Studies on the effects of disturbances on staging Brent Geese: a progress report

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Preliminary analyses of the effects of disturbance by a variety of recreational and other human activities on Dark-bellied Brent Geese *Branta bernicla bernicla* on their spring staging areas in the Schleswig-Holstein part of the Wadden Sea are reported. Three areas subject to different patterns and intensities of human use were studied. Recreational pressure appears to limit the use of this part of the Wadden Sea as a staging area, because when the number of tourists was high the geese were seen to use more restricted feeding areas and were seen in smaller numbers.

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INTRODUCTION

In the Schleswig-Holstein part of the Wadden Sea area an applied ecosystem research project started in May 1989 and will continue until 1993. The ornithological studies are carried out by the staff of the WWF-Wattenmeerstelle in Husum and by the scientific staff of the National Park Administration in Tönning. The project deals with three main topics: monitoring of migratory waders, ducks and geese; monitoring of breeding species; and the assessment of the influence of disturbances on birds. In this paper studies on the effects of human-related disturbances on staging Brent Geese *Branta bernicla* will be presented.

The consequences of human disturbance on spring-staging geese have only recently received attention and are poorly documented (Bélanger & Bédard 1989, 1990; Madsen 1985; Owen 1973; Owens 1977; Persson 1989; see also Bergmann & Stock (in press)). Many different stimuli cause disturbance to geese. In general they can be divided into natural and anthropogenic ones. Less information exists about the ecological and behavioural consequences of human-induced than about natural disturbances. Disturbances are expected to have a negative effect on bird numbers, distribution and behaviour. In addition, they can affect the activity budgets of the birds and thus the ability to store fat reserves for migration and breeding (Bélanger & Bédard 1990; Persson 1989). It is possible that behavioural constraints can hinder the exploitation of food resources. Within the Brent Goose project we attempt to answer the following questions:

- what kind of behavioural changes can be observed as a consequence of disturbances?
- is the distribution of Brent Geese affected by disturances?
- are time-budgets affected by different levels of disturbances?
- do the birds compensate for losses in daylight feeding-time or do they leave an area when it is heavily disturbed?
- do behavioural constraints hinder the exploitation of food resources?

STUDY AREAS

The studies are carried out at different locations within the Schleswig-Holstein part of the Wadden Sea area. The main study area is the Westerhever saltmarsh and the adjacent Tümmlauer Bucht area on the Eiderstedt Peninsula. In spring the whole area (265 ha) holds up to 7,000 Barnacle Geese *Branta leucopsis* and up to 4,000 Brent Geese. It consists mostly of a lower saltmarsh with *Puccinellia* predominating (Kempf *et al.* 1989). The area is heavily used by tourists, and up to 200 people can be counted simultaneously on a single day in spring. Besides tourists, aeroplanes from a nearby small private airport are considered to be the second most important cause of disturbance to the birds. A second site, undisturbed by human activities, is situated on the Norderheverkoog saltmarshes on the northern coast of the Eiderstedt Peninsula. Up to 5,000 Brent Geese can be counted there in spring. A third study area is situated on Hallig Langeness where up to 12,000 Brent Geese stage in April and May (Kempf *et al.* 1989).

METHODS

The geese were usually observed at random by 1 to 4 people under all tidal conditions, either during the whole daylight period or for several hours per day. During whole-day observations the number of birds engaged in various activities was recorded every 15 minutes by instantaneous scanning of the flock using the method of Altmann (1974). At certain places the number of geese were counted every 30 minutes and the distribution of the flocks was mapped. Additionally, the number of tourists in the saltmarsh, on the roads and on the dike were counted. For each disturbance, we noted the time of day, the flock size, the disturbing factor, the proportion of the flock taking flight, the time spent in flight, and the type and duration of post-disturbance behaviour. Food intake rates and feeding efficiency of the geese is being measured in relation to the food supply. To measure the digestibility of foodplants in spring both faeces and foodplants are being analysed using indigestible markers. To quantify night-feeding activities, the birds are fitted with radio transmitters with mercury activity switches. Individual diurnal behaviour patterns will be detected with the aid of a computerised activity recorded called 'Activ 500'. The data recorder is able to follow up to a maximum of 10 birds automatically and to register the activity patterns of the geese in different time intervals over the whole day. To assess the proportion of the day spent feeding we want to compare activity data received by telemetry, with that from following individual birds visually and by scanning flocks. The effects of disturbance on the time and energy budgets of the geese will be calculated. Detailed energy budgets of geese feeding under disturbed and undisturbed circumstances will be compared using the method of Bédard & Gauthier (1989).

