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VATTENFALL

## Norfolk Projects Offshore Wind Farms

# Kittiwake Implementation and Monitoring Plan

## Annex 3 Kittiwake Nesting Success on Artificial Structures

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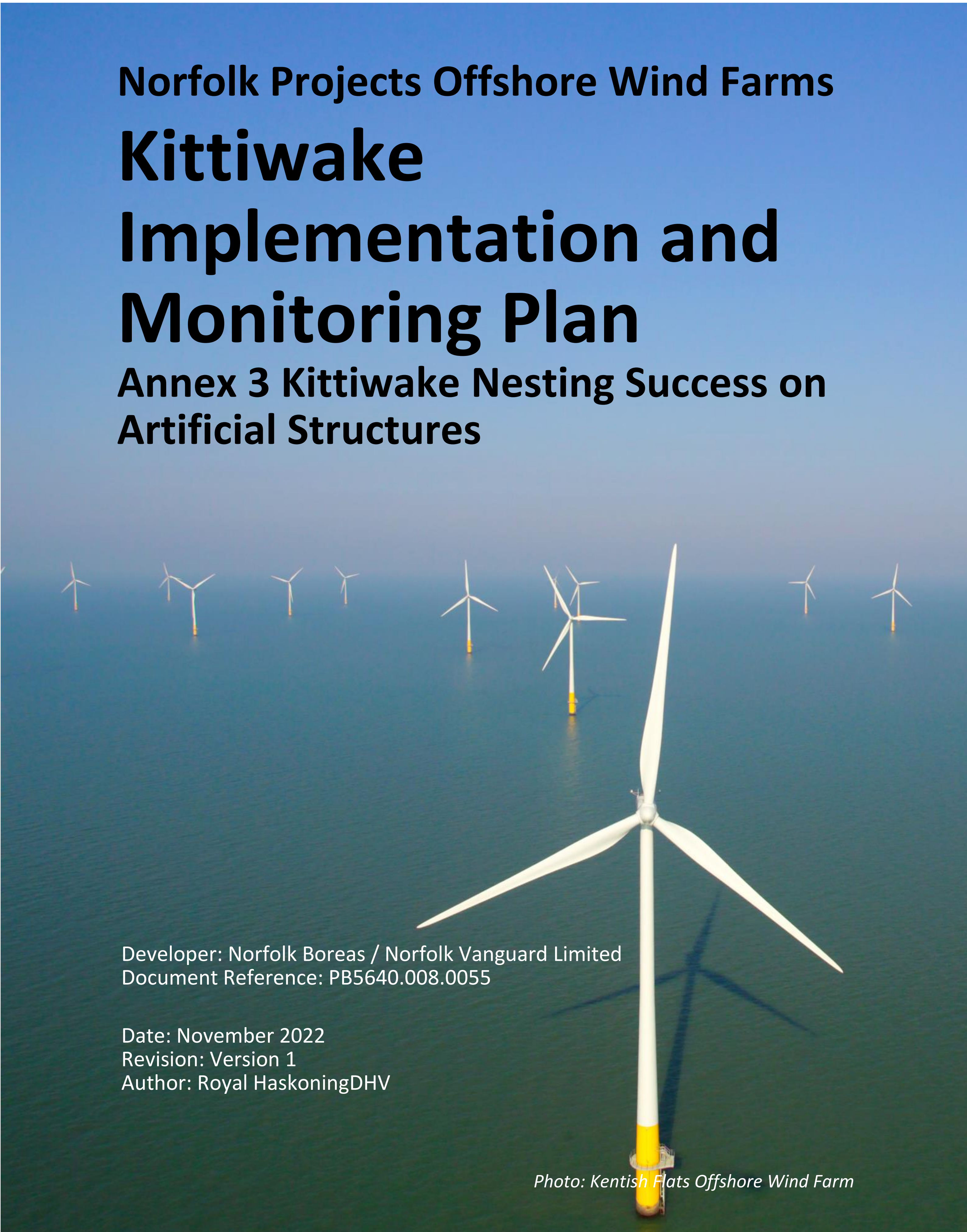

*Photo: Kentish Flats Offshore Wind Farm*

MacArthur Green

# Report to Vattenfall

# Kittiwakes nesting on artificial structures: features of nest sites and nesting success at Lowestoft, Tyne and Dunbar


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## EXECUTIVE SUMMARY

This report considers breeding success of kittiwakes on artificial structures, and presents new data collected in 2021. Fieldwork included scoring of features of kittiwake nests at selected sites at Dunbar Harbour (507 Apparently Occupied Nests, AONs, mostly on artificial structures), Tyne (1,449 AONs, mostly on artificial structures) and Lowestoft (645 AONs, all on artificial structures) and noting breeding success at each selected AON at these sites. Birds in 'club' flocks (comprising immature and sabbatical individuals) were also counted. Kittiwakes that breed successfully return to the same nest site each year. Birds that fail are likely to move elsewhere. Immatures try to recruit to breed close to birds that are successful. As a result, a survey of nest sites that are being used now will in large part reflect how successful these sites have been in recent years, with larger numbers of nests likely to be in sites that have consistently had higher breeding success. A survey of the features of kittiwake nests on man-made structures may therefore provide useful evidence as to the characteristics of such sites that have permitted successful breeding over recent years. In addition, breeding success in 2021 can be related to scored features of the nest sites.

The study found a very strong tendency for kittiwakes to use very narrow ledges, as previously reported in the literature. Most nest sites were also sheltered from direct sun, and some evidence indicated that breeding success was somewhat reduced for nests exposed to direct sun. Most nest sites were sheltered from rain, waves and sea spray, and were sheltered from crows and large gulls. Nevertheless, some evidence of predation impacting breeding success was detected. Most nest sites, but not all, were considered to be inaccessible to foxes, mink and rats. Many were scored as vulnerable to human disturbance, especially at Lowestoft. Although breeding success of birds scored as vulnerable to human disturbance was slightly lower at Dunbar, there was no effect of human disturbance at Tyne or Lowestoft in 2021. There was some evidence indicating that birds nesting on the edge of the colony had lower breeding success (as found in previous studies), but many nests on artificial structures were scored as 'edge' nests because most artificial structures did not permit nesting on multiple ledges. Despite this, nesting success of kittiwakes at Dunbar, Tyne and Lowestoft was high (around 1.2 to 1.3 chicks per nest in 2021). At Tyne and Lowestoft, some nest sites were on buildings where deterrents have been deployed to reduce or prevent kittiwake nesting. Despite deterrents, kittiwakes achieved high breeding success on many of those sites, although exclusion netting has reduced numbers nesting on some buildings, and exclusion netting deployed in 2021 reduced breeding success of birds forced to relocate at short notice.

At Lowestoft, BT provided new artificial ledges for kittiwakes on a building wall in early May 2021 after deploying exclusion netting over much of the area on their building that had previously been used by nesting kittiwakes. Kittiwakes adopted sites on the new ledges within days, but the timing of this resulted in low breeding success on the new ledges in 2021, although prospects for 2022 look good. The Lowestoft harbour wall ledge that was used from 1989 to 2017 but was abandoned in 2017 due to predator impacts, appears poorly designed, as the ledges are far too wide to suit kittiwakes, and are readily accessible to foxes as well as large gulls. However, the ledges were used for many years, despite those design flaws, and most likely contributed considerably to the growth in kittiwake numbers breeding in Lowestoft.

Based on the results of this study, 12 recommendations are made to guide the design of new structures for kittiwakes to use, and in relation to future monitoring of these populations on artificial sites.

# 1 INTRODUCTION

The black-legged kittiwake *Rissa tridactyla* (henceforth 'kittiwake') is the commonest gull in the world (Coulson 2011). In recent decades it has been in steep decline in numbers in much of its breeding range around the North Atlantic and North Pacific, and consequently has become red-listed by the IUCN. It is thought that the main factors driving the current decline are climate warming and in some areas the depletion by industrial fisheries of forage fish stocks, especially sandeels. In the North Sea in particular, breeding success and adult survival of kittiwakes is strongly influenced by the biomass of the lesser sandeel *Ammodytes marinus* stock on which they feed (Furness and Tasker 2000, Oro and Furness 2002, Frederiksen et al. 2004, 2005, Carroll et al. 2017, Olin et al. 2020).

Kittiwakes are relatively small gulls (380-400 mm from bill tip to tail tip), that breed in colonies, normally on steep sea cliffs, where they select narrow ledges on which to plaster their small cup nest made of mud and weed. Coulson (2011) points out that kittiwake nests are almost invariably built on ledges that are less than 300 mm wide, but can be as little as 80 mm wide. Where kittiwakes try to nest on wider ledges, they are likely to lose the nest site to other seabirds such as fulmars. The kittiwake nest is very standard in cup size (it has a diameter of 300 mm; Coulson 2011). It is just large enough to hold fully grown chicks, but adults project beyond the nest cup, so almost invariably stand or sit on the nest facing into the cliff or parallel with the ledge. Chicks crouch in the nest, facing the cliff. In contrast to nest width/depth, kittiwake nest height is highly variable as new nest material may be added to remains of nests used in previous years such that the nest may get considerably taller, though no wider or deeper (e.g. Photos 1.1 and 1.2). This nest site selection and construction method reduces competition with other seabirds such as auks and fulmars, as those birds are unable to land on most of the ledges used by kittiwakes. It also greatly reduces risk of predation of eggs or chicks, because predators (such as large gulls, crows, eagles) are also unable to land on those narrow ledges. As a result, kittiwakes are subject to less predation of eggs and chicks than are ground-nesting gulls. However, whereas most gulls tend to lay clutches of three eggs, most kittiwakes lay only two eggs, and a major cause of reduced productivity can be chicks falling (e.g. by accident as chicks grow, move about, and push each other) from the small nest that overhangs the edge of the narrow ledge. Accidental losses of chicks from falling out of the nest are especially likely if the nest contains three chicks (Coulson 2011). Predation is not entirely avoided either. Some nests remain exposed to predation when avian predators, especially crows and large gulls, snatch eggs or chicks from nests. There is some anecdotal evidence suggesting that nests closest to the top of a cliff are at higher risk of egg and chick losses to avian predators. However, Coulson (2011) points out that defecation by kittiwakes over the side of the nest that overhangs a ledge will foul birds in nests lower down on the cliff, and although adults can wash this off at sea, chicks in nests below others can become fouled, their insulation and waterproofing may be compromised and their survival reduced as a result. Breeding failures can also result from extreme weather, such as heavy rain washing nests off ledges, or sea spray or even waves from storms washing nests off cliffs if the nests are low on the cliff. It is also possible that direct sunshine may result in overheating of eggs or chicks (Coulson 2011). Nevertheless, kittiwakes can achieve high breeding success where feeding conditions and climate are favourable, often averaging between 0.8 and 1.4 chicks per nest (Coulson 2011).

Photo 1.1. Example of a kittiwake nest that has been added to over several years so is unusually tall (and extremely well sheltered)

**Photo 1.2. Part of Saltmeadows tower, Gateshead, showing the variety of kittiwake nest heights but relatively consistent nest cup width**

The first record of kittiwakes nesting on a man-made structure in Britain was in 1931, when a few pairs colonized the pier at Granton, Edinburgh, but they only nested there for a few years (Coulson 2011). Another colony was established in 1934 on a warehouse at Dunbar harbour, where kittiwakes nested until it was demolished in the 1960s. They then moved onto the ruins of the castle on the cliff overlooking Dunbar harbour, and onto the natural cliff beside the castle (Coleman et al. 2011, Coulson 2011). In 1949, kittiwakes colonized a warehouse at North Shields, near the mouth of the River Tyne. They then spread to many buildings along the Tyne, as far inland as Newcastle (Turner 2010, 2019). This habit has spread further, or developed independently at other locations. There are now colonies on man-made structures at Scarborough, Lowestoft, Sizewell and elsewhere in Britain (Brown and Grice 2005, Coulson 2011), and at man-made structures from France (Ponchon et al. 2017a) to Arctic Norway in Europe, with numerous sites on man-made structures, including buildings and harbour walls but also several offshore oil production platforms, along the coast of Norway (Christensen-Dalsgaard et al. 2019), and at sites in Alaska (Vincenzi et al. 2015). Coleman et al. (2011) report that 15 birds caught as adults nesting at Dunbar on man-made structures had originally been ringed as chicks at a variety of other colonies, and none of those individuals were from a man-made nest site, so it is clear that kittiwakes born on natural cliff nests may recruit to breed on man-made sites. Similarly, adults nesting at a colony on man-made structures in France include 14 birds ringed as chicks at both natural and man-made sites, from as far away as Sweden, Wales, and west Scotland, but including four chicks ringed at the Saltmeadows tower at Gateshead (Northumbria Ringing Group 2021). The man-made colony sites therefore are an integral part of the much larger meta-population of kittiwakes in western Europe.

A feature of kittiwakes nesting on man-made structures is a tendency to achieve high breeding success at such sites, often higher than at nearby natural colonies (Turner 2010, 2019, Coleman et al. 2011, Christensen-Dalsgaard et al. 2019, Reiertsen et al. 2019). This high breeding success may be due to colonies on man-made structures tending to be smaller than many of the monitored natural colonies so that competition for resources is lower (i.e. a consequence of density-dependence, which is known to particularly affect breeding kittiwakes (Furness and Birkhead 1984, Coulson 2011, 2017, Wakefield et al. 2017)). It may also be due to nest sites on artificial structures being better than those on natural cliffs in terms of some features such as protection from predators, weather, rough seas (Christensen-Dalsgaard et al. 2019). It may also be due to some artificial sites being closer to foraging grounds than are natural cliffs, and so reducing the energy costs and time required to commute from nest sites to feeding areas (Christensen-Dalsgaard et al. 2019). However, the detailed reasons for high breeding success on man-made sites remain somewhat uncertain, and the exact features of artificial nest sites that determine whether or not kittiwakes can breed successfully are not known in detail.

