# THE INFLUENCE OF REINDEER GRAZING AND TRAMPLING ON NEWLY SEEDED FIELDS IN FINNMARK, NORWAY



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# The influence of reindeer grazing and trampling on newly seeded fields in Finnmark, Norway

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# Contents

**Abstract:** In recent years, conflicts between reindeer herdsmen and resident farmers have increased in Finnmark, northern Norway. The causes of these conflicts vary, but one of the major causes is reindeer grazing and trampling on newly seeded fields in spring and early summer. I studied the effect reindeer have on the production of grass at harvesting time as a result of their grazing and trampling on newly seeded fields in early summer. Field experiments were conducted between June and September 2009 on a farmland at Sopnes in west Finnmark. Comparing grazed and ungrazed pastures when manipulated with two reindeer densities, crop reduction increased with increasing intensity of grazing and trampling. Two different ages of grass seeded with a three week interval showed no difference in tolerance towards reindeer grazing. Over-compensation is therefore expected under a relatively low grazing pressure on newly seeded fields. The grass along the fence where trampling was most prevalent appeared to overcompensate, opposite to expectation of more damage on heavily trampled pasture. Further studies focusing on the over-compensatory capacity of new seeded fields under a relatively low grazing intensive are required.

**Key words:** reindeer grazing, pasture**,** production of grass, compensatory capacity

## Introduction

Studies investigating plant-herbivore interactions have been ongoing for decades, resulting in various theories. Some studies show that pastures benefit from herbivory by increasing biomass production (Cargill & Jefferies 1984, Wegener & Odasz 1997ab), reproductive capacity (Tolvanen et al. 2001), nutrient supply (Olofsson et al. 2001), fruit and seed production, shoot production, rosette production, or propagative roots and tiller production (reviewed by Maschinski & Whitham 1989). Grazing can also cause negative effects on vegetation by reducing reproductive capacity (Ouellet et al. 1994, Kitti & Forbes 2006) and negatively influencing the species composition of vegetative communities by producing less heterogeneous outlying pastures (Manseau et al. 1996, Austrheim and Eriksson 2001). Still other studies have found that herbivores have no significant influence on the plants they eat (Moen 1990, Kitti & Forbes 2006).

In recent years (1990-2010), disagreements between pastoralist reindeer herdsmen and resident farmers have resulted in numerous conflicts, especially in Finnmark, northern Norway. The causes of these conflicts vary, but a major issue is reindeer grazing and trampling on the resident farmers' newly seeded fields in spring and early summer. In 2008 and 2009, the situation escalated dramatically when farmers shot several reindeer grazing on their fields and were also accused of shooting after the reindeer herdsmen. Many farmers claim that reindeer grazing and trampling on newly planted fields will drastically reduce the grasses growth and biomass production at harvest time. Surprisingly, no studies have investigated the effect reindeer actually have on the production of grass as a result of their grazing and trampling on newly seeded fields. Previous studies mostly focused on the reindeers' effects on the natural ecosystem and outlying fields (Zimov et al. 1995, Kashulina et al. 1997, Augustine & McNaughton 1998, Loffler 2000, Olofsson et al. 2001, Bråthen et al. 2007).

According to Kashulina et al (1997), on Finnmarksvidda (the inland part of Finnmark), the number of reindeer during winter (mostly after harvesting) increased from 90 000 to 210 000 during the mid-1970s to the mid-1980s (see also Hansen et al., 1996). Domestic reindeer herds are composed of predominately females, usually composing over 90% of the herd. If we assume that at least 50% of these calve, there could theoretically be over 300 000 reindeer in early summer after calving utilizing coastal pastures in Finnmark where resident farmers live. Kashulina et al (1997) claim that the major cause of ecosystem change in Norwegian arctic areas was reindeer overgrazing. Loffler (2000) emphasized that reindeer overgrazing not only impacts the vegetation but also changes soil and humus composition. It was concluded that reindeer herding at current levels was a destructive form of land use in the northern Norwegian high mountains, and hence, was not sustainable. Besides, reindeer herding at high levels induced a negative spatial density-dependent production among reindeer herds in Finnmark, which was consistent with the depletion of palatable plants in the summer pastures (Bråthen et al. 2007).

On the other hand, Zimov et al. (1995) showed that trampling and grazing by mammalian grazers on tundra pastures could cause a shift in dominance from mosses to grasses, resulting in increased productivity, and was supported by Olofsson et al. (2001). Wegener & Odasz (1997a) found evidence of overcompensation from laboratory simulated grazing on the biomass of the perennial arctic grass *Dupontia fisheri* from Svalbard. Numerous studies show that grazing stimulates productivity of vegetation in a wide range of ecosystems (Hik & Jefferies 1990; Frank & McNaughton 1993; Pandey and Singh 1992; reviewed by Olofsson et al. 2001). Reindeer may also invoke positive feedback on their preferred food supply in summer pastures, like graminoids (Olofsson et al 2001, Cloman et al 2009).

