Disturbance as a factor influencing behaviour and body condition of Greylag Geese *Anser anser*.

Investigating the effects of the management plan of Vega community

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This report is the result of a student research project and contains a preliminary analysis of data collected in the summer of 1998 at the Vega community.

More data collected in the same project can be found in:
-Tulner, P.J., (1999). Disturbance as a factor influencing terrain distribution of Greylag Geese *Anser anser* , student report Van Hall Institute.

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Contents

1. Summary

In this study the effect of the management plan of the Vega community on Greylag Geese (*Anser anser)* were studied. Conclusions are based on how disturbance influences behaviour and body condition of Greylag Geese *Anser anser.* Additional data collected in the same project about terrain distribution can be found in: Tulner, P., (1999) Disturbance as a factor influencing terrain distribution of Greylag Geese *Anser anser*, student report Van Hall Institute.

The Abdominal Profile Index (API) for non-breeding Greylags is expected to be higher than for breeding birds. Due to intra specific competition Greylags with a better body condition are expected to be found more on protected areas. The percentage of alert geese is expected to be higher on scared and agricultural areas in general. Expected is that the time for 10 pecks will be shorter on "scared" areas. On non-agricultural areas is the time that geese show their head down while foraging probably longer.

Non-breeding Greylags showed a relative higher API compared to adult Greylags belonging to families. Most likely because geese are loosing part of their body reserves during incubation and non-breeding Greylags are less restricted in their optimal foraging strategy. There was no relation between body condition and habitat use. Probably because the distribution of geese is spread over the whole study area and intra specific competition was low when there was a high availability of food due to the good summer.

The percentage alert is generally higher for agricultural areas. On areas where it was allowed to scare the geese was the percentage of alert geese much higher compared to the protected areas. Geese were sensitive for disturbance and needed in average more time for ten pecks on disturbed areas. Analysing the head down time there was no clear difference found between different managed habitats. This unexpected result has probably something to do with lack of sufficient data.

2. Introduction

During the last 20 years the amount of Greylag Geese *(Anser anser)* migrating through western Europe has increased substantially. In the beginning of the seventies the amount was 20.000 animals where as in the middle of the eighties it has risen to 130.000 (Madsen 1987, 1991) The breeding populations of Greylag geese have also increased markedly in Scandinavia as well in a number of other European countries (Rutschke 1987, Fog et al. 1984, Madsen 1991). In Norway, the breeding population of Greylag Geese is now estimated at about 7000-10000 (Follestad 1994) The growing populations of geese requiring more food space in the western Palearctic has led progressively to conflicts with agricultural interests (Roomen & Madsen 1992). To alleviate such conflicts, reserves have been created to attract geese away from vulnerable agricultural crops (Owen, 1980, 1990).

The Helgalanden, situated in Norway directly below the polar circle, are and have been an important moulting and breeding area for Greylag Geese as for Barnacle Geese. Traditionally the geese preferred to moult on the archipelagos where plenty food supplies was available due to facilitation by sheep grazing. In the seventies however a massive immigration of people from the archipelagos took place, leaving the islands without sheep grazing. This led to deteriorating foraging conditions in these places, leaving the growing numbers of geese no choice but to explore new areas (Prop, Black, Shimmings & Owen, 1997). Deteriorating forage conditions made carrying capacity for Greylag and Barnacle Geese on the archipelagos decline while the amount of moulting and breeding geese was increasing. This led to increasing numbers of geese settling some 15-km from the mainland on larger islands, in the 1980s where agricultural practice is the mainstay for about a dozen farming families. Black et al.,(1991) argued that the geese were attracted to the new area because the rich food supplies on the discovered fields surpassed the feeding opportunities in the traditional areas. Late summer can be a critical period for potential conflicts, because this is when Greylag Geese must accumulate body reserves needed for migration, and may achieve this by feeding on young crops that are also valuable for farmers. This situation has particularly been the case on Vega, one of the largest islands of the Helgalanden.

The fact that Vega offers a relative high amount of grass, the main source of food for foraging Greylag Geese, is part of the reason goose populations are increasing here. The population on Vega now exceeds 1000 animals. This has led to confrontation with farmers protecting their crops against geese foraging on their fields. In the past farmers have severely disturbed the geese on the island. To prevent this confrontation a management plan has been implemented in 1997. This management plan has set aside certain cultivated grasslands as free areas, meaning the farmers are allowed to harvest on their land but should not purposely disturb the goose populations there (the refuge strategy; Owen, 1990) The farmers are financially compensated by the Norwegian government for costs made. Now, one year later, the Vega authority wants to know if and how the management plan is working.

The management plan that has been implemented in 1997 on the island Vega introduced protected areas. In these areas it is not allowed to scare the Greylag Goose. The effectiveness of this management plan is important for as well local farmers as the Greylags that yearly visit this island.

In this study several hypotheses will be tested to answer the question what the effect of the management plan is. The introduced protected areas will be compared with other areas on the island Vega. In hypothesis the geese should prefer the fields listed as "protected" for they are less disturbed here then on grassfields outside these protected areas. The geese should probably be less disturbed on non-agricultural areas in stead of agricultural areas. The percentage of alert geese is expected to be higher on scared and agricultural areas in general. Expected is that the time for 10 pecks will be shorter on "scared" areas. On non-agricultural areas is the time that geese show their head down while foraging probably longer.

Management decisions can strongly influence survival chances of Greylags. Building up body reserves needed for successful migration to the south is dependent on foraging strategies before, during and after the moulting period. For this reason it is for example important when the hunting season starts.

An additional study has been done to the development of the body condition of the Greylags. Assuming that Greylags have to pass a certain threshold in body condition before they can migrate successfully to the south (v.Eerden, Zijlstra and Loonen 1991), the Abdominal Profile Index is scored to get a better insight of the periods which are most critical for foraging to increase the body condition of the Greylags. Because the moulting period influences the foraging strategy of the Greylags the moultstage is also scored (Kahlert, Fox & Ettrup 1996). Non-breeding Greylags do not have any incubation costs. Geese are usually loosing a large part of their body reserves during incubation. Non-breeding Greylags are less restricted to their chosen habitat because they don not have any eggs or goslings to take care of. For this reason they are able to look for different habitat types and choose the most suitable at particular moments. In hypothesis these two advantages will lead to a better body condition for non-breeding Greylags compared to breeding birds. Teunissen et al. (1985) showed that the best geese claim the best areas. This intra specific competition will be tested with the hypothesis that Greylags with a relative high API are more found on protected areas.

3. Methods

For a period of 10 weeks geese observations have been made on Vega. In this period there have been two excursions to the archipello of Laanan to observe the moulting non-breeding Greylag Geese. The set of data gained from this includes the co-ordinates the geese were spotted. Based on these co-ordinates one can divide the areas of geese observations in five different kinds of areas.

3.1 Classification of different managed habitat types

During the fieldwork geese observations took place on different managed habitat types. To compare behavioural aspects and body condition related to disturbance factors a classification of the different habitats has been made.