FIRST RESULTS FROM THE WESTERHEVER SALTMARSH

Behavioural responses and the distribution of spring-staging Brent Geese as a result of human induced

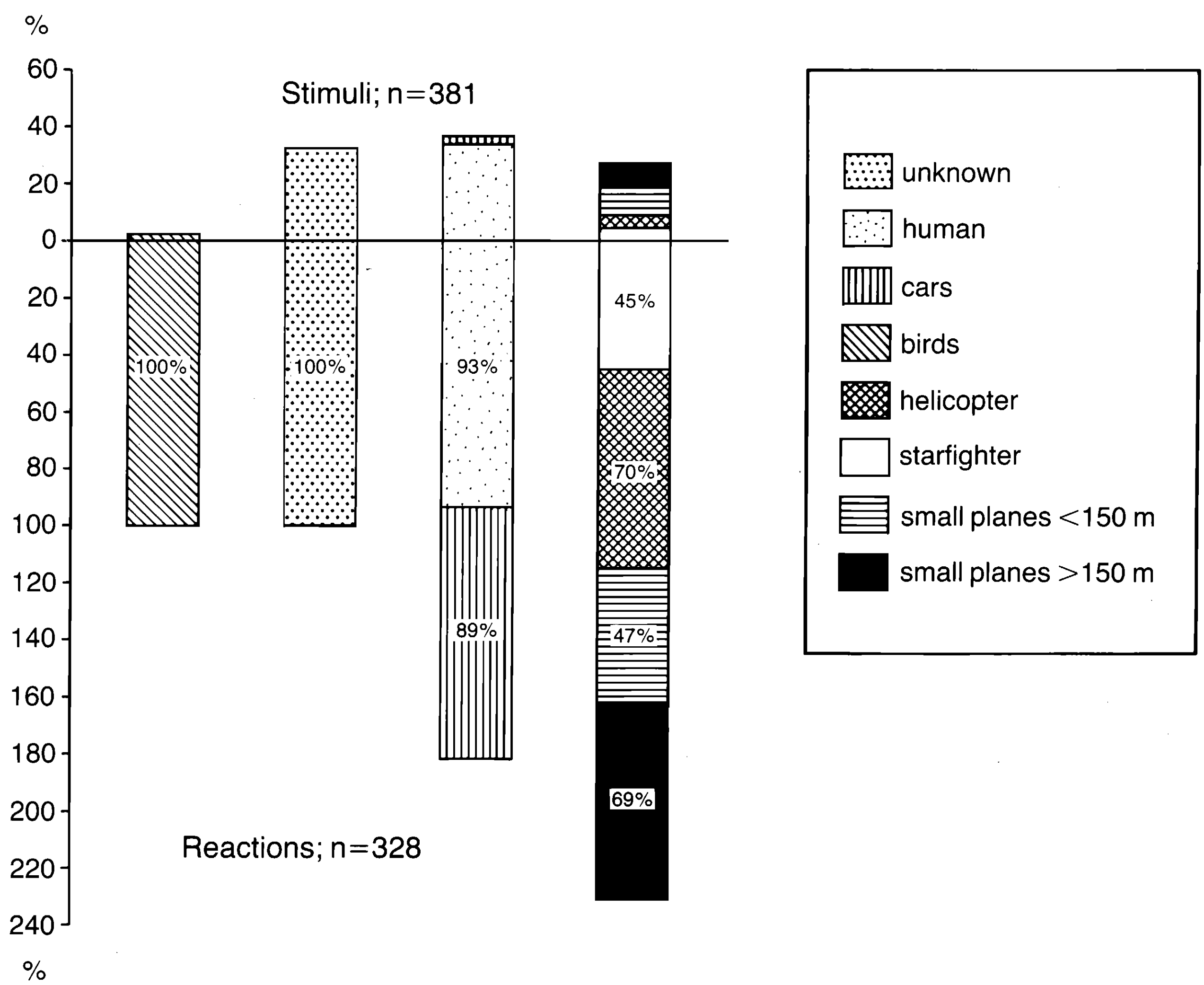

Figure 1. Stimuli and reaction. The upper part of the graph shows the percentage distribution of all possible stimuli recorded during the study. The lower part shows the reaction of the geese, expressed as a percentage of a certain stimuli.

disturbances were investigated between March and May 1990 on the Westerhever saltmarsh. First results of the studies are presented here and can also be found in Stock (in press). Because of a very high variability within the reactions, even to the same type of stimuli, all results are presented as means without standard deviations. No statistics are applied.

Stimuli and Reaction: The stimuli which caused disturbances were noted during 143 h of observation resulting in a rate of 0.22 to 6.90 disturbances per hour. The percentage distribution of all possible stimuli recorded during the spring season are shown in the upper part of Figure 1, Human-related disturbances were more often recorded than natural or unidentified disturbances with tourist activities ranking first and small aeroplane overflights ranking second. In 34.4% of all cases the geese reacted without any stimulus being detected. Some of these reactions are considered to be spontaneous. In 36% of all cases the geese were disturbed by man, and in 26% by different kinds of aircraft. Other man-made stimuli played a minor role. Overall, a reaction was observed to 86% of all potential disturbing factors. The reactions of the birds to the different