Fertilisation of coastal grasslands and capacity for accommodating geese

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In this study we aim to quantify to what extent the grazing intensity by geese (Dark-bellied Brent Geese *Branta bernicla bernicla* and Barnacle Geese *Branta leucopsis*) is affected by the fertilisation of grassland. The ability to estimate capacity for geese is valuable for policy makers and nature conservationists who aim to change management of such grasslands, or who wish to accommodate geese. There is a need for such data, for instance in the framework of Environmental Impact Assessments, required by current EU nature protection guidelines.

Fertilisation is assumed to be a major factor affecting capacity, because it has direct effects on quality and quantity of available forage. There is a tendency over large areas to diminish the use of fertilisers. Examples of such change in the Netherlands are found on the mainland and the barrier island salt marshes. We have documented grazing intensity in spring by geese, following a reduction in the application of fertilisers in these areas for some years. The time frame is in the order of multiple years to decades (1980s–present). On the barrier island of Schiermonnikoog we have also recorded changes in vegetation composition. Besides, we have performed field experiments to assess the short-term effects of adding or removing fertilisation on grazing intensity. The within-season effects of grassland fertilisation on geese are very apparent. Artificial fertilisers may enhance grazing pressure by a factor two. A ban on the application of fertilisers on the grazed sandy marsh of Schiermonnikoog has led to vegetational change with a lower cover of plant species indicating nutrient-rich soil conditions. The grazing intensity by Brent Geese on the grazed sandy marsh of Schiermonnikoog has been higher during the years when fertilisers had been applied. However, the long-term data on goose grazing in spring on mainland, more clayish soils, do not point at a lower grazing intensity within 6–20 years after a ban of fertiliser application.

Key words: Dark-bellied Brent Goose *Branta bernicla bernicla*; Barnacle Goose *Branta leucopsis*; fertiliser experiment, soil, salt marsh.

1. Introduction

The intensification of agriculture in the second half of the previous century in North America and Northwest Europe is thought to have had positive effects on the winter feeding conditions of Arctic breeding geese (Jefferies *et al.* 2006). Especially the increased use of artificial fertilisers has increased the opportunities for herbivorous waterfowl to graze on agricultural grassland (van Eerden *et al.* 1996; van Eerden *et al.* 2005). Nowadays, much effort is done to reduce fertiliser input in agriculture, for various reasons. Also nitrogen background atmospheric deposition should diminish in the near future. But especially on land that has changed function from agriculture to nature conservation, the inputs of fertiliser diminished or will be diminished.

Fertilisation, be it organic or inorganic, has effects on plant productivity, plant tissue quality and vegetation composition. The effects of fertilisation are mediated by other growing conditions for plants, amongst which are the characteristics of the soil. Nutrients, for instance, are quickly leached from sandy soils while clay soils strongly adsorb them. Generally clay soils are more nutrient-rich soils. But although salt marshes are productive systems, plantgrowth is still limited by nutrients (Kiehl *et al.* 1997; van Wijnen & Bakker 1999).

Many grassland areas along the Dutch Wadden Sea serve as a feeding area for wintering geese. Some of them are formerly agricultural grassland and nowadays receive less fertiliser than in the past. Foraging geese in wintering areas select their habitat based upon aspects affected by fertilisation, e.g. forage quantity, quality (Prins & Ydenberg 1985; Riddington *et al.* 1997; Bos *et al.* 2005), and vegetation composition (van de Koppel *et al.* 1996; van der Wal *et al.* 2000). Depending on the type of fertiliser and the amount added, Hassall & Lane (2001) reported 9–22% increases in grazing pressure by wintering Dark-bellied Brent Geese *Branta b. bernicla* on fertilised plots in comparison to controls. In the present paper we aim to evaluate to what extent the use of coastal grassland by geese is affected by fertiliser application in spring. We hypothesize that a reduction in application of fertilisers will ultimately lead to a reduced use of the terrain by geese. Insight in this phenomenon is relevant for policies related to goose population management and alternative feeding areas, but also for Environmental Impact Assessments.

In this paper, we illustrate the within-season effects of the application of fertilisers in three short-term experiments on the barrier islands of Texel and Schiermonnikoog (Fig. 1) in spring. Moreover, we compare changes in grazing pressure in spring over multiple years, after a reduction in the use of fertiliser application, for the mainland sites of Noord Friesland Buitendijks (NFB), the Bantpolder & Hoek van de Bant (BHB) and again for the barrier island of Schiermonnikoog.

