

Does every goose count?

Pitfalls of surveying breeding geese in urban areas

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Abstract

The size of local breeding populations of Greylag Geese *Anser anser* and Canada Geese *Branta canadensis* at a suburban site in Northrhine-Westphalia, Germany, was assessed between 2010 and 2012 using four different methods: nest surveys, counts of territorial pairs and two types of brood counts. For both species, nest surveys generated the highest estimate of breeding numbers. Geese recorded as territorial pairs made up 50–75% of the apparent nesting pairs (73% of all nesting Greylag Geese and 60% of all nesting Canada Geese in an area surveyed extensively in 2011). Numbers of broods recorded never exceeded 50% of the number of apparent nesting pairs. Moreover, the number of broods observed was heavily dependent on fieldwork intensity, with most broods found during highly frequent (twice-weekly) counts that allowed effective monitoring of the fate of individual broods, even without using individual marking. When broods are monitored less frequently, one has to rely on the maximum number of broods observed simultaneously in determining the number of pairs with young, which in our study represented only 10–25% of the apparent nesting number. Although nest counts may provide the highest estimate of breeding goose abundance, they may be impractical or undesirable (e.g. because of disturbance to other breeding birds). In such cases, territorial pair assessments may be the preferred method, if separation of breeding and non-breeding birds is not made too conservatively. For instance, only those birds that obviously behave as non-breeders, by leaving the nesting areas to feed on nearby agricultural fields during daytime, should be excluded from breeding numbers. Although counts of the total number of broods can contribute to measures of reproductive success, they can considerably underestimate the number of goose breeding pairs.

Key words: breeding bird census, brood counts, Canada Goose, Greylag Goose, nest counts.

In recent decades, numbers of breeding geese, notably Greylag Goose *Anser anser*, have shown exponential increases at many sites throughout central and northwest Europe. In addition, introduced species such as the Canada Goose *Branta canadensis* and Egyptian Goose *Alopochen aegyptiaca* have increased their breeding range and established thriving breeding populations in many regions (Allan *et al.* 1995; Madsen *et al.* 1999; Blair *et al.* 2000; Geiter *et al.* 2002; Rowell *et al.* 2004; Kampp & Preuss 2005; van der Jeugd *et al.* 2006; Austin *et al.* 2007; Fox *et al.* 2010; Kowarik 2010; Rehfishch *et al.* 2010; Gyimesi & Lensink 2012). These species not only favour natural breeding habitat, but may also occur in high breeding densities in urban and suburban areas such as parks and sand pits or gravel pits (Wright & Giles 1988; Rowell *et al.* 2004; Kampp & Preuss 2005; Havekes & Hoogkamer 2008). Such high goose densities may conflict with recreational use of parks (especially by fouling of park lawns by droppings) and cause damage to agricultural fields (Allan *et al.* 1995; van der Jeugd *et al.* 2006; Rehfishch *et al.* 2010). Hence, measures to prevent geese from feeding in parks and reduce grazing damage have been discussed and adopted at several sites (Wright & Phillips 1991; Baker *et al.* 1993; Allan *et al.* 1995; van der Jeugd *et al.* 2006; Voslamber 2010).

Knowledge of actual numbers of breeding geese is an important prerequisite for the appropriate design, implementation and monitoring of management measures introduced to reduce such conflicts successfully. However, surveying breeding geese is not error-free and Greylag Geese are particularly regarded as one of the more

difficult species to count effectively, as they often breed in poorly accessible areas and local numbers include a varying proportion of non-breeders (Voslamber *et al.* 2000). Hence, several censuses of breeding geese have focused on a survey of moulting sites, giving an overview of total population size, rather than assess the number of breeding pairs (Rowell *et al.* 2004; Austin *et al.* 2007). In this paper, we report on the comparative results of breeding bird censuses using different methods, applied in urban and suburban areas of Duisburg, Germany, as part of a population management project there relating to (reintroduced) Greylag and Canada Goose populations during 2010–2012. Our aim is to review the different methods commonly used in breeding bird surveys (Gedeon *et al.* 2004; Südbeck *et al.* 2005; van Dijk & Boele 2011), and to discuss their applicability in relation to their accuracy and practical implementation for ordinary field observers.

