

Baltray Little Tern Colony Report 2020

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Abstract

Wardening of the Little Tern (*Sternula albifrons*) colony at Baltray began in mid-May 2020 and ended on 9th August 2020. Night wardening (thus 24-hour colony-coverage) was initiated on June 8th. A total of 90 nesting attempts were made by an estimated 59 breeding pairs of Little Tern in 2020. The first eggs were found on May 19th. The last clutch was completed on July 10th. A total of 211 eggs were laid, the mean clutch size was 2.34 eggs per nest. The largest loss of eggs related to 59 eggs from 24 nests which were lost to predation by Red Foxes (*Vulpes vulpes*). Other losses included 20 eggs which were predated by corvids, eight eggs which were washed away by spring tides, one nest with two eggs which was covered by sand in strong wind, one nest containing two eggs which was walked on by a member of the public and 13 eggs which failed to hatch due to infertility or abandonment. A total of 106 chicks were known to have hatched out of 45 nests between 13th June and 21st July. The mean incubation period was 20.43 days. In total 51 chicks were ringed with metal rings this season, four of which also received green colour bands. Re-trap data were collected to estimate average growth rates. Of the 106 chicks hatched, a total of 16 young are known to have died. Fourteen chicks were found dead on the foreshore, probably due to exposure and starvation. Two fledged chicks were killed by a Sparrowhawk (*Accipiter nisus*). Thus, 90 chicks were presumed to have fledged, which equates to productivity this year of 1.52 fledglings per breeding pair. This is likely to be an overestimate; however, it gives a good indication of the success of the 2020 breeding season, which produced its highest number of breeding pairs and chicks presumed fledged since 2015.

1. Introduction

1.1 Background

The Little Tern (*Sternula albifrons*) is the smallest and scarcest of Ireland's five breeding tern species. Like many tern species, Little Terns are long distance migrants, wintering in West Africa and returning to Irish coasts to breed in late April and early May and departing again in late July or August. Unlike the other four Irish tern species, which primarily nest on islands, the majority of the Irish Little Tern population nests on mainland sand or shingle beaches. Nests are composed of a shallow dip scraped in the beach substrate above the high tide line, and the eggs and chicks are well camouflaged in the sand and shingle. Due to their nesting habitat, Little Terns are very vulnerable to recreational human disturbance, sea level rise and predation.

Little Terns are classed as an Annex 1 species under the EU birds Directive (79/409/EEC), requiring member states to take special conservation measures to ensure their survival and breeding success. In Ireland and the United Kingdom, the species is amber listed by BirdWatch Ireland and the RSPB (Royal Society for the Protection of Birds), indicating that this species is of medium conservation concern. The Little Tern is fully protected under the Wildlife Act (1976, Amended 2000).



Figure 1: Pair of Little Terns at nest in Baltray (Photo taken under NPWS licence by Billy Clarke)

1.2 Little Tern colonies in Ireland

Little Terns form relatively small colonies along the west and east coasts of Ireland, with 14 of the 24 colonies found in 1995 on coastal islands and ten colonies on the mainland. On the east coast there are colonies from Wexford to Louth, and on the west coast from Kerry [the map shows a site in Cork] to Donegal (Hannon *et al.*, 1997). The number of breeding pairs of Little Terns on the west coast is less well known than that on the east, but in 2016 a minimum of 100 pairs was reported in the NPWS Seabird Survey in Kerry, Galway, Mayo and Donegal (Newton *et al.*, 2016). Primary sites on the east coast are better known. Those that have recently supported colonies of breeding Little Tern are Kilcoole (Co. Wicklow), Baltray (Co. Louth, as covered in this report), Wexford Harbour and Tacumshin (Co. Wexford), and Portrane/Rogerstown (Co. Dublin).

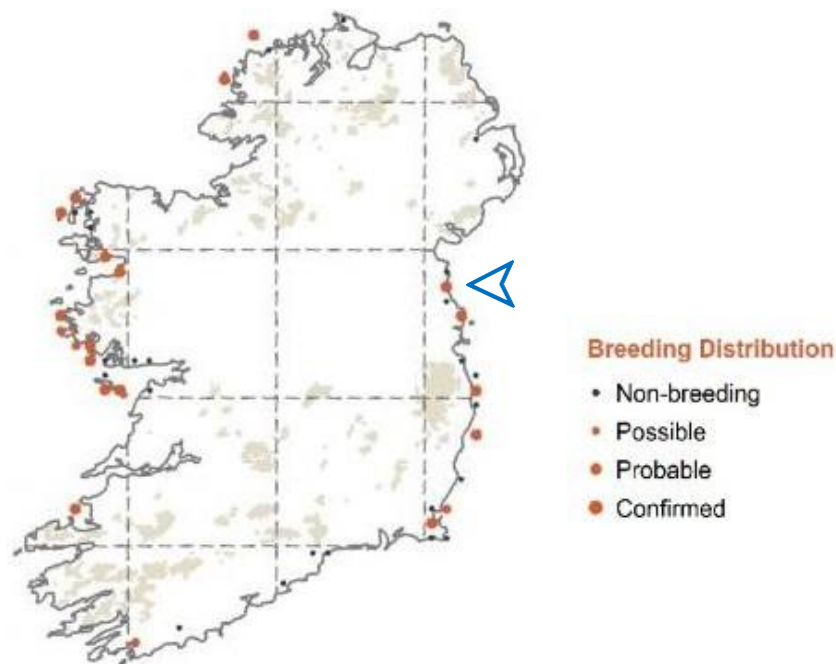


Figure 2: Breeding distribution of Little Terns in Ireland. Blue arrow indicates Baltray. (birdwatchireland.ie/birds/little-tern/)

North Bull Island (Co. Dublin), and Buckroney (Co. Wicklow) historically supported Little Tern colonies but are no longer used due to high levels of recreational disturbance. At Portrane, just a single pair successfully bred in the years 2009 to 2012. From 2013 to 2015, one or more pairs may have nested successfully but in 2016 a hot and sunny spell in early summer brought large crowds on to North Dublin beaches, including Portrane and this probably deterred Little Terns from settling. The establishment of a wardening scheme at Portrane in 2018 resulted in eleven breeding pairs producing fourteen fledged chicks that year. Breeding success in 2019 was hampered due to predation by Red Fox, resulting in just one pair out of fifteen fledging three young.

In County Wexford Little Terns have been recorded nesting in new breeding locations at Raven Point and a site known as “New Tern Island” off the Rosslare Backstrand in Wexford Harbour since 2009. Elsewhere in Co. Wexford, there are reports of nesting at Cahore in recent years. In 2017, an attempt was made to monitor the colony in Wexford Harbour (details extracted from the Irish Sea Tern Colony Network Facebook Page); the first visit on 9th June yielded a total of approximately 150 pairs and 64 nests were located of which more than 20 contained only a single

egg. On the 22nd June, the same number of adults were present, and a few chicks had hatched. No obvious change in colony status was detected on 5th July but the site was deserted by the 13th July and the colony was judged to have failed. Elsewhere in Wexford during 2017, two Little Terns were seen at Tacumshin Lake on 9th April, and a Little Tern nest with three eggs was located by Oran O'Sullivan at the 'cut' on 18th May, though its fate was not followed up. Only two birds were seen at Cahore on the 8th May (<http://www.irishbirding.com>).

Despite the success at sites such as Baltray (up to 2014) and the apparent expansion to former breeding locations, Kilcoole is most likely the only site on the east coast to have attracted nesting Little Terns every year since 1984. At Kilcoole in 2013, 45 pairs fledged 75 chicks (Keogh *et al.*, 2013). The relatively low number of pairs in 2013 may have been a result of the record breeding year here at Baltray, Co. Louth (Doyle *et al.*, 2013). The most successful breeding year to date, at Kilcoole, was in 2015, with 155 pairs producing 301 chicks, 289 of which were presumed successfully fledged (Doyle *et al.*, 2015). A poorer year was experienced in 2016 with starvation and significant fox predation of chicks the most significant factors behind poor productivity (Manley *et al.*, 2016). The 2017 season saw a significant improvement, with 141 pairs laying clutches and an overall productivity of 1.81 fledged young per pair (Johnson *et al.*, 2017). Kilcoole was the only fully wardened active Little Tern colony in 2018.

1.3 Little Tern Colony in Baltray

1.3.1 *The nineteenth and early twentieth centuries*

Little Terns were first definitively reported breeding in county Louth in 1900 by RJ Ussher: "Little Terns have laid on the coasts of Louth..." and this refers to records collected from 1866 (Ussher & Warren, 1900); unfortunately, Ussher does not mention the location in county Louth. Kennedy refers to a possible decline in Little Tern numbers since Ussher's report but reports one unidentified area in county Louth with up to ten nests in 1946 (Kennedy, 1953). Subsequently Kennedy (1954) reported a possible decline of Little Terns, however Hutchinson (Hutchinson, 1994) thought that this may have more accurately reflected changes to their nesting site, a phenomenon well known in the ecology of Little Terns (Cabot & Nisbet, 2013).

1.3.2 *The late twentieth century (1960s and 1970s onwards)*

There are no detailed records of the site during the 1960s and 1970s, but reliable observers noted Little Terns flying up and down the estuary, apparently nesting on both the beach and on sandbanks/mudbanks farther up the estuary than the present-day site (Dominic Hartigan, pers. comm. 2013).

During the 1960s and 1970s, Irish people started to frequent beach areas in unprecedented numbers. Oscar J. Merne reported Little Terns at Clogherhead in 1967. The site at Baltray is relatively inaccessible with 2km of dunes to cross, but nevertheless An Foras Forbartha reported that this was starting to become a significant issue by 1970 (NPWS). The 1968–72 Breeding Atlas (Gibbons, 1973) recorded a small colony at Baltray and this was apparently unchanged when the 1988–91 survey (Chapman, 1992) was undertaken, even though many of the other colonies on the east coast had clearly declined. Several surveys since then, notably Operation Seafarer covering 1969–70, the All

Ireland Tern Survey in 1984 and 1995, as well as Seabird 2000 covering 1998 – 2002, have provided more solid information on Little Tern numbers and trends.

Following the results of the 1984 tern survey (Whilde, 1985), the need for conservation of Little Terns was identified due to declining numbers and contraction into fewer colonies (Herbert, 1986). This effort was spearheaded by the Irish Wildbird Conservancy (now BirdWatch Ireland) in 1986 by John Coveney, Ian Herbert and Larry Lenahan with fencing, wardening and detailed surveillance and reporting. Thereafter, sporadic efforts were made at fencing and wardening but as this was largely volunteer-dependent it had mixed success (L. Lenahan, pers. comm. 2014). Historically the Little Terns at Baltray have undergone a series of extremely poor breeding seasons and occasional rearing of a small number of young but with productivity hovering just above zero. Attempts were made to monitor the site from 1984 onwards, with observers noting that Little Terns continued to attempt to breed at Baltray, but that breeding success was very low (Larry Lenahan, pers. comm.). Principally, breeding productivity of the colony was hampered by a combination of disturbance and predation by a range of nest predators.

1.3.3 Intensive wardening at Baltray, in the twenty-first century

It is from this point that the project at Baltray began in 2007, initially run by a team of volunteers coordinated by Sandra McKeever and Margaret Reilly; this effort resulted in their foundation of the Louth Nature Trust, with others, a factor which permitted the funding from the Heritage Council, Louth County Council and the NPWS.

The implementation of wardening by dedicated volunteers, in conjunction with fencing to protect the colony, led to a dramatic improvement in the breeding success of the Little Terns at Baltray. In 2007, 21 pairs fledged 41 chicks (McKeever and Reilly, 2007) and in 2008, 25 pairs fledged 29 chicks (Reilly, 2008). In 2007 and 2008 the project did not have sufficient funding for paid night wardens and suffered heavily from predation by Hooded Crows (*Corvus cornix*) (2007) and gull spp. (*Larus* spp.) (2008). The project reached its peak success in 2009 and 2010 when funding from both the NPWS and Heritage Council helped pay for wardens to cover the entire night, providing the colony with 24-hour protection. In both 2009 and 2010, 43 pairs bred, fledging 94 and 96 chicks respectively (Reilly, 2009; 2010). In 2011 withdrawal of NPWS funding meant that 24-hour wardening could not be provided, leading to the predation of 37 eggs, mostly between 11pm and 4am when wardens were absent. However, 2011 was still very successful with 49 pairs fledging 84 chicks (Reilly, 2011). The following year, 2012, proved to be a difficult year as extremely inclement weather led to the loss of 41 eggs to spring tides and 45 eggs were predated by a fox in the early hours of 17 June before the night warden arrived. Therefore 33 pairs fledged only 24 chicks (Reilly, 2012). This was the poorest breeding year experienced by the project so far, however given the very poor conditions for breeding in 2012 even 24 fledged chicks was a significant achievement and a testament to the hard work of the project wardens. This is especially true considering that Kilcoole experienced zero breeding success in 2012 due to similar circumstances (Keogh *et al.*, 2012).