2. Methods

2.1. Study sites

The study site on the island of Schiermonnikoog is described in several papers, (e.g. Olff *et al.* 1997; Bos *et al.* 2003). Our first experiment was performed in cattle-grazed high salt marsh west of the First Creek (referred to as high marsh) dominated by Red Fescue *Festuca rubra*. Our second experiment was in the cattle-grazed low marsh, between the First and Second Creek (referred to as low marsh), dominated by Common Saltmarsh Grass *Puccinellia maritima* and Saltmeadow Rush *Juncus gerardi*. The salt marsh is grazed by 0.5 Livestock Unit/ha since 1989. Before 1989 it was grazed at 1.5 Livestock Unit/ha. The most important vertebrate herbivores in this system are European Hare *Lepus europaeus* with a year-round presence and Barnacle Goose *Branta leucopsis* and Dark-bellied Brent Goose as seasonal grazers from October to May. From 1962 to 1987, artificial fertilisers were applied to the high marsh near the end of the goose season (mid May) by farmers. Yearly 100–200 kg NP/ha were applied, sometimes followed by 50 kg ANL/ha (Ebbinge & Boudewijn 1984). After 1987, the amounts applied diminished, and this fertilisation stopped entirely in 1989. The soil is a vlak vague soil (=Sandy hydrovague soil), calcareous with moderately fine sand (www.bodemdata.nl). Because Schiermonnikoog and Texel (see below) are barrier islands, they have sandy subsoil and are generally sandier than mainland areas (de Jong *et al.* 1999).

The Brent Goose reserve 'Zeeburg' lies in the northeastern part of the island of Texel (referred to as Zeeburg), and is mainly visited by Dark-bellied Brent Geese. It is embanked, but was previously a salt marsh. The soil is of the same type as on Schiermonnikoog. The pastures in the reserve (110 ha) consist of homogeneous swards of *Lolium perenne* and *Poa sp*. that are managed by fertilisation (during the goose season) and aftermath grazing with livestock in order to accommodate the geese.

The summer polder at Noord Friesland Buitendijks is cattle-grazed during summer (June–October). Barnacle Geese are present here in high numbers from October to May (Engelmoer *et al.* 2001). The polder was used for agriculture until 1996, but is managed as a nature reserve since. The area is grazed by livestock at 1 Livestock Unit/ha. The homogeneous grass vegetation was dominated by Rye Grass *Lolium perenne*, Creeping Bent *Agrostis stolonifera* and Marsh Foxtail *Alopecurus geniculatus*. Being on the mainland side of the Wadden Sea, its soil is more clayish than on the barrier islands. The soil is classified as a marine vlak vague soil, calcareous with sandy clay loam (www.bodemdata.nl). From 1998 until 2005, the summer polder has not been fertilised, but before 1996 it has been managed intensively and received a combination of slurry manure (15–20 ton/ha) or farmyard manure (5–15 ton/ha) and artificial fertiliser (100–200 kg N/ha). Fertilisers were applied after the goose season.

The study site Bantpolder & Hoek van de Bant includes two parts that slightly differ in soil and in history. The Bantpolder is an old embanked salt marsh, while the Hoek van de Bant is a former tidal area. Until 1969, when the Lauwersmeer became a fresh-water lake, the Hoek van de Bant was a salt marsh. The soil in the Hoek van de Bant is a marine vlak vague soil, calcareous with extra fine sand. The soil in the Bantpolder is the same as in Noord Friesland Buitendijks; a marine vlak vague soil, calcareous with sandy clay loam. Barnacle Goose normally is the most common species at this site. The area became a nature reserve in the early 1980s. Before that, both parts had been used as agricultural grassland and were managed for dairy cattle. During that period, both artificial and organic fertilisers were applied in quantities amounting to 200–300 kg N/ha, applied after the goose season. In 1985, fertilisation was reduced in the Bantpolder to 20 ton/ha of farmyard manure every three year, while fertilisation in the Hoek van de Bant stopped entirely. In order to increase attractiveness for birds, ponds have been dug and ditches enlarged.

2.2. Short-term experiments

We conducted three short-term experiments: 1.) Schiermonnikoog high marsh, 2.) Schiermonnikoog low marsh, 3.) Texel Zeeburg. These experiments have the same basic set-up in common. In the experiments we compare grazing intensity on fertilised and unfertilised plots. All experiments have been performed on barrier islands in the Wadden Sea in May and involve Dark-bellied Brent Geese.