In a controlled, replicated field experiment with two reindeer densities and two pasture age groups, I tested 1) the influence of different intensities of reindeer grazing and trampling on the production of grass at harvest, 2) the reindeers' influence on the different ages of grass and 3) the compensatory growth capacities (the extent that the experimental pastures could compensate for loss in biomass) of the two pasture age groups following the two intensities of reindeer grazing and trampling. I assume that an increase in reindeer density results in increased grazing intensity and trampling. I predicted that an increase in grazing intensity and trampling with increasing reindeer density will cause a significant decrease in biomass at harvest time for the grazed pastures compared to ungrazed pasture in both age groups of grass. I also predict that the older grass will tolerate grazing and trampling better than the younger grass and exhibit compensatory growth at the low reindeer density.

This study will contribute with important knowledge towards eventual crop reduction (or increment) as a result of reindeer grazing and crop damage (or benefits) caused by trampling on newly seeded fields in summer. This in turn can be applied to future pasture management in the region and conflict resolution and mediation between two important user-groups/industries in northern regions.

## Methods

### Study Area

Fieldwork was conducted between June and September 2009 on a farmland at Sopnes in Langfjordbotn, west Finnmark, Norway (69°59´N, 22°19´E). The area is under a sheltered climate. In the last 10 years, the average summer temperatures were 15°C (max) and 10.7°C (min). The average winter temperatures were -4°C (max) and -8.7°C (min). The average annual precipitation was 420mm (Source[1]). The farmland had been planted and harvested for animal (milk cows) fodder a number of years prior to 2003. The same area was then used for grazing experiments with reindeer and sheep until 2006 (Colman et al 2009). The sowed plant, *Agrostis Capillaris*, is a perennial grass that inhabits various environments ranging from dry to damp ground in neutral to acidic soils. It is a valuable agronomic species because of their ability to produce fodder as well as provide food for grazing animals (Source[2]).

### Experimental Design

Two sites were divided into two enclosures each (providing four enclosures). In order to test the reindeers' influence on the different ages of grass, I varied the time for seeding the grass with a three week interval. I divided each enclosure into four “invisible” plots (plot A to D), producing a 2 x 2 Latin square in each enclosure where plots A and D were planted first on June 14th as treatment "Old"; and plots B and C were planted 3 weeks later on July 4th as treatment "Young" (Fig. 1). In each plot, I randomly placed 4 grazing exclosure boxes (1×1 $m^2$) to protect these patches from grazing while surrounding areas were grazed (Fig. 1).

The impact of reindeer grazing and trampling along the fence is expected to cause visible damage, such as denuded of vegetation or tracks, similar to that reported by Evans (1994) (also see Moen & Danell 2003). Such damage might not be recovered by compensatory growth, which means the anticipation of the situation along the fence is considered as overgrazing. Hence, I placed exclosures away from the fence and only sampled from within at least 1 m inside from the edge of the grazing field. Visible observations and photographs were taken to investigate the grazing and trampling impacts on the edge of the fields along the fence (Appendix 1).

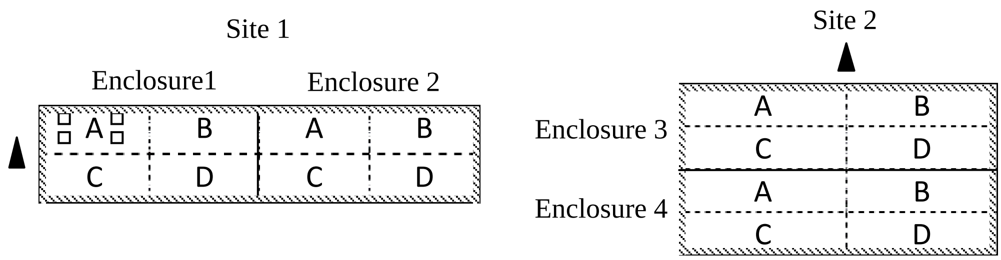


Figure1. Experimental design: The solid triangle '▲' represents watching tower. The empty square '□' represents grazing ex-closures. ‘▨’ is edge zone. Plots A and D were treatment “Old”; Plots B and C were treatment “Young”. Enclosure 1 and 3 were grazed by 3 reindeer; Enclosure 2 and 4 were grazed by 2 reindeer.

During grazing periods (between July 26 and August 1), three reindeer were introduced into Enclosure 1 and 3, while two reindeer were introduced into Enclosure 2 and 4 (Fig. 1 and Appendix 1 photo 1). Two seeding dates replicated 4 times in two sites and two densities of reindeer replicated two times in two sites produced 4 pair-wise observations within each plot where grass was harvested inside and outside $1m^2$ grazing ex-closures.