- scared:	Agricultural areas which are outside of the protected zones.
-protected:	Areas where it is not allowed to scare Greylag Geese.
-undisturbed:	Non-agricultural areas, mostly heath or shore, where geese can stay relatively undisturbed (see Tulner, P.J. (1999).
-maybe disturbed:	Non-agricultural areas within visual range of a road , building or human activities.
-Nordleinen:	Island without agricultural activities.

Areas mentioned as 'scared' are compared with areas mentioned as 'protected'. Both areas are distinguished from each other as a result of the introduced management plan. Protected areas consist of both agricultural- and non-agricultural areas. In order to find relevant conclusions about the influences of the management plan on agricultural fields, a direct comparison of 'scared' and 'protected' agricultural grassfields also have been made. More details about the development of different habitat types in the study area can be found in the report 'Disturbance as a factor influencing habitat use of Greylag Geese *Anser anser*' by P.J. Tulner (1999).

3.2 Abdominal Profile Index (API) readings for Greylag Geese *(Anser anser)*

With the help of pictures from *Ardea79*:261-264 (v. Eerden et al. 1991) and additional practical instructions from Berend Voslamber how to read API's for Greylag Geese, API readings have been done in the period from 10-06-'98 until 14-08-'98 on islands belonging to the Vega commune. The readings could only take place when the geese were spotted in side-view and the vegetation was low enough to see the abdomen. Two telescopes and a binocular (8 x 42) have been used. When the distance between the observer and the goose was to far or the goose showed too much various behaviour the API is not written down. On the 7th of December 1998 a calibration of the API readings took place with B. Voslamber on Greylags in the Dutch Ooipolder. Both B. Voslamber and J. Spitzen have scored individual geese without comparing the results during the fieldwork.

3.3 Moultstage

Seven different moultstages are recognised to describe the moulting period for Greylag Geese. The measurements took place when the Greylags where clearly visible through a telescope. The moultstages are subdivided as follows:

0. The goose has not started the moult yet.
0,5. Doubt between stage 0 and 1 because of unstructured plumage.
1. The goose is loosing one or more primaries.
2. The goose has no primaries left.
3. The new primaries are visible.
4. The new primaries have reached the beginning of the tail.
5. The new primaries are full-grown.

When there was any doubt between the stages 0 and 1 because of unstructured plumage the subdivision 0,5 is made. The period that the geese where flightless represent the moultstages 1 up to 4.

3.4 Percentage alert geese

One time per observation scan sampling took place. The activity pattern is scored for the geese that were clearly visible in the particular flock. For each goose is scored the behaviour that was shown at one particular moment. The following categories of behaviour where included to the ethogram:

-walking, w
-swimming, s
-flying, fl
-resting, r
-feeding, f
-preening, pr
-alert, al
-standing, st
-aggression, ag

With the behaviourtype "alert" is meant: 'The goose shows a stretched neck with the head as far in front as possible often combined with short movements of the head in different directions.' Only activities on land are dealing with the percentage alert geese.

3.5 Peckingrate

If the geese where visible for a longer period the peckingrate is scored. The peckingrate is divided into two different subjects:

-The time that is used for 10 pecks.
-The time that the goose showed his head down while foraging.

The two subjects are scored at least five times in a row not necessarily for different geese.

3.6 Statistical tests

Two independent samples were compared with a t-test. If Levene's test for equality of variances was not significant, equal variances were assumed. Otherwise, equal variances were not assumed. Several independent samples were test with an ANOVA. If the ANOVA gave significant results, the differences between the groups were tested with a Scheffe post-hoc test. Significant differences between groups are shown with different letters in the graphs.
Data on percentage alert were arcsine-transformed before they were tested:
new value=arcsine (square root (old value ranging between 0 and 1))

4. Results

4.1.1 API and moulting period

After 3 months of goose observations 383 API readings have been made. The non-breeding birds are scored 275 times, 107 times on the island Nordleinen and 168 times on Vega. The breeders are only scored on Vega, 108 times. Lowest API scored is 3, as well for breeders as non-breeders. Highest API is found for a non-breeding adult with 5,25, for the breeding birds was the highest score 5. Figure 1 and 2 show the variation of the API during time, the two social groups are separated. Because of travelling between Nordleinen and Vega the scored moultstages are not always representative. The beginning of the moulting period for the breeders is due to this reason uncertain. The moultstages in time scored for the different social groups (Appendix 1, figure 1 and 2.) are added together to get better insight of the moult timing. The moulting period in Figure 1 and 2 reflects the time that the geese where flightless and starts at 20-06-'98. The end of the flightless period is based on observations and literature about simultaneous wing moult and is set on 18-07-'98, 28 days later (Lebret & Timmerman 1968).

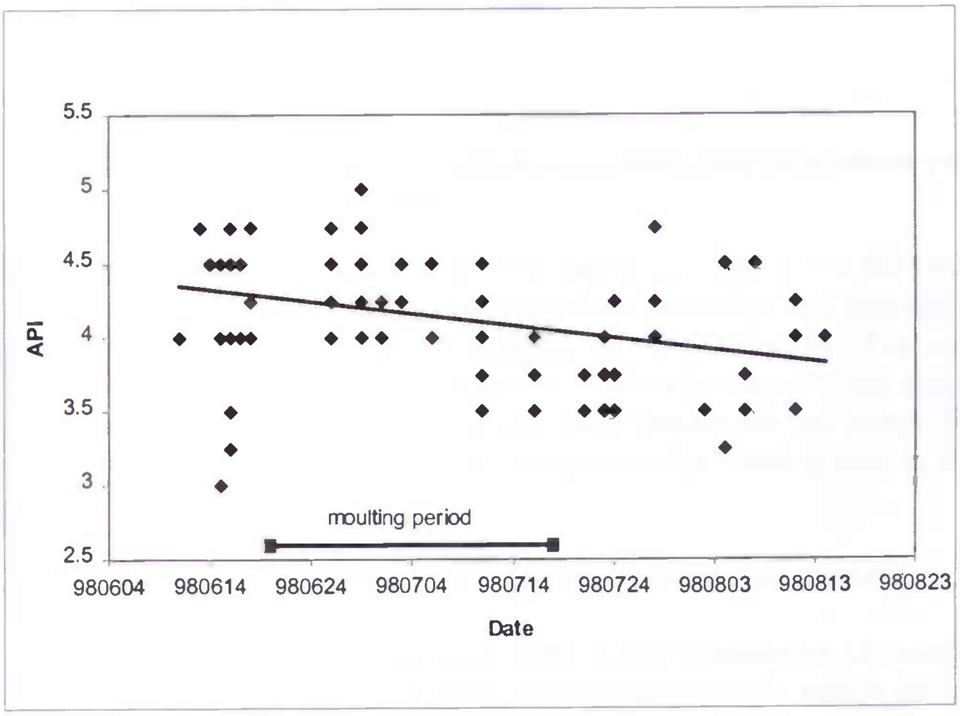

Figure 1: Abdominal Profile Index (API) differences for non-breeding Greylag Geese in the period from 10-06-'98 until 14-08-'98 on Vega.

