Supplementary Material

Table S1. Specifications for aerial photo data used to assess land cover change.

Acquisition Year	Province	Number of Photos or Tiles	Scale*	Colour	Resolution (m)	Georeferencing Error**	Source
1976	Alberta	77	1:12000	Monochromatic	0.27	2.55	Alberta Aerial Photographic Record System
1998	Alberta	20	1:30000	Monochromatic	0.66	3.28	Alberta Aerial Photographic Record System
2018	Alberta	12	N/A	Red, green, blue	0.25	0.00	Tarin Resource Services
1979	Saskatchewan	4	1:20000	Monochromatic	1.70	6.1	Saskatchewan Ministry of Parks, Culture & Sport
1991	Saskatchewan	42	1:21000	Monochromatic	0.87	3.83	Saskatchewan Ministry of Parks, Culture & Sport
2018	Saskatchewan	6	N/A	Red, green, blue	0.3	0.00	Saskatchewan Ministry of Parks, Culture & Sport

Table S2. Formulations for the set of candidate models. Models 1-10 were considered for all response variables. Models 11-20, which included effects of grazing, were only considered for regeneration density.

Model	Formula for linear predictor*
1	Base model
2	Base model × (1 + E)
3	Base model × (1 + S)
4	Base model × (1 + EA + NA)
5	Base model × (1 + E + S)
6	Base model × (1 + E + EA + NA)
7	Base model × (1 + S + EA + NA)
8	Base model × (1 + S x EA + S x NA)
9	Base model × (1 + E + S + EA + NA)
10	Base model × (1 + E + S x EA + S x NA)
11	Base model + G
12	Base model × (1 + E) + G
13	Base model × (1 + S) + G
14	Base model × (1 + EA + NA) + G
15	Base model × (1 + E + S) + G
16	Base model × (1 + E + EA + NA) + G
17	Base model × (1 + S + EA + NA) + G
18	Base model × (1 + E + S + EA + NA) + G
19	Base model × (1 + S x EA + S x NA) + G
20	Base model × (1 + E + S x EA + S x NA) + G

*E = (elevation-1300)/100; S= (slope/5); EA (easterly aspect) = cos(90-aspect);
 NA (northerly aspect) = sin(90-aspect); G = (grazing-5)/5

Table S3. Posterior estimates and credible interval (CI) values for the selected land cover change model (model 9 in Table S2).

Model parameter	Land cover change 1990s-2018 Model 9 Summary			Land cover change 1970s-1990s Model 9 Summary		
	Posterior estimate	Lower CI (95%)	Upper CI (95%)	Posterior estimate	Lower CI (95%)	Upper CI (95%)
Intercept	-4.16	-4.88	-3.50	-4.04	-4.81	-3.35
Distance	-1.88	-2.80	-1.01	-2.05	-3.02	-1.13
Elevation	0.28	-0.27	0.85	-0.01	-0.58	0.56
Slope	-1.63	-2.59	-0.72	-1.12	-1.99	-0.30
Easterly Aspect (EA)	0.67	0.04	1.31	0.38	-0.28	1.08
Northerly Aspect (NA)	0.46	-0.09	1.02	0.62	0.02	1.27
Distance*Elevation	0.49	-0.23	1.20	0.33	-0.40	1.08
Distance*Slope	-1.79	-2.93	-0.69	-1.39	-2.42	-0.39
Distance*EA	0.22	-0.60	1.04	-0.27	-1.11	0.64
Distance*NA	0.86	0.12	1.58	0.60	-0.20	1.45

Table S4. Posterior estimates and credible interval (CI) values for selected models estimating upper canopy height and canopy cover for forests established in time interval 1 (model 3 in Table S2), forests established in time interval 2 (models 2 and 6 in Table S2), and tree cover in grasslands within 50 m of the forest edge (models 8 and 10 in Table S2).