Methods

Study area

Censuses of breeding geese were conducted at three sites in a suburban area on the western fringe of the Rhein-Ruhr district, in the municipality of Duisburg (Northrhine-Westphalia, Germany). The study sites comprised Lake Uettelsheim, Lake Toepper, and a complex of Six Lakes at Duisburg-Wedau (Fig. 1). All lakes were created from sand or gravel extraction, but are now mainly used for recreational purposes. At all three sites, conflicts with recreational activities occur, because of flocks of geese fouling lawns and playgrounds with droppings, and therefore being considered

as a nuisance by the public. Nesting sites of geese were all located on small wooded islands (1–4 islands per site), ranging in total size from 0.6–4.2 ha at each site. On the islands, geese breed in colonies, sometimes concealed in dense vegetation of Common Bracken *Pteridium aquilinum* or Blackberries *Rubus fruticosus*. As soon as the young have hatched, broods move to the lawns around the lake shores to feed and remain there until they fledge. Two of the three study

sites are rather isolated and not likely to receive geese with broods from other breeding areas (Fig. 1). Only at Lake Toepper was immigration from nearby lakes likely (and was suspected during the study).

Nest surveys and population control measures

Since 2010, all goose populations breeding at the study sites have been subject to population control measures by the Forestry

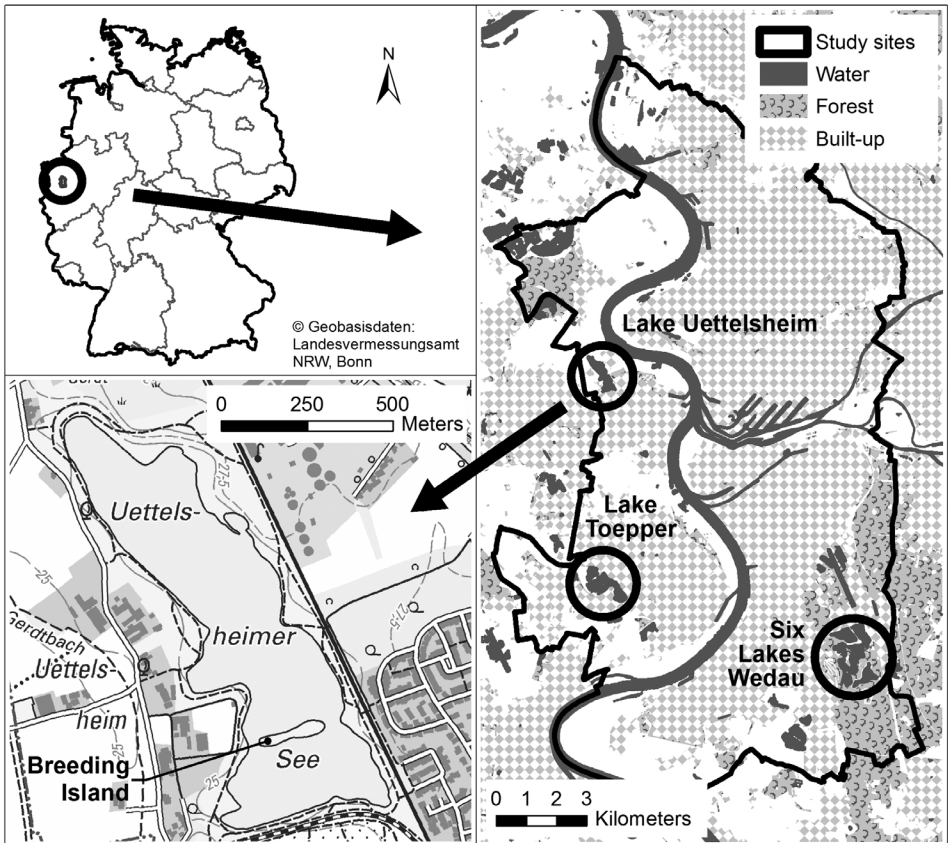


Figure 1. Map of the sites where Greylag Geese and Canada Geese were studied in 2010–12. The location of Duisburg, Germany, and the three study sites within Duisburg is illustrated, together with a more detailed plan of the main site at Lake Uettelsheim.

and Hunting Service from the city of Duisburg (Stadt Duisburg 2011, 2012). These measures aimed to reduce the number of eggs to two per clutch, in order to reduce clutch size without affecting the number of nesting pairs. Island nest sites were visited 2–3 times during March–April to search for active nests; *i.e.*, nests with clutches or freshly-hatched eggs. During each visit, Greylag and Canada Goose nests were marked and counted, and clutches reduced to two eggs. The nesting pair was usually found (and species identified) on flushing the incubating bird from the nest; sometimes by observing its partner defending the nest. The total number of nests was derived from successive visits to the colony. Empty nests were regarded as being hatched successfully; new nests recorded during successive visits were counted as being recently settled by new pairs. It was assumed that where clutches had been reduced, the pairs stayed on the same nest (B. Voslamber, pers. comm.). In some cases, as in Lake Uettelsheim in 2011, the total number of active nests of Greylag Geese and Canada Geese coincided with the maximum number of nests found on a single survey day.

