Large-scale egg-dumping by island nesting Greylag Geese *Anser anser*: an indication of density-dependent regulation in a breeding population in northwest Lower Saxony, Germany?

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Abstract

Large egg dumps of more than 100 eggs were observed on an island with colonial-breeding Greylag Geese *Anser anser* during an aerial survey in 2012. Observations made during subsequent visits to the island found extremely high goose breeding densities with low hatching success. These observations are discussed in relation to studies of density dependence in Greylag Geese and other goose species.

Key words: breeding density, egg-dumping, geese, *Anser anser*.

Greylag Geese *Anser anser* were eradicated by humans from northwest Germany in late mediaeval times, although a small breeding population persisted in eastern Germany, especially in Mecklenburg. From the 1960s onwards, Greylag Geese were reintroduced into Lower Saxony by private individuals and the Lower Saxony hunting association, supported by the Ministry of Agriculture (Bruns & Vauk 1985). Since 1982, the species has also been released onto the wetlands of Lower Saxony, beginning with Lake Dümmer (52.514°N, 8.336°E), Lake Steinhude (52.469°N, 9.326°E), Braunschweig-Riddagshausen (52.270°N, 10.578°E) and Lake Großes Meer (53.409°N, 7.278°E) in East Frisia (northwest Lower Saxony). From these areas, the geese have now recolonised much of their former breeding areas throughout the region and breed in most wetlands of any size across Lower Saxony (Krüger *et al.* 2014; Kruckenberg 2019). Traditionally Greylag Geese use dense vegetation such as reedbeds for breeding, preferably on predator-free islands (Kear 2005), and the lakes of central East Frisian therefore were one of the core release areas (Fig. 1). During the first ten years of the project numbers breeding in the area increased slowly, reaching *c.* 120 pairs in 2000 (Naturschutzbund Deutschland Ostfriesland & Flore 2001), with aerial surveys indicating a subsequent increase to *c.* 250 pairs by 2012 (H. Kruckenberg, unpubl. data).

As a result of their increasing local abundance and grazing pressure, conflicts

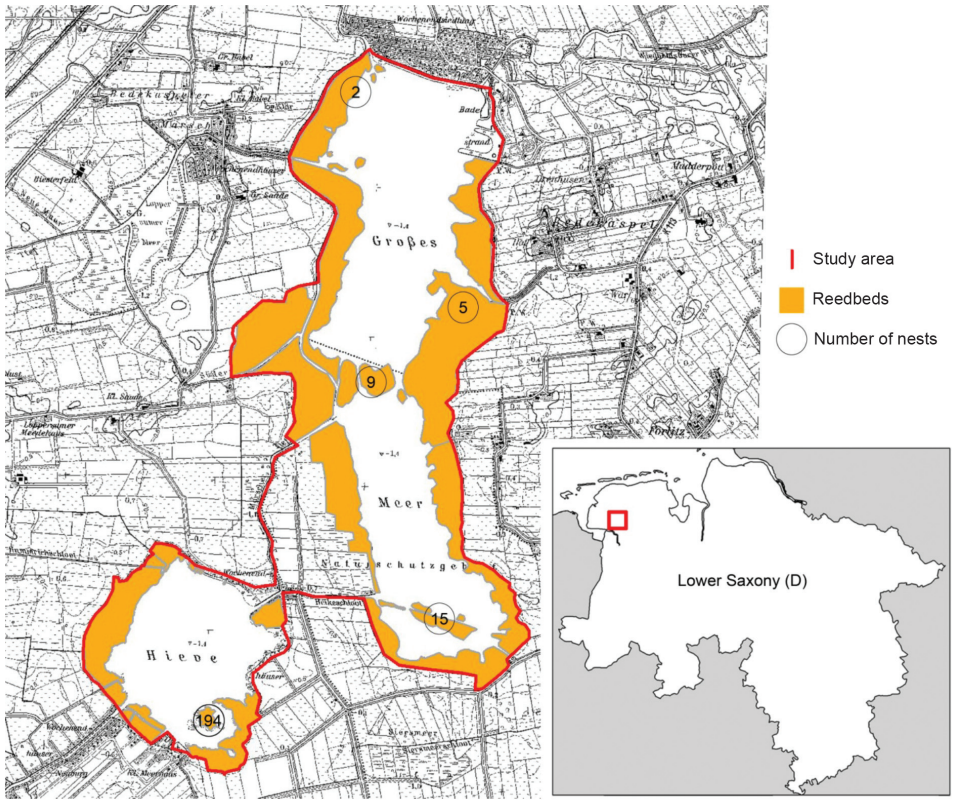

Figure 1. Study area of Lake Großes Meer and Hieve with reedbeds (orange) and the number of nests found. The breeding island shown in Fig. 2 is in the southern part of Lake Hieve.

arose between the geese and local farmers, and there was also concern about the potential for goose droppings to have an adverse impact on water quality. Aerial surveys of Greylag Geese nesting sites in central East Frisian therefore were undertaken in 2012, to assess whether this method was suitable for a broader monitoring programme for geese breeding in the region. During the course of these surveys, we located an island with exceptionally high densities of Greylag Goose nests and a large number of eggs scattered around the island, which forms the subject of the short note presented here.