Forests established in time interval 1 (1970s-90s)

Height

Model parameter	Posterior estimate	Lower CI (95%)	Upper CI (95%)
Intercept	13.8	13.46	14.13
Slope	-0.55	-0.82	-0.29

Canopy cover

Intercept	0.41	0.39	0.42
Slope	-0.02	-0.03	-0.01

Forests established in time interval 2 (1990s-2018)

Height

Model parameter	Posterior estimate	Lower CI (95%)	Upper CI (95%)
Intercept	11.74	11.35	12.13
Elevation	-1.17	-1.64	-0.71

Canopy cover

Intercept	0.39	0.37	0.41
Elevation	-0.06	-0.08	-0.04
Easterly aspect (EA)	0.02	-0.01	0.04
Northerly aspect (NA)	0.03	0.00	0.05

Grassland within 50 m of the forest edge

Height

Model parameter	Posterior estimate	Lower CI (95%)	Upper CI (95%)
Intercept	7.85	7.19	8.53
Slope	0.93	0.51	1.35
Easterly aspect (EA)	-0.13	-1.09	0.87
Northerly aspect (NA)	-0.16	-1.01	0.69
Slope x EA	0.51	-0.08	1.10
Slope x NA	0.52	-0.01	1.06

Canopy cover

Intercept	0.17	0.15	0.19
Elevation	-0.01	-0.02	0.00
Slope	0.02	0.01	0.03
Easterly aspect (EA)	0.00	-0.03	0.01
Northerly aspect (NA)	-0.01	-0.03	0.01
Slope x EA	0.01	0.00	0.03
Slope x NA	0.02	0.01	0.04

Table S5. Posterior estimates and credible intervals (CI) for the selected regeneration density models (model 9 in Table S2) for white spruce, trembling aspen and lodgepole pine.