Goose counts

In order to monitor goose numbers and breeding success, a small research project was initiated by the Biologische Station Westliches Ruhrgebiet (Biologische Station Westliches Ruhrgebiet 2011, 2012; Keil *et al.* 2012). Goose counts were conducted at the three study sites during the breeding seasons of 2010–2012, from March–July inclusive. The most comprehensive data were collected in 2011, with three counts each in

March, June and July and twice-weekly counts during the early stages of the gosling-rearing period in April and May. In 2010, counts started from early May onwards, but thereafter followed a similar pattern to 2011 with twice-weekly counts in May, and three counts per month in June and July. In 2012, a total of 10 counts were carried out from March–July (twice a month). During the incubation period (in March), observation frequency was similar to that of 2011, but observations were less frequent during the early gosling-rearing period. All counts were carried out from lake shores, using a 20–60× spotting scope and 8–10× binoculars. Geese on the lake and feeding on the surrounding lawns were all counted, and their status (*i.e.* the number of solitary birds, guarding males, and pairs with or without a brood) was recorded. One count took about 1–3 hours, depending on the size of the survey site. During the gosling-rearing period, broods were monitored by assessing the number and age of goslings (the latter with help of photographs, which illustrated gosling size for different age categories).

Interpretation of observations

Numbers of territorial pairs were determined until mid-April, by summing the number of pairs observed (including those with a nest, if visible from the bank of the lake) and the number of guarding males around the breeding island during a survey day. Only solitary birds close to the breeding island were recorded as guarding males. Single birds and loose gatherings of geese at larger distances elsewhere on the lake or the banks of the lake were assumed to be non-breeders,

as proposed in the German breeding bird census manual (Südbeck *et al.* 2005).

The number of successful breeding pairs was assessed by frequent monitoring of broods, recording the number of broods with goslings of different ages (indicated by their size) present on each occasion. Due to high count frequency, the fate of the broods within the study area could be assessed quite reliably without marking them, because broods recorded in previous counts could be distinguished by their size from new, recently hatched broods (but see Discussion). Also, when broods were missed during one visit (which occurred twice for the Canada Geese) they were quickly relocated during subsequent visits.

Methods and observation effort were similar in all three study areas. However, the surveys were subject to some practical problems, which occurred to differing extents both during the different years of the study and at the different study sites. For instance, nest counts at Lake Toepper were regarded as incomplete because one small breeding island was totally inaccessible. In 2012, nest counts at Lake Toepper and Six Lakes were unavoidably carried out too early, which led to an incomplete nest count of Canada Geese. At Lake Toepper, it was presumed that exchange of broods with nearby breeding sites took place, making an accurate analysis of the fate of single broods difficult. Hence, our results focus on the dataset from Lake Uettelsheim, where such problems did not occur and which was surveyed extensively in 2011. Data from 2012 and the other two study sites are presented to put the results of Lake Uettelsheim 2011 in a broader context. Data from 2010 were too

incomplete to enable a good comparison of the study methods.

Results

General results

Breeding Canada Geese and Greylag Geese occurred at all the three study sites in each year. Total numbers of breeding birds and the ratios of Canada Geese to Greylag Geese differed considerably between the sites, although they were rather stable (with a slight decline in Canada Geese) within each site over the 2010–2012 study period (Fig. 2). At Lake Toepper and Lake Uettelsheim, the Greylag Goose was the most abundant species; at the Six Lakes in Duisburg-Wedau the breeding population was dominated by Canada Geese. Egg laying by Greylags started by the end of February or early March, with eggs being laid well into April. Hatching was observed from the end of March onwards and most goslings fledged in June. Canada Goose breeding phenology followed about one month later, with laying starting in the second half of March and replacement clutches being found well into May. First broods were observed by the end of April and these fledged in July. Over the 3-year study, the number of breeding Greylag Geese at a single lake ranged from 15–42 pairs, compared with 6–40 breeding pairs per lake recorded for Canada Geese, both based on territory assessments (Fig. 2).