The 2012 breeding season illustrates the importance of the Little Tern protection scheme at Baltray. Since the Little Tern protection scheme at Kilcoole was set up in 1985, the breeding success of Little Terns on the east coast has been largely dependent on this one site. Such heavy dependence on one site would leave the east coast population very vulnerable if Kilcoole were to suffer a number of disastrous washout years such as was experienced in 2012. The upturn in fortunes in the Little Terns breeding in the vicinity of Wexford Harbour has helped to alleviate this problem, however this

site does not enjoy the intensive protection enjoyed at Kilcoole and breeding success has been more intermittent. Therefore, the setting up of a second, intensively-wardened Little Tern protection scheme at Baltray has been vitally important. It is helping the Irish Little Tern population to grow as well, as reducing the dependence on a single breeding site. From 2013 scientific reports were produced following the contracting of the ecological aspects of the project to BirdWatch Ireland.

The 2013 and 2014 seasons were very successful years with 102 breeding pairs, 203 hatched chicks and 193 fledglings in 2013, and 150 nesting attempts, 170 hatched chicks and 91 successfully fledged Little Tern chicks in 2014.

Due to a reduction of funding only one day time warden was in place in 2015 and this had a severe negative impact on the project's ability to mitigate corvid predation. A total of 66 nesting attempts were made by 25 breeding pairs, the lowest total of pairs recorded since the project began in 2007. Of the 66 nests, 20 chicks are known to have hatched successfully, and due to the hard work of the wardens no predation of chicks was observed and all 20 chicks successfully fledged. The project was funded, indirectly, by the Heritage Council in 2013, through the Heritage Office of Louth County Council, which dedicated the whole of its annual project funding from the HC to the Baltray project.



Figure 3: Little Tern flying over Baltray Beach, 2020.

The 2016 season was not a successful year for the Little Tern colony at Baltray, especially in comparison with the previous three years. Bird numbers were low (typically max counts of 20 with only 8-16 birds regularly recorded; there was some evidence of courtship and nest scraping but no chicks were produced). Later in the season a peak of 89 adults and at least three colour ringed fledglings (ringed in Kilcoole) were observed. Possible reasons for this poor breeding season in 2016 relate to a late start in wardening, a large corvid presence, and sustained easterly winds early in the season. During the Little Tern migration from West Africa towards Europe there were some continuous days of very strong easterly winds and it is possible that some birds got blown off course and did not make it to Ireland (B. Martin, pers. comm.). This bad weather seems to have affected all

of the Little Tern colonies throughout Ireland and the United Kingdom with the exception of the Gronant colony in Wales (P. Manley, pers. comm.), which has a westerly exposure rather than easterly, and could explain the low numbers of birds seen in the Baltray area. The Gronant colony recorded two adult Little Terns that had been ringed in Baltray, indicating that the species will move between sites and is not necessarily loyal to just one breeding site. This reinforces the idea that the terns just nested elsewhere in 2016. Another possible explanation for the lack of Little Terns at Baltray in 2016 may have been a food shortage. Food shortages have been reported as causing major mortality at both the Kilcoole nesting site and for the Common and Roseate Terns on Rockabill in 2016 (S. Newton & P. Manley, pers. comm.). Multiple dead chicks, with no external physical damage, were found along the foreshore in Kilcoole, some near fledgling age, indicating that they had probably died of starvation. On discussing this issue with the local anglers in the Baltray area, we were informed that a possible cause of this problem was that the mackerel had not begun to move in close to the coast yet (R. McElhinney, pers. comm.). As the mackerel move in, they push the sandeels and sprats closer to the coast, with Sprats going up the estuary, moving into the shallower water in which the Little Terns prefer to hunt.

Overall, the low tern numbers in the area in 2016 were likely down to a combination of reasons, including adverse weather during the migration, food shortage and heavy corvid disturbance suffered by the birds that did arrive. As the Little Terns arrived in such small numbers, they were unable to effectively mob the Hooded Crows and Rooks that were feeding in the nesting area and, although the wardens chased the corvids out as quickly as they were coming in, the large size of the nesting area (between 800 and 900m long) and the sheer number of corvids made this difficult. Corvids were observed to move in at several points simultaneously, therefore it was not possible to protect the entire area all of the time, even with both wardens working together.

The 2017 season was the worst breeding season seen at the Baltray site since the inception of the organised wardening and protection scheme in 2007, marked by the almost complete absence of courtship display. An exhaustive analysis of the possible causes of this eliminated factors such as weather, disturbance, predation etc and suggests that an increased dredging regimen both in time and in volume in late 2016 and through the breeding season in 2017 is a likely cause. The Little Tern conservation project in Baltray was not carried out in 2018 following the failure of Little Terns to breed in Baltray in the two years previously. A grant was not applied for due to the severe deleterious effects of the dredging (Breffni Martin, pers comm.)

Breeding success improved markedly in 2019, with over 36 pairs fledging an estimated 50 chicks. The project in 2019 was carried out with funding from the National Biodiversity Action Plan obtained through and supplemented by the Heritage Office of Louth County Council.

1.4 Project Aims

The principal aim of the Baltray Little Tern Protection Scheme is:

“To ensure the survival and breeding success of Little Terns at Baltray by minimising disturbance by humans and predators, in order to help fulfil Ireland’s legal obligations under the EU Birds Directive”.

Strategies employed by the Louth Nature Trust/BirdWatch Ireland partnership to achieve this aim are:

- To promote awareness amongst the visiting public, in order to seek their co-operation in minimising human disturbance.
- To create physical barriers to prevent terrestrial predators accessing nest sites, where possible.
- To maintain colony surveillance for the early detection of both avian and terrestrial predators, and take appropriate steps to prevent loss of eggs, chicks and adults to predators.
- To monitor the breeding performance of the colony, in order to measure the success of the project and increase our knowledge of Little Tern ecology.
- To survey and monitor other species and habitats at the mouth of the Boyne estuary

2. Methods

2.1 Study Site

Little Terns at Baltray breed in an area known as the Haven. The colony is situated within the boundary of the Boyne Coast and Estuary Special Area of Conservation (SAC) and the Boyne Estuary Special Protection Area (SPA). Little Terns have very specific requirements for nesting and this area is suitable because of the presence of a ridge of shingle and its proximity to the river Boyne. As a consequence of winter storms, the beach configuration at the Haven changes dramatically year on year. A combination of embryonic dune formation, vegetation encroachment and wave dynamics act together to shape the topography of the area. In 2020 the potential nesting area extended from the training wall next to the Boyne river ca. 900m northwards to the shingle area adjacent to the pump house. This area is constantly changing due to the effects of weather, primarily the direction of the wind, which redistributes the sand along the beach.

The Baltray site is subject to very large tides, with the horizontal width of the intertidal area measuring approximately 300m between the Mean High Water (MHW) and Mean Low Water (MLW) mark. The nesting area stretched from the MHW mark c.50m inland, though much less in certain areas. From the MHW there was c.20m gently sloped sand/small shingle followed by a c.10m transitional zone of mixed sand/medium shingle straddling a ridge which marked the beginning of the vegetation line and embryonic dune formation dominated by Marram Grass (*Ammophila arenaria*) and Sea Lyme Grass (*Elymus arenarius*)(Figure 4). In some sections the nesting area extended another c.20m into an area of large shingle mixed with patches of vegetation, though in much of the potential colony the vegetation was too dense for the terns to breed.



Figure 4: Nesting habitat of Little Terns on Baltray beach.

A track runs along behind the breeding area, separating it from the dunes, and is used to service the colony during the setting up and taking down of the fence. To facilitate the wardens and volunteers' presence on site, a portaloo was hired in each year from 2013. Due to concerns relating to Covid-19, two caravans were present on site in 2020 to allow adequate distancing while providing shelter to both wardens and volunteers. These facilities are vital to the running of this project.

2.2. Monitoring

Monitoring of the nesting site in Baltray began in early May, with some delays and constraints due to COVID-19 restrictions. Day wardens were present intermittently from the start of May, with the number wardens and of their hours present on site increasing from the third week of May and into early June when the number of nests with eggs began to increase. A full-time day warden (Róisín Normanly) was employed on 8th June, covering from 09:00 to 18:00 Monday to Saturday, with hours outside this period covered by volunteers. No full-time night warden was employed during 2020 but monitoring between 22:00-05:00 was undertaken by Maurice Conaghy, Dominic Hartigan, Gerard Murray and other volunteers after 8th June following nocturnal egg losses. Due to the COVID-19 lockdown, many new volunteers became available and volunteer wardens were present onsite 24 hours a day.

The warden's daily routine consisted of locating new nests and monitoring existing nests for the presence or absence of incubating birds. Nest visits were made to check the number of eggs and/or chicks present. As well as Little Terns, Ringed Plovers (*Charadrius hiaticula*) which nested within the colony were monitored in the same way. A daily log was kept, where details of personnel present, weather, tides, work done, tern activity, nest status, disturbances, visitors and all wildlife observations were recorded. Nest data tables were kept outlining the progress and due hatching dates for each nest. However, as entering the colony (beyond the electric fence) causes disturbance which may result in nests being abandoned, every effort was made to minimise visits into the colony. The colony was never entered in adverse weather conditions (during rainfall, high winds or fog). In addition to these duties, the wardens were responsible for erecting and maintaining the colony fence.

2.2.1. Little Tern Numbers

The number of adult Little Terns present at the colony was recorded by the wardens as often as possible, and at the end of each day the maximum number was entered into the daily log. Counts were conducted during full dreads, when the birds were flushed, or when they were counted, roosting at high tide along sandbars on the seaward side of the colony, using a telescope (during good weather); this was noted separately when it occurred. The presence of any colour ringed terns was also noted, and inscriptions read when conditions allowed.

Once chicks start to fledge, separate counts are made of fledglings to give an idea of productivity. This estimate decreases in accuracy after the first two weeks however, as fledglings begin to leave the colony around two weeks after fledging (Keogh *et al.*, 2011). Therefore, fledgling counts are not used to estimate the total number of fledglings produced in a breeding season. However, they are a useful monitoring technique, as very low fledgling counts may indicate that chicks are being heavily predated. Survey methods for fledglings consisted of counts at high tide when the majority of the Little Terns roost together along sandbars in front of the colony. These counts were undertaken during calm and clear weather when fledglings can easily be distinguished in amongst a flock of adults.

2.2.2. Nest Locations and Observations

Binoculars and telescopes were used to monitor tern activity and locate nests within the colony. Note was taken of the following behaviours: courtship feeding, courtship displaying, aerial

displaying, copulating, making nest scrapes or incubating. When it became apparent that a bird was incubating, an exploratory visit was made to locate the nest. Nest contents (i.e. number of eggs), nest substrate and approximate position in the colony were noted. The nest was marked by placing an upright red brick 1m in front of the nest. Nests were coded as follows: Little Tern (L $X.n$, where X is the pen number in which the nest occurs (see Figure 6) and n is the number of the nest in the order found) and Ringed Plover (RP $X.n$). If a nest was discovered outside a pen, it was given the number of the pen closest and labelled with an 'o' before the pen to indicate that it is outside. A map of each pen was drawn with the location of each new nest added. This greatly facilitated nest checks and observations.

All nests were observed daily for presence or absence of an incubating bird, thus allowing identification of abandoned or predated nests. When a clutch did not increase in size over three consecutive days, or when a third egg was laid, the clutch was considered complete. To minimise disturbance nests were not visited after clutch completion unless the incubating adult had not been observed incubating. It was very difficult to observe whether birds were actively incubating certain nests however a nest was considered to be still active if its surrounding scrape was being maintained. Hatching dates were predicted where the clutch completion date was known, and daily nest visits were resumed at this point to check for hatching. All details of daily nest visits and chicks re-trapped were recorded daily in a summary table. The data recorded here were the number of eggs or chicks per nest, and whether any predation incidents had taken place (Table 1). These details were confirmed each evening and allowed the warden on duty to identify which nests needed to be checked.

2.2.3. Biometrics and Ringing

Ringing of Little Tern chicks was carried out in 2020 under the supervision of Jennifer Lynch (National Parks and Wildlife Service). Rings were supplied by Dr Stephen Newton (BirdWatch Ireland). Three ringing sessions were conducted: on 20th June, 26th June and 10th July. The foreshore was searched during high tide and once a tern chick was found, its leg size was assessed to determine whether it was large enough to ring. When possible, chicks were fitted with a metal British Trust for Ornithology (BTO) ring in size B+ on their left leg, and a green plastic Darvic colour ring on their right leg.

