Urban Greylag Geese *Anser anser* nesting on roofs in the city of Hamburg, northern Germany

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Abstract

Greylag Geese *Anser anser* usually nest on the ground, close to water. In Hamburg, northern Germany, a pair of urban Greylag Geese was first seen nesting on a roof terrace of a building, 25 m above ground level, in 2013. Since then, the number of breeding pairs showing this unusual behaviour has steadily increased to 21 pairs nesting on roofs in the city in 2024. Hatchlings appeared unable to leave leave these new nesting locations on their own and required human intervention to reach ground level. This type of nesting behaviour now seems to have become established in Hamburg's Greylag Geese. As far as we know, there have been no previous reports of this behaviour in other towns or cities, and it therefore represents a new aspect in the species' urban ecology.

Key words: ecological trap, female philopatry, hatchling survival, nest.

Several goose species nest in exceptionally high places, such as on cliffs, steep slopes and in trees, from which the newly-hatched goslings make a spectacular jump of 20 m or more to the ground (*e.g.* Mitchell *et al.* 1998). In the wild, nesting in high places has been reported for species such as the Barnacle Goose *Branta leucopsis* (Owen 1980; Prestrud *et al.* 1989; Mitchell *et al.* 1998), Pink-footed Goose *Anser brachyrhynchos* (Glutz von Blotzheim 1990) and Canada Goose *Branta canadensis* (Nelson 1953; Lebada & Ratti 1983; McKey *et al.* 1988; Armstrong *et al.* 2017). Greylag Geese have however only occasionally been seen nesting in high trees, with such cases noted in the Czech Republic (Horák 1999; Horal & Heralt 2012; Horák 1999), England (Coath 2006) and the Netherlands (Kleefstra & Bles 2000). Usually, both *Anser* and *Branta* goose species choose nest sites close to the water at ground level, ideally out of reach of terrestrial predators, which in the wild is achieved mainly by breeding on islands or in reed beds (Hart & Downs 2020; Groom *et al.* 2020). Although some Greylag Geese have also been seen nesting on slightly elevated structures such as pollarded willows (Osiejuk & Kuczyński 2007), as well as on small sheds, garages, in planters or an unused Grey Heron *Ardea cinerea* nest (S. Hinrichs & F. Woog, pers. obs.) and the thatched roof of a boathouse (Hölzinger *et al.* 2004).

Nesting on buildings has been reported for urban Canada Geese in North America (Armstrong *et al.* 2017; Shearer *et al.* 2022; Askren 2021), but Greylag Geese nesting on high buildings in an urban setting appears not to have been previously documented. The study presented here therefore aims to describe the development of this behaviour in the city of Hamburg, northern Germany, over a 12-year period (2013–2024), with information provided on the location of the nest (including height above ground), along with an assessment of how the breeding success of roof-nesting pairs may have changed within that period. Finally, we discuss the ecological advantages and disadvantages that geese may have from nesting in high places are discussed.

Methods

Study population

The establishment of Greylag Geese in the urban area of Hamburg, northern Germany, dates back to reintroductions from waterfowl collections which started in 1954 (Nieß 1967) and continued until the 1980s (Hoff 2005; Kreutzkamp 1996). Breeding habitats were found mainly on lakes with islands, rainwater retention basins, the Alster Canal, and later also on parts of the Outer Alster. Between 1990 and 2002, the number of successful breeding pairs in the entire city of Hamburg was reported as having increased from 23 in 1990 to 83 in 2001 (Kreutzkamp 2003). More recently, since 2006, collection of data on the geese has concentrated on those within a smaller "core" study area of *c.* 120 km^2, in a part of Hamburg, located north of the Elbe and south of the airport (Supporting Materials Fig. S1). Within this area, the geese use numerous parks and water bodies that serve as nesting, roosting, feeding and moulting sites.

Data collection

Each year since 2006, geese in Hamburg have been caught when flightless during moult and fitted with a metal ring (issued by the Vogelwarte Helgoland) on one leg, with a blue plastic ring engraved with an alphanumeric code fitted to the other, to allow the identification of individual birds. In 2024, around half of the Greylag Goose population in Hamburg and > 70% of breeding pairs in the core area were individually marked. Ring numbers of key individuals are reported here as "metal ring, blue colour ring" (*e.g.* "272779, X12"). Goose counts and ring readings were carried out in the core area each week from 2006 onwards. During the breeding season, between March and June, visits were increased to 2–3 per week in order to detect breeding birds, their nests and freshly hatched goslings. In addition, searches for nests were made along the inner-city Alster River and the adjacent canals by canoe.