Greylag Goose

Breeding phenology at Lake Uettelsheim in 2011

At the start of the breeding season, in March, pairs were mainly observed at the

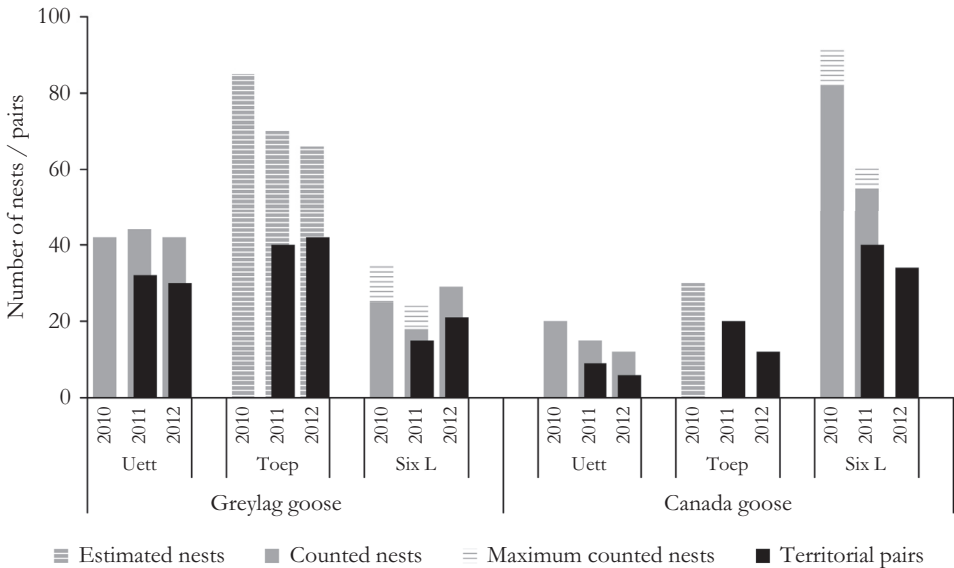


Figure 2. Numbers of nests and territorial pairs of Greylag Geese and Canada Geese at the three study sites in 2010–2012. Estimated nests are an estimate of the number of nests in the study area due to incomplete nest counts. Maximum counted nests are nests where species assignment was not possible (*i.e.* they may be either Greylag Goose or Canada Goose nests). When no bar is depicted, data are missing. Uett = Lake Uettelsheim, Toep = Lake Toepper, Six L = Six Lakes Wedau.

lake or breeding on the island (*i.e.* those visible from the bank of the lake), along with guarding individuals close to the breeding island (Fig. 3). The first goslings appeared on 4 April. The number of goslings counted increased until mid-April but gradually declined thereafter. The number of parents observed with broods showed a similar pattern, with a decline caused both by a total loss of broods and adoption of broods by other pairs. Nearly all adult birds that were not accompanied by a brood left the lake by the end of April or beginning of May, including those classified earlier (from their behaviour) as being non-breeders. Between mid-May and the beginning of June, an influx of birds was

observed, that came into the area to moult. At least part of the moulting flock probably consisted of unsuccessful breeding birds from the study site, as indicated by repeated observations of a neck-banded bird that had been recorded as a guarding male on the breeding island. The broods all fledged in June, and left the area immediately thereafter. Occasionally, pairs and fledged young returned to the breeding area in July. Since the number of fledged young counted on 10 July was higher than those regularly observed at Lake Uettelsheim during the gosling-rearing period (Fig. 3), we suspect that these flocks also constituted breeding pairs and offspring from other sites.