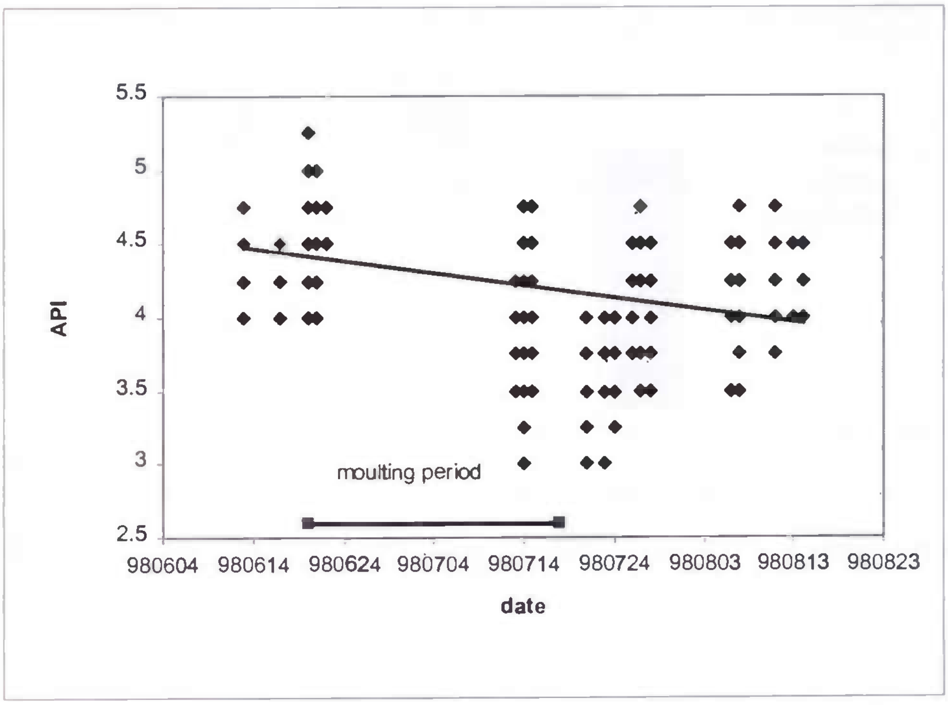

Figure 2: Abdominal Profile Index (API) differences for adult Greylag Geese belonging to families in the period from 10-06-'98 until 14-08-'98 on Vega.

There is a significant difference in API with date ($F_{1,380}$ = 48.36, P<0.001) with a slope of -0,008 API units per day. Between the two different social groups, breeding- and non-breeding birds, there is a significant difference in API ($F_{1,380}$ = 10.11, P<0.01). The non-breeding birds are 0,15 API units higher. There is no interaction between the two different groups and date. There is no significant difference in the date trend between the two groups ($F_{1,379}$ = 0.07, P=0.8) so the slope of -0,008 API units per day is similar for the breeding birds as well for the non-breeding birds.

Both social groups show a continue decrease of API during the moulting period.

Figure 3 shows that for the non-breeders there is some variation in API scores on different managed habitats. For each API reading, measured in a specific area, is calculated the distance to the trendline shown in Figure 1. The Greylags observed on the area's 'undisturbed' (b) show a relative lower API compared to the other areas (a) ($F_{4,270}$=8.78, P<0.001).

When 'scared' and 'protected' areas are compared to each other just for the agricultural grassfields there is no clear difference (t_{76}= -0.26, P=0.98). Figure 4 shows the average distance to the trendline for each API scored on two different managed agricultural areas.

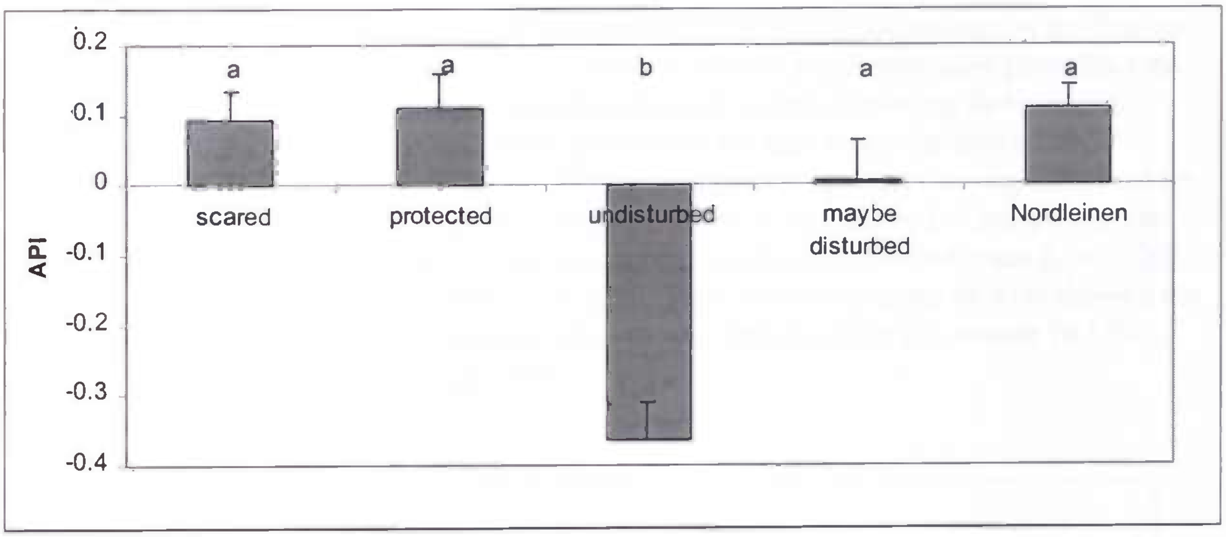

Figure 3: Relative differences in API for non-breeding Greylag Geese on different managed habitats of Vega community.

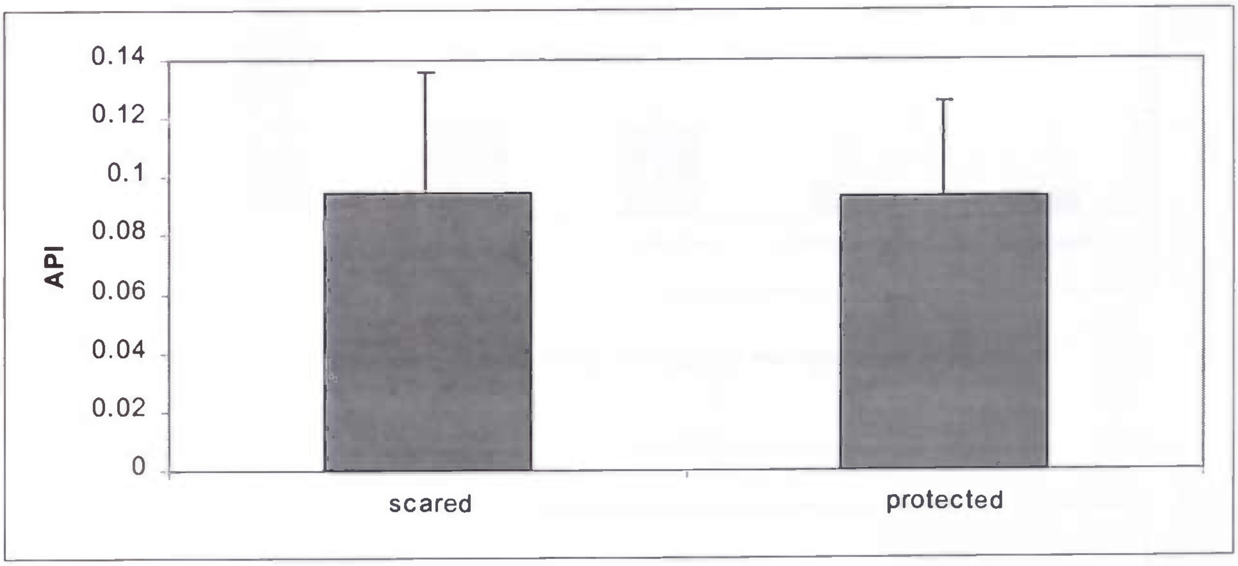

Figure 4: Relative differences in API for non-breeding Greylag Geese on different managed agricultural grassfields of Vega.