With the likelihood that offshore wind farm developers may have to compensate for impacts of offshore wind on kittiwake populations, and the possibility that such compensation may involve construction of artificial nest sites for kittiwakes in locations where natural sites are absent or scarce, a better understanding of the features of artificial nest sites that allow birds to achieve consistent high breeding success is desirable. This study reports on the features of nest sites used by kittiwakes at Lowestoft, Tyne and Dunbar in 2021, and on breeding success achieved by these birds in 2021 in relation to features of the nest sites.

Kittiwakes that nest successfully normally return to exactly the same nest site each year (Coulson 2011). However, birds that are unsuccessful may move to another nest site, and destruction of nest sites can sometimes force birds to move (Fairweather and Coulson 1995, Coulson 2011, Ponchon et al. 2015, 2017b). That will result, over a period of years, in more successful nest sites being occupied, and less successful nest sites being abandoned. In extreme cases, entire sub-colonies or colonies may be abandoned, with birds moving to sites where the chances of nesting successfully may be greater (Fairweather and Coulson 1995, Coulson 2011, Ponchon et al. 2015, 2017b). Immature kittiwakes ("recruits") tend to be attracted to try to establish ownership of nest sites in colonies, or parts of colonies, that have high breeding success, and will visit many colonies and areas within the favoured colony, to compare opportunities (Monnat et al. 1990, Cadiou et al. 1994, Ponchon et al. 2015, 2017b). Successful groups of nests will tend to persist, and increase in numbers, while unsuccessful groups of nests will tend to dwindle. This behavioural feature of the species means that a survey of nest sites that are being used now will in large part reflect how successful these sites have been in recent years, with larger numbers of nests likely to be in sites that have consistently had higher breeding success. A survey of the features of kittiwake nests on man-made structures may therefore provide some useful evidence as to the characteristics of such sites that have permitted successful breeding over recent years.

It seems that there have not been any previous studies of the features of kittiwake nest sites that influence breeding success, but such work has been reported for the Manx shearwater *Puffinus puffinus* (Thompson and Furness 1991) and the shag *Phalacrocorax aristotelis* (Potts et al. 1980, Velando and Freire 2003). Potts et al. (1980) scored shag nests categorically according to the criteria "protection from high seas", "exposure to rain", "capacity", "access to sea" and measured nest site density within the colony on the Farne Islands. They found that very few nests scored highly in all criteria, and that breeding success of shags at the Farne Islands was strongly influenced by nest site quality (expressed as a score that sums the individual criteria), which acted as a density-dependent constraint on breeding success. Velando and Freire (2003) pointed out that criteria of nest site quality most likely differ according to local conditions, and that the criteria defined by Potts et al. (1980) were not all appropriate for their study colony of shags in Spain, which mostly nested in caves or under boulders. They defined relevant nest site criteria as "entrance area", "gallery length", "chamber width", "chamber volume", "lateral cover", "overhead cover", "drainage", "accessibility", "structure of the chamber", and "visibility". They also found evidence of a limited number of high quality nest sites, and density-dependent constraint on breeding success of their study population. Average nest site quality declined as population increased, and overall colony breeding success declined as a result of poorer productivity of birds forced to use less suitable nest sites.

In the kittiwake, there is strong evidence that breeding success is closely related to food stocks in the vicinity of the colony (Furness and Tasker 2000, Oro and Furness 2002, Frederiksen et al. 2004, 2005, Carroll et al. 2017, Olin et al. 2020). Therefore, it would be inappropriate to compare breeding success of birds with particular nest site characteristics in one region with breeding success of birds in a different region. In this study breeding success is related to nest site characteristics within, but not between, three discrete local areas: Lowestoft, River Tyne, and Dunbar. Although much research has been carried out on kittiwake breeding ecology, there is little in the scientific literature to identify what features of kittiwake nests determine breeding success. However, Coulson (2011) emphasises the importance of social stimulation in breeding kittiwakes, with the birds in high density parts of the centre of colonies tending to be the highest quality individuals showing strong competition to gain nest sites in these better areas. Immer et al. (2021) showed experimentally that pairs nesting close to neighbours were influenced in their timing of breeding and levels of stress hormones by the birds close to them. Nesting density and position within the colony may therefore be important factors. Nesting at high local density may also assist kittiwakes in avoiding displacement from nests by other species (another kittiwake nesting on either side will buffer a nest from such disturbance) and may assist kittiwakes in communal mobbing of potential predators or kleptoparasites. Kittiwakes plaster their mud and vegetation nest material onto a variety of surfaces, but it is unclear whether all base surface materials are of equal value; those may be natural rock, stone/brick, timber, or metal, but each of these may differ in the extent to which it can hold nests, and in thermal and other properties. Nests can be destroyed by storms, resulting in wave action, sea spray and heavy rain. Kittiwakes may be displaced from their nest by other seabirds such as auks and fulmars if ledges are large enough to permit access to those other species. Eggs or chicks may be taken by predators if those can access nests (potentially possibly including crows, large gulls, birds of prey, mink, foxes and rats). Direct sunshine, especially combined with high temperature, can lead to overheating of seabird eggs or chicks and can cause mortality (Gaston 2002, Furness 2016), or additional energy expenditure by breeding adults (Oswald et al. 2008, 2011), so that shelter from direct sunshine may possibly benefit breeding success. Coulson (2011) noted that at the southern limit of kittiwake breeding, in Spain and Portugal, the few breeding kittiwakes that are found there only nest on north-facing cliffs where the sun does not shine directly on the nests. He presumed that this nest site selection is deliberate, in order "to avoid the intense heat from the sun, which would probably greatly reduce the breeding success". These factors may also interact: for example impacts of food shortage may be magnified by higher temperature or exposure to direct sun, whereas effects of sun may be less evident if food supply is plentiful and birds have 'spare' time available that could be devoted to brooding or standing over small chicks to prevent them from dehydrating or overheating. Human disturbance, and especially deliberate attempts to stop kittiwakes from nesting on some artificial sites (such as occupied offices, hotels or houses) may also influence breeding success. Therefore, all of these possibilities were considered in this study.

# 2 METHODS

The standard count unit for breeding kittiwakes is the 'Apparently Occupied Nest' (AON). Defining an AON can be difficult where a nest is not yet completed. In addition, kittiwake nests can remain largely intact from one breeding season to the next where they are sheltered from winter wind and rain (Coulson 2011), and so some old nests can appear to be possible current nests, where either the adult(s) are absent, or attendance may be by a prospecting nonbreeding bird (Walsh et al. 1995). At a kittiwake colony in Britain, the number of AONs will increase during late April and early May as birds return and refurbish nests or build new nests. Numbers of AONs will peak around late May or early June, but some nests that had been occupied earlier in the season may be lost while other new sites are added, and so the total number of AONs at a colony is not easy to define, and will vary slightly from day to day (Walsh et al. 1995). Numbers of AONs tend to plateau in late May, by which time most nests should be at least partly constructed and attended, but a small number may be added during early June while some may be lost by then. Timing of chick hatching and fledging can vary slightly from year to year, and between locations, but visits around mid-July will normally be before any chicks have fledged but after most chick mortality has occurred (Coulson 2011), so provide the opportunity to measure breeding success.

Dunbar, River Tyne, and Lowestoft kittiwake sites were visited in May, June and July 2021. On 24-28 May, photographs were taken of each colony, with the intention to include a high proportion of the kittiwake nests, excluding nests for which viewing possibilities were too limited to be likely to allow accurate determination of the number of chicks in those nests later in the summer. Photographs were printed as A4 images, and individual nests were numbered. On 18-23 June, these sites were revisited, presence of any additional nests was noted, as were any cases of nests disappearing between the first two visits. For each nest, features of the nest sites were scored and input into an Excel spreadsheet. On 17-21 July, a third visit was made, during which the numbers of chicks in each study nest were counted and subsequently input into the spreadsheet. Timing of the July visit was informed by the stage of breeding evident in the June visit. Kittiwake chicks remain at the nest most of the time for some days after they have become able to fly, as parents continue to feed their chicks at the nest for about a week after fledging of the young (Coulson 2011). However, because of the natural spread of timing of breeding, some nests may still contain eggs or very small chicks in mid-July, so the choice of date represents a compromise: as late as possible to avoid overestimating productivity, but before any chicks may be spending large amounts of time off their nest as fledglings.

Features of nests and, where appropriate how they were scored, were:

- Base material (stone/brick, timber, metal, natural rock cliff, or natural rock cliff inside a concrete erosion defence archway; coded as 5 alphabetical categories)
- Ledge width (0=less than the width of a kittiwake nest; 1=between one and two kittiwake nest widths; 2=twice or more the width of a kittiwake nest)
- Shelter from rain (0=none, 1=partial 2=considerable)
- Shelter from wind (0=none, 1=partial, 2=considerable)

- Shelter from sun (0=none, 1=partial, 2=considerable)
- Protection from crows and gulls (either by presence of near-vertical surface above and behind nest, and/or sufficiently small horizontal surface to inhibit crows or gulls from being able to land close to and then walk to the nest; 0=none, 1=partial, 2=considerable)
- Neighbouring nests adjacent (adjacent defined as almost within pecking distance for adults on the nests; 0=none, 1=one side only, 2=nests on either side)
- Walls at side of nest (0=none, 1=wall on one side only, 2=walls on either side)
- Access for foxes or mink (0=no likely access, 1=risk of access)
- Human disturbance (0=no likely human disturbance, 1=some risk, 2=high risk)
- Shelter from waves and sea spray during storms (0=poor, 1=good)
- Human deterrence of nesting (0=no indication of deterrence, 1=some, 2=considerable effort)
- Nest at edge of colony (0=no, 1=yes)
- Number of nests within 5 m and visible to focal nest (distances estimated based on a kittiwake nest being 300 mm wide, and an adult kittiwake 400 mm from bill-tip to tail tip)
- Presence of kittiwake nests above focal nest (0=no, 1=yes)
- Presence of kittiwake nests below focal nest (0=no, 1=yes)

Some of these criteria were straightforward to score, but some were more subjective. For consistency, all scores were made by the same person (Bob Furness), with the aim to compare among nest sites within each of the three study areas.

At each visit, a count was made of nonbreeding kittiwakes, as nonbreeders are known to be attracted to successful colonies, and also represent the extent to which numbers are likely to increase in future. These birds tend to form ‘clubs’ where they can readily be counted, although there may be additional immature birds that are less obvious. Therefore, counts of numbers attending club flocks will underestimate the total present and should be considered a minimum number. There will also be turnover of individuals in the nonbreeder flock, so that the total number of nonbreeders associating with a colony over the breeding season may be much larger than the snapshot count of birds present at any one time. The clubs tend to be on structures close to the colony but discrete from the nesting area and birds tend to sit in fairly tight flocks at those sites. The club may possibly contain some off-duty breeding birds, but breeding adults tend to attend the nest unless foraging or bathing. A high proportion of the club birds also show immature plumage, which is not seen among birds that are breeding adults at nests, so it is unlikely that the counts of birds at clubs include many breeding adults.

Any observations of predator activity at kittiwake nests were noted, as was any evidence of human disturbance or deliberate removal of kittiwake nests. At Dunbar and Tyne, numbers of herring gulls and lesser black-backed gulls holding territories close to the kittiwake colonies were fairly small in most sites, but their presence as potential predators on kittiwake nests was noted. However, very large numbers of herring gulls and lesser black-backed gulls nested at Lowestoft, sometimes in close association with kittiwakes. In June 2021 two half days were spent in counting numbers of herring gull and lesser black-backed gull nests in areas of Lowestoft where those large gulls might impact on breeding kittiwakes. Data on large gull numbers at Lowestoft are provided in Annex A.

To allow data on breeding success in relation to sunshine and rain to be put into context, data from The Met Office (Met Office 2021) were downloaded for spring and summer 2021 (with a focus on May, June and July).

# 3 RESULTS

At Dunbar Harbour, 507 nests were included in the study, features scored and number of chicks recorded. Most of those nests were on man-made structures (eroded walls) but a minority were on natural rock cliffs. At Tyne, 1,449 nests at 17 different sites (Annex B Table B.1) were included in the study, features scored and number of chicks recorded. Most of those nests were on man-made structures including three bridges, numerous buildings and a purpose-made nesting tower, but a small minority were on a natural cliff, some of which has been altered by concrete coastal defence structures. At Lowestoft, 645 nests at 45 different sites (Annex B Table B.2) were included in the study, features scored and number of chicks recorded. All nests at Lowestoft were on man-made structures, but those included timber piers as well as stone buildings.

Spring 2021 was unusually cool (Met Office 2021). Lowestoft had a spring mean temperature in 2021 between 1.0°C and 1.5°C below the 1981-2010 average, but with only 80% of average rainfall, and average sunshine. However, in June and July at Lowestoft the mean temperature was close to average, rainfall was slightly below average, and sunshine was also slightly below average (Met Office 2021). At Tyne, spring mean temperature in 2021 was average, rainfall was around 70% of average, while sunshine was 20% above average. In June and July at Tyne the mean temperature was 1°C above average, rainfall was 25% below average, and sunshine was 5% above average (Met Office 2021). At Dunbar, spring mean temperature in 2021 was average, rainfall was slightly below average, while sunshine was about 10% above average. In June and July at Dunbar the mean temperature was between 1.5°C and 2°C above average, rainfall was about 20% below average, and sunshine was about 10% above average (Met Office 2021).

