Baltray Little Tern Colony Report 2014

S. Egerton and S.F. Newton*

Matt Byrne

Seabird Conservation Team, BirdWatch Ireland, 20D Bullford Business Campus, Kilcoole, Co. Wicklow
* snewton@birdwatchireland.ie

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Contents

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Abstract

The 2014 Little Tern Conservation Project had another successful breeding season at Baltray, despite some major depredation issues towards the end. The highest number of breeding pairs of Little Terns (*Sternula albifrons*) ever recorded nesting at Baltray produced close to a hundred fledglings.

The project began on May 13th with continuous day wardening of the Little Tern colony at Baltray and ended on August 1st 2014. Night wardening (thus 24 hour colony-coverage) was initiated on May 19th and continued until July 29th. A total of 150 nesting attempts were made by a minimum of 111 breeding pairs of Little Terns in 2014.

53 nesting attempts occurred within or just outside the South colony and 59 in the North colony whilst an additional 32 nesting attempts occurred on the beach north of the main northern colony. The first eggs were found on May 12th and a total of 299 eggs were laid. The mean clutch size was 1.99 eggs per nest. The mean incubation period was 21.33 days. Forty-three percent of eggs (n=129) did not hatch. 10 eggs were lost to the tide, 16 eggs failed to hatch (infertile), four eggs were considered dumped, 11 eggs were in nests that were abandoned, 62 eggs were depredated by a fox and seven eggs are known to have been depredated by corvids whilst a further 15 were taken by an unknown predator and the outcome of four eggs is unknown.

170 chicks hatched from 89 nests. Six chicks died from natural causes. A Kestrel (*Falco tinnunculus*) was responsible for the loss of 26 older chicks and a Sparrowhawk (*Accipiter nisus*) was responsible for a further 10 chicks lost. Raptor attacks on the colony occurred regularly between July 3rd and 29th. A Sparrowhawk is believed to be responsible for two adult Little Terns depredated in the vicinity of the colony.

A colour ringing scheme was implemented in Baltray for the first time. 26 Little Tern chicks were colour ringed. 91 Little Tern chicks are presumed to have successfully fledged (53.5% of those hatched) with a productivity of 0.82 per breeding pair.

1. Introduction

1.1 Background

The Little Tern (*Sternula albifrons*) is the smallest of the five tern species which breed in Ireland. Having spent the winter off the west coast of Africa, Little Terns migrate to Europe to breed, arriving in Ireland from late April. Little Terns nest on shingle and sandy beaches, often adjacent to sources of brackish water. Access to brackish water can be important as they may require other species of 'freshwater' fish to feed their young during the first few days of their life. In Ireland the chief prey of Little Terns are small fish, especially sandeels and Sprats, and crustaceans. They feed by plunge diving into shallow water (Gochfeld and Burger, 1996). A clutch of one to three eggs is laid in late May or June. If their first nest fails a pair of Little Terns may breed again in July or, exceptionally, early August. The Little Tern's nest is little more than a shallow scrape in the shingle or sand in which they lay their eggs, although it may be decorated with a lining of shells or small stones. They rely on the excellent camouflage of their eggs and chicks to protect them. The incubation period is around 18-22 days (Cramp, 1985). At about 14 days chicks make their first attempts at flight, but do not fully fledge until they are about 20-24 days (Gochfeld and Burger, 1996). Little terns leave their colony in August, departing Ireland before September. Most Little Terns which breed in Western Europe winter in the Gulf of Guinea area (Gochfeld and Burger, 1996).

The Little Tern is the least numerous of the five tern species which breed in Ireland. Numbers of Little Terns declined nationally by 32% from 1984 when 257 pairs were found to 174 pairs in 1995 (Whilde, 1993; corrected in Hannon *et al.*, 1997). A similar decline in the overall population of Little Tern in Britain and Ireland was recorded by the Seabird 2000 census (1998-2002), where a 25% decline was noted since the Seabird Colony Register (SCR) census in 1984-1988 (Mitchell *et al.*, 2004). The European population has also undergone a long-term decline (Fasola *et al.*, 2002), although recent counts show increases in Belgium, Poland, the Netherlands, France, and Germany. Reduced breeding success and subsequent recruitment appears to be the main cause of this decline (Mitchell *et al.*, 2004). Threats to Little Terns include human disturbance, loss of suitable habitat and flooding from extreme tides and storms. Depredation by foxes, hooded crows, magpies, rats and raptors is another significant threat to fragile breeding colonies. In some instances predation can reduce the breeding productivity to zero.

A major and long-standing cause of low breeding success in this species is human disturbance (Lloyd *et al.*, 1975; Fasola *et al.*, 2002, Ratcliffe *et al*., 2008). Wardening schemes and the use of signs and fences to protect the breeding birds (regularly implemented since the mid-1970s in Britain and 1985 in Ireland) can effectively reduce this disturbance (Medeiros *et al.*, 2007). Recent increases at some Irish sites such as Illauntannig, Co. Kerry (O'Clery, 2007), and not least Kilcoole and Baltray, indicate that nationally the population has recovered somewhat. Seabird 2000 recorded 206 apparently occupied nests (AONs) in Ireland (Mitchell *et al.*, 2004). However, a co-ordinated national tern survey is needed to clarify this. To place the Irish breeding population in context, Seabird 2000 (1998-2002) found that 10% of the Little Tern population of Britain and Ireland breed in Ireland, which represents 1.0-1.2% of the European population, and 0.2-0.5% of the estimated world population (Mitchell *et al.*, 2004). The Little Tern is not considered to be threatened globally but many local populations are declining (Gochfeld and Burger, 1996).

The Little Tern is listed as an Annex 1 species in the EU Birds Directive (79/409/EEC), thus requiring member states to take special conservation measures to ensure the survival and breeding success of this species. It is also classified by BirdLife International as SPEC 3, that is, 'a species with global populations not concentrated in Europe, but which have an unfavourable conservation status in

Europe' (Tucker and Heath, 1994). On a national level in Ireland it is classified as both a rare and localised breeder (Coveney *et al.*, 1993) and a vulnerable species (Whilde, 1993). It is currently amber listed by BirdWatch Ireland and the RSPB (Royal Society for the Protection of Birds) (Cummins & Colhoun, 2013), indicating that this species is of medium conservation concern. The Little Tern is fully protected under the Irish Wildlife Act (1976, Amended 2000).

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 10 colonies on the mainland coast. On the east coast there are colonies from Wexford northwards to Louth, and on the west coast from Kerry to Donegal (Hannon *et al.*, 1997). The breeding population of Little Terns on the west coast is largely unknown due to the inability to regularly survey the larger colonies such as the Magharee Islands in Kerry and Tory Island in Donegal (Tony Murray, pers. comm.; S. Newton, pers. obs.) and check the multitude of islands in Connemara and west Donegal where the species in known to have bred in the past. It is thought that there may be 150 pairs on the west coast but little is known about their breeding success. Suddaby (2012) reported that only 3 young were fledged from 96 incubating adults on the Inishkea Islands in Co. Mayo due to heavy predation from Common Gulls (*Larus canus*) although 2013 was a better year with 67 pairs rearing 39 young.

Primary sites on the east coast that have recently supported colonies of breeding Little Tern are Baltray (Co. Louth), Kilcoole/Newcastle (Co. Wicklow) and the Raven and Wexford Harbour (Co. Wexford). The North Bull Island (Co. Dublin) had up to 80 pairs in 1987 but is no longer used by Little Terns due to high levels of recreational disturbance. Up to 20 Little Terns were present at the North Bull Island at the start of the 2013 breeding season however no breeding attempts were observed due to the continuing high levels of disturbance (Niall Harmey pers. comm.) A similar situation prevails at Buckroney (Co. Wicklow) and Portrane/Rogerstown (Co. Dublin). However, in 2011 five pairs were seen prospecting at Buckroney but no exact details on nesting attempts or success was received (Richard Nairn, pers. comm.). This follows an anecdotal report from two members of the public that a pair of Little Terns bred successfully at here in 2010 raising two chicks. Successful breeding by a single pair has also taken place at Portrane/Rogerstown each year from 2009 to 2013 (Julie Roe and Niall Harmey pers. comm.). This year 2 pairs were present at the Rogerstown Estuary Nature Reserve throughout the breeding season, however only one pair bred successfully and were seen with a single fledged chick (Niall Harmey, pers. comm.).

The sandy beach at Cahore, north Co. Wexford, was also a traditional nesting site for the Little Tern, but was not thought to have been used for a span of 15-20 years (Anthony McElheron, pers. obs.). In 2005, approximately 40 nesting pairs were discovered at Cahore and that year breeding was successful with a minimum count of 80 adult birds and 10 fledglings on the last day the site was visited (Helen Boland, pers. comm.). Despite extensive searching between Cahore and Tinnaberna in 2010, no Little Terns could be found in this area, possibly as a result of the increased recreational use of quad bikes and horse riding along that section of coast (William Earle, pers. comm.). In 2012 a minimum of 65 Little Terns were found by the Kilcoole Little Tern wardens between Cahore Point and Ballinoulart on 28th June, however there was no breeding evidence and high levels of disturbance (Keogh *et al.*, 2012).

In 2009, 20 Little Tern nests (with 2 eggs each) were found incidentally at an apparently newly occupied site (grid ref. T119232, OS map 77) near Raven Point in southeast Wexford (Helen Boland, pers. comm.), the number of breeding pairs may have been greater than this, but it was not possible to search the whole area. Since then, the Marram Grass (*Ammophila arenaria*) covered sand bank island off Rosslare Backstrand (close to the site of the famous 'Tern Island') has become

extensive enough to once again support a colony of breeding Little Terns. In July 2010, up to 30 adult Little Terns and 10 fledglings were seen on 'New Tern Island' (Paul Kelly, pers. comm.) but it is unclear as to whether these birds nested on the island in question or nearby at Raven Point. However, in 2011, flocks of up to 200 adult Little Terns were noted over 'New Tern Island' in June with a brief census of the colony there on 29th June revealing that approximately 70-90 pairs were indeed nesting with a mean clutch size of 1.95 from 27 nests sampled (Chris Wilson and Tony Murray, pers. comm.). In 2012, a record total of 124+ nests (mean clutch 2.27) on 'Tern Island' were washed away by bad weather during the first weekend in June (D. Daly & T. Murray, pers. comm.). Some of these may have attempted to re-nest on the Dogger sandbanks, just off Raven Point but it is thought that these were overwashed again a week or so later (D. Daly, pers. comm.).
The Little Tern has been recorded breeding at Kilcoole/Newcastle since at least 1879 (O'Briain and Farrelly, 1990). By the 1980s breeding success at the colony was consistently low due to predation and disturbance. In response to this, the Little Tern conservation project was set up in 1985. The colony has experienced several years of high productivity as a direct result of the scheme, notably in 1989 when 68 fledglings were produced, and more recently 2003 – 2005 and 2008 - 2010. Other years have not been as successful; despite a high number of breeding pairs (106) and high initial productivity (178 chicks hatched) in 2006, the colony was later devastated by foxes such that only 21 chicks fledged (Lynch *et al.*, 2006). Again in 2007 high levels of predation resulted in only 31 chicks fledging (O'Connell *et al.*, 2007). Since 2008 however, numbers of pairs and fledged chicks have been increasing despite initial heavy losses at times. In 2008, 74 breeding pairs fledged 130 chicks (Cockram *et al.*, 2008), 50 pairs fledged a total of 80 chicks in 2009 (Hall *et al.*, 2009) whilst in 2010, 66 pairs fledged 115 chicks (Keogh *et al.*, 2010). In 2011 99 pairs fledged 155 chicks (Keogh *et al.*, 2011). There was zero productivity at Kilcoole in 2012 due to the site being washed out by two severe storms in June and experiencing heavy Hooded Crow depredation (Keogh *et al*., 2012). There was some recovery in 2013 with 45 pairs fledging 75 chicks (Keogh *et al*., 2013). The success of the long term wardening effort at this site can be seen in the fact that Kilcoole/Newcastle is probably the only site on the east coast to have attracted nesting Little Terns every year since 1984 (Farrelly, 1993).

1.3 Little Tern Colony in Baltray

Historically the Little Terns at Baltray have undergone a series of extremely poor breeding seasons interspersed 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 Lenehan, pers. comm.). Principally, breeding productivity of the colony was hampered by a combination of disturbance and predation by a range of nest predators. It is from this point that the project at Baltray began in 2007, run by a team from the Louth Nature Trust spearheaded by Sandra McKeever and Margaret Reilly, with the help of funding from the Heritage Council and 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 didn't have sufficient funding for paid night wardens and suffered heavily from depredation 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 23:00h and 04:00h when wardens were absent. However 2011 was still very successful with 49 pairs fledging 84 chicks (Reilly, 2011). 2012 proved to be a difficult year as extremely inclement weather lead to the loss of 41 eggs to spring tides and 45 eggs were depredated by a fox in the early hours of 17th June 2012, therefore only 33 pairs fledged 24 chicks (Reilly, 2012). This was the poorest breeding year experienced by the project, 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 conservation project at Baltray. Since the Little Tern conservation project 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 they 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 conservation project 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.

1.4 Project Aims

The principal aim of the Little Tern Conservation Project is:

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

Strategies employed by BirdWatch Ireland and LNT in order 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 predators accessing nest sites, where possible.
- To maintain surveillance in order to achieve the early detection of predator threats, and take appropriate steps to prevent loss 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.

2. Study Site

2.1 Tern Colony

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 Protected Area (SPA) (Plate 1). 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 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. The nesting site was considerably larger than in 2013; approximately 775m long x 50m wide, the largest the nesting area has been

since the project was initiated in 2007 (see colony maps, below).
The Baltray site is hugely tidal, with a horizontal tidal range of c.300m between the Mean High Water (MHW) and Mean Low Water (MLW) marks. The nesting area stretched c.50m inland from the MHW mark, 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)*. In some sections of the colony the nesting area extended another c.20m into an area of large shingle mixed with patches of vegetation, though in much of the colony the vegetation was too thick. 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, an office and observation point was set up in a caravan overlooking the colony and a portaloo was rented for the duration of the 2014 season. The day wardens lived on site in caravans. These facilities are vital to the running of this project.

Plate 1: Ordinance survey map outlining the site area for Baltray's Little Tern Conservation Project

Colony Map – locations of nests

North Colony

(main colony)

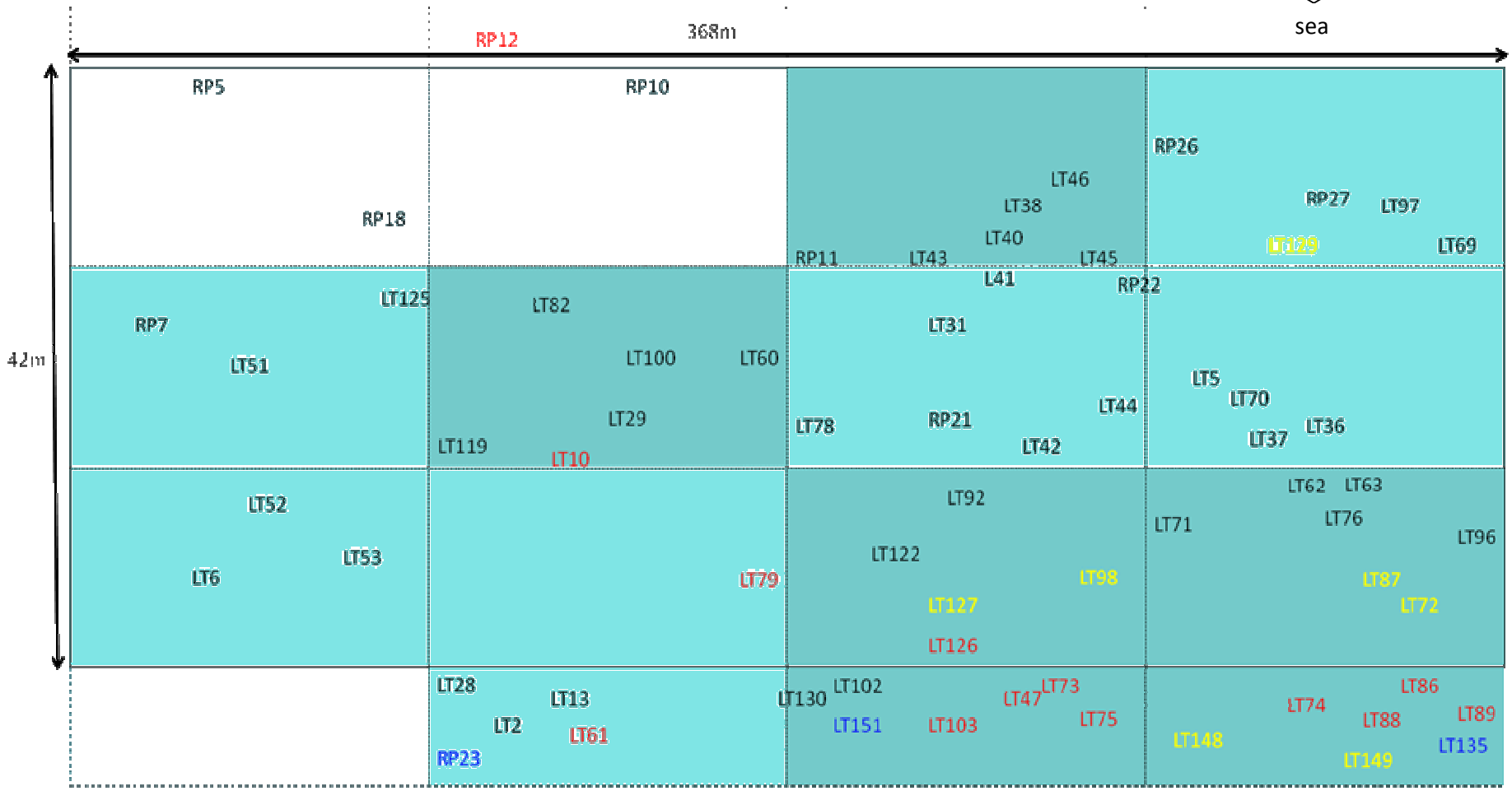
sand dunes

S colony

N colony (flutter)

sea

N



LT Little Tern nests
RP Ringed Plover nests
Nests numbered in order
Of recording by warden