4.1.2 Calibration of Abdominal Profile Index (API) readings

In the Dutch Ooipolder the API of 47 individual geese scored by both B. Voslamber and J. Spitzen. The API scores of B. Voslamber show an average difference of 0.61 with a standard deviation of +- 0.36 units of API. The difference between individual scores is significant dependent of the API height with (Voslamber-Spitzen) $r2=0.292$ and $P< 0.001$. Appendix 2 represent the calibration results between B. Voslamber and J. Spitzen.

4.2 Percentage alert Greylags on different managed habitats

For the calculations of the percentage alert Greylags on different managed habitats only the non-breeding birds are used. This because of the breeding birds, especially when the goslings are not able to fly, use generally different habitat types. Besides of this the male is mostly alert while the goslings and the female show more foraging behaviour.

The results are based on percentage alert Greylags per observation independent on the flocksize. Figure 5 shows that area's marked as 'scared' (a) have relative much more alert geese than the other areas. On the island 'Nordleinen' (b) where the only visible disturbing factor was the White-tailed Eagle (Haliaeëtus albicilla) the geese show the alert behaviour much less ($F_{4,61}$=6.777, P<0.001). Figure 6 shows the difference in percentage alert Greylags observed on different managed agricultural grassfields. The areas where it was allowed to scare the geese represent a much higher percentage of alert geese compared to the protected areas (t_{13}= -2.203, P=0.046 From the 197 Greylags observed on scared grassfields on average 44.91% showed the behaviourtype alert. On the protected grassfields showed 381 Greylags on average 10.12% of the scored behaviour the behaviourtype alert.

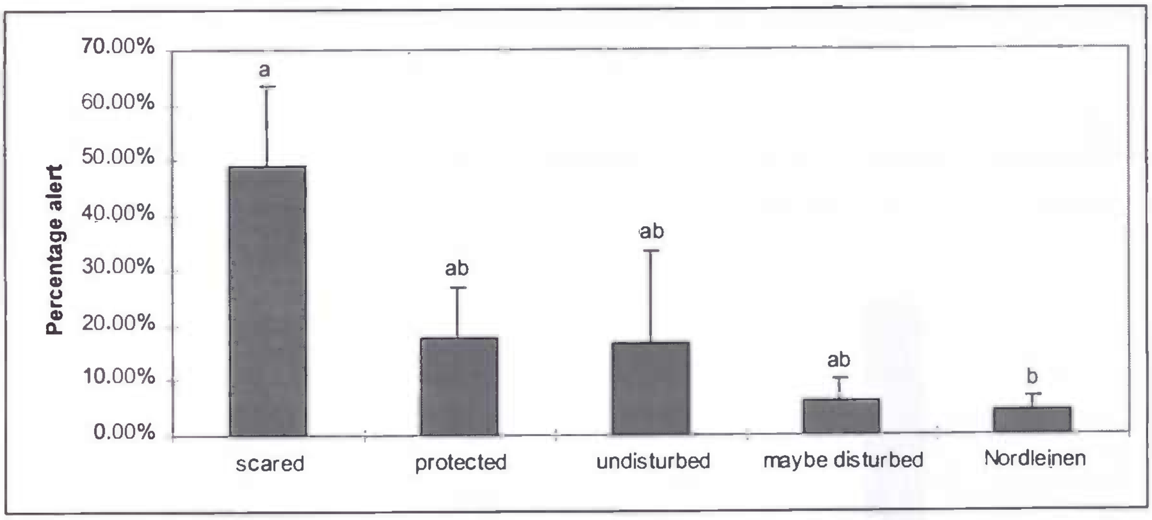

Figure 5: Percentage alert non-breeding Greylag Geese on different managed areas of Vega..

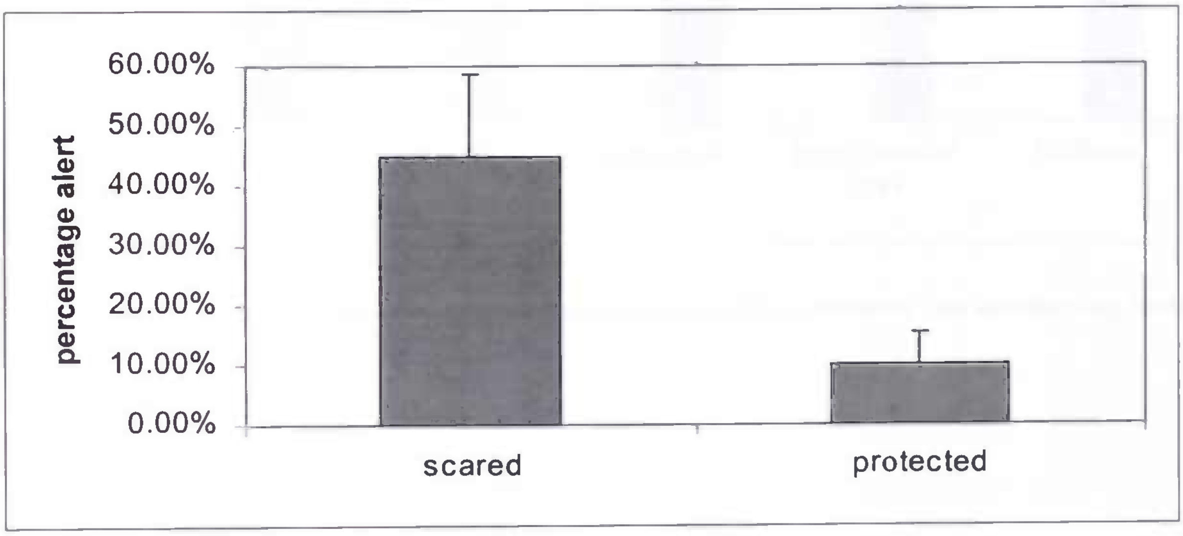

Figure 6: Percentage alert non-breeding Greylag Geese on different managed agricultural grassfields of Vega.

4.3 Management influences on peckingrate

Scoring the feeding behaviour required a flock of geese, which are observed over a long period. For five times it was possible to score both aspects on agricultural areas. The other 13 times for ten pecks and 15 times for head down readings where scored on non-agricultural areas, mostly on Nordleinen.