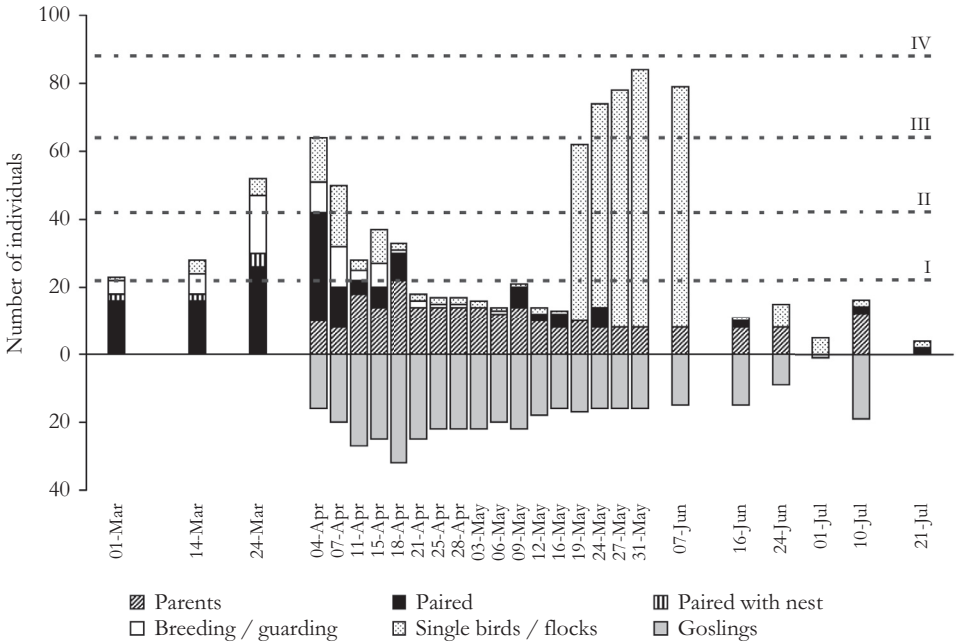


Figure 3. Phenology of numbers of Greylag Geese counted at Lake Uettelsheim, Duisburg, in 2011, separated according to status and age-groups. Numbers below the x-axis refer to the total numbers of goslings (including fledged young) counted. Also given is the size of the breeding population (expressed as the number of apparently paired individuals), derived from four different methods: I number of broods observed simultaneously, II total number of broods when taking age-differences of broods into account, III territorial pairs and IV number of nests found (see text for further explanation).

Numbers breeding at Lake Uettelsheim in 2011

During a visit to the breeding island of Lake Uettelsheim on 28 March, 44 active nests were found, indicating a breeding population of 88 adult individuals (method IV in Fig. 3). In some nests, large clutches of up to 16 eggs implied egg-dumping by several females, suggesting that even more individuals were reproductively active locally than the 44 nests alone would imply. On using all observations that indicated breeding to assess territory occupancy, 32 territorial pairs were found to be present on 24 March

(i.e. 64 adult individuals, method III in Fig. 3), consisting of 13 pairs, two pairs with an observed nest and 17 guarding males around the breeding island. These territorial pairs represented 73% of the apparent nesting pairs recorded. An estimated 21 pairs (42 adults) were seen with a brood during the detailed monitoring of the fate of individual broods in April–May (method II in Fig. 3). Hence, only 48% of the apparent nesting pairs were seen with goslings. If only the maximum number of successful families seen at once was considered, the numbers breeding would have been estimated at only