Methods

A trial monitoring flight was undertaken in central East Frisian on 19 April 2012, to test methods for making aerial counts of geese breeding in northwest Germany. Digital images were taken from a small aircraft (Ultralight FK9) of all banks, shores and reedbeds along the course of the River Ems and at Lake Großes Meer, using a Nikon 7100 digital camera fitted with a 200 mm lens, at a flight height of *c.* 150m. Subsequent analysis of the photographs enabled the presence of Greylag Goose

nests to be determined and counted, from a combination of sitting females visible in the photographs and conspicuous nest platforms with or without eggs evident within the reed beds, following the methods of a previous study of the species breeding in northern Denmark (Kristensen 1997). During the course of the aerial survey, very high densities of nesting Greylag Geese were detected on a small island in Lake Hieve (53.409°N, 7.2781°E, west of Lake Großes Meer, a Natura 2000 site, Code DE2509-401) from which the following results are derived. After hatching, we visited the island (1.15 ha in size; 112 m from the shore of the lake) by boat on 6 June 2012, took GPS-fixes of every nest, and documented the overall hatching success. We considered that eggs were predated if they were found to be broken or penetrated with traces of blood and laying close to the nest. Eggs were considered to have hatched if eggshells retained membranes, or if only dried membranes were present in the nest. A nest was classed as having been abandoned when complete clutches or several eggs in the nest were found cold, or if other hints (vegetation starts growing through the nest, wet feathers) indicated that an incubating female had not been on the nest for some time. "Nearest Feature, version 3.8" in ArcView 3.3 was used to determine retrospectively the minimal distance between neighbouring nests, based on their GPS positions.

Results

Post-survey analysis of the images revealed 194 nests on the island, accounting for 86% of all breeding pairs counted in the entire study area of Großes Meer / Hieve (> 225 nests, Fig. 1). Most of the reedbeds are harvested regularly to provide roofing thatch and such areas were not used for nesting. On inspecting the nests on 6 June, it was found that nearly half (n = 100; 44%) had been abandoned before hatching and that 13% of the clutches (n = 29) had been predated and approximately one third of the clutches had hatched (n = 65).

Nesting density on the island was very high (169 nests/ha; red circles in Fig. 2). The mean nearest neighbour distance between all geo-rectified nests was 1.953 m (n = 191 nests, with three nests evident on the aerial photograph not subsequently found on the ground). A conspicuous feature of the island was the large numbers of eggs scattered outside of the nests. These accumulations of eggs were not found close to the shore but were confined to the middle of the island (constituting the white patches in the image clearly visible in Fig. 2). On the island, five very large egg-dumps visible from the aerial photographs were located, each containing > 100 eggs (Fig. 3). Several nests containing large numbers of unhatched eggs (up to 25) were also found, which were not visible from the aerial imagery.

Discussion

Large egg dumps on a small island with high densities of nesting Greylag Geese were discovered during the aerial survey. Following the nesting period, the island was visited and a ground investigation confirmed the existence of the egg dumps. Counting and mapping of all 194 nests on the island found short inter-nest distances and a high proportion of clutches which never hatched. The survey indicated that