These data suggest that kittiwakes at Lowestoft and Tyne are unlikely to have been particularly challenged by temperature, sunshine or rain in 2021. Kittiwakes at Dunbar will have experienced slightly higher temperature and sunshine than normal in 2021, so may have been more vulnerable to overheating. However, with low rainfall the risk of nests being damaged by rain will have been low.

## 3.1 Dunbar Harbour

Dunbar Harbour is a busy working environment for crab and lobster fishermen in particular, and is visited by large numbers of tourists. There are two food stalls at the harbour serving fast food, and there is a busy public car park adjacent to the harbour. There is, therefore, considerable potential for nesting kittiwakes to be subject to high levels of human disturbance, from people on foot, from cars, and from boats. Kittiwake breeding numbers at Dunbar Coast increased from 641 pairs in 1991 to 1,155 in 2007 (Coleman et al. 2011). East Lothian Countryside Rangers now monitor kittiwake numbers breeding at Dunbar, but no longer monitor breeding success and have not ringed any kittiwakes since 2019 (Tara Sykes, pers. comm.). In 2019 they recorded a total of 713 kittiwake AONs at Dunbar Coast, while on 17 June 2020 they recorded a total of 808 kittiwake AONs (details on

Facebook posts). About half of the local population nests on the walls of the castle and about half on natural cliff areas along the coast, not just within the harbour (Coleman et al. 2011).

Features of 507 kittiwake nests at Dunbar Harbour that were readily visible from public access areas are summarised in Table 3.1. Photographs showing some examples of the colony are included in Annex C. Nests were labelled from the visit in May, selecting relatively few of the nests on natural cliff habitat but as many as possible on the man-made habitat. During the visit on 24 May, most adult kittiwakes were still actively adding to their nests, bringing mud, seaweed and grass. However, very few new nests were begun after the May visit; in June, the AONs identified in May were all still active, and hardly any extra sites had been added. On 17 July, no chicks were seen flying, although several appeared very close to doing so. A very few nests contained recently hatched chicks, but most had chicks that were well feathered and conspicuous. One nest contained a large dead chick, and three dead chicks were on the ground below nests, presumably having fallen (or been pushed). None of those dead chicks had been eaten by scavengers, and there were no patches of feathers indicative of chicks having been removed from nests and plucked by predators. However, nests that had failed (i.e. contained no live chicks) tended to be in groups rather than randomly distributed through the colony, suggesting that predation may have influenced success of neighbouring nests.

**Table 3-1 Summary scores for sample of kittiwake nests at Dunbar Harbour in 2021.**

| Metric | Category | Number | Percent of sample |
|---|---|---|---|
| Base material | Stone/brick walls (of ruined castle) | 373 | 74 |
| | Natural rock cliff | 134 | 26 |
| Ledge width | Less than a kittiwake nest width | 507 | 100 |
| | Between one and two kittiwake nest widths | 0 | 0 |
| | More than two kittiwake nest widths | 0 | 0 |
| Shelter from rain | None | 22 | 4 |
| | Partial | 485 | 96 |
| | Considerable | 0 | 0 |
| Shelter from wind | None | 0 | 0 |
| | Partial | 507 | 100 |
| | Considerable | 0 | 0 |
| Shelter from sun | None | 19 | 4 |
| | Partial | 488 | 96 |
| | Considerable | 0 | 0 |
| Shelter from crows/large gulls | None | 22 | 4 |
| | Partial | 485 | 96 |
| | Considerable | 0 | 0 |
| Neighbouring nests adjacent | None | 337 | 67 |
| | One on one side | 109 | 21 |
| | One on each side | 61 | 12 |
| Walls at side of nest | None | 419 | 82 |

| Metric | Category | Number | Percent of sample |
|---|---|---|---|
| | One on one side | 79 | 16 |
| | One on each side | 9 | 2 |
| Access for fox or mink | No likely risk of access to nest | 485 | 96 |
| | Apparent risk of access to nest | 22 | 4 |
| Human disturbance likely | No likely human disturbance | 326 | 64 |
| | Some vulnerability to human disturbance | 106 | 21 |
| | High vulnerability to human disturbance | 75 | 15 |
| Shelter from waves/sea spray | Poor | 0 | 0 |
| | Good | 507 | 100 |
| Human deterrence of nesting | None evident | 507 | 100 |
| | Some | 0 | 0 |
| | Considerable evidence of deterrence | 0 | 0 |
| Nest at edge of colony | No | 238 | 47 |
| | Yes | 269 | 53 |
| Nests within 5 m and visible | 0-4 | 9 | 2 |
| | 5-9 | 26 | 5 |
| | 10-19 | 133 | 26 |
| | 20-49 | 113 | 22 |
| | 50 or more | 226 | 45 |
| Layers of nests above | No | 150 | 30 |
| | Yes | 357 | 70 |
| Layers of nests below | No | 132 | 26 |
| | Yes | 375 | 74 |
| Chicks produced | 0 | 93 | 18 |
| | 1 | 233 | 46 |
| | 2 | 181 | 36 |
| | 3 | 0 | 0 |
| Chicks per nest | (mean) | 1.17 | |

Noteworthy features of sampled kittiwake nests at Dunbar Harbour are that all the study nests were on ledges that are narrower than the width of a kittiwake nest and were well sheltered from any risk of waves or sea spray. Almost all were sheltered from rain, wind, sun, crows and gulls, and mammal predators. Although most were on artificial structures (castle walls of heavily eroded stone or brick), some were on natural rock cliff. Although no nests were on sites where deterrents had been deployed to discourage nesting, 15% were in locations deemed highly vulnerable to human disturbance, and a further 21% were in locations deemed somewhat vulnerable to human disturbance. In addition, it was observed that an area low down on the castle walls immediately beside the harbour which is currently used by fishermen to store equipment has old kittiwake nests that have been abandoned (Photo 3.1.1). It seems likely that the nests in that area have been abandoned as a result of human activity and the piling of fishing gear close to the nests.

**Photo 3.1.1. Castle wall where fishermen store equipment (flags show the top of that pile of equipment). Note presence of several abandoned kittiwake nests (from before 2021) in this area below the area now occupied by active nests occupied in 2021.**

Nesting density varied considerably at this site, with a few nests that had fewer than 5 neighbours within 5 m to a density in some areas that exceeded 50 nests within a 5 m radius of a focal nest. High nesting density was favoured where the eroded castle wall allowed numerous rows of kittiwakes to nest on the walls (Photo 3.1.2), but tended to be lower on the natural rock cliff face (e.g. Photo 3.1.3).

**Photo 3.1.2. Kittiwakes nesting on Dunbar Castle eroded walls, showing the high nest density that can result.**

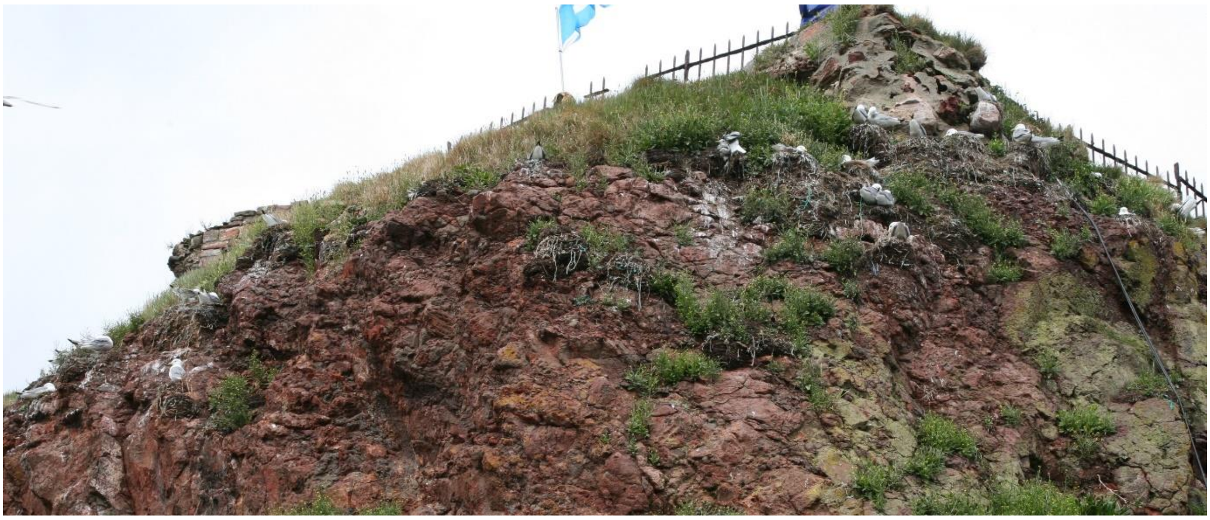

Photo 3.1.3. Example of kittiwakes nesting on natural rock cliff substrate at Dunbar Harbour.

Breeding success of the study pairs at Dunbar Harbour was very good overall (mean of 1.17 chicks per nest). In May 2021, carrion crows were seen attempting to steal kittiwake eggs from nests, apparently mostly targeting nests highest up on the walls/cliff. Some herring gulls and lesser black-backed gulls were present, but only in small numbers, and they were not seen to attempt to access kittiwake nests, although they did appear to be showing interest in some kittiwake nests, especially those closest to the top of the cliff (such as those in Photo 3.1.3).

Productivity of nests scored as highly vulnerable to human disturbance (n=75 nests, mean 1.09 chicks per nest) and somewhat vulnerable to human disturbance (n=106 nests, mean 1.05 chicks per nest) was lower than productivity of nests scored as not being at risk of human disturbance (n=326 nests, mean 1.23 chicks per nest). Only 14% of nests scored as not being at risk of human disturbance failed to rear any chicks, whereas 22% of those scored as slightly vulnerable failed, as did 35% of those scored as highly vulnerable to human disturbance.

The 93 nests that failed to produce chicks in 2021 tended to be in areas with lower nest density than were successful nests. Nests that were scored as being on the edge of the colony (n=269) averaged 1.10 chicks per nest, whereas nests that were scored as being in the centre of the colony (n=238) averaged 1.26 chicks per nest. Since nests at the edge will tend to have fewer neighbours within a 5 m radius than nests in the centre, this result is related to the difference in success between nests at high and low nest density, and is consistent with that comparison.

Nests on natural rock cliff substrate (n=135) produced an average of 1.09 chicks per nest, whereas nests on castle walls (n=372) produced an average of 1.20 chicks per nest. This may also relate to nest density, nests on the castle walls tending to be at a higher nest density than those on natural cliff. In view of these correlations between features, it is difficult to infer which of the features most influences nest success, but the evidence is clear that nests on the artificial structures at Dunbar Harbour are at least as successful as those on natural rock cliff, and probably more successful.

Only 19 nests were scored as having no shelter from direct sun. Those nests produced an average of 0.89 chicks per nest, whereas sheltered nests (n=488) produced an average of 1.18 chicks per nest. Five of the 19 nests fully exposed to direct sunshine reared broods of two chicks, so it is clearly possible for nests in direct sunshine to be successful, but the difference suggests that direct sunshine may be a factor that can reduce breeding success of kittiwakes. Sunshine may increase risk of dehydration or overheating of eggs, and especially small chicks before they have developed plumage. It is notable that kittiwakes pant when in direct sunshine on warm afternoons in order to reduce temperature by evaporative heat loss (Photo 3.1.4). Summer temperature and sunshine were above average in 2021 (Met Office 2021) at Dunbar which may emphasise the influence of this factor.

**Photo 3.1.4. Kittiwake adult and chicks on a nest site exposed to direct sunshine (in this example a nest at Newcastle Quayside) panting to shed heat by evaporative water loss.**

Only 22 nests were scored as vulnerable to access by crows and large gulls, and those same nests were the only ones considered to be at risk of access by mammal predators such as foxes. Those nests averaged 0.82 chicks per nest, compared to an average of 1.19 chicks per nest at nests scored as sheltered from access by crows or large gulls and unlikely to be accessible to mammal predators. This suggests that, while there appeared to be a small impact of predation at this colony, the risk of predation may in fact lead to almost all nest sites being selected to avoid exposure to nest predation in the first instance.

## 3.2 Tyne

Kittiwakes have nested for many years on numerous sites along the River Tyne, from Tynemouth at the open sea up to the High Level Bridge between Newcastle and Gateshead (Turner 2010, 2019). The largest colonies are now at Tynemouth, at Akzo Nobel's factory, at the Baltic Mill Arts Centre Gateshead, at the Tyne Bridge, at Saltmeadows tower, and on the railway bridge at Dean Street, with small numbers on various buildings on Newcastle Quayside adjacent to the Tyne Bridge (Turner 2019). There were 1,705 AONs at the Tyne sites in 2019 (Turner 2019).

Features of 1,449 kittiwake nests at the River Tyne that were readily visible from public access areas are summarised in Table 3.2. These represent a high percentage of the kittiwake nests present at most sites except Tyne Bridge. The smaller proportion sampled at Tyne Bridge was due to the difficulty of viewing many of those nests from any suitable vantage point in order to determine nest contents when breeding success was assessed in July. The sample excludes a small number of nests that were not evident during the May visit but had been added by late June. Photographs showing some examples of the colony are included in Annex D.