Both figure 7 and figure 8 show that on the areas which are more sensitive for disturbance the geese needed in average more time for ten pecks. Figure 7 shows that on areas mentioned as 'scared' (a) geese need more time for 10 pecks compared to other areas. On 'protected' area's (ab) geese need significant more time for 10 pecks than on the area's 'undisturbed' and 'Nordleinen' (b) ($F_{3,16}$=9.560, P=0.001). Only one time a flock is scored on the area marked as 'maybe disturbed' so it was impossible to calculate the standard error for this area. The average time for ten pecks on agricultural areas (figure 8) is with 8,5 seconds significant higher contrary 5,7 seconds on non-agricultural areas (t_{16}= -2.912, P=0.010).

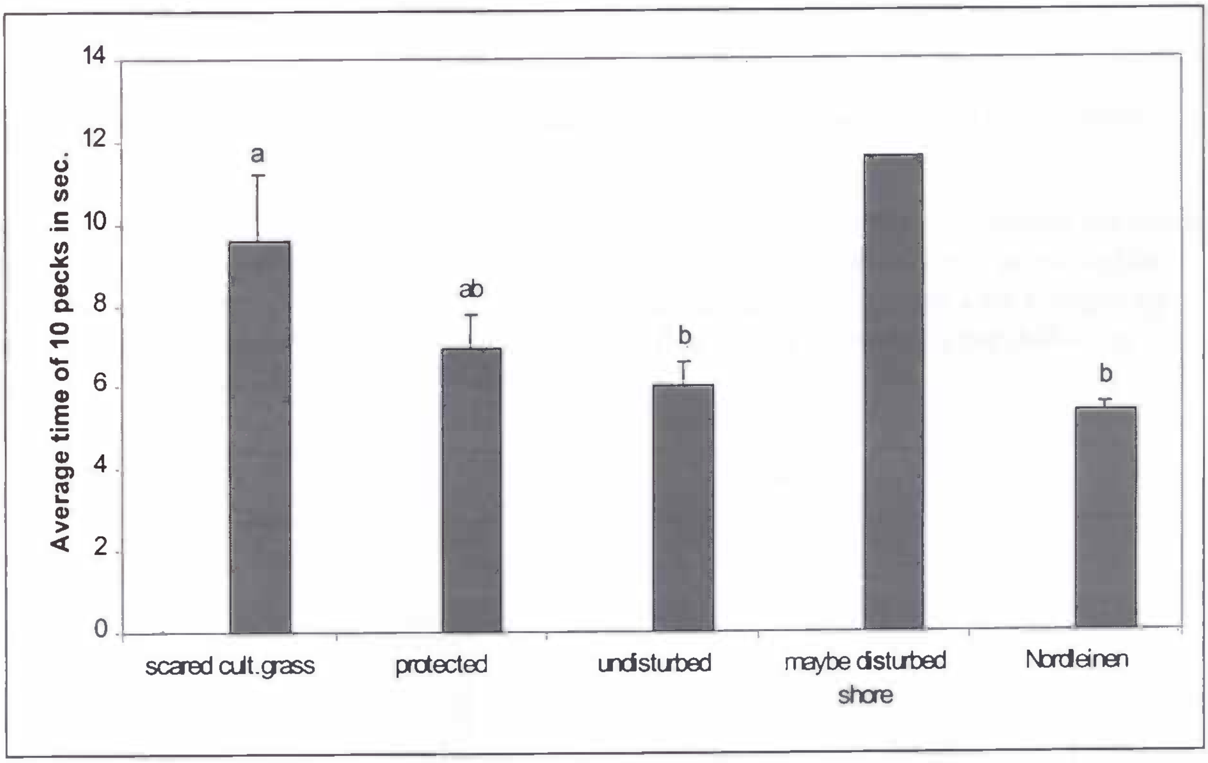

Figure 7: Average time for 10 pecks on different managed areas of Vega community with non-breeding Greylag Geese.

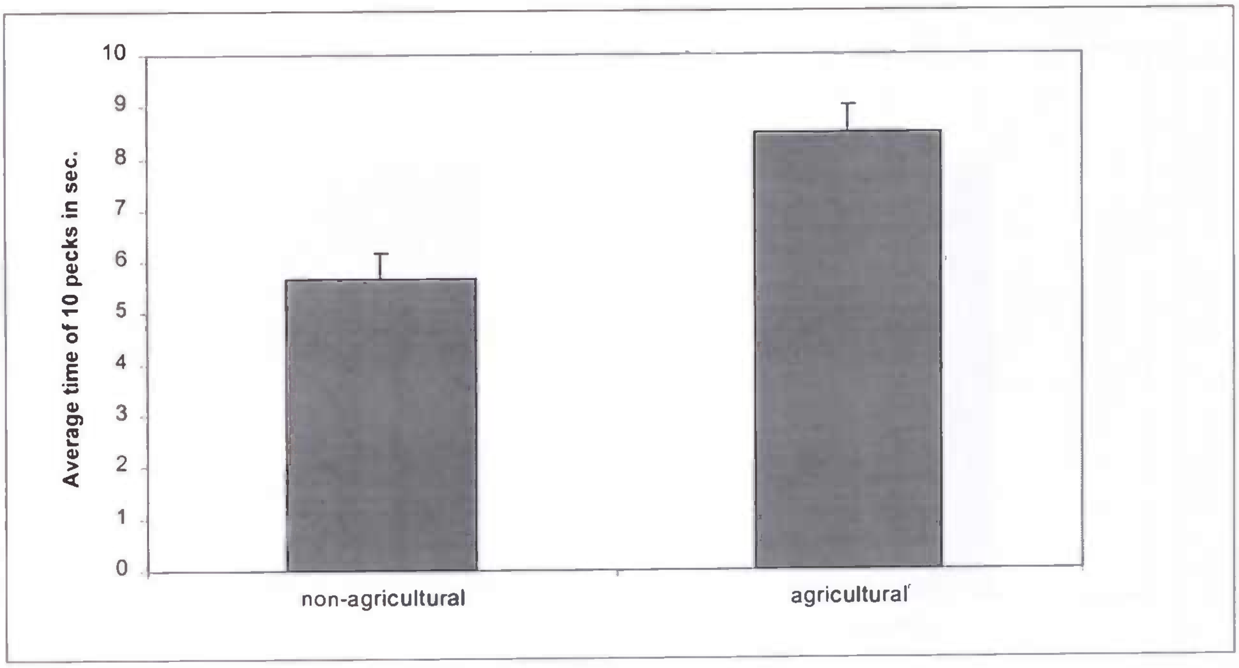

Figure 8: Average time for 10 pecks on different managed areas of Vega with non-breeding Greylag Geese.

The head down time looks in figure 9 much longer on the areas 'scared' and 'protected' but this is not significant ($F_{3,18}$=0.787, P=0.520) . Only one time a flock is scored on the area marked as 'maybe disturbed' so it was impossible to calculate the standard error for this area. Comparing the agricultural areas with the non-agricultural areas (Figure 10) there is no clear difference between these to areas (t_{18}= -0.690, P=0.499).