Outcome of nest is delineated by font colour
Hatched
Predated
Washed out
Other outcome

Density of Little Tern nests in colony areas
0 nests
1-4 nests
5-9 nests
≥ 10 nests

main fence
flutter fence
imaginary division

N ⇨

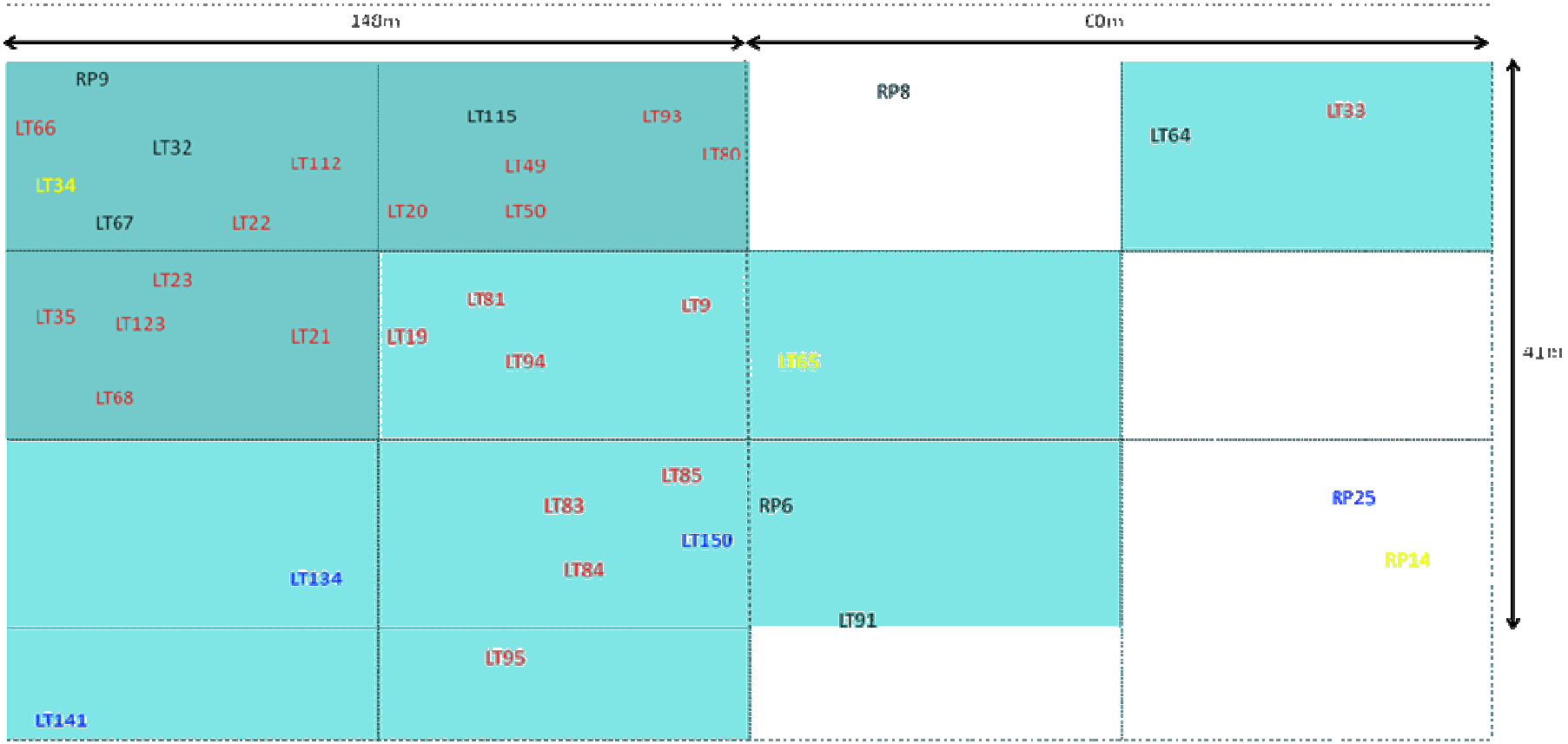
North Colony

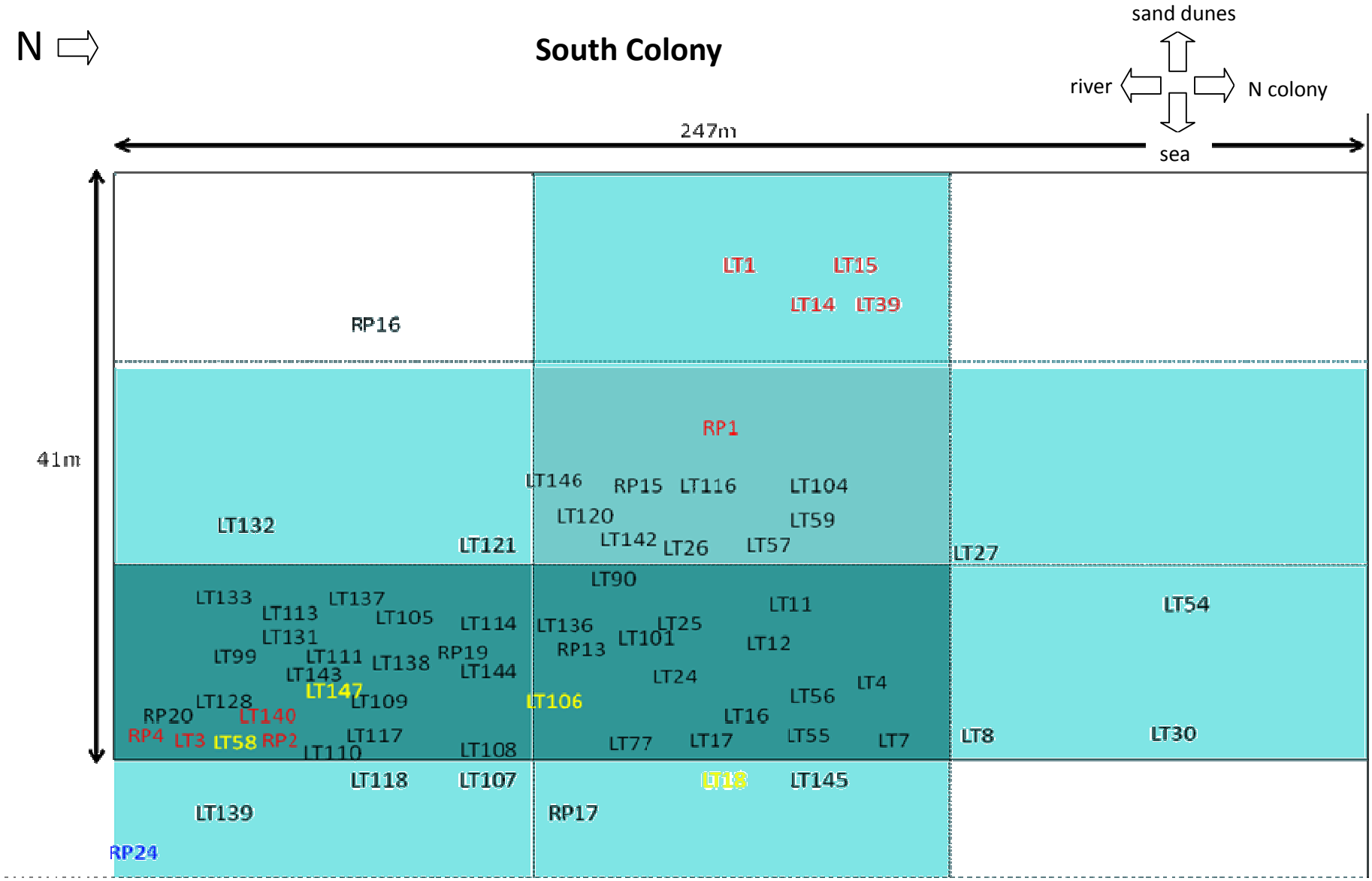
(flutter fenced only area)

sand dunes

N colony ⇦ ⇨ public beach

sea




N
South Colony
sand dunes
river
N colony
sea
247m
41m
RP16
LT1
LT15
LT14
LT39
RP1
LT146
RP15
LT116
LT104
LT120
LT59
LT132
LT121
LT142
LT26
LT57
LT27
LT90
LT133
LT137
LT113
LT105
LT114
LT11
LT54
LT136
LT25
LT131
LT101
LT12
LT99
LT111
LT138
RP19
RP13
LT143
LT144
LT24
LT4
LT147
LT56
LT128
LT109
LT106
LT16
RP20
LT140
RP4
LT3
LT58
RP2
LT117
LT110
LT108
LT77
LT17
LT55
LT7
LT8
LT30
LT118
LT107
LT18
LT145
LT139
RP17
RP24

2.2. Weather

A daily synopsis of the weather for this season can be found in the daily logs and are available on request from BirdWatch Ireland.

In brief, the weather during 2014 was largely warm and dry with moderate winds rarely reaching above force five. At the beginning of the season temperatures were in the low to mid-teens. Winds began westerly or south-westerly but turned northerly for a period and varied from calm to force five. During this time showers were common every couple of days, cloud ranged from zero to eight octas and visibility tended to be very good. From the middle of June, around the time of the spring tides, temperatures increased to between high teens and mid-twenties, precipitation became rare and visibility tended to be very good or excellent although there were a few mornings when sea fog was present. Wind direction turned at this time from the south and south-east to northerly. Temperatures remained between 14 – 18^{o}C in July. Precipitation became more frequent with spells of thundery showers at the beginning of the month. For the first half of the month cloud cover was typically seven or eight octas but this reduced at the month progressed. Wind was light, typically no more than force two and direction was changeable but came from a westerly direction during the spring tides. Sea fog came in on three occasions between the 19th and 22nd July, otherwise tended to be very good.

3. Methods

3.1 Monitoring

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 (Appendix 2: Table 6). 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 expected hatching dates for each nest. However, as entering the colony (beyond the string fence) causes disturbance which may result in nests being abandoned, every effort was made to coordinate activities so that visits into the colony were minimised. 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, predator mitigation and public engagement.

Night duty was initiated on May 29th, the week of the first Little Tern eggs were found and continued until the end of the project. This was conducted by Tony Glass (Sunday-Thursday) and Maurice Conaghy (Friday-Saturday). The night wardens covered the hours between 22:00 and 06:00. This provided 24 hour protection to the Little Terns. The value of 24 hour protection was shown by the huge success of the 2009 and 2010 breeding seasons (Reilly, 2009; 2010). Both of the night wardens are experienced gamekeepers and they were responsible for monitoring nocturnal predator activity.

3.1.1. Little Tern Numbers

The number of adult Little Terns present at the colony was recorded as often as possible by the wardens, 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 in front of the colony using a telescope during good weather.
Once chicks started to fledge, separate counts were made for fledglings to give an idea of productivity. This estimation decreases in accuracy after the first 2 weeks however, as fledglings begin to leave the colony around 2 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.

3.1.2. Nest Locations and Observations

Binoculars and telescopes were used to monitor tern activity and locate nests within the colony. Birds observed courtship feeding, courtship displaying, aerial displaying, copulating, making nest scrapes or incubating were noted. When it became apparent a bird was incubating, an exploratory visit was made to locate the nest. Nest contents (i.e. number of eggs), approximate distance along the fence-line and approximate position in the colony were noted. Using a hand-held GARMIN eTrex Vista HCx GPS, obtained part-way through the season, the majority of nest locations were recorded. The diameter of each nest was measured and the substrate the nest was made on was recorded. The nest substrate was categorised as either soft open sand, fine shingle (where particle size average is less than 2cm) or coarse shingle (shingle with particle size average of 2cm or more, in width, up to the size of small rocks), and finally, shell and shell fragments or a combination of these. The nest was marked by writing an ID code on a stone which was then placed upright 1m in front and, when necessary, behind the nest. Nests were coded as follows: Little Tern (LT *n*, where *n* is the number of the nest in the order found) and Ringed Plover (RP *n*). Both sides of the stones were written on, with the back being distinguished by adding a B to the beginning of the code.
In addition to this, a marker stone showing the nest ID was also positioned along the electric fence. Furthermore, a crude judgement of distance of the nest from the fence marker stone, using a Close (C), Middle (M) Far (F) or Seaward side of east fence (S) denotation, was noted along with whether the nest was visible (V) from the path or not visible (NV). This allowed the nests to be coded (e.g. LT48, MV), thus the approximate location of the nest could be estimated to facilitate nest checks and nest observations. A map of the colony was drawn and hung in the project caravan, to which the location of each new nest was 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. Viewpoints were set up in the dunes and on the seaward side of the colony in locations from which multiple nests could be viewed to minimise disturbance by removing the need to view each nest individually from the electric fence.
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. Some nests were very hard to view incubating from any angle, but if its scrape was still being maintained this indicated that the nest was still active. Hatching dates were predicted where clutch completion was known, and daily nest visits were resumed at this point to check for hatching. All details were recorded on the individual nest identification sheets.

3.1.3. Biometrics and Ringing

Chicks were fitted with a British Trust for Ornithology (BTO) ring (size B+) on their left leg. Baltray chicks were ringed on their left leg to distinguish them from Kilcoole chicks which were ringed on their right leg. Most Little Tern chicks were ringed in or near the nest scrape meaning that their nest of origin and exact ages were known when they were subsequently re-trapped on the foreshore. Day of hatching was allocated as Day 0, such that a 1 day old chick was one that hatched on the previous day.

Green plastic darvic colour rings were received by the project on July 9th. From this date, when older chicks (between 11 – 17 days) were re-trapped a green plastic darvic colour ring was placed on their right leg. Kilcoole Little Terns were colour ringed on their left leg. On each ring was a unique three figure numeric code preceded by the letter 'I'. The I and green colour distinguishes the birds as ringed in Ireland and the numeric code distinguishes them as individuals. The ring was always applied so that the 'I' was nearest the foot. Chicks could only be colour ringed once their tarsus was long enough to fit a colour ring, so concerted efforts were made to catch chicks of over a week old. Each chick had to be assessed on an individual basis, however, to see if its tarsus was long enough.

The wing length of each chick was measured (maximum wing chord) to the nearest 0.5 mm using a stopped rule (Redfern and Clark, 2001). Chicks were weighed using an electronic balance to the nearest 0.01g up until July 13th. After this date chicks were weighed using a spring balance to the nearest 0.1g. These measurements were used to study the growth of the Little Tern chicks. Once the majority of chicks had left their nest scrapes, the area of foreshore along the colony was searched most days (weather permitting) for chicks. Re-trapped chicks were identified by ring number and measured. Re-trap data was used to create average growth curves and monitor chick development.

3.1.4. Diet Study

The aim of the dietary observations was to investigate the food types and the size of food items that were offered to Little Tern chicks of varying ages. Hatchlings through to chicks reaching fledgling age were observed. The date, time, chick age, food type, food item size and whether the chick accepted the offered food were recorded for each feeding event. Each event was recorded as "food offered" whether the chick accepted it or not. By recording the time, the approximate number of feedings per hour could be estimated.

Chicks up to seven days old could be observed at or nearby the nest using a telescope. The chick age was known from its nest. Each nest/nest area was observed for one hour at a time. The food type was identifiable by eye and the food length was deduced by comparing it to the length of the bill of the adult Little Tern. Thus food size was measured in "bill-lengths", with one unit equivalent to the length of a bill. It was possible to observe several nests during one observation period.

When the chicks moved away from the nesting area, it became necessary to search the colony area by sweeps with the telescope. Once they had been located, however, observing the diet was done using the same method as with younger chicks. Chicks aged 10 to 15 days could be aged by identifying their ring number before or after the observation period. This involved re-trapping the chick due to the difficulty in reading the rings on mobile chicks. Because chicks of this age are quite mobile, only one or two sets of siblings could be observed simultaneously.

3.2. Conservation Measures

3.2.1. Use of Fences

The entire site was observed for a week after the Little Terns began prospecting to see which areas they were favouring. They were using the entire shingle area, and it was decided to enclose most of it starting 5m from the Boyne estuary sea wall and stretching northward, to reduce the probability of breeding failure caused by mammalian predators and to protect them from human disturbance. The fence was put up between the May 10th and May 17th by the warden and a team of volunteers.

A string cordon was put on the outside the nesting area, enclosing an area of approximately 835m by 75m. To make the cordon, steel pig tail fence posts were used along with blue baler twine and 8ft wooden posts were used on the seaward side as these could endure tidal immersion. Coloured streamers were attached to the baler twine at intervals to make it more visible to the public. The string cordon went well further north than the actual nesting enclosure, the previous year this had proved very useful as it acted as a buffer zone so that people and dogs were well away from the nesting terns when they approached from the north side of the beach and it was hoped that this would be repeated. The nesting area was divided into two zones and each zone was enclosed separately, leaving a walkway between them. These zones were created using 5ft wooden posts and 1m high plastic mesh cable tied to the posts. The mesh was curved outwards and had sand shovelled onto it to partially bury it and deter burrowing predatory animals. The mesh used was the same as had been used in 2013 and much of it had been in use since the 2012 project. The northern zone was over double the length (c.515m) of the southern zone (c. 250m). Both zones were c. 50m wide, though narrower at the ends. The walkway led straight out from where the office caravan was situated, facilitating wardens and volunteers in quickly reaching beach goers on the foreshore. Green plastic mesh was not used on the east side of the enclosure. This made repair of storm damage easier and also allowed chicks to leave the fenced area. To prevent avian predators using the wooden posts as perches, inverted cut plastic bottles were attached on top of each post. Consequently if a bird attempted to land, the bottles would not support their weight. This worked very well as a deterrent.