stimuli – expressed as a percentage – are shown in the lower part of Figure 1. Non-human disturbing factors always led to reaction by the geese. Reactions were greatest after a disturbance by people or cars. The reactions to aeroplanes were not so clear cut. Helicopters caused the strongest reaction whereas starfighters (jet-fighters) caused the lowest one. The differences in the reaction of the birds to small aeroplanes flying at various heights are not clear.

Different Answers. Slightly disturbed geese interrupted feeding and raised their heads. Intense disturbance usually caused the birds, or part of the flock, to take flight, circle around and land after some minutes to continue feeding. Very strong stimuli caused the birds to leave the area. After each flight, feeding was interrupted for a while and the birds remained alert or started to preen. The percentage of birds in a flock taking flight after a disturbance varied according to stimulus, averaging between 50 and 88% (Figure 2). The highest percentage was caused by helicopters and small aeroplanes, which also caused the highest reaction time, expressed as time in flight (dotted bars) and retention time – time taken to resume feeding after a disturbance flight. Overall, a reaction lasted between one and two minutes.

Spatial Distribution. Brent Geese showed a clear reaction in their spatial and temporal distribution in response to the numbers of tourists visiting the area. During the early morning and in the later afternoon – when there were few tourists – the geese used nearly the whole area of the available saltmarsh. The undisturbed south-eastern part acted as a refuge and

