Assessment of long-term options for colony maintenance and establishment throughout the roseate tern range in NW Europe

LIFE14 NAT/UK/000394 ROSEATE TERN

Final internal report

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2 Summary

This report pulls together information from a number of sources to scope out future management options for roseate tern. The report has been prepared as part of the Roseate Tern LIFE Recovery Project (LIFE14 NAT/UK/000394), action A2 - *Assessment of long-term options for colony maintenance and establishment throughout the roseate tern range in NW Europe*.

For the purpose of this study, the NW European population is defined as that currently restricted to France, the Republic of Ireland (RoI) and the UK and excludes the Azores population.

The assessment involved:

1. An assessment of the potential range – drawing on the historic range, current range and predicted changes in the light of climate change.
2. Results of the tern diet review (action A3), and the identification of prey availability hotspots.
3. Results of the demography study (action A4) in relation to source colony management and efforts to increase the range.
4. An audit of all roseate and common tern colonies within the range defined by the above exercise. Thriving common tern colonies are the most likely receptor sites for roseate terns. We have compiled a database with information on locations, population and trends, ownership, threats and management.
5. For those sites which include offshore islands, we have identified issues relating to invasive non-native mammals and highlighted next steps in terms of further assessment, biosecurity, control or eradication.
6. For those sites which are low lying soft coast islands and features we have identified risks and opportunities arising from sea level rise, predicted habitat loss/change and coastal developments and opportunities for new habitat creation projects including managed realignments, regulated tidal exchange and beneficial use of dredged material.

The report concludes that:

1. There are many uncertainties involved in predicting the future range of roseate tern, particularly given its limited current distribution and limited dispersal. Although modelling suggests a slight northward shift in range, we suggest that this might be limited by food availability, particularly relating to sandeels. Therefore, we suggest that conservation of roseate tern should remain broadly focused within the current range.
2. The diet review (Action A3) identifies prey hotspots and we suggest that areas with an abundance of more than one prey species, and those supporting sprats are likely to be most important in the future.
3. Another important factor in determining potential future distribution of roseate tern is the presence of thriving common tern colonies. While common terns can breed inland, the diet of these birds are different than those nesting along the coast and islands. Coastal common tern colonies rely on similar diet as roseate terns and therefore can serve as a proxy of good feeding resources. Additionally, roseate terns in Western Europe usually share colonies with more aggressive common terns.
4. The demography study (Action A4) suggests the potential for colony re-establishment given the increasing numbers at Rockabill. The future roseate tern sites will need to be assessed carefully, as they might act as a sink for the metapopulation. Decisions will need to be made as to whether invest into management of these sites. They might slow the overall population

growth, but on the other hand act as a back-up sites for the source colonies in case of potential catastrophic events caused by the weather, predation or depletion of food resources. On a broad scale, common tern colonies within the prey hotspot areas have been prioritised for conservation action to benefit terns in general and roseate tern specifically.

5. The two Irish and the single UK colony of roseate terns are under conservation management and support thriving productive colonies of other tern species. The management of all three will be improved by the C1-C2 actions in the LIFE project. There is though less security over the management of the roseate tern colonies in Brittany, with the need to intensify efforts for securing nesting conditions, disturbance control and monitoring. We will begin to address these issues through networking activities (E3), but much more work will be required here post LIFE project.
6. Potential for establishing new colonies will be enhanced through current LIFE actions. The priority is the restoration of Blue Circle Island within Larne Lough SPA in Northern Ireland, but also restoration of Tern Island on Cemlyn Bay and alternative habitat creation within Solent and Southampton SPA (C3).
7. A series of recommendations are made for further work to be initiated during the LIFE project but developed post LIFE to deliver the to inform the long-term conservation strategy, which includes further assessment of Brittany sites, and exploration of threats and opportunities for range expansion around the Irish Sea. We also propose developing partnership working amongst tern colony managers in the six areas of greatest current and potential importance for roseate tern – the East coast of Island of Ireland, Anglesey to Cumbria, Northumberland to Firth of Forth, Norfolk to the Thames, South Coast of England (Kent to Dorset) and Brittany. More detailed exploration and developments of new opportunities will be taken forward through these groups working with all the appropriate local stakeholders.

3 Introduction

The roseate tern population in the NE Atlantic has always been small and localised. The species nearly became extinct in the 19th Century, because their plumage was prized during the hat-making craze. Legal protection saved them. However, since the 1960s they have experienced one of the most dramatic population's crashes of any of our nesting seabirds both in terms of the population size and range. The population is currently confined to two principle colonies in the Republic of Ireland (Rol), one in the UK and one in Brittany (France), with a handful of ephemeral sites across the range. Since the 1980s, their prospects improved again due to the long-term efforts of conservationists, the four remaining colonies in Western Europe are now recovering and support just over 2000 pairs (2018). However, there are still many challenges roseate terns encounter. These are:

- Eroding nesting habitat due to the sea level increase and extreme weather events
- Food shortages due to climate-induced changes in marine environment
- Human disturbance at nesting colonies, including egg collectors
- Predation from a range of mammalian and avian species, such as foxes, otters, rats, large gulls, crows and peregrine falcons.
- Multiple threats during migration and at wintering grounds, including deterioration of their roosting sites and illegal trapping.

While the core roseate tern colonies are growing, there is a need to plan for the long-term future of the species and its potential to expand their range. The LIFE project aims to further improve breeding conditions at three core colonies in Ireland and the UK, while preparing the former breeding sites for the eventual expansion.

The aims of this study are to:

1. Assess the potential future range considering:
    a. historic and current distribution and trends,
    b. location of roseate tern SPAs
    c. climate change models,
    d. distribution of prey species,
    e. distribution common tern colonies,
2. Identify target areas and outline overarching actions for these areas.
3. Identify opportunities for soft coast habitat creation opportunities and island restoration within target areas.

4 Assessment of potential range of roseate tern

4.1 Long-term population trends in north-western Europe

From the late 1960s., the European population of roseate tern experienced a drastic decline (Cabot & Nisbet, 2013), most likely due to adverse conditions on wintering grounds as the declines were simultaneous across all colonies (Cabot, 1996). The NW European population has declined from nearly 4000 pairs in late 1960s. down to 500+ throughout 1980s (Figure 1) (Cadiou, 2010).

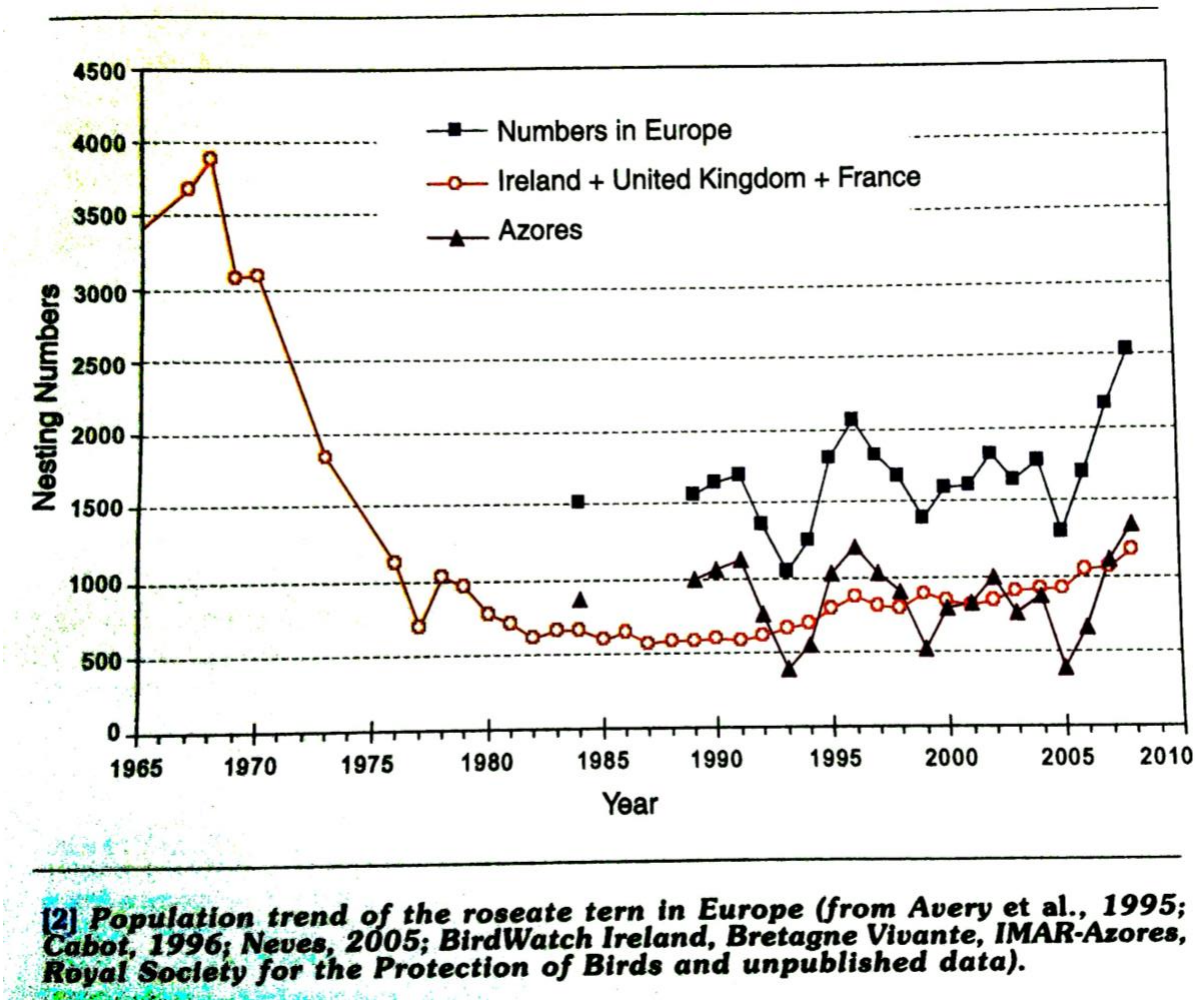

Figure 1 Population trend of the roseate tern in Europe (Cadiou, 2010)

Due to the intensive management, the Irish and the UK populations have been increasing since the 1990s – the trend, which has intensified since the early 2000s on all three colonies due to the introduction of nest boxes (Figure 2), with the most positive relative growth rate recorded on Lady's Island Lake (Figure 3). It is expected that the population will eventually expand to other places since there is a limited capacity for nesting space, especially at Rockabill, where the declining productivity might indicate some density related effects already at play (Figure 4).