**Table 3-2 Summary scores for sample of kittiwake nests at River Tyne in 2021.**

| Metric | Category | Number | Percent of sample |
|---|---|---|---|
| Base material | Stone/brick | 907 | 62 |
| | Timber | 66 | 5 |
| | Metal | 204 | 14 |
| | Natural rock cliff | 163 | 11 |
| | Natural rock cliff inside concrete arch | 109 | 8 |
| Ledge width | Less than a kittiwake nest width | 1239 | 86 |
| | Between 1 and 2 times a kittiwake nest width | 210 | 14 |
| | More than twice a kittiwake nest width | 0 | 0 |
| Shelter from rain | None | 40 | 3 |
| | Partial | 1053 | 73 |
| | Considerable | 356 | 24 |
| Shelter from wind | None | 143 | 10 |
| | Partial | 948 | 65 |
| | Considerable | 358 | 25 |
| Shelter from sun | None | 131 | 9 |
| | Partial | 416 | 29 |
| | Considerable | 902 | 62 |
| Shelter from crows/large gulls | None | 0 | 0 |
| | Partial | 1096 | 76 |
| | Considerable | 353 | 24 |
| Neighbouring nests adjacent | None | 389 | 27 |
| | One on one side | 375 | 26 |
| | One on each side | 685 | 47 |
| Walls at side of nest | None | 1232 | 85 |
| | One on one side | 157 | 11 |
| | One on each side | 60 | 4 |
| Access for fox or mink | No likely risk of access to nest | 1426 | 98 |
| | Apparent risk of access to nest | 23 | 2 |
| Human disturbance likely | No likely human disturbance | 944 | 65 |
| | Some vulnerability to human disturbance | 452 | 31 |

| Metric | Category | Number | Percent of sample |
|---|---|---|---|
| | High vulnerability to human disturbance | 53 | 4 |
| Shelter from waves/sea spray | Poor | 0 | 0 |
| | Good | 1449 | 100 |
| Human deterrence of nesting | None evident | 1177 | 81 |
| | Some | 232 | 16 |
| | Considerable evidence of deterrence | 40 | 3 |
| Nest at edge of colony | No | 590 | 41 |
| | Yes | 859 | 59 |
| Nests within 5 m and visible | 0-4 | 77 | 5 |
| | 5-9 | 127 | 9 |
| | 10-19 | 563 | 39 |
| | 20-49 | 577 | 40 |
| | 50 or more | 105 | 7 |
| Layers of nests above | No | 546 | 38 |
| | Yes | 903 | 62 |
| Layers of nests below | No | 603 | 42 |
| | Yes | 846 | 58 |
| Chicks produced | 0 | 184 | 13 |
| | 1 | 651 | 45 |
| | 2 | 608 | 42 |
| | 3 | 6 | 0 |
| Chicks per nest | (mean) | 1.30 | |

The colonies at Tyne are on a variety of substrates, especially stone/brick (62% of the sampled nests), but also timber (mostly where birds nest on boarded-up windows of the Tyne Bridge abutments), metal (Tyne Bridge girders and Saltmeadows tower), natural rock cliff (parts of Tynemouth colony) and natural rock cliff inside concrete arch erosion defences (parts of Tynemouth colony). Extensive use of different substrate materials indicates flexibility in kittiwake nest site selection in terms of materials on which they will construct nests. Chick production varied little across the range of substrate materials in 2021.

Few kittiwakes nested on ledges that were as wide as a kittiwake nest; 86% were narrower and only 14% were slightly wider than the width of a nest. No ledges that were used by kittiwakes were more than twice the width of a kittiwake nest. All nest sites were sheltered from waves or sea spray. Most nest sites were sheltered from rain, wind and direct sun, crows and large gulls, and were inaccessible to foxes. Nevertheless, carrion crows were seen attempting to steal kittiwake eggs from nests at Tynemouth cliff in late May, apparently with some success. Three closely adjacent kittiwake nests at Tynemouth included in the study sample were destroyed by a fulmar which managed to take up ownership of the site, flattening the three nests into a suitable single platform for it to nest on, and displacing the kittiwakes from the site.

Breeding success at the 131 nest sites scored as having no shelter from direct sun averaged 1.08 chicks per nest, whereas breeding success at the 1,318 nest sites scored as having some or considerable shelter from direct sun averaged 1.32 chicks per nest. This suggests that solar heating may reduce breeding success of kittiwakes when the nest is exposed to direct sun. The Saltmeadows tower provides an interesting potential test of this; one face of the tower is to the north so is sheltered from the sun. One face is to the east, and one face is to the south-west. The tower is slightly off vertical such that the east face is tipped slightly downwards and the south-west face slightly upwards. This exposes the kittiwakes nesting on the south-west face to more direct sun, especially during the heat of early afternoon. The south-west face of the tower held only 13 nests in May and 15 in June 2021. By comparison the east face held 52 nests in May and 54 nests in June 2021. The north face of the tower held 53 nests in May and 55 in June 2021. All faces are identical in size and construction details, so only the orientation differs. This suggests that solar heating may reduce the attractiveness of the south-west facing side of the tower, although it is possible that the orientation of the three faces of the tower may introduce other differences such as exposure to human disturbance, or wind. Nevertheless, many pairs do nest successfully on the sites that are fully exposed to the sun, and some nest sites on the exposed side of the tower are clearly used each year. Summer temperature and sunshine were above average at the Tyne in 2021 (Met Office 2021) which may emphasise the importance of this factor.

Although 944 nest sites were scored as at no risk of human disturbance, in most cases because they were on buildings not accessible to the public (e.g. Akzo Nobel, where the building on which kittiwakes nest is in private land from which the public are excluded and the birds nest on the north face of the building, overhanging the riverside so that any access that could create human disturbance is highly restricted) or high up on buildings well beyond even stone throwing range (e.g. Baltic Arts Centre), 452 nests were scored as somewhat vulnerable to human disturbance, and 53 as at high risk of human disturbance. The last category includes some nests on Tyne Bridge where birds are at road level only some cm from the footpath adjacent to the four-lane trunk road carrying heavy traffic, and birds nesting relatively low down on buildings in busy areas of Newcastle Quayside and low down on the Tyne Bridge (e.g. Photo 3.2.1).


**Photo 3.2.1. Disturbance risk for some kittiwake nests low down on the Tyne Bridge abutments was assessed as high**

Nests scored as at high risk of human disturbance averaged 1.30 chicks per nest; nests scored as at moderate risk of human disturbance averaged 1.28 chicks per nest; nests scored as not being at risk of human disturbance averaged 1.31 chicks per nest. The similar breeding success of pairs with different risk of human disturbance suggests that human disturbance was not a major factor affecting breeding success of Tyne kittiwakes in 2021.

Some nest sites used by kittiwakes are on structures where deterrent methods are in place to try to reduce breeding numbers of kittiwakes. Those include spikes on ledges, electric shock wires, optical gel fires, and exclusion netting. Many of the buildings where these deterrents have been used still have kittiwakes nesting at their established nest sites despite deterrence, but numbers have been reduced, especially by deployment of exclusion netting and electric shock wires (D.M. Turner, pers. comm., and data in annual monitoring reports up to Turner 2019). At sites where buildings have had exclusion netting placed over areas that had previously held kittiwake nests, some pairs have rebuilt nests on top of the netting (e.g. Photos 3.2.2. and 3.2.3.) In some cases they were successful with that strategy, but some nests were broken up by wind moving the netting and breaking up the nest structure.

**Photo 3.2.2. Kittiwake incubating on a nest constructed on top of exclusion netting on the Guildhall, Newcastle Quayside.**

**Photo 3.2.3. Kittiwake nest constructed on top of exclusion netting on a building at Newcastle Quayside.**

**Photo 3.2.4. Kittiwake nests constructed on top of anti-bird spikes on the Guildhall at Newcastle Quayside**

At two sites, Vermont Hotel and Vermont Aparthotel, kittiwake nests, at which birds were incubating eggs in late May, had disappeared completely by late June. No nests disappeared from other sites during that period, but all three nests that were on window ledges of Vermont Hotel completely disappeared, as did four of six nests on Vermont Aparthotel.

Overall, breeding success in 2021 showed very little, if any, relationship with the level of deterrence of kittiwake nesting evident at each site. The 40 nests where deterrence was scored as 'high' averaged 1.18 chicks per nest, the 232 nests where deterrence was scored as 'some' averaged 1.46 chicks per nest, whereas the 1,177 nests where there was no deterrence averaged 1.27 chicks per nest. While deterrents may reduce numbers of kittiwakes attempting to breed on a particular structure, the numbers of nests destroyed during breeding in 2021 were small (probably a total of no more than ten) in relation to losses caused by other factors in this relatively large population.

Overall, numbers of chicks reared at Tyne nests suggested a weak relationship with the number of kittiwake nests within 5 m. For broods of three the mean number of kittiwake nests within 5 m was 27.7 nests (although the sample size was only 6 nests), for broods of two it was 23.5, for broods of one it was 20.6 and for failed nests it was 17.6. These data suggest that kittiwakes benefit in terms of breeding success from nesting at higher density.

## 3.3 Lowestoft

Features of 645 kittiwake nests at Lowestoft that were readily visible in late May 2021 from public access areas or from private land within ABPorts site at Lowestoft Outer Harbour are summarised in Table 3.3. These represent almost all of the kittiwake nests in Lowestoft, although some additional nests were constructed between the visits in May and June, increasing the number of AONs by about 5% over that period, and one site was overlooked in May, so that the total population size in 2021 was ca. 700 AONs. The 5% increase in AONs between May and June visits was a larger proportional increase than at Dunbar or Tyne, despite the timing of breeding being slightly earlier at Lowestoft than at the other two sites, and may indicate a more rapid rate of population growth at Lowestoft, with larger numbers of new birds joining the population relatively late in the season. Lowestoft not only has kittiwakes nesting on piers and on buildings adjacent to the harbour, but there are also considerable numbers nesting on many buildings surprisingly far from the sea, including in the main downtown shopping street (London Road North). For example, the BT building and Our Lady Star of the Sea RC Church are both about 650 m inland from the sea, but more strikingly the commute from nests on these buildings to the sea takes kittiwakes over four or five roads, including a major trunk road, and over four to six blocks of buildings between the roads, before reaching water. The distance is trivial in relation to the typical foraging range of breeding kittiwakes (up to 770 km with a mean maximum range of 156.1 km; Woodward et al. 2019), but it represents a move much further 'inland' than is normal for this cliff-nesting seabird. Photographs showing some examples of the colony are included in Annex D.

**Table 3-3 Summary scores for sample of kittiwake nests at Lowestoft in 2021.**

| Metric | Category | Number | Percent of sample |
|---|---|---|---|
| Base material | Stone/brick | 483 | 75 |
| | Timber | 161 | 25 |
| | Metal | 1 | 0 |
| Ledge width | Less than a kittiwake nest width | 643 | 100 |
| | Between one and two kittiwake nest widths | 2 | 0 |

| Metric | Category | Number | Percent of sample |
|---|---|---|---|
| | More than twice the width of a kittiwake nest | 0 | 0 |
| Shelter from rain | None | 35 | 5 |
| | Partial | 478 | 74 |
| | Considerable | 132 | 21 |
| Shelter from wind | None | 36 | 6 |
| | Partial | 466 | 72 |
| | Considerable | 143 | 22 |
| Shelter from sun | None | 70 | 11 |
| | Partial | 422 | 65 |
| | Considerable | 153 | 24 |
| Shelter from crows/large gulls | None | 8 | 1 |
| | Partial | 504 | 78 |
| | Considerable | 133 | 21 |
| Neighbouring nests adjacent | None | 140 | 22 |
| | One on one side | 249 | 38 |
| | One on each side | 256 | 40 |
| Walls at side of nest | None | 483 | 75 |
| | One on one side | 140 | 22 |
| | One on each side | 22 | 3 |
| Access for fox or mink | No likely risk of access to nest | 526 | 82 |
| | Apparent risk of access to nest | 119 | 18 |
| Human disturbance likely | No likely human disturbance | 302 | 47 |
| | Some vulnerability to human disturbance | 245 | 38 |
| | High vulnerability to human disturbance | 98 | 15 |
| Shelter from waves/sea spray | Poor | 171 | 27 |
| | Good | 474 | 73 |
| Human deterrence of nesting | None evident | 528 | 82 |
| | Some | 68 | 11 |
| | Considerable evidence of deterrence | 49 | 7 |
| Nest at edge of colony | No | 145 | 22 |
| | Yes | 500 | 78 |
| Nests within 5 m and visible | 0-4 | 83 | 13 |
| | 5-9 | 175 | 27 |
| | 10-19 | 123 | 19 |
| | 20-49 | 187 | 29 |
| | 50 or more | 77 | 12 |
| Layers of nests above | No | 426 | 66 |
| | Yes | 219 | 34 |
| Layers of nests below | No | 435 | 67 |

| Metric | Category | Number | Percent of sample |
|---|---|---|---|
| | Yes | 210 | 33 |
| Chicks produced | 0 | 157 | 24 |
| | 1 | 222 | 35 |
| | 2 | 254 | 39 |
| | 3 | 12 | 2 |
| Chicks per nest | (mean) | 1.19 | |

Most nest sites at Lowestoft were on stone, because most nests were situated on buildings. One was on metal, on top of a street light. None were on natural rock cliff, but a substantial number were on timber, at Claremont Pier, and Waveney Dock, the latter site also having large numbers of tyres with many of the kittiwake nests on timber but with tyres providing a 'wall' beside the nest, and occasionally the nest built on a tyre itself.

Almost all nests were on ledges scored as less than the width of a kittiwake nest, so that nests overhang the edge of the ledge. Only two nests were scored as being on ledges marginally wider than the width of a kittiwake nest.

Although most nest sites were scored as providing some or considerable shelter from direct sun, 70 nests were on sites where there was no shelter from direct sun. This represents only 11% of all the nest sites studied at Lowestoft, so suggests that kittiwakes tend to select nest sites that are not usually exposed to direct sun. However, those 70 sites produced an average of 1.39 chicks per nest, suggesting that direct sun did not have any strong adverse effect on breeding success. By comparison, nests scored as slightly sheltered from direct sun (n=422) produced an average of 1.22 chicks per nest, and nests scored as strongly sheltered from direct sun (n=153) produced an average of 1.01 chicks per nest. Many of the nests that were strongly sheltered were in Waveney Dock, where nest success may have been influenced by other factors, but the comparison suggests that exposure to direct sun is not a key factor determining nest failure for this population. Considering only those birds nesting on the church, nests exposed to direct sun (n=45) produced an average of 1.31 chicks per nest whereas nests on the church that were scored as sheltered from direct sun (n=130) produced an average of 1.41 chicks per nest. This comparison is of nest sites that are like for like in most other respects, and suggests that exposure to direct sun may have a slight adverse effect on breeding productivity, but that direct sun does not necessarily prevent pairs from achieving high breeding success. Summer temperature at Lowestoft was close to the long-term average, and sunshine was slightly below average (Met Office 2021) so exposure to sun may have had less impact in 2021 than it might in other years.

