Wildlife Biology

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Appendix 1

Validation of the postulates regarding the effectiveness of the experimental manipulation of forage production and quality by fertilization of fields, and of risk avoidance by creation of various widths of forested patches between fields.

Methods

We validated changes in forage production and quality one and two years after the fertilization treatment. To do so, we estimated forage production in 2013 and 2014 using two 2 × 2-m deer exclosures per experimental unit. We installed exclosures in June 2013 at two random locations among the four fields of each experimental unit, restricting the number of exclosures to one per field and positioning them >2 m from the forest edge. In October 2013 and 2014, we clipped all aboveground vegetation in two 30 × 30-cm quadrats located at random locations (but >30 cm from the fence to avoid edge effect) inside each exclosure. Within any given exclosure, we changed quadrat locations the second year to avoid clipping vegetation that was clipped the first year.

We dried vegetation samples at 50°C until constant mass, sorted and weighted them at the species level in milligrams (AE-200, Mettler Toledo, Mississauga, Canada). We used the mean of the two quadrats per exclosure (expressed in g/m^2) as an estimate of forage production. To assess forage quality, we pooled the vegetation of the two quadrats and submitted the material to a macro-Kjeldahl extraction with flow injection analysis for foliar N concentration (Parkinson and Allen 1975). We estimated neutral detergent fiber (NDF; hemicellulose, cellulose, and lignin) following Goering and Van Soest (1970; A200, Ankom Technology, Macedon, NY). We used foliar N and NDF concentration as proxies of forage quality. Even though deer forage selectively, we pooled all vegetation to have a general representation of the effect of fertilizers on forage production and quality.

We validated that the experimental manipulation of the widths of residual forested patches between fields (30 or 60 m) influences risk avoidance using an estimation of the sight distance concealing a target within the residual patch from a fixed observer in the field. We selected 15 random locations at the edge of the three forested strips of each experimental unit and used a rangefinder (Scout 1000 ARC, Bushnell, Overland Park, KS) to measure the sight distance between the fixed observer standing at these locations and a person walking with an orange vest through the forested strip until the observer could no longer see the vest (adapted from Mysterud 1996). All observations were performed by the same person.

Data analysis

We examined the effects of fertilization, year, and their interaction on forage quality and on forage production using general linear mixed models (GLMM; PROC MIXED) with blocks and exclosures as random effects. We used year as a repeated measure with a heterogeneous compound symmetry (csh) structure because the variance was not the same for both years (Wolfinger 1996). We analyzed the effect of the width of the residual forest cover on the sight distance in the forested strips with a GLMM using blocks and each measurement locations as random factors. Data were verified for normality and homoscedasticity; transformations were used when required. We performed all analyses with SAS 9.4 (SAS Institute Inc., Cary, NC) and used 0.05 as alpha value.

Results

Table A1.1. Mean forage production in g m^{-2} by species or functional groups depending on the combination of the fertilization treatment and the width of forested strips in experimental fields on Anticosti Island, Québec, Canada. The 30 most abundant species or functional groups were American bracken (*Pteridium aquilinum*), aster (*Symphyotrichum ciliolatum, S. ×tardiflorum, Oclemena nemoralis*), avens (*Geum aleppicum, G. macrophyllum*), bedstraw (*Galium asprellum, G. triflorum*), blueberry (*Vaccinium angustifolium, V. myrtilloides*), Canada mayflower (*Maianthemum canadense*), Canadian bunchberry (*Cornus canadensis*), Canadian burnet (*Sanguisorba canadensis*), coltsfoot (*Tussilago farfara, Petasites frigidus* var. *palmatus*), common dandelion (*Taraxacum officinale*), creeping snowberry (*Gaultheria hispidula*), everlasting (*Anaphalis margaritacea*), false violet (*Rubus repens*), grasses (*Danthonia spicata, Calamagrostis canadensis, Bromus ciliates, Panicum sp.* and 8 other species), hawkweed (*Pilosella caespitosa , Hieracium sp.*), horsetail (*Equisetum arvense, E. scirpoides, E. variegatum*), iris (*Iris versicolor*), Labrador tea (*Rhododendron groenlandicum*), naked miterwort (*Mitella nuda*), pussytoes (*Antennaria sp.*), raspberry (*Rubus idaeus, R. pubescens*), sheep laurel (*Kalmia angustifolia*), star flower (*Lysimachia borealis*), strawberry (*Fragaria sp.*), sweet gale (*Myrica gale*), thistle (*Cirsium arvense, C. vulgare*), threeleaf goldthread (*Coptis trifolia*), trailing arbutus (*Epigaea repens*), twinflower (*Linnaea borealis*) and violet (*Viola* sp.).