The green Darvic band is used for Little Terns on the east coast of Ireland, and the position of the rings allows them to be distinguished from Kilcoole chicks from a distance, which have metal rings on the right and Darvic rings on the left. The green Darvic rings have a unique three letter/number code engraved in white lettering which can be read through a telescope to identify the individual. Chicks can only be colour ringed when their tarsus is long enough to fit a colour ring, usually at around one week old. Each chick had to be assessed on an individual basis to see if its tarsus was long enough. Metal bands can be fitted from hatching and chicks were usually ringed in or near the nest scrape, meaning that the exact age and nest of origin of these chicks was known if they were recaptured. Day 0 was used to denote the day of hatch, so 1-day old chicks had hatched the previous day.

Wing length and weight were measured when chicks were encountered to monitor their development. The nest site was searched for chicks during egg checks, and after most chicks had left the nest scrape, the foreshore was searched most days. Ring numbers, when present, were recorded and used to identify the age of the chick. Wing length (maximum chord length) was

measured to the nearest mm using a stopped rule. Weight was measured using an electronic balance to the nearest 0.01g.

2.3. Conservation Measures

2.3.1. Use of Fences

Initial work on erecting fencing and signs began in mid-May thanks to Dominic Hartigan and a team of volunteers. Fencing from previous years was reused again in 2020. The area of shingle enclosed stretched from approximately 500 metres north of the Boyne wall northwards towards the pump house. The fence is used to reduce the probability of breeding failure caused by mammalian predators and to protect the area from human disturbance. Green plastic mesh was used on all but the east (seaward) side of the site (Figure 5). This made repair of storm damage easier and allowed chicks to leave the fenced area. A section of approximately 20 metres of dunes to the west of the beach was also enclosed, and the green mesh fence also went further north than the actual nesting enclosure. This was very useful as it acted as a buffer zone so that people and dogs were kept well away from the nesting terns when they approached from the north side of the beach.



Figure 5: Green mesh outer fence, with motion-activated solar powered lamp.

This year, the nesting area was divided into eight pens and each pen was enclosed separately (Figure 6). These pens were created using posts and one metre high electric mesh fence. A line of posts was erected along the HWM to the seaward side of the fence, to remind people to keep away from the fence.

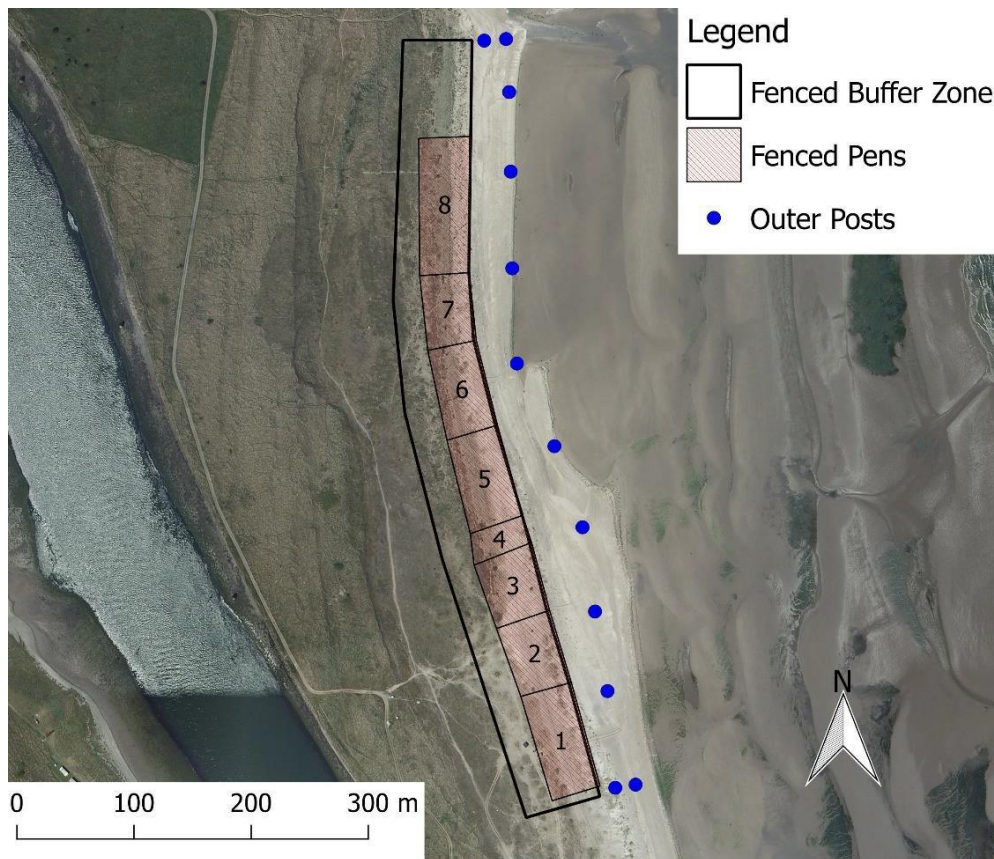


Figure 6: Map of the Little Tern nesting area showing total fenced area, fenced pens (1-8) and line of outer posts on seaward side of the colony.

To prevent avian predators using the wooden posts as perches, cut plastic bottles were attached on top of each post. Consequently, if a bird attempted to land, the cut bottles would not support their weight. This worked well as a deterrent. Motion-activated solar powered lamps were positioned at strategic points around the north, west and south ends of the main colony perimeter mesh fence. These lamps charge during the day and are activated at night when something crosses the sensor within a metre in front of the lamp. This served as a deterrent to nocturnal predators and a warning system for night wardens.

2.3.2. Use of Signs

Several types of signs were erected around the conservation site (Figure 7). These included basic information signs regarding the Little Terns, protected area signs, warning signs for the electric fence and chicks on the foreshore signs. To cater for non-English speaking visitors, some were designed using symbols and pictures. These were erected at all entrances to the area, on the northern end of the beach and all around the nesting enclosure. Two large 1m² signs were erected at the entrances to the beach North and South of the site. These were full colour interpretive signs, outlining the project and providing information about the Little Tern.

Signs were erected along the walkway from Baltray to the beach as well as along the fence at either end, asking people to keep dogs on leads to protect ground-nesting birds. Signs were placed along the stakes of the buffer zone around the entire north and south ends of the colony and

at a stile by which many people access the beach. This proved very successful at cutting down on the number of people who attempted to walk along the foreshore.



Figure 7: A selection of signs erected around the Little Tern conservation site.

2.3.3. Chick Shelters

Around 15 lengths plastic pipe were placed on the beach as chick shelters. A variety of pipes were used, the diameters ranged from 6cm to 10cm, and the length was typically 20cm. These were half-buried in the shingle and sand to provide chicks with shelter from the elements and from predators. Shelters were placed beside newly hatched nests, and on the foreshore on the seaward side of the fence. They were redistributed to areas with a lot of chick activity as necessary. Several young chicks were observed sheltering in and beside the pipes throughout June and July. A variety of natural and man-made debris present on the shore was also utilised by chicks for shelter – pieces of driftwood, large rocks and large plastic rubbish provided shelter to chicks on occasion.

2.3.4. Predator Management

As a ground-nesting species, Little Terns are very vulnerable to predators during the breeding season. In addition to the protection afforded by the fencing, wardens and volunteers were present 24 hours a day between 8th June and 28th July and attempted to scare away any potential predator spotted. The presence of people on site was a deterrent to most predators. The focus of predator management this year were Red Foxes (*Vulpes vulpes*), Sparrowhawks (*Accipiter nisus*) and corvids (Hooded Crows (*Corvus cornex*) and Rooks (*Corvus frugilegus*)).

Motion activated solar lights were placed at intervals along the fence, to disturb predators and alert wardens to their presence. During nocturnal disturbances, a searchlight was used to locate and scare foxes, and a radio was used as a noise deterrent. Cage traps of various sizes and designs

were set in the vicinity of the site to capture potential predators so they could be relocated to a more suitable area.

2.4. Public Awareness

2.4.1 Interaction with beach users

A daily effort was made to increase public awareness and appreciation of the Little Tern. This was carried out by talking to interested walkers and, when possible, showing them an incubating adult or chick through a telescope or on a leaflet. When beach users were seen to be walking along the foreshore on the seaward side of the colony, or were in danger of entering the colony, they were approached by wardens, informed about the Little Tern colony and politely redirected. When people were unaware of the project it was explained, nests were pointed out when possible and alternative routes were suggested. When loose dogs came too close to the colony, wardens asked owners to place them on leads or take them away from the nesting site.

A blackboard was placed at the north end of the conservation site near the access pathway from Baltray. This was updated daily with counts of nests and eggs, and any news on the colony. This was well received, and many regular beach users enjoyed keeping updated on the colony.

2.4.2 Group Talks & Outings

An invitation was extended to members of Louth County Council to visit the colony and on 14th July Councillor Michelle Hall paid a visit. A discussion was had with volunteers and wardens about the project, she was given a tour of the colony and shown fledglings and chicks through binoculars. On 25th July and 2nd August, two groups of approximately 60 walkers each from the Drogheda Ramblers visited the colony while on an outing. The warden gave a talk to the group outlining the importance of the project and gave them a tour of the colony. As there were no active nests remaining at this time, the groups were shown an abandoned nest with eggs at the edge of the colony. An informal talk was given to a group of 10-12 local scouts who were on the beach with their scout leaders on 25th July. A volunteer gave them an impromptu talk about the project and pointed out the Little Terns flying over the colony. The talks were well received and much appreciated by all of those who attended.

2.4.3 Media Coverage

Louth Nature Trust (LNT) has an active Facebook page which was used regularly to create awareness, promote, support, and share information about Baltray's Little Tern Conservation Project. The Facebook page now has 1193 followers and is a great resource for inviting new volunteers to join the project. Many of the new volunteers this year joined after following the progress of the Little Terns on this page. Long term volunteer Matt Byrne is an administrator of the page and was very involved in taking photographs and posting them on LNT's Facebook page.

3. Results

3.1 Weather

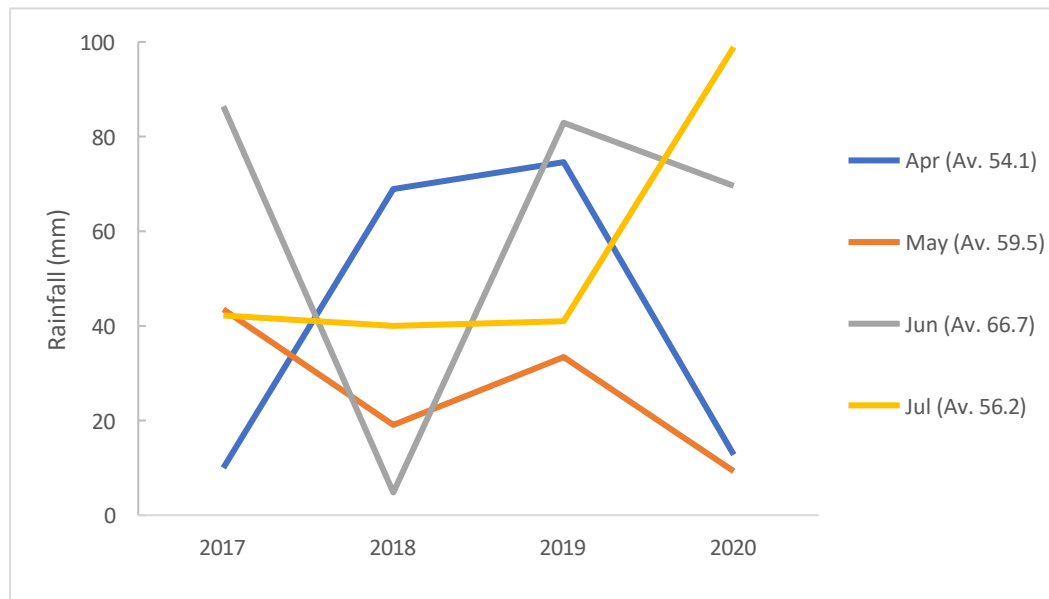


Figure 8: Average monthly rainfall (April-blue, May-red, June-grey and July-yellow) at Dublin Airport weather station between 2017 and 2020. Average given in brackets represents the mean rainfall (mm) for the period 1981-2010. (www.met.ie/climate/available-data/monthly-data)

The weather during 2020 was relatively warm and calm but with some strong winds, and higher rainfall towards the end of breeding season. The monthly rainfall as recorded in Dublin Airport in both April and May was low compared to previous years (see Figure 8: April 12.8 mm, May 9.3 mm). The monthly rainfall for June and July was higher, with July rainfall (98.9mm) much higher than the previous three years. Several nests outside the main fenced area were lost during spring tides. Strong winds on June 12th resulted in the loss of one nest as it was buried by sand. On July 7th, constant heavy rain resulted in the loss of four newly hatched chicks due to exposure.