**Behavioural Observation**

Reindeer were introduced into enclosures in the evening of July 26th and observations began the next day, providing the reindeer with time to adjust before our behavior registrations began (Colman et al 2009). Reindeer remained within the enclosures for 6 days. All reindeer were released at the same time on August 1st. Except for the first day with 4.5 hours, reindeers were observed on average 8.5 hours at each site each day. Observations were separated into three periods of the day (early morning, daytime and nighttime). Observations were conducted from towers using eyesight (or binoculars when necessary). Reindeer position in the enclosures and behavior were registered every 10 minutes. Behavior was categorized as "G"= grazing, "M"=moving or "L"=lying. Reindeer behavior when grazing or moving along the edge of the enclosures was also recorded. Pictures and videos were taken and used to visually compare how reindeer behaved when being harassed by parasitic insects, as this may change the reindeers' influence on the production of grass through trampling or reduced grazing.

Between the outside fence and most of the planted field-area there was a 1 m wide zone termed the "edge zone" (Fig. 1 and Appendix 1 photo 1) where reindeer could graze freely and move along the fence. However, visual data collected here would be used only as a reference when construing the reindeer's preference on the different ages of grass and examining the pastures response to trails created by trampling along the fence.

**The Production of the Grass**

Enclosure 3 and 4 were harvested on 1st September and Enclosure 1 and 2 on 2nd September. All vegetation within the center 0.25 $m^2$ within each 1 $m^2$ exclosure was hand cut and put into paper bags and represents the control measurements. Equal sized 0.25 $m^2$ plots outside each exclosure, to the east direction and exactly 1 m from the outside edge of the exclosure, was also collected in the same manner and represents the test measurements. A square wood frame was used as a measuring tool when hand-clipping the vegetation (Appendix 1 photo 2). All aboveground biomass within the frame was collected into a paper bag marked with the plot number. The bags were then kept in a drying room ca 60-70°C for four days. To facilitate drying, the bags that contained too much grass were cut open and placed into raschel bags (Appendix 1 photo 3). Samples were then weighed, providing 64 pair-wise data on the net weight of vegetation inside and outside the grazing exclosure (Appendix 2).

**Statistical analysis**

All statistical analyses were conducted with R-project (http://www.r-project.org) and Minitab 15. One-way Anova and Simple Linear Regression Analysis was used to analyze the relationship among grazing intensity (Number of available data N =16), the biomass loss for each pair-wise sample (ΔW, N=64) and the age of grass.

**Data preparation**

In the statistical models, I used reindeers' grazing intensity (GI) calculated by equation (1) as the test measurement for the intensity of both grazing and trampling:

$$GI = GF_i + MF_i \qquad (1)$$

$GF_i$ and $MF_i$, respectively, represent the frequency of grazing and moving. For each plot, 1 point of $GF_i$ was counted when grazed once by one reindeer (for example, if 2 reindeer grazed at plot A at the same time then $GF_i$ of plot A gains 2 points). $MF_i$ was counted in the same way. A total of 586 behavior and position registrations were recorded and used for analysis. I combined the frequency of the behavior "grazing" (G) and "moving" (M) together as a total grazing intensity (GI) because it was difficult to separate the effect of grazing and trampling. The GI for each plot during the observation time was calculated to test the relevance of grazing and trampling intensity would have on the production of grass at harvest.

Delta weight (ΔW) was calculated by equation (2) represented the reduction or increment of the biomass of each pair-wise sample.

$$\Delta W = W_E - W_G \qquad (2)$$

Where $W_E$ = the net weight of vegetation within the exclosure; $W_G$ = the net weight of vegetation outside the exclosure (Appendix 2).

To match the grazing intensity data, the total crop reduction or increment for each plot ($\Delta W_p$) was calculated by equation (3) for analyzing the relevance between grazing intensity and fodder production. The calculation equation was

$$\Delta W_p = \Delta W_1 + \Delta W_2 + \Delta W_3 + \Delta W_4 \qquad (3)$$

$\Delta W_1$, $\Delta W_2$, $\Delta W_3$, $\Delta W_4$ represented the ΔW of each 4 pair-wise samples of each plot.

**Classification Standards**

All 64 pair-wise samples were used to categorize the effect of reindeers’ grazing and trampling on newly seeded fields: overgrazing, no-harm or overcompensation. Overgrazing, in an ecological sense, usually refers to vegetation degradation and erosion as a result of grazing, sometimes in combination with trampling (Heikkilä 2006). Moen & Danell (2003) also suggest that overgrazing could only be considered when animal production is affected, and should not be used when effects on vegetation are discussed. Since I only tested the effects on the production of fodder at harvest time, overgrazing is defined as the situation when the loss of production is more than $5g/0.25m^2$ after grazing and trampling for 6 days by reindeer.

Considering the errors generated from hand-operation, we used ±5g as the cut-off point. Hence all samples were classified into 3 categories:

Overgrazing: $\Delta W > 5g$;

No-harm: $\Delta W = (-5 \sim 5g)$

Overcompensation: $\Delta W < -5g$

## Results

Among all the factors: age of grass (young, old), reindeer density (high, low) and site effect (refers to the nutrition supply), the linear mixed-effects model showed that the main effect for biomass loss was reindeer density (Table 1, number of observation=64). Reindeer grazing intensity was mainly affected by reindeer density. When using grazing intensity instead of density as the predictor variable, the results also showed that the only significant effect for biomass loss was reindeer grazing intensity (Table 2, number of observation=16).

