Kittiwake Nesting Behaviour on Walney Two Offshore Substation: Data and Recommendations

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Glossary of abbreviations

OFTO	Offshore Wind Transmission Owner
OSS	Offshore Substation
MCZ	Marine Conservation Zone
OWF	Offshore Wind Farm

1. Introduction

The United Kingdom (UK) Government have set targets to install 50GW of offshore wind energy by 2030, helping to reduce anthropogenic climate impact and strengthen energy security (DBEIS, 2022). As such, there is now an increasing number of Offshore Wind Farm (OWF) developments being built in UK waters, which have the potential to impact on natural receptors in the marine environment. Certain seabird populations are thought to be vulnerable to the impacts of offshore windfarm development, through collisions and obstruction of foraging areas. However, black-legged kittiwakes (*Rissa tridactyla*, henceforth referred to as “kittiwakes”), which are thought to be particularly sensitive to offshore developments, have been observed nesting on the underside of the OSS in the Walney Two OWF. This colony presents a good opportunity to carry out monitoring of kittiwake nesting behaviour on offshore artificial nesting sites located within windfarm arrays. This could provide insight into kittiwake behaviour, breeding phenology, and productivity. Furthermore, research into this colony could inform possible conservation measures, highlight areas for future study to resolve uncertainties, and provide developers with opportunities for environmental compensation and net gain.

1.1 Kittiwake ecology

Kittiwakes are a globally widespread species of seabird, which have maintained vast resident and breeding populations in the UK (JNCC, 2021). Pairs typically spend winter at sea, before nesting as early as March or April, returning to sea around August (Furness, 2015). During their lifecycle, individuals feed heavily upon small pelagic fish, particularly sandeels, which make up a large proportion of breeding kittiwakes' diet across UK colonies (Furness et al., 2013). However, some evidence from the west coast indicates a weaker reliance on sandeels (Ruffino et al., 2023).

New kittiwake colonies will typically grow rapidly at first, doubling in size annually for the first two to four years. After this time, population growth slows to roughly 10-20% (Kildaw, 2005; Coulson, 2011). The success of these new colonies is largely dependent on recruitment as productivity rates are likely to be relatively low during the first couple of years of colonisation (Coulson, 2011). This is because first time breeders who make up a large proportion of the colony are typically unsuccessful (Cam & Monnat 2000).

Although kittiwakes are largely not philopatric, meaning birds do not tend to return to their natal colony to breed (Coulson & Coulson, 2007), once birds have successfully recruited into a breeding colony, they show high levels of site fidelity, often retuning to the same nest year after year (Coulson, 2011). Thus, once established, locations of colonies tend to be retained over many decades. Site fidelity is ultimately dependent on individual reproductive success (Cam et al. 1998; Boulinier et al., 2008). Research shows that failed breeders may continue to make prospective flights to other colonies within the same breeding season and that this behaviour becomes more prevalent within colonies experiencing widespread breeding failure (Ponchon et al., 2015). Successful breeders and birds nesting in successful colonies do not seem to make these prospecting trips.

Kittiwakes primarily nest on cliff faces that are in direct contact with the sea, using very narrow horizontal shelves and ledges, enabling them to avoid mammalian predators (Coulson, 2011). Weather can also influence kittiwake colony locations, as exposure to storms and wave action can reduce breeding productivity, so sheltered ledges are more likely to produce fledglings (Newell et al., 2015; Christensen-Dalsgaard et al., 2018). As pairs often reclaim previously successful nest sites, this may mean sheltered cliff ledges are more likely to house pairs for subsequent years (Ponchon et al., 2015).

1.2 Pressures on kittiwakes

The UK kittiwake population increased during the late 60s to mid-80s, however the populations then decreased rapidly, with an overall decline of 40% since the 1980s (Descamps et al. 2017; BirdLife International 2018). Kittiwakes are facing significant challenges with climate change and pressures from commercial fisheries causing food scarcity. The abundance of prey is critical to the breeding success of kittiwakes, and links have been found between sandeel stocks and productivity, however the relationship is complex (Furness & Tasker, 2000; Frederiksen et al., 2008; Carroll et al., 2017). These key pelagic fish populations are thought to be under stress due to overfishing and are unable to withstand rising sea temperatures caused by climate change (Heath et al., 2012).

Whilst OWFs are being developed to help address climate change, the array areas have potential to limit kittiwake access to foraging areas and terrestrial breeding grounds, through the barrier effect. In order to avoid turbines, birds are often required to deviate flight paths in and around OWFs to reach nesting and feeding grounds, increasing flight distance and energy expenditure. Collision with turbine blades is also a cause of potential mortality, potentially impacting breeding populations (RSPB, 2021).

Furthermore, highly pathogenic avian influenza, commonly known as avian flu has negatively impacted kittiwake populations, particularly in recent years. The virus is known to cause mass mortality events and reduced reproductive success. This combined with the aforementioned factors is potentially leading to the overall decline in kittiwake populations. As such, despite the fact they are the most globally prolific gull species, they are now listed as vulnerable on the International Union for Conservation of Nature (IUCN) Red List and the Birds of Conservation Concern Red List, with frequent and widespread breeding failure now being observed throughout the UK.

1.3 Kittiwakes on offshore structures

A potential opportunity for kittiwake population recovery comes in the form of artificial nesting on anthropogenic structures. Under the right environmental conditions, kittiwakes have been observed colonising structures such as buildings and piers that have similar features to natural nesting sites (vertical faces with narrow ledges, close to the water). These sites have been readily adopted by kittiwakes in locations where natural breeding sites are limited (Hatch et al., 1993; Camphuysen & de Vreeze, 2005; Camphuysen & Leopold, 2007; Turner, 2010; Coulson 2011; Ponchon et al., 2017; Harris et al., 2019). Furthermore, studies have suggested that within these urban colonies, populations appear stable (see Appendix) and, in some cases, increasing (Turner 2010 & 2018; JNCC 2020).

In the 1990s the first successful breeding kittiwake population to colonise an offshore structure was observed on a platform in the Norwegian sea (Christensen-Dalsgaard, 2019) and they were first seen breeding successfully on an offshore structure in the UK at the Morecambe Gas Platform in the Irish Sea in 1998 (Unwin, 1999). Offshore structures continue to be colonised and within a few years of their construction productive colonies can form (Ørsted, 2021).