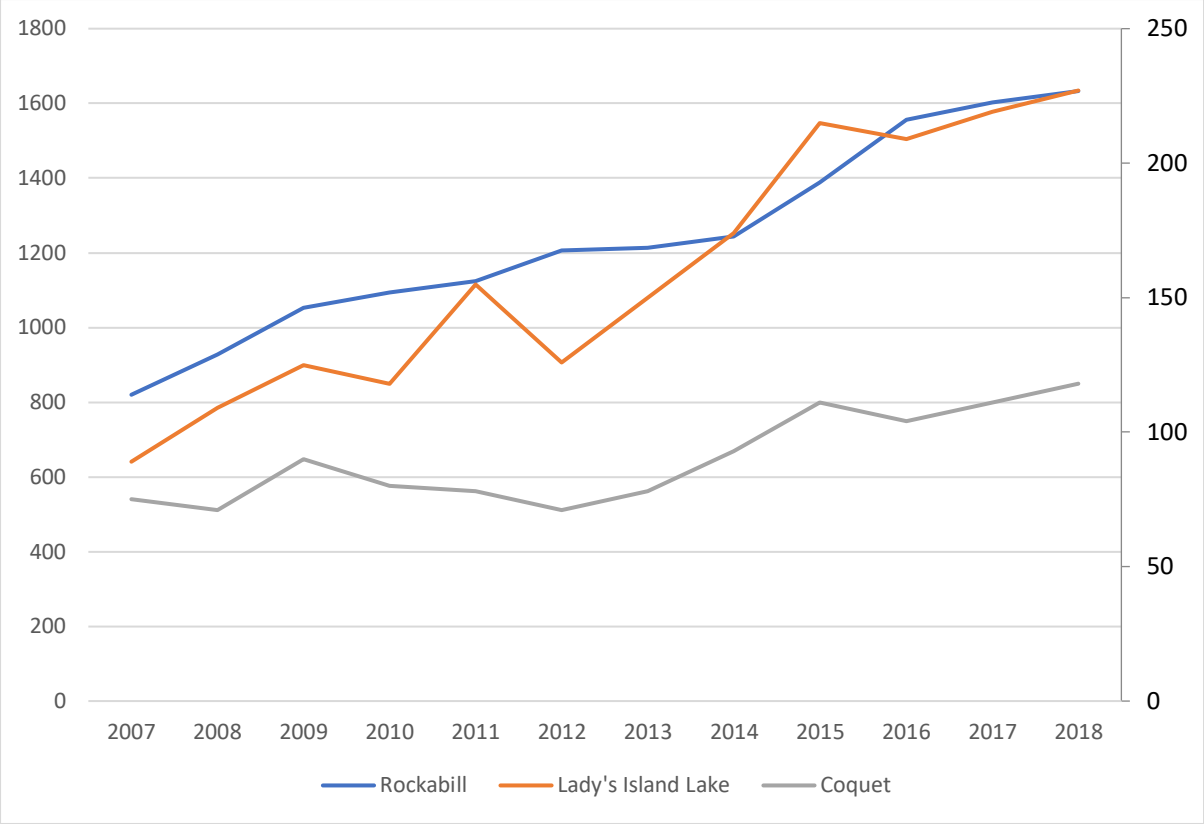

Figure 2 Population trend on Rockabill and Lady's Island Lake and Coquet Island in 2007-2017. LIL and COQ on the secondary axis

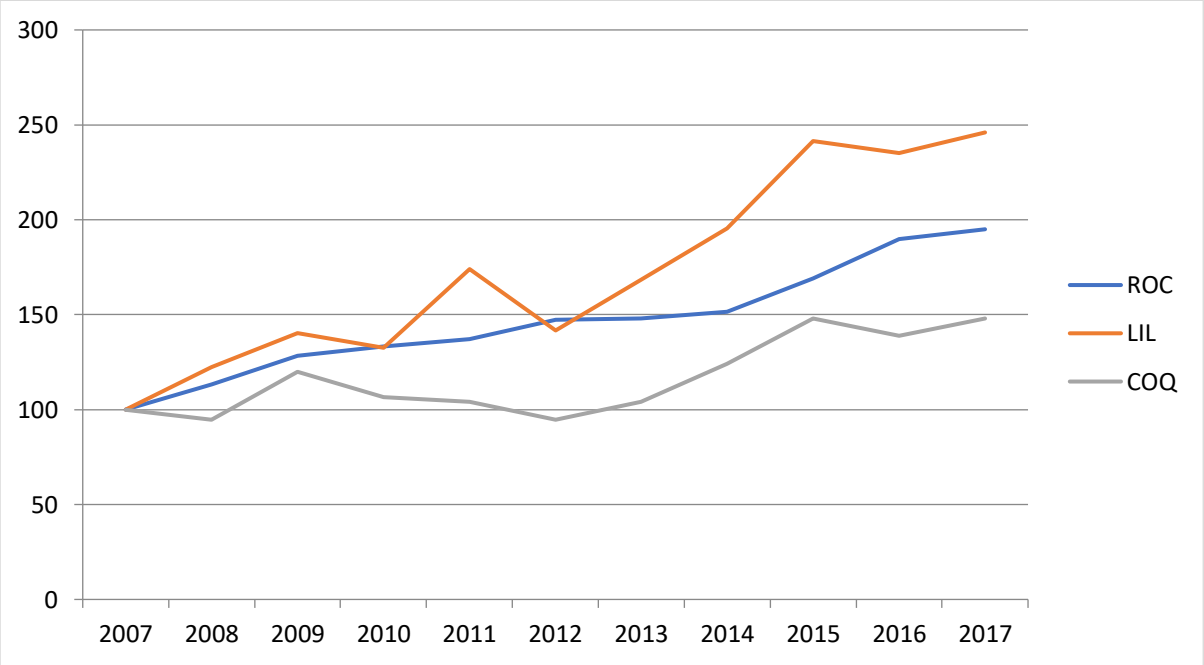

Figure 3 Relative population growth on Rockabill (ROC), Lady's Island Lake (LIL) and Coquet COQ in 2007-2017.

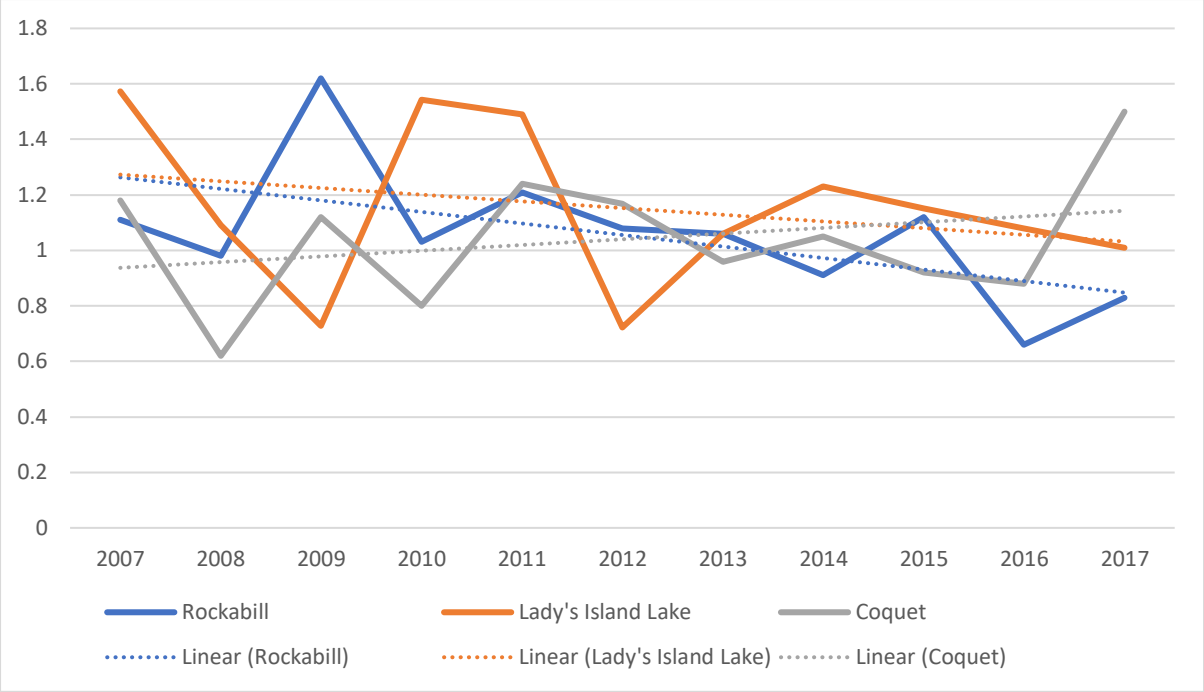

Figure 4 Productivity Trend for Rockabill, Lady's Island Lake and Coquet in 2007-2017.

4.2 Current and historical range of Roseate terns in Europe

The roseate tern has historically bred in the UK, RoI and France. There are no breeding records elsewhere in Europe, apart from historic and sporadic attempts of breeding in the Netherlands, Belgium and Germany (mostly hybridisation with common tern). The species is a rare vagrant in Belgium, Netherlands, Germany, Denmark, Sweden, Norway, Poland, Austria, Switzerland Balearic Islands, Italy, Malta Israel, Tunisia and Canary Islands. The species breeds infrequently on Madeira (BWP).

The distinct Azorean population has fluctuated between 400 and 1200 pairs since 1989 when the monitoring began (538 pairs in 2016 and 891 in 2017) (Government of the Azores, 2017).