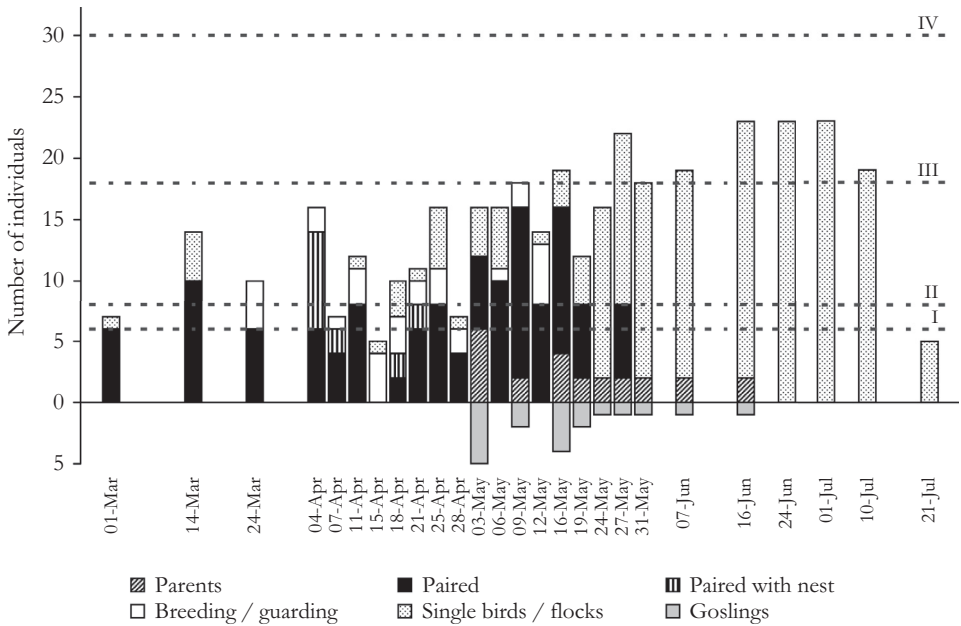


Figure 4. Phenology of numbers of Canada Geese counted at Lake Uettelsheim, Duisburg, in 2011, separated according to status and age-groups. Numbers below the x-axis refer to the total numbers of goslings counted. Also given is the size of the breeding population (expressed as the number of apparently paired individuals), derived from four different methods: I number of broods observed simultaneously, II total number of broods when taking age-differences of broods into account, III territorial pairs and IV number of nests found (see text for further explanation).

11 pairs (*i.e.* 22 individuals with broods, method I in Fig 3), observed on 18 April. This constitutes only 25% of the apparent number of nesting pairs.

Numbers breeding at other study sites and in 2012

Data from 2012 and from the other two breeding sites gave similar results, with the number of territorial pairs recorded during the spring counts being 60–75% of the number of nesting pairs estimated from counts during nest visits. The number of pairs accompanied with broods at the other sites in 2011 represented at least 30% (20% when only broods recorded simultaneously

were taken into account) of the number of nests. In 2012, much lower numbers of broods were recorded during the less frequent (once every two weeks) surveys: 10–25% of the estimated number of nesting pairs were found to have broods on following individual families over several count days; 10–13% when considering only broods observed simultaneously.

Canada Goose

Breeding phenology at Lake Uettelsheim in 2011

Up to mid-March, Canada Geese were only observed as pairs or single individuals at Lake Uettelsheim (Fig. 4). From the end of

March onwards, guarding males were seen around the breeding island, and in April incubating females were also observed from the banks of the lake. The first goslings appeared in the first days of May. On 6 and 12 May, no broods could be found, but during later visits these broods were identified by their age and plumage characteristics. Only one gosling reached the age of six weeks, and then disappeared. Fledging success therefore was apparently zero. Few Canada Geese were classified as non-breeders during the surveys, and these congregated with the unsuccessful breeding pairs during May. In contrast to Greylags, all Canada Geese stayed around the breeding site after losing their broods. A marked immigration of birds during moult (observed for Greylag Geese at the site) was not recorded for the Canada Geese.

Numbers breeding at Lake Uettelsheim in 2011

A nest count on 11 April found 15 active nests on the island, indicating 30 breeding adults (method IV in Fig. 4). Some of the nesting Canada Geese had taken over old Greylag nests after their eggs had hatched. Territorial behaviour (including guarding males), suggested nine territorial Canada Geese pairs at Lake Uettelsheim (*i.e.* 18 adult individuals; method III in Fig. 4), based on a count of three pairs, four pairs with a nest and two guarding males around the breeding island on 4 April, *i.e.* 60% of the apparent nesting pairs. Only three pairs (*i.e.* six adult individuals) were observed simultaneously with goslings on 3 May (method I in Fig. 4). One more pair with recently hatched goslings was seen on 16 May, suggesting four pairs with goslings in total (Method II

in Fig. 4). Thus 26% of the number of apparent nesting pairs was recorded with young (20% when using only the maximum number of broods).

Numbers breeding at other study sites and in 2012

At the two other study sites in 2011 and Lake Uettelsheim in 2012, 50–75% of all apparent nesting pairs were assessed as holding territories. In 2011, up to 40% of them were seen with broods (up to 25% when only broods observed simultaneously were taken into account). Data from 2012 from the other two study sites were insufficient as nest counts of Canada Geese were regarded as incomplete.

Discussion

Pitfalls of the different survey methods

Despite their size, appearance and conspicuousness, surveying breeding geese is a challenge and recommending the most suitable method has not been made easier by the fact that, historically, this has been carried out using different methods, or a combination of methods. The data presented here showed radically different results obtained using different methods which make comparisons between sites or between years very difficult based on different methods. Unfortunately, each of the methods has its own drawbacks and their application will also depend on site-specific and practical issues. Use of individually marked birds would greatly improve possibilities to assess the size of a local breeding population and movements of broods (Nilsson & Persson 2001; Kampp & Preuss 2005), but is not possible

at a larger scale and is often not an option for volunteer counters. Here, we discuss the problems and advantages of each counting method that does not rely on marking, and compare guidelines from census manuals and other methods that aim to assess population size in breeding geese.