Nest sites scored very highly in terms of shelter from rain (95% of sites somewhat or well sheltered), wind (94% of sites somewhat or well sheltered), and shelter from crows and large gulls (99% somewhat or well sheltered). There were large numbers of rooftop-nesting herring gulls and lesser black-backed gulls in Lowestoft (Annex 2), including on roofs of some of the buildings where kittiwakes nest, so there is considerable potential for interactions between large gulls and kittiwakes. During the May visit, several large gulls showed interest in kittiwake nests on buildings in Lowestoft, but no successful predation was observed during that visit, or during either of the subsequent visits. Kittiwakes did not avoid nesting on buildings where large gulls had nests on the roof, suggesting that their selection of nest sites on narrow ledges, out of reach from wider surfaces where a large gull could perch, provided adequate protection from large gulls.

Although the majority of nest sites were scored as safe from fox or mink access, a substantial minority (119 nest sites, representing 18% of the total) were scored as at risk of mammal access. Those were mostly the nest sites in Waveney Dock, which were on the edge of the dock (Photo 3.3.1) and appeared potentially vulnerable to mink (and possibly rats). Although the Waveney Dock is very sheltered, due to being very close to water level, those sites also were scored as being at risk from waves. They would potentially also be at risk of disturbance by any boats that berthed along that part of the harbour. Breeding success of kittiwakes at nests in Waveney Dock was lower than for Lowestoft in general (Waveney Dock, n=104 nests, average 0.87 chicks per nest; Lowestoft total n=645, average 1.19 chicks per nest), but the cause of the lower productivity at Waveney Dock nests is unclear.

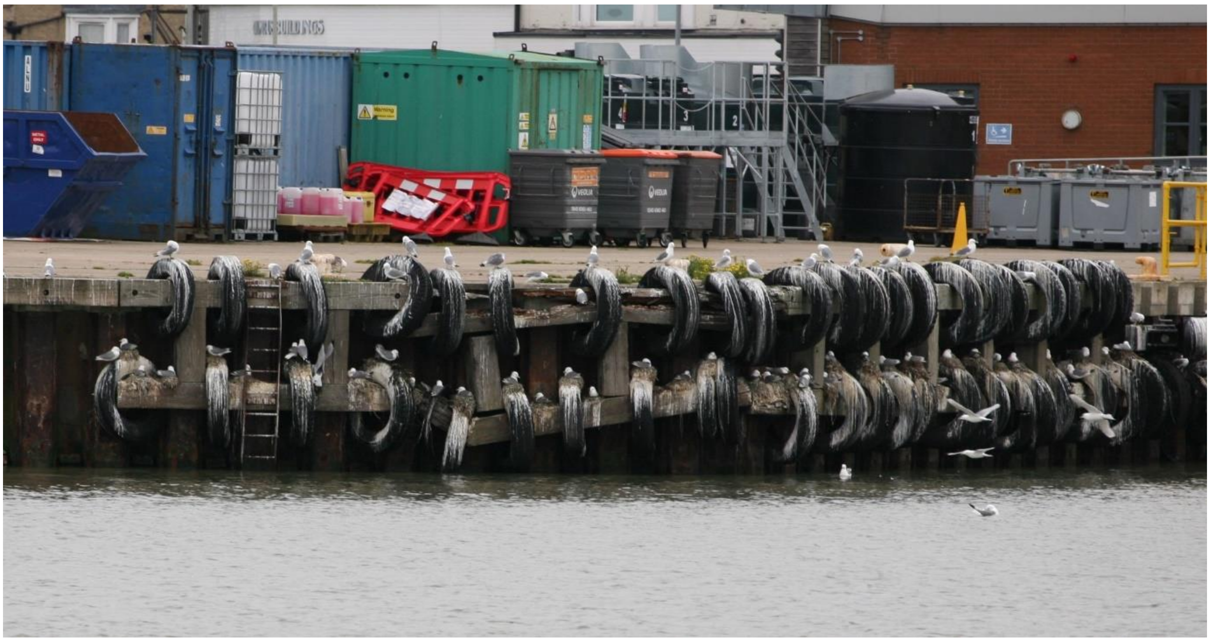

**Photo 3.3.1. Part of the Waveney Dock kittiwake colony. Note the relatively easy access to these nests for mink or rats, and also the potential vulnerability of these nests to wave wash from vessel movements in the dock area.**

Some kittiwake nest sites on Claremont Pier were also scored as at risk from waves and sea spray. The risk there seems likely to be highest for nests towards the seaward end of the pier, and least for nests closest to shore. However, the risk from human disturbance at Claremont Pier will show the opposite trend, being high at the landward end of the pier but very low at the seaward end, particularly because the pier is no longer considered safe for public use so there is no public access onto the pier structure and human disturbance is therefore mostly from the public accessing the beach below and adjacent to the pier. This beach is very busy in summer, and large numbers of people walk, play and sunbathe very close to the kittiwake nests at the landward end of the pier. It is noteworthy that kittiwakes generally do not nest on most of the seaward part of the pier, where possibly wave action and sea spray during rough weather may damage nests. Nor do they nest on the landward end of the pier with highest human activity; nests are mostly in the section of the pier that is somewhat protected from human disturbance by the sea but in the shallower water where wave height will be less during storms. Numbers of nests on Claremont Pier seem to have increased less than numbers at many other sites in Lowestoft, suggesting that kittiwakes are reluctant to colonize the parts of the pier most at risk from waves and spray and the parts most at risk from human disturbance. However, birds nesting closest to shore are remarkably tolerant of humans, remaining on the nest when people walk within 2 m of their nests, and several of the nests at the inshore part of the pier successfully reared chicks in 2021, despite very high numbers of people in that area, especially during the kittiwake chick-rearing period in June-July.

Overall, 245 nest sites at Lowestoft were scored as at some risk from human disturbance and 98 sites as highly vulnerable to human disturbance, with 302 nest sites scored as not vulnerable to human disturbance. However, productivity was almost the same in all these three groups: high risk of human disturbance (n=98) average of 1.19 chicks per nest, some risk (n=245) average of 1.18 chicks per nest, no risk of human disturbance (n=302) average of 1.19 chicks per nest. Human disturbance seems not to have been a significant driver of kittiwake breeding success at Lowestoft in 2021. The fact that large numbers of nest sites appear vulnerable to human disturbance also suggests that kittiwakes are sufficiently tolerant of human activity to be able to nest successfully over many years on nest sites close to high levels of human activity, urban and industrial noise.

With kittiwakes nesting on a large and increasing number of buildings in Lowestoft, it is not surprising that deterrents are now being deployed at a number of sites where the birds are unwelcome. The 49 nests where deterrence was scored as ‘high’ averaged 1.08 chicks per nest, the 68 nests where deterrence was scored as ‘some’ averaged 1.18 chicks per nest, whereas the 528 nests where there was no deterrence averaged 1.20 chicks per nest. Although active deterrence of kittiwake nesting appears to have reduced breeding success of kittiwakes in 2021, the reduction is perhaps surprisingly small, and even on sites with apparently high levels of deterrence, kittiwakes produced relatively high numbers of chicks compared to the typical productivity at many natural colonies.

There is evidence from survey data of numbers being reduced at some sites as a result of deterrence and/or renovation of buildings. For example, there were 36 AONs on Columbus Buildings in 2017 (CH2M 2017), but only two AONs there in 2021. At the BT building, exclusion netting was put up early in 2021 to deter kittiwakes from nesting; there were 49 AONs on that building in 2017 (CH2M 2017). Kittiwakes were prevented from accessing their traditional nest sites on most of that building in early 2021, but in response to local concerns about kittiwake conservation, BT constructed new artificial ledges for the displaced kittiwakes on one face of their building in early May 2021. However, on 26 May 2021 the BT site had only 21 AONs, plus some tens of displaced birds without nests. On 19 June there were 37 AONs, so some of the displaced birds had built nests relatively late as a result of the exclusion netting and provision of new artificial ledges on the building. On 18 July the 37 AONs held 32 chicks, so produced 0.86 chicks per nest, a much lower productivity than in most sites in Lowestoft, with the reduced productivity being attributable to the exclusion of most of the established pairs from their traditional nest sites on the building, and the late opportunity to relocate onto new artificial ledges.

Exclusion netting was also erected at Station Square over two-thirds of the upper front of a building (covering the part above Papa John’s Pizza shop, but not over the semi-detached neighbour). There were 21 AONs on that building in 2017 (CH2M 2017), and Google Streetview shows 34 AONs were present in July 2019. In May 2021 there were 17 AONs on the building, all on the one-third not covered by netting. In addition, several pairs colonized window-ledges on the end of the building which had not previously been occupied by kittiwakes, and one pair nested on a street light in front of the building. It is not certain that these new nest sites were occupied by birds displaced from the front of the building by exclusion netting, but that seems likely.

There are several buildings, particularly on London Road North, where exclusion netting has been erected and where there is now less opportunity for kittiwakes to nest. However, the sophistication of deterrence at Lowestoft is less developed than at sites in Newcastle Quayside; several sites in Lowestoft have deployed spikes along ledges, but those seem to have little or no effect in deterring kittiwakes from nest building (as shown for example in Photo 3.2.3, but there are many examples such as that). At least two sites in Lowestoft were deploying vocalisations of birds of prey as deterrents though possibly aimed as much at pigeons and herring gulls as at kittiwakes. There was no evidence to suggest that kittiwakes were paying any attention to those broadcast calls. Several sites had deployed plastic owl or plastic peregrine models; again there was no evidence to suggest that kittiwakes paid any attention to those. Anecdotally, one kittiwake nest which produced two chicks was within 1 m of a plastic owl that had a head that rotated through 360 degrees in the wind, but the kittiwakes were completely unresponsive to the model owl and its rotating head.

As at the Tyne, there were a very few sites where nests disappeared completely between visits. For example, there were 6 AONs at one house in May and 7 AONs there in June, but all traces of all 7 nests and the chicks that had been in them in June were gone in July. A very high number of failed nests at sites on another street also suggests that deliberate interference may have occurred at those sites. Nevertheless, the numbers of nests affected in this way were too few to have a noticeable influence on the productivity of the Lowestoft kittiwake population.

## 3.4 Lowestoft Harbour Wall artificial ledge

Two ledges were constructed on Lowestoft Harbour wall in 1989 specifically to provide a nesting site for kittiwakes that were going to be displaced from the nearby Pier Pavilion on which kittiwakes were nesting and which was scheduled for demolition. The ledges are located immediately on the north side the main entrance into Lowestoft Harbour, on the inshore side of the outer wall of the harbour, so sheltered from the sea, and also as far from human activity on the ground as possible within the harbour itself. The ledges were colonized immediately by kittiwakes, and nesting numbers there increased to 259 pairs in 1995, more than double the highest number nesting on the pavilion in its final year of use in 1998 before demolition (Brown and Grice 2005). Old photographs (e.g. Photo 3.4.1) show kittiwakes nesting on the two ledges, with apparently slightly larger numbers on the upper ledge, and a few adults resting along the layer below the two ledges (and indeed one or two pairs nesting there) or resting on top of the wall.

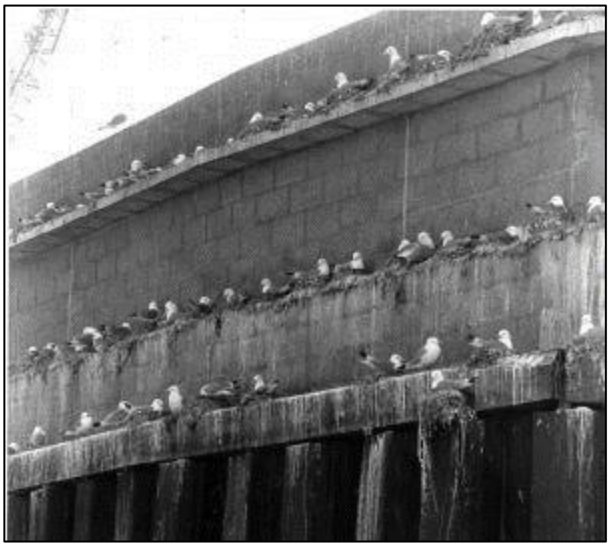

Photo 3.4.1. Kittiwakes nesting on ledges along the harbour wall in Lowestoft, Suffolk in 1989 (Photo from https://www.suffolkarchives.co.uk/places/suffolk-day-2018/k-is-for-kittiwakes/)

Photo 3.4.2. The artificial ledge in 2017 (photo by Andrew Easton, published in The Lowestoft Journal).

Kittiwakes nested there as recently as 2017 (Photo 3.4.2). However, despite the success for many years (from 1989 to 2017), the site was abandoned by kittiwakes in 2017, apparently as a result of predation by foxes and herring gulls. Although these ledges are now no longer used for nesting by kittiwakes, in May 2021 there were twelve kittiwakes standing on these ledges, clearly showing an interest in the possibility of nesting there, and a few birds were carrying nesting material to the ledges. However, no nests were completed, and no kittiwakes were on these ledges during observations in June or July 2021.