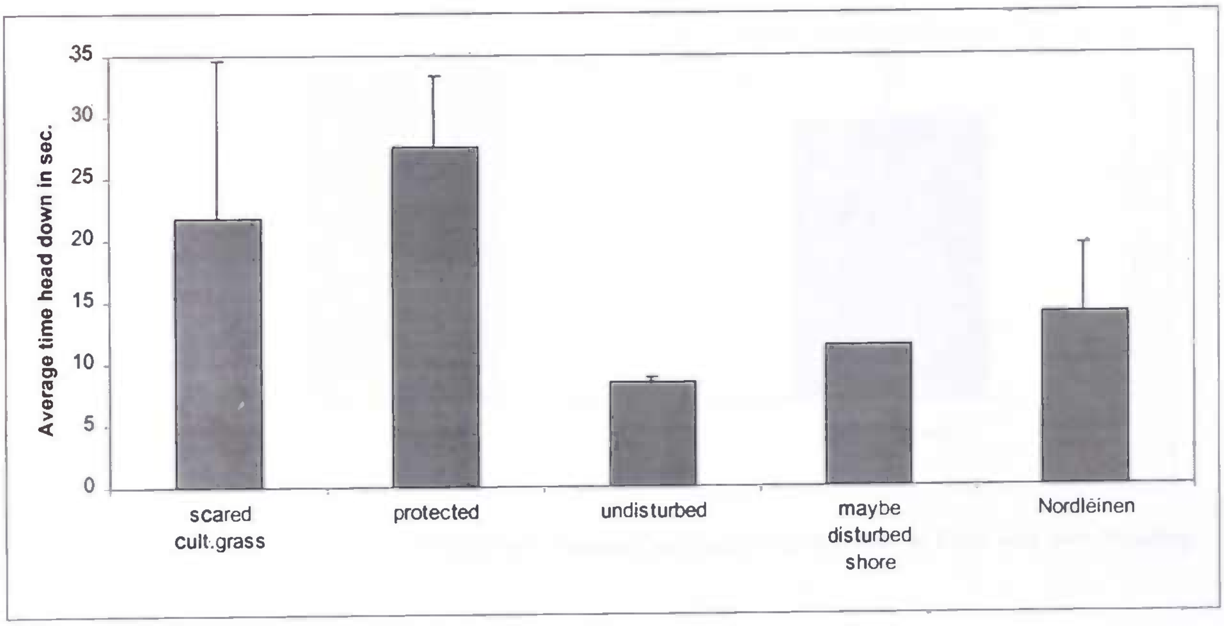

Figure 9: Average time head down on different managed areas of Vega community with non-breeding Greylag Geese.

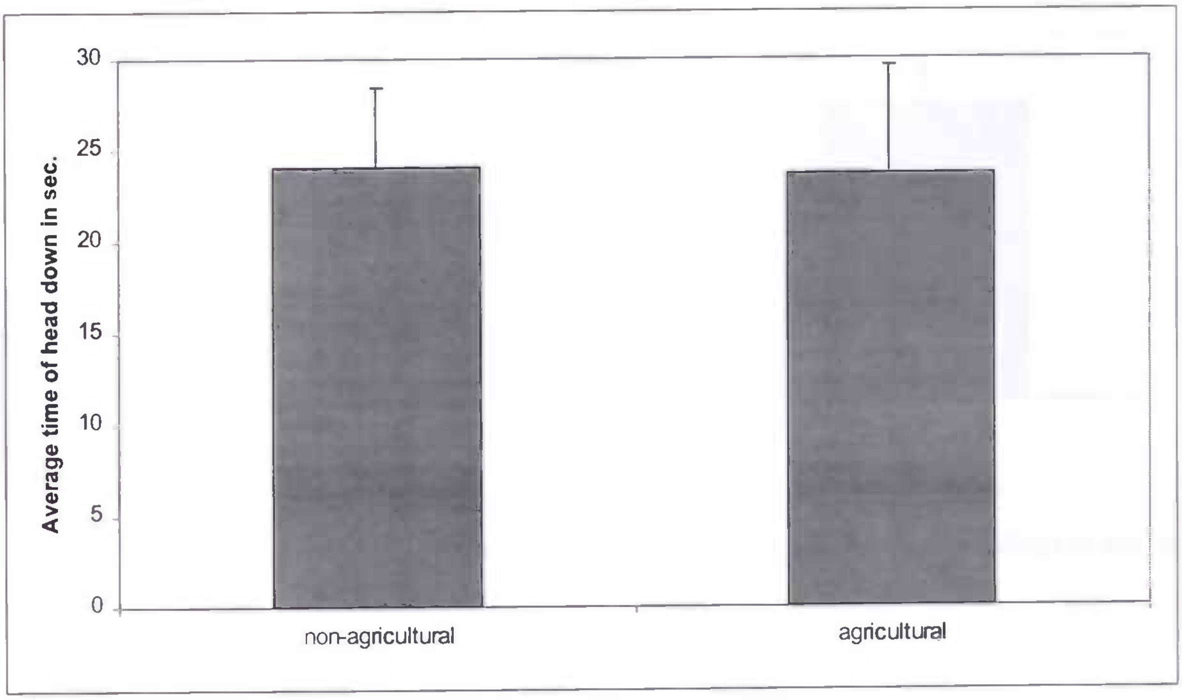

Figure 10: Average time head down on different managed areas of Vega with non-breeding Greylag Geese.

Figure 11 and 12 show differences in peckingrate between scared and protected grassfields. The peckingrate is scored only five times for these areas. The average time for 10 pecks is higher on scared areas (Figure 11) but this result is not significant (t_3= -1.403, P=0.255). The average head down time is lower on scared areas (Figure 12) but also this result is not significant (t_3=0.980, P=0.399).

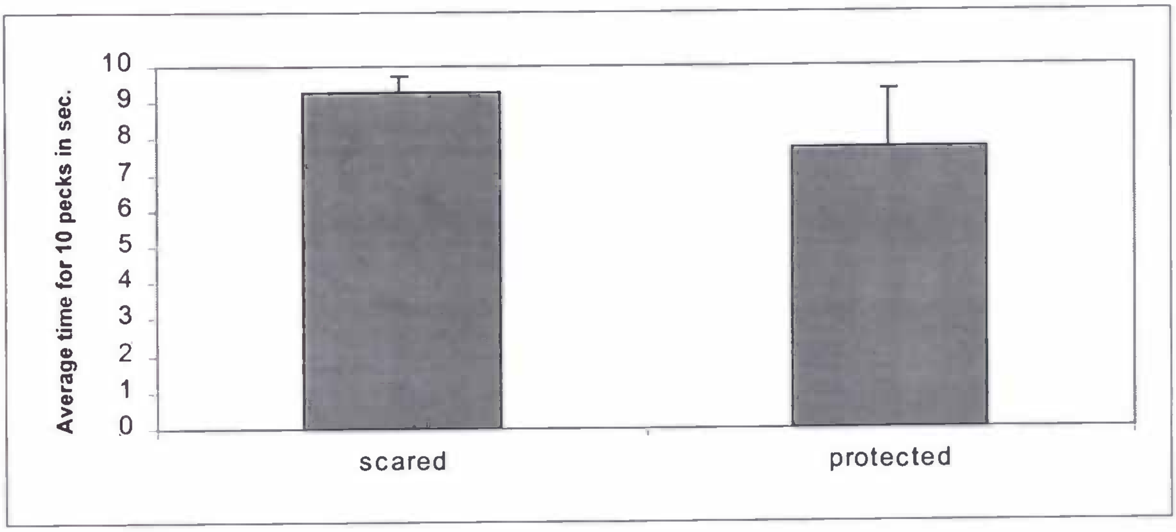

Figure 11: Average time for 10 pecks on different managed agricultural grassfields of Vega with non-breeding Greylag Geese.