It is thought that offshore structures that fulfil kittiwake nesting requirements could provide additional benefits as they are generally closer to potential foraging sites and further away from land-based predators (Christensen-Dalsgaard et al., 2019). As such, with the population on the decline, offshore artificial nesting sites may provide a vital refuge to support coastal population conservation. Furthermore, it has been hypothesised that the provision of additional undisturbed nesting spaces could enable enhanced recruitment to other nesting populations (Ørsted and Natural England, personal communications, 2023).

To date, there are 26 kittiwake colonies on offshore installations globally that have been recorded and breeding confirmed (Ørsted, 2021). However, due to the nature of offshore structures, there is a lack of data on population trends as they are difficult to access and survey. This means that there is a shortage of data on colonisation rates and population growth rates (Ørsted, 2021). Ornithological studies of offshore platforms off the Norwegian coast suggest breeding success might be higher on artificial structures than at natural sites (Christensen-Dalsgaard et al., 2019). There have also been studies on the Morecambe Gas Platform and the Dutch platform L8-P with multiple counts documented over the past couple of years, but historic data remains sparse. Nevertheless, colony growth patterns appear similar to those observed at natural sites.

1.4 Offshore wind compensation opportunities

The rapid onset of climate change has led many nations to make progress towards lower emissions through renewable energy. The UK, along with other countries, has set targets to achieve net zero emissions by 2050 (O'Beirne et al., 2020). Offshore wind has been recognised as a crucial element and the UK governments British Energy Security Strategy has set out a policy to generate 50GW of offshore wind by 2030 (DBEIS, 2022). However, OWFs pose concerns for the marine environment (Nowacek et al., 2007; Gould, 2008; Inger et al., 2009). For example, marine bird populations are thought to be at risk and are particularly sensitive to collisions, displacement, and barrier effects (RSPB, 2021). As a result, compensatory measures are sometimes deemed necessary if environmental impacts cannot be fully mitigated (Wilson & Elliott, 2009). Hornsea Three and Hornsea Four OWFs, developed by Ørsted in the North Sea, are required to provide alternative habitat to offset the potential impact the array could have on the kittiwake breeding colony in the Flamborough and Filey Coast Special Protected Areas (Ørsted, 2021). Kittiwake compensation by windfarm developers has potential to mitigate declining populations through the creation of offshore artificial nesting structures. These are closer to foraging areas and are thus likely to have high productivity (Daunt et al., 2002; Christensen-Dalsgaard et al., 2019).

1.5 Walney Two Offshore Wind Farm and Substation

Walney Two OWF is located approximately 15km from the coastline of Walney Island in South Cumbria. Comprising of 51 turbines, and positioned within a designated Marine Conservation Zone (MCZ), the windfarm is owned by Walney (UK) Offshore Windfarms Limited, and was developed and operated by Ørsted. It has been fully operational since 2012 (Ørsted, 2017). The OSS ownership was transferred to an OFTO in 2012.

Within recent years' observations from Ørsted technicians have indicated the presence of nesting kittiwake colonies on Walney Two OSS. This colony appears to be in the early stages of establishment; successful nests are often returned to in subsequent years, but observations here have indicated that most nests are relatively new.

This colony could display genetic connectivity with nearby colonies such as St Bees Head (Natural England, personal communications, 2023). Located approximately 60km north of the Walney Two OSS (Figure 1), the population at St Bees Head is the nearest significant colony to the Walney Two OSS colony and within recent years it has experienced low productivity rates. Possible explanations for this include outbreaks of avian flu, restriction of habitat, and fish stock dynamics. Although populations here have reduced over the past 20 years, it is possible that the colonies on the Walney Two OWF substations could provide recruits to the onshore population. Despite this there is no baseline data on the Walney offshore colony. Furthermore, other colonies such as Puffin Island fall within the maximum prospective flight distance for the Walney OSS colony.