Table 1. Linear mixed-effects model for predicting the causes of the biomass loss of fields grazed by reindeer in Finnmark, northern Norway. Models include random intercept for plot and all possible combinations of the variables: age of grass (young, old), reindeer density (high, low), and site effect.

| Variable | Value | SE | DF | *t*-value | *P*-value |
|---|---|---|---|---|---|
| Intercept | 54.87 | 9.37 | 48 | 5.86 | 0.0000 |
| Age*reindeer density | -11.56 | 26.87 | 9 | -0.43 | 0.6770 |
| Age*Site | 30.56 | 26.68 | 10 | 1.15 | 0.2786 |
| Site*reindeer density | -34.44 | 26.75 | 11 | -1.29 | 0.2243 |
| Site | 4.03 | 13.45 | 12 | 0.30 | 0.7695 |
| Age | 5.22 | 13.35 | 13 | 0.39 | 0.7021 |
| Reindeer density | -44.03 | 13.25 | 14 | -3.32 | 0.005 |

Test statistics for each predictor variable are given as if they were the next predictor to be removed in a stepwise backward elimination procedure (Dahle et al 2008).

Table 2. Linear mixed-effects model for predicting the causes of the biomass loss of fields grazed by reindeer in Finnmark, northern Norway. Models include random intercept for plot and all possible combinations of the variables: age of grass (young, old), grazing intensity, and site effect.

| Variable | Value | SE | DF | *t*-value | *P*-value |
|---|---|---|---|---|---|
| Intercept | -82.73 | 58.10 | 14 | -1.42 | 0.1764 |
| Site*grazing intensity | -0.14 | 1.90 | 9 | -0.07 | 0.9431 |
| Age*Site | -7.42 | 108.03 | 10 | -0.07 | 0.9466 |
| Age*grazing intensity | 1.23 | 1.42 | 11 | 0.86 | 0.4085 |
| Site | -14.86 | 48.45 | 12 | -0.31 | 0.7644 |
| Age | 51.48 | 46.71 | 13 | 1.10 | 0.2904 |
| Grazing intensity | 2.61 | 0.65 | 14 | 4.02 | 0.0013 |

Test statistics for each predictor variable are given as if they were the next predictor to be removed in a stepwise backward elimination procedure (Dahle et al 2008).

### The Tolerance of Different Ages of Grass

The mean value of grazing intensity for Old and Young grass was 87.8 (SE=13.2) and 76.5 (SE=13.5), respectively. Reindeer grazing intensity was not significantly related to the ages of grass (P=0.562, Fig. 2).

The mean value of biomass loss (ΔW) for Old and Young grass was 30.25 (SE=9.21) and 35.5 (SE=11.0), respectively. There was no significant difference

(P=0.718, Fig. 3) in crop reduction between Old and Young grass. Thus, there were no signs of differences in tolerance between these two ages of grass exposed to these two levels of reindeer grazing intensities.


Figure 2. Qualitative data analysis of reindeer grazing preference on the two ages of grass. The solid line in the box-plot represents the median of each group: 81.5 of Old; 70 of Young. The whiskers of Old grass range to (37, 140) and of Young grass range to (42, 90). Asterisk (*) represents the outlier. There is no significant relevance between the two variables (P=0.562).

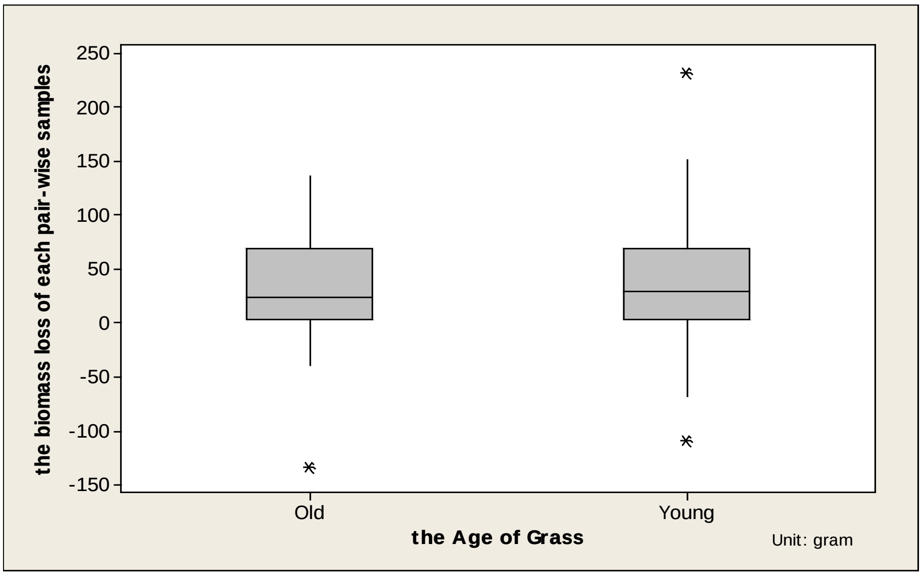


Figure 3. Qualitative data analysis of the distribution of the biomass loss based on the two ages of grass. The solid line in the box-plot represents the median of each group: 24 of Old; 29.5 of Young. The whiskers of Old grass range to (-39, 137) and of Young grass range to (-68, 152). Asterisk (*) represents the outliers. There is no significant differences of the biomass loss between 'Old' and 'Young' treatment (P=0.718).