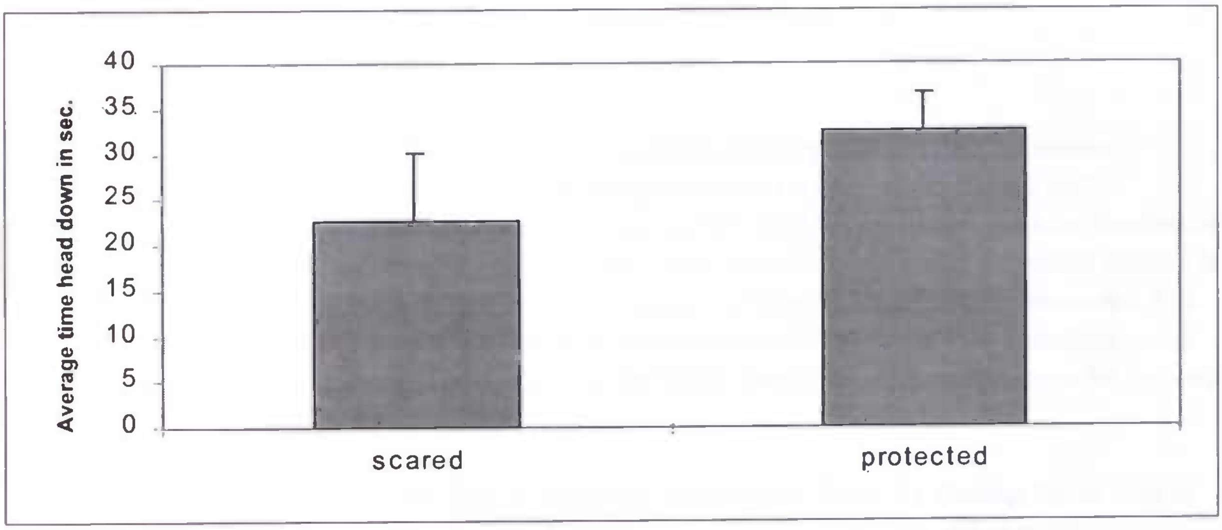

Figure 12: Average time head down on different managed grassfields of Vega with non-breeding Greylag Geese.

5. Discussion

5.1 Abdominal Profile Index (API)

In this study the API has been analysed for as well relations with date as relations between different managed habitats. Measuring abdominal profiles is a matter of practising and calibration. When a specific flock of Greylags is measured by different observers a calibration of measuring method is necessary before conclusions about this flock are made. For most studies to show differences in API is more important than a standard method for adjudging the exact API for an individual Greylag. It is useful to practise and discuss API readings with somebody who is well experienced in this method of measuring the body condition of Greylag Geese before one starts with the data collection.

The geese showed a significant decline in API with date (Figure 1 and 2). During the moulting period there was a continuous decrease of API for both social groups. Nevertheless the non-breeding adults succeed in rebuilding their body condition after the moulting period (see Appendix 1). As expected, the non-breeding birds show a significant higher API compared to the breeding birds. It is difficult to determine a certain threshold in body condition before the geese can migrate successfully. This because of the hunting season which manipulated extremely the date of migration. Three days after the hunting season had started (15 Aug.) most of the Greylags had left the island Vega. To answer the question if they migrated successfully, available data of geese found on Vega can be used in combination with observations of these geese from other countries (see Folkestad 1983). The period after the moult and before the migration is needed to rebuilt body condition. When the hunting season starts soon after the moulting period it is possible that Greylags are not able to reach the certain threshold for successful migration. Regular measurements of abdominal profiles for an individual migrating goose can be interesting to get better insight of the certain threshold in body condition for Greylags. With regard to differences in migration routes. Because there are no regular stopover sites in France (Madsen 1987), the threshold might be higher for geese which migrate from the Netherlands to Spain compared to geese which migrate from Norway to the Netherlands.

Geese of better quality are expected to feed on the best areas (Teunissen et al. 1985). The expectation that non-breeding geese with a relative higher API claim 'protected' instead of 'scared' agricultural areas is not true (Figure 4). Non-breeding birds observed on the habitat marked as 'undisturbed' have relative lower API. This unexpected habitat use might have something to do with the situation on Vega. First, there was probably less intra specific competition because of the highly amount of berries and grass due to the good summer. Secondly, the island has a high variety in habitat types. Geese visit various habitat types at one day. This makes it hard to score abdominal profiles from different Greylags on different habitats. As a result there is not enough data to extract good conclusions.
To answer more questions about the development of body condition in Greylags on Vega compared to factors as; disturbance, food availability, weather and timing of the moult, additional data of successive years is needed.

5.2 Moultstage

Due to observations on different locations some data are missing which are needed for calculating the exact moulting period. At the first day on Nordleinen (20 Jun.) non-breeding Greylags started their moult. Six days later back on Vega some adult geese belonging to families already where in their moult. So it is not sure when the breeders exactly started their moult. The same applies for the end of the moulting period. The period that most Greylags where flightless on Vega in 1998 is set from 20 of June until the 18 of August (28 days (Lebret & Timmerman 1968)).

5.3 Percentage alert Greylags on different managed habitats

The percentage alert Greylags was expected to be higher for agricultural fields and especially scared areas. Comparing agricultural grassfields where it was allowed to scare the geese with grassfields that where protected for scaring devices this expectation was certainly true. Habitats, which are not used for agricultural purposes, show in general a lower percentage alert Greylags. The results are dealing with the percentage alert Greylags per observation independent on the flocksize. Because of this, one observed goose that shows the behaviour alert influences the results relative more than 15 alert geese in a flock of 150.

Powell (1974) showed that the percentage alert sparrows (*Sturnus vulgaris*) decreased when the number of birds increased. This decrease directly influenced the available foraging time. The percentage alert geese found per observation might be influenced by the flocksize. This effect is not taken into account in the results shown in figure 5 and 6.

When more information is needed about effects of the current management plan additional behaviour studies can be done. Distance from scaring devices as for example gascanons can be related to percentage alert or foraging Greylags per flock.

5.4 Peckingrate on different managed habitats

Apart from the amount of data about peckingrate, the results are in contradiction with the expectation. The average time for 10 pecks is higher on agricultural areas. For the average in head down time there is no significant different between agricultural and non-agricultural areas (Figure 8 and 10). Keeping in mind that for only five times the peckingrate is scored on agricultural areas, the hypothesis that on scared areas the head down time should be lower than at protected areas seems to be true (figure 12). Nevertheless is the average time for 10 pecks higher at scared areas.