Whenever Greylag Geese were spotted on roofs, the rooftops were searched for nests. Most nest discoveries were made by people on whose rooftops or terraces the geese were nesting. These reports, sent to the NGO Neuntöter e.V. (Association for Research and Diversity, Hamburg) were extremely important because nests on roofs were not always visible from below. The interest for roof nests was also communicated to the city council and to the local community via the press. In subsequent years, known nesting sites were checked, as many goose pairs returned to their established nesting location. It is possible that some nests on rooftops were overlooked, especially if they were unsuccessful. It can be assumed that goslings hatched on roofs will not survive without human intervention for two reasons: Firstly, if they cannot jump due to physical barriers around the roof terraces, they become prey to Carrion Crows *Corvus corone corone*, or they starve or die of thirst. Secondly, if they jump themselves, either they do not survive the jump due to the physical impact or they become victims of crows in the process of jumping or shortly after landing. Therefore, when the goslings hatched, they were rescued by the NGO Neuntöter. In the process, one parent, usually the female, was caught by hand to keep with the goslings during translocation. In most cases, male partners were known from resightings, and the female and gosling(s) were released in proximity to the male so that the family could be reunited. This proved to be important, because single parental females were often attacked by other geese (S. Hinrichs, pers. obs.).

Data analysis

All data analyses were conducted in R 4.5.0 (R Core Team 2025) using RStudio 2025.9.0.387 (Posit Team 2025). For data manipulation and reshaping the packages reshape2 (Wickham 2007), plyr (Wickham 2011), dplyr (Wickham *et al.* 2023) and tidyr (Wickham *et al.* 2024) were used. Figures were created and arranged with the packages ggplot2 (Wickham 2016), grid (R Core Team 2025) and gridExtra (Auguie 2017).

Two measures of breeding success recorded over the 12 years of the study were assessed. First, success was defined at the brood level for all broods, including those with no goslings. Each brood in which at least one gosling survived to post-fledging was classified as successful, otherwise it was classified as failed. This binary variable ($1 = \geq 1$ fledgling, $0 =$ none) was taken as the response variable in a mixed effects logistic regression, formulated as a binomial generalized linear mixed model (GLMM) with a logit link, which was fitted using the package lme4 (Bates *et al.* 2015). To account for repeated broods from the same female, female identity (which was known for each brood) was added as a random intercept. The calendar year was mean-centred and used as the predictor variable to test for a temporal trend in the probability of brood success for each individual brood. Model outputs were tidied with the package broom (Robinson *et al.* 2025). As the dataset was small, multiple model diagnostics and robustness checks were conducted to assess adequacy and stability. Simulation based residual diagnostics were performed using the package DHARMa (Hartig 2024) to check for dispersion, zero inflation and overall fit. Inference was based on the binomial likelihood and not on transformed proportions. Numerical stability was verified by checking the convergence after refitting the model with a panel of optimisers and verifying that fixed effect estimates and s.e.

value. Fledging success was analysed with a second binomial GLMM with a logit link, mean-centred year as the fixed effect and female identity as a random intercept. In this case, only the broods with at least one gosling were considered. The response variable was taken as the number of rescued goslings presumed to have survived to post-fledging compared to the number that did not survive to post-fledging. In one brood, the number of fledglings, which exceeded the number of goslings, were truncated to the number of goslings. The same parameters and *post-hoc* tests as for the previous GLMM were performed to assess model adequacy and robustness. For descriptive visualisation, yearly fledging success was also plotted as the proportion of rescued goslings presumed to have survived to post-fledging with Wilson 95% binomial confidence intervals (CIs) calculated using the package binom (Dorai Raj 2022).

Summaries for each nest height of the number of broods and the proportion of successful broods (with Wilson 95% CIs) were also visualised and are presented for descriptive analysis.