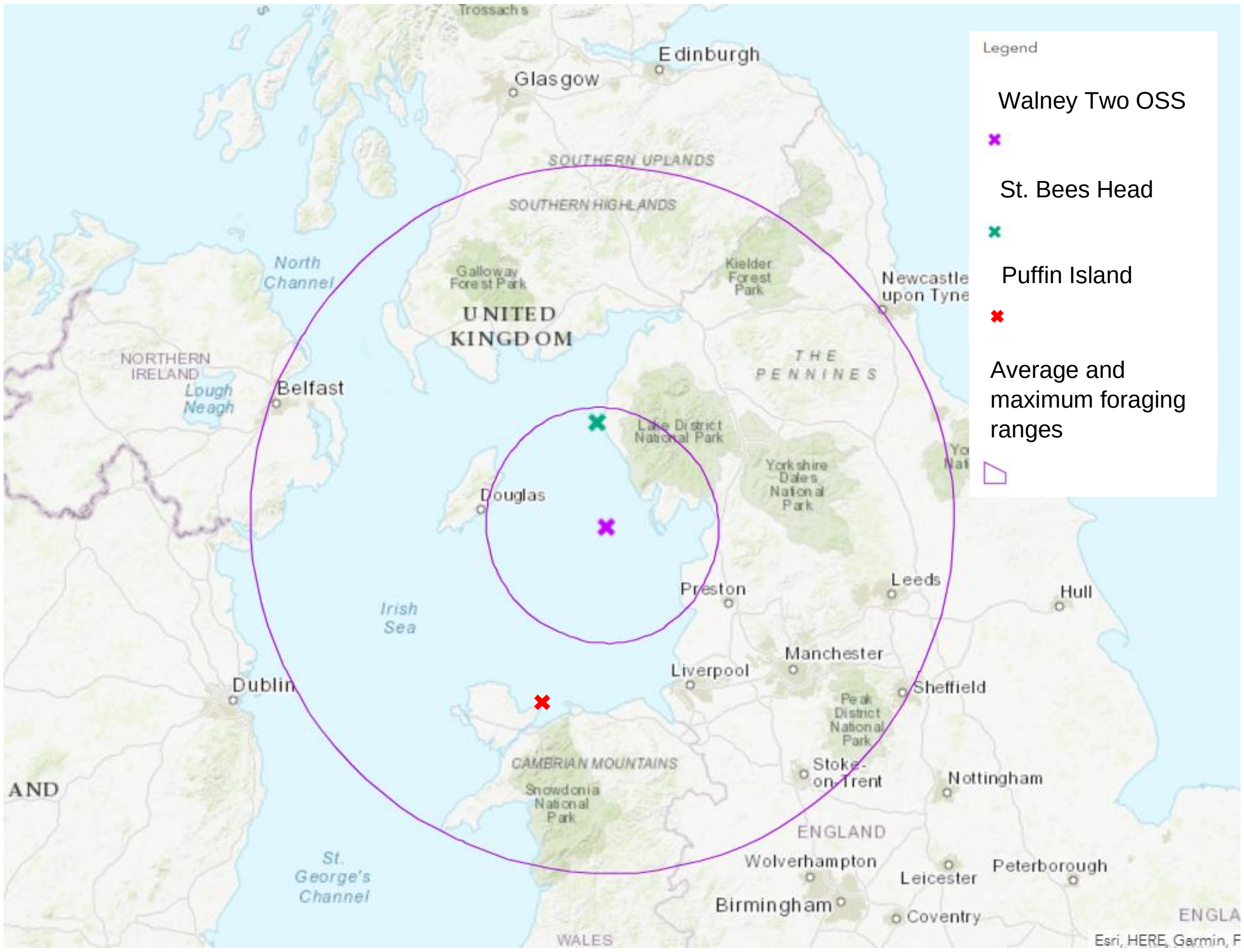

Figure 1: Expected range overlap between the Walney Two OSS colony, and the terrestrial colonies of St Bees Head and Puffin Island. Small purple circle represents average kittiwake foraging range (60km), big purple circle represents maximum recorded kittiwake foraging range (156km).

1.6 Aims and objectives

This report aims to gather baseline data for the kittiwake colony on the Walney Two OSS, and to provide a set of recommendations to Ørsted for future study and breeding enhancements to support greater resilience of the kittiwake population in the Northwest of England. This will improve Ørsted's evidence base with regard to kittiwake compensation measures and net gain. Ørsted does not own the substation but the OFTO is willing to assist Ørsted in further studies subject to any operational constraints.

The objectives of this report are:

1) Monitoring: quantify the number of adults, fledglings and nests present to assess productivity.
2) Investigate aspect (the orientation of the substation sides including north, east, south, west and the underside of the platform), to determine which sides are more productive, and to highlight areas of the substation for priority for nesting enhancement.
3) Identify potential options for nesting enhancement to enhance productivity.
4) Compare baseline data and productivity of the Walney Two colony to the St Bees population.
5) Outline effective methodology for future studies.

2. Methodology

2.1 Data collection

Surveys were undertaken at the Walney Two OSS on the 19th April, 28th July and 18th August 2023 during the kittiwake breeding season. This substation was highlighted by Ørsted as housing a significant kittiwake breeding population.

The survey vessel first approached the north side, before heading clockwise towards the east, south and west sides (Figure 2). The survey was carried out from the deck of the survey vessel that maintained a minimum distance of 100m from the edge of the platform to avoid potential disturbance to the birds and to reduce the risk of drifting into the platform. The vessel motored around the substation slowly at a distance of 100-200m. When required, the vessel held off in certain positions to allow surveyors time to observe and record findings at each aspect of the substation. Different vantage points along the deck were used to achieve an optimum viewing position. As per operator health and safety requirements, the vessel was not permitted to hold off where there was a potential risk of drifting onto the platform. As such, conditions were assessed before entering the 500m buffer zones.

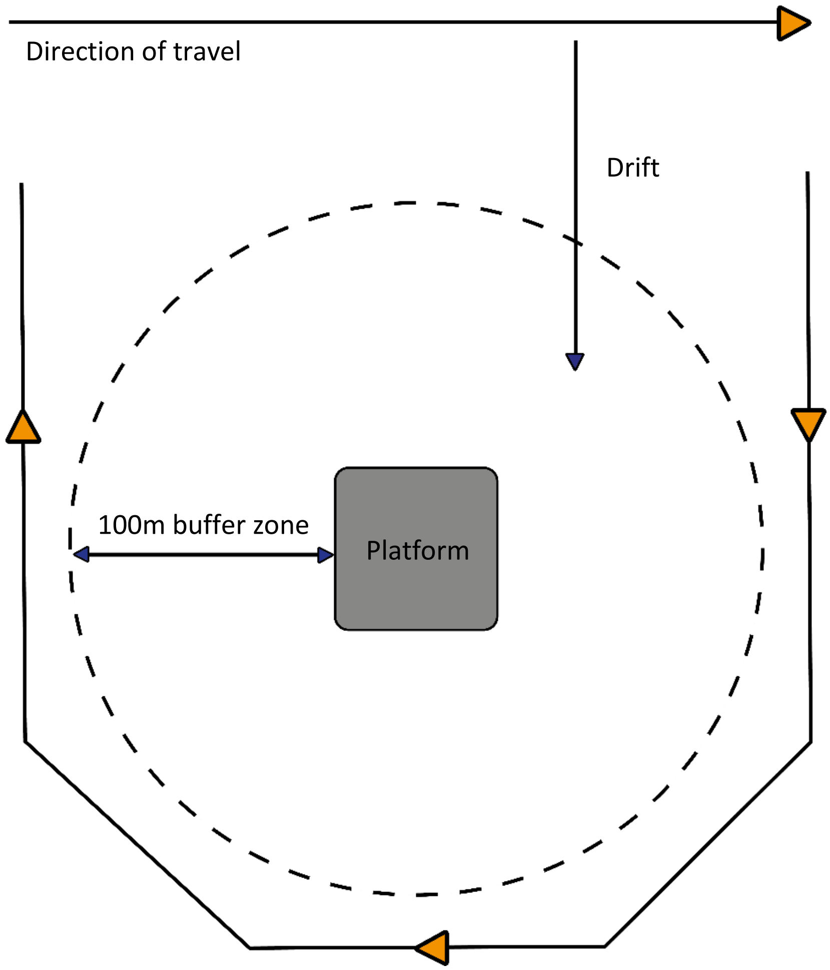

Figure 2: Diagram of the route taken around the substation and distance maintained.