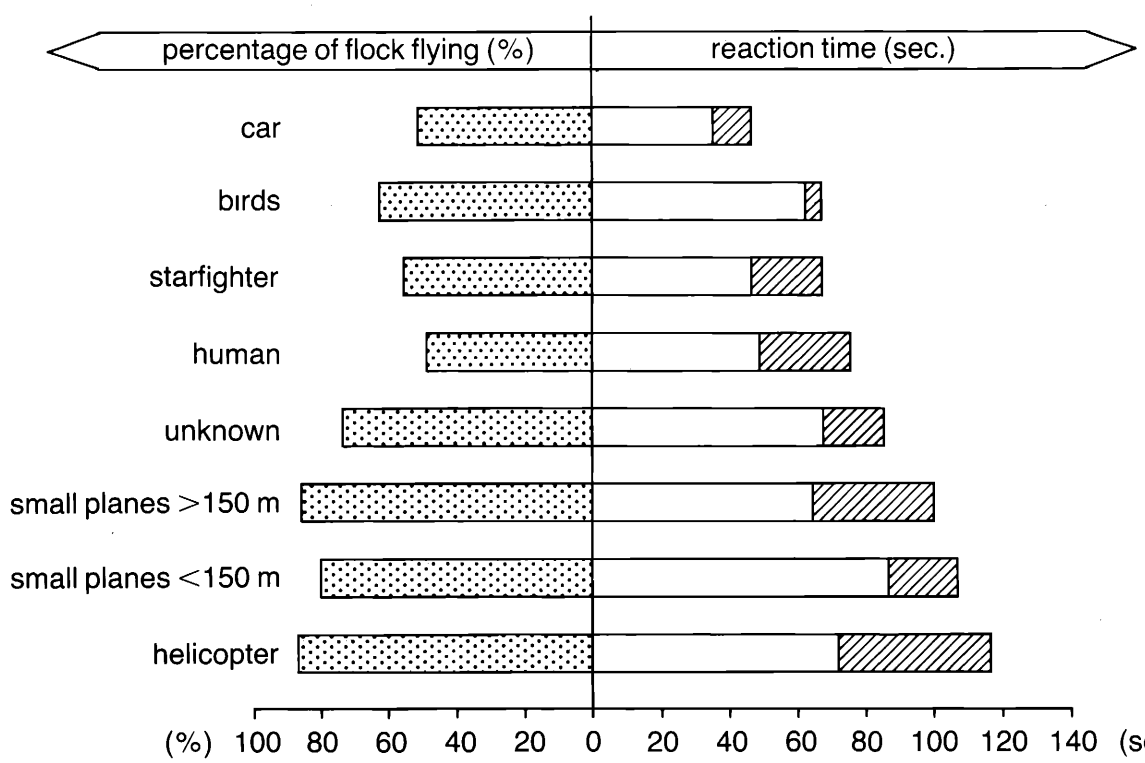

Figure 2. The proportion of birds in a flock taking flight after a disturbance (dotted bars; $n=309$), the reaction time ($n=272$), expressed as flight time (clear bars), and the time to resume feeding (cross-hatched bars) are shown in relation to the different stimuli.