| Model parameter	White Spruce			Trembling Aspen			Lodgepole Pine		
	Posterior estimate	Lower CI (95%)	Upper CI (95%)	Posterior estimate	Lower CI (95%)	Upper CI (95%)	Posterior estimate	Lower CI (95%)	Upper CI (95%)
Random effects									
$\sigma_{Intercept}$	0.98	0.04	2.58	3.34	2.73	4.03	2.16	1.38	3.09
$\sigma_{Distance}$	1.38	0.65	2.20	1.02	0.83	1.24	0.47	0.15	0.80
$\sigma_{Intercept, Distance}$	0.17	-0.76	0.96	-0.39	-0.64	-0.07	-0.29	-0.78	0.43
Regression Coefficients									
Intercept	-4.39	-6.32	-2.73	-0.56	-1.78	0.61	-8.45	-10.96	-6.37
Distance	-2.95	-4.67	-1.54	-1.74	-2.26	-1.26	-0.28	-1.15	0.48
Elevation	-1.30	-2.09	-0.61	-1.01	-1.68	-0.36	2.5	1.19	4.07
Slope	1.34	0.37	2.35	-0.17	-1.01	0.67	0.59	-0.26	1.50
Easterly aspect (EA)	1.25	0.00	2.50	-0.73	-1.76	0.28	1.9	0.58	2.94
Northerly aspect (NA)	1.36	0.48	5.27	0.31	-0.49	1.10	-0.21	-1.15	0.64
Distance x Elevation	0.97	0.40	1.62	0.03	-0.25	0.29	-0.05	-0.52	0.47
Distance x Slope	-0.03	-0.68	0.66	0.03	-0.30	0.37	-0.22	-0.53	0.08
Distance x EA	-0.17	-1.02	0.69	0.23	-0.16	0.60	0.21	-0.17	0.62