Using binoculars, the number of nests (occupied with fledglings) and trace nests (unoccupied with no fledglings) were recorded on each side along with the number of breeding pairs and fledglings. Nests were defined as a build-up of matter including guano and seaweed. Using a DSLR camera equipped with a 70-300mm stabilised lens, the location of all visible nests, adults and fledgling were photographed to analyse nest materials, nest quality, location and to conduct counts after the survey. Counts of kittiwakes present on (but not breeding on) around the structure were also recorded. Upon approaching the substation on each side (north, east, south, west), a whole aspect photograph was taken (Figure 3).

Figure 3: Whole aspect photo of the southeast corner of the substation (taken 18th August 2023).

The substation was divided up according to aspect to enable each section to be surveyed and mapped accurately and repeatably. The data was then formatted ready for analysis. Substation sides were also categorised into vertical layers in order to investigate nest position. These layers included bottom, middle, and top, and the underside was also included in comparison (as shown in Figure 4). Finally, when analysing nest quality, individual nests with birds present were allocated a nest quality of 1 (low) to 3 (high). In places where birds were present but with no nest, a quality of N/A was allocated (Figure 5).

Figure 4: South side of the substation divided into layers based on height.

Figure 5: Birds from the underside of the platform displaying nests of quality 1 (poor), 2 (adequate) and 3 (good).

3. Results

3.1 Preliminary survey 19th April 2023

The preliminary survey carried out on the 19th April was used to verify the presence of the kittiwake colony and estimate it's size. Observations suggested that this was the minimum count as there were lots of unattended proto-nests and many established nests only had one bird in attendance (Appendix 1).

3.2 Survey on 28th July 2023

A more comprehensive survey was carried out on the 28th July. A total 409 kittiwakes and 192 nests were observed, including 255 adults and 154 fledglings.

The underside of the platform had the most adults, fledglings, and nests. In contrast, the fewest nests were observed on the west and east sides. The east side had the lowest number of adult kittiwakes, while the west side had the lowest number of fledglings (Appendix 2 and Figure 6). It is of note that the underside of the platform is made up of a lattice of steel beams which provides more surface area for kittiwakes to nest on.

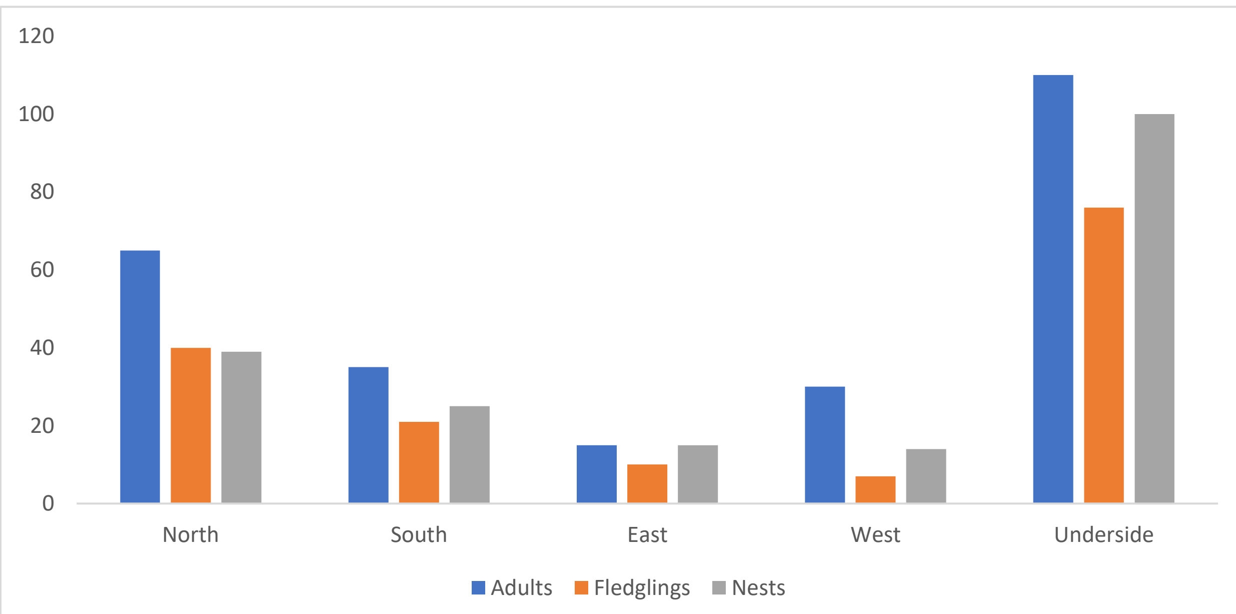

Figure 6: Number of adult/fledgling kittiwakes and associated nests, on the north, south, east, west and underside of the substation. Survey was undertaken on 28th July 2023.

Position analysis shows that the bottom of each substation side had a greater number of adults, fledglings and nests than the middle or top sections (Appendix 3 and Figure 7).