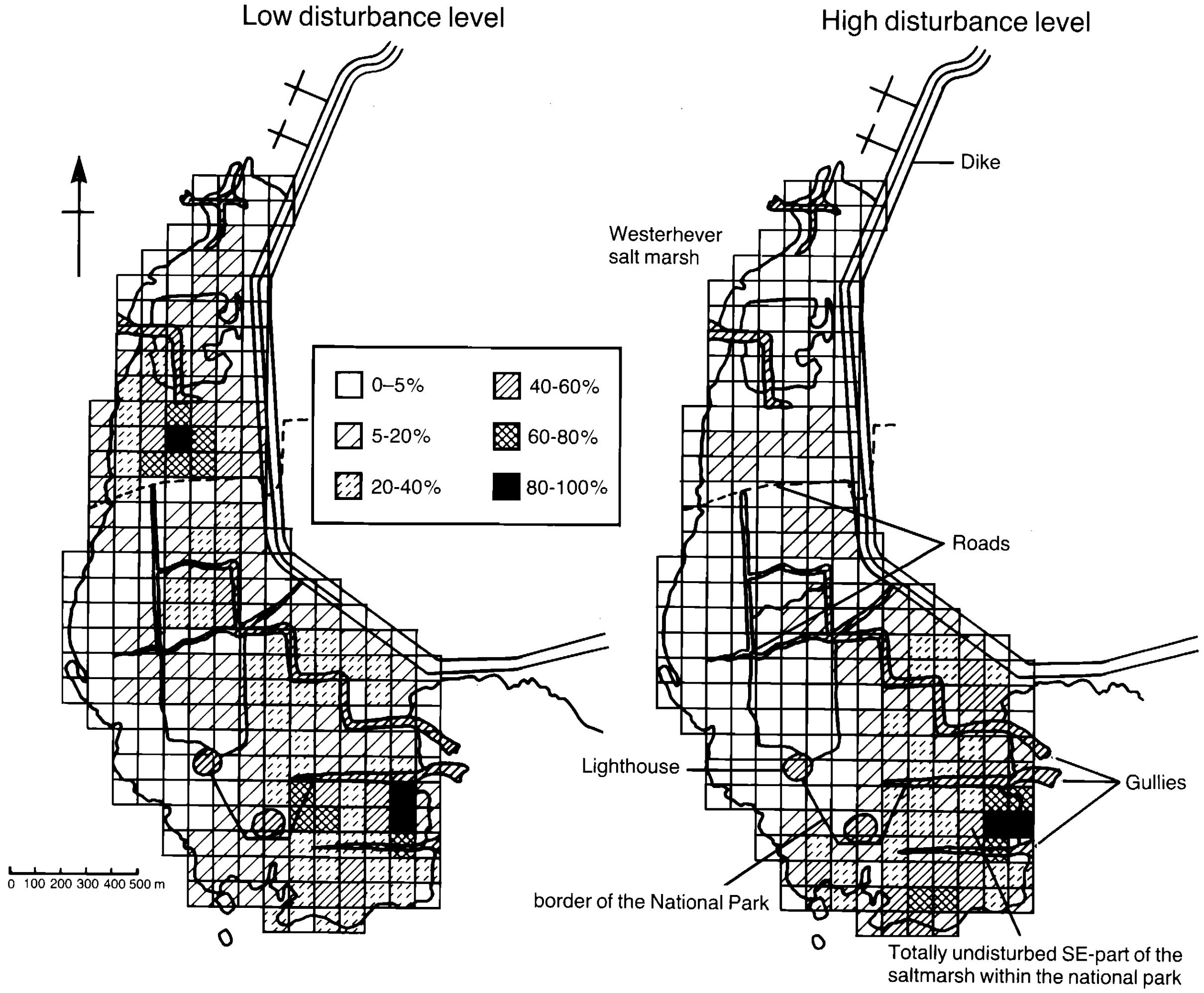

Figure 3. The distribution of Brent Geese on the saltmarsh of Westerhever in relation to the disturbance pressure. The usage of the area by geese is expressed as percentage of the quadrat with the highest number. Each map represents 166 scans made several times a day scattered over the whole observation period. The left map shows the distribution during low disturbance pressure, the right during high disturbance pressure.

was used by large numbers until most of the tourists had left the area. In the early morning and late afternoon the rest of the area was also used. In the course of the season the total number of geese in the saltmarsh studied decreased with increasing disturbance level, whereas in the total Wadden Sea the numbers increased during the same period. The overall usage of the study area by geese is therefore low (488 goose-hours/ha). The map shows the distribution of the geese on days with low (<30 tourists) and high (>30 tourists) disturbance levels (Figure 3). In both circumstances there was a similar mean flock size in the area. Under high disturbance pressure the geese left the area and flew to an adjacent, undisturbed saltmarsh.

Activity Budgets: The whole-day observations on feeding birds during April and May in Westerhever revealed no relationship between the feeding activity of the geese and the level of disturbance ($r^2 = 0.02$). Estimates of the percentage of time devoted to grazing were lower than those reported for other goose species. On average, the birds spent 70.7 ± 9.51% of their time grazing. Under undisturbed conditions, in the salt-marshes in the Norderheverkoog area, the geese spent 59.1 ± 10.25% of their time feeding and the proportion of time spent preening and swimming was twice as high as in the heavily disturbed Westerhever saltmarsh. The differences between the feeding activity accounted for 19.7%. Activities such as being alert increased with increasing disturbance levels ($r^2 = 0.40$) whereas those such as comfort movements decreased ($r^2 = -0.30$) (Figure 4).