There has been a marked decline in the range of the roseate tern breeding population as clearly illustrated when comparing the maps and sites from Figure 1, 5 and 6. Historically, roseate terns were breeding on the west and north coast of Scotland and also the west coast of Ireland. In years 1968-72 and 1988-91, Britain lost 17.4% of its breeding sites, while Ireland lost 50% (Gibbons, D. 1993) (Figure 5).

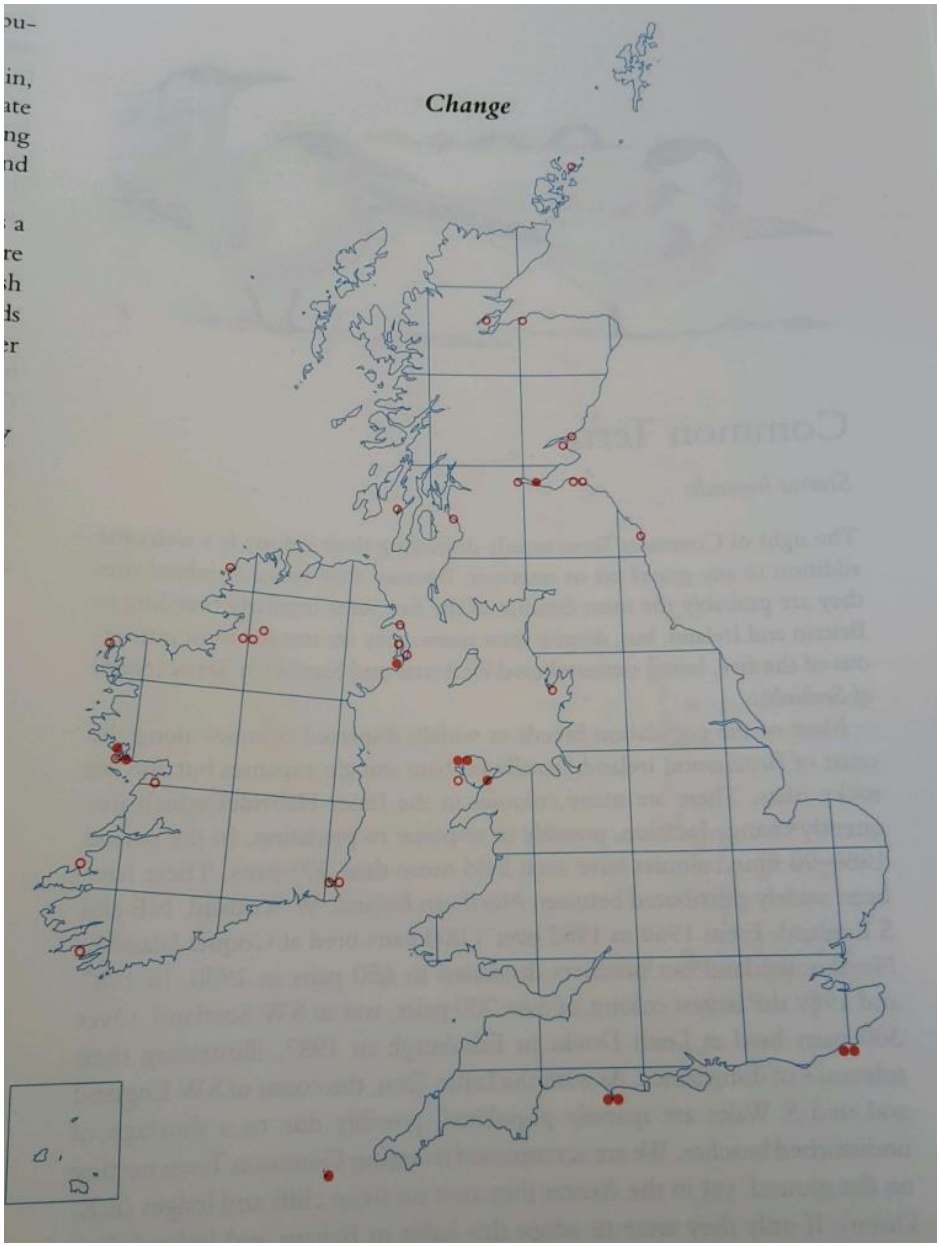

Figure 5: Historical changes in Roseate Tern breeding range in the UK between 1968-72 and 1988-91 (Gibbons, D. 1993)

Figure 6 from Breeding Birds Atlas (BTO, 2013) clearly shows that the roseate tern population had become even more restricted and that by 2011; there were no roseate tern colonies recorded on the west coast of Ireland and Scotland. In addition, the northern sites in Scotland and the south eastern sites in England have been lost.

Figure 7 provides the breeding numbers of roseate terns (AON) in their respective counties across Britain and Ireland 1969-72 from operation Seafarer (Mitchell et al, 2004). This information gives an indication on what the roseate tern distribution used to be with 691 pairs breeding in Great Britain and 1,693 pairs across all of Ireland. Scotland supported 134 breeding pairs, the Isle of Scilly had 20 pairs and Wales had 202. In Northern Ireland, county Down apparently supported 251 pairs which would include Strangford Lough, Larne Lough, Portavogie, Carlingford Lough. On the west coast of Ireland, county Donegal (presumably at the site of Illancrone), there were 6 pairs, county Kerry (possibly at

Magharee Islands) there was one pair and in county Cork (historical site currently unknown) there were 20 pairs.

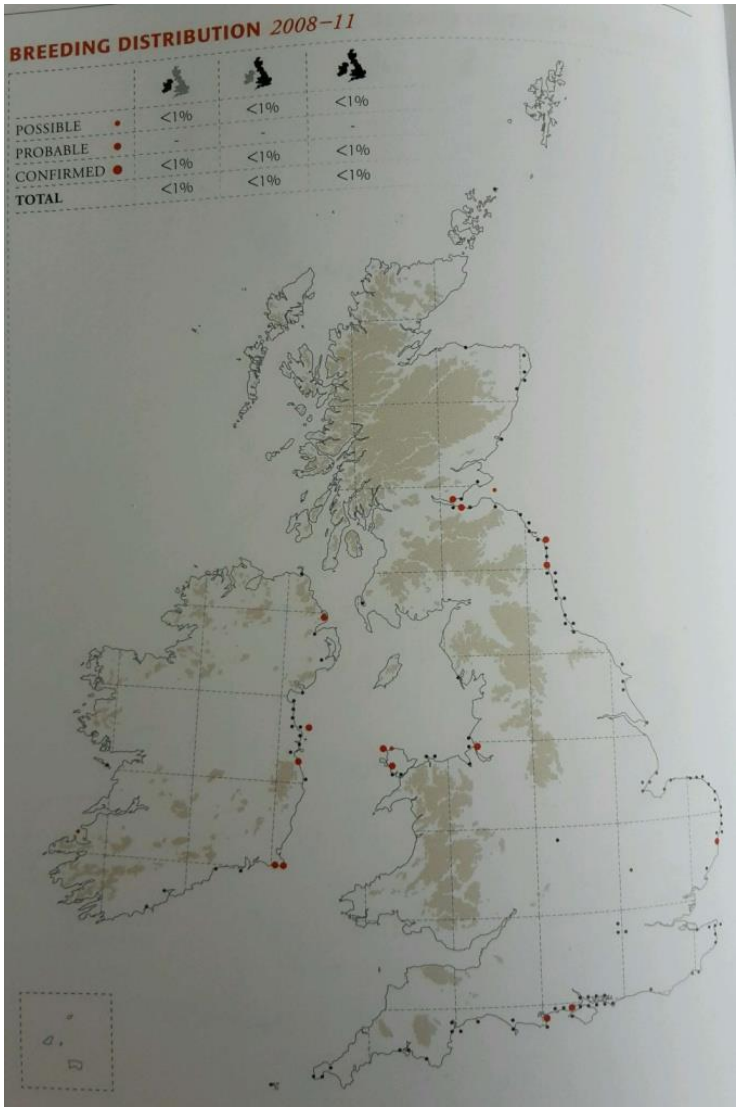

Figure 6: Breeding Distribution of Roseate Terns 2008-2011 (BTO, 2013)

Administrative area or country	*Operation Seafarer (1969–70)*
Orkney	3
Angus	1
Northeast Fife	
Dunfermline	5
City of Edinburgh	
East Lothian	107
Argyll & Bute	3
Kyle & Carrick	15
Scotland Total	134
Northumberland	332
Norfolk	
Hampshire	2
Isles of Scilly	20
Cumbria	1
England Total	355
Gwynedd	202
Wales Total	202
Great Britain, Isle of Man & Channel Islands Total	691
Co. Antrim	13
Co. Down	251
Co. Dublin	60
Co. Wexford	1,352
Co. Cork	10
Co. Kerry	1
Co. Donegal	6
All-Ireland Total	1,693
Britain and Ireland Total	2,384

Figure 7. Operation Seafarer (1969-72) data of the recorded breeding roseate terns across Britain and Ireland - Excerpt from the JNCC (Mitchell et al, 2004)

Currently there are only three regular sites which have supported a stable or increasing population over the past 15 years: Coquet Island (England), Rockabill and Lady's Island Lake (Republic of Ireland). There are several areas where roseate terns have bred intermittently over the past two decades.

In France, breeding roseate tern population has historically only been located in the province of Brittany (Bretagne) (Figure 5). The population followed a similar declining trend to the rest of Europe, however it continued to decline whereas in Britain and Ireland breeding populations stabilised/increased. France had an average of 360 breeding pairs in 1954-1973 (Yeatman-Berthelot, 1994), however after 1980, there have been between 90-100 breeding pairs. In 2005, there were only 70 pairs breeding in France, the majority located on Ile aux Dames in the bay of Morlaix, which has been their main nesting site since 1986.