Results

Growth in numbers and roof nesting activity

In the core Hamburg study area, the total number of successful breeding pairs with at least one (known) gosling increased from 75 in 2006 to 188 in 2017, and to 282 in 2024 (S. Hinrichs, unpubl. data). Within this area, the first Greylag Geese seen sitting on roofs, scanning their surroundings, were reported in 2008 and 2009. Some individuals spent a considerable amount of time in this new habitat. The first roof brood was discovered in 2013, in a small planter/flower box (*c.* 20 litres) on the seventh floor of a building, at a height of 25 m above Mühlenkamp street (in Hamburg-Winterhude), on the banks of the Osterbek Canal. The male was ringed when the nest was checked (272779, X12). On 6 April, the nest was still occupied, but on 16 April, the pair was seen elsewhere without offspring. The female partner was later ringed during moult in May (275519, 1T9). In 2014, although there was no evidence of breeding on a roof, the breeding pair from 2013 returned to their previous site but did not nest; the cause for this remains unclear. In 2015, the same pair bred in a flower box on a different roof terrace, at a height of 19 m, above the fifth floor of a building on Zimmerstraße (Hamburg-Uhlenhorst). The female abandoned the nest when hatching of the goslings was imminent and the brood failed.

In 2017, three broods were reported on roof terraces in Hamburg. Goose 277813 nested on a roof terrace at a height of 25 m, above the sixth floor (Lämmersieth, Hamburg-Barmbek) in a planter. On 10 April 2017, the newly hatched goslings and the parental female were translocated from the roof terrace to the Osterbek Canal, which is just 20 m from the building. The gander joined the family shortly after translocation. Another goose (277814) was breeding on a roof terrace in a larger planter above the fifth floor, at a height of 19 m (Forsmannstraße, Hamburg-Winterhude). On 11 April 2017, the newly hatched goslings and their parental female were translocated from the roof terrace to the nearby Goldbek

Canal. Again the parental male joined the family shortly thereafter. A third goose (277816, 22V) was breeding in a large planter on the fourth floor, at a height of 16 m (Emil-Janßen-Straße, Hamburg-Barmbek). On 22 April 2017, the newly hatched goslings and their parental female were translocated from the roof terrace to the Barmbek Canal where the gander was waiting for them. The latter pair was observed without goslings on 3 May 2017. From 2018 to 2024, new roof broods were recorded every year. Goslings and at least one accompanying parent from roof broods were continuously translocated and ringed by the first author. Ringed geese were usually re-sighted within the same season, so the fledging success of associating goslings could be determined.

Success of roof broods

Between 2013 and 2024, more than half of the roof broods failed (n = 53; Fig. 1). Failures were defined as broods with no