**The Impact of Reindeer Grazing and Trampling**

The Pearson correlation between the biomass loss of each plot ($\Delta W_p$) and grazing intensity (GI) was 0.732, supporting a linear correlation (P=0.001) between these two variables. Simple Linear Regression showed:

$$\Delta W_p = - 82.73 + 2.608 \, GI \qquad (4)$$

The production of grass was significantly (P=0.001) affected by grazing intensity (Fig.4). Although the standard error (S=92.97) was relatively large, indicating more scatter around the line, the R-Sq showed more than half of the variation can be explained by the regression model. Hence, the regression line was considered to be a good fit to the data; crop reduction increased with increasing grazing intensity and trampling.

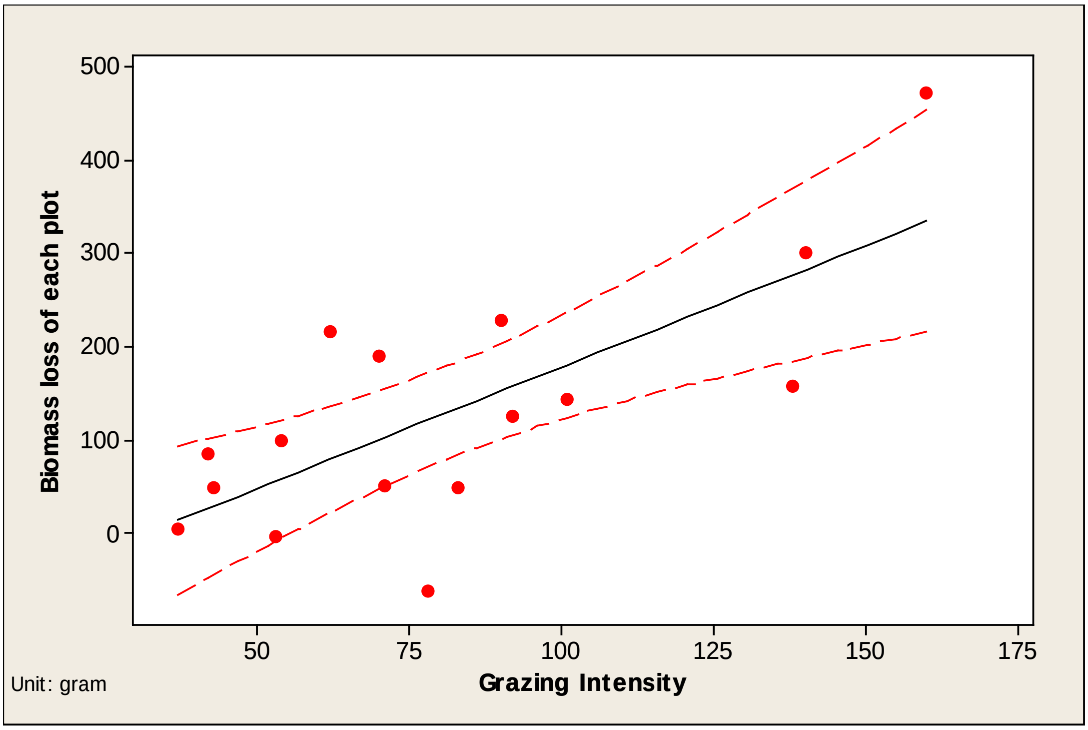


Figure 4. The Fitted Line of the biomass loss of each plot ($\Delta W_p$) versus Grazing Intensity. The solid black line represents the regression line of $\Delta W_p$ versus grazing frequency. Red dotted lines represent 95% confidence interval. P-value=0.001. The standard error (S=92.97) was relatively large compared to the data set, indicating more scatter around the line.

**Overgrazing, no-harm or overcompensation**

In all 64 pair-wise samples, 67.2% supported overgrazing, while 11.0% supported an over-compensatory capacity (Fig. 5). The overcompensation mostly occurred in Enclosure 4, which likely had the lowest grazing intensity because the two reindeer were a female and calf. For Enclosure 2, occupied by 2 adult reindeer, 11/16 samples' ΔW were less than 15g, therein 7/11 samples were classified as no-harm. For Enclosures 1 and 3, each grazed by 3 adult reindeer, 25/32 samples were overgrazed.