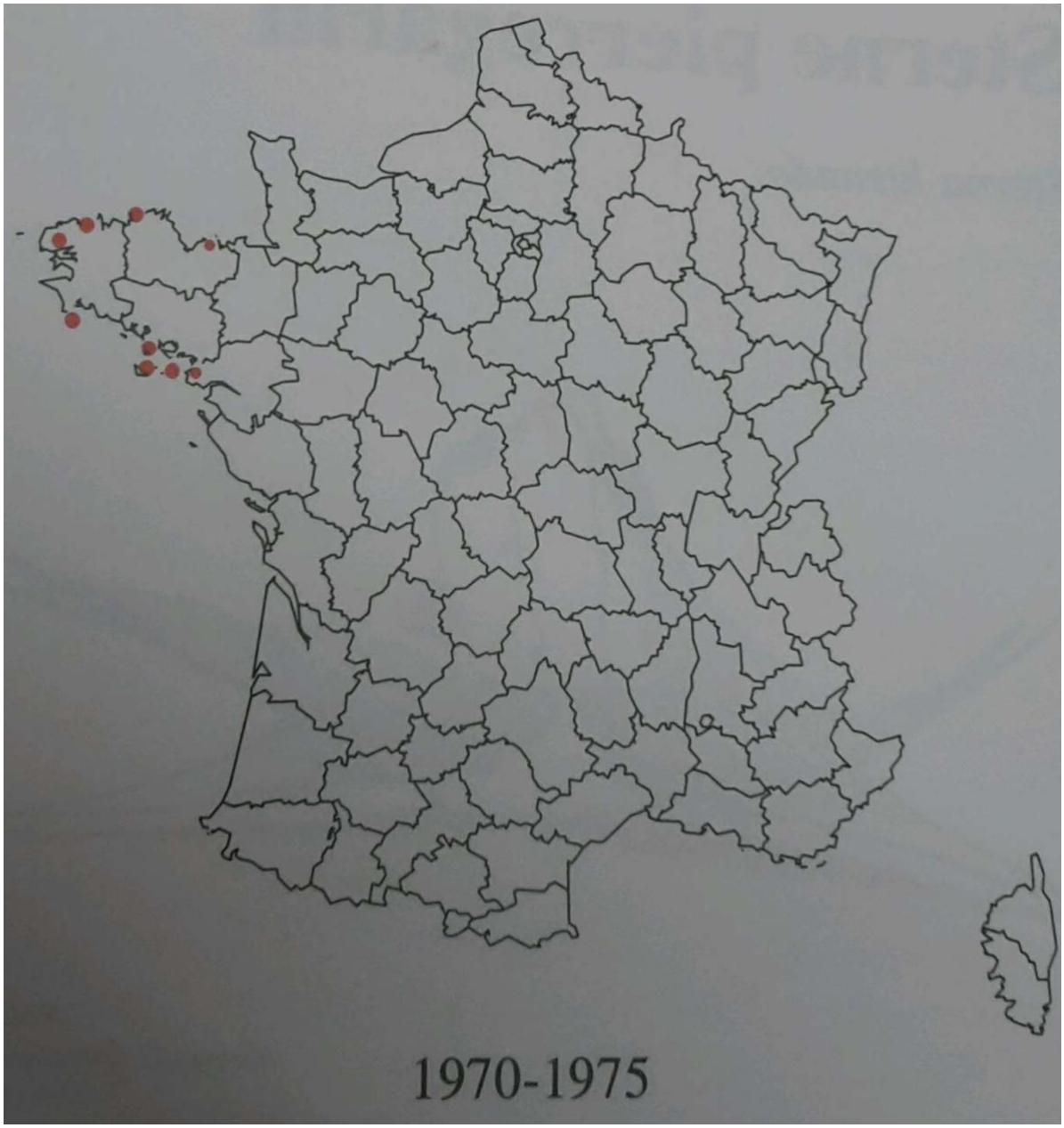

Figure 8 Breeding population of roseate terns in France between 1970-1975 (Yeatman-Berthelot, 1994)

In years 2005-2010, France implemented a LIFE project focused roseate terns in Brittany with five project sites: La Colombière, L'Ile aux Dames, Trevorc'h, L'Ile aux Moutons and le Petit Veizit (Figure 6). The location of the project sites is in areas where historically the roseate terns used to nest.

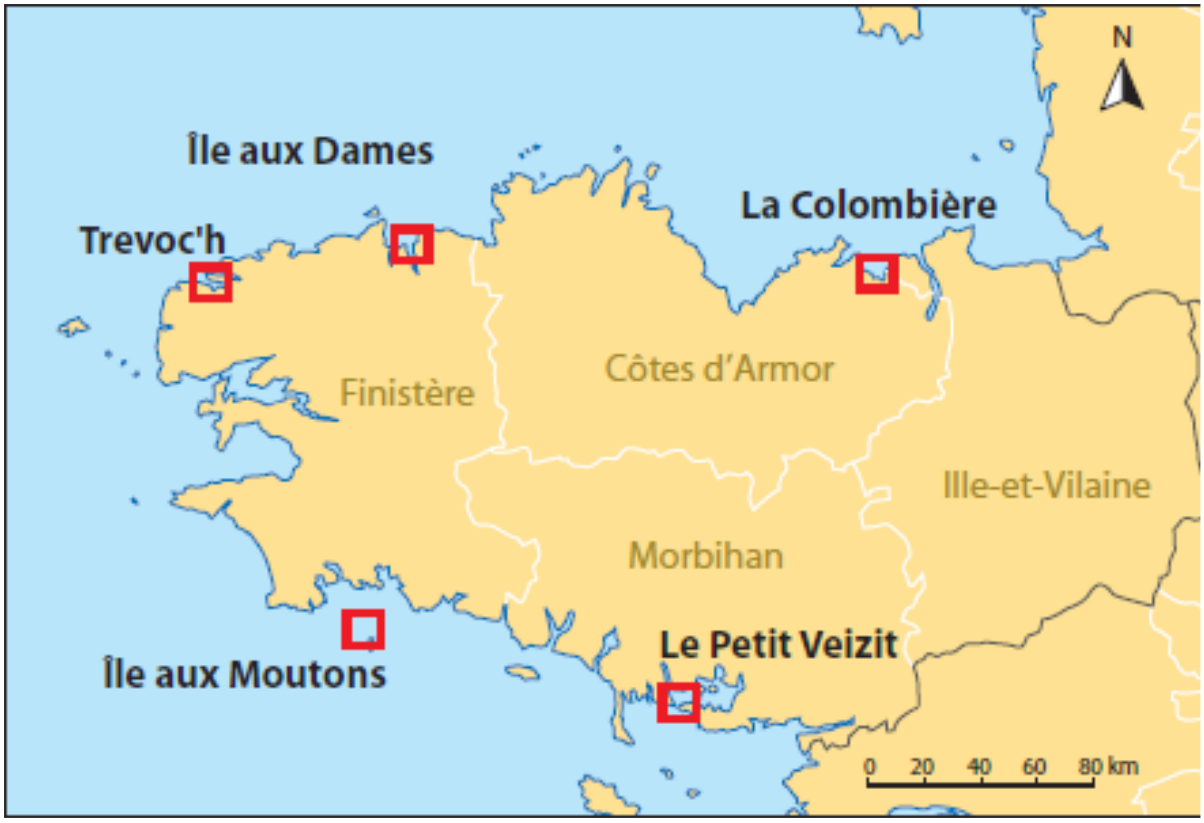

Figure 9 The project sites for the LIFE programme in Brittany, 2005-2010 (Hennique, S & Quemmerais-Amice, G, 2010).

Although unsuccessful in improving roseate tern productivity, the LIFE project showed that L'Ile aux Dames, La Colombière and L'Ile aux Moutons were found to be favourable to the species, with the latter site having successful breeding attempts in 2010 and in 2011. From 2012 onwards, the number of breeding roseate terns on L'Ile aux Moutons and La Colombière increased. It is possible these terns were displaced as no roseate terns nested on their main breeding site Ile aux Dames in 2011. In 2015 and 2016, La Colombière have had no roseate terns nesting there, while Ile aux Moutons supported 46 pairs of breeding roseate terns in 2017. On the west coast of Brittany, there were 3-5 roseate terns that attempted to breed on the island of Kemenez in 2016 (per comms, Yann Jacob, 2016).

4.3 Roseate tern SPAs in the UK and Republic of Ireland

The current network of SPAs in the UK and RoI reflects closely the distribution of breeding pairs between 2008 and 2011 (Figure 10). Below, we have described SPAs, which are not participating in the project.

Lindisfarne comprises a wide range of coastal habitats including extensive intertidal sand and mudflats which support internationally important wintering populations of waders and wildfowl, as well as coastal features and rock exposures of physiographical and geological importance. The site supports a number of rare plants and invertebrates and important breeding populations of seabirds. Breeding bird populations include little terns and a small number of roseate terns as well as common, arctic and, in some years, sandwich terns (JNCC, 2001). In the SPA the roseate tern is listed as a reproducing species although no units are mentioned. In abundance categories is it listed as present and that the quality is poor (JNCC, 2015). Currently, there are no important colonies of common tern within this SPA, but the site will be reviewed in the regional strategy.

Figure 10 Location of SPAs designated for roseate terns. Sites in yellow indicate SPAs included in the LIFE project.

The Farne Islands comprise a group of rocky offshore islands and stacks lying between 2-6 km off the Northumberland coast. The islands are important as nesting areas for these birds, especially terns, gulls and auks. The seabirds feed outside the SPA in the nearby waters, as well as more distantly in the North Sea (JNCC, 2001). There are 4 species of terns listed for this SPA, roseates (historically), common, Arctic and Sandwich. The most urgent action here is to maintain tight biosecurity measures due to the large number of tourist vessels landing at the National Trust reserve.

The North Norfolk Coast SPA encompasses much of the northern coastline of Norfolk in eastern England. It is a low-lying barrier coast that extends for 40 km from Holme to Weybourne and includes a great variety of coastal habitats. In summer, the site holds large breeding populations of numerous birds' species including four species of terns. Breeding terns, particularly Sandwich Tern, and wintering sea-ducks regularly feed outside the SPA in adjacent coastal waters (JNCC, 2015). Roseate tern has not bred here for over 20 years, but the site supports large size common tern colonies, as well as Sandwich and little terns, within the most important tern assemblages in the UK. Although, no recent history of roseate terns breeding, should they occur within these well established and generally well protected and

managed tern colonies, there would be the potential for them to become established breeders within the colonies.