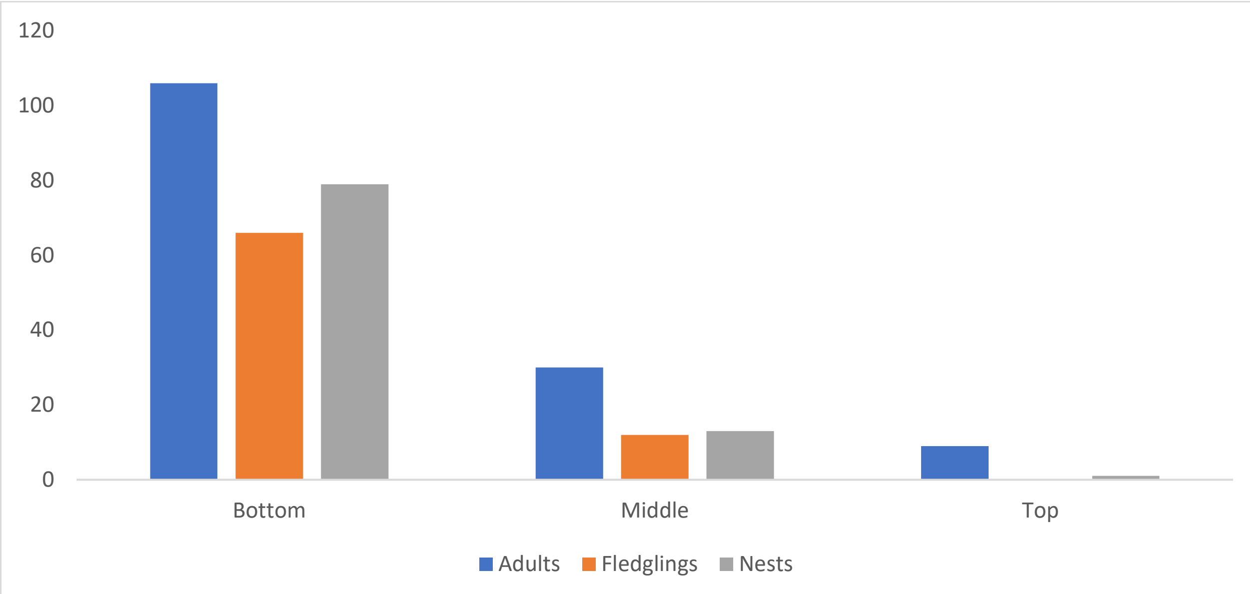

Figure 7: Number of adults/fledgling kittiwakes and associated nests, on the bottom, middle, and top of substation sides. Survey was undertaken on 28th July 2023.

3.3 Survey on 18th August 2023

In total, 274 kittiwakes and 167 nests were observed during the August survey. This included 178 adults and 96 fledglings. This means there were 77 fewer adults and 58 fewer fledglings observed during this survey compared to the July survey. As this survey took place almost a month after the initial survey, assumptions were made that many juvenile birds had fledged.

The underside of the substation had the most nests and fledglings, with most adults observed on the north side. The fewest nests and fledglings were observed on the west side (Appendix 4 and Figure 8).

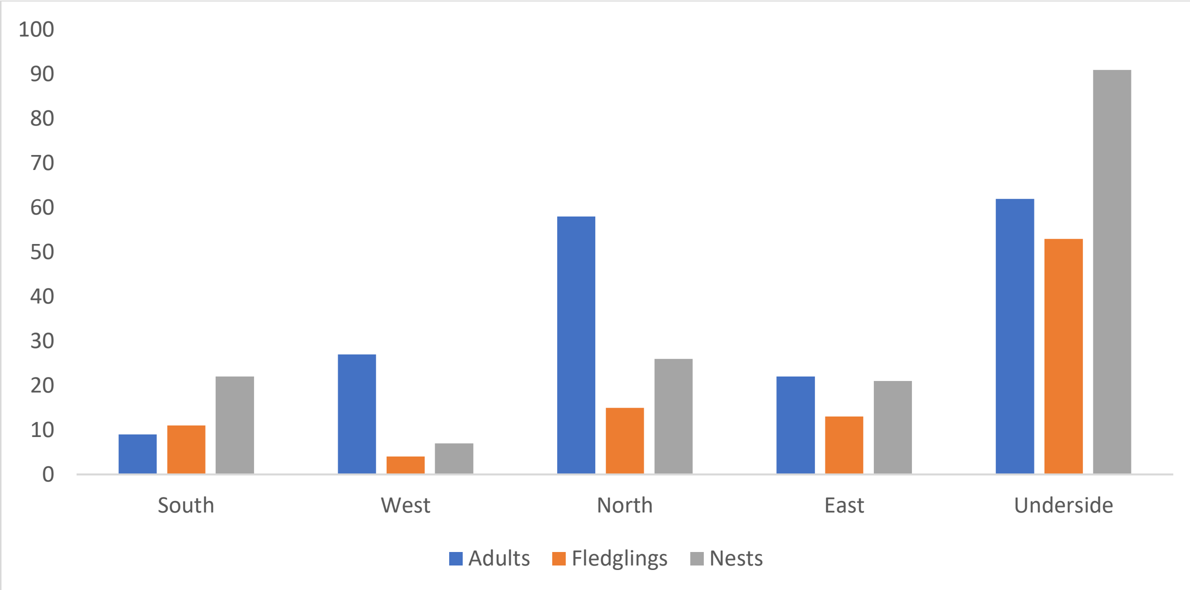

Figure 8: Number of adult/fledgling kittiwakes and associated nests, on the north, south, east, west and underside of the substation. Survey was undertaken on 18th August 2023.

Position analysis was also conducted on the 18th August survey data. In accordance with the previous survey, the bottom layer of the substation had a greater number of adults, fledglings and nests than the middle and top of the platform (Appendix 5, Figure 9).

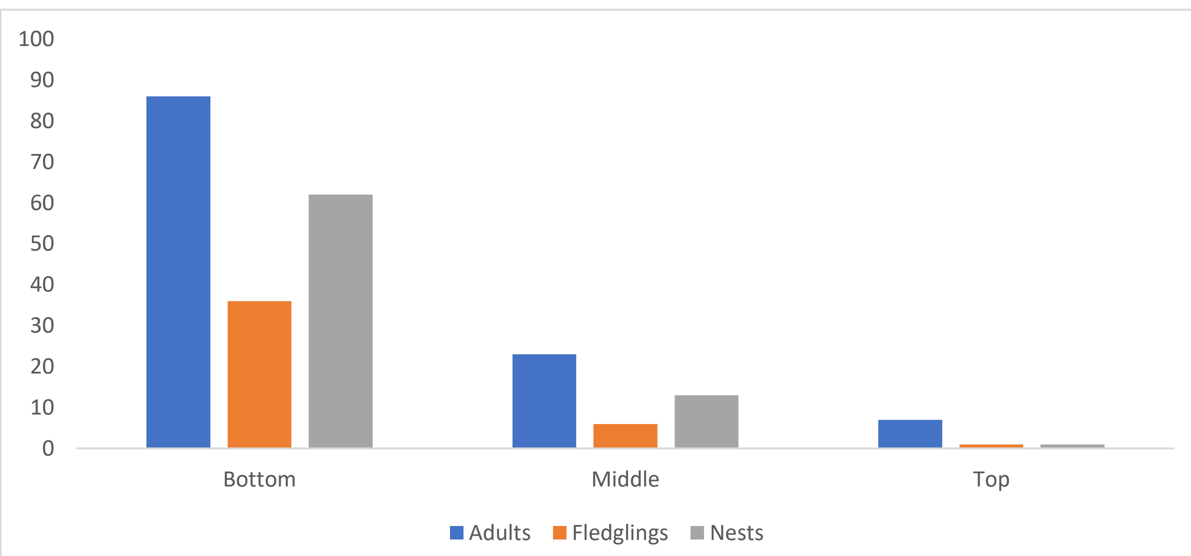

Figure 9: Number of adults/fledgling kittiwakes and associated nests, on the bottom, middle, and top of substation sides. Survey was undertaken on 18th August 2023.