Species	Treatment combination				Total (g m^{-2})
	Fertilized and 30 m strips (g m^{-2})	Fertilized and 60 m strips (g m^{-2})	Unfertilized and 30 m strips (g m^{-2})	Unfertilized and 60 m strips (g m^{-2})	
American bracken	26.5	26.0	2.2	7.0	61.7
Aster	2.4	1.1	3.3	3.6	10.4
Avens	0.0	0.0	1.3	0.0	1.3
Bedstraw	0.3	0.0	0.2	0.0	0.5
Blueberry	14.2	24.5	5.5	16.5	60.7
Canada mayflower	0.5	0.2	0.2	0.3	1.2
Canadian bunchberry	23.6	21.0	14.3	34.2	93.1
Canadian burnet	5.3	6.1	5.6	1.7	18.6
Coltsfoot	7.8	4.9	0.3	9.7	22.6
Common dandelion	0.7	1.3	1.7	1.2	4.9
Creeping snowberry	0.0	0.0	0.5	0.0	0.5
Equisetum	2.3	0.4	0.9	1.1	4.7
Everlasting	0.3	0.4	0.8	3.3	4.7
False violet	3.7	0.6	4.6	2.0	10.8
Grasses	99.4	31.6	53.8	31.5	216.3
Hawkweed	7.3	8.1	2.3	11.8	29.5
Iris	8.7	0.0	0.0	0.0	8.7
Labrador tea	0.0	0.0	0.0	1.3	1.3
Naked miterwort	0.3	0.1	1.3	0.2	1.9
Pussytoes	0.0	0.8	0.9	0.0	1.8
Raspberry	3.0	20.0	5.7	6.0	34.8
Sheep laurel	0.0	0.0	3.4	3.3	6.8
Star flower	0.5	0.0	0.0	0.2	0.6
Strawberry	7.2	4.1	4.3	8.8	24.5
Sweet gale	24.6	0.0	0.0	1.6	26.2
Thistle	9.6	15.6	15.9	10.1	51.1
Threeleaf goldthread	0.7	1.1	1.3	1.7	4.8
Trailing arbutus	0.0	0.0	0.1	0.1	0.2
Twinflower	0.0	0.1	0.8	0.1	1.0
Violet	0.7	0.1	1.3	0.8	2.8