4.4 Climate change models

4.4.1 Roseate Tern

Climate change models have been developed for all European birds including roseate tern (Huntley at al 2007), but there is less confidence in the models for seabirds than other birds, because the models do not include marine based variables such as sea surface temperature. Models for seabirds have been further developed by Russell et al 2015, which do address this issue. However, the models can only highlight potential broad-scale geographical ranges rather than fine-scale distributions. Neither of the models considered trophic changes in marine environment and their impact on availably of fish.

Although seabirds are mobile species; many, including roseate terns, are site faithful, returning to the same colony including specific ledges/burrows. This means they may not change their breeding grounds as the climate continues to change (Russell et al, 2015). Therefore, the creation of new colonies is often a protracted process, which means that any change on the distribution with seabirds may take time and affect the ability of some birds to keep pace with climatic change. As a result, Russell (2015) examined predicated changes in species distribution under the condition of no and unlimited dispersal which will provide the worse and best-case scenarios of future distribution. The scenarios that were looked at were:

- A1 which assumes rapid economic growth with scenario A1b assuming a reliance on multiple energy sources, whereas
- A2 assumes slower and more fragmented growth and technological development than under the A1 scenarios, resulting higher greenhouse gas emissions (Russell et al, 2015).

Using the modelled distributions in 1985 and to predict distributions of seabirds in 2100, a 30 year means of predicted climatic variables were used for the period 2071 to 2100.

The potential European distribution of roseate tern under scenario A1 (a) and A2 (b) are shown in maps Figure 11. The roseate tern breeding distribution will continue to be very restricted, but it does indicate a general shift to the north and west in several parts of the UK and Republic of Ireland. Russell's paper in particular simulates the potential for range extension in the following areas: East coast of mainland Scotland from Firth of Forth to Moray Firth, West coast of Ireland (Cork to Illancrone), Isle of Scilly, and parts of the Norway coast. There is also a shift to the north coast of Spain, but it most likely relates to the expansion of the Azorean population.

Although both maps have identified similar ranges on the east coast of the UK, as there are two emission scenarios; the GCMs outputs are slightly different with A1b establishing Northumberland/Firth of Forth coast as the most suitable area on the east coast while B concludes that the Aberdeenshire coast will be. Both emission scenarios agree that areas on the east coast of the Republic of Ireland will continue to be more climatic suitable (under 2-3 models), however the model also determined that the west coast of Ireland will become suitable under one or two models.

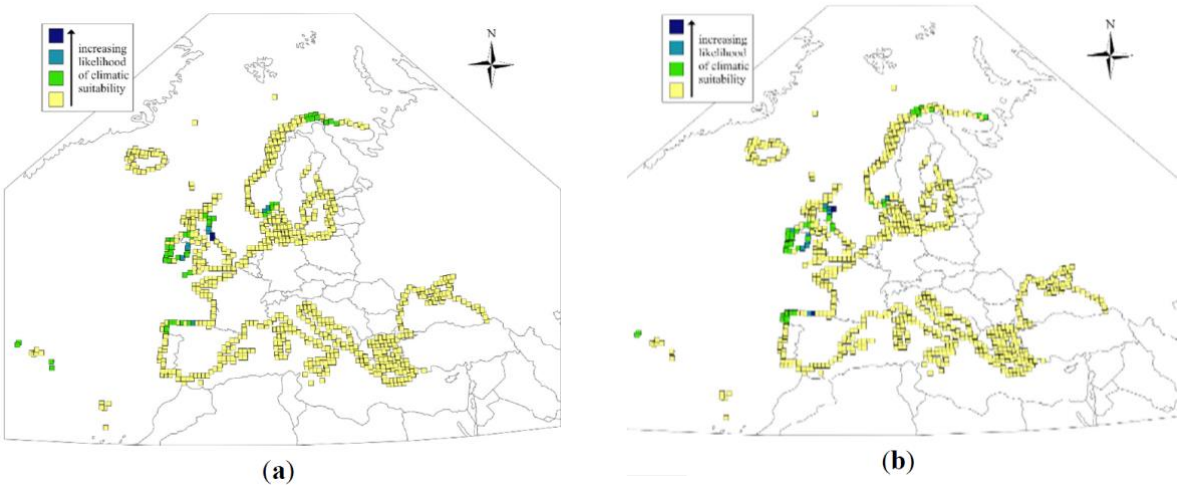

Figure 11: These two maps show the potential European breeding distribution of the roseate tern in 2100 under emission scenarios A1b (a) and A2 (b) based in climatic suitability predicted for the climatic scenarios derived from three GCMs (yellow - unsuitable under all three GCMs; light green – suitable under one GCM, dark green - suitable under two GCMs; dark blue – suitable under all three GCMs) (Russell et al, 2015)

4.4.2 Common tern

As in NW Europe, roseate terns are always associated with common terns, it is useful to consider the potential range of common terns. Any potential roseate tern sites are likely to be those supporting a robust colony of common terns.

The two maps with the different emission scenarios in Figure 12 show the potential range of common terns in 2100 (Russell et al, 2015). Using these models, common terns are predicted to occur in all areas which are highlighted as having potential roseate terns in the future.

Under both a and b scenarios, the common tern potential range remains widespread and covers most of the current and potential range of roseate tern highlighted above. However, the lower suitability of SW England and Brittany is noted – which could impact on the longer-term suitability of Brittany and prospects for the Isles of Scilly and Channel Islands.

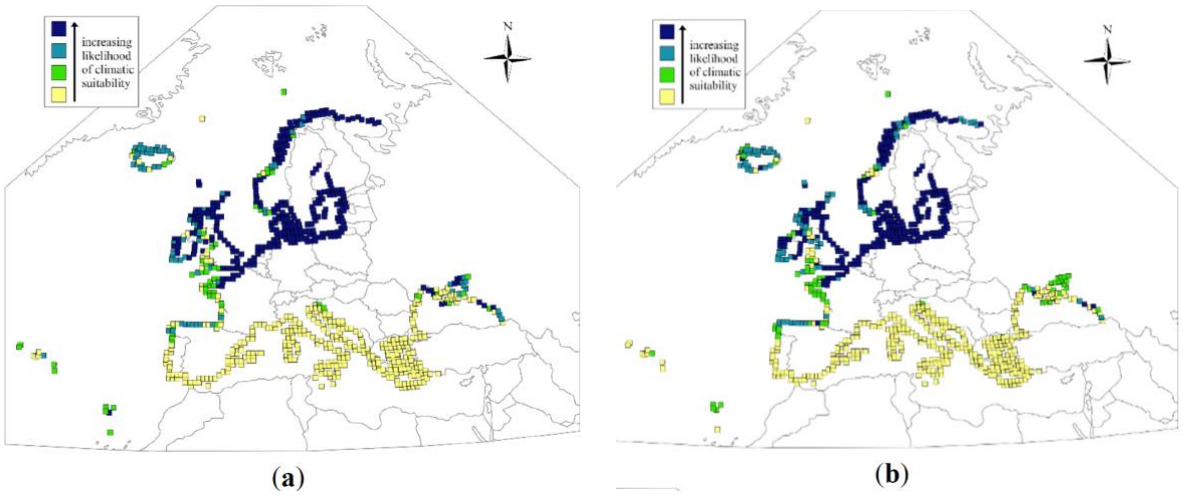

Figure 12: These two maps show the potential European breeding distribution of the common tern in 2100 under emission scenarios A1b (a) and A2 (b) based in climatic suitability predicted for the climatic scenarios derived from three GCMs (yellow - unsuitable under all three GCMs; light green – suitable under one GCM, dark green - suitable under two GCMs; dark blue – suitable under all three GCMs) (Russell et al, 2015)

4.4.3 Predator/competitor species

Large gulls can compete for space and predate terns' eggs and chicks. Although Russel highlights some range changes for herring, lesser black backed and greater black backed gulls, they are all present throughout the current and potential range of roseate tern. They may continue to be an issue at the site-specific level but not an issue at the range level.

However, the predicted continued expansion of Mediterranean gulls in south and east England/northern France could be an issue for roseate terns and their host species common tern. Large and increasing populations of aggressive Mediterranean gulls could displace, predate and impact on existing and potential tern colonies. However overall, there is no reason to rule out potential areas of range of roseate or common tern because of the potential presence of gulls, as to large extent this can be managed by site wardens.

4.5 Distribution and availability of prey species

Climate change has been considered to be playing a significant role in the declines in breeding seabird numbers (Russell et al, 2014). As they are apex predators, they are likely to experience indirect climate change impacts arising through the negative impacts on their food webs (Carroll et al, 2015). As a result, their breeding success is influenced by prey availability as under poorer feeding conditions body condition is poorer, nest attendance falls, and chicks can starve (Carroll et al 2015).

Whilst there is a scarcity of information on the distribution and availability of prey species such as sandeels, there are regional patterns. Since the late 1980s colonies of sandeel specialist species in the Northern Islands and along the northern area of the North Sea of Britain have experienced successive years of poor breeding success due to sandeel shortages (Mavor et al, 2004). Cook et al (2014) stated that their trends revealed that with regards to the North Sea species abundance at breeding colonies is

declining and breeding failure rates are increasing. In contrast to this, the Celtic Seas showed a more varied result with some species in decline while others are relatively stable or increasing. Cook et al (2014) discussed that this discrepancy may be reflected in the differences of prey availability. It was determined that herring was considered to be more important part of seabird diet in the Celtic Seas than in the North Sea (Cook et al, 2014). In addition, Mavor et al (2006) stated that common tern colonies adjacent to the Irish Sea were considered to be more productive, in comparison to other areas in the UK.