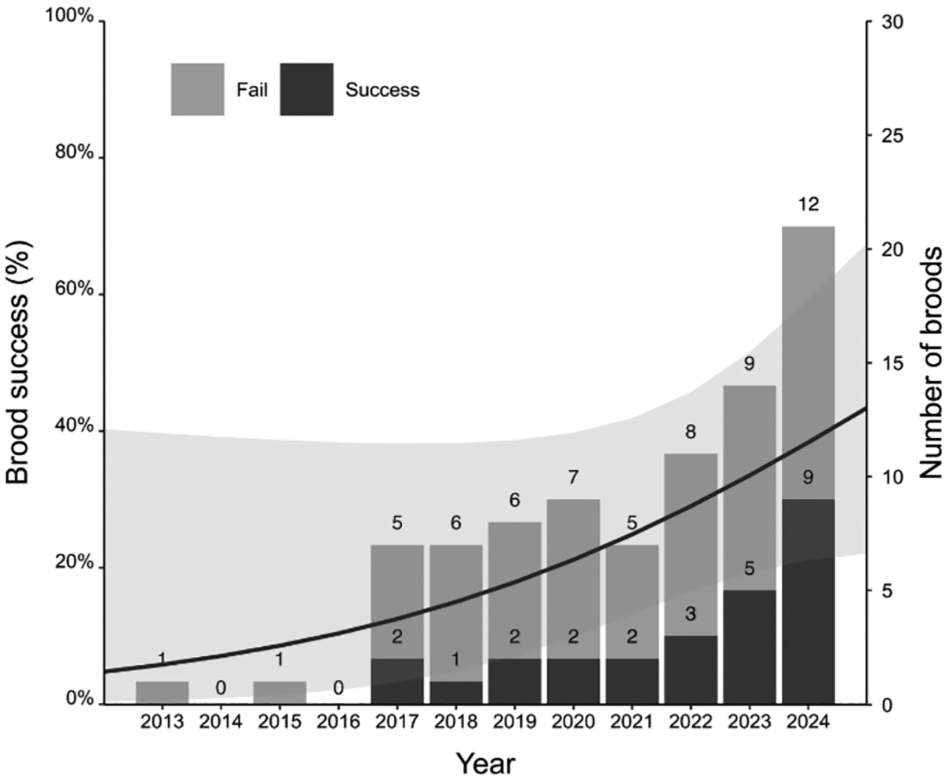

Figure 1. Brood success, defined as at least one gosling surviving to post-fledging per brood of Greylag Geese for all nesting attempts on roofs in Hamburg, 2013–2024. The line shows the modelled probability of brood success from the binomial GLMM, with the shaded area indicating 95% CIs. Stacked bars show the number of successful broods (dark grey) and failed broods (light grey), with numbers indicating the brood counts.

hatchlings rescued (*n* = 7), for example if the nest was abandoned at the egg stage (at least *n* = 3) or when one of the parents died (at least *n* = 2). Most failed broods were from broods in which none of the rescued goslings survived to post-fledging (*n* = 46).

The mean yearly breeding success, calculated by the GLMM, was 25.5% (logit intercept ± s.e. = −1.07 ± 0.39, $z = -2.75$, $P = 0.006$). The GLMM also indicated a positive but non-significant temporal trend in the probability of brood success ($\beta = 0.21$, s.e. = 0.13, OR = 1.23, 95% CI = 0.97–1.58, $z = 1.68$, $P = 0.09$), corresponding to an estimated 23% per year increase in the odds of brood success (Fig. 1). The likelihood ratio test, comparing the model with a null model, also indicated that the effect of the year was not significant ($\chi^2_1 = 3.37$, $P = 0.066$).

Fledging success, calculated with the second GLMM as the per-gosling probability of survival to post-fledging, was low overall, averaging at 5.7% per year over the study period (logit intercept ± s.e. = −2.80 ± 0.67, $z = -4.17$, $P < 0.001$, Fig. 2A). Survival probability increased significantly over time, with the odds of fledging success increasing by an estimated 36% per year ($\beta = 0.31$, s.e. = 0.13, OR = 1.36, 95% CI = 1.06–1.75, $z = 2.41$, $P = 0.016$, Fig. 2B). The likelihood ratio test confirmed that including year significantly improved the model fit ($\chi^2_1 = 6.8$, $P = 0.009$), and model checks showed neither over-dispersion ($P = 0.85$) nor zero inflation ($P = 0.75$), and the year effect was adequately described by a linear trend. Between-female variation was high ($\sigma = 2.30$), indicating substantial heterogeneity in fledging success of the goslings among breeding pairs.

Nest height

The roof terraces on which Greylag Geese bred in Hamburg were located between the 3rd floor and above the 7th floor of buildings, between 13–25 m off the ground (Figs. 3 & 4). In almost all cases the geese nested in planters of different shapes ranging from 20–60 litres or more, between various plants (usually large perennials or small shrubs) in the planters (Fig. 5 and Supporting Materials Fig. S2). Some also nested on flat roofs not used by people.

Discussion

Observations on roof nesting

Naturalised Greylag Geese in the city of Hamburg, northern Germany, were first recorded to nest on a roof terrace of a high building at a height of 25 m in 2013 and since then, this unusual nesting behaviour has become widely established. The yearly number of breeding pairs nesting on roofs has risen steadily to 21 in 2024. Roof-nesting by Greylag Geese appears not to have been previously documented. It has been reported for Canada Geese in urban areas in the USA such as in Indiana (Shearer *et al.* 2022), Chicago (Askren 2021) and in Calgary in Canada (T. Armstrong, pers. obs. in Armstrong *et al.* 2017). Roof nesting in other bird groups was first reviewed by Fisk (1978), who reported a worldwide increase of roof nesting in 22 bird species, mostly altricial species that feed their chicks until they fledge such as gulls and terns (see also Mainwaring 2015). Roof nesting in precocial bird species appears to be much rarer maybe because in many cases, it is not easy for the young to leave the roof unharmed.