3.2 Little Tern Numbers

An average count of approximately 40 adult Little Terns was recorded daily in the colony. The main method of counting was dreads counts. Dreads typically consisted of 30 to 60 Terns. These numbers are considerably lower than what would have been expected given the number of breeding pairs present. A peak count of 73 adult Little Terns roosting on a sandbar occurred on 10th July. The number of adult Terns increased throughout May, with numbers dropping in early June after a predation event resulting in the loss of 20 nests (Figure 9).

The first egg was discovered on May 19th and the number of active nests continued to increase for the rest of May, dropping in early June following predation by a fox (Figure 9). The first nest hatched on June 13th. As chicks fledged, there was a drop in Little Tern numbers as some of the population began to move around the eastern coastline. In July, the population increased once again as large numbers of adult Little Terns began to gather in loafing flocks before migration. In mid-July, numbers decreased as Terns began migration.

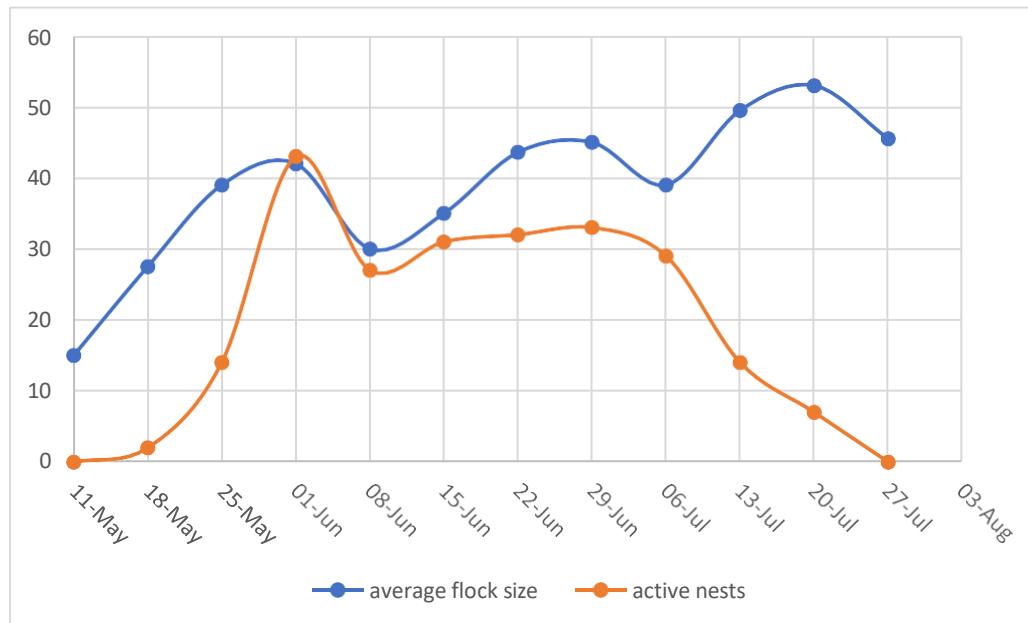


Figure 9: Average Little Tern flock size and the number of active nests per week at the Baltray colony from 11th May to 27th July 2020.

3.3 Nesting

3.3.1 Number of Breeding Pairs

With prolonged periods of nest loss and re-laying it can be hard to ascertain the exact number of pairs involved. The maximum number of clutches (both hatched and incubating) occurred on the 3rd of July with 59 clutches present. This means at least 59 pairs were active in Baltray, however it is likely that the number of pairs that attempted to breed is higher. Fox predation early in the season may have caused some pairs to desert the colony, but, due to the number of new nests found later in the season, many of these seem to have re-nested in Baltray.

3.3.2 Pattern of Nesting

Of the 90 nesting attempts, 64 were made inside the fenced area. Three attempts occurred in the buffer zone to the north of the site, with another outside the fence to the north and three more outside the fence to the south. Nineteen nesting attempts were made between the electric fence and the HWM on a sand bank on the seaward side of the colony. Due to the layout of the beach this year it would not have been practical to extend the fence any farther out as it would be at risk of damage by high tides. Of the nests outside the fence and in the buffer zone, 73% were lost prior to hatching and of the 64 nests inside the fence, 37.5% were lost before hatching. This highlights the importance of the fence in protecting the nesting site.

The first nest was discovered on 19th May, and numbers increased until 8th June, when predation by a red fox resulted in the loss of 20 nests. Active nest numbers increased again until the 18th June when a large number of eggs hatched. A third round of nesting peaked on the 30th June (Figure 10).

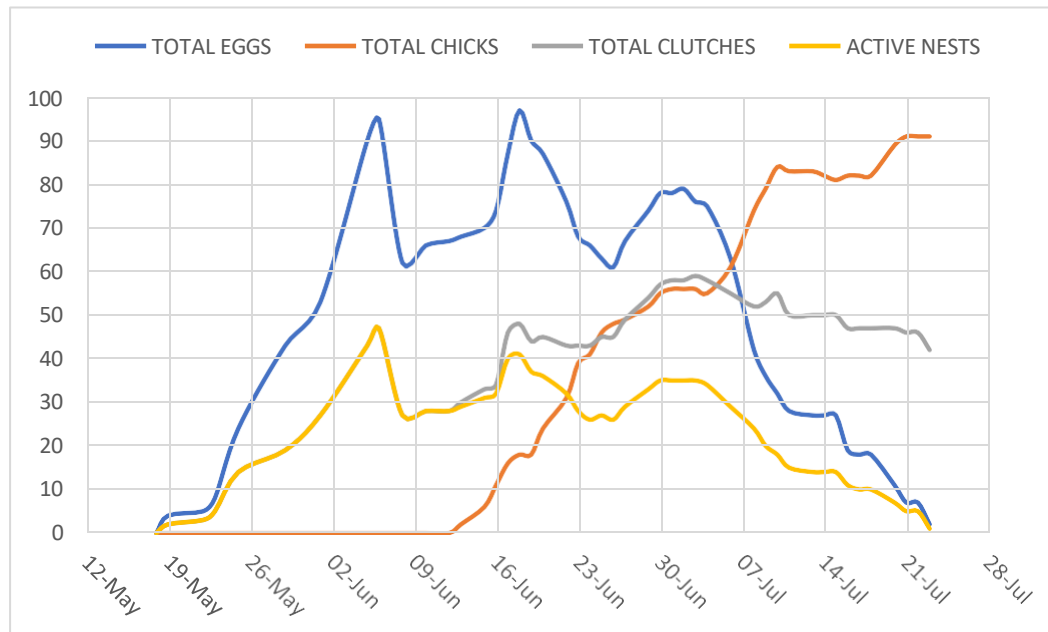


Figure 10: Trend of a) total egg numbers b) total chick numbers c) total clutches (active nests and hatched nests) d) active nests for the Little Terns over the whole nesting season (9th May – 23rd July)

3.3.3 Cutch Size and Incubation Period

Of the 90 nesting attempts, four clutches contained one egg, 51 clutches contained two eggs and 35 clutches contained three eggs. The average clutch size was 2.34 eggs. The exact incubation period is known for 23 nests (Table 1). The mean incubation period was 20.43 days. The shortest incubation period was 18 days, and the longest was 23 days.

Table 1: Incubation period of Baltray Little Terns in 2020 breeding season. Data only available for nests discovered before reaching full clutch. Incubation period covers time from when laying of the full clutch is completed until the first chick hatches (n = 23).

Nest Number	Incubation period	Incubation Length (Days)
L1.2	10-30 June	20
L1.6	13 June – 06 July	23
L1.7	18 June – 08 July	20
L1.8	17 June – 10 July	23
L3.7	18 June – 08 July	20
L3.8	18 June – 08 July	20
L3.9	17 June – 08 July	21
L3.10	19 June – 09 July	20
L3.14	30 June – 20 July	20
L4.1	10-30 June	20
L5.15	18 June – 08 July	20
L5.16	17 June – 08 July	21
L5.18	30 June – 19 July	19
L6.1	08-29 June	21
L6.3	08-29 June	21
L6.4	17 June – 08 July	21
L7.3	10-29 June	19
L7.5	17 June – 08 July	21
L7.6	18 June – 08 July	20
L7.7	21 June – 09 July	18
L7.8	27 June – 17 July	20
L7.9	27 Jun – 19 July	22
L7.10	29 Jun – 19 July	20

3.3.4 Hatching Success

In total 211 eggs were laid throughout the season in 90 nests. Of these eggs 104 did not hatch due to the following causes (Figure 11): fox predation (59 eggs), corvid predation (20 eggs), washed away by spring tides (8 eggs), covered by sand in strong wind (2 eggs), infertility or abandonment (13 eggs) and walked on by human (2 eggs). The remaining 106 chicks successfully hatched from 45 nests. The overall hatching success was 50.2% of eggs laid. Hatching commenced on 13th June and continued until 21st July.

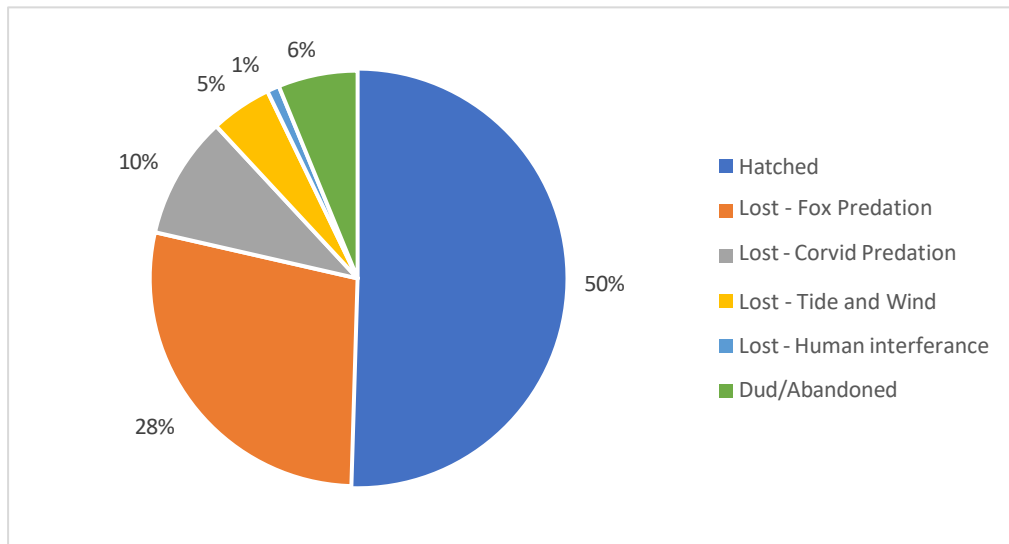


Figure 11: Percentage of outcomes of each Little Tern egg laid in Baltray in 2020 (n=211).

3.3.5 Fledgling Success

Of 106 chicks hatched, 16 are known to have died before fledging. 14 chicks were found dead, probably due to exposure and starvation – 12 of these were found near the nest scrape at less than four days old, often after periods of poor weather. The other two chicks were found on the beach and were estimated to be a week old and three weeks old, respectively. A Sparrowhawk hunted in the colony regularly between 9th and 14th July, resulting in the loss of two fledglings. The number of chicks taken by the Sparrowhawk was estimated through the number of piles of plucked feathers found in the surrounding sand dunes. These piles of feathers were used to identify the birds which were taken as fledged chicks, as they lacked full adult colouration (Figure 12) (Baker, 1993). No rings were found in the piles of plucked feathers.



Figure 12: Little Tern Fledgling with characteristic juvenile plumage.

Any chick not known to have died is assumed alive. Ninety chicks (85% of the total hatched) are assumed alive and fledged (Figure 13). This is likely an overestimate, but as the colony was observed on a 24 hour basis, and frequent searches were undertaken within the colony for chicks, it is thought that the majority of predations events and other chick deaths were accounted for, so this should be close to the true figure.