Nest counts

In the study area in Duisburg, nest counts produced the highest assessments of the size of the local breeding population. This was likely the result of the physical limitations imposed on the birds to breed on an accessible and small breeding island. Hence, nearly all potential nesting habitat could be searched effectively for nests, and nest identification was easy by visual observation of the owner of the nest. However, without a boat, and without permission to access such islands (in case of protected areas), a nest survey would already be much more difficult, especially for volunteer counters. Moreover, in marsh areas with vast reed beds, nest surveys will often be impossible and might pose an important source of disturbance to other reed-breeding birds (especially when done repeatedly during one breeding season), as has been shown in the Netherlands (Schekkerman *et al.* 2000; van der Jeugd *et al.* 2006). Furthermore, dump clutching and an unknown number of nests that are predated before being found, may further confound nest censuses and underestimate the number of actively reproducing pairs. In our study area, the nest site limitation resulted in Canada Geese using nests of Greylag Geese after hatching. Hence, identification of nests by using downy feathers, as proposed by

Ferguson-Lees *et al.* (2011), would have been difficult. The fact that multiple nest use by two species with different breeding phenology has occurred also implies that in mixed breeding populations, repeated nest counts should be carried out, including marking of all nests found for both species.

Territorial pairs

When combining the results of all three study sites, the assessment of territorial birds revealed for Greylag Goose 60–75% of the apparently nesting population, and for Canada Goose 50–75%. Thus assessment of territories is likely to underestimate the size of the local breeding population. Usually, a survey of territorial pairs in March and April is recommended (Gedeon *et al.* 2004 (for Greylags); Südbeck *et al.* 2005; van Dijk & Boele 2011). However, a major source of bias in such a survey is that all birds present in the study area must be distinguished as breeders or non-breeders. Single pairs showing territorial behaviour or males with obvious guarding behaviour around a nest site can easily be assigned to the breeding population. With single birds or small flocks that do not show any territorial or alert behaviour, this will be more difficult. According to Voslamber *et al.* (2000), non-breeding Greylag Geese often feed in flocks on agricultural fields around the breeding area, before leaving the area for moulting sites from May onwards. They proposed to take into account all birds around the direct nesting site for an assessment of territorial pairs, and exclude only those birds that are obviously non-breeders, feeding in flocks on agricultural fields at larger distances from

the potential nesting site during daytime. It is not clear if our study area supported any non-breeding birds, as numbers observed were always much lower than the number of nesting pairs suggested. Indeed, if we had considered all single birds at Lake Uettelsheim on 4 April 2011 as breeders, this would have resulted in 43 territorial pairs (constituting 5 pairs with a brood, 16 pairs without a brood and 22 single birds that were presumably guarding males), in line with the number of active nests (44). This implies that our approach to distinguish breeders and non-breeders was perhaps too conservative. Such a conservative approach is also propagated by several manuals (Gedeon *et al.* 2004; Südbeck *et al.* 2005), that try to exclude as many geese as possible in the assessment of territories, by only taking into account clearly distinguishable pairs and obvious guarding males. This approach is likely to underestimate the local breeding population, as is shown in our study. On the other hand, Sovon (2013a) proposes to count all Greylag Geese present in the breeding area and divide the maximum number by 1.5, in areas where separation of breeding and non-breeding geese is impossible. Also this method would have resulted in 43 territorial pairs at Lake Uettelsheim in 2011, again matching with the number of apparent nesting pairs.

Usually, it is proposed to survey territories before breeding has started, often by the end of February or in March for Greylag Geese and in the end of March or April for Canada Geese (Voslamber *et al.* 2000; Südbeck *et al.* 2005; Sovon 2013a,b). This assumes, however, that breeding is

highly synchronised, which in our study and in some of the studies elsewhere (*e.g.* Lensink 1998) was not the case. Moreover, we observed that some geese in our study area arrived late and immediately started to nest. Hence, the timing of the survey should be adapted to the local situation and advancement of spring weather, preferably with multiple counts carried out during a short period before incubation starts, *e.g.* on 1 March, 16 March, 1 April and 16 April. Guidelines like those given for the German breeding bird atlas for Greylag Geese (Gedeon *et al.* 2004) and focusing on counts in April (in order to avoid confusion with migrants) are not recommended at most breeding sites, as breeding usually starts earlier than this and many birds will be breeding concealed in vegetation by this time and thus be overlooked during a survey.