Our first experiment was performed in the cattle-grazed high salt marsh of Schiermonnikoog. Eighteen plots of 2 m × 2 m were placed in two transects over the marsh, perpendicular to the existing slight elevational gradient. Fertilisation was accomplished using a commercial fertiliser ($CaCO_3.NH_4NO_3$, 27 %), dissolved in 0.5 litre water and sprayed over the vegetation, resulting in a net addition of 25 g of N/m^2. The experiment started with fertilisation on 2nd April 1997 and was monitored from 9th April until 26th May. This first experiment was in fact a repetition from an identical experiment in 1985. That experiment had one fertilised plot of 80 m^2, fertilised on 1st May and monitored from 8th to 21st May. Although it lacked proper replication, we shall nonetheless show its result as a single data point in the results of Experiment 1

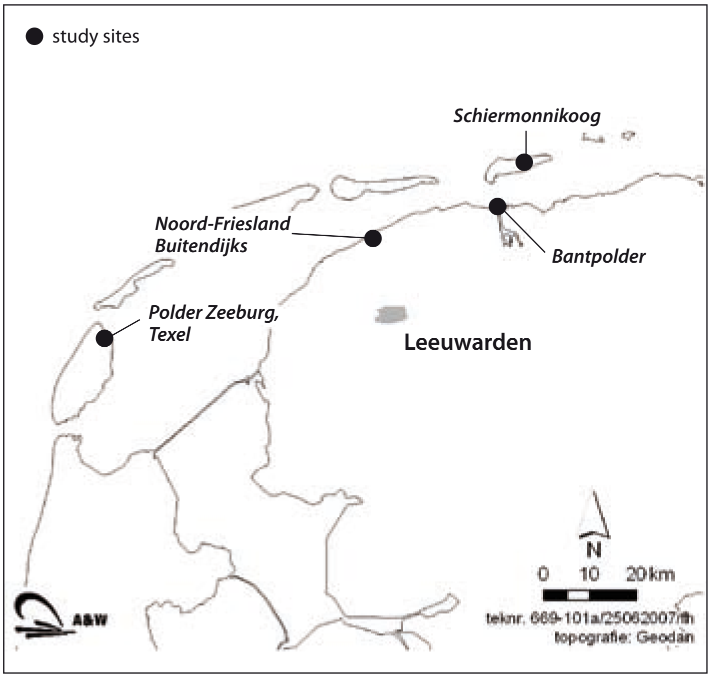

Fig. 1: Location of the four study sites. – *Lage der vier Untersuchungsgebiete.*

of this paper, for the sake of comparison. Our second experiment was in the cattle-grazed lower salt marsh of Schiermonnikoog. Here, 16 plots of 2 m x 6 m were laid out in a full factorial design, with fertilisation and temporary exclosure as factors (Bos *et al.* 2005). Fertiliser application was as in Experiment 1. Geese and hares were excluded for three weeks using chicken wire (5 cm mesh width, 50 cm high). The experiment started on 5th April 1998. The third experiment took place on the Brent goose reserve "Zeeburg" on Texel (Fig. 1, Bos *et al.* 2004). We positioned seven replicated blocks of six plots in a randomised block design. The plots were 4 m x 4 m in size. The fields were managed according to standard practice by fertilising them with an artificial fertiliser (11 g N/m^2), but for this experiment we prevented application by temporarily placing a plastic foil over half of the plots, effectively catching the fertiliser. As was the case in Experiment 2, part of the plots had been left ungrazed, but in this case for two different periods of time. Grazing was prevented again by fencing these plots using chicken wire (5 cm mesh width, 50 cm high). The fences for the different treatments were erected three and one week(s) prior to 7th May 2000. The geese were not excluded in the control treatments.