DISCUSSION

Disturbance of spring-staging Brent Geese affects their behaviour and the subsequent use of the area. The mean disturbance level we recorded can be considered as high (2.19 disturbances/h). It was three times higher than that observed by Owens (1977) for wintering Brent Geese in England (0.68/h) and nearly twice as high as observed by Bélanger & Bédard (1989) on wintering Snow Geese *Anser caerulescens* in Canada. Only Prevett & Macinnes (1980) noticed similar levels

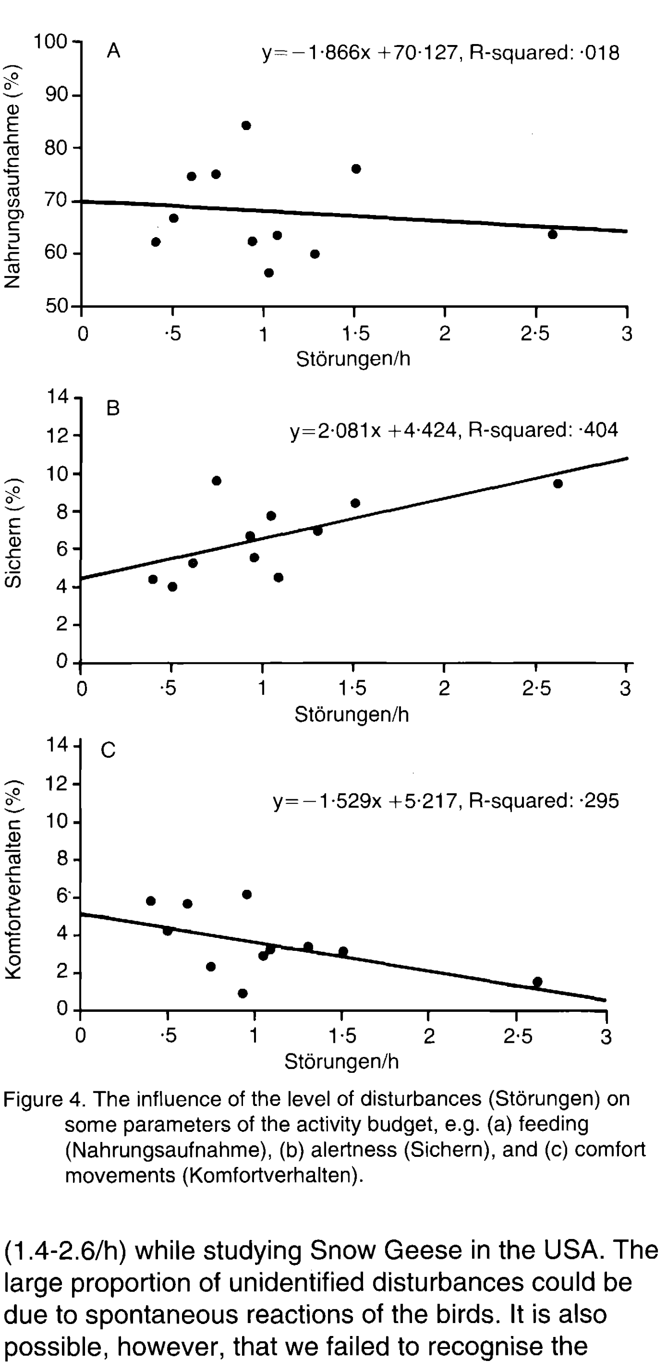

Figure 4. The influence of the level of disturbances (Störungen) on some parameters of the activity budget, e.g. (a) feeding (Nahrungsaufnahme), (b) alertness (Sichern), and (c) comfort movements (Komfortverhalten).

(1.4-2.6/h) while studying Snow Geese in the USA. The large proportion of unidentified disturbances could be due to spontaneous reactions of the birds. It is also possible, however, that we failed to recognise the stimuli and thus the disturbance level may be somewhat higher. Moreover, because we only noticed disturbances severe enough to cause the geese to take flight, the data represent a minimum estimate.