Both of the enclosed zones were fenced with electric fencing, using four rows of six strand wire. Plastic electric fence posts were used and these were easily inserted into the sand immediately outside the plastic mesh. Three strands of electric fence wire were placed on the three lowest rungs of the posts and one was placed on a mid-level rung. The plastic posts were attached to wooden posts at intervals to strengthen them. Both of the zones had separate electric fencer units and these were placed in boxes inserted into holes in the ground and covered with wooden boards. Over-ground switches were discretely wired from the fencer to wooden posts and these were used for turning them on and off. The electric fence was on at all times and checked at regular intervals throughout the season. If any debris was earthing the electric fence wires it was removed.

An extension was made to the string cordon at the northern end of the colony to bring it to within 5m of the public entrance path for people coming to the beach. This was done to protect several nests which had set up outside the buffer zone to the north of the colony. Due to a limitation in fencing resources the green mesh and electric fencing were not extended.

The spring tides in June (14th to 18th) and particularly in July (11th to 18th) damaged the fence, knocking out segments of the east electric fence and causing it to become tangled and buried in lumps of seaweed and sand. This put the electric fence out of action for from the 18th to 22nd July, leaving the colony exposed. At this point, because of the lack of chicks in the colony area, the decision was made to take down the electric fencing rather than attempt to re-erect it.

Between July 23rd and 30th the wardens, with the help of volunteers, began to pack up the fencing.

Dominic Hartigan's assistance to the project in helping put up and take down the fence, delivering and removing materials and equipment and storing all fencing material and the project caravans in his yard was invaluable. All the equipment was removed from the site by July 31st.

3.2.2. Use of Signs

Several types of information signs were available for deployment. 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 people, many 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 1m x 1m full colour interpretative signs were erected, one at the end of Baltray village at the approach to the Haven and the second further on at the main parking area beside the locked gate. Signs were also placed on stakes by the entrance to the colony site, by the project portaloo and at a stile by which many people access the beach.
As soon as the chicks began to hatch a line of large 8 ft wooden poles connected with string and with additional signs were placed along a sandbar (which protected them from the tides) to the north of the colony. This proved very successful at cutting down on the number of people who attempted to walk along the foreshore.

3.2.3. Nest Moves

Nests in danger of being washed out by the tides were moved further inland. At least two days before a nest was moved two pieces of conspicuous rubbish (blue glove etc.) were placed within half a metre on either side of the nest to give the parents something to orientate themselves by. The nest was monitored to ensure the parents located the nest with the new rubbish. Once the bird had adjusted to the new markers the nest, along with surrounding sand and debris, was placed on a thin square wooden board and every effort was made to exactly mimic the arrangement of shells etc. around the nest. The nest was again monitored to ensure the parents accepted the new nest condition. The nest was then left in its original position for at least another day before being moved. When the board with the nest was moved the rubbish was moved in relation to it. In this fashion the nest could be moved by up to one metre a day (although if time allowed it was moved shorter distances at the beginning) while the parents were still easily able to locate their nest. At any stage if a parent bird failed to relocate its newly positioned nest within 20-45 minutes (depending on the weather conditions) the nest was moved back to its previous position.

3.2.4. Egg Fostering

On June 21st a single egg was located close to a low high water mark. When found there was no parent present and it was not clear if it had been dumped. The egg was too far down the beach to move using the nest moving methods described above, however it was not going to survive to hatching in the location it was in. The egg was moved to another nest where the parent had recently laid two eggs, LT41. An 'X' mark was drawn on the base of the egg with a pencil to identify it from others and the nest was monitored to ensure the parent accepted the addition of a new egg. The fostered egg was readily accepted by the parents and hatched on the same day as the first biological egg and the chick was tended to by the foster parents.
After the high tides on July 15th, when five nests were washed out, three eggs were recovered from

the seaweed in the strandline. The eggs were found in the vicinity of nests LT134, LT135 and LT150. The nest number was written on the base of each egg and the eggs were added to nest LT148, LT147 and LT144 respectively. These nests did not necessarily have eggs that were laid on a similar day, as would be ideal, however they were the most suitable ones available considering the small number of unhatched nests remaining. None of the fostered chicks on these occasions hatched successfully. Nest LT148 was abandoned, possibly before the addition of the new egg. When the parent did not return to incubate the nest with the increased number of eggs in it the foster egg was removed but incubating did not resume. The foster parents of nest LT147 readily accepted the additional egg and incubated it for six days before abandoning the entire nest. The foster parent of nest LT144 also readily accepted a third egg. The biological chicks in this nest hatched, however, the day after the fostered egg was added. The parent remained sitting on the fostered egg for two subsequent days, even after the chicks had left the scrape, before abandoning it.

3.2.5. Chick Shelters

A total of 14 chick shelters were provided this year, consisting of plastic piping half-buried in the shingle, camouflaged with pebbles, seaweed & debris. They were placed throughout the colony when the first chicks began to hatch, concentrated where clusters of nests were present. The majority of chick shelters were located on the mid-section of the beach or near the seaward fence as most chicks were moved towards the foreshore by their parents after a few days. Several chick shelters were utilised regularly by some of the older chicks from early July onwards, particularly during periods of inclement weather or when the mid-day sun was at its most intense.

3.2.6. Predator Management

Little Terns are very vulnerable to predators when breeding. In addition to the protection afforded by the fencing, the wardens and volunteers made every effort to scare away any potential predator. The simple presence of humans at the colony helped keep many predators at bay. This year the predator management focused on Hooded Crows (*Corvus cornix*), Rooks (*Corvus frugilegus*), Red Foxes (*Vulpes vulpes*), Kestrels (*Falco tinnunculus*) and Sparrowhawks (*Accipiter nisus*) for which specific preventative actions had to be taken.

Hooded Crows were major predators of Little Tern nests in 2007 (Reilly, 2007) and to a lesser extent in 2013 (Doyle *et al.*, 2013) and Red Foxes were major predators in 2011 and 2012 (Reilly, 2011; 2012), so the vicinity of the colony was closely monitored for these species. Rooks are known predators of Little Tern eggs and predated 36 eggs from 16 nests at Kilcoole in 2011 (Keogh *et al.*, 2011). Hooded Crows, Rooks or Red Foxes which were considered a danger to the colony were removed under license. Kestrels are noted predators of Little Tern chicks. They have taken a large number of fledglings at Kilcoole in certain years (Hall *et al*., 2009; Keogh *et al*., 2010) and predated eight chicks at Baltray on the last week of July in 2013 (Doyle *et al.*, 2013). A number of other raptor species that may take Little Tern chicks, including Merlin (*Falco columbarius*), Sparrowhawk (*Accipiter nisus*), Peregrine Falcon (*Falco peregrinus*) and Short-eared Owl (*Asio flammeus*), are known to hunt in the area. Noise deterrence was used to disturb these birds if seen hunting in the vicinity of the colony.

3.3. Public Awareness

3.3.1 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 walkers and, when possible, showing them an incubating adult or chick through a telescope. When beach users were seen to be walking along the foreshore in front of the colony, or were in danger of entering the colony, they were approached by wardens, informed about the Little Tern colony and politely directed away from the colony.

3.3.2 Group Talks & Outings

A group of six bird watchers visited the Little Tern colony breeding site in Baltray on 24th May and an RSPB bird watching group from Northern Ireland visited the site on July 2nd. The visiting groups were given talks outlining the Little Tern conservation project and shown around the colony. As part of a local walking festival the colony was visited by a group of 80 guided walkers on May 31st. The group was welcomed and given a short talk by the warden on duty about the Little Terns, why they're protected and what was done at this project to help them. A call for new volunteers was made and the group were able to look at the pictures and information that was erected on the office caravan to gain further information. Aine Walsh, a volunteer and former director of the Louth Nature Trust, brought a group of work colleagues and their children to visit the colony on July 8th. The warden gave a talk to the group outlining the importance of the project and gave them a tour of the colony. The children were shown incubating Little Terns through a telescope and shown pictures of tern eggs. They were given a talk outlining the Little Tern conservation project and shown around the colony.
Two formal powerpoint presentations about the Baltray Little Tern Conservation Project were given this season; one to Termonfeckin National School on June 4th and the second to the local community and interested parties at Louth Golf Club on Jul 10th. On June 5th the colony was visited by a parent and four children from Termonfeckin National School who came to see the Little Terns after hearing about them in school. At the community talk in Louth Golf Club a cheque was presented to Louth Nature Trust, accepted by Trust Director Abby McSherry, from Paul Fleming, CEO of Drogheda Port to support the continuation of the Baltray Little Tern Conservation Project. All of the above talks were well received and much appreciated by all of those who attended.

3.3.3. Media Coverage

Newspaper: The Drogheda Leader wrote an article “Terning out well” on Wednesday July 9th about the 2014 season of the Little Tern Conservation Project in Baltray. It was based on a telephone interview that was had with day warden Sian Egerton on July 2nd and the photograph attached was taken on Sunday July 6th. After the community talk in Louth Golf Club, an article entitled “Port Company helps fund little tern project” was written in the Drogheda Leader describing the event and the generous donation that was given by Drogheda Port (Appendix 3).

Television: On July 17th day warden Sian Egerton, Louth Nature Trust Director Dominic Hartigan and project volunteer Gerard Murray were interviewed by Co. Louth's Irish T.V. production team for episode 11 of County Matters: Louth, shown on July 24th on Sky channel 191, freesat channel 400 and available to stream online on their website from July 29th.

3.3.4. Website & Social Media

A weekly blog was uploaded to the Little Tern section of the Louth Nature Trust website (www.louthnaturetrust.org) to provide updates of the week's events at the project site. The site appeared to receive about 100 visits per day with peaks of around 180 visits when new blogs were uploaded (Figure 1). The keywords used to search the internet, that resulted in a visit to the website were; www.louthnaturetrust.com–Welcome (10), louth nature trust (2), louth nature (2), where to photograph little terns (1), gronant sands little tern colony still there august 2014 (1). Aside from the home page, the Little Tern page which held the weekly blogs was the most visited page (154 views). After this the most visited pages were news-events (37), wildlife (32), contact us (31). All figures here are taken from statistics relating to the website between July 14th and August 13th, but provide a good example for the entire 2014 season.

Louth Nature Trust (LNT) also has an active Facebook page which was used regularly to create awareness, promote support and share information about Baltray's Little Tern Conservation Project. LNT's Director Cathal Johnson invited the day warden to become an administrator of the page and this greatly facilitated weekly posting on the page and ensured that a wider audience was reached. Between May and August the day warden posted 23 times on the Facebook page. Many of these posts directed people to the blog on LNT's website. The highest running post reached 396 people. Long-term volunteer Matt Byrne was very involved in taking photographs and posting them on LNT's Facebook page. It was decided at the end of the season to make Matt Byrne an administrator of the page as his participation will greatly aid promotion and publicity of the project into the future.

Figure 1: Unique visitors to have viewed the Louth Nature Trust website during the second half of July and beginning of August 2014.

4. Results

4.1 Little Tern Numbers

An average count of approximately 75 adult Little Terns was recorded daily in the colony. The main method of counting was dread and flush counts. Dreads typically consisted of 50 to 100 Terns. These numbers are considerably lower than what would have been expected given the number of breeding pairs present. A peak count of 204 adult Little Terns fishing at sea close to the shore occurred on the May 29th and a maximum roost count of 130 adults was made on July 22nd.

The number of adult Terns recorded increased throughout May (Figure 2). The first egg was discovered on May 24th and the number of active nests continued to increase up until the middle of June (Figure 2). The colony was significantly depredated by a Fox on June 13th and 15th when nine and 21 nests were lost respectively. The first nest hatched on June 18th. From this time onwards the number of active nests began to decrease as they hatched. Chicks began to fledge from July 8th. After this date, Little Tern counts began to increase as less birds were sitting on nests and large numbers of adult Little Terns began to gather in loafing flocks before migration. Population numbers peaked in the last week of July before suddenly decreasing from 83 to zero in the last few days of July as the terns left the site.

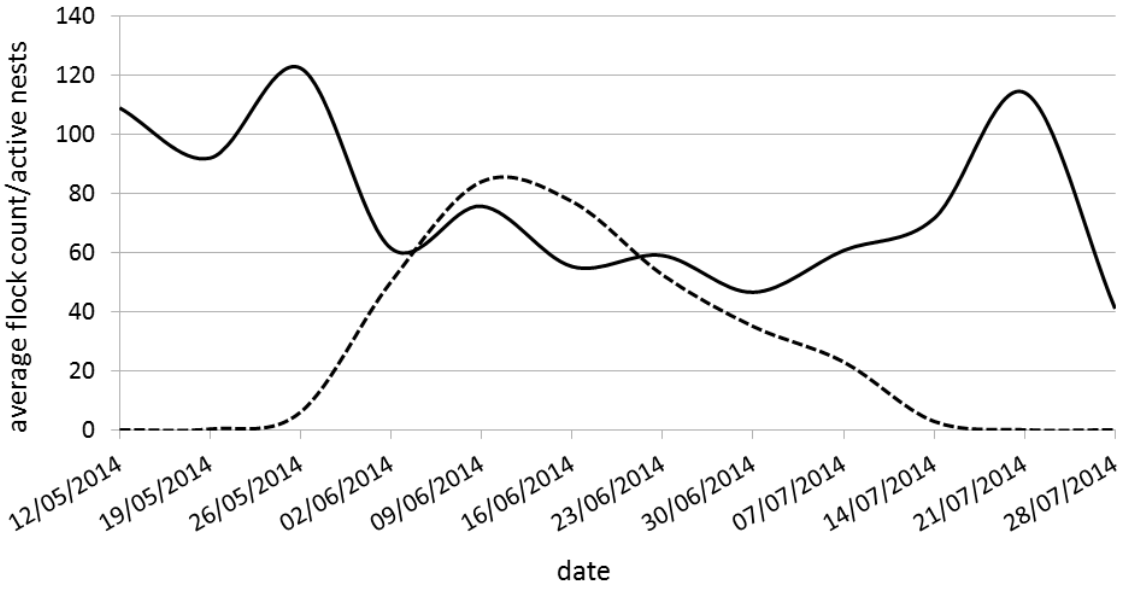


Figure 2: average Little Tern flock size (——) and the average number of active nests (-------) per week at the Baltray colony from 14th May to 1st August 2014.

4.2 Nesting

4.2.1 Number of Breeding Pairs

Accurately calculating numbers of breeding pairs becomes a challenge once significant depredation or loss has occurred at the egg stage in a Little Tern colony. A best estimate of between 109 (maximum number of nests on July 15th – including those predated that day (95) + any nests predated 7 days previous to this (14)) and 114 (maximum number of nests on July 15th – including those predated that day (95) + any nests predated 4 days previous to this (12) + any nests gained 3 days after this date (7)) breeding pairs was reached using two formulas that considered that Little Terns take, on average, 7 days to re-lay after they have lost a nest at the egg stage. These pairs laid 147 nests of which 54 were lost to depredation, abandonment or spring tides. The number of breeding pairs in 2013 was similar (n = 102), while in previous years the maximum number of breeding pairs was 49 in 2011 (Reilly, 2011) and before the conservation project in Baltray began in 2007 numbers above 35 pairs were never recorded (L. Lenihan, unpublished) (Figure 2).

4.2.2 Pattern of Nesting

Scrapes occurred throughout the northern and southern enclosures, with 53 found within the southern enclosure, 59 found within the northern enclosure and 32 north of the northern enclosure (see colony map). The density of nests in the southern enclosure was much higher as it was only half of the size of the northern enclosure. In common with 2013, a concentration of nests was found in the southern half, towards the front and just outside of the south enclosure. This year 40 nests, compared to last year's 22, were found. Interestingly, many of these nests were laid quite late in the season and many are likely to have been re-lays. Most scrapes were on the flat beachfront, but some were further up the beach into embryonic sand dune habitat. A large number of nests were laid outside the colony on the seaward side of the fencing (23) and to the north of the main enclosure (32), four of which were even outside of the original cordon flutter fence. Extra flutter fencing was added for their protection in June, extending the protected area by 60m. Of the 23 nests that were situated between the electric fence and waterline nine survived, mainly as a result of moving nests inland onto slightly higher ground.

The largest scrape diameter recorded was 13.8cm and the smallest was 7.0cm, with the average being 10.2cm (n = 76). With 59 nest scrapes, fine shingle was the most commonly used substrate. 34 nests were in soft open sand and 36 in coarse shingle (Figure 3; Plate 2). Of these nest scrapes 32 were in the vicinity of substrate that was largely composed of Thin Tellin (*Angulus tenuis*) shells (Plate 3a). Among the Little Tern nest scrapes, 8 were made on a bed of small pale coloured shells collected by the parent with its beak from the immediate surrounding area (Plate 3b).

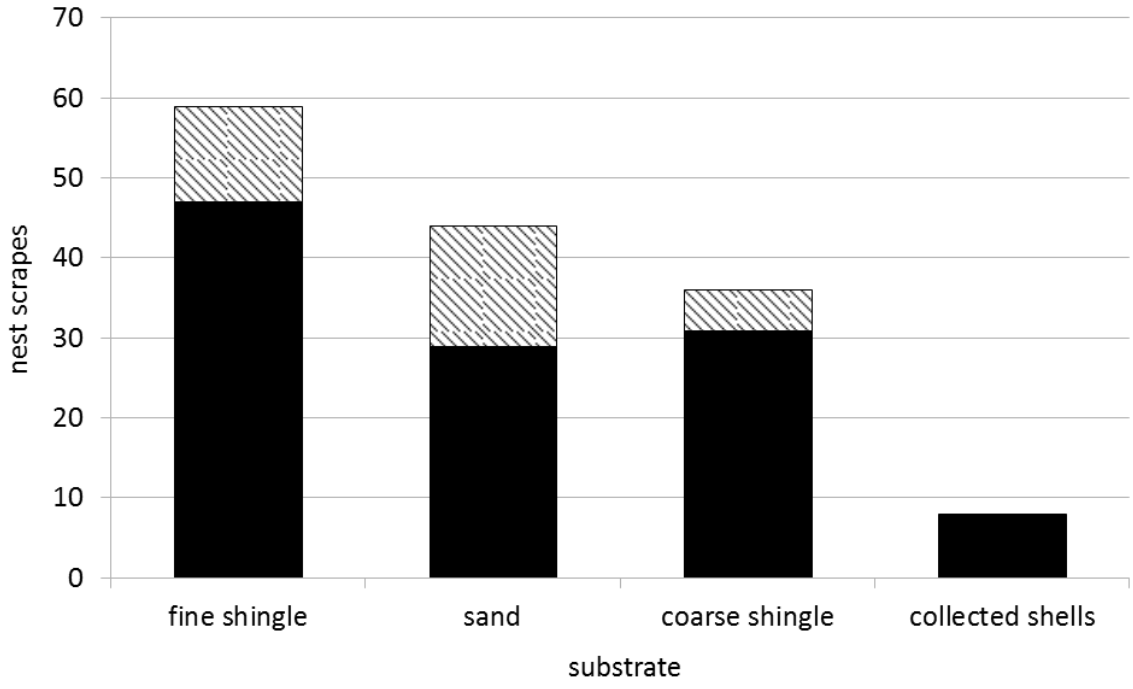


Figure 3: number of nest scrapes per substrate type (■ substrate type ▨ nests with surrounding tellin shell substrate), n = 147.