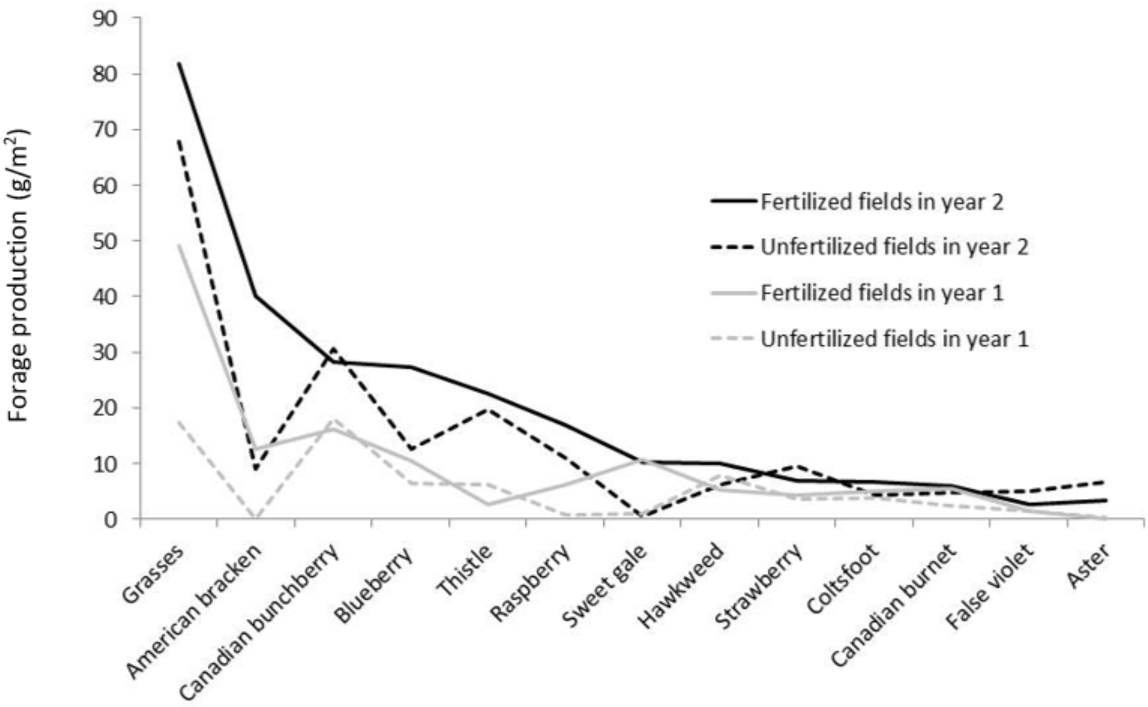

Figure A1.1. Mean forage production by species varied depending on year and fertilization treatment in experimental fields on Anticosti Island, Québec, Canada. The 13 most productive species or functional groups, with a total production over 10 g m^{-2}, were grasses (*Danthonia spicata, Calamagrostis canadensis, Bromus ciliates, Panicum* sp. and 8 other species), American bracken (*Pteridium aquilinum*), Canadian bunchberry (*Cornus canadensis*), blueberry (*Vaccinium angustifolium, V. myrtilloides*), thistle (*Cirsium arvense, C. vulgare*), raspberry (*Rubus idaeus, R. pubescens*), sweet gale (*Myrica gale*), hawkweed (*Pilosella caespitosa, Hieracium* sp.), coltsfoot (*Tussilago farfara*), and Canadian burnet (*Sanguisorba canadensis*).

Forage production tended to be higher in the fertilized fields (213 ± 56 g m^{-2}; 95% CL) than in the unfertilized fields (152 ± 38 g m^{-2}) and it increased from 114 ± 40 g m^{-2} in year 1 to 251 ± 44 g m^{-2} in year 2 (Table A1.2, Fig. A1.2). Foliar concentration of N was not affected by fertilization, year or their interaction (fertilized units = 1.1 ± 0.1% versus unfertilized units = 1.1 ± 0.1%, year 1 = 1.1 ± 0.1% versus year 2 = 1.2 ± 0.1%; Table A1.2). NDF concentration of dried forage significantly increased from year 1 to year 2 in unfertilized fields ($F_{1,29.4}$ = 16.86, p = <0.001), but not in fertilized fields ($F_{1, 28.4}$ = 1.80, p = 0.19; Table A1.2, Fig. A1.3). Similarly, grasses production also increased in unfertilized fields from year 1 (17.4 g m^{-2}) to year 2 (67.9 g m^{-2}; Fig. A1.1).

We postulated that sight distance would be reduced as the width of the forested strips increases, but our results demonstrated that sight distance was not significantly different in the 30-m-wide strips (36 ± 5 m; 95% CL) compared to the 60-m-wide strips (31 ± 5 m; $F_{1,3}$ = 1.43, p = 0.32).

Table A1.2. Effects of fertilization, year, and their interaction on forage production, foliar nitrogen (N) and neutral detergent fiber (NDF) concentrations in experimental fields on Anticosti Island, Québec, Canada. The experiment corresponded to a completely randomized block design with 16 experimental units in 4 blocks involving a 2-level treatment of fertilization (fertilized and unfertilized) over 2 years (2013, 2014). Forage was collected in 2 4-m^2 exclosures per unit each fall. We performed analyses with general linear mixed models with blocks and exclosures as random factors and year as a repeated measure. A square root transformation was applied to forage production data.

Source	Forage production			Foliar N concentration			NDF concentration		
	$df_{num, den}$	F	p	$df_{num, den}$	F	p	$df_{num, den}$	F	p
Fert. (F)	1, 27.3	3.38	0.08	1, 13.3	0.20	0.66	1, 28.8	1.06	0.31
Year (Y)	1, 30	127.06	≤0.001*	1, 29.4	2.90	0.10	1, 29	15.26	≤0.001*
F × Y	1, 30	1.11	0.30	1, 29.4	0.32	0.57	1, 29	4.24	0.05*