Distance x NA	-0.75	-1.45	-0.11	-0.14	-0.44	0.18	-0.22	-0.52	0.07
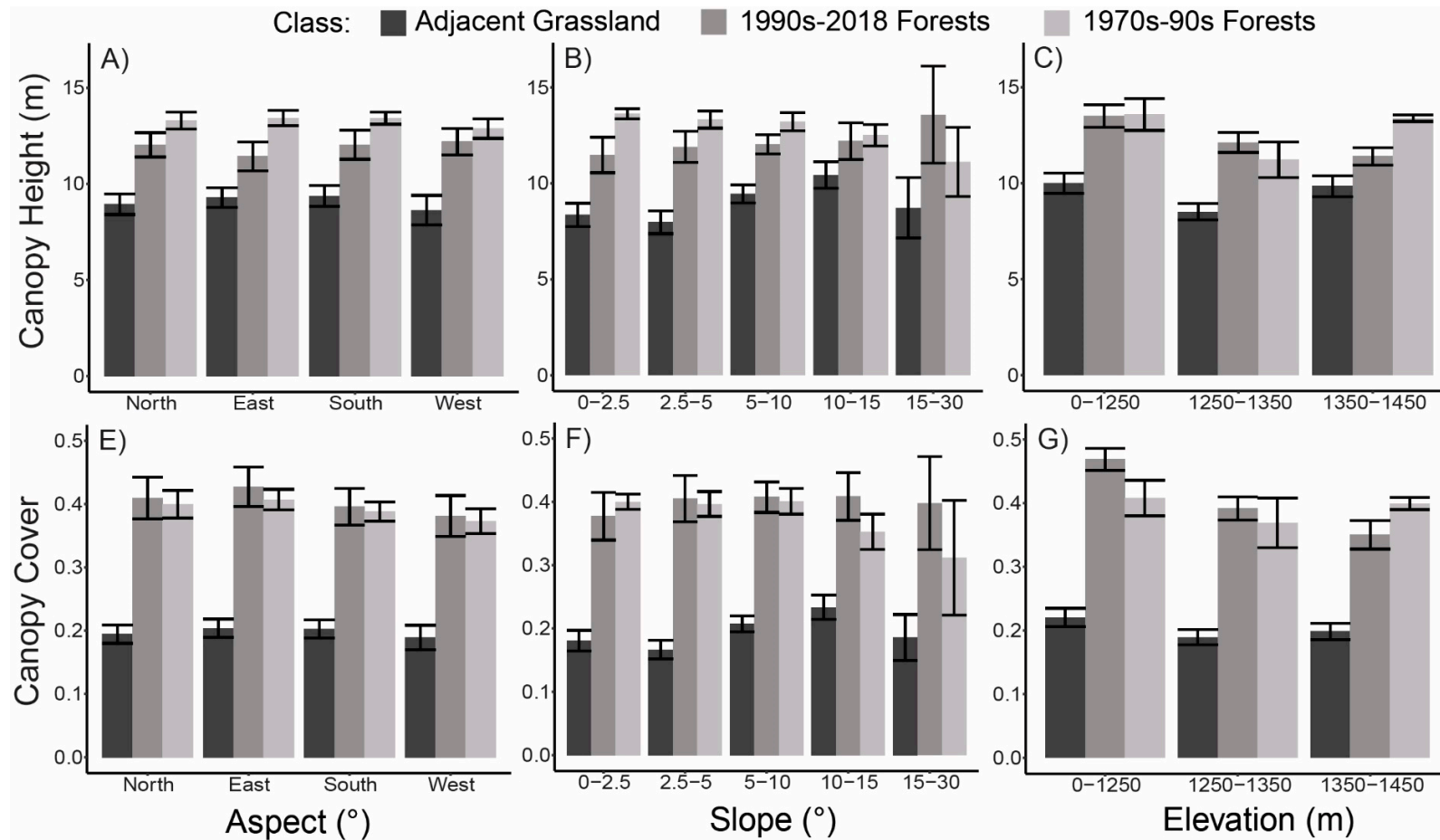
Figure S1. Observed upper canopy height (95th percentile) and canopy cover of ~1-ha areas by land cover category in relation to aspect, slope and elevation. Error bars represent standard error.
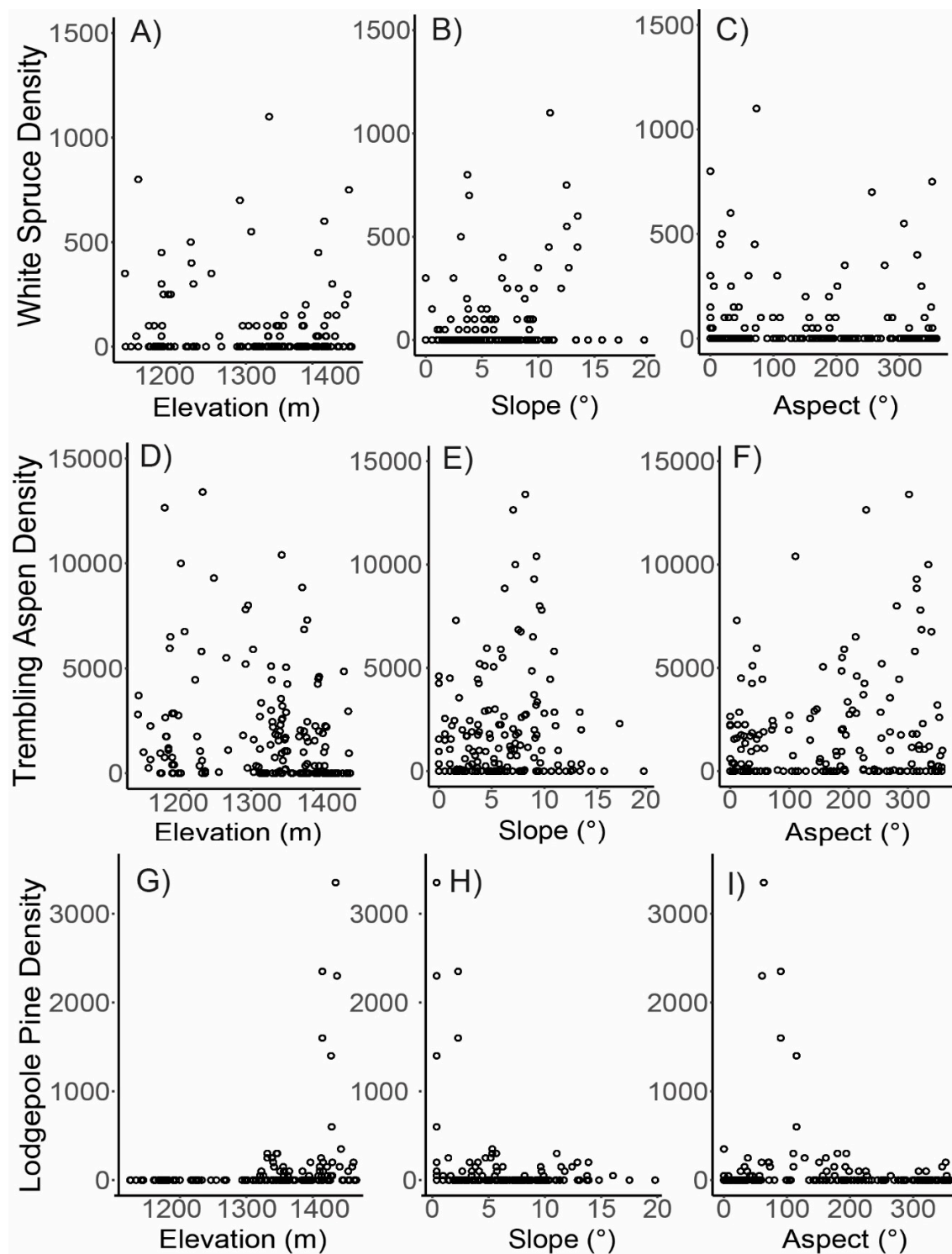
Figure S2. Mean regeneration density (stems/ha) from field transects of white spruce (A-C), trembling aspen (D-F), and lodgepole pine (G-I) in relation to elevation, slope and aspect.