Plate 2: nest on a) coarse shingle (nest LT1), b) fine shingle (nest LT7), c) soft open sand (nest LT16).

Plate 3: a) nest with surrounding tellin shell substrate (nest LT34), b) nest on collected shells (nest LT131).

4.2.3 Clutch Size and Incubation Period

There were 150 nesting attempts recorded in the 2014 breeding season. Of these 18 comprised of only one egg (12%), 115 had two eggs (76.67%) and 17 had three eggs (11.33%). The mean clutch size was 1.99 eggs. Clutches comprising of one and three eggs were laid only in May and June. The

exact incubation period is known for 15 nests (Table1). The mean incubation period was 21.33 days.

Table 1: incubation period of Baltray Little Terns in 2014 breeding season. Data only available for nests discovered before reaching full clutch. Incubation period covers time from full clutch until first chick hatches, n = 15.

Nest I.D.	Incubation period	Incubation length
LT2	28 May – 18 June	21
LT4	1 – 21 June	20
LT5	3 – 24 June	21
LT8	3 – 25 June	22
LT12	3 – 24 June	21
LT13	2 – 23 June	21
LT17	2 – 26 June	24
LT24	3 – 24 June	21
LT25	3 – 23 June	20
LT28	4 – 28 June	24
LT30	4 – 23 June	19
LT44	6 – 28 June	22
LT45	6 – 27 June	21
LT82	12 June – 2 July	20
LT91	11 June – 3 July	23

minimum incubation period 19 days
maximum incubation period 24 days
mean incubation period 21.33 days

4.2.4 Hatching Success

Of the 150 nests found over the breeding season, there were 299 eggs recorded in total. A total of 129 (43%) eggs failed to hatch for the following reasons; four eggs were 'dumped', 16 eggs from 14 nests were infertile, 11 eggs from six nests were abandoned, 10 eggs from five nests were washed out in the July high tides and 62 eggs from 29 nests were depredated by foxes. Four nests containing seven eggs were depredated at the beginning of the nesting season by corvids, primarily Rooks, *Corvus frugilegus*. A further 15 eggs were depredated by an unknown predator. The fate of the final four eggs was unknown. The four eggs considered dumped were all solitary eggs and were classified as such after monitoring failed to identify any parental attention. Three of the infertile eggs were part of clutches where the siblings hatched successfully, while three were from two nests where the parents sat for an extended period before eventually abandoning the eggs. Of the abandoned nests, it is believed that the parent of one of them, LT129, was depredated and the partner subsequently abandoned the nest. Two of the other abandoned nests were done so during the July high tides when the nests were either washed over or around but the eggs remained at the nest site (Figure 4).

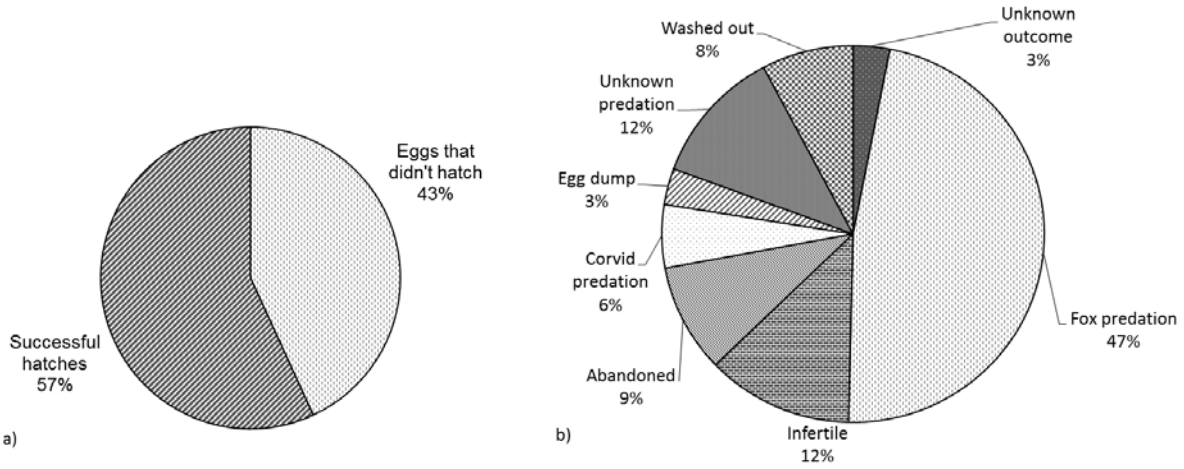


Figure 4: a) the percentage of Little Tern eggs successfully hatched and the percentage of eggs that did not hatch; b) the various factors that led to egg failure and the percentage to which they contributed to egg loss.

4.2.5 Fledgling Success

Survival rate for chicks appeared to be low this season with 53.5% (91) of the hatched chicks thought to have survived to fledging age. Six chicks were recorded to have died from natural causes. Three chicks were found dead in their nest scrapes, when they were only one or two days old. Two of these chicks, from nest LT53 and LT71, were notably weak and under-developed when they hatched. The third chick, found in LT143, appeared healthy but squashed as if trampled by an animal, potentially a hare. Of the other three chicks, one was found inside the southern enclosure with the BTO ring NW45050 (from nest LT104) and two were found on the eastern side of the green mesh fence on the northern enclosure. They were found only half a metre away from a large hole that had been created by hares and had starved, unable to find their way back into the colony. One chick was ringed NW438786 and was from nest LT38 while the other chick was unringed. Both chicks were of similar age, approximately 5 days old and were found in almost identical locations within a week of each other.

36 chicks are known to have been taken by avian predators. The first chick lost to a Kestrel, occurred on July 3rd. At this point the oldest chick in the colony was 14 days. One dead chick was recovered from the Kestrel after the event. It had the ring number NW438762, was from nest LT30 and was 18 days old. The Kestrel and the Sparrowhawk tended to take larger chicks close to fledging age. This was confirmed by piles of plucked feathers found in the surrounding sand dunes which lacked full adult colouration (Baker, 1993). No rings were found in the piles of plucked feathers.

Aside from the known chick losses it was estimated that 37 other chicks did not survive to fledging age. No chick, or parent carrying fish were recorded on the beach after July 23rd. Therefore, any chicks that were less than 18 days, the average age for fledging, were assumed not to have survived.

Counts of fledglings were made from July 13th. The highest count, of 44 fledglings, was recorded on July 27th. This figure provides us with a minimum number of fledglings from Baltray in the 2014 season. Fledgling counts, however, only provide an indication of the survival rates of the chicks, as they can leave the colony within two weeks of fledging (Keogh *et al*., 2011). A significant number of older chicks may have left the colony by the time of the highest count on the 27th. Fledged chicks may roost in different areas at Baltray making counts more difficult. In the last weeks of July the

Little Tern flock was often missing in its entirety from the project site and roosting flocks of 50–100 birds were recorded by volunteers north towards Clogherhead and south on Bettystown beach at this time. Because of this, any fledgling count will have been an underestimate of the total number of fledglings for 2014. However, the counts still serve as an indicator of productivity.
It has been concluded that any chick not known to have died and to have been 18 days or older or July 23rd are assumed to have lived to fledging age. 91 chicks (53.5%) are assumed alive and fledged (Figure 5). 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 predation events and other chick deaths were accounted for, so this should be close to the true figure.

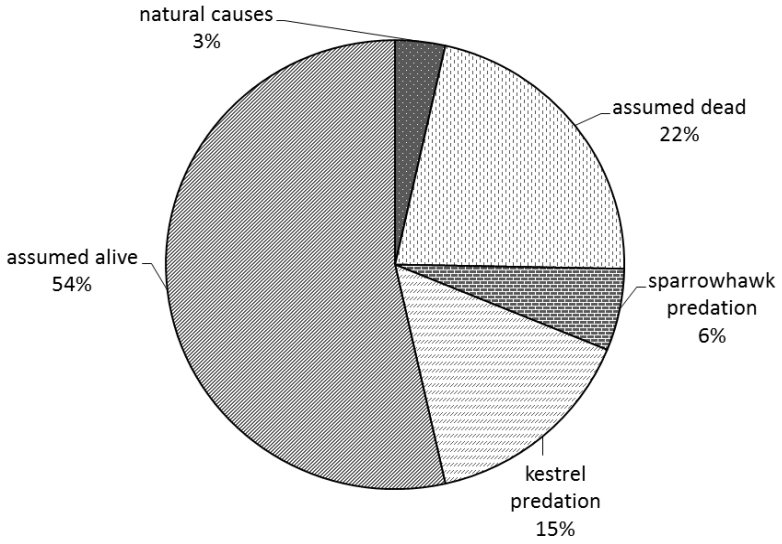


Figure5: outcome of each successfully hatched chick.

4.2.6 Productivity

An estimated 111 pairs (midpoint of range) of Little Tern nested at Baltray in 2014. This is approximately equal to the number that nested last year (Doyle *et al.*, 2013) and more than double the previous high point before 2013 of 49 pairs in 2011 (Reilly, 2011). Estimating the number of fledged chicks is difficult for terns. An estimate based on highest fledgling count (44) puts productivity at 0.4 fledged chicks per nesting pair. However this is known to be an underestimate, as outlined above. Basing the estimate on number of chicks re-trapped at least once (141) gives a productivity at 1.27 fledged chicks per nesting pair. This is certain to be an overestimate as re-trapping chicks at Baltray is made difficult by the huge tidal range of the beach, meaning chicks were widely spread during the day. Also, a chick being re-tapped in its first few days is no real indication that it will survive to fledge. Therefore the productivity for this season is based on chicks assumed alive. As outlined above this may still be an overestimate but is thought to be the closest to the real figure. 111 pairs produced 91 fledglings, giving a productivity of 0.82 fledglings per egg-laying pair.

4.2.7 Success of the Baltray Little Tern Conservation Project

Despite the attention of avian predators at the later stages of the chick-rearing period, the Baltray Little Tern breeding colony in 2014 was still deemed to have had a successful season. Putting aside the exceptionally good year in 2013, the number of fledged chicks was similar to those achieved in

the most successful years since the conservation project began (2009 = 94 and 2010 = 96 fledglings; Reilly 2009, 2010) (Figure 6). Rigorous monitoring of the Little Terns at Baltray did not occur until the initiation of the Little Tern Conservation Project but early attempts at monitoring the breeding success of the colony from 1984 give an indication of the health of the colony. The colony was in serious decline from the mid-1980s to the mid-1990s, with little or no breeding success. From the mid-1990s there was zero breeding success. A notable increase in breeding pairs and numbers of fledglings occurred from 2007 onwards, when fencing and wardening of the beach began. Numbers have generally continued to rise since that point, with the exception of 2012 which was a very poor year for Little Terns on the east coast due to inclement weather (Reilly, 2012; Keogh et al., 2012).

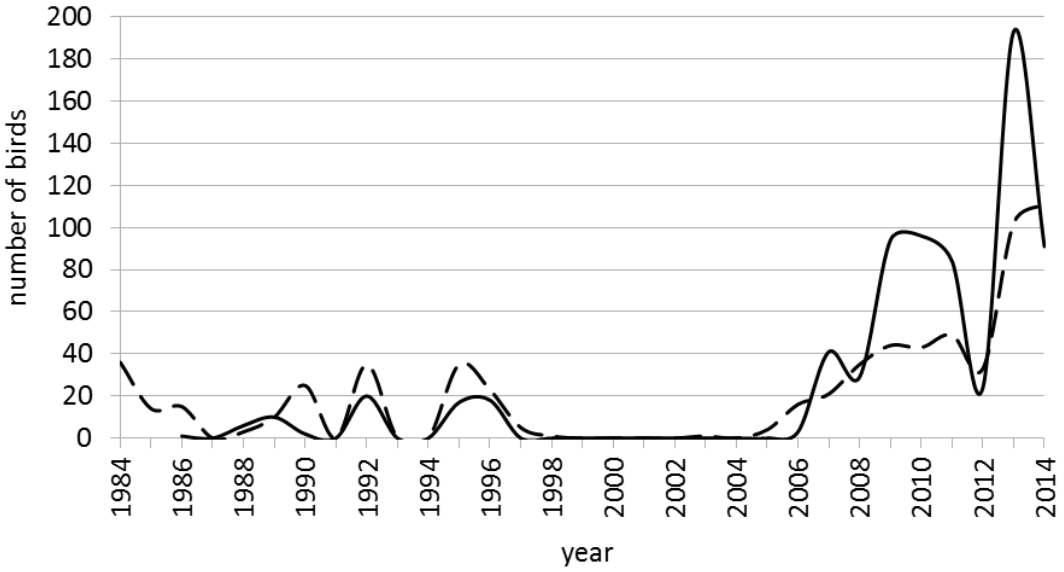


Figure 6: the number of breeding pairs of Little Terns (- - - -) and the number of Little Tern chicks presumed to have fledged (——) recorded at the Haven, Baltray from 1984 to present. The figures from 1984-2006 were provided by Larry Lenehan (unpublished data). The figures from 2007-2012 were taken from McKeever and Reilly (2007) and Reilly (2008; 2009; 2010; 2011 and 2012) and the figures from 2013 were taken from Doyle *et al*. (2013).

4.3 Ringing and morphometric measurements

4.3.1 Ringing

Ringing commenced on June 20th, two days after the first chick hatched and the last Little Tern ringed was on July 16th (Appendix 2: Table 7). In total 160 chicks were ringed, of which 154 chicks of known age were ringed, 141 on the day they hatched (Day 0), 8 on Day 1, 3 on Day 2, 1 on Day 5 and 1 on Day 6. Chicks ringed between Day 0 and 4 were ringed at or near the scrape and so could be aged and attributed to a marked nest. The chicks ringed on Day 5 and 6 were trapped with siblings who had been ringed at the scrape, and so they could be aged and attributed to a nest. Also, 6 chicks were ringed at a later age. The nest they came from was deduced from the area they were caught in, their approximate age and any potential sibling they were caught in the vicinity of. These chicks were ringed at approximately day 7, 8, 9, 10 and two at day 14.

In 2013 17% of chicks were not ringed. This occurred when ringing was delayed for day 0 chicks

whom were considered too small to take a ring. However, the chick then quickly moved away from the scrape and was never re-trapped for ringing. For this reason in 2014 every attempt was made to ring as many chicks as possible on day 0. As a consequence, on six occasions re-trapped chicks were found without a ring that had been put on the previous day. When this occurred a new ring was added to the chick if the old ring could not be located. 94% of chicks were successfully ringed in 2014.

For the first time, darvic colour ringing took place as part of the Baltray Little Tern Conservation Project. Darvic ringing took place between the 9th and 21st July. 26 darvic rings were added to chicks that were between 10 and 18 days old and had wing lengths of between 64 and 117mm. The addition of darvic rings will benefit the conservation project greatly into the future by allowing a whole series of new data to be collected about the biology and ecology of individual birds and their movements, helping to build a clearer picture of the life history of Little Terns on the east coast of Ireland.

Table 2: age (days) and size (wing length [millimetres] and weight [grams]) of Little Tern chicks on the day that a darvic ring was added to them during the 2014 breeding season in Baltray.

BTO ring number	darvic ring number	nest	age (days)	wing length (mm)	weight (g)
NW45008	I01	LT57	11	66	38.89
NW45023	I02	LT78	11	69	39.19
NW45026	I03	LT55	10	64	42.43
NW45010	I05	LT52	11	64	37.57
NW45005	I06	LT41	11	68	36.60
NW45006	I07	LT41	11	68	40.22
NW38757	I09	LT27	17	116	44.11
NW38750	I10	LT30	14	101	42.28
NW45012	I11	LT53	12	67	43.47
NW45016	I12	LT54	12	72	41.85
NW38752	I13	LT26	17	117	45.53
NW38779	I16	LT12	16	96	43.27
NW38780	I17	LT12	16	96	43.13
NW38774	I18	LT24	16	102	42.72
NW38790	I19	LT17	12	90	41.77
NW45025	I20	LT55	11	74	42.24
NW45042	I21	LT46	13	105	38.85
NW45071	I23	LT60	14	86	47.00
NW38776	I24	LT25	17	109	47.13
NW45029	I27	LT100	14	79	-
NW45019	I28	LT44	16	89	-
NW45018	I29	LT44	17	90.5	-
NW45032	I30	LT82	12	73	-
NW45039	I33	LT101	13	78	45.00
NW45056	I35	LT51	18	64	39.50
NW45072	I36	LT119	11	65	34.50
	minimum		10.0	64.0	34.50
	average		13.6	83.4	41.70
	maximum		18.0	117.0	47.1

4.3.2 Re-traps & Chick Biometrics

A total of 141 (83%) of the 170 chicks were re-trapped at least once before fledging. The maximum number of re-traps was six times. Six chicks, NW38762 from LT30, NW45008 from LT57, NW45035 from LT62, NW45039 from LT101, NW45091 from LT138 and NW45093 from LT125 were all re-trapped this many times (Appendix 2: Table 7). At 3-4 days old chicks become increasingly mobile and so the number of re-traps of older chicks is reduced, however it still gives an indication of chick growth and survival (Table 2 and Figures 7-9). Re-trap data, comprising of 515 measurements, were taken of chick biometrics and these were used to create average growth curves and monitor chick development (Figures 7-9).