3.4 Nest quality

Nest quality was assessed during the 28th July survey (Appendix 6). Most nests occupied by fledglings were of quality 2. Most nests unoccupied by fledglings were of a quality of 1 and nests rated with a quality of 3 were more likely to be occupied by 2 fledglings as opposed to 1.
The survey on the 18th August 2023 (Figure 10, Appendix 7) showed most nests occupied by fledglings were of quality 1, while the least occupied nests were of quality 3. However, occupied nests of quality 3 a greater number of fledglings per nest, compared to nests of quality 1, which displayed the least. Only 12 fledglings were observed without nests. As such, it is theorised that the best quality nests were associated with early breeders, which had already fledged.

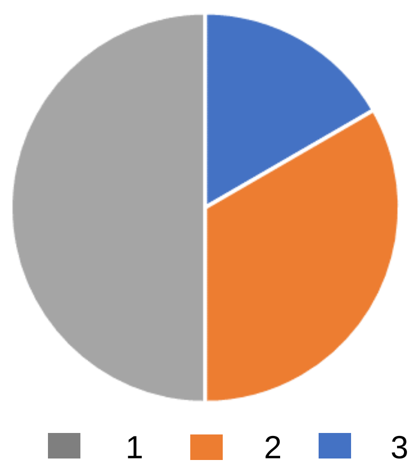

Figure 10: percentage of nests of each quality (1,2, and 3) recorded on the 18th August survey.

3.5 Productivity

As there were fewer fledglings present on the OSS during the August survey compared to the July survey it was assumed that many of the fledglings fledged. As such, the July survey was used to calculate breeding productivity for the substation colony which showed a productivity of 0.82, which is considered to be above what is required to maintain a stable population (Coulson, 2011). Furthermore, this was much higher than that of the nearest terrestrial colony (St. Bees Head), which had a productivity of 0.25 (Shackleton, RSPB, personal communications, 2023).

4. Discussion

4.1 Study outcomes

4.1.1 Aspect and Position

This study found more kittiwake adults, fledglings and nests on the north and underside of the platform. However, further analysis using R could give greater insight and clarity into the relationship between aspect and nesting preference using a generalised linear model, Kruskal-Wallis test and a non- parametric equivalent of a Tukey Honestly Significant Difference test.

Previous research has shown no global trend in aspect preference. However, it has been suggested that site-specific confounding factors may influence aspect preferences on a case-by-case basis (Coulson, 2011; Ørsted, 2021). The impact of environmental conditions experienced at different aspects such as exposure to sun, wind and rain may differ depending on the geographical location of the structure, as may the potential predation risk and the influence of any surrounding structures (e.g. shading/shelter). As such, the observed preference for the north and underside of the platform in this study are specific to this site.

Evidence for Equinor's Sheringham Shoal and Dudgeon Sands Extension Project suggests that exposure to direct sunlight produces on average fewer chicks per nest than that of nests not exposed to direct sunlight (MacArthur Green, 2021). This is in accordance with the results from this study which found a nesting preference for the north and underside of the platform. As there are no other surrounding structures to create shade, the Walney Two OSS predominantly experiences the highest levels of sun exposure on the south facing side, closely followed by east and west, with the north and underside of the platform experiencing the lowest levels of sunlight. It would be of use to verify this though a comparison with other colonies on anthropogenic structures with multiple available aspects.

In addition to sunlight, there is evidence supporting the idea that wind and rain exposure affects nest site preference (Coulson, 2011; Newell et al., 2015), with interannual variation in seabird breeding success linked to storm events (Coulson, 2011). On the Isle of May, kittiwake nests orientated in the direction of storm events had a 15.6% higher rate of breeding failure in comparison to nests not facing the storm (Newell et al 2015). Therefore, this suggests that it is most likely that a combination of weather conditions that explains the distribution of kittiwake nests on the substation as the beams on the underside of the platform create shelter from the elements in almost all directions. However, further studies using an anemometer to assess exposure on different aspects and levels of the platform could be carried out to verify this theory.

As kittiwakes are naturally a cliff nesting species, most research investigating aspect has previously only considered north, east, south and west, as this is what is available at natural terrestrial sites. This information has been used to inform design decisions for the recent implementation of artificial nesting structures on projects such as Hornsea Three and Four. This study suggests that incorporating the underside of an artificial nesting structure has the potential to aid productivity of the kittiwake population by minimising the effects of sun, wind and rain exposure. This is further supported by previous studies investigating kittiwake colonies on oil and gas platforms which also found large number of kittiwakes nesting on the underside of platforms (Unwin,1999; Ørsted 2021).

4.1.2 Productivity

The offshore colony on Walney Two OSS had a significantly higher breeding success than that of the terrestrial population nesting at St Bees Head. This study hypothesises higher productivity is due to their proximity to productive feeding grounds.

Kittiwake distribution is largely driven by prey availability within the constraints of foraging ranges (Cox et al 2013). On average kittiwakes forage within 54.7km of their breeding colony but have been known to travel as far as 156.1km in search for food (Woodward et al., 2019) (Figure 1). However, shorter foraging distances have been linked to higher breeding success (Daunt et al 2002).

Walney Two is located in an area with relatively low levels of commercial fishing activity, with an interesting mix of stakeholders including the crown dependencies of the Isle of Man who place restrictions on local fishing. Additionally, the wind farm is located within the West of Walney MCZ, in which bottom trawling fishing gear is prohibited. This likely means kittiwake prey fish stocks are good, however further study would need to confirm this.

4.2 Recommendations

4.2.1 Camera installation

It is currently unclear where the Walney Two substation kittiwake colony is foraging. Camera traps could be used to record the duration of adult foraging trips, timing how long individuals are away from nests, indicating how far foraging grounds are from the substation. Photographic evidence could also be used to identify what the kittiwakes are feeding on which can better inform kittiwake fish stock interactions and therefore management decisions.

Cameras can be attached directly below the walkways to gain a good view of the nests. Ltl-Acorn 5210MC time lapse cameras have been used in past studies to assess foraging trip duration over long time scales (De Pascalis et al., 2018). However, there are considerations regarding salt spray on camera lenses obscuring images, battery life and access to download footage.