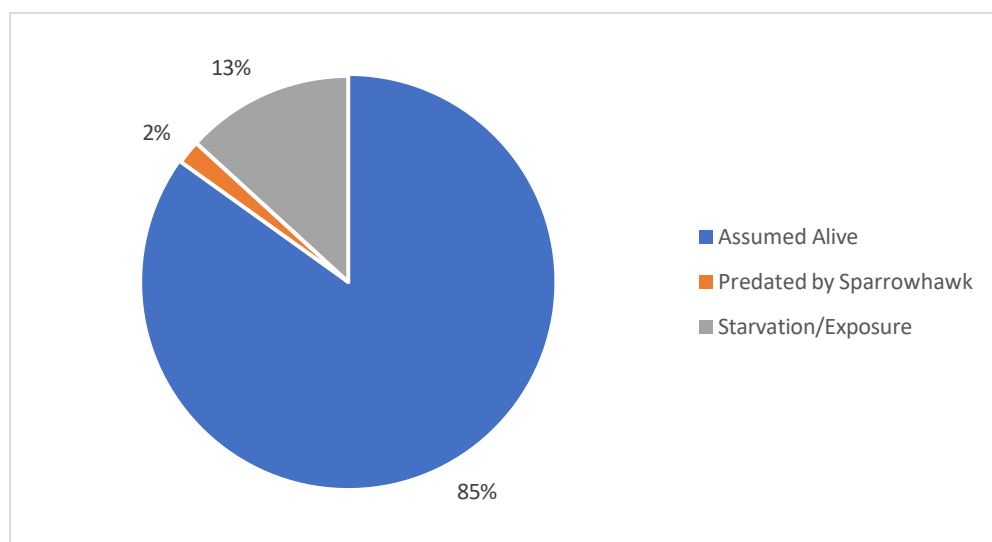


Figure 13: Outcome of each successfully hatched Little Tern chick in Baltray in 2020 (n=106)

3.3.6 Productivity

The productivity for this season is based on chicks assumed alive. As outlined above this is likely an overestimate but is thought to be the closest to the real figure. Fifty-nine pairs produced 90 fledglings, giving a productivity of 1.52 fledglings per pair.

3.4 Ringing and morphometric measurements

3.4.1 Ringing

Ringing was carried out in three sessions on 20th and 26th June, and 10th July. In total 50 chicks were ringed with metal BTO band, four of which also received green Darvic colour bands. On a couple of occasions the decision was made not to ring a chick whose tarsus was considered too small to take a metal ring when initially trapped, and the majority of chicks caught for ringing were too small to fit with Darvic rings. Despite this, 47.16% of chicks were successfully ringed in 2020 with a metal band, while only 3.7% of chicks were ringed with green Darvic rings.

3.4.2 Ring Recoveries

Rings were recovered from three dead chicks from the same clutch found around the nest scrape on 11th July, the day after they were ringed – NW46682, NW46683 and NW46682. They appear to have died from exposure.

Two dead adults were found on the beach, however neither had rings.

3.4.3 Ring Resightings

At least nine colour-ringed individuals were observed at Baltray in 2017, none in 2018 and two in 2019. In 2020, twelve colour-ringed individuals were identified in Baltray, with details provided in Table 2. Eight of these individuals were hatched in Kilcoole, two were from Gronant in Wales, and one each from Portrane and Baltray.

One individual (ACA) was ringed with a metal band as a chick in Kilcoole in 2005, making it 15 years old. It was subsequently retrapped at Rue point in the Isle of man in 2016 when it was fitted with a yellow Darvic ring on its left leg. In July 2018 it was recorded in Gronant, Wales and in 2020 in Baltray. Of the 12 colour-ringed individuals recorded, 11 were adults and one was a fledgling. The fledgling (ABH) was recorded in Baltray only 12 days after it was ringed in Kilcoole.

Table 2: Colour-ringed Little Terns observed at Baltray in 2020.

Darvic	Leg	Location Ringed	Date Ringed	Date Observed	Observer	Comment
IL6	L	Kilcoole		14.6.2020	Jan Rod	Non breeder?
ISL	L	Kilcoole		14.6.2020	Jan Rod	Non breeder?
IZ5	R	Portrane	2018	14.6.2020	Jan Rod	Non breeder?
ZXE	R	Gronant	2018	14.6.2020	Jan Rod	Non breeder? ringed as a chick
ZCN	R	Gronant	22.7.2018	14.6.2020	Jan Rod	Non breeder? ringed as a chick
ACA	L	Kilcoole	16.6.2005	14.6.2020	Jan Rod	7/6/2016 Rue point, Isle of Man 6/7/2018 Gronant, Wales
IK4	L	Kilcoole		13.7.2020	Jan Rod	Non breeder?
IJ8	L	Kilcoole		13.7.2020	Jan Rod	Non breeder?
IJ7	L	Kilcoole	6.7.2018	13.7.2020	Jan Rod	Non breeder?
ID4	L	Kilcoole		13.7.2020	Jan Rod	Read as IDA/ID4, reviewed record
I44	R	Baltray		13.7.2020	Jan Rod	With 3 fledged chicks on shore but association unclear
ABH	L	Kilcoole	10.7.2020	22.7.2020	Roisin Normanly	Fledgling

Of the four chicks fitted with colour rings in Baltray this year, three were resighted by Jan Rod along the coast of north Co. Dublin between 5th August and 18th August. (Table 3)(Figure 14).

Table 3. Resightings of colour-ringed Little Terns fledglings from Baltray in 2020.

Darvic	Leg	Metal	Date Observed	Location Observed	Observer
IV6	R	NW46662	9.8.2020	Portrane	Jan Rod
IV6	R	NW46662	10.8.2020	Rush	Jan Rod
IV6	R	NW46662	17.8.2020	Rush	Jan Rod
IT6	R	NW46649	5.8.2020	Portrane	Jan Rod
IT6	R	NW46649	6.8.2020	Portrane	Jan Rod
IT6	R	NW46649	7.8.2020	Portrane	Jan Rod
IT6	R	NW46649	10.8.2020	Rush	Jan Rod
IT6	R	NW46649	13.8.2020	Gormanston	Jan Rod
IT9	R	NW46650	18.8.2020	Gormanston	Jan Rod



Figure 14: Baltray Fledglings IT9 (left) and IT6 (right) in North Co. Dublin. (Photo by Jan Rod).

3.4.4 Summary Statistics

The numbers of Little Terns caught in their first few days is very high, though the sample size drops quickly after day 0-1 as they become more mobile and leave the nest scrape. There is some variation around the means, but the measurements were quite consistent for each age group; this is difficult to tell in older chicks due to the small sample size. Biometric measurements are summarised in Table 4.

Table 4: minimum, maximum, and mean (a) wing length (n = 78) and (b) weight values (n = 99) for Little Tern chicks age Day 0 to Day 19.

Age (Days)	Wing Length (mm)				Weight (g)			
	n	Min	Mean	Max	n	Min	Mean	Max
0	(14)	13	14.2	15	(21)	5.7	6.82	7.81
1	(25)	14	15.8	19	(29)	6.06	8.69	11.49
2	(18)	15	17.6	20	(23)	8.36	11.46	15.47
3	(6)	17	18.7	20	(10)	9.53	13.39	18.58
4	(1)	-	23	-	(2)	14.7	16.59	18.48
5	(2)	25	35	45	(3)	16.9	21.83	30.62
6	(2)	30	33.5	37	(2)	22.04	24.42	26.8
7	(1)	-	52	-	(1)	-	28.56	-
9	(1)	-	50	-	(1)	-	37.4	-
10	(1)	-	63	-	(1)	-	41.17	-
11	(1)	-	65	-	(1)	-	36.41	-
13	(3)	58	75.3	96	(3)	45.2	46.03	47.12
14	(1)	-	85	-	(1)	-	47.69	-
17	(1)	-	101	-	(1)	-	49.41	-
19	(1)	-	97	-	(1)	-	51.76	-

3.4.5 Chick Wing Length

Wing length increases slowly during the first few days. After day four, the rate of wing growth increased as the chicks' pins started to come through (Figure 15 and Table 4). The rate of wing length increase did not appear to be slowing in the older chicks. The average wing length for adult Little Terns is 176- 187mm for males and 167-180mm for females (Baker, 1993), so the wing length of the chicks would be expected to continue increasing until it reaches adult size.

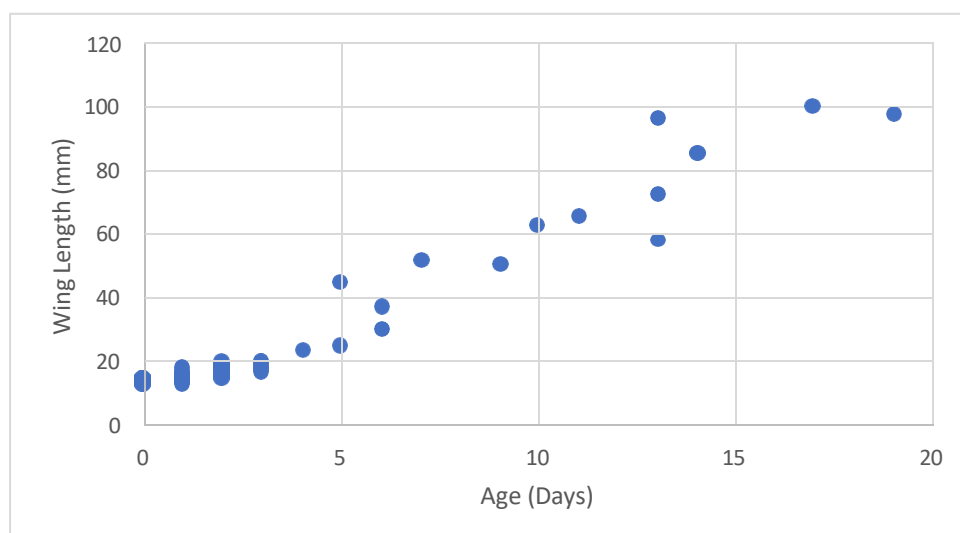


Figure 15: Little Tern wing length (mm) plotted against age (Days). n =78

3.4.6 Chick Weight

Chicks rapidly increased in weight during their first days (Figure 16). They typically doubled their weight or more in the first five days. At approximately day nine, the growth rate begins to slow as the chick approaches its adult weight. The average weight for an adult Little Tern is 50g (Gochfeld and Burger, 1996), and this was reached by some chicks from Day 14 (Table 4 and Figure 16).

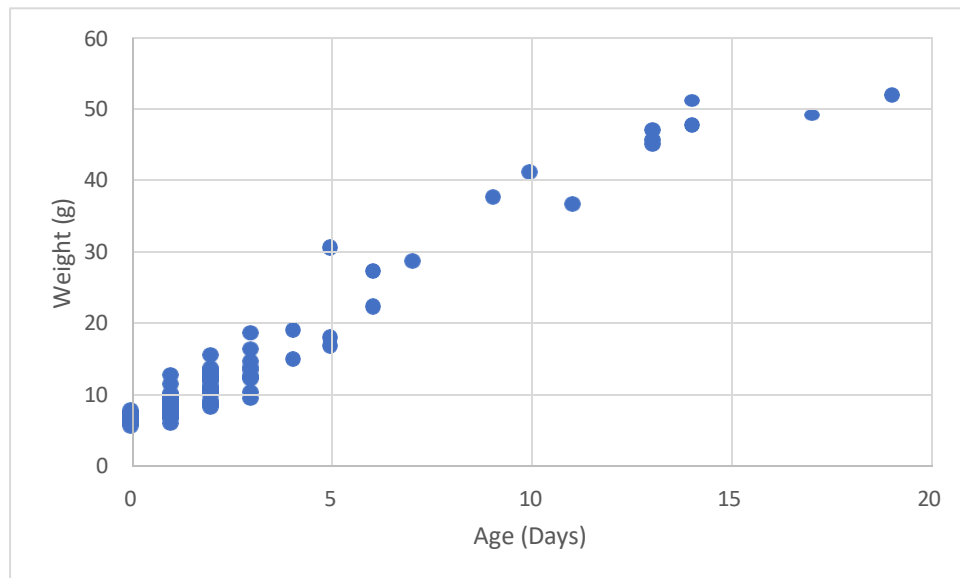


Figure 16: Little Tern chick weight (g) plotted against age (Days) ($n = 99$).

3.7 Predators and Disturbance

3.7.1 Terrestrial Predators

Predation by Red Foxes was the largest cause of egg loss for the Little Terns this year, with a total of 59 eggs taken by foxes. The largest predation event occurred between 22:00 on 7th June and 5:30 on 8th June, when 45 eggs were lost from 18 nests. After this event, night wardening was implemented. A fox was seen inside the fence again on 10th and 11th June, and one further nest with two eggs was lost. On 22nd June, a vixen and three cubs were seen in the dunes behind the colony. A single fox was seen on June 27th, 29th, July 2nd, and July 3rd, and two nests with three eggs each were lost. Foxes were seen on seven nights between 7th and 20th July, with two seen on the 14th and 15th. Three nests with a total of six eggs were lost on 16th July. No foxes were seen in the vicinity of the colony after 20th July. A rat (*Rattus norvegicus*) was seen on the track behind the colony on 16th July.