2.3. Changes in grazing pressure over time

Droppings have been counted in circular plots of 4 m^2 and removed at regular intervals in each of the experiments, and the results have all been expressed as number of droppings/m^2/day. In order to compare changes in grazing pressure over time, we assembled an overview of available dropping counts for those sites that had experienced a change in the application of fertilisers. For three sites we were able to assemble multiple estimates of grazing pressure over multiple years. These sites were 1.) high salt marsh of the island of Schiermonnikoog, the mainland sites 2.) BHB and 3.) NFB (Fig. 1). Important sources are van der Graaf *et al.* (2002) and Ebbinge & Boudewijn (1984), but we also used unpublished results from Tiemersma (Bantpolder, eight plots of 4 m^2 and Hoek van de Bant, seven plots of 4 m^2 monitored year-round). For the high marsh on Schiermonnikoog we were able to analyse changes in vegetation composition as well. Vegetation composition had been recorded yearly in five permanent plots in August, from 1986 until the end of our study period. In addition, goose counts had been performed yearly by students of the University of Groningen. During the month of May, as long as the geese were present on the island, the number of geese at the high marsh has been recorded twice an hour from dusk to dawn. These data have been summarised in this paper in terms of goose hours to allow comparison between years.

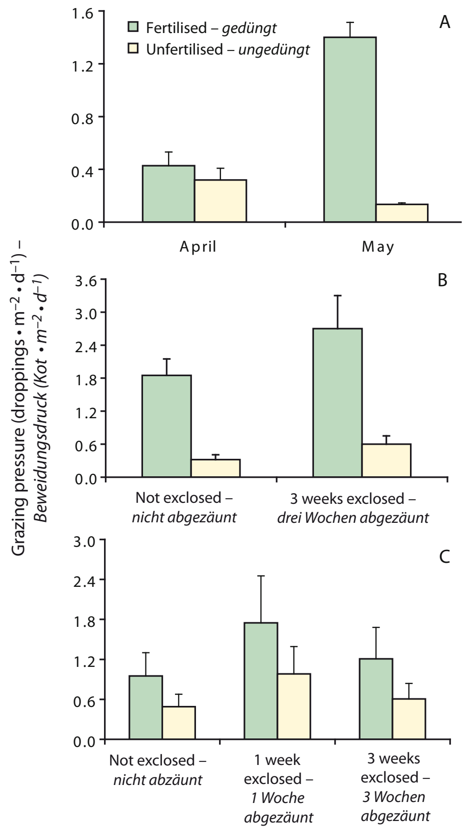

Fig. 2: Results of three different fertilisation experiments on grazing pressure by Dark-bellied Brent Geese in spring. A) Cattle-grazed *Festuca* salt marsh on Schiermonnikoog. OBK Experiment spring 1997, n = 2 × 9. B) Cattle-grazed *Puccinellia/Juncus* marsh on Schiermonnikoog. NBK Experiment May 1998, n = 4 × 4. C) Agricultural grassland Texel. Zeeburg Experiment May 2000, n = 7 × 6 (Bos *et al.* 2004).– *Ergebnisse von drei unterschiedlichen Düngungsexperimenten zur Beweidungsintensität durch Dunkelbäuchige Ringelgänse im Frühjahr. A) Beweidete* Festuca-*Salzwiesen auf Schiermonnikoog. OBK Experiment Frühjahr 1997, n = 2 × 9. B) Beweidete* Puccinellia/Juncus-*Salzwiese auf Schiermonnikoog, NBK Experiment Mai 1998, n = 4 × 4. C) Intensiv-Grünland auf Texel, Zeeburg Experiment Mai 2000, n = 7 × 6* (Bos *et al.* 2004).

3. Results

The results of the three short-term experiments with fertilisation are very consistent. By adding fertiliser early in spring, the intensity of grazing by Dark-bellied Brent Geese increased 2–3fold. This is consistent over the study sites (Fig. 2 A–C), but also holds for the plots that had been exclosed for 1–3 weeks. Exclosed plots (Fig. 2B and C) had developed higher standing biomass, but this did not affect grazing intensity to the same extent as did fertilisation.

The long-term goose count data on the high salt marsh of Schiermonnikoog illustrate that high values of grazing pressure only occurred in the period before the ban of fertilisation, but the variation in observed values is high (Fig. 3A). The dropping counts data are more robust (Fig. 3B), and clearly illustrate high values of grazing pressure before, and low values after fertilisation stopped. This is in spite of the fact that the number of Brent Geese on the island increased (van der Wal *et al.* 2000). Interestingly, we have two measurements of grazing in experimentally fertilised plots, plots that had been fertilised during the goose season, for the years 1985 and 1997. The latter data point refers to our short-term experiment at the high marsh (Fig. 2A), while the experiment in 1985 has been performed on a single plot of 80 m^2. The geese grazed the experimentally fertilised plots in 1997 with the same intensity as they did in 1985, but the control plots were grazed at a much lower level of intensity in that year. Important changes in vegetation cover were observed for *E. repens* and *L. perenne*, which strongly declined (Fig. 3C), and for *T. repens* that increased. *F. rubra* first increased, but declined again later.