4.2.2 Tracking studies

Seabird collisions with turbine blades are perceived to be an ecological risk, particularly for kittiwakes. However, few collision studies have been undertaken at constructed OWFs and most estimates of seabird collision are based on theory rather than empirical evidence (Perrow, 2019).

A review of the factors influencing collision risk, including species and site specific factors, showed time spent flying at collision risk height is the most important determinant factor. Due to the high productivity of the colony, this study suggests that the local abundance in food means individuals from the Walney Two colony may not need to spend as long at cruising heights, where the risk of collision is high, in order to forage. Alternatively, kittiwakes may display learned behaviour to navigate the wind farm and avoid turbines. As such, this report recommends future tracking studies to further inform foraging ground location and to provide valuable data on collision risk modelling.

A 5m pole complete with a noose on the end can be used to capture individual adult kittiwakes, during the early stages of the breeding season, by a licensed individual, as outlined by the British Trust for Ornithology (BTO). From here, pathtrack GPS tracking devices or geolocators such as the Mk14 British Antarctic Survey geolocator can be attached using self-amalgamating or TESA® tape, and data analysed using GIS (Kotzerka et al., 2009; Frederiksen et al., 2011; González-Solís et al., 2011).

This survey would not recommend tracking of juvenile kittiwakes, only adults. A report by Heggøy et al., (2015) shows attachment of geolocators can cause numerous physiological effects on kittiwakes, including increased concentrations of corticosterone (the avian stress hormone), reduced nest attendance and increased time foraging. These effects may have a more pronounced impact on fledglings leaving the nest for the first time, and so only adults should be tracked.

4.2.3 Ringing

Further study into the dispersal of juvenile kittiwakes could provide insight into colony connectivity. After reviewing available literature, this study found very few published estimates of juvenile and immature survival rates, breeding, and natal dispersal. Those that were found had high levels of uncertainty, in part due to low detection rates of marked individuals (O'Hanlon et al., 2021). As such, empirical data remains scarce and it is unknown to what extent dispersal rates and distances differ between regions, for different age classes and sex.

This report recommends the establishment of ringing studies to help develop the database on kittiwake dispersal and survival rates, however the feasibility of this may be difficult. Research suggests that to achieve high levels of precision in estimations, only studies spanning 10 years or longer can provide high levels of precision for survival estimates (Horswill et al., 2018). It would also be necessary to maintain a marked population of 100-150 adults to estimate colony specific adult survival. Furthermore, to estimate juvenile or immature survival rates, several hundred chicks per year would need to be ringed.

Thus, whilst it may not be feasible to inform precise survival rates, a colour ringing study would still be of use to track movement between the two colonies of Walney Two OSS and St Bees Head. This study would likely be successful due to continual efforts that are already in place at St Bees Head to monitor populations, however further collaboration with the Royal Society for the Protection of Birds (RSPB) would be required. This would help identify if there is genetic connectivity between the two sites which could provide compensation opportunities and further inform conservation decision making.

The above methodology (see section 4.2.2) can be used to capture individual adult kittiwakes. From here this report recommends the ringing methodology set out by the BTO on their Retrap Adult Survival (RAS) study on kittiwake. This entails ringing adult birds in the early stages of the breeding season with uniquely engraved colour rings so that each bird can be identified in the field in future years. Re-sightings of colour-marked individuals and captures of adult birds can be used to calculate the proportion of survivors each year and their movements between colonies. Colour marks should be readable from boat-based surveys.

4.2.4 Diet samples

Diet analyses could give greater insight into foraging ranges and the type of prey the colony are feeding on. To collect faecal samples a long pole with a scraper attached to one end could be used from the walkway of the substations to collect guano found around the nests. Faecal samples take roughly two to three days to process before samples are ready to be analysed and approximately 50 samples can be analysed in one day by a trained observer (Borrelli et al., 2020). Most seabird dietary analyses undertaken in the UK is currently carried out by the Centre for Ecology and Hydrology. Physical analysis and eDNA techniques can also be used.

4.2.5 Supplementary nesting material

Kittiwake nests in onshore environments consist of a mud-based foundation, helping it adhere to ledges. This mud is compacted with grasses and seaweeds to form a shallow cup (Figure 11). At natural sites, nest materials are collected from cliff edges, tidelines and the sea surface typically within 2km of the colony (Coulson 2011). The mud is often collected after periods of rain when it is soft and easier for kittiwakes to collect in their bills (Coulson, 2011).

At offshore artificial nesting sites, terrestrial nest matter is scarce and it has been suggested that the availability of mud and grass may be a limiting factor to offshore nesting birds (Coulson 2011). Although birds on the OSS did appear capable of raising fledglings successfully in poor quality nests, made up of seaweed and guano (Figure 12), nests of a high quality (indicated by their larger size, built up over many breeding seasons) had on average more fledglings per nest. This could be because poor quality nests provide little structural stability. Furthermore, fledglings that fledged earlier on in the season were associated with nests of higher quality.

Figure 11: Kittiwake at an onshore nesting colony. Note that nests display mainly terrestrial plant matter and mud, and comparatively little guano compared to the substation colony.

Figure 12: Kittiwake nests observed on the Walney Two OSS. Nests are of poor quality made up of seaweed and guano.

This study recommends the provision of wet mud and plant matter within a 2km radius of the structure to limit distance travelled in search of nest materials, improve nest structure, and limit the impact of high concentrations of guano on operations and maintenance. However, in order to limit collision risk, this study recommends the terrestrial nest matter be placed on the top level of the substation itself. Additionally, it would be of value to track the progression of nest quality, for example if nests of quality one progress to quality three over time via build-up of guano and utilisation of provided terrestrial nest matter.

An artificial nest structure in Norway trialled the provision of nesting materials to compensate for the lack of materials in Tromsø. Wet mud (manure) and straw was distributed along the clifftops close to the Marsden kittiwake colony at the beginning of the breeding season in April. Results showed that almost every nest utilised the compensatory nesting materials (Coulson, 2011).