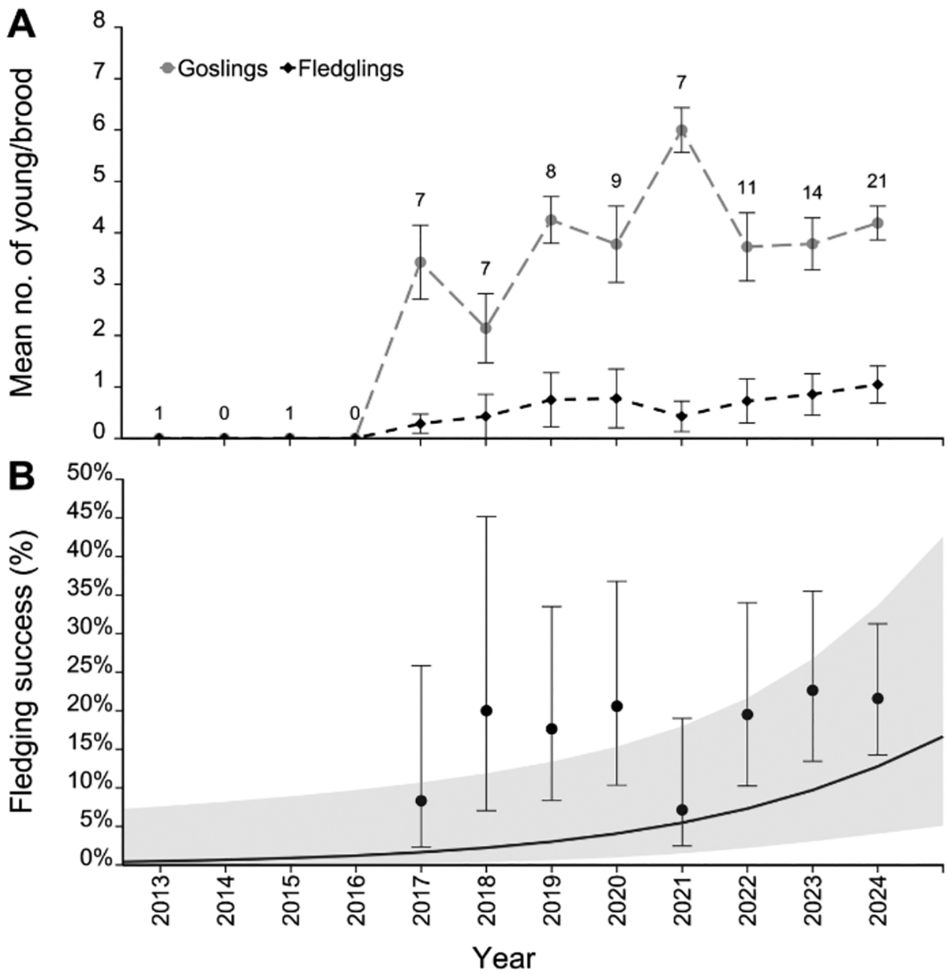

Figure 2. (A) Mean number of goslings (grey) during rescue that survived to post-fledging (black) per brood (± s.e.) for all successful roof-nesting broods of Greylag Geese in Hamburg, 2013–2024. Numbers above the points indicate the yearly number of broods. (B) Fledging success, defined as the proportion of goslings per brood surviving to post-fledging. Points show yearly means with Wilson 95% binomial CIs. The line shows the modelled per-gosling probability of survival to post-fledging from a binomial GLMM, with the shaded area indicating 95% CIs.

Reasons for nesting on roofs

Mainwaring (2015) reviewed the costs and benefits for birds using man-made structures as a nesting site. He found that the benefits for birds breeding on roofs outweighed the costs. The reasons for roof nesting have been attributed to adaptations forced by human pressure on original breeding sites with a reduction in predation risk by ground predators and human disturbance. It may