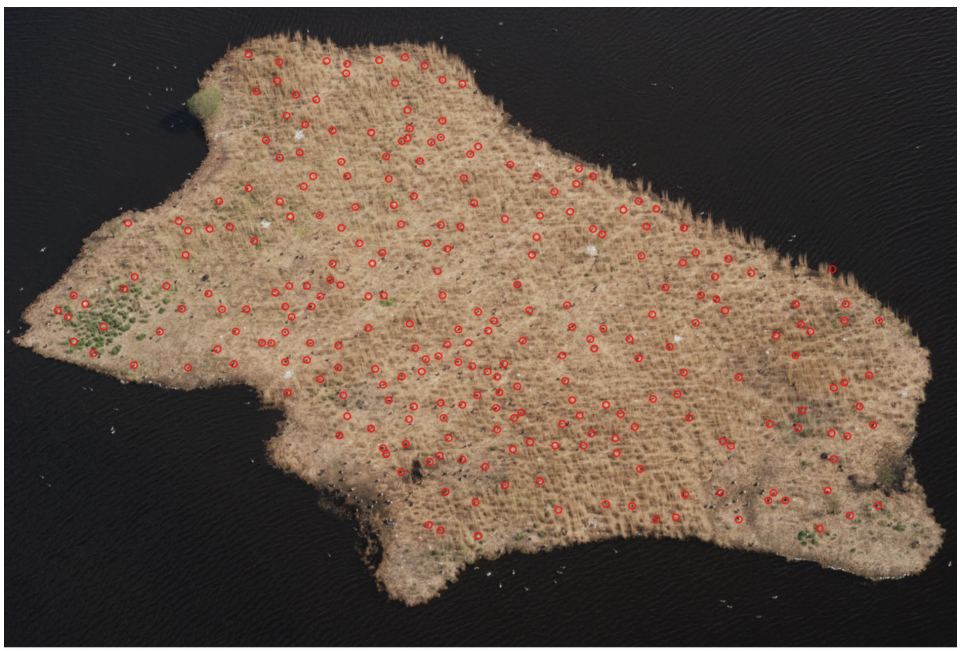

Figure 2. Aerial photograph taken on 19 April 2012 of the Greylag Goose breeding island at Lake Hieve, Landkreis Aurich, Lower Saxony, Germany, showing all located nests as red circles (n = 194). Note the five conspicuous large aggregations of eggs dumped at specific locations, which show up as strong white clumps on this image. Photograph by H. Kruckenberg.

Greylag Geese bred on this island mainly because of the limited extent of suitable and safe reedbeds (subject to traditional reed-cutting which rendered other areas unsuitable) and the high accessibility of reedbeds by ground predators in other parts of both lakes.

The existence of many hundreds of goose eggs away from nests, witnessed at this Greylag Goose breeding site, does not seem to have been frequently recorded for this species before in the literature. Comparable egg-dumping of 26–70 eggs has however been described among Lesser Snow Geese *Chen caerulescens* nesting on Wrangel Island in the Russian Arctic (Uspensky 1965; Syroechkovski 1979), where eggs were regularly observed being dumped by pairs lacking their own nests. Litvin & Syroechkovsky (1984) described in detail the behaviour of a pair observed doing so, in which they stated that geese did not necessarily lay eggs directly into a nest. Because incubating females will draw eggs into their own nests when situated < 1 m from the edge of their nests, eggs laid in close proximity have a chance of being manoeuvred into the nest (Syroechkovski 2016), because of the female's innate behaviour of egg retrieval (Lorenz & Tinbergen 1938). Limited nesting space was considered the reason for Blue Lesser Snow

Figure 3. An example of a Greylag Goose egg dump found in the reeds on the island at Lake Hieve, Landkreis Aurich, Lower Saxony, Germany on 6 June 2012. Photograph by H. Kruckenberg.

Geese in Canada dumping eggs (Prevett *et al.* 1972) and on Kolguev Island in the Barents Sea inter-specific egg-dumping was also considered the result of exceptionally high local densities of arctic-nesting geese (Kruckenberg *et al.* 2008; Kondratyev *et al.* 2013). Hence, one potential mechanism to explain the extreme degree of egg-dumping reported here is that these are accumulations of eggs that have been laid by females unable to secure a nest site, as a secondary reproductive strategy, in the hope of "retrieval" behaviour by incubating females incorporating eggs into their clutch. The large numbers of unhatched eggs in some nests suggests either that this happened but with the higher number of eggs perhaps provoking the female to desert the clutch, or alternatively egg-dumping in nests may have taken place after the abandonment of a nest, or both these events may have occurred. The restricted space for nesting could also have driven subdominant females to lay their eggs somewhere on the island. Detailed behavioural observations would be required to test these hypotheses.

Explanation of egg-dumping

Egg-dumping (laying eggs in the nest of other birds) is well described amongst waterbirds, mainly in the context of nest parasitism (Weller 1959), with the Black headed Duck *Heteronetta atricapilla* the only obligate parasite among wildfowl (Rees & Hillgarth 1984). Most studies of egg-dumping have been concerned with assessing

the costs and benefits associated with brood parasitism, their fitness consequences and the potential to increase individual reproductive output (Weller 1959; Sorensen 1991; Andersson 2001). Brood parasitism occurs when a female deliberately lays her eggs in the nest of other individuals that subsequently care for the brood (Kear 2005). Forslund & Larsson (1995) found intraspecific nest parasitism several times in Barnacle Geese *Branta leucopsis* on Gotland, Sweden, with parasitic females (lacking their own nests) laying eggs in nests of other females before, during and after the onset of incubation, concluding such females were adopting a facultative "best of a bad job" strategy. Nest parasitism was also found in Greylag Geese in the population at the Konrad Lorenz Institute Seewiesen (Bavaria, Germany) to increase individual fitness (Schreiber *et al.* 2013). Pienkowski & Evans (1982) predicted that Common Shelduck *Tadorna tadorna* females may dump eggs in the nests of others because of poor body condition, early nest loss, or high competition for a restricted number of suitable nest sites, increasing the number of her own eggs incubated or spreading potential predation risk to increase individual fitness. This hypothesis is supported by observations made by Lank *et al.* (1989), who found increasing egg-dumping in Lesser Snow Geese when the availability of nest sites was restricted by late snow-melt on the breeding grounds.