Results on peckingrate can be influenced by many different factors. Especially on an island as Vega which has a high variety in habitats, disturbance factors and weather conditions.
-Both on scared grassfields and on protected grassfields differences in grass species, mowing date and water availability exist.
-Feeding on grass requires different techniques than feeding on berries.
-Data from Nordleinen is mainly collected during the night as it did not get dark due to the midnight sun.
-Greylags on Vega where exposed to more disturbance factors and the days became shorter.
All these factors might have influenced the results found for peckingrate or will do this in future studies. Due to this reason it's is important which habitats and periods are chosen for further studies on peckingrate. Results about peckingrate found for scared and protected areas can be combined with results on percentage alert, dropping density and body condition.

5.5 Variation between different managed habitats.
Analysing the data found on Vega and Nordleinen several study items are related to the effectiveness of the introduced management plan. Combining the results of these study items it is clear that the management plan strongly influences terrain use of Greylags (Tulner, 1999). The management plan seems to work.

Disturbance influences goose behaviour. Greylags prefer the areas where there is less disturbance thus also protected areas. Greylags show different behaviour on this areas, the geese are less alert. The development in body condition shows the importance of foraging possibilities on the island Vega.

The effect of protected areas on fitness of Greylags can differ every year due to weather condition and human activities. To get a better insight of the effectiveness of the management plan it might be useful to do additional studies in a year with a lower availability of food.

6. Conclusions

Non-breeding Greylags showed a relative higher Abdominal Profile Index (API) compared to adult Greylags belonging to families. Both social groups showed a decrease in body condition in the period from 10-06-'98 until 14-08-'98 with a slope of -0,008 API units per day. There was no relation between body condition and habitat use.

The percentage alert non-breeding Greylag Geese is generally higher for agricultural areas. Areas where it was allowed to scare the geese represent a much higher percentage of alert geese compared to the protected areas. The areas which are more sensitive for disturbance geese needed in average more time for ten pecks.
Analysing the head down time there was no clear difference found between different managed habitats.

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Appendix 1: Development of body condition related with date for both non-breeding Greylags (Figure 1) and Greylags belonging to families (Figure 2).

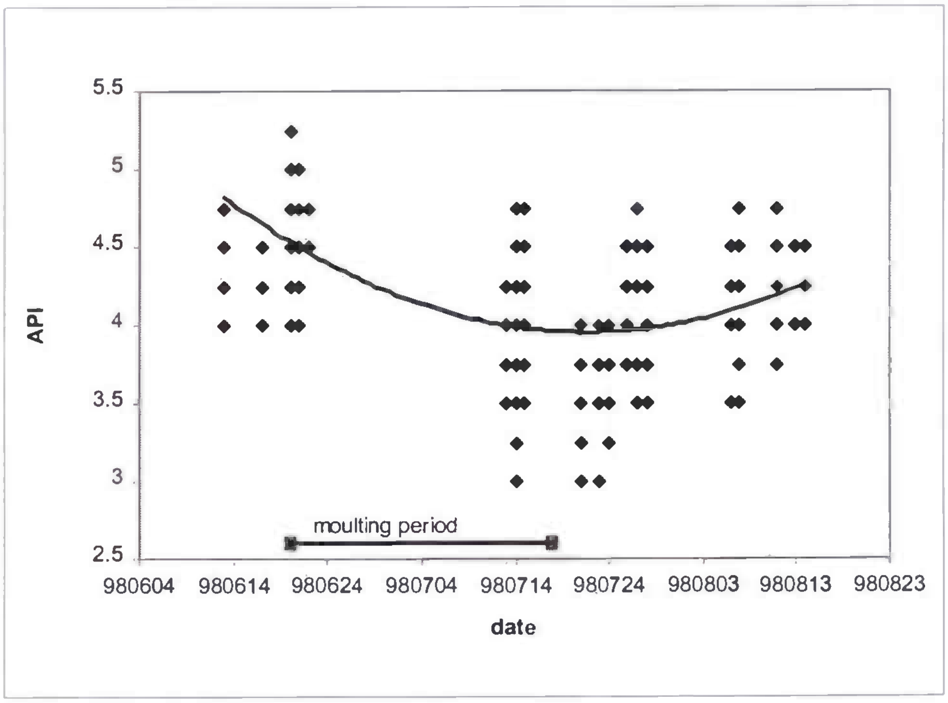

Figure 1. Development of body condition in API with date for non-breeding Greylag Geese on Vega community with a moulting period from 20-06-'98 to 18-07-'98.

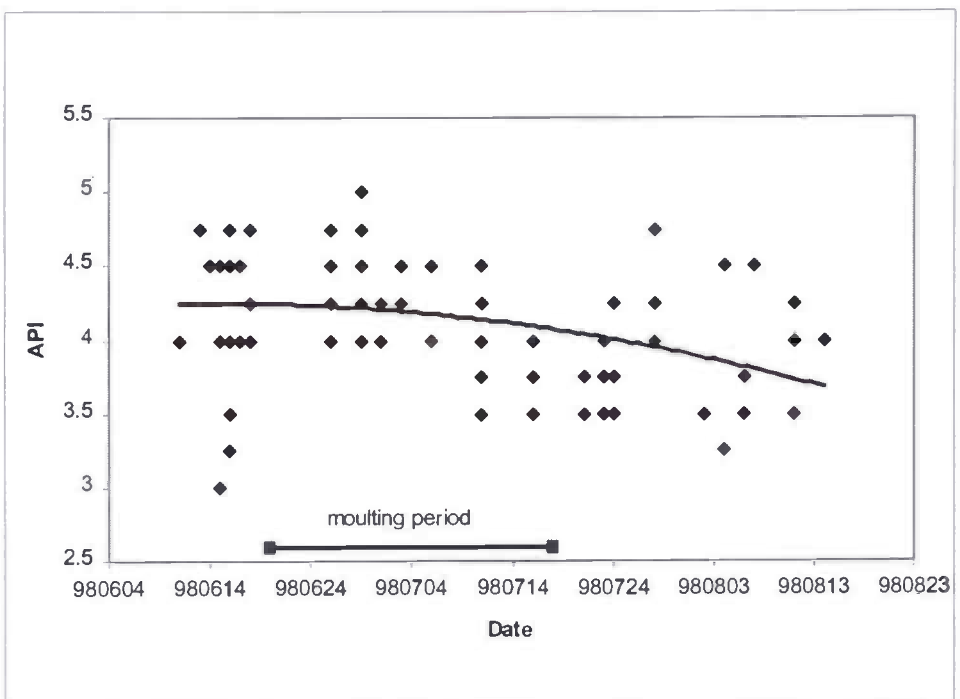

Figure 2. Development of body condition in API with date for adult Greylag Geese belonging to families on Vega community with a moulting period from 20-06-'98 to 18-07-'98.

Appendix 2: Calibration of Abdominal Profile Index (API) readings between B. Voslamber and J. Spitzen in the Dutch Ooipolder at the 7th of December 1998.

Abdominal Profile Index (API) readings between B. Voslamber and J. Spitzen in the Dutch Ooipolder at the 7th of December 1998.

J. Spitzen

	API	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**
B. Voslamber	**3.0**					
	3.5		1			
	4.0	3	12	5		
	4.5		10	9	2	
	5.0			5		