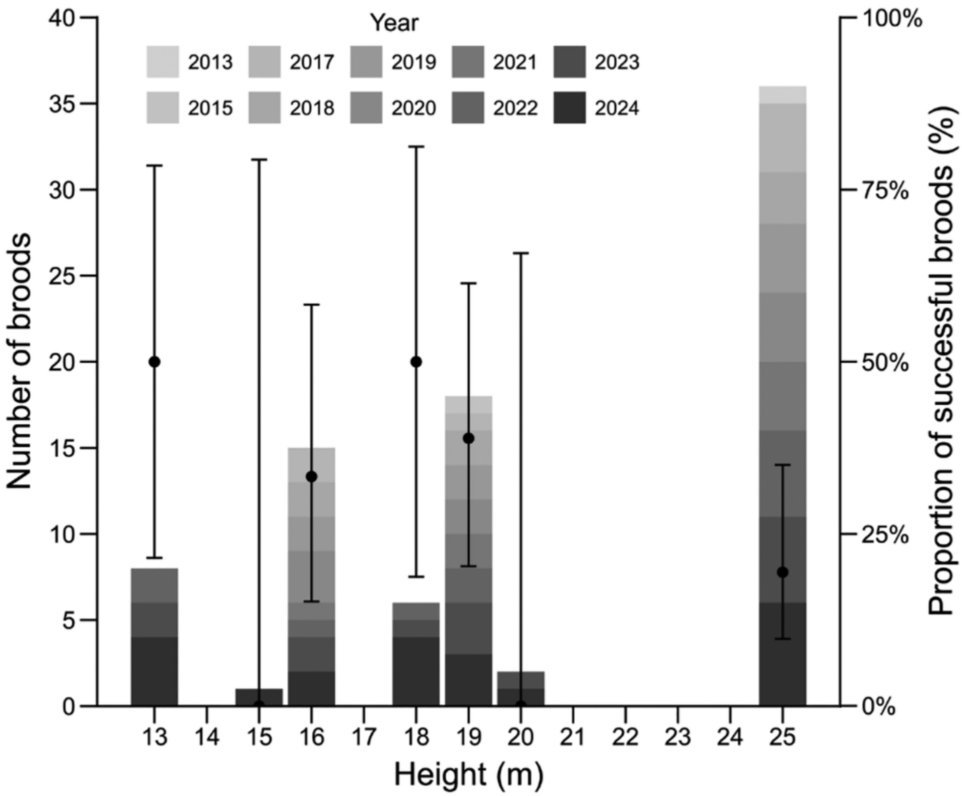

Figure 3. Number of roof-broods of Greylag Geese in Hamburg, 2013–2024, in relation to nest height above ground (m). Bars indicate brood counts per height, with each colour depicting a specific year. Points with error bars show the proportion of successful broods, defined as at least one gosling surviving to post-fledging per brood per height, with Wilson 95% binomial CIs.

also have arisen because suitable nest sites on the ground were not available for all breeding pairs, forcing some birds to use the best available alternative. Whether this is a successful strategy for increasing reproductive success needs to be investigated further.

Whilst roofs offer protection from ground predators and frequent human disturbance, aerial predators such as Carrion Crows are still a threat to eggs and freshly hatched goslings in the study area. This has also been reported for roof-nesting Eurasian Oystercatchers *Haematopus ostralegus* elsewhere (Duncan *et al.* 2001). Because most hatched Greylag Goose goslings are, without human intervention, unable to leave the nest sites unharmed, nesting on roofs could be regarded as an ecological trap leading to reproductive failure (reviewed for other roof breeding bird species by Mainwaring 2015).

Nesting on high buildings seems not to have been previously observed for Greylag Geese, but in some populations, they have

Figure 4. The first Greylag Goose nest found on a roof in Hamburg (on 1 April 2013), by Simon Hinrichs.

been reported to nest in high trees. For example, in southern Moravia, Czech Republic, Greylag Geese used to nest in trees, this might have been explained by unregulated rivers causing nests to be flooded up to about 1975, making nesting on the ground unsuccessful. When the water level of those rivers became regulated, there was no more reason to nest in trees, as there was no unpredictable flooding. Some birds kept nesting in trees, but this behaviour ceased in the late 1990s (Horák 1999). This indicates that Greylag Geese are very adaptable to environmental change.

Success of roof broods

Mitchell *et al.* (1998) compared the reproductive success of cliff-nesting and island-nesting Barnacle Geese in Svalbard, where they found that cliff-nesting pairs had 13% lower reproductive success (*i.e.* the number of goslings per female), and that goslings showed 8.6–16.9% lower survival rates in one of the two study years. In Hamburg, both the number of Greylag Geese nesting on roofs and the per-gosling probability of survival to post-fledging increased significantly over the years. The difference between females in the fledging success of their goslings was also notable. In contrast, increases in brood success (measured as the likelihood of at least one gosling surviving to post-fledging) was slight but not significant. Comparisons of the breeding performance of Yellow-legged Gulls *Larus michahellis* nesting at traditional