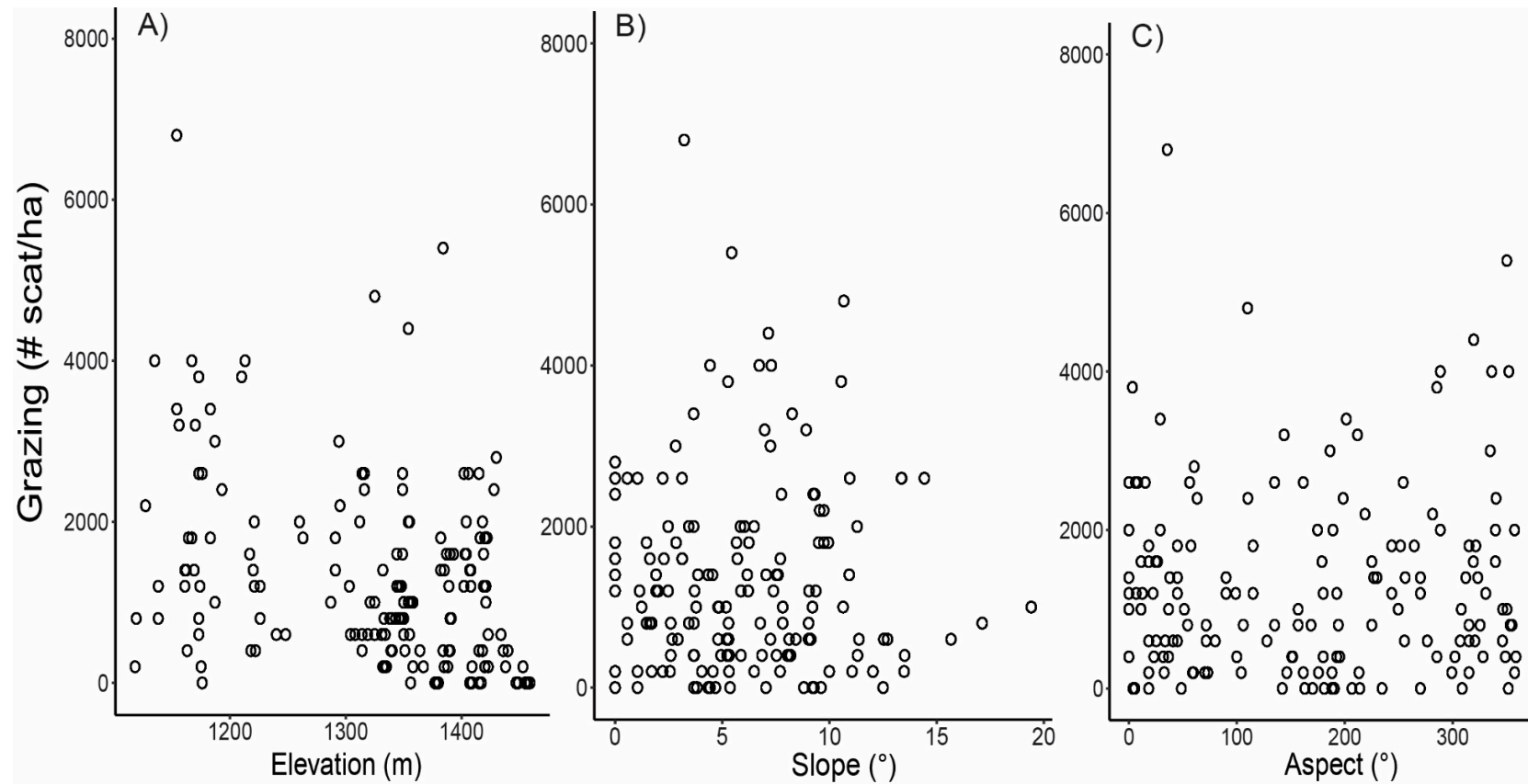
Figure S3. Variation in activity of cattle and other ungulates, as measured by scat density, by elevation, slope, and aspect.
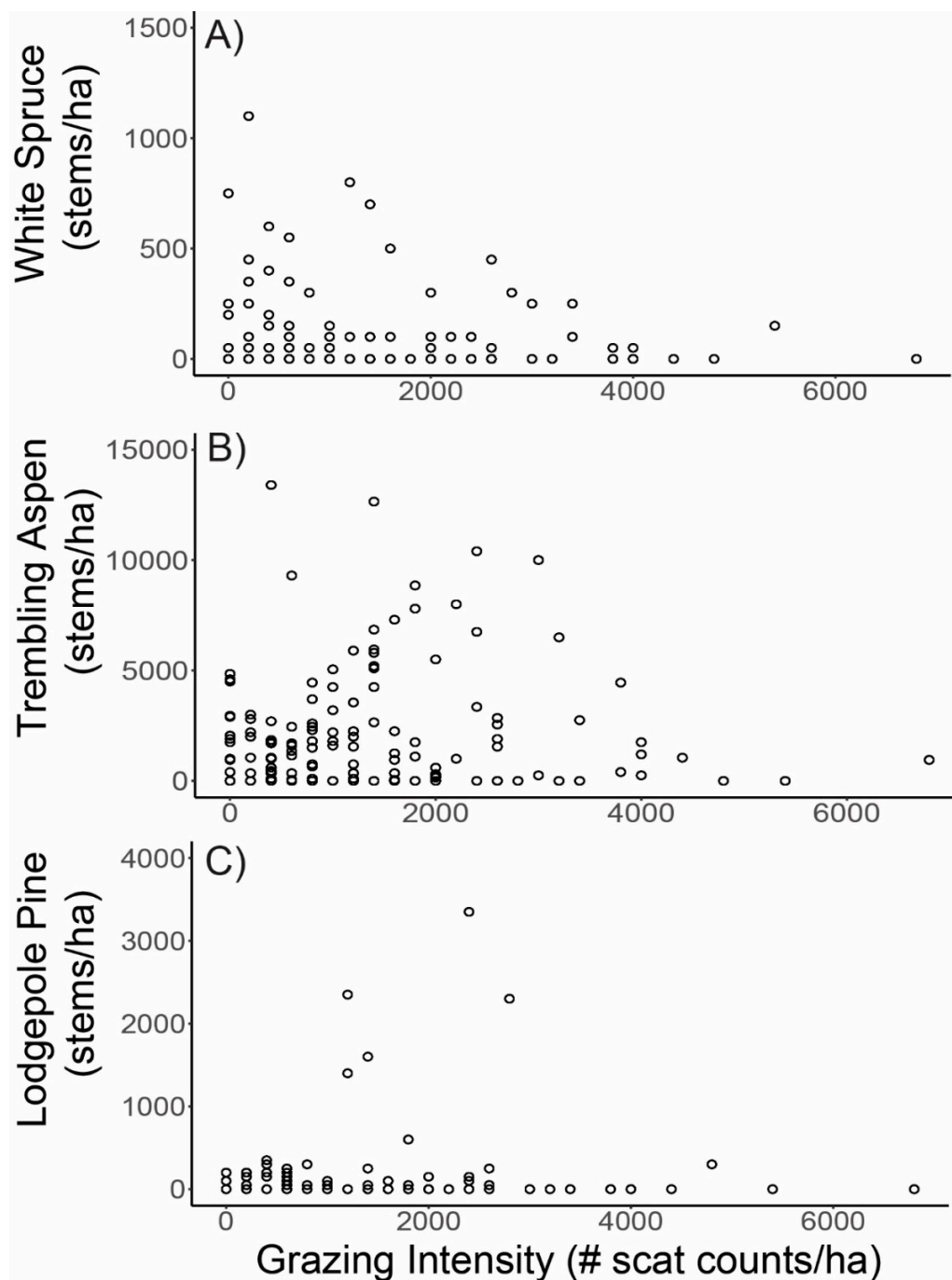
Figure S4. Relationships between tree regeneration density in grassland areas within 50 m of the forest edge and grazing intensity. Topographic variables appeared to explain these patterns, as an independent grazing effect was not supported by our model selection proces