4.2.6 Future study

This study recommends continual surveys be conducted in the future to assess interannual variation in productivity, nest quality, and aspect preference. The survey on 28th July was valuable in providing data, as most nests were occupied by adults and fledglings. However, most fledglings had left the substation by the 18th August. As such, this study recommends surveys be carried out earlier into the breeding season in order to get maximum data value. Furthermore, this study recommends more than two surveys be carried out per breeding season, in order to provide a greater volume of data, which will likely yield greater accuracy in statistical analysis. Finally, when conducting productivity comparison with other colonies, this report recommends future studies use the most current data in the form of the Seabird Count 2023 (published by the JNCC, 2023) and any additional local data that has been collected in a consistent manner over time.

4.3 Health and safety considerations

A potential barrier to implementation of the above recommendations is accessibility. Due to health and safety regulations, vessels are unable to get close enough to capture individual kittiwakes.

However, if further study was permitted suitably trained personnel (GWO trained) would only require access to the walkways or ladders to monitor adults and chicks during the kittiwake breeding season, subject to any operational limitations.

While this study recommends improvements to the accessibility of the colony, it is of note that there are some health and safety considerations. Avian flu has devastated many populations of seabirds since 2021. This study recommends that personnel in close proximity to the kittiwake colony wear masks and gloves as well as following any other standard Health and Safety precautions considered necessary, to protect both themselves and the birds. Additionally, concerns have been raised surrounding guano causing slipping hazards on other substations, particularly from cormorants on Burbo Bank OWF (Clifford & Mather, 2021). However, observations from this study suggests this will not be an issue as the kittiwake at Walney Two OSS have only been observed on girder ledges and no nests, adults or fledglings were seen on or around the walkways or ladders. Further study is recommended to assess the impact of guano on the OSS and the potential impact to health and safety.

5. Conclusion

This study provides the first baseline data set for kittiwakes nesting on the Walney Two OSS. Data showed the kittiwake colony was stable and productive, with most birds found nesting on the north side and underside of the platform. This is perhaps due to protection from environmental conditions, including sunlight, harsh winds, and heavy rain. However, further monitoring of this population is required to address knowledge gaps including population dynamics, reasons for productivity, and connectivity with other colonies. As such the following measures are recommended, subject to any health and safety and/or operational limitations:

1) Annual counts spread throughout the kittiwake breeding season to address any uncertainties from this study and to determine any interannual variability.
2) Investigation into the potential impact of guano on the OSS and impacts for health and safety.
3) Installing a box of terrestrial nest matter to improve nest quality and breeding success, subject to any health and safety and/or operational limitations.
4) Ringing of nesting adults and juveniles to investigate kittiwake dispersal.
5) Tagging of adults with geolocators to investigate where kittiwakes forage and how they navigate the windfarm.
6) Collecting and analysing guano samples to assess diet.
7) Installing camera traps to assess diet and feeding grounds and general behaviour.

6. Acknowledgments

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8. Appendix

Appendix 1: Number of adult kittiwakes present on the Walney Two substation during a preliminary site survey on 19th April 2023. Data from Natural England.

Side	Adults
North	41
East	39
South	39
West	8
Underside	1
Total	110

Appendix 2: Number of adult and fledgling kittiwakes, and occupied nests, observed on each side of the substation. From the 28th July 2023 survey.

Side	Adults	Fledglings	Nests
North	65	40	39
East	15	10	15
South	35	21	25
West	30	7	14
Underside	110	76	100

Appendix 3: Number of adult and fledgling kittiwakes, and occupied nests, observed on each layer of substation. From the 28th July 2023 survey.

Position	Adults	Fledglings	Nests
Bottom	106	66	79
Middle	30	12	13
Top	9	0	1

Appendix 4: Number of adult and fledgling kittiwakes, and occupied nests, observed on each side of the substation. From the 18th August 2023 survey.

Side	Adults	Fledglings	Nests
South	9	22	11
West	27	7	4
North	58	26	15
East	22	21	13
Underside	62	91	53

Appendix 5: Number of adult and fledgling kittiwakes, and occupied nests, observed on each layer of substation. From the 18th August 2023 survey.

Position	Adults	Nests	Fledglings
Bottom	86	62	36
Middle	23	13	6
Top	7	1	1

Appendix 6: Number of low, medium and high quality nests observed on the offshore substation. Nests were rated from low (1) to high (3) quality, based on size and composition. The number of fledglings associated with the nests were also recorded. N/A indicates the absence of a nest. Collected on 28th July 2023 survey.

Nest quality	Nests	Fledglings	Fledglings/nest
N/A	38	4	0.12
1	49	35	0.71
2	108	71	0.66
3	38	44	1.16

Appendix 7: Number of low, medium and high quality nests observed on the offshore substation. Nests were rated from low (1) to high (3) quality, based on size and composition. The number of fledglings associated with the nests were also recorded. N/A indicates the absence of a nest. Collected on 18th August 2023 survey.

Nest quality	Nests	Fledglings	Fledglings/nest
N/A	46	12	0.26

1	77	33	0.43
2	55	26	0.47
3	35	25	0.71

Appendix 8: list of contacts and the contributions/insight they provided for this study.

Name	Organisation	Contribution
Bart Donato, Laurence Browning & Richard Berridge	Natural England	Kittiwake ecology
		Examples of offshore nesting
		Survey methodology
		Health and safety considerations
		Set of recommendations
		Diet sampling
		Report draft feedback
Susan King	Cumbria Bird Club	Kittiwake ecology
		Productivity & total bird counts
Emma Ahart	Ørsted	Kittiwake ecology
		Project briefing and outcomes
		Set of recommendations
		Compensation and legislation
		Survey methodology
Tom Brady, Harry Cale & Toby Naylor	Ørsted	Communications with internal personnel
		Health and safety/risk assessment requirements
		Survey equipment
		Social media and data sharing
Emma Darnell	Ørsted	Nest quality
		Artificial kittiwake Nesting Structures
		Encouragement of nesting using decoys
Eleni Antoniou	Ørsted	Set of recommendations
		Artificial kittiwake Nesting Structures
		Compensation and legislation
Stefan Bartlett	Ørsted	OFTO Liaison
Gary Thornton and David Holmes	OFTO	Report review and recommendations
Georgia de Jong Cleyndert	North West Wildlife Trusts	Project briefing and outcomes
		Survey equipment
Jack Price & Harriet Baldwin	The Crown Estate	Report feedback and mentorship
Dave Shackleton	RSPB	St Bees Head Productivity data