On the mainland sites of NFB and BHB we found no indications that the grazing pressure by geese (mainly Barnacle Geese) declined after fertilisation stopped. At NFB (Fig. 4) the time frame is limited to six years of observation. Over this period, the goose grazing pressure in the summer polder increased, paralleling a regional increase

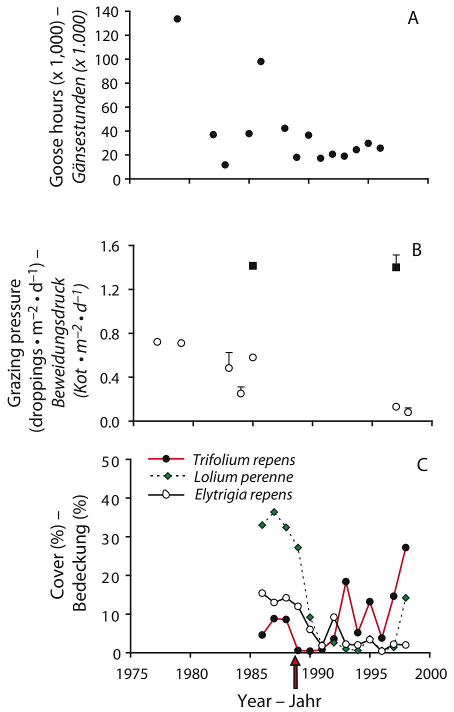

Fig. 3: Developments in goose grazing pressure and vegetation on the cattle-grazed *Festuca* salt-marsh of Schiermonnikoog (OBK). A) Comparison of goose count data over time. B) Results of various dropping counts (sources: Ebbinge & Boudewijn 1984; ML & DB own data, Jouke Prop pers. comm.). The two black square markers refer to plots that had been fertilised experimentally during the goose season, for the years 1985 (single plot of 80 m²) and 1997 (same data as Fig. 2, panel A). C) Long-term vegetation change. *Lolium perenne* and *Elytrigia repens* decline, while *Trifolium repens* increases (source J. P. Bakker, unpublished results. Fertilisation stopped 1989 (indicated by the arrow). – *Entwicklung von Beweidungsintensität und Vegetation auf der beweideten* Festuca-*Salzwiese, Schiermonnikoog (OBK). A) Vergleich der Daten der Gänsezählungen über den Untersuchungszeitraum. B) Ergebnisse der verschiedenen Kotstangenzählungen (Quelle: Ebbinge & Boudewijn 1984; ML & DB eigene Daten, Jouke Prop pers. Mitt.). Die zwei schwarzen Quadrate beziehen sich auf Probeflächen, die im Rahmen des Experiments in den Jahren 1985 (eine Probefläche von 80 m²) und 1997 (gleiche Daten wie in Fig. 2, Abschnitt A) während der Gänsesaison gedüngt wurden. C) Langfristige Änderungen der Vegetation.* Lolium perenne *und* Elytrigia repens *nahmen ab, während* Trifolium repens *zunahm (Quelle: J. P. Bakker, unveröff.). Die Düngung wurde 1989 eingestellt (angegeben durch den Pfeil).*

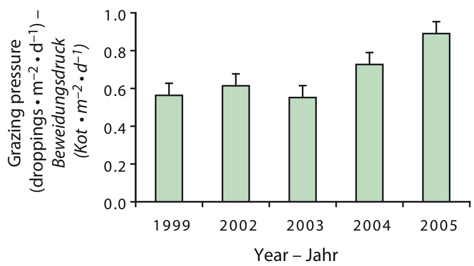

Fig. 4: Average goose grazing pressure in April and May on permanent grassland in the summer polder of Noord Friesland Buitendijks (van Duin *et al.* 2007). Fertilisation had been reduced in 1996 and stopped entirely in 1998. – *Durchschnittliche Beweidungsintensität im April und Mai auf Dauergrünland im Sommerpolder Nord-Friesland Buitendijks (van Duin* et al. *2007). Die Düngung wurde 1996 reduziert und 1998 eingestellt.*