4.3.3 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 (Table 3). Though there is some variation around the means, the measurements were relatively consistent for each age group. However, this is difficult to tell in older chicks due to the small sample size.

Table 3: minimum, maximum and mean (a) wing length and (b) weight values for Little Tern chicks age Day 0 to Day 18.

	wing length (mm)				weight (g)			
age (days)		min	-mean-	max.		min	-mean-	max.
0	n=143	10.5	12.9	16	n=134	3.83	7.12	10.7
1	n=110	10.5	14.1	19	n=101	5.11	8.47	12.52
2	n=70	8.5	15.5	22.5	n=70	6.23	10.91	10.91
3	n=34	14	18.8	25	n=34	10.5	14.61	18.78
4	n=21	17.5	23.8	34	n=21	13.19	18.09	25.02
5	n=22	21	27.1	42	n=22	16.5	21.23	30.6
6	n=14	24	37.9	55	n=14	20.51	27.73	37.6
7	n=13	29	43.8	61	n=13	23.5	32.78	42
8	n=7	35	46.6	54	n=7	26.61	34.00	43.35
9	n=8	45	54.8	64.5	n=8	31.4	37.46	43.36
10	n=14	38	58.0	82	n=14	28.75	38.03	45.81
11	n=12	64	68.2	75	n=12	33.06	40.18	52.39
12	n=10	61	73.9	92	n=10	40.34	42.51	47.18
13	n=6	78	86.8	105	n=6	38.85	43.49	46.2
14	n=11	78.5	87.0	101	n=11	40.6	45.68	50
15	n=6	81	89.5	95	n=6	38.83	47.40	56.5
16	n=9	85	96.1	106.5	n=9	42.72	45.03	47.83
17	n=4	90.5	108.1	117	n=4	44.11	45.59	47.13
18	n=1	104	104.0	104	n=1	32.5	32.5	32.5

n = 515

4.3.4 Chick Wing Length

Wing length increased slowly during the first few days. From day four, the rate of wing growth increased more significantly each day as the chicks' pins started to come through (Figure 7). Chicks began to show true flight feathers from day 13. The rate of wing length increase did not appear to be slowing in the older chicks though the small sample size of oldest chicks makes this hard to confirm definitively. 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, post-fledging, until it reaches adult size. Wing length is strongly positively correlated with age showing that any change in age is tightly linked to a change in wing length (Correlation coefficient, n = 515, r = 0.97).

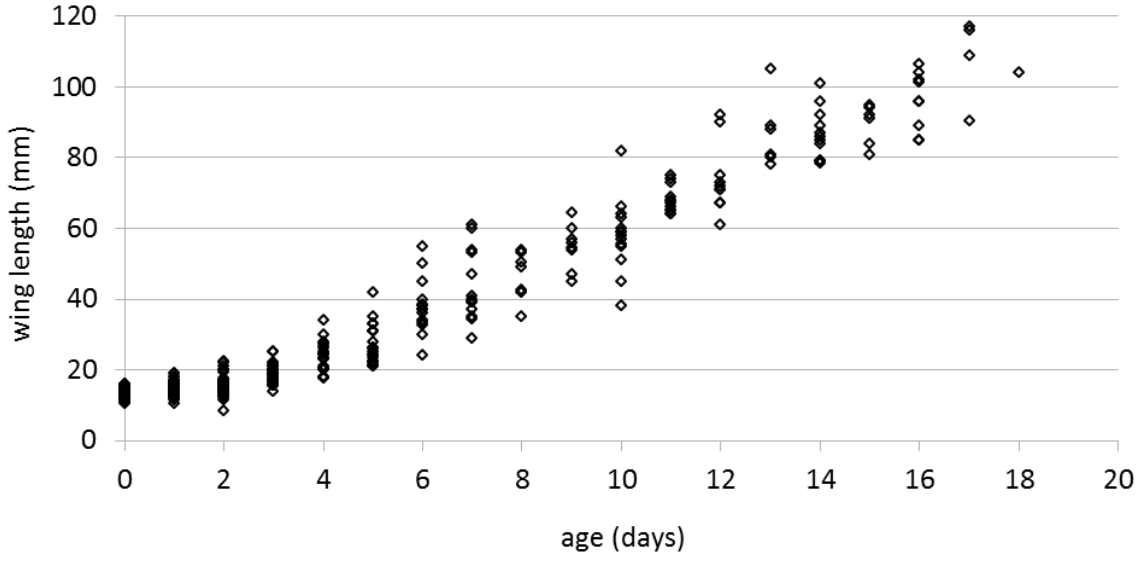


Figure 7: the rate of wing growth as Little Tern chick's age increases. n = 516

4.3.5 Chick Weight

Chicks rapidly increase in weight during their first days (Figure 7). They will easily double their weight or more in the first five days. At approximately day nine, the growth rate asymptotes and 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 chicks as young as 11 days but on average is reached at about two weeks (Table 3). Weight is strongly positively correlated with age, showing that any change in age is tightly linked to a change in weight (Correlation coefficient, n = 488, r = 0.96). Therefore the asymptote in the relationship after day nine has little affect on the strength of the linear relationship and is possibly due to a lack of data points for chicks older than day nine.

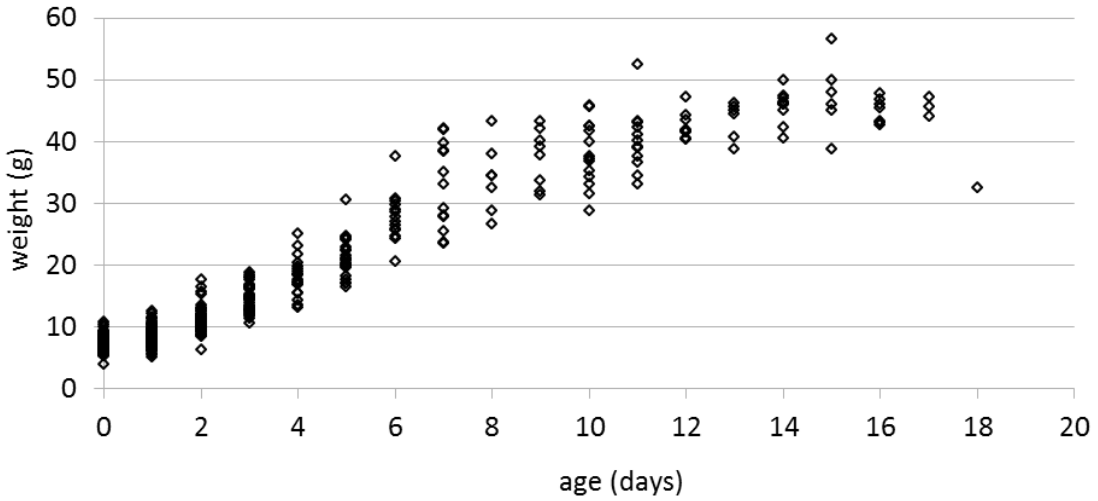


Figure 8: rate of increase in Little Tern chick weight as age increases. n = 488

4.3.6 Chick Wing Length vs. Weight

Wing length and body weight are closely linked measures of gross morphology, taken together they give a picture of the size of a bird. The wing length and weight of growing Little Tern chicks were positively correlated (Correlation coefficient, n = 515, r = 0.95). This shows that a change in one is closely linked to a change in the other (Figure 9). The tail of the graph begins to describe an upwards curve as older chicks (13-16 days old) begin to reach their adult weight, but continue to increase in wing length as they have not yet reached adult wing length.

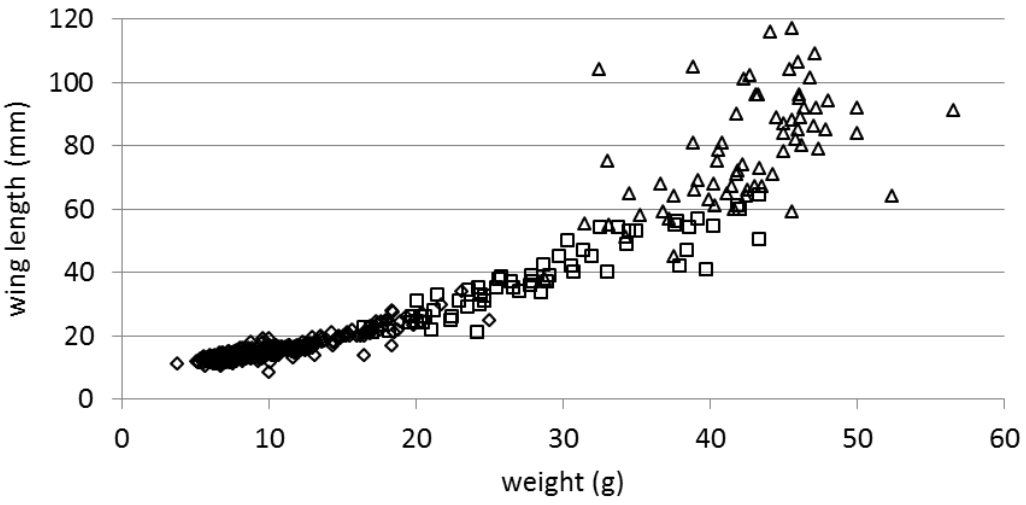


Figure 9: the correlation between Little Tern wing length (in millimetres) and body weight (in grams). Age group is indicated: ◇ age 0 to 4 days; □ age 5 to 9 days and; △ age ≥10 days. n = 515

4.4 Dietary observations

68 parent-feeding-chick events were observed throughout the study. Chicks were observed aged Day 0, Day 1, Day 2, Day 3, Day 4, Day 5, Day 6, Day 7, Day 8, Day 17 and Day 18. Fish recorded offered to Little Tern chicks were Sprat (*Sprattus sprattus*) and sandeels (*Ammodytes* spp.). On all but one occasion Day 0 chicks accepted and ate the offered food which measured between 1.0 and 2.0 adult bill lengths (BLS). Day 1 - 3 chicks consumed sandeel and Sprat which were an average of 1.4 BLS. Day 5 - 8 chicks consumed a similar diet but the average size of the food offered increased to 1.85 BLS. Dietary observations were attempted on Day 17 and 18 chicks; no feeding attempt was recorded in 60 minutes with the Day 17 chick while the Day 18 chick was recorded being offered and consuming three Sprat with an average length of 1.17 BLS in a 60 minute survey. This fish length was lower than would have been expected considering the average for Day 5 – 8 chicks but the small sample size is likely to have skewed the result (Table 4). Statistical analysis of food length indicated that there was no significant difference in the size of food pieces offered to chicks of different ages (general linear model, n = 68, p = 0.6)

Table 4: food substrate type and size offered to chicks of different ages (note that although the food was offered, it was not always consumed by the chick). Chick age is measured in days. Food size is measured in “bill-lengths” –one unit is the length of an adult Little Tern bill. n = 68

age of chick (days)	proportion of food substrates offered to chick by parent bird	minimum, maximum and average length of substrate offered to chicks of this age (bill lengths)
0 n = 8	Sprat - (62.5%) Sandeel - (37.5%)	1.0 (min) – 2.0 (max) average: 1.5
1 n = 27	Sprat - (62.5%) Sprat - (70.4%) Sandeel - (18.5%) no feeding during observation - (11%)	1.0 (min) – 2.0 (max) average: 1.3
2 n = 12	Sprat – (50%) Sandeel – (25%) no feeding during observation – (25%)	1.0 (min) – 2.0 (max) average: 1.5
3 n = 2	Sprat – (50%) Sandeel – (50%)	1.5 (min) – 2.0 (max) average: 1.75
4 n = 3	Sprat – (100%)	1.0 (min) – 1.5 (max) average: 1.17
5 n = 1	Sandeel – (100%)	2.0 (min) – 2.0 (max) average: 2.0
6 n = 3	Sprat – (75%) no feeding during observation – (25%)	2.0 (min) – 2.0 (max) average: 2.0
7 n = 7	Sprat – (85.7%) Sandeel – (14.3%)	1.5 (min) – 2.0 (max) average: 1.93
8 n = 1	Sprat – (100%)	1.0 (min) – 1.0 (max) average: 1.0
17 n = 1	no feeding during observation – (100%)	-
18 n = 3	Sprat – (100%)	1.0 (min) – 1.5 (max) average: 1.17

The majority of parent-feeding-chick events resulted in the food being accepted and consumed by the chick. In the case of the eight feeding events observed for Day 0 chicks, the food offered was only rejected once. Fish offered were rejected on four out of the 20 occasions when Day 1 chicks were offered food, the highest number of rejections recorded for any age group. The only other rejections of food recorded were once by a Day 2 and once by a Day 7 chick. Sprat were rejected more often than sandeels, however, they were also offered more frequently (Figure 10). On two occasions rejected Sprat was consumed by the parent bird.

Two chicks from nest LT101 were monitored for feeding when they were one and two days old. During both these 60 minute monitoring sessions no parent-feeding-chick events were recorded. Similarly no feeding events were recorded for a third Day 1 and different Day 2 chick as well as a Day 6 and Day 17 chick, when monitored for 60 minutes at a time. No clear trends are apparent from the data collected, probably as a result of the small sample size. Sprat, however, appear to be an important and prevalent food source for Little Tern chicks, similar to previous years.

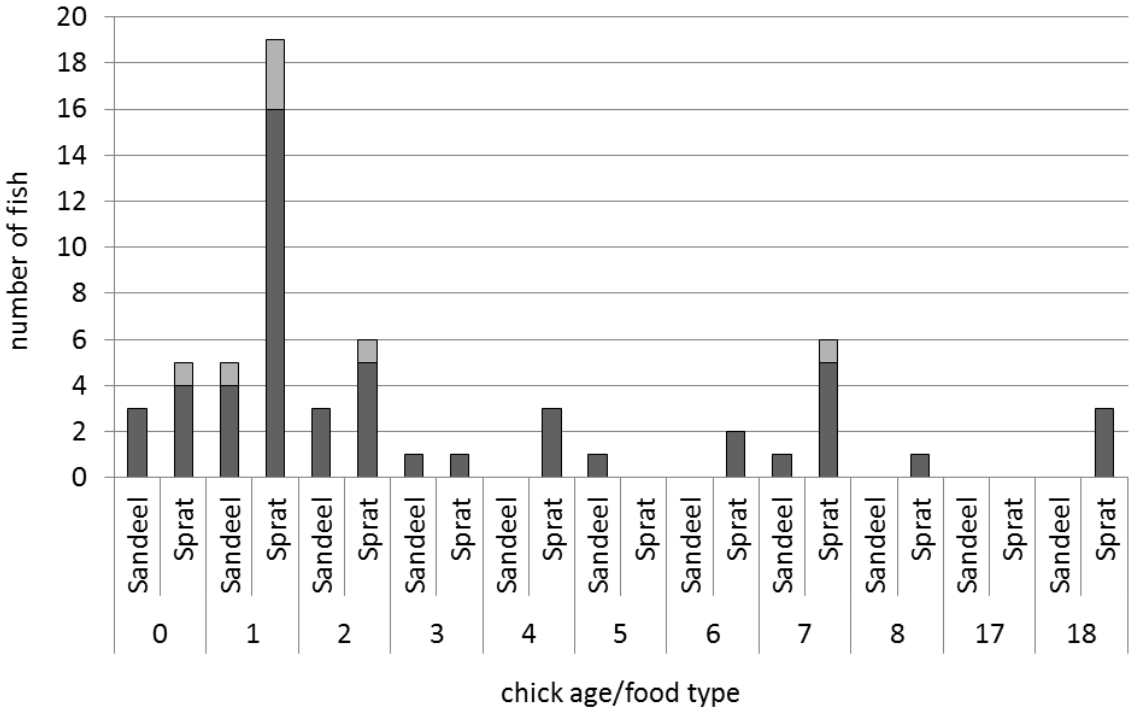


Figure 10: the number of: sandeel and Sprat ■ accepted and □ rejected by Little Tern chicks of varying age groups when offered by their parents during the 2014 breeding season in Baltray. n = 60

4.5 Nest moves

In 2014, the day wardens attempted to move 20 Little Tern and one Ringed Plover nests, as detailed below.

June Spring Tides [14th - 18th]
10/6/14 - LT2, LT13, LT28, LT47
11/6/14 – LT73, LT74, LT75, LT86, LT88, LT89, LT102, LT107

21/6/14 – RP17, LT111, LT118

July Spring Tide [13th - 17th]
8/7/14 – LT130, LT135, LT141, LT149
9/7/14 – LT139, LT151

The moving process of each nest took place over a few days to a week. All but one Little Tern nest move was successfully accepted by the parent birds. The parent birds incubating nest LT89 rejected the first markers that were placed around the nest to assist them with location after the nest move. When the birds failed to recognise their nest with the new markers after 40 minutes they were removed. The parent birds of nest LT107 accepted their nest move up until it was bordering the colony fence, at which point they moved the nest off the 'transport board' into a new scrape in the sand next to it, where it was left. Out of the 19 successful moves, eight hatched chicks. Seven nests that had been partially moved, but not yet inside the electric fencing, were depredated by a fox on June 13th. Four Little Tern nests, three of which had been moved to their final planned destination, were washed out during the July spring tide and one was washed over in the same tide and subsequently abandoned. The only Ringed Plover nest 2, successfully hatched three of its

four eggs.