3.7.2 Avian Predators

Several potential avian predators posing a danger to fledged Little Terns and adults were observed in the area. As Kestrels (*Falco tinnunculus*) and Sparrowhawks (*Accipiter nisus*) have been major predators of Little Tern fledglings in Baltray in the past, the site was closely monitored for their presence. A Sparrowhawk was seen flying over the colony on 15th June, and a kestrel was spotted at the outer gate to the beach on 30th June. A Sparrowhawk hunted in the colony regularly between 9th and 14th July, resulting in the loss of two fledglings. A Knot (*Calidris canutus*) was also taken by the Sparrowhawk on one occasion. In an attempt to deter the Sparrowhawk, wardens

would shout and chase the bird, with some success - on 13th July it made five visits to the beach, but due to disturbance by wardens it did not appear to catch anything (empty claws were seen as it flew away).

A pellet from a Short-eared Owl (*Asio flammeus*) was found on the track behind the site on 30th June, but it is believed to have been from a couple of months previously. A Peregrine Falcon (*Falco peregrinus*) was seen hunting the resident flock of Knot on 16th June. A juvenile Peregrine regularly hunted on the beach between 16th and 28th July. It did not appear to be interested in the Little Terns, and primarily hunted the Knot flock. On one occasion it was seen to take a Redshank (*Tringa tetanus*). On 20th July, a kestrel was seen flying over the colony, but it did not appear to be hunting.

A flock of Hooded Crows and Rooks was present throughout the season, and often landed on the beachfront or in the dunes to the west of the colony. They are believed to be responsible for the loss of 20 eggs in ten nests. The predated nests were primarily from the northern and southern extremities of the colony, where they were not visible to wardens. When Corvids were seen in or near the site, they were chased away.

Several seabirds which presented potential threats to Little Tern chicks and eggs were present throughout the season; the Lesser Black-backed Gull (*Larus fuscus*), Great Black-backed Gull (*Larus marinus*), Herring Gull (*Larus argentatus*), Black-headed Gull (*Chroicocephalus ridibundus*), and Grey Heron (*Ardea cinerea*). Gulls were thought to have been responsible for heavy predation of Little Tern eggs in 2008 (Reilly, 2008) and any gull species flying over the colony was relentlessly mobbed by the Little Terns. However, no predation by any seabirds was observed. Flocks of up to 100 Starlings (*Sturnus vulgaris*) were observed throughout the season. They were considered a potential threat to the Little Tern eggs as they are thought to have predated two nests in 2011 (Reilly, 2011). They were chased away whenever they entered the enclosure.

3.7.3 Human Disturbance

The Covid-19 restrictions are likely to have caused a greater number of visitors to the beach than in previous years, as other attractions were closed, and people explored their local areas. These visitors also stayed for longer and engaged in more activities. Because the beachfront of the Haven is very exposed during low tide, there was a daily presence of people in the vicinity of the Little Terns. Many recreational walkers had to be guided away from the colony by the wardens. Most of these people had missed seeing the information signs about the project and were unaware of the situation. On 8th July, a nest with two eggs was walked on and destroyed. The walkers in question had missed the signs and were being redirected but stepped on the nest as they tried to leave the area. Many dogs were also let off the lead on the beachfront by their owners, despite the signs. Dogs frequently chased the birds, including the Little Terns and the wardens regularly had to request they be put back on the lead. However, it appears that none of these activities led to the damage of Little Tern eggs or chicks due to quick reactions by the wardens. On June 30th, a large dog was discovered inside the fence in a cage trap intended for foxes. No owner was seen, and the dog ran off towards Baltray as soon as it was released. It was not reported to the dog warden as the dog had a collar and walking harness and was clearly looked after. The dog was not seen again so was most likely found by its owner.

Drones were flown in the vicinity of the colony on June 1st, 27th and July 19th. This was a major threat to the breeding adults, as they may view the drone as a predator and try to drive it off which could result in serious injuries to the birds. As the operators were not visible, and may have been across the river, a plea was put out on social media to inform the public about the colony and to ask that drones not be flown over the southern section of the beach in Baltray. Recreational aircraft flew low over the area on 1st June and 11th July, with both a powered hang-glider and a small plane making an appearance. The Coastguard helicopter flew over on July 30th. Although the Little Terns did rise up in alarm, the presence of the helicopter was so brief that disturbance was minimal. On three occasions in July, riders on horseback attempted to ride down the beachfront at low tide. While disturbance was minimal, there was a chance that chicks could be crushed so the riders were informed about the project by the wardens and did not ride near the protected area again. Quads and scramblers were present on the beach on occasion but tended to stay north of the nesting site. Up to five Jet skis regularly went through the river and estuary. These may cause disturbance to Little Terns feeding.

3.7.4 Dredging

As in previous years, dredging continued at the mouth of the river Boyne in 2020 (a dredger registered under the name of Argus). It was recorded dredging on at least 26 occasions between the 8th June and 31st July. The area of operations was limited, and it did not move greatly north or south of the river mouth. Dredging typically took place at low tide, and an took an average of 3.5 hours. In 2019, observations of foraging terns during dredging operations were carried out in Baltray which found that the terns did not actively forage in the wake or plume of the dredger and seemed to actively avoid it.



Figure 1 Argus discharging dredge opposite nesting area 2019 - photo Niall Keogh

Drogheda Port Company report the following dumping at sea information in their 2020 AER Report (EPA):
Quantity of material dumped at sea:

- TSD Sospan Dau, commenced 20.02.20, completed 26.02.20 (1st campaign): 47,058 tonnes.
- TSD Sospan Dau, commenced 27.11.20, completed 03.12.20 (2nd campaign): 43,960.5 tonnes.

The campaign in June/July is not referenced so we may conclude that this was not dumped, but instead used for “beneficial reuse” which involves discharging to the quay wall for use in construction; the amount are therefore unknown.

The reported 185,708 tonnes in 2018 is approximately double the amount of 91,000 tonnes in 2020; furthermore the 2018 campaign continued throughout the summer months. The complete record for 2019 is not available at the time of writing but 2018 is a useful reference, since 2018 corresponds to the lowest productivity seen at the colony to date. This in a context where other colonies were successful that year.

3.8 Ringed Plover and other species

Alongside the Little Terns, at least six Ringed Plover (*Charadrius hiaticula*) pairs nested in the monitored site. The first Ringed Plover chicks hatched on 16th June, with the last clutch hatching on 11th August. Ringed plovers have two (occasionally three) clutches per year, so the later nesting attempts may be second clutches for earlier pairs (Robinson, 2005). Ringed Plovers made 11 nesting attempts in and around the fenced area, resulted in the hatching of 29 chicks from 42 eggs. Nine eggs were lost due to predation – with four taken by a fox and five taken by corvids (Figure 17).

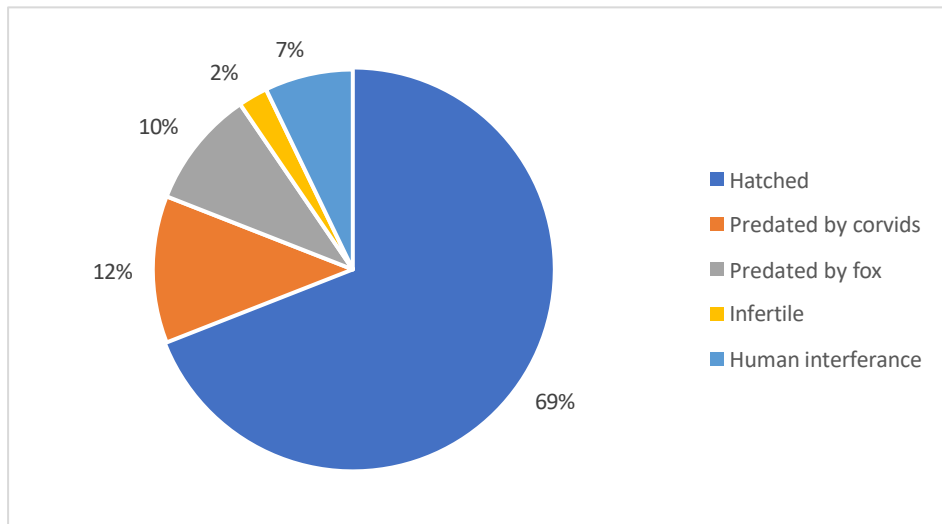


Figure 17: Outcome of each Ringed Plover egg recorded in Baltray in 2020 (n = 42)

A dead Ringed Plover chick was discovered on the beach on 25th June. It appeared to be a couple of days old and may have died due to starvation or exposure. This is the only recorded mortality of a ringed plover chick or fledging this year, which suggests a good rate of chick survival.

A nest containing three eggs, located approximately 500m north of the Little Tern colony, was disturbed by a member of the public, who removed them from the nest supposedly under the impression that they were abandoned. This incident highlights the vulnerability of ground nesting species on beaches, and the value of fencing off areas of beach to protect them from areas of human activity.

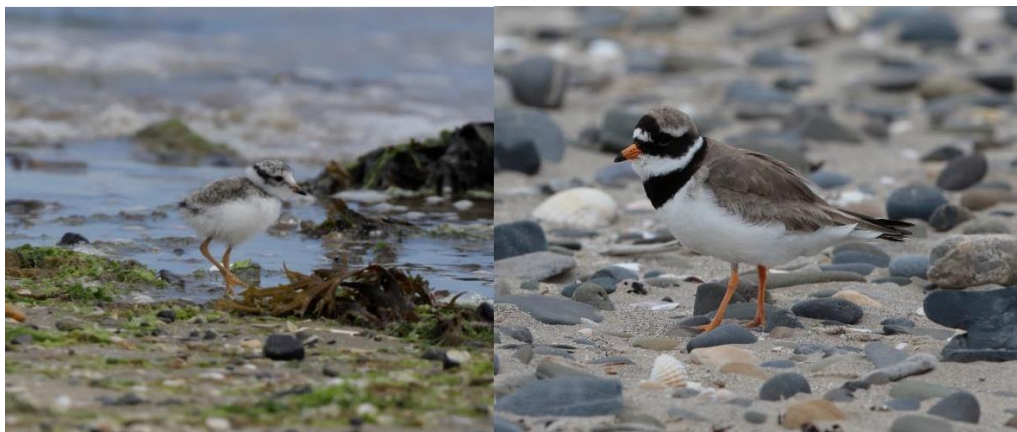


Figure 18: Ringed Plover chick (left) and adult (left) on Baltray beach (photos by Billy Clarke)

A lark nest was discovered inside the outer fence, from which three chicks fledged. A further lark family was observed at the northern end of the enclosure. A stonechat pair was frequently observed on the fence, and a piece of stonechat eggshell was found on the track behind the site.

3.8.1 Knot

A flock of Knot (*Calidris canutus*) were present to the south of Baltray beach almost every day between 24th May and 27th July. While the numbers varied over the summer, a peak of over 8,000 individuals was present on 23rd July (as estimated from Figure 19). Knot are a typically a winter migrant to Ireland which breed in the arctic, so such a large flock in Baltray during the summer is unusual. They roosted on the sandbank to the seaward side of the tern colony and fed on the beach as the tide went out. They were frequently disturbed by walkers so they may have roosted on the sandbank to avoid human disturbance.

The fact that they remained on the beach to feed and roost suggests that this area provided a suitable habitat to support a flock of several thousand knot. This is important as knot are a near threatened globally and their populations are decreasing (BirdLife International, 2018). The species is red listed by BirdWatch Ireland. Despite spending a lot of time in close proximity to the Little Terns breeding area, the terns were not disturbed by the large flock. It is possible that the presence of the flock may have provided some protection for the terns from birds of prey, as visiting Sparrowhawks and Peregrine Falcons appeared to focus on the Knot.



Figure 19: Flock of Knot in flight on Baltray beach on 23rd July estimated to contain over 8,000 individuals.

4. Discussion

4.1 The 2020 Breeding Season in Baltray

The success of any breeding season at a Little Tern colony can be primarily judged by the number of pairs that attempt to breed in that year and how many fledglings are produced from these nesting attempts. This year an estimated 59 breeding pairs produced 106 chicks, 90 of which are presumed to have fledged. This is the most successful season for numbers of pairs and fledglings since 2015. This year's estimated productivity of 1.52 fledglings per breeding pair is a positive reflection on the conservation measure undertaken. The mean incubation period was 20.43 days, within the standard incubation period for Little Terns, cited as 18-22 days (Cramp, 1985). The longest incubation period for a nest in 2020 was 23 days, whilst the shortest incubation period recorded was 18 days.