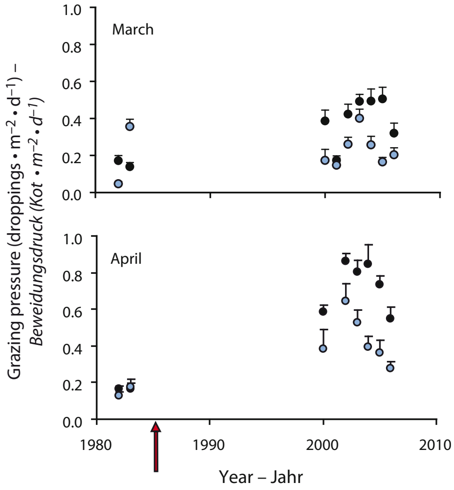

Fig 5: Average goose grazing pressure in March and April on permanent grassland in the Bantpolder (black dots) and the Hoek van de Bant (blue dots). Fertilisation had been reduced in 1985 in the Bantpolder and had stopped entirely in the Hoek van de Bant at that time (indicated by the arrow). – *Durchschnittliche Beweidungsintensität im April und Mai auf Dauergrünland im Bantpolder (schwarze Punkte) und im Hoek van de Bant (blaue Kreise). Die Düngung wurde 1985 im Bantpolder reduziert und im Hoek van de Bant eingestellt (angegeben durch den Pfeil).*

in goose numbers over that period. At BHB the trends in grazing pressure over time are almost identical between the two subsites Bantpolder and Hoek van de Bant. In spite of the fact that fertilisation stopped in the Hoek van de Bant in 1985, the values are generally higher than in the early 1980s, both in March and in April (Fig. 5). The variation in recent years is large. Similarly, in the Bantpolder itself, no decline in grazing pressure by geese is observed in a comparison between recent years and the early 1980s.

4. Discussion

The short-term experiments allow to illustrate that within-season effects of fertiliser application on geese are very apparent. Geese are attracted to fertilised plots and willing to fight over them (Bos *et al.* 2005). They also spent more time on these plots. The results are consistent with findings by Hassal & Lane (2001) who, in autumn, found increases in grazing pressure on fertilised plots in the order of 10–20 % in comparison to controls. It is noticeable, that the difference between fertilised plots and controls in our short-term experiments is much larger. Given the fact that temporary exclosure of herbivores has a much smaller effect, we conclude that the preference is not caused by a higher standing biomass. Rather, it should be related to higher tissue quality of the grass. A higher primary productivity, which also results from applying fertilisers, allows for a greater harvest of grass and helps explaining a longer time spent on the plots. The interaction between food biomass and food quality has been reported upon in more detail in Bos *et al.* (2005).

Observed grazing intensity is, of course, governed by goose preference, local standing biomass and additional primary productivity, but also by the relative availability of food. This is dependent upon food conditions elsewhere and flyway population size. These aspects complicate our comparisons and shall be discussed below. The goose numbers present in the regions of our study sites have increased over time following the increases in the entire flyway populations. This is valid for Dark-bellied Brent Geese on Schiermonnikoog as well as for Barnacle Geese on the mainland sites. In addition to that, the Barnacle Geese tend to stay longer in the Wadden Sea than in the past (Engelmoer *et al.* 2001). This is one of the confounding factors that make it more difficult to judge effects of fertilisation per se. But still, in line with our hypothesis, the ban of fertiliser use on the marsh of Schiermonnikoog resulted in lower grazing pressures than measured before. Geese were present on the island after the ban in numbers higher than before. They also regularly visited the study site, and responded directly to our experimental fertilisation in 1997. Finally, the vegetation data clearly point at a change in nutrient levels in the soil; plants that indicate high nitrogen levels of the soil(*Elytrigia repens* and *Lolium perenne* for example, Ellenberg *et al.* 1991) disappear after fertilisation has stopped. The soil at the sandy high marsh of the barrier island Schiermonnikoog is apparently such, that the nutrient availability can change measurably within a few years; measurable in terms of vegetation composition and goose grazing pressure.

In contrast we found no indications that grazing pressure by geese declined on the mainland sites of NFB and the BHB after fertilisation had stopped there. At NFB the time span is modest (six years). In the Bantpolder and Hoek van de Bant, however, the time frame of our study is large. There is 23 years of difference between the measurements in 1983 and 2006. This suggests that the soils on the mainland are much more resilient to this type of change, and that other factors are more important in explaining short- and medium-term variation in goose grazing pressure than fertilisation on these soils. However, in the long run we still expect changes in soil fertility to be expressed in a lower capacity for accommodating geese on mainland sites.