Nevertheless, it is interesting to note that ABPorts consider that it would be desirable to renovate the ledges to make them more suitable for kittiwakes. In that context, it is worth noting that all three ledges on the wall are much wider than would be ideal for kittiwakes; in particular the upper and lower ledge are so wide that it would be very easy for foxes to walk all the way along those ledges, and for herring gulls or lesser black-backed gulls to land on those ledges and walk to each kittiwake nest in turn to remove eggs or chicks. The abandoned ledges are shown in Photos 3.4.3, 3.4.4 and 3.4.5, all taken in May 2021. Even the narrowest of the three ledges (the middle one) is too wide to be ideal for kittiwakes. In addition, the three ledges have no baffle at the landward end, so that foxes could easily jump up onto the end of the ledge and walk along. Some wire mesh is hanging from the top of the wall, but serves no useful purpose. Previously used kittiwake nests were removed from these ledges by ABPorts to clean up the site. ABPorts have the intention of improving it for kittiwakes to reoccupy, but work to do so has not yet begun.

**Photo 3.4.3. The artificial ledge in May 2021, showing the general appearance, and a few kittiwakes showing some interest in holding sites on the ledges**

Photo 3.4.4. The artificial ledges in May 2021, showing the width of these ledges to be considerably greater than that normally selected for nesting by kittiwakes (compare for example with Photos 3.1.2 and 3.2.3)

Photo 3.4.5. The artificial ledge in 2021, showing the upper ledge and wire mesh put above, possibly intended to exclude herring gulls from landing on the ledge

## 3.5 Nonbreeding birds

At Dunbar Harbour, a discrete 'club' of nonbreeding kittiwakes was present in late May and in late June, roosting on the rocks close to the harbour entrance. There were 220 kittiwakes in the flock there on 24 May, and 200 on 18 June. On 17 July the number was only 110. At least 60% of these club birds had some immature plumage features, so were likely to be 1 to 3 years old, rather than full adults of potential breeding age. However, about 40% appeared to be in full adult plumage, so may be birds of potential breeding age. There was no sign of any birds moving between attended nests and this flock, suggesting that there were probably no off-duty breeding birds in the flock.

At Tynemouth, a club of 150 birds was settled on rocks adjacent to the colony on 24 May. Similar numbers were present in June, but many fewer in late July. About 60% of the birds in the club flock had clear signs of immature plumage whereas about 40% appeared to be in fully adult plumage. At Akzo Nobel a club flock of 100 birds was roosting on the roof of the factory, with another club flock of 80 birds along the edge of the river on the waterfront retaining wall. In late May, at Saltmeadows tower and at Baltic Arts Centre, club birds gathered in flocks, each of about 100 birds, that spent most of their time in the river, bathing or roosting. Another flock of about 80 birds was present in May on the roof and on the metal railing high on the Baltic Arts Centre, and a flock roosted on the derelict ground on the north shore of the Tyne opposite the Saltmeadows tower. At Newcastle-Gateshead in the vicinity of Tyne Bridge, a flock of about 250 birds roosted on the timber base of the Swing Bridge just up-river from the Tyne Bridge. Another 50 birds roosted on the roofs of buildings on the east side adjacent to the north end of Tyne Bridge, another 50 on the bases of the supporting structures of the High Level Bridge, and another 30 on the river wall in front of the Royal Navy building at Gateshead. Numbers at those sites were similar in June, but far fewer birds were present during the late July visit.

In Lowestoft, there was a club flock of kittiwakes that roosted on the seaward end of Claremont Pier. There were 260 birds in that flock in May and 245 on 20 June, but very few were present in July. About half of the birds in that flock had some visible immature plumage. A flock of 100 was present in a club on the roof of the Britten Shopping Centre in May and in June, but was not present in July. A flock of 60 birds was on the church roof (away from the nesting area on the tower) in May, and 40 were there in June. Those birds had gone by late July. At Waveney Dock there were 50 kittiwakes in a flock at the former nesting area by the harbour entrance (now not used by breeding birds), and 60 in a flock on the concrete dock area adjacent to the SSE lease. Both those flocks were absent in June and in July.

# 4 DISCUSSION

## 4.1 Nest site features

Kittiwakes showed strong and consistent nest site features at Dunbar, Tyne and Lowestoft. There was very strong use of narrow ledges. At Dunbar and Lowestoft, 100% of sites were on ledges that were less than the width of a kittiwake nest (300 mm). At Tyne, 86% were in that category, and many of those were on ledges that were considerably less than 150 mm (see for example Photo 4.1.1), and 14% were between 1 and 2 nest widths. None were more than 2 times a nest width (i.e. 600 mm). Many ledges were available at all three sites that were much wider; those were not used by kittiwakes.

Despite the strong selection for narrow ledges, three kittiwake nests were taken over by a fulmar, and some predation of eggs and chicks appears to have occurred, emphasising the importance of narrow ledges for this species. These observations are entirely consistent with the statement by Coulson (2011) that kittiwakes almost invariably select very narrow ledges for their nests, and that this is important in reducing risk of nest sites being taken over by other seabird species and in minimizing risk of predation of eggs and chicks.

**Photo 4.1.1. Some of the narrowest ledges used by kittiwakes are on the Tyne Bridge where chipboard covers have been placed over the windows of the bridge abutment towers below the road level.**

There was a strong tendency for kittiwake nests to be sheltered from crows and large gulls (96% at Dunbar, 100% at Tyne, 99% at Lowestoft). This consistently very high proportion of nest sites that appeared sheltered from larger avian predators suggests that kittiwakes select strongly for safe nest sites in terms of predation risk, or that predation is a strong selective pressure leading to abandonment of more vulnerable sites. The latter would be consistent with the observed abandonment of the Lowestoft harbour wall ledge, where predation by gulls was thought to be a serious problem in 2017 though had not been in earlier years.

There was a strong tendency for kittiwake nests to be sheltered from direct sunshine (96% at Dunbar, 91% at Tyne, 89% at Lowestoft). There was also some evidence to suggest that kittiwakes are more likely to abandon sites that are exposed to direct sunshine. At Dunbar and at the Tyne, nests exposed to direct sunshine had slightly lower breeding success in 2021 than nests sheltered from the sun. However, that was not the case at Lowestoft; it may be relevant that summer sunshine was slightly below average in 2021 at Lowestoft, but was slightly above average at Dunbar and Tyne (Met Office 2021). Numbers of nests on the SW face of Saltmeadows tower were much lower than on the other two faces that are more sheltered from the sun, and there were slightly more nests on the north side of Tyne bridge abutments than on the south side on the section above the road (where the south-facing sides are exposed to the sun). In 2021, the Northumbria Ringing Group ringed kittiwake chicks on the Saltmeadows tower on 5 July. They ringed 14 chicks on the south face, 63 on the east face, and 92 on the west face (Andy Rickeard, in litt.). This provides further support for the idea that kittiwake productivity may be reduced where nests are exposed to direct sunshine. In Lowestoft, numbers of kittiwake nests were similar on the north and south sides of the church tower, suggesting no strong avoidance of the sun there, but the breeding success of pairs on the south face of the tower was slightly lower in 2021 than on the north face. Although the evidence that direct sun reduces kittiwake breeding success is not strong, the data suggest that this may be the case. With climate change models predicting warmer summers and more sunshine in summer, this effect may become more important in future. It may also become more evident if kittiwakes were constrained by food shortage (so were less able to devote time to brooding or shading chicks). At present, the high breeding success at all three sites suggests that these populations are not strongly limited by food, and so may have more 'spare time' than would be the case if food was limiting. There was evidence that chicks were stressed by direct sun during July 2021; chicks that were exposed to direct sun were seen panting at several sites (e.g. Photo 3.1.4).

There was a strong tendency for kittiwake nests to be sheltered from rain (96% at Dunbar, 97% at Tyne, 95% at Lowestoft). Heavy rain can dislodge kittiwake nests or could flood nests and so chill eggs or chicks. Flooding caused by bursts of heavy rain during the breeding season is known to reduce breeding success of ground-nesting seabirds, but has also been identified as affecting some cliff-nesting seabirds, though probably to a lesser extent. Climate models indicate increased incidence of heavy rainfall events as temperatures increase, so shelter from rain is likely to be a feature that influences kittiwake breeding success, and may be increasingly important in future. However rainfall in spring 2021 and in summer 2021 was below average at all three sites (Met Office 2021).

There was a strong tendency for kittiwake nests to be sheltered from wind (100% at Dunbar, 90% at Tyne, 94% at Lowestoft). It is possible that chicks are more at risk of falling from the nest during windy conditions. However, shelter from wind tends to correlate with shelter from rain and from crows/large gulls, so the relationship may be a correlation rather than being a causal relationship.

There was a strong tendency for kittiwake nests to be on sites that appeared unlikely to be accessible to foxes or mink (96% at Dunbar, 98% at Tyne, 82% at Lowestoft). At Lowestoft, many nest sites on Waveney Dock and Trawler Dock looked highly vulnerable to access by mink or rats, and those sites did have relatively low breeding success in 2021. However, they were also vulnerable to wave wash and the cause of the low breeding success is unknown.

There was a strong tendency for kittiwake nests to be sheltered from the risk of waves or sea spray during storms (100% at Dunbar, 100% at Tyne, 73% at Lowestoft). At Lowestoft, many nest sites on Waveney Dock and Trawler Dock, and some on the outer part of Claremont Pier, looked highly vulnerable to seawater. At Waveney Dock and Trawler Dock the sites looked vulnerable to wave wash caused by vessel movements but would be less vulnerable to storm effects because the harbour is relatively sheltered. Those sites did have relatively low breeding success in 2021. However, they were also considered to be vulnerable to mammal predators such as mink or rats and the cause of the low breeding success is unknown.

At Dunbar and Tyne, breeding success in 2021 was higher where kittiwake nest density was higher. There was no obvious influence of nest density on breeding success in 2021 and nest density at Lowestoft. Other factors seem to be more important there.

At Dunbar, breeding success in 2021 was higher for kittiwakes which nested in the 'centre' of the colony and was lower for nests on the edge. There was no obvious influence of centre-edge on breeding success in 2021 at Tyne or at Lowestoft. Other factors seem to be more important at those sites.

Vulnerability to human disturbance is difficult to score and the probability of human disturbance may not be closely related to assessed vulnerability. For example, the Saltmeadows tower is located within a fenced meadow between an industrial area and the river, where numbers of people going near to the structure are very small. Most people passing that area are dog walkers or walkers who are unlikely to disturb kittiwakes that are on the tower. In contrast, some nests on the Tyne Bridge are very accessible to passing people so seem very vulnerable to disturbance. For example, council staff using pressure hoses to wash kittiwake droppings off the walls and pavement could rather easily wash nests off by accident. However, there have been instances of people throwing stones at kittiwake nests 'for fun' at Tynemouth cliffs and at Saltmeadows tower, whereas such behaviour is perhaps less likely in busy areas such as Newcastle Quayside. So a clear relationship between breeding success in any one year and perceived vulnerability to human disturbance may be difficult to find. At Dunbar, breeding success of pairs at sites assessed as vulnerable to human disturbance was slightly lower that at sites assessed as not being vulnerable. At Tyne and Lowestoft, there was no difference. At Dunbar, there was evidence that a number of kittiwake nests closest to the (new) piles of pots and nests of fishermen on the harbour edge had been abandoned in the last few years, suggesting that birds found the activity in that area too much to be compatible with nesting low down on that wall.

There was no deployment of deterrents and apparently no deliberate nest destruction at Dunbar. At Tyne and at Lowestoft, a small minority of kittiwake nest sites were on buildings where deterrents were deployed, and a small number of nests 'disappeared' between visits in a way suggesting that nests had been destroyed. Because the proportion of the total nest sites that were on buildings deploying deterrents or destroying nests was small, the influence on breeding success overall was small. At Tyne, breeding success on sites deploying the strongest deterrents was slightly lower than on other sites. At Lowestoft, sites deploying deterrents showed lower breeding success than those without deterrents. Nevertheless, the difference was small. In summary, other factors seem to influence breeding success more.

## 4.2 Colony productivity and demography

Breeding success of the study kittiwakes in 2021 was very good at Dunbar (1.17 chicks per nest for the sample of 507 AONs), Tyne (1.30 chicks per nest for the sample of 1,449 AONs) and Lowestoft (1.19 chicks per nest for the sample of 645 AONs). These figures will differ slightly from those reported by local monitoring as the AONs selected in this study will differ from the AONs sampled by local monitoring. Also, this study excluded nests that were first seen in June but had not been identified as AONs in May. Comparisons with previously published data on productivity must be made with caution. However, in all three sites in 2021 kittiwake breeding success was well above the 0.8 chicks per pair required to balance typical losses due to annual mortality Coulson (2017). High breeding success has been reported for these three sites over recent years. At Lowestoft, it has been suggested that the high breeding success may relate at least in part to the availability of a local stock of sprats in addition to the presence offshore of sandeels.

Regurgitates have been collected from kittiwakes ringed at sites in Lowestoft each year between 2007 and 2016 (M. Swindells, in litt.). A total of 179 samples included 114 containing sandeels and 93 containing clupeids (sprats, where species could be identified). Other prey were relatively scarce, but included gadids (mainly whiting) in 14 regurgitates, and crustacea (shrimps) in five. Sampling during ringing limits the data to one or two days in late June or early July in most years. Nonetheless, in most years sandeels were the most frequent prey, with sprats appearing to represent an important alternative and possibly were the predominant prey in a few years. The high breeding success that has been a feature of the Lowestoft kittiwakes may at least in part be due to the availability of sprats as prey in addition to sandeels. At the Saltmeadows tower, Gateshead, all regurgitates sampled in 2020 were sandeels; samples from 2021 have yet to be analysed. However, at Howick, Northumberland, some kittiwakes regurgitated sprats as well as sandeels in 2021 (Andy Rickeard, in litt.). The importance of sprats for these populations remains uncertain, but appears to be higher than for kittiwake colonies in north or east Scotland.