Nest site density in the region as a whole and nest site limitation

Greylag Geese became extinct in Lower Saxony during the late Middle Ages, as a result of human persecution, melioration of rivers and drainage of wetlands (Krüger *et al.* 2014; Kruckenberg 2019). Since their reintroduction to Lower Saxony and North-Rhine Westfalia in Germany, and also to the Netherlands in the 1970s and 1980s, Greylag Geese have increasingly spread into their former distribution range in northern Germany (Kruckenberg 2019). The area of Lake Großes Meer was one of the first release areas in 1982 and Greylag Geese were quickly re-established successfully there. After a period of confinement to the original release areas during the 1980s, the geese have subsequently started to expand their range. Availability of suitable nest sites can limit local breeding populations (Newton 1998) and breeding Greylag Geese prefer nesting on islands, although they will nest in reedbeds or in high vegetation far from water bodies to avoid predators (Kampe-Persson 2002). In this study area, reedbeds are harvested regularly for traditional roofing thatch. Kristiansen (1998) showed that Greylag Geese prefer reedbeds harvested five or more years ago; hence reedbed age, as well as the accessibility for ground predators such as the Red Fox *Vulpes vulpes*, Racoon Dog *Nyctereutes procyonoides* or Wild Boar *Sus srofa* may explain the attractiveness of the small island 50–60 m offshore. The extremely low densities of nesting Greylag Geese found throughout the rest of the entire survey area suggest that the island represents highly desirable nesting habitat, which supports this theory.

Meanwhile, the situation in the study area has changed; in 2014 a pair of White-tailed Eagle *Haliaetus albicilla* has started to nest in the area. At the same time, the island was

reduced to *c.* 60% of its former size by waves and storms. This may explain why, during another aerial monitoring flight in 2016 and visits in 2017 and 2019, we found a substantial decrease in the number of nests on the island (2016: 130 nests, 2017: 126 nests, 2019: 64 nests) and many more nests in other parts of the study area. Egg dumps like those described above were found in 2017 on a much smaller scale (one with 35 eggs) and did not occur at all in 2019.

Problems associated with high goose nesting densities

Whereas most grey geese *Anser* sp. nest at low densities, Greylag Geese nesting in colonies are known to occur at several sites across the breeding range (Kampe-Persson 2002). In such colonies, pair density can be high, but this causes elevated levels of intraspecific aggression. Such aggression causes interactions between incubating birds, which in turn can cause disruption and displacement of eggs lost out of nests as well as egg breakage (Hudec & Rooth 1995; Kear 2005), an effect that increases with decreasing distance to nearest neighbours in Canada Geese *Branta canadensis* (Lebeuf & Giroux 2014). Hence, loss of eggs from nests and dumping of eggs close to nests may be the cause of the large numbers of solitary Greylag Goose eggs found lying around across the island. Elevated levels of dump clutching within nests may also result in eggs being lost from clutches so large that females cannot adequately cover numerous eggs and incubate them, resulting in females deserting large clutches (Syroechkovski 2016). Both were found here: a high percentage of abandoned clutches as well as over-sized clutch which were deserted by females. This indicates a process of interspecific natural population limitation.

Concluding comments

It therefore seems likely that limited access to nesting sites in the entire area of Lake Großes Meer and Hieve makes the island highly attractive to nesting Greylag Goose females, but that the unusually high density of females results in the levels of egg loss and egg-dumping observed. Reedbeds aged 4–5 years are the most suitable nesting places for Greylag Geese (Kristensen 1998), but these are rare due to reed harvesting, so the island represents an area safe from ground predators which is highly attractive and in great demand. Subdominant or late-nesting females likely fail to acquire their own nest sites because of the high density of established pairs nesting at the site, with the result that they parasitically lay their eggs in nests or adjacent to nests as the optimal reproductive strategy in such a situation. Given the general lack of other safe nest sites throughout the study area and the high nesting densities on the island, it seems likely that this limitation on nesting success amongst a potentially reproductive element could contribute to limiting the size of this particular Greylag Goose population. This mechanism can be interpreted as one extreme mechanism whereby breeding density is reducing growth rates for a population that has reached its local carrying capacity.

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Photograph: Greylag Geese on their breeding island at Lake Hieve, 9 May 2017, by H. Kruckenberg.