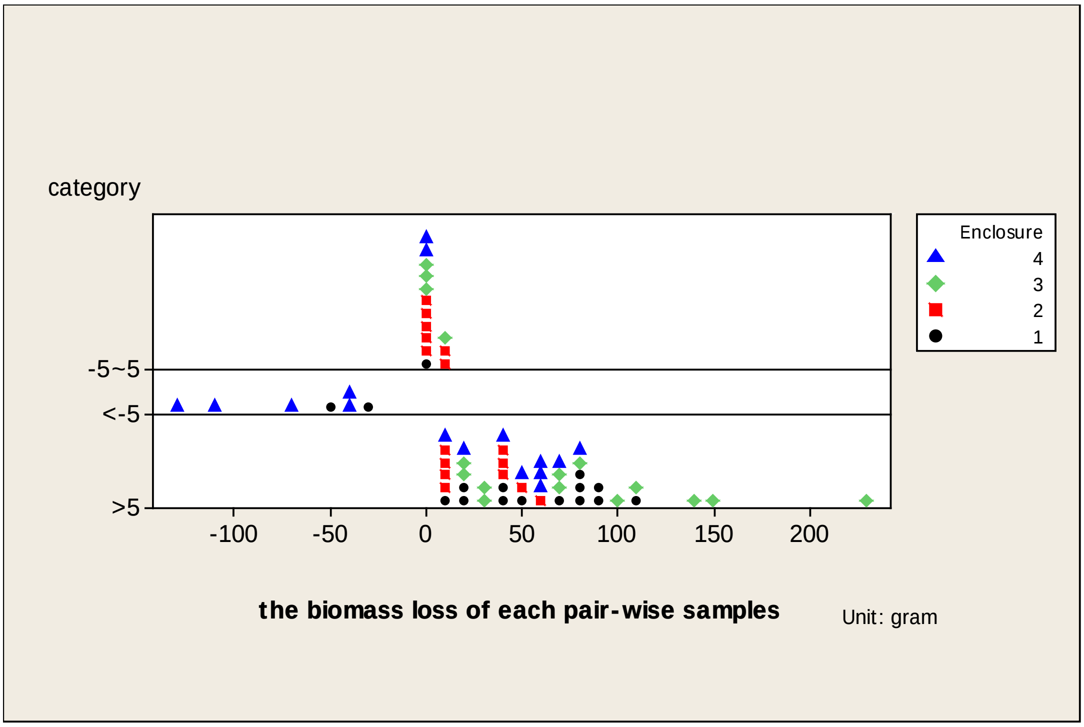


Figure 5. The categories of the influence of reindeer grazing and trampling on each pair-wise samples (N=64): overcompensation <-5; no-harm -5~5; overgrazing >5.

## Discussion

I predicted that an increase in grazing intensity and trampling with increasing reindeer density would cause a significant decrease in biomass at harvest time for the grazed pastures compared to ungrazed pasture in both age groups of grass. For all high density plots, biomass at harvest was reduced, supporting this prediction. However, I also found indications that at relatively low reindeer densities, the influence of grazing and trampling improved the production of grass at harvest, supporting overcompensation in a few plots. Herbivory interacts with plant architecture, photosynthesis, dynamics of energy and nutrients, and expressions of defense and tolerance (Skarpe & Hester 2008, Hester et al. 2006). The plant responses to grazing vary with habitat and resources (Maschinski & Whitham 1989) and the compensatory capacity depends on, among other things, the intensity and timing of grazing and the supply of nutrients, especially nitrogen (Houle & Simard 1996, see in Kitti & Forbes 2006). It is difficult to analyze the effect of purely the act of reindeer grazing independent of many other factors. The present experiment was conducted on farmland and the supply of fertilizer was ensured. I prepared and treated the entire study area (all four enclosures) in terms of plowing, raking and fertilizing equally prior to planting the grass. After planting the grass, I subsequently controlled for any other environmental variables through replication and simultaneous timing of treatments in all enclosures. The environmental conditions created in this experiment thus allowed me to remove other interference factors, such as habitat, resources and nutrient effects when analyzing the reindeer density/intensity effect and the age of grass.

Most of the grazing studies have been conducted on climatically determined, natural grasslands (Skarpe & Hester 2008), and some of these studies found that grazed grasslands have higher productivity (Hik & Jefferies 1990, Frank & McNaughton 1993). In this study, there are 7 overcompensation instances out of 64 samples: 5/7 samples are found at Enclosure 4 (contained one mother deer and one calf) which is considered to be under the lowest grazing and trampling pressure (Fig.5); and 6/7 samples are found at a relatively low grazing intention (50<GI<100). Accordingly, to some extent, the potential of higher productivity, or over-compensation, could be expected under a relatively low grazing pressure.