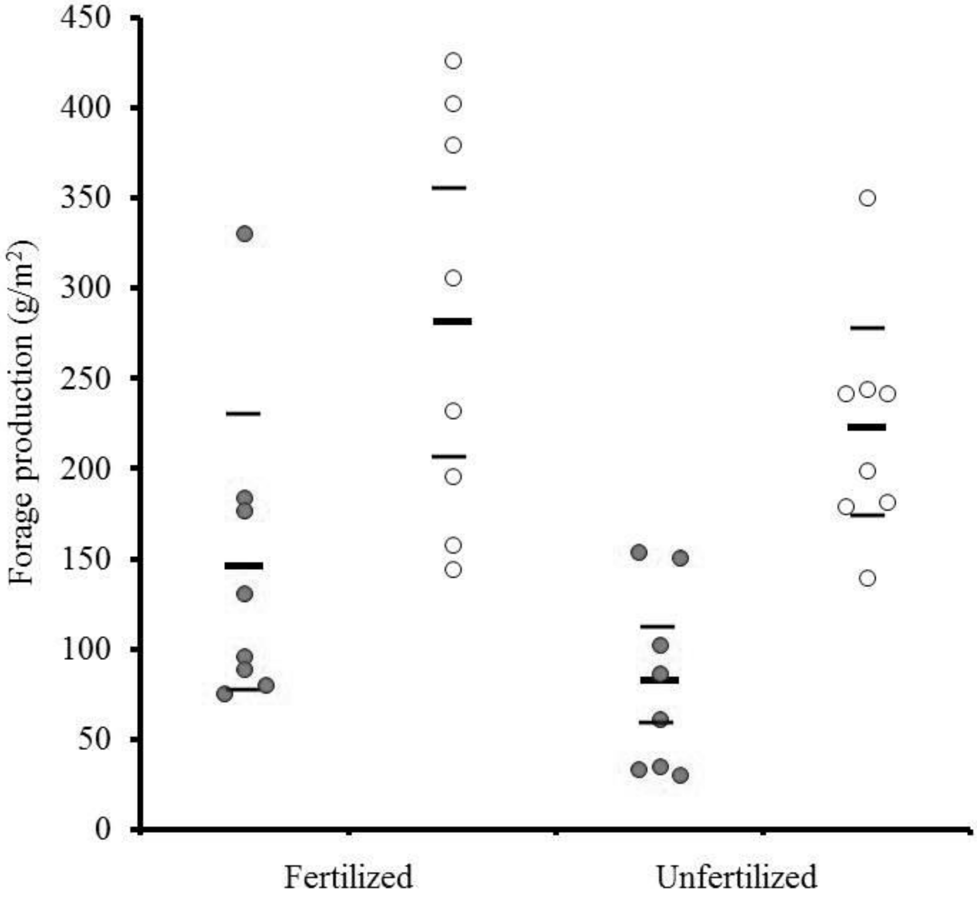

Figure A1.2. Forage production tended to be higher in fertilized fields than in unfertilized fields and it increased from year 1 (grey dots) to year 2 (white dots) in all experimental fields on Anticosti Island, Québec, Canada. Each dot represents the annual mean of 2 exclosures per experimental unit and the black horizontal bars represent the overall mean of every combination of fertilization and year with the 95% CI (thinner bars).