The largest loss of eggs in 2020 related to 59 eggs from 24 nests which were lost to predation by Red Foxes (*Vulpes vulpes*). This highlights the importance of overnight wardening, as a single fox can do a lot of damage in one night. Corvid depredation accounted for the loss of 20 eggs. Corvids are a significant threat to Little Tern nests but mainly predated nests at the extremities of the nesting area where they couldn't be seen by wardens. Thirteen eggs failed to hatch due to infertility or abandonment. Egg abandonment could be due to inexperienced parents or disturbance.

Natural mortality accounted for 14 chicks this year (13% of the total), which is quite high. This may reflect competition for food. Higher than average rainfall in June and July may also play a role in mortality due to exposure: on July 7th, constant heavy rain resulted in the loss of four newly hatched chicks. A Sparrowhawk hunted in the colony regularly between 9th and 14th July, resulting in the loss of two fledglings.

A total of 50 Little Tern chicks were metal ringed this year (47.16% of chicks). Re-trapping was carried out as often as possible in order to collect data on growth rates. Across years, these could be used as an indicator of feeding rates, and hence the availability of prey to Little Terns at Kilcoole. interesting insight into the growth of chicks near fledging. It appears that Little Tern chicks are approaching their final adult weight at about 2 weeks old, but their wing length continues to increase. Four chicks also received green Darvic colour bands (3.7% of chicks). Of these four chicks, three were resighted along the coast of North Co. Dublin, a positive sign for the survival of Little Terns in Baltray after fledging. A ringed Juvenile from Kilcoole (ABH) was spotted in Baltray on the 22nd July only 12 days after it was ringed in Kilcoole – highlighting the mobility of Little Terns once fledged. In 2020, 11 colour-ringed adults were identified in Baltray, seven of which hatched in Kilcoole, two were from Gronant in Wales, and one each from Portrane and Baltray. One individual (ACA) was ringed with a metal band as a chick in Kilcoole in 2005, making it 15 years old. It was subsequently retrapped at Rue point in the Isle of man in 2016 when it was fitted with a yellow Darvic ring on its left leg. In July 2018 it was recorded in Gronant, Wales and in 2020 in Baltray. These observations show the connectedness of the Irish Sea Little Tern population.

Baltray saw a return to productivity in 2020, with a very successful Little Tern breeding season. Combined with high numbers in Kilcoole (over 300 chicks fledged) and 12 chicks fledged from the relatively new colony in Portrane, over 400 chicks have fledged from the east coast of Ireland. This is a significant contribution to Irelands population of Little Terns, and a positive sign for the future of this species on Irelands east coast.

4.2 Dredging

Dredging has been ongoing along at the Boyne estuary to a greater or lesser extent for at least a few hundred years. Dredging has probably increased in recent decades in line with increased activity at the port and larger ships. Capital dredging is typically carried out to maintain shipping berths and the estuary channel, where silt builds up over time carried down by the river, and mouth of the river, where sand builds up thanks to the south to north longshore drift in the Irish Sea. This drift causes sand to be conveyed south to north and build up along the south training wall, onto the bar and so on northwards. To prevent the build-up of both silt and sand, dredging is carried out under a Foreshore Licence issued by the Department of the Marine. The licence specifies how much material can be removed, how it can be removed, at what frequency it can be undertaken (in terms of days per year) and where it may be disposed of (dumping at sea or beneficial reuse). During the 2017- 2019 nesting seasons, several wardens and other regular visitors to the site made anecdotal observations that dredging had apparently significantly increased, with plumes of material constantly visible in the water column, and almost daily activity by one or two suction dredgers (Argus and Sospan Dau). In 2019 and 2020 the work was carried out solely by the Argus.

To gain an understanding of this phenomenon the Foreshore Licence was checked. Because the whole area is designated under both the Birds and Habitats Directives, dredging requires an Appropriate Assessment (AA) to be carried out (Habitats Directive Article 4). The AA is the mechanism whereby impact on the Natura 2000 site is assessed; if any likely or uncertain impact is identified an Environmental Impact Assessment must be undertaken. Therefore, from the point of view of the Habitats Directive, the AA is the key permitting document since the dredging permit is dependent on it. An examination of the AA document under the heading Little Terns states as follows:

“3.5 Future Maintenance Dredging Requirements

Dredging at the river mouth and approaches generally takes place twice yearly, although in some years over the previous decade there have been three annual campaigns. The dredging at this location is generally in response to weather events. The time of year for dredging is dictated by the weather and weather events. A typical campaign takes about three weeks, working each tide, twice daily, generally from three hours before the high water to about 1 hour after the highwater.

Over the previous maintenance licence periods the port has accumulated a good deal of data and experience on the performance of the river and bar and the effects of weather. This coupled with mathematical modelling see reports by Kirk McClure Morton and RPS enclosed at Attachments B1 and D6 to this Dumping at Sea Permit application) allow realistic figures of annual maintenance dredging predictions. Monitoring of the bar/river mouth and the most sensitive area of the river in dredging requirement terms is now carried out by the port internal hydrographic unit, thereby maintaining a good check on depths particularly after easterly wind storm events.

The estimated annual quantity of maintenance dredging for the commercial channel, berths & swing basins from Drogheda town quays to the sea at Mornington is 30,000m³ or 48,000 tonnes, for the seaward approaches 90,000m³ or 144, 000 tonnes, with an additional annual contingency of 100,000m³ to allow for the unexpected and unplanned events that may impede the navigation channel. This is to cover an unexpected weather event or where the

river retaining walls that created the estuarine polders collapse (as occurred in 2000) and the material contained within a polder flows out into the main navigation channel. This can occur due to a differential in the water pressure between the retained waters in the polder and the river falling tide levels. The river walls were constructed in the 1850s and their construction and current condition leave them susceptible to the effects of ship wash and hydrodynamic action. The contingency also allows for unexpected weather events at the river mouth and seaward approaches.

A detailed breakdown of historic figures upon which this annual estimate is based on is provided in the main application. The majority of the material will come from the bar mouth and approach channel with much smaller quantities arising from the channel from the town to sea including all berths and ship turning areas.”

The same document assesses the impact of the above activity on little terns nesting in the area as follows:

“4.3 Boyne Estuary SPA 4080 Disturbance to birds

Little Terns are breeding on the beach at Baltray. The dredging activities will be remote from this location and will have no impact on this species.

The wintering bird populations in this SPA use the polders which are behind the training walls that define the river channel. These polders become exposed at low tide and are used for feeding and roosting by wintering bird species which the SPA is designated for. There will be no dredging activity within the polders and so there will be no direct impact on wintering birds.

Given that the waterfowl populations in the Boyne estuary currently tolerate a high volume of shipping through the SPA, it is considered highly unlikely that the additional barges, which will be in operation for 2 – 3 weeks at a time on a number of occasions during the year, associated with the disposal of the dredged sediments will have any significant impact on waterfowl populations for which the SPA is designated.

Impact Prediction: No significant impact.”

Source: Provision of Information for An Appropriate Assessment For A Maintenance Dredging Plan For The Drogheda Port Company, Co. Louth 2012, Scott-Cawley

The above paragraphs contain a factual error, in that Little Terns breed in an area immediately adjacent to the dredging activity, and their foraging area is directly coincident with it. A review of available literature on the impact of dredging on Little Terns would suggest that the statement that dredging will have no impact is also erroneous:

“4.2.19 Little Tern

As Little Terns tend to feed close to the shore, they are at a low exposure to the disturbance and impacts on the benthos and associated fish species associated with marine aggregate dredging operations. Consequently, their vulnerability to these issues has been assessed as being low. As they are relatively insensitive to issues related to shipping, their vulnerability to the shipping associated with marine aggregate dredging operations has also been assessed as being low. Little Terns are highly exposed to the turbidity and increased sedimentation associated with marine aggregate dredging operations. Little Terns may be sensitive to increased sedimentation as the deposition of re-suspended sediment may smother the eggs

and larvae of key prey species. Consequently, Little Terns have been assessed as being moderately vulnerable to the effects of increased sedimentation. As vision is an important part of Little Tern foraging ability, and Little Terns are highly exposed to changes in turbidity, Little Terns have been assessed as being very highly vulnerable to changes in turbidity associated with marine aggregate dredging.”

Source: A Review of the Potential Impacts of Marine Aggregate Extraction on Seabirds, Cook *et al.* British Trust for Ornithology, 2010.

A review of the actual number of days of dredging (as well as quantities of dredged material recovered or dumped) was undertaken in 2017 (Lynch *et al.*, 2017). This information was provided by Drogheda Port on foot of an Information request under the AIE Directive. Note that in some instances dates appear as duplicates; this represents where operations were undertaken on two tides in the same day. According to Drogheda Port, overall 152 sailings were undertaken over 80 days up to end September in three campaigns, one lasting from 15/02/2017 to 26/02/2017 (10 days; 91,000), the second lasting from 19/04/2017 to 28/07/2017 (99 days) and the third from 30/08/2017 to 31/10/2017 (60 days); the quantity from 19/04/17 is 74,000 m³. The port therefore reports that 165,000m³ were dredged up to September 2017 (against the predicted maximum of 120,000m³ excepting contingency for exceptional events). In addition to this, a further 75,000m³ was removed/dredged from the river mouth in November 2016 so that the amount from November 2016 to September 2017 is a remarkable 240,000m³! Taken together the licence conditions, the actual level of dredging, the appropriate assessment, and the BTO study on the likely impacts, it is clear that there is a possible adverse impact on Little Terns, both as a result of turbidity and as a result of the knock-on impact on the reproduction and availability of a key prey resource, sandeels and sprats.

Sandeels (*Ammodytes* spp. mainly *Ammodytes tobianus*) are a major prey item for Little Terns. The species lives and breeds over sandy and light shingle seabeds close to the shore and are rarely found in water more than twenty metres deep. Harbours, estuaries and sheltered bays often hold large populations where they are depredated by fish and seabirds. They typically spawn twice a year, once in spring and once in autumn. Spawning involves depositing eggs on the substrate (sand or mud) where they hatch into larvae. They typically spend the winter hibernating in up to 20cm of sand (Source: A Students Guide to the Seashore - Fish and Fish 2011). Other less important prey include sprat (*Sprattus sprattus*), young herring (*Clupea* sp.), butterfish (*Pholis* sp.) and others, may also be adversely affected by dredging. Given the timing and reported locations of dredging it may be inferred that the November 2016 campaign likely impacted overwintering sandeels, the spring campaign impacted spawning and eggs, and the extended summer dredging increased turbidity in the water. This may explain the almost complete failure of the Little Tern colony in 2017, hitherto unprecedented.

Overall the level of dredging in 2020 was reduced vis-à-vis the reference year of 2018, when at least 185,000 tonnes was dredged, not including other material dredged for beneficial reuse, and when the little tern productivity collapsed.

5. Recommendations

5.1 Dredging

Going forward it would be beneficial to establish an agreement between the various parties (Including Drogheda Port and Louth County Council) for a dredging regimen in the Boyne estuary that will result in compliance with the Habitats Directive and ensure the favorable status of little terns into the future in accordance with the Irish and EU legislation.

Furthermore, the appropriate assessment in terms of the impact of dredging on little terns is clearly inadequate, and where beneficial reuse activities, including “beach nutrition” activities are not even assessed.

5.2 Monitoring

5.2.1 Coloured Darvic Rings

An increased focus on reading coloured Darvic rings would provide more information on the birds breeding and visiting Baltray. This could involve training interested volunteers to read rings and setting go-pro cameras on nesting adults to read rings as they come and go from the nest.

This year only 4 chicks were ringed with coloured Darvic rings but increasing this will give a greater indication of fledging success and survival of juveniles. It would be worthwhile to have trained ringers onsite to ring chicks whenever they are found.

5.2.2 Night Wardening

Employing a full-time night warden during the Little Tern breeding season would reduce the pressure on volunteers. Night wardening should ideally be provided from late May. As earlier clutches typically have three eggs while re-nesting attempts have fewer, focussing on protecting the first clutches will result in higher numbers hatching and hopefully higher numbers fledging.

5.2.3 Nest labelling

Previously the nests in Baltray were labelled with the nest code on a marker at the nest. In the last couple of years this was not done but I would recommend that it is carried out in future. This would make the nests easier to track and reduce any confusion.

5.2.4 Fencing

Separating the fenced area into pens should be repeated next year. The numbered pens made it easy to note locations, and the separation appeared to prevent foxes from continuing through the whole nesting site once they accessed a pen.

5.3 Equipment

5.3.1 Telescope

A telescope would be a huge help for wardens and volunteers in monitoring the site. This year counting fledglings was extremely difficult, and it was not possible to read the codes on Darvic rings. The provision of a telescope would also reduce disturbance to the Little Tern, as it would be possible to observe them from a greater distance.