Grasses can produce new leaves following a grazing event (Skarpe & Hester 2008, see also Lemaire & Chapman 1996.), and the ability of compensatory growth varies with species, growth form, and time of grazing (Briske 1996). Wegener & Odasz (1997b) found that clipping (simulated reindeer grazing) once early in the growth period increased accumulated aboveground biomass of *Calamagrostis stricta* by 15% (after 2 months regrowth). They concluded that grazing stimulated allocation from belowground reserves to regrowing tissues and increase net photosynthesis rates of regrowing leaves in *C. stricta* in the short-term. Quellet et al. (1994) concluded that clipping, for the most part, reduced plant net production and the responses differed among and within plant types according to the timing and intensity of clipping.

I also predict that the older grass would tolerate grazing and trampling better than the younger grass and exhibit compensatory growth at the low reindeer density. Reindeer showed no preference for different ages of grass. Furthermore, there was no significant difference in biomass loss between the two ages of grass, indicating that the ability for compensatory growth in *Agrostis capillaris* was similar for the two ages. The most important variable was the grazing intensity, with a decrease in grass production with increasing reindeer grazing intensities.

Surprisingly, visual inspections indicated that the most trampled areas were very productive compared to the rest of the experimental area. As expected, intensive trampling and grazing along the fence denuded the vegetation and produced clear paths while the reindeer were in the enclosures (Appendix 1, Photo 4). However, compensatory growth of the grass along the paths appeared to be better than the rest of the grazed area (Appendix 1, Photo 5). The height and the density of the grasses along the paths was almost the same as, or even more frondent, than the adjacent grazed areas. Without empirical data, I cannot categorize and test the impact of the intensive grazing and trampling along the paths, but the visual confirmation was not as predicted. Zimov et al. (1995) highlighted the significant effect of trampling in preventing grassland transforming into tundra. They found that trampling disturbs the bryophyte carpet that keeps the soil wet and cold, producing drier and warmer soil and thus, may increase the primary productivity (see also

Olofsson et al. 2001).

In productive grasslands, positive effects of herbivory on soil biota and nutrient cycling would occur when dominant plant species respond to grazing by exhibiting compensatory growth (Augustine & McNaughton 1998, Kathryn & Richard 2008). By depositing urine and dung, grasses along the paths would receive and store nutrients which are recycled in forms that are more available to plants and soil microbes (Frank & Evans 1997, Kathryn & Richard 2008). Thus, and assuming there was more dung and urin along the paths than the rest of the area, the compensatory capacity along the paths has the possibility to surpass the other grazed area.

## Conclusion

Reindeer grazing and trampling on newly seeded field, for the most part, will reduce the production of grass. No evidence is found in tolerance difference among different ages of grass. Overcompensation could be expected under a relatively low grazing pressure on newly seeded fields. Further studies focusing on the over-compensatory capacity of fodder under a relatively low grazing pressure and intensive grazing are required.

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Source[1]: Alta (last 10 years). Storm Weather Center.

Source[2]: Global Invasive Species Database http://www.issg.org/database &
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Appendix 1


Photo 1. Three reindeer grazing at Enclosure 1 (foreground) and two reindeer at Enclosure 2 (background)


Photo 2. The vegetation within the frame (0.25 $m^2$) was hand-clipped and collected into a paper bag before drying and weighing.

Photo 3. All samples were hung in a dry room kept at 60-70°C for four days. Samples that contained too much vegetation for the paper bags were cut open and placed into raschel bags.


Photo 4. The paths along the fence within the Enclosure 3 & 4. Soil was exposed as a result of the denuded of vegetation.


Photo 5. The paths along the fence within the Enclosure 3 & 4 after 1 month's re-growth.