4.6 Predators and disturbance

Terrestrial: Two significant depredation events occurred on June 13th and 15th by a Red Fox. The Fox was not detected by the night wardens on the first night of predation. On this night it took eight Little Tern nests (LT47, LT73, LT74, LT75, LT86, LT88, LT89, LT103) that were located on the seaward side of the eastern electric fence of the north colony. The Fox was not sighted on June 14th. On June 15th, presumably the same individual, depredated 23 Little Tern nests and one Ringed Plover nest (LT9, LT19, LT21, LT22, LT23, LT32, LT35, LT39, LT49, LT50, LT61, LT65, LT66, LT68, LT80, LT81, LT83, LT84, LT85, LT93, LT94, LT95, LT112, RP12). These nests were located north of the electric fencing of the northern enclosure and were only protected by a string cordon. The Fox was removed on June 15th by the night warden on duty. No other Fox was seen in the area until the last week of July when one was spotted on the beach north of the Little Tern colony on July 24th. The Fox was easily scared by the lights of the night warden before coming close to the colony.
An Otter (*Lutra lutra*) was seen by the night wardens in the vicinity of the river on two occasions but it caused no disturbance to the nesting colony. At least one Brown Rat (*Rattus norvegicus*) was also recorded in the nearby dunes of the colony but no losses were attributed to it. Irish Hare (*Lepus timidus hibernicus*) were prevalent in the nearby dunes and within the colony itself throughout the 2014 breeding season. Four adult Hares were recorded together within the south colony on May 29th and leverets were discovered on three separate occasions. The Hares were seen almost daily and caused significant disturbance to the Little Terns. When a Hare ran through the colony the nesting birds were flushed and would often form a mob to push the Hare out of the nesting area. The Hares entered the colony from the seaward side of the fencing, jumping over the electric fencing or through holes they gnawed in the green mesh fencing on the western edge of the colony. When these holes were first discovered they were mended, however, the Hares would simply gnaw through the patched hole again or create a new one adjacent to it (Plate 4). For this reason, subsequent holes were left open. The death of one 2 day old chick from nest LT143 was attributed to hares running through the colony and trampling it (Plate 5).

Plate 4: hole created in green mesh fencing by Irish Hares (*Lepus timidus hibernicus*).

Plate 5: two day old chick found dead in nest LT143. Assumed killed when trampled by a passing hare.

Avian: Corvids, especially Rooks, were a threat to the Little Tern colony at the beginning of the season. Two Larsen traps were deployed from 17th May until 26th July. In the first two weeks of their deployment a Hooded Crow on 21st May and a Rook on 23rd May were removed using the traps. Corvids, primarily Rooks, are known to have taken four Little Tern and three Ringed Plover

nests. Six other Little Tern nests that were recorded as lost to unknown predators were likely to have also been taken by corvids. This conclusion was reached because no evidence was left behind and the other nests in the surrounding vicinity were not attacked. Corvid numbers at the beginning of the season were high and small groups of up to 12 but usually between two and six Hooded Crows and Rooks were seen patrolling the colony area searching for eggs in May and the beginning of June. On 9th June the night warden on duty removed one Hooded Crow. This measure was highly effective in deterring the number of corvids in the area. When corvid numbers began to increase again later in the season they remained in the dunes behind the colony and were wary of humans.
Several potential avian predators posing a danger to older chicks, fledged Little Terns and adults were observed in the area. A pair of Kestrels, believed to be raising a brood, regularly hunted within the colony between July 3rd and 29th. They were commonly observed hunting in the nearby dunes before and after this date. A minimum of 26 Little Tern chicks were depredated by Kestrels in that time. In an attempt to deter the Kestrels wardens would shout, bang metal objects together and use a siren on a megaphone provided by Louth Nature Trust. However, the Kestrels soon grew accustomed to this noise deterrence and these attempts only met with limited success. Walking out underneath where they hunted seemed to perturb them but they would usually just fly to the opposite end of the colony to the warden and resume hunting. Also the Kestrels would often fly in very low, thus avoiding detection until the terns were disturbed. Several other birds of prey were observed hunting in the colony area. A female Sparrowhawk was regularly observed hunting on the foreshore in front of the colony between 10th and 26th July. During this period it is known to have taken 10 Little Tern chicks or fledglings. A dead Little Tern adult was found on the path on the western side of the south colony on June 1st. It is suspected of being predated by a Sparrowhawk that was seen in the area earlier in the morning by the night warden on duty. On July 17th, 19th, 20th and 27th a Peregrine Falcon (*Falco peregrinus*) was recorded hunting in the area but there was no evidence of successful depredation. A Short-eared Owl (*Asio flammeus*) was sighted in the area on April 29th but no sightings were made during the breeding season.
Although gull species; Lesser Black-backed Gull (*Larus fuscus*), Great Black-backed Gull (*Larus marinus*), Herring Gull (*Larus argentatus*), Black-headed Gull (*Chroicocephalus ridibundus*), were present in high numbers in the vicinity of the colony throughout the breeding season, no depredation by any seabirds was observed. However, 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.

Human: Experienced volunteers observed that this year there was a notable decrease in the number of people using the beach area surrounding the Little Tern colony. Since there was long periods of very good weather during the summer this is attributed to the culmination of hard work that has been put into increasing public awareness over the previous years. Once chicks had hatched and were on the lower beach a line of wooden poles connected with string, with additional signs, was place along the northern sandbar. This successfully resulted in little to no walkers passing into the cordoned off area of the colony. People accessed the beach on a path immediately next to the northern limit of the colony. The Little Terns in this area did experience more frequent disturbance from walkers and their, often unleashed, dogs. During the season there were recreational walkers who had to be guided away from the colony by the wardens, most of whom had missed the information signs about the project and were unaware of the situation. Occasionally dogs were also let off the lead on the beach front by their owners, despite the signs, and at times chased the birds, including the Little Terns. These events were less frequent than previous years (Doyle *et al.*, 2013) and when wardens requested they be put back on the lead people usually obliged. None of these activities appear to have led to the damage of Little Tern

eggs or chicks due to quick reactions by the wardens.
Drogheda Port made the decision to repair the furthest beacon on their northerly seawall this summer. To complete their work they required access through the Little Tern Conservation Site, which was granted. They carried out the repair work between June 16th and 27th. To complete their work they needed to drive a large JCB and building materials past the southern end of the southern enclosure down to the lower shore. The project manager and his staff were obliging and conscientious, making an effort to complete their work with as little disturbance to the Little Terns as possible. Although the timing of the repairs was not ideal, because they worked around low tide and because there were no eggs laid at that date in the far southern end of the south colony minimal disturbance to the breeding colony was made.
On 31st May at approximately 20:00 two quad bikes were driven down the lower bank of the river. The drivers then attempted to lift the quad bikes over the sea wall onto the beach, for which they were successful with one. Much to the distress of other beach users, one of the quad bikes was driven at high speed along the beach from between the sea wall and the beached shipwreck. Although many passers-by requested them to stop they continued for about an hour. When they returned to the second quad bike that had been abandoned on the river side of the sea wall, the warden on duty went to speak with them and make them aware of the laws that they were breaking. This was unsuccessful, however, as they claimed to not understand English. At this point the warden contacted local Gardaí for assistance. When the quad bike owners went to leave the area they found that they could no longer use the river front because the tide was coming in. As a result they struggled for a long time to pull the second quad bike onto the beach and drove out through the dunes and private road way, breaking a wooden stile on their way. The night warden monitored them as they left to ensure they caused minimal disturbance to the Little Terns. The wardens provided the Gardaí with the car details and registration number but no known follow up was made. Jet skis regularly went through the river and estuary which may have caused some disturbance to Little Terns feeding.

5. Discussion

The goal of investment in Little Tern conservation projects is to increase numbers in the population by protecting breeding habitat and reducing threats and disturbance. The success of any breeding season at a Little Tern colony depends upon both the number of pairs that attempt to breed in that year at the site, and how many of their nesting attempts are productive (go on to fledge chicks). This year, after careful review, it is estimated that 111 breeding pairs produced 170 chicks of which 91 are presumed to have fledged. The number of breeding pairs in 2014 was the higher than previously ever recorded in Baltray (102) or in fact Kilcoole, Co. Wicklow (106), where Little Terns have been wardened and protected since 1985. This year, Kilcoole similarly recorded record breaking numbers of breeding pairs (120) (O'Connell *et al.*, 2014). In 2013 they recorded similarly high numbers of breeders in Baltray. However, previous to this the number of breeding pairs averaged at 37.5 since the conservation project was started in 2007. Unfortunately the potential productivity of the large breeding population was not reached this year. Productivity in 2014 may have been as low as 0.4 but is believed to be closer to 0.82 fledglings per pair. This is the second lowest since 2007. In 2012 productivity was calculated at 0.73 and in 2008 at 0.83 fledglings per pair. In 2008 major losses were experienced as a result of gull depredation and spring high tides. Similarly Spring high tides were a problem in 2012, whereas the main predator in that instance was a Red Fox. Despite the perceived low productivity measure, 2014 was a very successful breeding season for Little Terns in Baltray, producing similar fledgling numbers to the very successful years of 2009 (94) and 2010 (96) where productivity was measured at 2.14 and 2.23 respectively. The productivity of pairs of Little Terns at Baltray is in general very high (especially when 24 hour wardening is in place) underlining the suitability of this site for Little Tern breeding.

This year the first Little Tern eggs were found on 24th May, similar to the average for previous years, May 25th (McKeever and Reilly 2007; Reilly, 2008; 2009; 2010; 2011; 2012; Doyle *et al*. 2013). The last nest, which was a re-lay and was washed out in the July spring tides, was found on July 7th. The last nest to successfully hatch was laid on July 4th. These dates are earlier than the estimated average of previous years (11th July). However, if one ignores the particularly late finish in 2013 (18th July), it is closer to the average of July 9th. Hatching began on the 18th of June and continued until July 16th. The commencement of hatching was similar to the average of previous years, June 16th. The 2014 season, however, finished exceptionally early with the last successful hatching of six chicks from four nests hatching on July 16th. These last hatchings were a full 12 days earlier than the average of July 28th in previous years. This early finish of hatching was the result of the latest nests being abandoned or lost during the spring tides between July 13th – 17th. The modal incubation length was 21.33 days, well within the 18-22 day range cited by Cramp (1985), indicating favourable conditions.

5.1 Egg losses

The potential for high productivity in 2014 was not attained primarily because of very high depredation levels of both eggs and chicks. Eggs were lost to high tides, abandonment and as a result of infertility. Ten eggs were lost directly in spring tides this year. This is only marginally more than last year and is substantially lower than many previous years (McKeever and Reilly 2007; Reilly, 2008; 2009; 2010; 2011; 2012; Doyle *et al.,* 2013). This success is due to two factors, favourable tides and multiple successful nest moves. The tides this year were very favourable. During the June spring tides a combination of high pressure and a westerly wind prevented the tides coming too far up the beach. Also, any nests that had been in danger of flooding were relocated up the beach in advance. The July spring tide was much higher despite a light westerly

breeze. The tide inundated the enclosure significantly, especially in the northern end and managed to wash out nests that had been relocated by up to three metres. Overall the nest moves were extremely successful as seven nests, which would have otherwise been washed out, successfully hatched. This figure would have been higher except for the fox depredation in June.

Six eggs from three nests were indirectly lost as a result of the July spring tides. LT149 was washed over by the tide but remained in its original location. Consequentially the parents abandoned the nest. LT148, also very close to the high tide limit, was abandoned during the July spring tide and LT147 was abandoned shortly afterwards. LT147 was the only nest in its vicinity still being attended after the high tides and the bird may have felt too vulnerable to remain sitting with the frequent raptor attacks. Three other nests were abandoned in 2014. Of these it is thought that one was left after a parent was depredated, while the reasons behind the other two are unclear.

Four eggs found during the season appear to have been dumped, outside of any scrape, at random on the upper beach. No incubation was ever recorded for these eggs. Compared to last year this is a four-fold increase, however considering the number of eggs laid in 2014, this is only a little over 1% of the total. These 'dumped eggs' may have been laid by inexperienced females who had not yet chosen a suitable scrape.

There were 14 nests that contained infertile eggs which never hatched. Four of these nests had three eggs of which one egg did not hatch and seven were two egg nests which had one infertile egg. There were three nests that were sat on for a prolonged period but no egg ever hatched and they were eventually abandoned. One of these nests had only one egg while the other two had two eggs. A percentage of eggs will always be infertile and this is quite a small number considering the large number of eggs laid this season; with only 5% of eggs laid proving to be infertile, a similar result as in 2013 (Doyle *et al.,* 2013). Inexperienced breeders often fail to hatch all of their eggs and with such high numbers of nesting pairs there will always be a proportion of first year breeders (Keogh *et al*. 2010). In coming years the newly added darvic rings will help to confirm that it is younger birds that are in fact responsible for the infertile, unhatched eggs.

Depredation was the most serious problem limiting productivity in 2014. Although it appeared at the beginning of the season that corvids, primarily Rooks, were going to be a serious problem, they only depredated between four and 16 nests in the end (see section 3.7.2 Avian predators for details). The conservation measures used were very effective at mitigating corvid predation and should be continued in future years.

The largest loss of eggs in 2014 was, however, during two fox depredation events in June when 60 eggs from 29 nests were lost. Since the beginning of the warden-led conservation project in 2007 there has only been one other year (2012) when the same high number of nests were lost to a fox. The fox was easily able to take so many nests in 2012 because the colony fencing was often down or damaged as a result of stormy weather and unusually high tides. This year the nests that were taken were outside the main fenced colony area and were therefore unprotected from ground predators. Eight of these nests were on the eastern side of the northern colony fencing (see map of colony). The only way that these could have been feasibly saved was if they had been moved to within the protected colony before this date. Many of the nests that were depredated in this area were on boards and in the process of being moved toward the fenced colony to protect them from the forthcoming June spring tide. There were three nests originally in this area which had been successfully moved to within the fenced area shortly before the depredation event. It is most likely that these nests would have also been depredated if still in their original locations. The second fox depredation event occurred to the north of the northern enclosure. Although a few nests in this area (three Ringed Plover and four of Little Tern) survived the attack almost every nest (21 out of 25 Little Tern nests) was taken. All but one (RP) of the surviving nests were located close to, or in, the western vegetation line (see map of colony). These depredation events highlight the effectiveness and importance of the protective fencing.

5.2 Chick losses

5.2.1 Raptor depredation

Avian depredation of chicks was another serious hindrance to Little Tern productivity in 2014. 26 near-fledged chicks were taken by a breeding pair of Kestrels and ten by a Sparrowhawk. Although this figure is lower than that for foxes, it is likely to have had a greater negative impact. The fox depredation took place in mid-June which meant that there was still the opportunity for the affected parents to re-lay. Loss of near-fledgings, however, meant removing young late in the season to which considerable investment had already been made. Kestrels hunting in the area of the breeding colony have been a regular occurrence every year. Up until 2013 they remained hunting in the nearby dunes and although they were seen flying over the enclosure no Little Tern losses were ever attributed to them. At the end of 2013 the Kestrels began hunting in the Little Tern colony and took eight chicks in 13 days at the end of the season. In 2014 Kestrel depredations began on July 3rd, nearly two weeks earlier than in 2013. At the outset the Kestrel displayed characteristic hovering behaviour while trying to hunt within the enclosure. This alerted the Little Tern adults and they were frequently able to chase it off before any depredation occurred. In the first week it only managed to take a chick every couple of days. After this initial period the Kestrel (although there were a pair in the area, it was primarily the male who hunted in the enclosure) changed its hunting behaviour and began flying in very low, thus frequently avoiding detection by wardens and terns alike. The depredation events peaked on July 9th when four Little Tern and one Ringed Plover chick were taken. After this date it visited the colony hunting up to seven times a day. However, due to enormous effort on the part of the wardens and volunteers rarely more than one chick a day was lost.

A Sparrowhawk also began to hunt regularly in the area from July 12th. In 2010, 2011 and 2012 a Sparrowhawk was recorded depredating a Little Tern adult but not chicks. The female Sparrowhawk in 2014 usually hunted on the foreshore during low tide but was observed on occasion coming up to the enclosure area. It is thought to have been responsible for two adult Little Tern losses and a minimum of ten Little Tern chicks were taken. The bird often hunted a great distance from the wardens and for this reason it was difficult to always accurately record the prey species taken. Similarly, as in 2013, there were few methods of effective mitigation, aside from acute human presence. The number of people wardening the area during this period in July was doubled. This required a huge amount of commitment from the volunteers involved. The wardens employed noise deterrents to deter the Kestrels, but this only had a short-term effect. On one occasion a volunteer brought a gas canister powered horn to aid in deterrence. This device appeared to have been the most effective apparatus tried throughout the season (Plate 6). It should be noted, however, it was used close to the bird and in combination with three people chasing it away. Frequently attempts to perturb the raptors would only result in them flying to the opposite end of the beach to the warden and resume hunting. Therefore, due to the length of the protective area, it was essential to have people positioned at both ends.

Kestrels are well known predators of Little Terns and supplementary or diversionary feeding has been used in mitigation at a number of Little Tern conservation projects. A study of such diversionary feeding in Great Yarmouth, Norfolk has showed a reduction in predation on Little Tern chicks although there was variation among years which may have resulted from differing availability of alternate natural prey (Smart *et al.*, 2009). If a feeding programme is to be put into place, the nest of the raptors needs to be found early on, before the Little Tern breeding season has begun. It has been noted that in some cases, when trying to manage tern predators on an

individual basis, they may be difficult to identify or locate (Donehower et al., 2007). Kestrels are known to hunt within a few kilometres of their nesting site given summer territory size range between 3 and 9 km^2 (Shrubb, 1993). On the basis of the frequency of appearance at Baltray, the Kestrel nest cannot be too far away. However, if one fails to locate the nesting site it is still possible to attempt supplementary feeding. Such a case occurred this year at The Little Tern Conservation Project at Chesil Beach. They adjusted their strategy by supplying supplementary food on a nearby favourite perch. This was done with some success but there was the added challenge of preventing gulls from also taking the food (Sean Foote, on-line blog, 2014). It should be recognised that if a supplementary food programme is to be put in place there is a risk that predator breeding success or density might increase in future years, which could serve to exacerbate the problem rather than solve it (Reynolds and Tapper, 1996).

Plate 6: gas-powered hand-held horn used to scare off predatory raptors.