Count of broods

When only successful breeders (*i.e.* the number of broods) were counted, only 25–50% of the breeding population would have been accounted for. However, this figure varied considerably with counting effort: more families were found when the area was checked more frequently. Even with a count frequency of once every two weeks, proper monitoring of broods is prone to largely underestimate the number of successful pairs, especially when carried out at larger breeding sites with many breeding pairs. When only the maximum number of broods seen at once was taken into account, as few as 10–25% of the apparent nesting pairs would have been recorded. This large underestimate occurred both amongst surveys of Greylag and Canada Geese.

Moreover, a count of broods only registers the successful element of the population that is subject to annual variation in nest or hatching success. Nevertheless, many surveys assume the number of broods to represent the breeding population (*e.g.* Geiter *et al.* 2002; Gedeon *et al.* 2004 for Canada Geese). Brood surveys are often favoured because they avoid the ambiguity about assigning geese as “breeding” or “non-breeding”. However, this method ignores the fact that nest success often does not exceed 50% (see next section), given that many pairs attempt to breed but are unsuccessful. Besides, only a proportion of family parties are detected when counting broods, especially when survey intensity is low or where only one count is carried out. In our study, where survey effort was high and the fate of individual broods could be followed, up to *c.* 50% of the Greylag Geese breeding locally were observed with broods. In Canada Geese this was slightly lower (up to 40%). Another source of bias is emigration or immigration of broods from nearby nesting sites (as we suspected at one of our study sites). Broods might wander considerable distances to suitable gosling-rearing areas, a source of error likely to increase through the course of a breeding season (Schekkerman *et al.* 2000). Without individual marking of the adults, such movements are not detectable and may further confound assessment of local breeding populations.

Comparison with other areas

In order to check whether the breeding strategy and the results of our analysis

were not site-specific but could also be applied to other regions, we compared the reproductive output of breeding geese in Duisburg with other studies of (re-)introduced goose populations. For this purpose the number of observed broods was used as a proxy for nest success, albeit it is likely that it is an underestimation as we did not carry out nest surveillance, as done in most of the studies cited below.

In areas without any population management, nest success was 63–69% in Greylag Geese and 66–69% in Canada Geese (Wright & Giles 1988; Buss 2004; Havekes & Hoogkamer 2008). At sites with high predation pressure or cattle trampling, nest success was lower, 26–53% in Greylag Geese (Kristiansen 1998) and 46% in Canada Geese (Johnson & Sibley 1993). Much lower rates of nest success were found on the island of Texel in the Netherlands, where extensive population management was carried out and only 5–31% of all Greylag nests were successful (Hondshorst & Voorbergen 2005). Fewer studies have used the number of broods as a proxy for nesting success, as we did in our study. Kampp & Preuss (2005) estimated an average nesting success of 60% for Greylag Geese in an urban population in Copenhagen, using the high density of marked birds in their local populations to monitor the breeding performance of individual breeding pairs. Lensink (1998), who used similar data as we did (also without ringing, but taking only territorial pairs and broods into account) recorded 18–68% successful pairs in Greylag Geese which is in line with the 15–40% in our

study if we would have used the number of territorial pairs as size of the local breeding population. Sorge (unpublished) made an intensive study of Greylag and Canada Geese in parks in Munich and found 10–40% of the territorial pairs in both species to be successful, falling to 0–14% in years with population management. All these studies show that nest success is highly variable between sites and years, and that our results fall around the average, neither extremely high, nor extremely low.

Conclusions

The result of our study show that censuses of breeding Greylag Geese and Canada Geese which use assessment of territories or counts of broods underestimates local nesting abundance. Nest counts on the other hand, provided the highest estimate for the local breeding population, but may not always be possible for practical reasons or not desirable for reasons of disturbance to other breeding birds. The underestimate by using indirect methods is especially pronounced when relying on counts of broods only. Without intensive fieldwork or marking of birds, the fate of individual broods cannot be monitored and the number of breeding birds is only a small fraction of the apparent nesting population. Assessment of territories is an alternative for nest counts, provided that one is not too conservative in separating breeding birds and non-breeding birds. Moreover, territory assessment should preferably be carried out during multiple visits before the main part of the population starts to incubate and remains concealed in vegetation (*i.e.* early in the breeding season).

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