Appendix 2

| Site | Enclosure | Plot | $W_E$ | $W_G$ | ΔW | Grazing Intensity | the Age of Grass | Reindeer Density | Reindeer Density |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | A | 192 | 113 | 79 | 140 | Old | 3R | High |
| 1 | 1 | A | 198 | 106 | 92 | 140 | Old | 3R | High |
| 1 | 1 | A | 221 | 184 | 37 | 140 | Old | 3R | High |
| 1 | 1 | A | 203 | 111 | 92 | 140 | Old | 3R | High |
| 1 | 1 | B | 105 | 151 | -46 | 83 | Young | 3R | High |
| 1 | 1 | B | 142 | 62 | 80 | 83 | Young | 3R | High |
| 1 | 1 | B | 44 | 29 | 15 | 83 | Young | 3R | High |
| 1 | 1 | B | 113 | 113 | 0 | 83 | Young | 3R | High |
| 1 | 1 | C | 203 | 159 | 44 | 62 | Young | 3R | High |
| 1 | 1 | C | 120 | 69 | 51 | 62 | Young | 3R | High |
| 1 | 1 | C | 37 | 29 | 8 | 62 | Young | 3R | High |
| 1 | 1 | C | 306 | 193 | 113 | 62 | Young | 3R | High |
| 1 | 1 | D | 165 | 84 | 81 | 101 | Old | 3R | High |
| 1 | 1 | D | 37 | 66 | -29 | 101 | Old | 3R | High |
| 1 | 1 | D | 36 | 16 | 20 | 101 | Old | 3R | High |
| 1 | 1 | D | 102 | 31 | 71 | 101 | Old | 3R | High |
| 1 | 2 | A | 5 | 1 | 4 | 37 | Old | 2R | Low |
| 1 | 2 | A | 1 | 5 | -4 | 37 | Old | 2R | Low |
| 1 | 2 | A | 16 | 11 | 5 | 37 | Old | 2R | Low |
| 1 | 2 | A | 19 | 19 | 0 | 37 | Old | 2R | Low |
| 1 | 2 | B | 12 | 7 | 5 | 54 | Young | 2R | Low |
| 1 | 2 | B | 9 | 6 | 3 | 54 | Young | 2R | Low |
| 1 | 2 | B | 186 | 136 | 50 | 54 | Young | 2R | Low |
| 1 | 2 | B | 82 | 40 | 42 | 54 | Young | 2R | Low |
| 1 | 2 | C | 6 | 11 | -5 | 43 | Young | 2R | Low |
| 1 | 2 | C | 39 | 3 | 36 | 43 | Young | 2R | Low |
| 1 | 2 | C | 23 | 15 | 8 | 43 | Young | 2R | Low |
| 1 | 2 | C | 24 | 15 | 9 | 43 | Young | 2R | Low |
| 1 | 2 | D | 155 | 91 | 64 | 92 | Old | 2R | Low |
| 1 | 2 | D | 67 | 28 | 39 | 92 | Old | 2R | Low |
| 1 | 2 | D | 19 | 8 | 11 | 92 | Old | 2R | Low |
| 1 | 2 | D | 35 | 23 | 12 | 92 | Old | 2R | Low |
| 2 | 3 | A | 70 | 48 | 22 | 70 | Old | 3R | High |
| 2 | 3 | A | 40 | 14 | 26 | 70 | Old | 3R | High |
| 2 | 3 | A | 166 | 29 | 137 | 70 | Old | 3R | High |
| 2 | 3 | A | 20 | 16 | 4 | 70 | Old | 3R | High |
| 2 | 3 | B | 162 | 92 | 70 | 90 | Young | 3R | High |
| 2 | 3 | B | 97 | 92 | 5 | 90 | Young | 3R | High |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 3 | B | 244 | 92 | 152 | 90 | Young | 3R | High |
| 2 | 3 | B | 114 | 112 | 2 | 90 | Young | 3R | High |
| 2 | 3 | C | 231 | 134 | 97 | 160 | Young | 3R | High |
| 2 | 3 | C | 104 | 36 | 68 | 160 | Young | 3R | High |
| 2 | 3 | C | 366 | 134 | 232 | 160 | Young | 3R | High |
| 2 | 3 | C | 145 | 70 | 75 | 160 | Young | 3R | High |
| 2 | 3 | D | 78 | 83 | -5 | 138 | Old | 3R | High |
| 2 | 3 | D | 69 | 47 | 22 | 138 | Old | 3R | High |
| 2 | 3 | D | 149 | 40 | 109 | 138 | Old | 3R | High |
| 2 | 3 | D | 186 | 154 | 32 | 138 | Old | 3R | High |
| 2 | 4 | A | 117 | 156 | -39 | 71 | Old | 2R | Low |
| 2 | 4 | A | 102 | 139 | -37 | 71 | Old | 2R | Low |
| 2 | 4 | A | 84 | 39 | 45 | 71 | Old | 2R | Low |
| 2 | 4 | A | 122 | 40 | 82 | 71 | Old | 2R | Low |
| 2 | 4 | B | 99 | 57 | 42 | 78 | Young | 2R | Low |
| 2 | 4 | B | 122 | 190 | -68 | 78 | Young | 2R | Low |
| 2 | 4 | B | 48 | 157 | -109 | 78 | Young | 2R | Low |
| 2 | 4 | B | 298 | 226 | 72 | 78 | Young | 2R | Low |
| 2 | 4 | C | 287 | 228 | 59 | 42 | Young | 2R | Low |
| 2 | 4 | C | 119 | 115 | 4 | 42 | Young | 2R | Low |
| 2 | 4 | C | 7 | 9 | -2 | 42 | Young | 2R | Low |
| 2 | 4 | C | 48 | 25 | 23 | 42 | Young | 2R | Low |
| 2 | 4 | D | 245 | 234 | 11 | 53 | Old | 2R | Low |
| 2 | 4 | D | 194 | 130 | 64 | 53 | Old | 2R | Low |
| 2 | 4 | D | 160 | 105 | 55 | 53 | Old | 2R | Low |
| 2 | 4 | D | 22 | 156 | -134 | 53 | Old | 2R | Low |

*$W_G$- the weight of grass grazed by reindeer (outside the exclosure);

$W_E$ - the weight of controlled grass (inside the exclosure);

$\Delta W = W_E - W_G$.