Figure 5. Greylag Goose nesting in a flower planter, on a balcony in Hamburg, by Simon Hinrichs.

sites and on newly colonised roofs in the city of Venice, Italy, showed their reproductive success was similar (Soldatini *et al.* 2008). In Oystercatchers, the reproductive success of roof nesting pairs was similar to that on islands, but much better when compared to agricultural sites (Duncan *et al.* 2011). In a future study of Greylag Geese in Hamburg, a comparison of reproductive success could be made between birds nesting on the ground and on roofs. More long-term data on the outcome for roof broods (Dinsmore *et al.* 2002; Shaffer *et al.* 2004) will also be necessary for a deeper look at the trends of reproductive success in urban Greylag Geese.

Nest height

When nesting in trees, geese often use old nests of other bird species or use tree stumps. The nests in trees used by Greylag Geese in the Czech Republic were located rather high up, at between 12–26 m above ground level, which is very similar to the roof nests in Hamburg. Survival rates have not yet been reported for the broods which hatched in trees. Canada Geese in urban Indiana, USA, nested at heights up to 12.2 m above ground (Shearer *et al.* 2022). As both Greylag Geese and Canada Geese are capable of nesting at these heights, this behaviour therefore may be within the behavioural reaction norm of the species (as defined by Dingemanse *et al.* 2010). It should however be noted that roof nesting appears not yet to have been observed in other urban Greylag Geese, despite them also facing high competition for suitable nest sites (Mai *et al.* 2022; Woog 2025).

Behavioural coordination

When goslings jump from high places to the ground, coordination between parents and goslings is important to minimise predation risk, because the goslings are vulnerable during the move, with Mitchell *et al.* (1998) reporting individual variation in the coordination ability of parents and goslings at this time. This difference in behaviour between parents probably also influences the probability of survival of goslings to post-fledging in roof-nesting Greylag Geese in Hamburg, as shown by the marked heterogeneity in fledging success between broods. Coordination was often lacking with one or both parents leaving prematurely, making the freshly hatched goslings easy prey for crows. In a few cases, the goslings were observed to jump from roofs on their own account; some survived the physical impact, but coordination with the parents was lacking. On some occasions, the parental geese flew down but not fast enough to protect the goslings against predators; in other cases they flew down prematurely, leaving the goslings alone at the top without protection. In both situations the goslings were preyed upon by crows.

Conclusion

Nesting on the roofs of Hamburg so far seems to be an ecological trap for Greylag Geese, rather than a successful strategy in evolutionary terms. Rather than not nesting at all, the geese may choose this option as the best one available. Inclusion of more years of data, along with further analysis of the data, may elucidate possible differences between ground nesting and roof nesting geese that could explain the observed behaviours more clearly. For instance, there is anecdotal evidence that most females breeding on roofs to date hatched on the ground themselves, which may be attributable to roof nesting being a new strategy, but the choice of nest sites appears to be flexible with females that previously nested on a roof subsequently nesting on the ground again, and *vice versa* (S. Hinrichs, pers. obs.). In a case of two females having hatched from the same clutch, one subsequently nested on the ground, while the other nested on a roof. More data are needed on such cases and other aspects of roof nesting behaviour, to provide a better understanding of the reasons driving this activity, and whether it will be increasingly adopted by Greylag Geese and other species in the future.

Acknowledgements

We sincerely thank all people and companies that reported roof nesting geese to us, and we are indebted to all volunteers who helped with the subsequent retrievals (namely A. Ackermann, C. Bernard, F. Burghardt, K. Busche, C. Geisler, B. Güney, Y. Hoffmann, C. Jahn, D. Jüdes, S. Kaatz, I. Kirchhoff, S. Kirchhoff, D. Kraeft, N. Kraeft, I. Kreutzkamp, H. Kramer, N. Meisner, C. Monticelli, Y. Petry, J. Reicke, D. Schnabel, Z. Wilson, N. Wolski, A. Zielke and A. Zours) and the following companies: Chroma Wohnen GmbH & Co. KG; GG Immobilien GbR Hamburg; and PONTON GmbH. Special thanks go to S. Martens, H.-J. Hoff and A. Zours and Irmtraut Kreutzkamp (†) for their advice. We are indebted to two anonymous reviewers for commenting on earlier drafts of the manuscript.

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