5.2.2 Other chick losses

Six chicks were recorded as dying from natural causes. This relatively low number reflects the generally good weather this season. One of these chick deaths may have been caused by a hare (see section 3.7.1 Ground predators for details). The hares caused alarm amongst the wardens on duty on multiple occasions, when they were alerted by the Little Terns aggressive behaviour to a potential predator in the enclosure. With the encroaching vegetation likely to increase in the enclosure area it is likely that hares will remain problematic in coming seasons. It would be greatly beneficial to try and deter the hares from entering the enclosure. Alana Ecology apparently sell a wildlife sound system for deterring hares which may be a worthwhile investment for the coming season (B. Martin, pers. comm.).

Aside from the known depredations and deaths from natural causes, 37 chicks are assumed to have died before fledging. These were all situated in the southern enclosure and were the latest chicks to have hatched in the season. From the 20th to the 23rd of July the number of observed unfledged chicks and adult Little Terns caring for young decreased significantly. The 18th July was

the last day that any very young chicks (a two day and four day old chick) were re-trapped and no chicks were seen or re-trapped after July 23rd. Similarly, no parents were observed showing feeding behaviour to young (swooping down with fish on to the beach) after this date. It was concluded, therefore, that through some unknown event the last of the Little Tern chicks were lost. Any chick that was 18 days or older on July 23rd is assumed to have successfully fledged unless evidence indicated otherwise. During this period the electric fencing on the seaward side of the colony was in disrepair after the high July spring tides. It is therefore possible that terrestrial predator(s) may have accessed the colony. The only evidence to support this in any way is the observation of a fox by the night warden on the beach north of the colony area on the week of July 21st. However, it was easily scared away with lights and was not seen close to the enclosure. Other possible causes include depredation by gulls. Large mixed communities of gulls commonly frequent Baltray beach. Gull species have been recorded taking Little Tern chicks on Baltray beach in 2008. The likelihood of this occurring unbeknownst to the wardens and volunteers monitoring the site is very low unless it occurred at night as has been recorded in Maine, USA (Nocera & Kress, 1996).

5.3 Biometrics and Chick Ringing

Re-trapping was carried out as often as possible in order to collect data on growth rates. 141 (83%) chicks were re-trapped at least once before fledging. The growth curves that were constructed with this data show very similar trends to those created from data collected in Baltray in 2013 as well as in Kilcoole in previous years (Doyle *et al*., 2013; Keogh *et al.,* 2011; 2010). Although still limited, a greater number of older chicks were re-trapped in 2014 compared to 2013. The data supported the initial observations that Little Tern chicks are approaching their final adult weight at about 2 weeks of age, but their wing length continues to increase. Comparing growth curves across years could be used as an indicator of feeding rates, and hence the availability of prey. Collecting such data on a long-term basis allows changes in the Little Tern breeding population ecology to be assessed. The disturbance involved in such a process, however, is inevitably high. A hypothesis that this increased level of disturbance needed to collect such data may have negatively affected the productivity of the Little Terns in Baltray was discussed this year. The possibility that this disturbance may have led to increased and more successful avian predator attacks on chicks was considered. It is not practical to test the validity of such a hypothesis and it would be wise to err on the side of caution. Consideration should be made as to whether it may be sufficiently beneficial to collect biometric data every second or third year, thereby, continuing to build a valuable long-term data set while providing a degree of relief from possible human-mediated avian predation.

A very high percentage (94%) of chicks were successfully metal ringed this year. Similarly to last year they were ringed on the left leg to distinguish them from those ringed at Kilcoole which were ringed on the right leg. In addition 26 nearly fledged chicks received darvic colour rings. Three fledged chicks were observed with coloured rings on their right legs while roosting. It is unfortunate that a higher proportion of chicks did not receive coloured rings this year but the high level of predator disturbance that the wardens had to deal with in July meant that time could not be dedicated to this activity. In Kilcoole this year 133 chicks were colour ringed. Methods for catching large numbers of older chicks were fine tuned this year at Kilcoole and this knowledge will aid in higher proportions of chicks being colour ringed at the projects in future years. In 2013 a Little Tern metal ringed at Kilcoole was found dead at Baltray, another was re-trapped as a breeding adult on the Isle of Man and this year a breeding Little Tern metal ringed on its left leg was observed in Baltray, illustrating that movements between breeding sites are taking place (Doyle *et al.*, 2013; Keogh *et al.*, 2013). As Kilcoole Little Tern chicks are also being colour ringed under this scheme, and Little Terns are being colour ringed with yellow rings engraved with black

characters on the Isle of Man, we will have a much better insight into any such movements in the future. As well as giving insights into movements between sites we may gain a greater insight into aspects of their biology such as pair fidelity, recruitment rate of fledglings into the breeding population, individual preference in nest location and adult longevity. Five sightings of 2014 colour ringed birds from Kilcoole have already been made in the UK, France and Portugal. These sightings shed further light on the movements of Little Terns in the Irish Sea and beyond in the early-migration period.

5.4 Feeding Study

The feeding ecology of the Little Tern chicks at Baltray was continued this year. The data collected supported the importance of Sprat and sandeels in Little Tern chicks' diet, a result that was also apparent in 2013. This year the food species offered to the chicks was less diverse than that recorded in 2013. The size of the food offered also increased on average as the chicks developed. Further data collection will have to be carried out in future years before any more firm conclusions can be drawn.

5.5 Pattern of Nesting

The nesting site of Little Terns at Baltray is a dynamic one. The topography and substrate of the beach is constantly changing and with each year the encroachment of dune vegetation develops. Analysis of the nesting patterns of the Little Terns is important to assist in conservation decisions for coming years. In 2013 the buffer fence on the southern end of the southern enclosure was extended to protect seven Little Tern and two Ringed Plover nests in the area. In 2014 the electric fencing of the southern enclosure was laid out to within 10 metres of the sea wall and in this year the highest density of Little Tern nests (33) occurred on the foreshore of the middle and south end of the southern enclosure. Interestingly, many of the most southerly nests were laid later in the season and are likely to have been re-lays. Fewer nests, compared to 2013, were made in the northern part of the southern enclosure. In 2013 it appears that no birds (Ringed Plover or Little Terns) nested in the back-shore of the southern enclosure. This year one Ringed Plover nest that successfully hatched and four, later depredated, Little Tern nests were recorded in this area. High levels of Ringed Plover activity was also observed in this area and it is believed that unrecorded Ringed Plover nests occurred there (see southern enclosure map (above) and Doyle *et al.,* 2013).
The electric and green mesh fence of the northern enclosure was laid out around a similar area as last year. The density of Little Tern nests in the southern half of the northern enclosure this year was far less (12 compared to 31) than in 2013. The preference in 2014 was for the northern half of the northern enclosure but also a considerable number of birds chose to lay outside of the fenced colony area altogether. 18 Little Tern nests were recorded on the seaward side and 31 were recorded to the north of the northern enclosure. Of these nests 10 (20%) successfully hatched young, four because they were relocated inside the colony fencing. Although time consuming, if nests are laid just west of the colony fencing it is relatively easy to move them to a location safely inside the fencing. This is the only feasible method of conserving such nests as it is impractical to extend the fencing further toward the sea where it is more vulnerable to damage from tides. Four Little Tern and two Ringed Plover nests were recorded between the electric fence and the northern buffer fence in 2013. In 2014 this increased to 26 Little Tern and one Ringed Plover nests. During this season the buffer fence was extended north to enclose a further four Little Tern and four Ringed Plover nests, bringing the fencing almost in line with the pedestrian entrance to the beach. This area of beach has a substrate of fine shingle and small shells that are favoured by nesting Little

Terns (see Figure 3). It also has a significantly wider area of ideal substrate where vegetation has not yet advanced. These factors mean that, although it is further from the river and closer to higher levels of disturbance, it is likely that Little Terns will continue to nest in this area. It is recommended that in the 2015 season the electric and green mesh fencing is extended to where the original northern flutter fence was situated in 2014 and that the northern boundary flutter fence is erected in the area it was extended to during the season. The effect that vegetation has on nesting Little Terns is unclear but a number of studies have shown that they react positively to it (Perrow & Eglington, 2014). Ratcliffe *et al.* (2008) found that Little Terns in East Anglia positively selected for beaches with vegetation cover. From the nest locations in Baltray, however, it appears that the majority of Little Terns avoid nesting in surrounding vegetation, as they do at Kilcoole (S. Newton, pers. obs.). Little Terns have also been found to prefer a shell-based substrate to nest on, with improved camouflage the explanation usually put forward (Goutner, 1990; Valle & Scarton, 1999). Little Terns at Baltray appear to also show this preference. The patterns in which the Little Terns choose to nest in relation to the bordering vegetation and the substrate types on the beach should continue to be monitored in coming years.

6. Conclusion

The suitability of Baltray as a nesting site for Little Terns is obvious. The implementation of the Little Tern conservation project here has allowed the potential of this coastline to be achieved. A dramatic recovery of the colony at Baltray has been observed since wardening began in 2007. Between 1984 and 2006 even the most optimistic estimates showed that less than 80 chicks had fledged from the Baltray colony, with almost zero breeding success since the mid-1990s (L. Lenehan, unpublished data). In the eight breeding seasons since this project began 755 chicks are presumed to have fledged (McKeever and Reilly 2007; Reilly, 2008; 2009; 2010; 2011; 2012; Doyle *et al.,* 2013). There has been an increase in breeding pairs of Little Terns every year since the project was initiated (Figure 5). The only exception to this was the 2012 season when the number of breeding pairs dropped to 33, however 2012 was an exceptionally poor breeding season for Little Terns along the east coast due to inclement easterly dominated weather (Keogh *et al*., 2012; Reilly, 2012), and the fact that Baltray was the only major breeding site to fledge any chicks on the east coast in 2012 underlines the success of the project. The number of chicks successfully fledging from this site is remaining high, though this has been more variable, reflecting the vulnerability of this species to being washed out by tides (2012) and heavy predation by corvids (2007), gulls (2008), foxes (2011, 2012 and 2014) and raptors (2014) (McKeever and Reilly 2007; Reilly, 2008; 2011; 2012). Foxes are a particularly serious risk as they can wipe out an entire colony in one night, emphasising the importance of protective fencing. The success of the fencing was further supported this year by fox depredations occurring only to nests outside of the colony fencing. The importance of 24 hour wardening is shown by the peak years, 2009, 2010, 2013 and 2014 having 24 hour wardening.

The number of breeding pairs of Little Terns at Baltray increased again this year. 2013 was astounding, more than doubling the previous high of 49 in 2011 and this year the numbers increased again (Reilly, 2011). There were also record numbers of breeding Little Terns at Kilcoole this year. It is likely that this is the culmination of conservation efforts that have been taking place in Ireland, and a rejuvenated population of a threatened species. The success of this breeding season is likely built on the good breeding seasons between 2009 and 2011. High numbers of the chicks fledged in those seasons have likely returned to Baltray to breed. Though the trend has been a general increase since wardening began, poor breeding years such as 2012 and the losses seen this year reflect the continued vulnerability of this species to predators, especially ground

predators such as foxes, which can decimate a colony in a single night and to flooding brought on by onshore winds and high tides. Birds of prey, chiefly Kestrels, have become a new and significant threat in the last two years. If wardening and strong volunteer effort had not been in place in 2014 it is likely that little to no chicks would have survived to fledge.
Overall, 2014 was a very good year for all breeding colonies of Little Terns along the east coast of Ireland. Confirmed breeding took place at three sites; Baltray (111 pairs producing 91 fledglings), Kilcoole (120 pairs producing 219 fledglings) and Wexford Harbour (approximately 180 pairs). Therefore, approximately 411 pairs of Little Terns bred on the Irish east coast in 2014. This compares favourably to 2013 when 362-364 pairs bred at a total of four sites along the east coast. The 2013 breeding season was itself a large increase on 2012, when 244-245 pairs bred on the east coast, showing a dramatic upsurge in Little Tern breeding success in the last two years, recovering from the disastrous breeding season in 2012. The total number of breeding pairs of Little Terns on the west coast in 2014 is unknown, though 62 pairs of Little Terns are thought to have bred on the Inishkea Islands, which was similar to the number which bred in 2013 (67 pairs) (D. Suddaby, pers. comm.). In comparison, surveys conducted in previous years estimated the national population of Little Terns as a whole to be 257 pairs in 1984 and 174 pairs in 1995 (Whilde, 1993; corrected in Hannon *et al.*, 1997). Therefore it would seem that the national population is, at least for the time being, on the increase, with an estimated 411 pairs on the east coast and at least 62 pairs on the west coast. On the east coast at least, this is largely down to increased effectiveness of the wardening schemes at Baltray and Kilcoole/Newcastle as well as the relocation of the Wexford Harbour colony to a less accessible breeding locations on sandbanks.

7. Recommendations

7.1 Little Tern Conservation Measures

7.1.1 Kestrel Supplementary Feeding Project

The initiation of a Kestrel supplementary feeding project at Baltray would help to reduce chick losses in coming years. Such projects have been successfully set up in Norfolk and Chesil Beach in England and have helped to mitigate this predation problem using non-lethal measures. For the scheme to work successfully, pre-season effort is needed to find the nesting locations, prior to the arrival of the Little Terns at Baltray.

7.1.2 Fencing Materials

New fencing materials are required to replace those which have been lost or badly damaged by storms in previous years. Additional fencing materials would also ensure that a greater area of the North colony could be enclosed, thus reducing the risk of nests being depredated or trampled. No protection from mammalian predators was provided this year by the simple fencing that was erected and the results were the loss of multiple nests.

7.1.3 Signs

Signs asking people not to walk along the area in front of the colony and informing them that chicks are present on the foreshore once hatching begins would be helpful. Many people seemed to be under the impression that the Little Terns did not leave the fenced off area and would walk

along the string fence, endangering chicks.

7.1.4 Observation Platform

Much of the nesting area this year was not visible from the inland side of the protective fence. This made watching for new nests and carrying out incubation checks more difficult. Often nests in non-visible areas could only be found by entering the colony and searching for nests, which was not ideal. Also it was usually not possible to ascertain the exact date any nest found this way was laid if it was found with more than one egg, which meant that these nests had to be visited much more regularly to check for evidence of hatching. The provision of a number of high chairs or raised observation hides would be of great benefit as this would reduce the number of visits made to the colony and cut down on disturbance. To cover all non-visible areas 3-4 such observation platforms would be necessary.

7.1.5 Fledgling and Flock Counts

Accuracy of productivity estimates would greatly benefit from increased numbers of fledgling counts at the end of the season. It is known that once fledglings join mobile flocks of Little Terns that travel up and down the coast before leaving Ireland. This year volunteers recorded flocks that included fledglings in Bettystown beach and towards Clogherhead. Organised counts by volunteers at different areas north and south of Baltray beach at the end of the season would help to increase our knowledge of actual numbers fledged.

7.1.6 Chick Biometrics

After consultation, it is recommended that the activity of re-trapping as many chicks as possible as frequently as possible is reviewed prior to the 2015 season. If Kestrel nests can be located and given supplemental food, then Kestrel visitation rates to the colony should decline and losses to this cause diminish. A cost-benefit analysis needs to be conducted to review the importance of re-trapping chicks in our studies of chick survival and growth rates etc. against researcher presence in the colony that may give cues to birds of prey as to the presence of chicks. To continue the darvic colour ringing, we need to retrap chicks at least once about 10 days post-hatching and this can only be minimised if egg-laying in the colony is fairly synchronous.

7.1.7 Fencing Repairs

After the July Spring tides the electric fencing around both colonies was down for an extended period. The level of damage, lack of human resources and diversion caused by avian predatory attacks meant that the electric fencing took up to two weeks to restore. This may have resulted in an unobserved predation event that took out the remaining unfledged chicks. For this reason it should be highlighted that fencing repair should be made a key priority and that extra voluntary assistance should be requested to ensure repairs are completed in as short a time as possible.

7.2 Raising Public Awareness

7.2.1 Project Website

It would be beneficial for increasing awareness of the Baltray Project to add the blog informing the public of the progress of the Little Terns breeding at Baltray to the website set up in 2011 to house the Kilcoole blog (www.littleternconservation.blogsot.com). This website is the number one result found by a Google search for “Little Tern”. A Baltray page could be added to this website, allowing the public to follow the progress of the Baltray and Kilcoole sites from the same site, giving people a better idea of the progress of the Little Tern on a national level. If there is a strong will to keep the Baltray blog on the Louth Nature Trust website (http://www.louthnaturetrust.org/little-terns) it is imperative that further information is added to the site.

7.2.2 Facebook

The Louth Nature Trust Facebook page that was set up by Cathal Johnson in 2008 is becoming extremely successful in disseminating information and gaining interest from the wider public. Photographs, rather than written posts, of daily activities and the Little Terns reached the highest numbers of people. Similarly to this year, in the future the warden should be made an administrator of the page to allow for their posts to reach the highest number of people possible. It would be preferable if the project mobile phone is set up with internet access as this will allow the wardens to make posts while out on site as things occur and therefore be able to engage with more people.

7.2.3 Education

Efforts should be made to allow the wardens to continue to visit local schools and arranging school trips to visit the site. The school visit this year was met with great interest and continuing this will help to increase community involvement in the project in future years.

7.2.4 Maritime Festival

Arrangements should be made for Louth Nature Trust to have a stand at Drogheda's Maritime Festival. It is an extremely relevant event for Louth Nature Trust to take part in and an ideal platform to use for increasing awareness and much needed support for Baltray's Little Tern Conservation Project. Dominic Hartigan and Áine Walsh have agreed to take responsibility for the initial arrangements, Patricia Fuentes and Carol Bennett have offered to man any stall organised and Andrew Kelly has kindly agreed to investigate acquiring a large pull-up poster to advertise Louth Nature Trust and the Baltray Little Tern Conservation Project at the event.

7.3. Staff and Volunteers

The Baltray Little Tern Conservation Project has expanded and as it does new challenges are experienced. In 2014, to complete the daily work tasks and carry out successful mitigation of predators, it was necessary to have two wardens and two volunteers on duty at all times. Due to a lack of staff and volunteers this was often not possible and the project suffered at times as a result.