The amplitude of the response varied with its cause. Therefore, the impact of disturbance is related to its frequency and stimuli. Tourist activities were the most important sources of disturbance, followed by different types of aircraft. The difference in responses to high-flying aeroplanes compared with low-flying ones is not clear. A possible explanation is the fact that only the height and not the vertical distance to the flocks was noticed. Owens (1977) found that Brent Geese were particularly susceptible to disturbance by aircraft, and any aeroplane below 500 m and up to 1.5 km away could put the geese to flight. In general, we could not observe any habituation to the disturbances in the course of the season. On the contrary, we found a slight increase of the mean reaction time ($y = 0.57x \times 44.1$; $r^2 = 0.36$). Our observations are in accordance with those of Owens (1977), who also found that Brent Geese do not habituate to aeroplanes that took off regularly from a nearby airport. Nevertheless, small aeroplanes and helicopters cause the most severe disturbance to geese, either expressed as a percentage of the flock taking flight or as the total reaction time.

Even on the heavily disturbed Westerhever saltmarsh Brent Geese spent a relatively low proportion of time grazing (70.7%). Different authors found values between 75% and 90% for Brent Geese in different wintering areas (Dijkstra & Dijkstra de Vlieger 1977, Madsen 1988, White-Robinson 1982). Studying Barnacle Geese on the wintering grounds. Ebbinge *et al.* (1975) estimated a value of 82%, whereas Madsen (1985) reported 80% for Pink-footed Geese *Anser brachyrhynchus*. The low level of time spent feeding in our study is not yet totally understood.

Bélanger & Bédard (1990) found no relationship between feeding rate and disturbance level in Snow Geese. They concluded that the birds do not compensate for a loss of feeding time by increasing their daily foraging time. They considered an increase in night-time feeding as compensation, such as Madsen (1988) showed for Brent Geese. As we do not have valid data to show night-time feeding we worked with activity-telemetry in 1992 to give an assessment plan of compensatory night-time feeding under disturbed and undisturbed circumstances. The findings mentioned above are in contrast of those of Schilperoord & Schilperoord-Huisman (1981) studying the effects of disturbances on time budgets of wintering Pink-footed Geese. They found that geese caused to fly by disturbances compensated for the loss in feeding time by an increase in feeding activity after a disturbance. High levels of disturbance caused a shift in the activity pattern of the birds. Alertness and walking increased while comfort movements decreased. While making activity observations, flight activity itself was not measured but Owens (1977) found a seven-fold increase in the time spent flying due to disturbances. The geese lost 11.7% of their grazing time during the day. An increase in alertness was found by Owen (1972) also in White-fronted Geese *Anser albifrons.* In conclusion, disturbance can be considered as harmful to the birds if it consistently results in a loss of energy through extra flight and a loss of feeding time which the birds are not able to compensate for by increased food intake.

An extreme response of wintering or spring-staging geese to severe and frequent disturbance is to leave the area. This is extremely likely if there are undisturbed areas in the near surroundings. Besides habituation, geese may learn to identify certain kinds of danger on a particular site and thus avoid the area (Madsen 1985). Bélanger & Bédard (1989) showed that a rate of more than two disturbances/hour on one day leads to lower bird numbers the following day in the same area. Under undisturbed situations, *e.g.* low numbers of tourists in the area, the geese in our study were equally distributed over nearly the whole saltmarsh. Only the higher parts of the westernmost tip were not utilised. This pattern is biased by the vegetation type in this area, a sandy and *Festuca*-rich saltmarsh, which is general is seldom used by Brent Geese. Concentration points are to be found in the well protected parts of the area in the north and south-east. If the number of tourists increased the birds retreated and were concentrated in the almost undisturbed south east part or left the area and flew to the nearby undisturbed saltmarshes of the Tümmler Bucht. The south-east part lies within Zone 1 of the National Park (no access to the public) and acts as a refuge. Nevertheless, the total number of birds in the area decreased from 3,000 in March to less than 1,000 in May. This indicates that parts of the saltmarsh cannot be utilised by geese as a consequence of the frequent disturbances and thus possibly large parts of the food-stocks are not optimally utilised.

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