This position is updated by the diet review (A3) which summaries ecology, distribution and impacts of climate change not only for sandeel, but also for sprat and juvenile herrings, which together constitute a clear majority of tern diet around the UK and Ireland. Sprat feeds on warm-tolerant zooplankton species such as *Calanus helgolandicus* and *Temora longicornis* (De Silva, 1973; Fauchald et al., 2011; ICES, 2013a) and sprat recruitment has been shown to increase with temperature (Mackenzie and Köster, 2004; Baumann et al., 2006; Peck et al., 2012). Thus, the suitability of UK waters is expected to increase for sprat by the mid-21st Century (Jones et al., 2013). This is likely to benefit terns, as sprat has the highest energy content of the three prey species (Harris and Hislop, 1978; Hislop et al., 1991). In contrast, herring and sandeels feed preferentially on the large, cold-water species *C. finmarchicus* (van Deurs et al., 2009; van Deurs et al., 2013) and recruitment of both species is negatively related to temperature (Grainger, 1980, cited by Clarke et al., 2011; Arnott and Ruxton, 2002; Frederiksen et al., 2004; Clarke et al., 2011). Therefore, the suitability of UK waters is predicted to decline for herring (Jones et al., 2013) and is likely to decline for sandeels, which are unable to shift their distributions due to strong habitat associations with coarse-grained sandy sediment (Wright et al., 2000; Holland et al., 2005; Heath et al., 2012). The distributions of sandeel, sprat and herring are shown in Figure 13. The "prey hotspots" are where two or three species overlap.

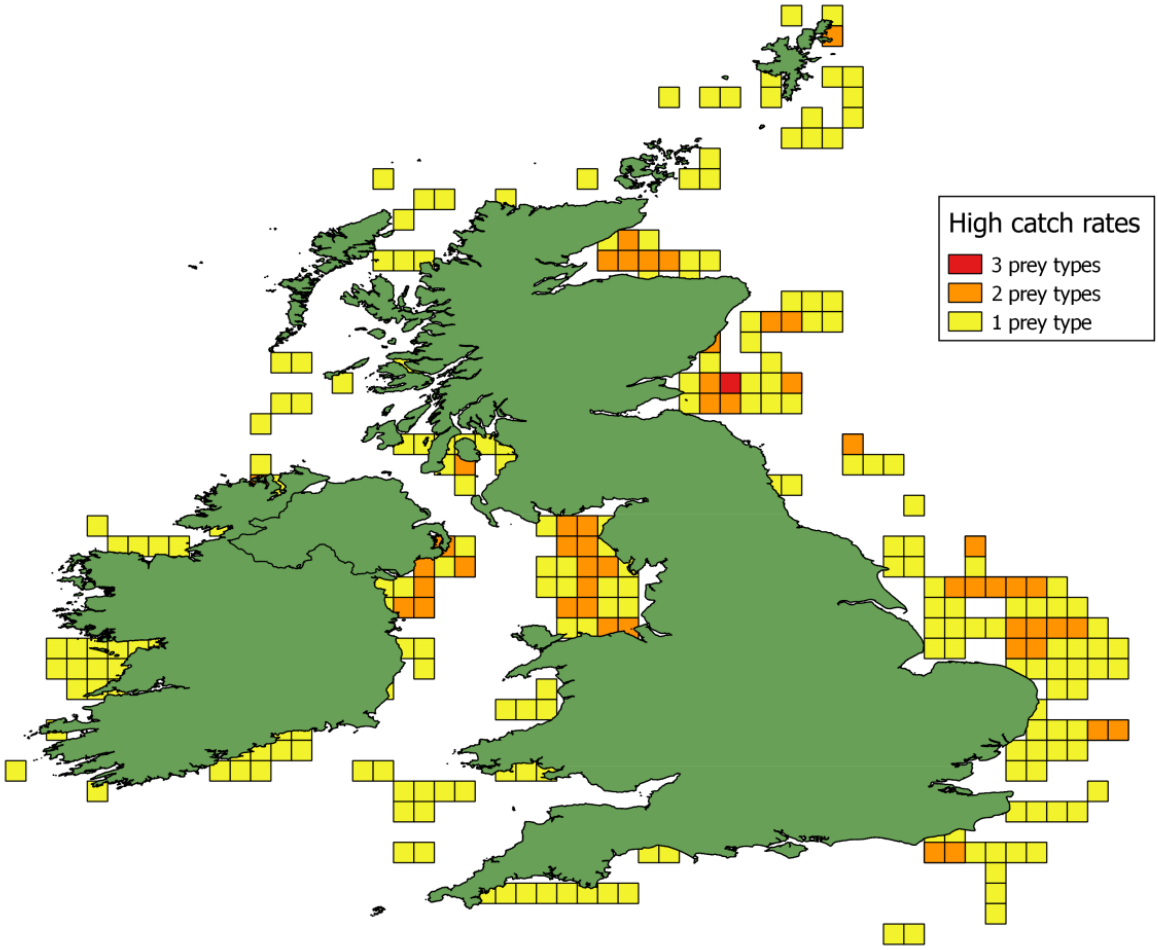

Figure 13 Prey hotspots map showing approximate areas with high catch rates of three major prey types for terns (Ammodytidae sandeels, sprat and juvenile herring) based on data presented by Ellis et al. (2012) and Heessen et al. (2015). Red = high catches of 3 prey types; orange = high catches of 2 prey types; yellow = high catches of 1 prey type.

A decline in herring and particularly sandeels would have a strong negative impact on populations of breeding terns. However, sprats are likely to be more abundant and widespread. Arctic terns, which are more dependent on sandeel, are particularly vulnerable to climate change, especially in the north, for example around Orkney and Shetland archipelagos where alternative prey is absent. Roseate terns however will take sandeels, sprat and herring and are currently benefitting from the abundance of these species in the Irish Sea and are likely to benefit from the increase in sprat in various locations around Britain, particularly North and Irish Seas as well around Forth, where an isolated population of sprat exists.

4.6 Audit of all roseate and common tern colonies

We have compiled a database with information on locations, population and trends for all common tern and roseate tern colonies. The most recent full census of tern colonies is Seabird 2000, but we have sourced all available more recent information on the seabird colony register and through contact with site managers, who have also provided information on site management and issues. Common tern colonies located further than 5 km in-shore were excluded from the analyses. This information is stored

in Annex 1 and will be a working document that we continue to update and develop as more information is available.

Within the broad range defined for prey hotspots (see above), common terns are widespread, but many colonies are under pressure from habitat loss/change, disturbance and predation effects. The largest single colonies or concentrations of colonies for common terns currently occur in the East coast of RoI, East coast of N. Ireland, Anglesey, Dee/Mersey, Firth of Forth, Northumberland, N Norfolk, and Morbihan (Brittany) (Figure 14).

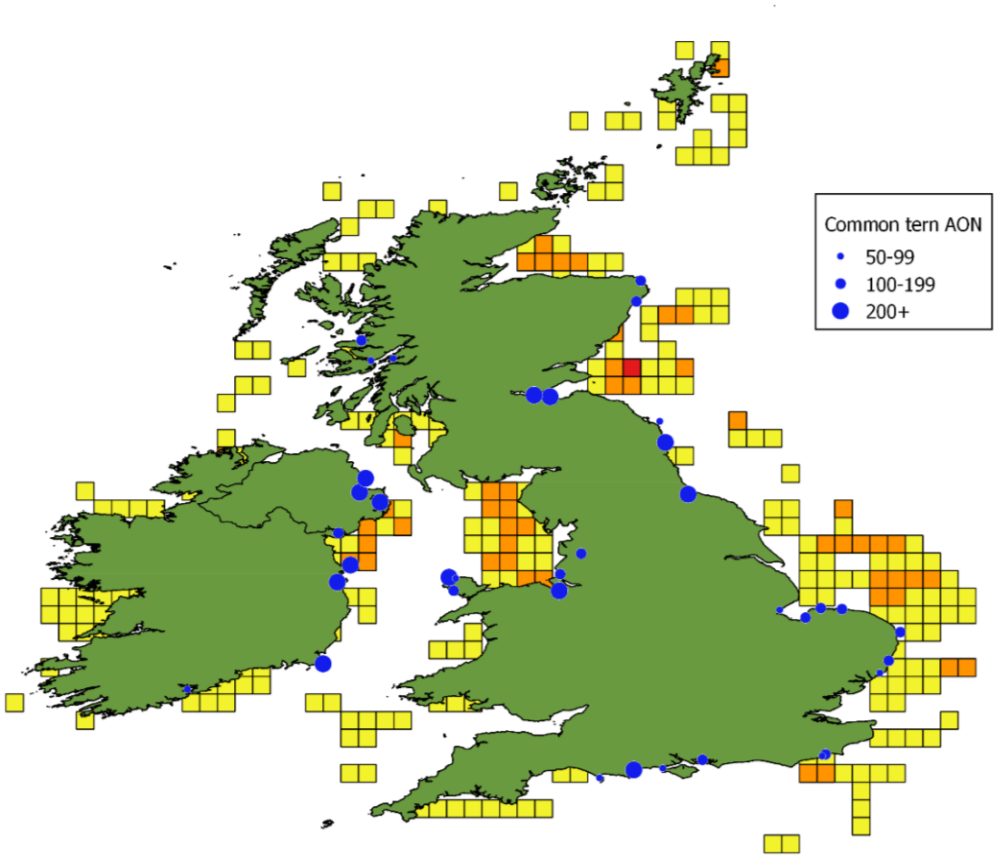

Figure 14 Active common tern colonies with ≥50 apparently occupied nests (AON) in the past 5 years, overlying the prey hotspots map.

Common terns and roseate terns are regularly associated with other breeding terns and seabirds. For these colonies, the importance of the assemblage as a whole will drive conservation management priorities. Areas with important assemblages will be priorities for protection and management and in these situations, roseate terns may be a beneficiary of conservation work driven by the other seabird species e.g. island restoration and coastal habitat creation projects (see below). In these areas, it would be relatively easy to build in specific needs of roseate terns into the generic seabird management should roseate tern occur. We have therefore identified the most important UK tern assemblage areas, so that any particular opportunities can be realised.