7.3.1 Wardens

The site of the Baltray Little Tern Conservation Project is more than double the size of the site at Kilcoole (775m versus 400m in length, but with a far greater width and tidal beach area). Due to the success of conservation efforts at Baltray the breeding population in the area is now equalling or on some years surpassing that at Kilcoole. For these reasons the duties that the Baltray wardens undertake are far more time consuming and physically demanding. For the project to reach its full potential it is important that a minimum of two paid day wardens as well as a full time intern or key volunteer are employed full-time in future years. Ideally, the services of a third night warden would also be needed to aid with sharing the workload and provide some relief throughout the season.

7.3.2 Relief Warden

The creation of a paid relief warden position would greatly aid the running of the project in future. This year, when one of the wardens needed a day off, the other warden needed to work a double shift to cover them. The relief warden could be hired on a part-time basis to cover one or two days a week. Alternatively, a full-time relief warden position could be created to cover all of the wardened tern sites, so that the relief warden would cover days in Baltray, Kilcoole and possibly Rockabill. This would be more challenging logistically, but full-time hours may make the position more attractive and the cost would be split between projects.

7.3.3 Volunteers

A core group of volunteers is a key factor in the success of this conservation project. The amount of time that the current volunteers dedicate to the project is commendable. Without the addition of new volunteers, however, the reliance on a select few can have detrimental effects in the long term. Efforts should be continued to attract new volunteers to the project. Current volunteers have been asked to invite friends and associates to join the voluntary group in the coming year. A pre-season article should be placed in locals newspapers, and aired on local radio (LMFM) in Spring 2015 calling for new volunteers.

The provision of some level of training for new as well as current volunteers would help to standardise the duties and responsibilities of volunteers. In this way people would have a clear understanding of what they were coming to take part in and, if necessary at times, it would be easier for volunteers to work without a warden present.

At least one, but preferably two meetings annually should be organised for volunteers, wardens and directors to discuss the successes and challenges of the previous season and to plan for the forthcoming one. Organising such meetings also creates a feeling of ownership of the project among volunteers and allows for directors to hear insights from people who have been working on site.

7.4 Site Maintenance and Equipment

7.4.1 Water Pipe

If a water pipe could be extended from the field adjacent to the site this would remove the need for wardens to ferry water from Dominic Hartigan’s yard, reducing wear on the track down to the site, which is needed for removing project equipment.

7.4.2 Manual & Emergency Phone Numbers

A manual outlining the set-up and running of the conservation project and details of living arrangements should be provided for wardens in the future. A series of special emergency contact numbers and protocols for dealing with incidents should be established for future projects.

7.4.3 First Aid Kit and Fire Extinguisher

A fire extinguisher is needed for the project caravan and it should be ensured that a first aid kit is present on site again next year in case of emergencies.

7.4.4 Weather Station

A simple weather station with a thermometer and an anemometer would be of great assistance to improving accurate weather recordings.

7.4.5 Two-way Radios

A set of two-way radios were loaned by a volunteer to the project this year and proved incredibly useful for making quick communication possible and especially aiding chick trapping. The addition of two-way radios to the project equipment would be a worthwhile investment.

7.4.6 Night Warden Equipment

The night wardens would benefit greatly from a portable high chair that they could use when on the lookout at the northern end of the colony.
The use of movement sensitive lights that could be attached to posts at the northern end of the colony would assist greatly in disturbing potentially predatory foxes or other mammals in the area.

7.4.7 Living Quarters

The wardens living area should be relocated further north so that it is closer to the path across the dunes to the port-a-loo area. This new position would also be preferential for the addition of a water pipe. If passers-by become a problem at the new location, which is closer to widely used walking paths, fencing around the living area should be considered.

7.4.8 Caravans and Fridges

The addition of a third caravan to house the extra staff member would be an important addition for 2015. The gas powered fridge in the larger caravan should be repaired so it can be used in coming years.

7.4.9 Container/Prefab

A medium sized container, on site for the duration of the project, would be extremely helpful for the day to day living on site. Ideally, the container would provide storage space for equipment and if it were insulated, it may provide a reasonably comfortable common space for the wardens. It would help in the drying of damp clothes and also prevent further dilapidation of the caravans.

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Appendices

Appendix 1: Site Biodiversity

Species observed at the Baltray site from May 13th to August 9th 2013. 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.

AVES (65 species)

1. **Little Tern** (*Sternula albifrons*)
2. **Common Tern** (*Sterna hirundo*)
3. **Roseate Tern** (*Sterna dougallii*)
4. **Sandwich Tern** (*Thalass sandvichenis*)
5. **Arctic Tern** (*Sterna paradisaea*)
6. **Ringed Plover** (*Charadrius hiaticula*)
7. **Oystercatcher** (*Haematopus ostralegus*)
8. **Black-tailed Godwit** *(Limosa limosa)*
9. **Bar-tailed Godwit** (*Limosa lapponica*)
10. **Turnstone** (*Arenaria interpres*)
11. **Sanderling** (*Calidris alba*)
12. **Dunlin** (*Calidris alpina*)
13. **Redshank (***Tringa totanus*)
14. **Knot** (*Calidris canutus*)
15. **Curlew** (*Numenius arquata*)
16. **Whimbrel** (*Numenius phaeopus*)
17. **Lesser Black-backed Gull** (*Larus fuscus*)
18. **Great Black-backed Gull** (*Larus marinus*)
19. **Herring Gull** (*Larus argentatus*)
20. **Black-headed Gull** (*Chroicocephalus ridibundus*)
21. **Common Gull** (*Larus canus*)
22. **Little Gull** (*Hydrocoloeus minutus*)
23. **Guillemot** (*Uria aalge*)
24. **Black Guillemot** (*Cepphus grylle*)
25. **Razorbill** (*Alca torda*)
26. **Manx Shearwater** (*Puffinus puffinus*)
27. **Northern Fulmar** (*Fulmarus glacialis*)
28. **Cormorant** (*Phalacrocorax carbo*)
29. **Gannet** (*Morus bassanus*)
30. **Mute Swan** (*Cygnus olor*)
31. **Common Scooter** (*Melanitta nigra*)
32. **Eider** (*Somateria mollissima*)
33. **Shelduck** (*Tadorna tadorna*)
34. **Mallard** (*Anas platyrhynchos*)
35. **Grey Heron** (*Ardea cinerea*)
36. **Little Egret** (*Egretta garzetta*)
37. **European Starling** (*Sturnus vulgaris*)
38. **Meadow Pipit** (*Anthus pratensis*)
39. **Skylark** (*Alauda arvensis*)
40. **Blackbird** (*Turdus merula*)
41. **Song Thrush** (*Turdus philomelos*)
42. **Yellowhammer** (*Emberiza citrinella*)
43. **Reed Bunting** (*Emberiza schoeniclus*)
44. **Sedge Warbler** (*Acrocephalus schoenobaenus*)
45. **Willow Warbler** (*Phylloscopus trochilus*)
46. **Stonechat** (*Saxicola torquata*)
47. **Pied Wagtail** (*Motacilla alba yarrellii*)
48. **Linnet** (*Carduelis cannabina*)
49. **Wheatear** (*Oenanthe oenanthe*)
50. **Barn Swallow** (*Hirundo rustica*)
51. **Sand Martin** (*Riparia riparia*)
52. **House Martin** (*Delichon urbicum*)
53. **Magpie** (*Pica pica*)
54. **Hooded Crow** (*Corvus cornix*)
55. **Rook** (*Corvus frugilegus*)
56. **Raven** (*Corvus corax*)
57. **Jackdaw** (*Corvus monedula*)
58. **Swift** (*Apus apus*)
59. **Feral pigeon** (*Columba livia*)
60. **Wood pigeon** (*Columba palumbus*)
61. **Collared Dove** (*Streptopelia decaocto*)
62. **Short-eared Owl** (*Asio flammeus*)
63. **Sparrowhawk** (*Accipiter nisus*)
64. **Kestrel** (*Falco tinnunculus*)
65. **Peregrine Falcon** (*Falco peregrinus*)

MAMMALIA (7 species)
Irish Mountain Hare (*Lepus timidus hibernicus*)
Otter (*Lutra lutra*)
Red Fox (*Vulpes vulpes*)
Brown Rat (*Rattus norvegicus*)
Rabbit (*Oryctolagus cuniculus*)
Grey Seal (*Halichoerus grypus*)
Harbour Porpoise (*Phocoena phocoena*)

ACTINOPTERYGII (1 species)
Sprat (*Sprattus sprattus*)

REPTILIA (1 species)
Viviparous Lizard (*Lacerta vivipara*)

INSECTA (18 species)
LEPIDOPTERA: BUTTERFLIES AND MOTHS
Common Blue (*Polyommatus icarus*)
Orange-tip (*Anthocharis cardamines*)
Small White (*Pieris rapae*)
Large White (*Pieris brassicae*)
Green-veined White (*Pieris napi*)
Meadow Brown (*Maniola jurtina*)
Small Tortoiseshell (*Nymphalis urticae*)
Red Admiral (*Vanessa atalanta*)
Small Heath (*Coenonympha pamphilus*)
Five-spot Burnet (*Zygaena trifolii*)
Cinnebar (*Tyria jacobaeae*)

HYMENOPTERA: BEES, ANTS AND WASPS
Red-tailed Bumble Bee (*Bombus lapidarius*)
White-tailed Bumble Bee (*Bombus leucorum*)
Black Garden Ant (*Lasius niger*)
Red Ant (*Myrmica rubra*)

COLEOPTERA: BEETLES
7-spot Ladybird (*Coccinella 7-punctata*)
14-spot Ladybird (*Propylea 14-punctata*)
Ground Beetle (*Pterostichus madidus*)

OTHER INVERTEBRATA (23 species)
White-lipped Snail (*Cepaea hortensis*)
White Garden Snail (*Theba pisana*)
Edible Crab (*Cancer pagurus*)
Shore Crab (*Carcinus maenas*)
Masked Crab (*Corystes cassivelaunus*)
Compass jellyfish (*Chrysaora isosceles*)
Moon Jellyfish (*Aurelia aurita*)
Barrel Jellyfish (*Rhizostoma octopus*)
Common Brittle-star (*Ophiothrix fragilis*)
Common Starfish (*Asterias rubens*)
Sea Potato (*Echinocardium cordatum*)
Common Mussel (*Mytilus edulis*)
Common Oyster (*Ostrea edulis*)
Portugese Oyster (*Crassostrea angulata*)
Common Razorshell (*Ensis ensis*)
Bean Razorshell (*Pharus legumen*)
Pod Razorshell (*Ensis siliqua*)
Common Cockle (*Cerastoderma edule*)
Prickly Cockle (*Acanthocardia echinata*)
Common Whelk (*Buccinium undatum*)
Red Whelk (*Neptunea antiqua*)
Dog Whelk (*Nucella lapillus*)
Netted Dog Whelk (*Hinia reticulata*)
Necklace Shell (*Euspira catena*)
Thin Tellin (*Angulus tenuis*)
Baltic Tellin (*Macoma balthica*)
Green Ormer (*Haliotis tuberculata*)
Slipper Limpet (*Crepidula fornicata*)
Common Limpet (*Patella vulgata*)
Common Periwinkle (*Littorina littorea*)
Flat Periwinkle (*Littorina obtusata*)
Laver Spire Shell (*Hydrobia ulvae*)
Pelican's Foot (*Aporrhais pespelecani*)
Auger Shell (*Turnitella communis*)
Great Scallop (*Pecten maximus*)
Queen Scallop (*Aequipecten opercularis*)
Icelandic Cyprine (*Artica islandica*)
Striped Venus (*Chamelea gallina*)
Warty Venus (*Venus verrucosa*)
Rayed Trough Shell (*Mactra stulorum*)
Common Otter Shell (*Lutraria lutraria*)
Faroe Sunset Shell (*Gari fervensis*)
Acteon tornatilis

PLANTAE (59 species)

Sea Holly (*Eryngium maritimum*)
Rosebay Willowherb (*Epilobium angustifolium*)
Sea Sandwort (*Honkenya peploides*)
Biting Stonecrop (*Sedum acre*)
Wild Radish (*Raphanus raphanistrum maritimus*)
Spring Vetch (*Vicia sativa*)
Kidney Vetch (*Anthyllis vulneraria*)
Restharrow (Ononis *repens*)
Eyebright (*Euphrasia officinalis*)
Knotted Pearlwort (*Sagina nodosa*)
Hawksbit sp. (*Leodontum sp.*)
Wild Carrot (*Daucus carota*)
Thrift (*Armeria maritima*)
Heart-ease Pansy (V*iola tricolor*)
Pyramidal Orchid (*Anacamptis pyramidalis*)
Common Spotted Orchid (*Dactylorhiza fuchsii*)
Lady's Bedstraw (*Galium verum*)
Common Orache (*Atriplex patula*)
Yellow Rattle (*Rhinanthus minor*)
Sea Bindweed (*Calystegia soldanella*)
Sea Mayweed (*Tripleurospermum maritimum*)
Brambles (*Rubus sp.*)
Field Scabious (*Knautia arvensis*)
Ox-eye Daisy (*Leucanthemum vulgare*)
Viper's-bugloss (*Echium vulgare*)
White Campion (*Silene latifolia*)
Sea Campion (*Silene maritime*)
Birdsfoot Treefoil (*Lotus corniculatus*)
Hare's-foot Clover (*Trifolium arvense*)
Sea Rocket (*Cakile maritima*)
Sea Spurge (*Euphorbia paralias*)
Ragwort (*Senecio jacobaea*)
Marram Grass (*Ammophila arenaria*)
Sand Cat's-tail (*Phleum arenarium*)
Sea Lyme Grass (*Elymus arenarius*)
Couch (*Elytrigia repens*)
Thongweed (*Himanthalia elongata*)
Eelgrass (*Zostera marina*)
Serrated Wrack (*Fucus serratus*)

Yorkshire Fog (*Holcus lanatus*)
Sea Plantain (*Plantago maritima*)
Ribwort Plantain (*Plantago lanceolata*)
Sea Beet (*Beta vulgaris ssp. maritima*)
White Clover (*Trifolium repens*)
Red Clover (*Trifolium pratense*)
Silverweed (*Argentina anserina*)
Goldilocks Buttercup (*Ranunculus auricomus*)
Red Fescue (*Festuca rubra*)
Fennel (*Foeniculum vulgare*)
Cock's Foot (*Dactylis glomerata*)
Water Dropwort sp. (*Oenanthe* sp.)
Sea Purslane (*Halimione portulacoides*)
Japanese Rose (*Rosa rugosa*)
Common Knapweed (*Centaurea nigra*)
Perforate St John's Wort (*Hypericum perforatum*)
Viper's Bugloss (*Echium vulgare*)
Creeping Thistle (*Cirsium arvense*)
Water Dock (*Rumex hydrolapathum*)
Wild Thyme (*Thymus serpyllum*)

FUNGI (1 species)

Field Mushroom (*Agaricus campestris*)

Appendix 3: Project publicity

Appendix 3.1 Drogheda Leader newspaper article

'Terning' out well

Over 110 chicks thriving at Little Terns site in Baltray and more on the way

Myriam el Harouchy, Sander Bik and Sian Egerton at the Little Terns nesting site in Baltray. Picture: www.newsfile.ie

By Ian Watters

THE conservation work is continuing at the Little Terns nesting site at Baltray, with over 110 chicks hatched and doing well. There are still over 80 nests, which could mean the record figures from last year could be matched or surpassed.

The Louth Nature Trust, in collaboration with Birdwatch Ireland is looking after the project and there are wardens living on site in caravans to keep an eye on the chicks in their struggle to survive. Last year saw record numbers of chicks fledge, with nearly 200 surviving.

The voluntary conservation project in Baltray began seven years ago and it has grown from 20 chicks in the first year to the amazing figure last year. The *Drogheda Leader* spoke to Sian Egerton who is Cork native. She studied Zoology and has a Masters in Conservation. She is staying on site with the other wardens until the season is over and is there to offer advice and help to the volunteers also.

"We are actually still finding nests and it is very interesting. We have day and night wardens and are being kept busy. Unfortunately at the start of the nesting period we had some predation. A fox took about 30 nests that were outside the area we cover. We have also had some chicks taken by corbets and only one recently by a kestrel," she explained. There have been fences put up and they are working to deter would be predators.

Local Cllr Frank Godfrey visited the volunteers at the site and praised the good work they are doing.

"The work they are doing is amazing. They volunteers and the workers there are so caring and are committed to the important work they are doing. I commend them in the work they are doing," he said.

People who would like to volunteer and help can contact 086-2434874 or go to www.louthnaturetrust.ie for more information

Appendix 3.2 Drogheda Independent newspaper article

Port Company helps fund little tern project

Published 30/07/2014 05:28

THE LOUTH Nature Trust has rounded off a very successful nesting season for the Baltray little tern project with a financial donation from Drogheda Port Company.

The presentation of €1,000 was made at an information event in Co Louth Golf Club and the money will be used to cover ongoing cost of the project.

'We are delighted to have the port authorities on board, as it will help keep the project as successful has it has been for the past eight years,' says volunteer Dominic Hartigan.

'We had a record number of little terns hatch last year of 190, and although we are slightly down this year with 150, it is still a fantastic result.'

The evening was attended by Louth Nature Trust, National Parks & Wildlife, Drogheda Port Company, Louth County Council, Volunteers and a number of experts in the ornithological field.

Brendan McSherry of Louth Heritage Council spoke about the wealth and importance of biodiversity in the area and how the local community can help to enhance this further in one way through the Tidy Towns scheme.

Project warden Sian gave a talk about the Little Tern project and updated everyone on progress so far.

A special acknowledgement and thanks were made to Margaret Reilly and Sandra McKeever, the two sisters who originally implemented the wardening system at the location.

'The project in Baltray has up to a third of the Irish population of Little Terns, and they have a lifespan of up to 20 years,' he adds.

'We have over 35 active volunteers with us, and we will always welcome more, so to volunteer to warden at Baltray beach please call 086 2434874.'
Drogheda Independent