Many kittiwakes have been colour ringed at Lowestoft and at Saltmeadows tower. Many have been BTO metal ringed as chicks and adults at Dunbar, Tyne and Lowestoft. There is scope to develop a more coordinated programme at those sites to increase ringing effort and effectiveness of resighting of colour ringed individuals, as advocated by O'Hanlon et al. (2021). Monitoring of adult survival and of meta-population structure (movements of birds ringed as chicks to breed elsewhere) could be further developed at these sites.

## 4.3 Colony and site growth

Numbers of kittiwake AONs/pairs at Dunbar appear to have remained moderately stable since the 1990s, with a similar number in 2019 (713 pairs) and 2020 (808 pairs) to the numbers present in the 1990s (640 to 1,000 pairs; Coleman et al. 2011). Breeding numbers at Dunbar may have increased up to around 2010 and decreased slightly over the last ten years, but there are no data in the JNCC SMP database for years since 2008 (JNCC 2021). Numbers at River Tyne sites have been increasing (548 pairs in 2001, 994 in 2010, 1,257 in 2015, 1,705 in 2019 (Turner 2019). Numbers at Lowestoft (including town, harbour and pier) have increased considerably (185 pairs in 2010 (JNCC 2021), 390 pairs in 2017 (CH2M 2017), 446 pairs in 2018 (JNCC 2021), 700 pairs in 2021 (this study)). The growth in breeding numbers within Lowestoft is variable among sites, which is interesting as it suggests that some sites are possibly either full to capacity (have no remaining potential nest sites of high quality), or are less attractive because they consistently achieve lower productivity than other sites nearby. For example, numbers nesting on the church increased from 100 pairs in 2017 (CH2M 2017) to about 200 pairs in 2021 (an increase of 100%), whereas numbers nesting in Waveney Dock increased from 94 pairs in 2017 (CH2M 2017) to 104 pairs in 2021 (an increase of only 11%) and numbers nesting on Claremont Pier increased from 45 pairs in 2017 (CH2M 2017) to 58 pairs in 2021 (an increase of 29%). The relatively small increase at Waveney Dock is consistent with most possible nest sites along that dock edge being occupied. The smaller increase at Claremont Pier than on the church or for Lowestoft as a whole is interesting as there are many posts and beams on the pier that are not occupied by kittiwakes, perhaps giving further support to the suggestion that the seaward part of the pier may be too exposed to wave and spray impacts during storms and the landward part of the pier may be too exposed to mammal predators or human disturbance.

### 4.4 Immatures seeking to recruit

Kittiwake adult mortality is typically 0.146 (Horswill and Robinson 2015), therefore a colony of 800 pairs would require an average of 234 birds to recruit into the colony each year to maintain stable numbers. Recruitment to replace overwinter mortality most likely takes place in April and early May, so would already have occurred before the first visit in late May. Nevertheless, there were 220 birds in a 'club' flock at Dunbar in late May, which may have been looking for the opportunity to recruit in spring 2022. That flock was a snapshot count on one date, and will no doubt involve turnover of individuals spending some time at a variety of colonies. But it suggests that the pool of immatures seeking to recruit is of an appropriate scale for the size of that colony. There were 150 birds in a 'club' flock at Tynemouth (local population about 350 pairs), 150 at Akzo Nobel (local population about 220 pairs), 180 at Saltmeadows (local population about 120 pairs), 180 at Baltic Four Mill (local population about 200 pairs) and 350 near Tyne Bridge (local population including Newcastle Quayside around 900 pairs). These flocks of nonbreeders suggest that there is a healthy pool of nonbreeders that are seeking to join the breeding populations. Similarly, at Lowestoft, a flock of 260 at Claremont Pier and 160 at the shopping centre and church roofs, suggests considerable recruitment pressure that is likely to maintain the current growth rate in that population at least in the short term.

### 4.5 Other considerations

Several sites currently occupied by kittiwakes at Lowestoft are private houses or commercial buildings that appear to be at risk of demolition or require redevelopment that would most likely result in kittiwakes being 'evicted'. The rapid growth of kittiwake breeding numbers at Lowestoft suggests considerable scope for improving the possibility for kittiwake population growth on sites that cause less conflict with people.

Many sites chosen by kittiwakes for nesting in Lowestoft and at Newcastle Quayside result in conflict with property owners and tenants, and nuisance for the public. While artificial structures as compensation for predicted impacts of offshore wind farms on kittiwake populations is a statutory requirement, there is undoubtedly also scope to reduce conflict between kittiwakes and people by a) education (kittiwakes are not just 'seagulls') and b) developing artificial nest sites away from urban centres by providing superior nesting opportunities 'out of town' thereby reducing the pressure on urban sites from increasing numbers of nesting kittiwakes in areas where they are unwelcome.

There is scope for a programme of kittiwake conservation action that could be a partnership between Natural England, RSPB, offshore wind developers, local ornithologists, local councils, and local businesses, in order to improve kittiwake conservation status while also reducing conflicts caused by increased urban nesting by kittiwakes.

# 5 RECOMMENDATIONS

- Any new sites developed as breeding colonies for kittiwakes should aim to provide nesting ledges that are between 80 and 150 mm wide, and no more than 200 mm wide.
- Several rows of ledges would be preferable to a single row, as kittiwakes benefit from nesting at high density. However, it would be desirable to design structures to reduce risk that birds nesting on lower ledges will be fouled by excrement ejected by kittiwakes on ledges higher up. That might be achieved by having a stepped structure with the lower ledges recessed relative to the ledges above, or a back wall angled outwards at few degrees from the vertical. Such a design could also increase shelter from rain, wind, sun and predators.
- The location should be selected to ensure shelter from waves or sea spray during storms.
- Direct access for the birds to the sea would be desirable, but seems not to be essential as kittiwakes will nest on artificial structures hundreds of metres inland. However, since 'clubs' of immature birds tend to gather close to existing colonies, locating new sites near to existing colonies would be likely to result in faster colonisation of a new site.
- Shelter from direct sun should be provided, either by selecting north, north-east or north-west-facing sites for artificial ledges, or by providing a large overhanging roof.
- Shelter from crow and large gull access should be designed into the structure. That could be achieved by providing a large overhanging roof, but is also inherent in narrow ledges.
- Shelter from rain should be designed into the structure. That could be achieved by providing a large overhanging roof.
- Any new site should be constructed to minimize risk that kittiwake nests could be accessed by fox, mink or rat.
- Construction material may be stone, brick, concrete, timber and even tyres, as kittiwakes seem content to nest on all of these. Metal may be suitable too, providing the site is sheltered from direct sun to avoid it overheating, but metal should certainly be avoided if it might be in direct sunshine.
- Ledges can be continuous without breaks, as on the Saltmeadows tower, but having stops built into ledges every 1.5 m or so may be beneficial, as kittiwakes often select nest sites against a side wall. Side walls are likely to further increase protection of the nest site against crows, large gulls, fulmars, pigeons, and mammals such as rats.
- Kittiwakes are highly tolerant of human activity and noise around their nests, so sites do not need to be away from human activity and could be compatible with industrial activity, but the noise and mess made by kittiwakes means that sites away from human residential, commercial or business areas would be preferable.
- There is a risk that effort currently being put into monitoring of kittiwake breeding numbers and breeding success (by various volunteers) may be reduced in coming years; it would be highly desirable to ensure that monitoring is able to continue, and preferably be increased in scope to improve understanding of kittiwake diets, demography, and

movements between colonies (meta-population dynamics). Increased ringing of kittiwakes should be encouraged as a key part of such monitoring.

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## 7 REFERENCES

Blight, L.K., Bertram, D.F. and Kroc, E. 2019. Evaluating UAV-based techniques to census an urban-nesting gull population on Canada's Pacific coast. Journal of Unmanned Vehicle Systems 7, 312-324.

Brown, A. and Grice, P. 2005. Birds in England. T & AD Poyser, London.

Cadiou, B., Monnat, J.Y. and Danchin, E. 1994. Prospecting in the kittiwake, *Rissa tridactyla* – different behavioural patterns and the role of squatting in recruitment. Animal Behaviour 47, 847-856.

Carroll, M.J., Bolton, M., Owen, E., Anderson, G.Q.A., Mackley, E.K., Dunn, E.K. and Furness, R.W. 2017. Kittiwake breeding success in the southern North Sea correlates with prior sandeel fishing mortality. Aquatic Conservation: Marine and Freshwater Ecosystems 27, 1164-1175.

CH2M 2017. Lowestoft flood risk management project nesting kittiwake survey.

Christensen-Dalsgaard, S., Langset, M. and Anker-Nilssen, T. 2019. Offshore oil rigs – a breeding refuge for Norwegian black-legged kittiwakes *Rissa tridactyla*? Seabird 32, 20-32.

Coleman, J.T., Coleman, A.E., Rickeard, A. and Anderson, R. 2011. Long-term monitoring of a colony of black-legged kittiwakes *Rissa tridactyla* in Scotland. Ringing & Migration 26, 9-14.

Coulson, J.C. 2011. The Kittiwake. T. & A.D. Poyser, London.

Coulson, J.C. 2017. Productivity of the black-legged kittiwake *Rissa tridactyla* required to maintain numbers. Bird Study, 64, 84-89.

Coulson, J.C. and Coulson, B.A. 2015. The accuracy of urban nesting gull censuses. Bird Study 62, 170-176.

Fairweather, J.A. and Coulson, J.C. 1995. The influence of forced site change on the dispersal and breeding of the black-legged kittiwake *Rissa tridactyla*. Colonial Waterbirds 18, 30-40.

Frederiksen, M., Wanless, S., Harris, M. P., Rothery, P. and Wilson, L. J. 2004. The role of industrial fisheries and oceanographic change in the decline of North Sea black-legged kittiwakes. Journal of Applied Ecology 41, 1129–1139.

Frederiksen, M., Wright, P. J., Harris, M. P., Mavor, R. A., Heubeck, M. and Wanless, S. 2005. Regional patterns of kittiwake *Rissa tridactyla* breeding success are related to variability in sandeel recruitment. Marine Ecology Progress Series 300, 201–211.

Furness, R.W. 2016. Impacts and effects of ocean warming on seabirds. pp.271-288 In Laffoley, D. and Baxter, J.M. (Eds.). *Explaining Ocean Warming: Causes, scale, effects and consequences*. IUCN, Gland.

Furness, R.W. and Birkhead, T.R. 1984. Seabird colony distributions suggest competition for food supplies during the breeding season. Nature 311, 655-656.

Furness, R.W. and Tasker, M.L. 2000. Seabird-fishery interactions: Quantifying the sensitivity of seabirds to reductions in sandeel abundance, and identification of key areas for sensitive seabirds in the North Sea. Marine Ecology Progress Series 202, 253–264.

Gaston, A.J., Hipfner, J.M. and Campbell, D. 2002. Heat and mosquitoes cause breeding failures and adult mortality in an Arctic-nesting seabird. Ibis 144, 185-191.

Horswill, C. and Robinson, R.A. 2015. Review of seabird demographic rates and density dependence. JNCC Report No. 552. JNCC, Peterborough.

Immer, A., Merkling, T., Chastel, O., Hatch, S.A., Danchin, E., Blanchard, P. and Leclaire, S. 2021. Spying on your neighbours? Social information affects timing of breeding and stress hormone levels in a colonial seabird. Evolutionary Ecology 35, 463-481.

Met Office 2021a. Seasonal Assessment – Spring 2021; Seasonal Assessment – Summer 2021 First 2 months – June and July 2021. Climate summaries - Met Office

Monnat, J.Y., Danchin, E. and Estrella, R.R. 1990. Assessment of environmental quality within the framework of prospecting and recruitment – the squatterism in the kittiwake. Comptes Rendus de l'Academie des Sciences Serie III Life Sciences 311, 391-396.

Northumbria Ringing Group 2021. From Get Carter to The French Connection – Gateshead Kittiwake dispersal to Northern France – Northumbria Ringing Group

O'Hanlon, N.J., Wischnewski, S., Ewing, D., Newman, K., Gunn, C., Jones, E.L., Newell, M., Butler, A., Quintin, M., Searle, K., Walker, R., Humphreys, E.M., Wright, L.J., Daunt, F. and Robinson, R.A. 2021. Feasibility study of large-scale deployment of colour-ringing on black-legged kittiwake populations to improve the realism of demographic models assessing the population impacts of offshore wind farms. JNCC Report No. 684. JNCC, Peterborough.

Olin, A.B., Banas, N.S., Wright, P.J., Heath, M.R. and Nager, R.G. 2020. Spatial synchrony of breeding success in the black-legged kittiwake *Rissa tridactyla* reflects the spatial dynamics of its sandeel prey. Marine Ecology Progress Series 638, 177-190.

Oro, D. and Furness, R.W. 2002. Influences of food availability and predation on survival of kittiwakes. Ecology 83, 2516-2528.

Oswald, S., Bearhop, S., Furness, R.W., Huntley, B. and Hamer, K.C. 2008. Heat stress in a high-latitude seabird: effects of temperature and food supply on bathing and nest attendance of great skuas *Catharacta skua*. Journal of Avian Biology 39, 163-169.

Oswald, S.A., Huntley, B., Collingham, Y.C., Russell, D.J.F., Anderson, B.J., Arnold, J.M., Furness, R.W. and Hamer, K.C. 2011. Physiological effects of climate on distributions of endothermic species. Journal of Biogeography 38, 430-438.

Piotrowski, S. 2012. Lesser black-backed gull and herring gull breeding colonies in Suffolk. Suffolk Bird Report 2012, 23-30.