5.3.2 Two-way Radios and megaphone

A set of two-way radios for the project wardens and volunteers on site would be an advantage, preferably shock and waterproof. This would make it easier to manage the large stretch of beach. A megaphone could be helpful in asking people to avoid the Little Tern Breeding area. Once people have missed the signs, it can be difficult to get their attention to turn back or put their dog on a lead.

5.4 Community Engagement

5.4.1 Blackboard

The blackboard was successful in engaging beach walkers and keeping them updated on the project. I would recommend that it is used again next year. A larger smooth surface blackboard may be easier to read and to write on.

5.4.2 Group visits

Due to the Covid-19 restrictions only a small number of group talks were given, but they were well received, and the groups were very interested in the project. In the future, an invitation could be extended to local groups such as youth groups, schools, or environmental groups to visit the site. It would be a wonderful opportunity to raise awareness of the project, demonstrate conservation in action and to recruit new volunteers.

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Appendices

Appendix 1: Avian Biodiversity in Baltray

Bird Species observed at the Baltray site from June 8th to July 31st. Species were recorded from the within and the immediate area of beach around the colony (BCH), offshore (OFF), on the river (RIV), in the adjacent sand dunes (DUN) and on the track (TRK) leading to the site.

CHARADRIIFORMES: SHOREBIRDS AND RELATIVES

Little Tern (*Sternula albifrons*) – present throughout and breeding, BCH
Common Tern (*Sterna hirundo*) – ~30 present throughout, 200+ present June-July in loafing flocks with juveniles, BCH
Roseate Tern (*Sterna dougallii*) – 1-2 seen occasionally throughout, 10+ present late-June to July, present with juveniles in loafing flocks in late July and July BCH
Sandwich Tern (*Thalass sandvichenis*) – 40+ present June-July in loafing flocks with juveniles, BCH
Arctic Tern (*Sterna paradisaea*) – 20+ present June-July in loafing flocks with juveniles, BCH
Ringed Plover (*Charadrius hiaticula*) – breeding throughout, BCH
Oystercatcher (*Haematopus ostralegus*) – ~50 present throughout, BCH, RIV
Turnstone (*Arenaria interpres*) – 7-30 present June to July, BCH, RIV
Sanderling (*Calidris alba*) – present throughout, BCH
Dunlin (*Calidris alpina*) – present throughout, BCH
Redshank (*Tringa totanus*) - present occasionally, one predated on by peregrine, BCH
Knot (*Calidris canutus*) – up to 8000 present throughout, BCH
Curlew (*Numenius arquata*) – 1 to 3 present throughout, BCH
Lesser Black-backed Gull (*Larus fuscus*) – up to 20 regularly present throughout, BCH
Great Black-backed Gull (*Larus marinus*) – up to 50 present throughout, BCH
Herring Gull (*Larus argentatus*) – 100-300 present throughout with juveniles, BCH
Black-headed Gull (*Chroicocephalus ridibundus*) – up to 10 present throughout, BCH
Common Gull – (*Larus canus*) – on occasion, BCH

PELECANIFORMES: CORMORANTS AND RELATIVES

Comorant (*Phalacrocorax carbo*) – 20-150 present throughout, BCH, RIV
Gannet (*Morus bassanus*) – occasionally present throughout, OFF

CICONIIFORMES: HERONS AND RELATIVES

Grey heron (*Ardea cinerea*) – 1 to 2 present throughout, BCH
Little Egret (*Egretta garzetta*) – 1-2 frequently seen throughout, BCH, RIV

PASSERIFORMES: PERCHING BIRDS

European Starling (*Sturnus vulgaris*) – juvenile flocks of several hundred present throughout, DUN, BCH
Meadow Pipit (*Anthus pratensis*) – present throughout, DUN, BCH
Skylark (*Alauda arvensis*) – present throughout and breeding DUN, BCH

Blackbird (*Turdus merula*) – occasionally seen throughout, TRK
Reed Bunting (*Emberiza schoeniclus*) – occasionally seen throughout, DUN
Stonechat (*Saxicola torquata*) – present throughout and breeding, DUN
Pied Wagtail (*Motacilla alba yarrellii*) – present throughout, BCH, DUN
Linnet (*Carduelis cannabina*) – present throughout, DUN
Goldfinch (*Carduelis carduelis*) – 2-6 present throughout June & July
Wheatear (*Oenanthe oenanthe*) – occasionally seen in late-July, TRK
Barn Swallow (*Hirundo rustica*) – occasionally seen throughout, DUN
Sand Martin (*Riparia riparia*) – occasionally seen throughout, DUN
Hooded Crow (*Corvus cornix*) – 2 to 10 present throughout. RIV, DUN
Rook (*Corvus frugilegus*) – 30 present throughout RIV, DUN
Jackdaw (*Corvus monedula*) – 3 present 24th and 25th May, DUN

APODIFORMES: SWIFTS AND RELATIVES

Swift (*Apus apus*) – 2/3 present on occasion

COLUMBIFORMES: DOVES AND PIGEONS

Woodpigeon (*Columba palumbus*) – occasionally seen throughout, DUN, TRK

CUCULIFORMES: CUCKOOS AND RELATIVES

Cuckoo (*Cuculus canorus*) – audible May, juvenile seen July 25-30th

FALCONIFORMES: BIRDS OF PREY

Sparrowhawk (*Accipiter nisus*) – 1 hunting in colony between the 9th and 14th July, BCH, DUN
Kestrel (*Falco tinnunculus*) – 1 seen over colony 20th July, BCH, DUN
Peregrine Falcon (*Falco peregrinus*) – hunting in colony 22nd and 26th May, BCH, DUN

Appendix 2: Nesting Data

The table below is an account of the outcome of each nesting attempt at the Baltray colony in 2020. A total of 90 nests were found.

Nests are coded as follows: Little Tern (L X.n, where X is the pen number in which the nest occurs (see Figure 3) and n is the number of the nest in the order found) and Ringed Plover (RP X.n). If a nest was discovered outside a pen, it was given the number of the pen closest and labelled with an 'o' before the pen to indicate that it is outside.

In addition to the chicks found dead in and around the nest scrape, two unringed older chicks were found dead on the beach, and two unringed fledglings were lost to a Sparrowhawk.

<i>Nest No.</i>	<i>No. Eggs</i>	<i>Egg outcome</i>	<i>Date Found/Clutch completed</i>	<i>Date Lost</i>	<i>Date Hatched</i>	<i>Chicks Lost in nest</i>	<i>Chicks Survived</i>
L1.1	3	Hatched	<8/6/20		15/6/20		3
L1.2	2	Hatched	10/6/20		30/6/20	1	1
L1.3	2	Hatched	<8/6/20		16/6/20		2
L1.4	2	Hatched	<8/6/20		16/6/20		2
Lo1.5	2	Corvid predation	12/6/20	22/6/20			
L1.6	2	Hatched	13/6/20		6/7/20	2	
L1.7	3	Hatched	18/6/20		8/7/20		3
L1.8	2	Hatched	17/6/20		10/7/20	1	1
L1.9	2	Corvid predation	29/6/20	11/7/20			
Lo1.10	1	Corvid predation	3/7/20	4/7/20			
Lo1.11	2	Corvid predation	10/7/20	21/7/20			
L2.1	3	Hatched	<8/6/20		23/6/20		3
L2.2	2	Hatched (1) Infertile (1)	<8/6/20		18/6/20		1
L2.3	2	Hatched	<8/6/20		13/6/20		2
L2.4	2	Hatched	<8/6/20		22/6/20		2
L2.5	3	Hatched	<8/6/20		22/6/20		3
L2.6	3	Hatched	<8/6/20		23/6/20		3
L2.7	3	Hatched	<8/6/20		17/6/20		3
Lo2.8	3	Hatched	10/6/20		25/6/20	1	2
Lo2.9	3	fox predation	18/6/20	2/7/20			
Lo2.10	3	fox predation	18/6/20	2/7/20			
L2.11	3	Hatched	19/6/20		8/7/20		3
L2.12	3	Hatched	20/6/20		6/7/20	2	
Lo2.13	2	fox predation	29/6/20	16/7/20			
Lo2.14	2	fox predation	30/6/20	17/7/20			
Lo2.15	2	fox predation	3/7/20	18/7/20			
L3.1	1	fox predation	<8/6/20	9/6/20			
L3.2	3	fox predation	<8/6/20	9/6/20			
L3.3	2	fox predation	<8/6/20	9/6/20			
L3.4	3	fox predation	<8/6/20	9/6/20			
L3.5	2	fox predation	<8/6/20	9/6/20			
L3.6	3	fox predation	<8/6/20	9/6/20			

L3.7	3	Hatched	18/6/20	8/7/20	3	
L3.8	3	Hatched (2) Infertile (1)	18/6/20	8/7/20		2
L3.9	2	Hatched	17/6/20	8/7/20		
Lo3.10	3	Hatched	19/6/20	9/7/20		3
L3.11	2	Hatched	22/6/20	6/7/20		2
Lo3.12	2	Walked on	25/6/20	8/7/20		
Lo3.13	2	Washed out by tide	30/6/20	6/7/20		
Lo3.14	3	Hatched	30/6/20	20/7/20		3
L4.1	3	Hatched	10/6/20	30/6/20		3
Lo4.2	2	Abandoned	<8/6/20			
L5.1	2	fox predation	<8/6/20	9/6/20		
L5.2	3	fox predation	<8/6/20	9/6/20		
L5.3	3	fox predation	<8/6/20	9/6/20		
L5.4	2	fox predation	<8/6/20	9/6/20		
L5.5	2	Hatched	<8/6/20	15/6/20		2
L5.6	3	fox predation	<8/6/20	9/6/20		
L5.7	2	fox predation	<8/6/20	9/6/20		
L5.8	3	fox predation	<8/6/20	9/6/20		
L5.9	3	fox predation	<8/6/20	9/6/20		
Lo5.10	2	Hatched	<8/6/20	20/6/20		2
Lo5.11	2	Washed out by tide	<8/6/20	22/6/20		
Lo5.12	3	Hatched	10/6/20	17/6/20		3
Lo5.13	2	Washed out by tide	12/6/20	22/6/20		
Lo5.14	2	Abandoned	15/6/20			
L5.15	3	Hatched	18/6/20	8/7/20		3
Lo5.16	2	Hatched	17/6/20	8/7/20		2
Lo5.17	2	Washed out by tide	29/6/20	6/7/20		
L5.18	2	Hatched	30/6/20	19/7/20		2
Lo5.19	2	Abandoned	1/7/20			
L6.1	2	Hatched	8/6/20	29/6/20		2
L6.2	2	fox predation	<8/6/20	9/6/20		
L6.3	2	Hatched	8/6/20	29/6/20		2
L6.4	2	Hatched (1) Corvid Predation (1)	17/6/20	25/6/20	8/7/20	1
L6.5	2	Infertile	29/6/20			
L7.1	3	fox predation	<8/6/20	9/6/20		
L7.2	2	fox predation	<8/6/20	10/6/20		
L7.3	2	Hatched (1) Infertile (1)	10/6/20	29/6/20		1
L7.4	2	Covered by sand	<8/6/20	12/6/20		
L7.5	2	Hatched	17/6/20	8/7/20		2
L7.6	3	Hatched	18/6/20	8/7/20		3
L7.7	3	Hatched	21/6/20	9/7/20		3
L7.8	2	Hatched	27/6/20	17/7/20		2
L7.9	2	Hatched	27/6/20	19/7/20		2
L7.10	2	Hatched	29/6/20	19/7/20		2
L7.11	1	Abandoned	29/6/20			

<i>I7.12</i>	1	Abandoned	3/7/20		
<i>L8.1</i>	2	Hatched	<8/6/20	22/6/20	2
<i>L8.2</i>	3	fox predation	10/6/20	10/6/20	
<i>L8.3</i>	2	Hatched	<8/6/20	22/6/20	2
<i>L8.4</i>	3	Hatched	<8/6/20	20/6/20	3
<i>L8.5</i>	2	Corvid predation	10/6/21	19/6/20	
<i>L8.6</i>	3	Hatched	<8/6/20	20/6/20	3
<i>L8.7</i>	3	Hatched	<8/6/20	25/6/20	3
<i>L8.8</i>	2	fox predation	<8/6/20	9/6/20	
<i>L9.1</i>	2	Corvid predation	19/6/20	17/6/20	
<i>L9.2</i>	2	Corvid predation	19/6/20	17/6/20	
<i>L9.3</i>	3	Corvid predation	19/6/20	18/6/20	
<i>Lo9.4</i>	3	Corvid predation	19/6/20	15/6/20	