4.7 Demography

The demographic study undertaken as part of the project (A4, D1) highlighted the demographic parameters responsible for the population growth of each colony. It concluded that the population

growth of Rockabill and Lady's Island Lake depends mostly on the survival of adults/ juveniles and productivity, whereas Coquet is more dependent on immigration from Rockabill. Therefore, if there was no immigration, the Coquet colony would decline, but also the metapopulation size would be larger. This is because birds which chose to breed on Coquet have lower productivity and probability of juvenile survival (cryptic sink). Juvenile birds from Coquet have lower fitness, probably due to poorer food resources. This has a direct consequence for the metapopulation management and long-term strategy. Instead of trying to lure roseate terns to new sites, we should focus on providing the best conditions for nesting on Rockabill and Lady's Island Lake, until these birds choose to expand naturally into adequately managed "receptor" sites. These receptor sites should be selected carefully to avoid luring birds to ecological traps. Factors to consider should be:

- Assemblage composition
- Size of the population and recent trends of common terns
- Threats and management to date
- If possible, diet composition and provisioning rates for common terns.

The above detailed assessment of the common tern colonies will be carried out as part of the partnership work in preparation for exit strategy, but a series of broad recommendations are made for each target area. Some of the colonies, although listed in the target areas, will not be sufficiently safe or have enough potential, either because of the assemblage composition or difficult to manage threats, to invest serious resources into management. Priority sites were selected, where management will continue, and other potential sites identified as part of the long-term international strategy through partnership working and advocacy.

4.8 Conclusions

There are many uncertainties involved in predicting the future range of roseate tern particularly given its limited current distribution, and limited dispersal. Although modelling suggests a slight northward shift in range, we suggest that this might be limited by food availability particularly relating to sandeels. We suggest that conservation of roseate tern should remain broadly focused within the current range. The diet review (Action A3) identifies prey hotspots and we suggest that areas with an abundance of more than one prey species, and those supporting sprats (which are predicted to increase) are likely to be most important in the future. Furthermore, the distribution of large common tern colonies should be considered when selecting target areas as the likely receptor sites for roseate tern recolonization.

5 Long-term management opportunities

As tern colonies occur on soft coast (dunes, shingle, salt marsh) habitats and offshore rock islands, we have identified the threats and opportunities faced by both sets of habitats. Broadly the threats faced by terns along the soft coast are changes to the physical environment and habitats through sea level rise, erosion, habitat succession. Terns on both soft coast and offshore islands are impacted by predation and human disturbance but these are in general greater and more difficult to manage away from islands. Most of the key islands are designated sites and/or nature reserves where human activities can be managed and therefore the principle threat is that posed by invasive non-native mammals e.g. rats, American mink, which predate upon eggs and chicks, as well as adults of some seabird species, and can cause colony abandonment.

In this section, we have reviewed opportunities to address the issues affecting soft coast habitat and offshore islands. In practice, there is some overlap between 'soft coast' and 'island' issues. For example, Blue Circle island in Larne Lough is a nearshore island, experiencing erosion and habitat change, but also the impact of invasive non- native mammals, and the solutions involve addressing long term habitat change and island biosecurity.

5.1 Soft coast habitats

For those sites, which are low lying soft coast islands and features we have identified risks and opportunities arising from sea level rise, predicted habitat loss/change and coastal developments and opportunities for new habitat creation projects including managed realignments, regulated tidal exchange and beneficial use of dredged material. For the UK, we have drawn on information compiled by the RSPB (Miles and Richardson 2018 in prep.).

5.1.1 Loss and importance

The coastal habitats around the UK are of international conservation importance. Over 30% of European estuarine area and saltmarsh area is within the UK and reflecting this more than 80% of the existing saltmarsh in the UK is protected by national and international conservation designations. Other coastal habitats, such as intertidal mud and sand flats, sand dunes, vegetated shingle and saline lagoons are of outstanding ecological importance and consequently are also protected by national and international conservation designations. These habitats support most of the UKs tern colonies.

The UK's coastal habitats provide more than £48 billions in ecosystem services such as tourism and recreation, fisheries, water quality improvement, carbon sequestration and flood risk mitigation (UKNEA, 2011). They provide a natural buffer significantly reducing wave energy and the height of surge waves. These flood risk management benefits alone are calculated to be worth more than £4.5 billion (Beaumont, 2014).

Despite this, the UK has lost more than 15% of intertidal habitat (>8,000 ha of saltmarsh and even more mudflat) since 1945 (ONS, 2016), 46% of shingle and 18% of sand dune habitat area.

Whilst the EU Nature Directives have been instrumental in reducing the rate of further losses arising from development projects the coastal habitat that remains is in a woeful condition, with all SAC Annex 1 coastal habitat types assessed as being in bad or inadequate condition in terms of structure and function, and most of the UK saltmarsh assessed so far failing to meet the Water Framework Directive requirement of Good Ecological Status.

Looking forward, the UK is expected to lose at least a further 80ha of protected habitat per year across the UK due to climate change, sea level rise and coastal squeeze. Most of these past and predicted losses are in England. These losses will impact on many of our most important sites for breeding terns.

5.1.2 Policy drivers for coastal habitat creation

The most significant driver is through the EU Nature Directives. The assessments of future loss in England and the determination of a habitat balance account undertaken by the Environment Agency as part of their National Habitat Compensation Programme (NHCP) have been comprehensive, done on a regional basis and have been reviewed and updated by Environment Agency and Natural England in 2017. They do, however, focus solely to coastal squeeze related losses of Natura 2000 sites. They do not fully reflect historic losses (e.g. the significant losses going back to 1945); habitat condition and functionality or the loss of habitat outside of Natural 2000 designated areas. However, there are significant drivers for habitat creation to offset losses in England, and these can provide very significant opportunities for terns.

The assessment of future loss in Wales have been undertaken by Natural Resources Wales as part of their National Habitat Creation Programme (NHCP) and were last published in 2015. They have taken a similar approach to that in England, but the scale of loss and scale of opportunity is much lower. In Scotland, the results from the National Climate Change Assessment (NCCA) project released in 2017 indicate the amount of designated habitat (SSSI as well as Natura 2000 sites) projected to be lost to coastal erosion. Currently the published assessments do not detail which habitat types are potentially impacted or look at loss of condition. The recommendations from the project include better strategic planning through targeted SMPs, Scotland's Climate Change Adaptation Programme and a Scottish National Habitat Creation Programme to deal with the potential losses. To date there have been no similar assessments published in Northern Ireland so currently we are limited to using the ONS 2016 scoping report to estimate potential losses in Northern Ireland, which project only 28ha of saltmarsh loss by 2060 using a simple extrapolation of recent loss rates. However, we are aware that a number of important tern nesting sites within Northern Ireland are deteriorating as a result of rising sea levels and erosion.

Although much coastal habitat creation is driven by the EU Nature Directives, as highlighted above, there are additional policy drivers for coastal habitat creation.

Shoreline Management Plans in England, Wales and Scotland identify where managed realignment or no-active intervention is the preferred flood management policy in the short (Epoch 1: to 2025), medium (Epoch 2: 2025 – 2050) and long term (post 2050). However, the rate of implementation of managed realignment policy in England is around 5 times slower than proposed for Epoch 1, due in large part to funding. It has become increasingly difficult for projects to be funded solely based on their FCRM and coastal sustainability value as described in the SMP. Most schemes rely on having an additional funding driver, usually relating to the legal requirements of providing compensatory habitat under the Habitats Regulations.

The Water Framework Directive is an increasingly important driver for coastal habitat work. Firstly, saltmarsh is a WFD biological element and so there is a legal obligation to prevent its deterioration in transitional and coastal water bodies and an objective to improve saltmarsh quality to good ecological status by 2027. Secondly, where WFD water bodies have been classified as heavily modified for example due to the presence of flood defence structures then managed realignment or habitat enhancement may be identified as a mitigation measure to get them to good ecological potential.

Despite a largely positive Waste Management policy environment very little of the 50million m3 of dredged material generated each year (largely by the port sector) is reused in the UK for habitat creation (circa 1%). Most is disposed at sea. This issue, and the need to protect and enhance inshore and coastal habitat, is being picked up in the emerging Marine Plans being developed around the UK.

Climate change adaptation is an increasingly important driver for action. The National Climate Change Committee has highlighted the failure to adapt to climate change on the coast and coastal flood risk is a major risk in the 2017 risk assessment.

5.1.3 Habitat creation techniques

Coastal habitats can be created through a range of techniques. The majority of coastal habitat creation projects to date have involved the use of managed realignment defined as ***deliberately breaching, or removing, seawalls to allow tidal waters from adjacent coasts or estuaries onto the land.*** However, a similar result can be achieved through an alternative technique called Regulated Tidal Exchange (RTE) where saline or brackish water is introduced to a site through a combination of pipes and sluices through an existing sea defence. Both managed realignment and RTE can be used to create a range of habitats including mudflats, saltmarsh, brackish grazing marsh and saline lagoons. The main difference is that with RTE the primary sea defence will remain in situ, therefore this may be the preferred option where the existing defence is in good condition and/or the construction of a new line of defence would be prohibitively expensive. 'Beneficial Use' refers to the use of dredged sediments (BUD) as a productive material as opposed to being disposed as a waste product. Clean dredged sediments are an excellent source of material to create or restore a wide variety of coastal habitats. Beneficial use can be used in isolation or combined with other techniques like managed realignment and RTE to create a mosaic of habitats. It can be used to create habitats behind existing sea defences, or in advance of them where they can support coastal management policies of *holding the line*, where they may offer a more cost effective and sustainable solution to improving or maintaining hard defences, or *no active intervention*. In most cases beneficial use does not require the acquisition of land and will not change currently defended land into intertidal habitat, so potentially has fewer conflicts with alternative land uses, although impacts on the receiving land must be considered. Beneficial use of dredged materials is a major opportunity for habitat creation for terns. This can be used to recharge and stabilise eroding saltmarsh and mudflats. This is the intervention currently being investigated on the Solent. Material can be used to create offshore islands within bunded areas to provide safe disturbance and predator free habitats. This is being used to great effect at the Marker Wadden in the Markermeer, The Netherlands – creating 100 square kilometres of new habitats now being colonised by 1000s of breeding terns. Nothing of this type has been created in the UK or Ireland. Sand and shingle can be used as recharge of islands, spits and beaches which is not overtopped at high tides. This has the potential to be the most widely used technique and could generally applicable for many sites around the coast.