Ponchon, A., Chambert, T., Lobato, E., Tveraa, T., Grémillet, D. and Boulinier, T. 2015. Breeding failure induces large scale prospecting movements in the black-legged kittiwake. Journal of Experimental Marine Biology and Ecology 473, 138-145.

Ponchon, A., Aulert, C., Le Guillou, G., Gallien, F., Péron, C. and Grémillet, D. 2017a. Spatial overlaps of foraging and resting areas of black-legged kittiwakes breeding in the English Channel with existing marine protected areas. Marine Biology 164, 119.

Ponchon, A., Iliszko, L., Grémillet, D., Tveraa, T. and Boulinier, T. 2017b. Intense prospecting movements of failed breeders nesting in an unsuccessful breeding colony. Animal Behaviour 124, 183-191.

Potts, G.R., Coulson, J.C. and Deans, I.R. 1980. Population dynamics and breeding success of the shag, *Phalacrocorax aristotelis*, on the Farne Islands, Northumberland. Journal of Animal Ecology 49, 465-484.

Reiertsen, T.R., Jacobsen, K.O., Holmgaard, S.B., Wilson, H., Rafter, E., and Eide, B. 2019. Urban kittiwakes – human/kittiwake co-existence in urban space. http://www.ifram.no/db.343156.no.html?lid=575.cb601dbd3eaa6495273b608176e1fd8a

Swindells, M. 2019. Non-breeding movements of black-legged kittiwakes *Rissa tridactyla* from a North Sea urban colony. Seabird 32, 33-45.

Thompson, K.R. and Furness, R.W. 1991. The influence of rainfall and nest site quality on the population dynamics of the Manx shearwater *Puffinus puffinus* on Rhum. Journal of Zoology, London 225, 427-437.

Turner, D.M. 2010. Counts and breeding success of Black-legged Kittiwake *Rissa tridactyla* nesting on made-made structures along the River Tyne, northeast England, 1994–2009. Seabird 23, 111–126.

Turner, D.M. 2019. Black-legged kittiwake *Rissa tridactyla* breeding data recorded on the River Tyne during 2019. Summary Report (version 4), 15 December 2019.

Velando, A. and Freire, J. 2003. Nest site characteristics, occupation and breeding success in the European shag. Waterbirds 26, 473-483.

Vincenzi, S., Hatch, S., Merkling, T. and Kitaysky, A.S. 2015. Carry-over effects of food supplementation on recruitment and breeding performance of long-lived seabirds. Proceedings of the Royal Society B 282, 20150762.

Wakefield, E.D., Owen, E., Baer, J. et al. 2017. Breeding density, fine-scale tracking, and large-scale modeling reveal the regional distribution of four seabird species. Ecological Applications 27, 2074-2091.

Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W. and Tasker, M.L. 1995. Seabird Monitoring Handbook for Britain and Ireland. JNCC, RSPB, ITE and The Seabird Group, Peterborough.

Woodward, I., Thaxter, C.B., Owen, E. and Cook, A.S.C.P. 2019. Desk-based revision of seabird foraging ranges used for HRA screening. BTO Research Report No. 724.

## ANNEX A. HERRING GULL AND LESSER BLACK-BACKED GULL NUMBERS AT LOWESTOFT

Gull numbers were counted on 18 and 19 June 2021 using gull census method 1 recommended by JNCC (Walsh et al. 1995; vantage point counts of Apparently Occupied Nests). The counts are likely to be minimum numbers that were present, as some nests will have been impossible to see from available vantage points. Such counts are known to tend to underestimate numbers of roof-top nesting gulls; Coulson and Coulson (2015) determined that vantage point counts of gull AONs on rooftops in Dumfries found only 75% of the total present, giving an indication of the likely underestimate involved in this method. More reliable counts of breeding gull numbers on roofs can be obtained using drones (Blight et al. 2019) but flying drone surveys over urban areas can be difficult to arrange.

Six separate areas were surveyed for nesting gulls; Waveney Drive warehouses (defined as north of Waveney Drive, south of Inner Harbour, west of Suffolk County Council Lowestoft Riverside, and east of Lowestoft Enterprise Park), Brooke Business Park, Kirkley Business Park, Normanston, Pakefield Industrial Park, and Lowestoft Town Centre (north of Inner Harbour, south of Gunton, west of the sea and east of Hollingsworth Road and Rotterdam Road).

Total numbers of AONs are summarised in Table A.1. In addition to these totals, there were large numbers of pairs of gulls standing on the ground at Waveney Drive warehouses where three of the warehouses have been demolished. Those gulls appeared to be holding territories, possibly below where they had previously nested on roofs, but showed very little sign of nesting on the ground, so did not qualify as AONs. There were about 80 pairs of lesser black-backed gulls and 35 pairs of herring gulls on the ground that could potentially be added to the total numbers of AONs on roofs in Table A1. However, the demolition of the warehouses on which those birds previously nested may result in their dispersal over a larger area in future, as nesting on the ground seems unlikely because of the presence of urban foxes, dogs and cats.

Table A.1. Counts of herring gull and lesser black-backed gull AONs at Lowestoft in six defined areas, made on 18 and 19 June 2021 following gull census method 1 (Walsh et al. 1995).

| Area | Herring gull (AONs) | Lesser black-backed gull (AONs) |
|---|---|---|
| Waveney Drive warehouses | 640 | 1,720 |
| Brooke Business Park | 45 | 60 |
| Kirkley Business Park | 28 | 25 |
| Normanston | 28 | 17 |
| Pakefield Industrial Park | 43 | 31 |
| Lowestoft town centre | 303 | 215 |
| Total | 1,087 | 2,068 |

In Lowestoft town centre, herring gulls outnumbered lesser black-backed gulls, and the gulls tended to nest as lone pairs or groups of 2 to 6 nests rather than in large aggregations, whereas at Waveney Drive warehouses, which held the largest breeding numbers of both species, lesser black-backed gulls considerably outnumbered herring gulls, and birds nested in large aggregations on suitable warehouse roofs, especially those with grass and moss coverings.

There are some previously published counts of breeding numbers of herring gulls and lesser black-backed gulls at Lowestoft. Breeding numbers in Lowestoft increased rapidly from a few pairs in 1996 to tens of pairs in 1999 to 750 pairs of lesser black-backed gulls and 250 pairs of herring gulls in 2001 (Piotrowski 2012). There were thought to be about 4,500 pairs nesting on rooftops in 2008 and 3,500 pairs in 2011 (the proportions of herring and lesser black-back not being determined in those estimates). A count during 5-15 May 2012 was affected both by being early in the breeding season in a year of cold weather when gull nesting was late, and by torrential rain having washed many nests off roofs, with only 627 lesser black-backed gull and 469 herring gull AONs remaining that were counted that year in Lowestoft and another 52 pairs of herring gulls and 31 pairs of lesser black-backed gulls at Pakefield (Piotrowski 2012). Therefore, the estimates for 2021 of at least 1,087 herring gull AONs and 2,068 lesser black-backed gull AONs are broadly consistent with previous counts, but suggest that measures being taken to deter large gulls since 2000 (Piotrowski 2012) may have broadly stabilized breeding numbers in Lowestoft, or perhaps slightly reduced numbers from peak numbers in 2008.

Despite these large numbers, there was very little to suggest that herring gulls or lesser black-backed gulls have any strong influence on kittiwake nesting success at Lowestoft, although their presence may tend to encourage kittiwakes to select nest sites that are relatively inaccessible to large gulls.

# ANNEX B. LISTS OF SITES IN TYNE AND IN LOWESTOFT MONITORED IN 2021

### Table B.1. Kittiwake study nest sites at River Tyne

| Site | Sample of nests studied 2021 | Mean chicks per nest in 2021 study sample | AONs in 2019 (Turner 2019) | Productivity in 2019 (chicks per nest) (Turner 2019) |
|---|---|---|---|---|
| Tynemouth cliffs | 280 | 1.22 | 350 | 1.07 |
| Akzo Nobel | 222 | 1.40 | 212 | 1.06 |
| Saltmeadows tower | 118 | 1.35 | 111 | 0.79 |
| Baltic Arts Centre | 191 | 1.45 | 130 | 1.11 |
| Guildhall | 30 | 1.50 | 31 | 0.77 |
| Street lights | 2 | 1.50 | 3 | 0.67 |
| Phoenix House | 26 | 1.50 | 24 | 0.79 |
| Floodlights | 3 | 0.67 | 3 | 1.33 |
| Lombard House | 14 | 1.43 | 11 | 1.00 |
| Queen Street | 2 | 1.00 | 0 | |
| Dean Street railway bridge | 77 | 1.00 | 62 | 0.97 |
| Redhouse | 15 | 1.13 | 5 | 1.60 |
| St Mary's Heritage Centre | 1 | 2.00 | 1 | 0.00 |
| High Level Bridge | 10 | 0.90 | 4 | 1.00 |
| Vermont Hotel | 3 | 0.00 | 0 | |
| Vermont Aparthotel | 6 | 0.33 | 6 | 0.17 |
| Tyne Bridge | 449 | 1.29 | 736 | 0.96 |

### Table B.2. Kittiwake study nest sites at Lowestoft

| Site | Sample of nests studied 2021 | Chicks produced | Chicks per nest | AONs in June 2017 (Ch2M 2017) | AONs in July 2019 (Google streetview) |
|---|---|---|---|---|---|
| Claremont Pier | 58 | 77 | 1.33 | 45 | No data |
| Waveney Dock | 104 | 90 | 0.87 | 94 | No data |
| Trawler Dock | 15 | 12 | 0.80 | 9 | No data |
| Our Lady Star of the Sea RC Church | 175 | 242 | 1.38 | 100 | No data |
| House in Commercial Road | 6 | 9 | 1.50 | 0 | 0 |
| House in Commercial Road | 4 | 2 | 0.50 | 0 | 0 |
| House in Commercial Road | 5 | 5 | 1.00 | 0 | 0 |
| House in Commercial Road | 6 | 0 | 0.00 | 0 | 0 |
| Station Square (front) | 8 | 14 | 1.75 | 21 | 34 |
| Street light in Station Square | 1 | 2 | 2.00 | 0 | 0 |

| Site | Sample of nests studied 2021 | Chicks produced | Chicks per nest | AONs in June 2017 (Ch2M 2017) | AONs in July 2019 (Google streetview) |
|---|---|---|---|---|---|
| Taylor Properties Station Square | 2 | 4 | 2.00 | 0 | 0 |
| Waveney Road (Columbus Buildings) | 2 | 3 | 1.50 | 36 | 1 |
| Building in Waveney Road | 3 | 3 | 1.00 | 0 | 0 |
| Gourock Ropework Co Ltd | 3 | 3 | 1.00 | 0 | 1 |
| Battery Green Road Ice Factory | 9 | 3 | 0.33 | 14 | 9 |
| Battery Green Road Warehouse | 1 | 1 | 1.00 | 0 | 0 |
| Ice Factory Office block inside ABPort | 10 | 15 | 1.50 | No data | No data |
| House in Battery Green Road | 23 | 31 | 1.35 | 14 | 18 |
| House in Battery Green Road | 13 | 23 | 1.77 | 0 | 2 |
| Beach Mews (off Suffolk Street) | 12 | 18 | 1.50 | 1 | 1 |
| House in Suffolk Street | 9 | 13 | 1.44 | 3 | 2 |
| House in Suffolk Street | 1 | 1 | 1.00 | 0 | 0 |
| Marina Theatre (front and Stage Door) | 15 | 22 | 1.47 | 0 | 11 |
| Marina House | 7 | 9 | 1.29 | 0 | 0 |
| House in Grove Road | 14 | 14 | 1.00 | 0 | 3 |
| House in Grove Road | 14 | 20 | 1.43 | 0 | 4 |
| Boots rear wall (at Grove Road) | 1 | 0 | 0.00 | 4 | 0 |
| House in Bevan Street East | 1 | 1 | 1.00 | 0 | 0 |
| House in Clapham Road South | 4 | 7 | 1.75 | 0 | 0 |
| House in Surrey Street | 5 | 8 | 1.60 | 0 | 0 |
| Surrey Street (Surrey Chambers) | 5 | 7 | 1.40 | 0 | 0 |
| House in Surrey Street | 28 | 45 | 1.61 | 0 | 16 |
| House in Surrey Street | 2 | 0 | 0.00 | 0 | 0 |
| Surrey Street (NatWest) | 1 | 1 | 1.00 | 0 | 0 |
| BT Surrey Street side | 4 | 4 | 1.00 | 0 | 4 |
| BT Clapham Road side | 33 | 28 | 0.85 | 49 | 30+ |
| Britten Centre car park | 1 | 0 | 0.00 | 0 | No data |
| London Road North (above Subway) | 9 | 2 | 0.22 | 0 | 2 |
| London Road North (above Boots) | 3 | 4 | 1.33 | 0 | 0 |
| House in London Road North | 3 | 0 | 0.00 | 0 | 2 |
| House in London Road North | 1 | 0 | 0.00 | 0 | 0 |
| Pier Terrace | 11 | 10 | 0.91 | 0 | 0 |
| Station Square End Wall | 9 | 9 | 1.00 | 0 | 0 |
| Britten Shopping Centre roof | 3 | 2 | 0.67 | 0 | 0 |
| House in Gordon Road | 1 | 2 | 2.00 | 0 | 0 |

## ANNEX C. EXAMPLES OF KITTIWAKE NESTS IN THE DUNBAR HARBOUR COLONY

See separate file

## ANNEX D. EXAMPLES OF KITTIWAKE NESTS IN THE TYNE COLONIES

See separate file

## ANNEX E. EXAMPLES OF KITTIWAKE NESTS IN THE LOWESTOFT COLONIES

See separate file