

* indicates significance at α = 0.05

Table A11. Results from the top-ranked (AIC) generalized linear models for factors influencing fence crossing proportions for wolves and elk at the landscape scale. Beta coefficient estimate (β), standard error (SE), z-statistic (z), and significance (p). Reference variables are no fence (configuration) and Panther (location).

	Parameter	β	SE	z	p
Wolves	Intercept	-0.735	0.77	-0.96	0.339
	Wildlife permeable	1.996	0.76	2.62	0.008*
	Bison deflection	-1.469	0.63	-2.33	0.020*
	Location Red Deer	1.341	0.66	2.04	0.046*
Elk	Intercept	1.533	0.25	6.06	< 0.001*
	Wildlife permeable	-0.116	0.47	-0.25	0.81
	Bison deflection	-0.660	0.34	-1.95	0.051

* indicates significance at α = 0.05