This study should not be interpreted as a claim to fertilise feeding areas for geese. True, fertiliser application can be effective in the management of an alternative feeding area in order to reduce damage by grazing wildfowl elsewhere (Hassall & Lane 2001). In particular cases, it can be helpful as such and may be cost-effective. There may, however, be disadvantages in concentrating the animals in an artificial way. Prop & Black (1998) have shown that food on very homogeneous pastures may be inadequate to provide all nutrients required for balanced body-stores. Barnacle Goose breeding at Svalbard show reduced reproduction rate at fertilised grassland as compared to unfertilised grassland used as stop-over sites along the Norwegian coast (Prop & Black 1998; Black *et al.* 2007). Also, the role of diseases may become more prominent at high bird densities. The geese have evolved without artificial fertilisers and do not depend on them. In a tidal environment there is regular nutrient input from the sea, and fertilisation serves no ecological purpose. In polder systems, organic fertilisers, rather than artificial ones, may be considered for nature areas, if the ecological targets require so.

5. Conclusions

The within-season effects of grassland fertilisation on geese are very apparent. Artificial fertilisers may enhance grazing pressure by a factor two or more in spring. A ban of fertiliser application on the grazed sandy marsh of Schiermonnikoog has led to measurable vegetational change and coincides with a lower grazing intensity by Dark-bellied Brent Geese. However, long-term data on goose grazing in spring on more clayish, mainland soils, do not point at a lower grazing intensity after a ban of fertiliser application within 6–20 years.

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6. Zusammenfassung

Bos, D., M. J. J. E. Loonen & J. P. Bakker 2008: Düngung von Küstengrünland und die Beweidungskapazität für Gänse. Vogelwelt 129: 141–146.

Zweck dieser Arbeit war, zu quantifizieren, wie stark die Beweidungsintensität durch Gänse (Dunkelbäuchige Ringelgans *Branta b. bernicla* und Weißwangengans *Branta leucopsis*) von der Düngung des Grünlandes abhängt. Die Möglichkeit, die Kapazität von Flächen für Gänse einzuschätzen, ist wichtig für Politik, Verwaltung und Naturschützer, die das Management solcher Flächen planen oder dort den Aufenthalt von Gänsen ermöglichen möchten. Solche Daten werden zum Beispiel für Umweltverträglichkeitsstudien, wie sie von den derzeitigen EU-Naturschutzrichtlinien gefordert werden, gebraucht.

Es wird angenommen, dass die Kapazität vornehmlich durch Düngung beeinflusst wird, weil sich diese unmittelbar auf Qualität und Quantität der zur Verfügung stehenden Nahrung auswirkt. Es besteht gegenwärtig die Tendenz, den Einsatz von Düngemitteln großflächig zu reduzieren. Beispiele dieser Entwicklung findet man in den Niederlanden sowohl auf dem Festland als auch auf den Salzwiesen der Wattenmeerinseln. Im Rahmen dieser Arbeit wurde über mehrere Jahren die Beweidungsintensität durch Gänse im Frühjahr nach Reduktion der Düngergaben auf solchen Flächen dokumentiert. Der Untersuchungszeitraum erstreckte sich über mehrere Jahre bis Jahrzehnte (1980er Jahre bis heute). Auf der Watteninsel Schiermonnikoog wurden darüber hinaus auch die Änderungen der Vegetation erfasst. Daneben wurden auch Freiland-Experimente durchgeführt, um die kurzfristigen Auswirkungen von Düngung oder Düngeverzicht zu untersuchen. Innerhalb einer Saison waren die Auswirkungen der Grünlanddüngung auf Gänse sehr offenkundig. Eine zusätzliche Düngegabe kann die Beweidungsintensität um mehr als den Faktor zwei zunehmen lassen. Das Düngeverbot auf den beweideten sandigen Salzwiesen von Schiermonnikoog führte zu Vegetationsänderungen mit einer geringeren Flächendeckung bei Pflanzenarten, die auf nährstoffreiche Böden hinweisen. Die Beweidungsintensität der Ringelgänse auf den beweideten sandigen Salzwiesen von Schiermonnikoog war in den Jahren, als noch gedüngt wurde, höher. Die langjährigen Daten der Gänsebeweidung im Frühjahr auf den lehmigeren Böden des Festlandes weisen nicht auf eine geringere Beweidungsintensität während der 6–20 Jahre seit dem Düngeverbot hin.

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