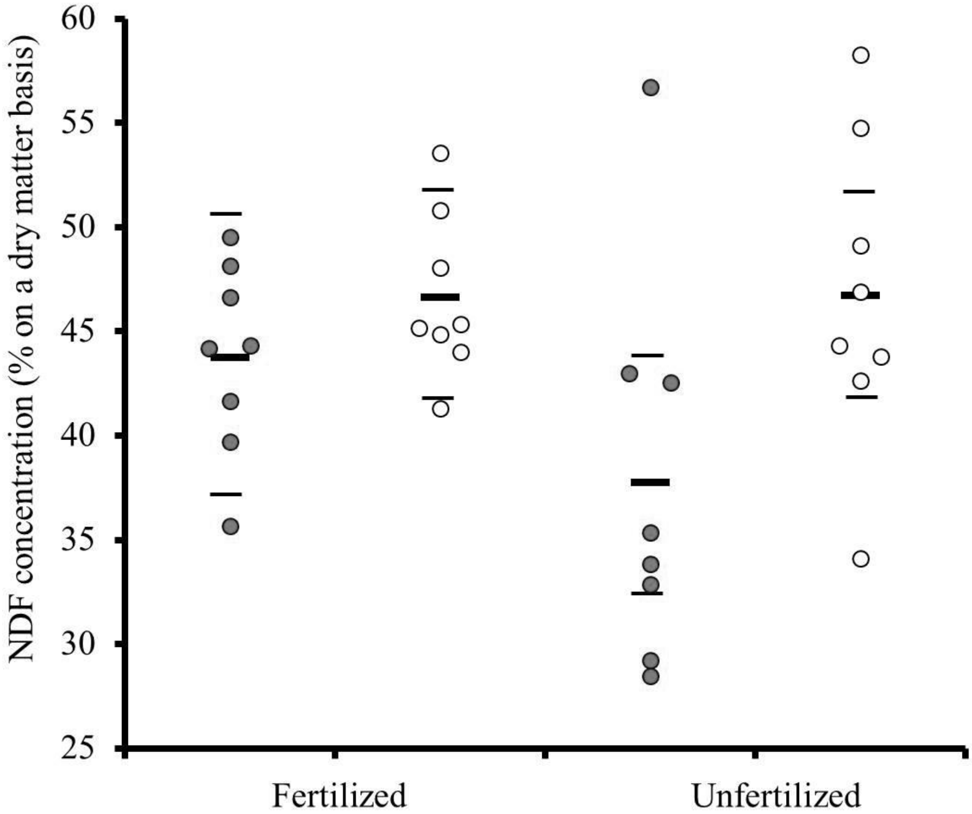

Figure A1.3. From year 1 (grey dots) to year 2 (white dots), the concentration of neutral detergent fiber (NDF) significantly increased in unfertilized fields, but not in fertilized fields, on Anticosti Island, Québec, Canada. Each dot represents the annual mean of two exclosures per unit. Black bars represent the overall mean of every combination of fertilization and year with the 95% CI (thinner bars).

References

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Mysterud, A. 1996. Bed-site selection by adult roe deer *Capreolus capreolus* in southern Norway during summer – Wildlife Biol. 2: 101–106.

Parkinson, J. A. and Allen, S. E. 1975. A wet oxidation procedure suitable for the determination of nitrogen and mineral nutrients in biological materials – Comm. Soil Sci. Plant Anal. 6: 1–11.

Wolfinger, R. D. 1996. Heterogeneous variance: covariance structures for repeated measures – J. Agr. Biol. Envir. St. 1: 205–230.

Appendix 2

Table A2.2. Periods when all cameras within a block worked without technical problems for both years (grey cells) in experimental fields on Anticosti Island, Québec, Canada.

	Month	June				July				August			
	Week	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Year	**Block**												
2013	A												
2013	B												
2013	C												
2013	D												
2014	A												
2014	B												
2014	C												
2014	D												

	Month	September				October				November			
	Week	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Year	**Block**												
2013	A												
2013	B												
2013	C												
2013	D												
2014	A												
2014	B												
2014	C												
2014	D												

Table A2.2. Number of pictures taken per camera during periods for which all cameras within a block worked and the number of deer seen. We selected these periods to ensure the same sampling effort between treatment combinations. All camera traps were set to systematically trigger each 30 min during daylight from June to November.

Date	Block	Unit	Camera	No. picture	No. deer seen
2013	A	NO1	4	3491	72
2013	A	NO1	22	3495	108
2013	A	NO2	1	3486	253
2013	A	NO3	23	3491	271
2013	A	NO4	3	3495	72
2013	B	NO5	5	4715	784
2013	B	NO6	8	4715	189
2013	B	NO6	17	4714	178
2013	B	NO7	7	4717	83
2013	B	NO8	6	4714	409
2013	C	MC1	9	2584	180
2013	C	MC2	10	2584	109
2013	C	MC3	12	2583	135
2013	C	MC4	24	2581	81
2013	D	MC5	15	2048	83
2013	D	MC5	21	2047	58
2013	D	MC6	13	2046	138
2013	D	MC7	16	2047	192
2013	D	MC8	14	2047	410
2014	A	NO1	4	2582	20
2014	A	NO1	22	2580	20
2014	A	NO2	1	2578	55
2014	A	NO3	23	2587	75
2014	A	NO3	2	2584	15
2014	A	NO4	3	2585	17
2014	B	NO5	18	2056	73
2014	B	NO6	17	2048	23
2014	B	NO7	7	2047	22
2014	B	NO7	8	2047	21
2014	B	NO8	6	2047	26
2014	C	MC1	9	1139	24
2014	C	MC2	10	1140	10
2014	C	MC3	12	1124	9
2014	C	MC3	24	1111	52
2014	C	MC4	11	1125	12
2014	D	MC5	15	1560	33
2014	D	MC5	21	1559	20
2014	D	MC6	13	1558	53
2014	D	MC7	16	1561	32
2014	D	MC8	14	1551	121