Over the past 25 years, there have been more than 70 managed realignment and regulated tidal exchange schemes (ABPmer, 2016). The involvement of organisations such as RSPB has helped design these schemes to provide maximum benefit for conservation. The RSPB has been involved in the creation of 880ha of habitat including large schemes such as Medmerry (Sussex) and Wallasea Wild Coast (Essex) providing landscape scale benefits for wildlife and people. At both these sites, specific habitats have been created for nesting terns – with lagoons and nesting islands. At Wallasea, the availability of new habitat in 2017 encouraged colonisation by 43 pairs of breeding common terns, but there is the potential for the site to hold colonies of several hundred.

5.1.4 Habitat creation opportunities

Through discussion with the regulatory authorities in England, Scotland, Wales and Northern Ireland and with other NGOs and coastal habitat creation experts, 10,000 ha of habitat creation opportunities have been identified around the UK (Miles and Richardson, 2018). These are heavily concentrated along the East coast of England between the Humber and the Thames, but with significant opportunities in all four UK countries. Specifically, we have selected priority projects within the target areas (Figure 16), which constitute over 5,000ha of potential habitat creation, including features for terns.

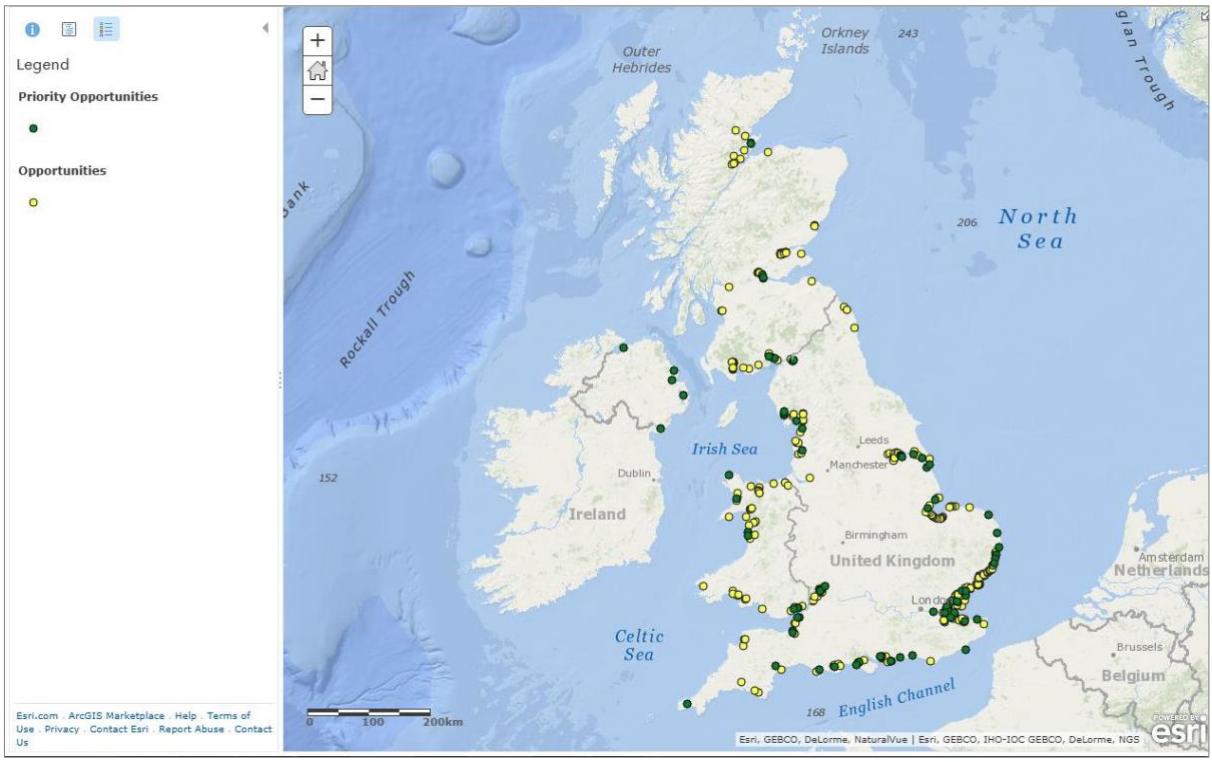

Figure 15 Potential opportunities for coastal habitat creation around the UK, priority opportunities shown in green.

Most of these opportunities are in the South and East of England, where the policy drivers are most strongly in favour of creating new habitat. This is where:

- Sea level rise projections will be exacerbated by isostatic rebound.
- IPENS identifies the majority of Natura 2000 sites in the south and eastern region being impacted by, or at risk from, coastal habitat loss, primarily as a result of coastal squeeze and/or inappropriate coastal management.
- North Norfolk Coast, Alde Ore and Butley Estuaries and Essex Estuaries Thanet Coast, Solent Maritime and Solent & Isle of Wight Lagoons SACs and The Wash & North Norfolk Coast and Thames Estuary and Marshes, The Swale, Thanet Coast and Sandwich Bay, Pagham Harbour and the Solent and Southampton Water SPAs have been identified as being most at risk from the impacts of climate change.
- Largest area of potential opportunities because of geomorphology and amount of land reclamation that occurred historically.

- Precedent for delivering projects in the regions and continues to be a lot of interest by local stakeholders.
- Potential funding availability due to development in the Greater Thames and flood risk management in London and other built up areas.
- Flood risk management required to protect coastal communities in Norfolk, Suffolk and Essex, Sussex and Hampshire.
- Significant land in conservation ownership in key areas so organisations such as RSPB, National Trust and Wildlife Trusts are key/influential stakeholders.
- Value of existing projects e.g. Wallasea (Essex), Medmerry (Sussex) as demonstration sites.
- Importance of coastline for breeding and non-breeding waterbirds and need to address past/projected habitat changes to maintain these populations.

There are constraints notably

- The more obvious sites have already been developed so new projects are harder to deliver.
- High cost of land
- Extensive areas of designated habitat including behind seawalls and so the need to compensate for losses arising from coastal management projects
- Extensive urbanisation of coast in some areas which limits potential for habitat creation schemes.

However, overall this area from the Wash around Norfolk Suffolk Essex, The Thames and along the south coast to the Solent provides the greatest opportunities to create new coastal habitats in the UK including creating new habitats for tern colonies. Wallasea and Medmerry alone have delivered over 1000 ha of new habitat - almost 40% of the total area of new coastal habitat created in the past 26 years. In only its second year, Wallasea has established a population of 40 common tern. A handful of such schemes delivered over the next decade could create significant new opportunities for a range of coastal species including breeding terns. If food supplies are not limiting, these new sites could provide safe breeding sites for hundreds of breeding terns into the future – with the potential to attract roseate tern amongst them. Key to developing new sites is effective working with a range of critical stakeholders – notably Environment Agency, Natural England, DEFRA, National Trust and Wildlife Trust, and local landowners to develop large scale multi objective coastal schemes which deliver new habitats. The most likely opportunities include flood management projects along the Suffolk Coast, Blackwater Estuary and the Greater Thames.

Although this area between the Wash and the Solent does not currently support a significant population of roseate terns, this is the area of the UK which could provide the most significant new areas for nesting terns in the UK and will almost certainly provide significant opportunities for common terns. It is uncertain whether roseate terns will take advantage of the new opportunities, but the potential is there for a significant new roseate tern colony to be established in this area.

Specific priority opportunities have been listed under each target area. In summary, these are:

- Large scale multi-purpose schemes in Norfolk, Suffolk, Essex and Kent.
- Beneficial use of dredged sediment to create tern nesting in the Solent and Essex.
- Various habitat projects in the NI Loughs to restore existing islands and create replacement sites.

5.2 Management of invasive species on Islands

For those areas which include offshore islands, we have identified issues relating to invasive non-native mammals and highlighted next steps in terms of further assessment, biosecurity, control or eradication. Within the last 50 years, island restoration has become a mainstream conservation measure across the globe with invasive animal species, usually but not exclusively mammals, eradicated from hundreds of islands around the world and improved biosecurity measures in place to prevent their (re) invasion. For the UK and Crown Dependencies, we have drawn on the Island Database compiled by RSPB and reported in Stanbury et al 2017, which summarises data on almost 100 vertebrate species of conservation importance, and 12 invasive mammal species on 9688 islands. Islands were then prioritised in terms of both vertebrate eradication and biosecurity. This audit highlights that of 148 islands larger than 100ha, only 31 (21%) are free of potentially high impacting alien species. However, eradications are very costly and high risk requiring very careful assessment and planning. Furthermore, the islands where the biggest conservation benefits could be achieved are generally large with substantial human populations and support multiple invasive species posing very significant logistical, technical and financial challenges.

Within the UK, there are also many islands which are close enough to other islands or the mainland to impact on the sustainability of an eradication. Swimming distances for mink and brown rat are around 6500m and 2000m respectively and human assisted pathways can facilitate the movement of mammals between sites over greater distances. For some islands, where eradication is not sustainable, we propose alternative approaches such as localised control around specific colonies, or an control-monitor-control strategy which aims to keep small islands free of invasive predators but acknowledges and prepares for the high risk of reinvasion. However, within the UK, the installation of biosecurity measures for islands free of the most damaging invasive species is perhaps the highest priority action (Thomas at al 2017). The top 25 rodent-free islands support more than 90% of UK population of Atlantic puffin, storm and Leach's petrels and roseate tern. A recent audit of biosecurity across the 41 UK SPA s designated for seabirds (Thomas et al 2016) highlighted the low level of awareness of biosecurity risks, and very limited installation of biosecurity measures across these sites. Recent reports of rat incursions on a number of important islands including Coquet, which supports 44,000 seabirds including the entire UK population of roseate tern, highlights that this is an ongoing threat. Important seabird islands often remain free of predators by accident rather than design and much greater emphasis needs to be placed on establishing comprehensive biosecurity measures.

With this threat in mind, RSPB and partners have recently started a new project Biosecurity for LIFE (LIFE17 GIE/UK/05720) in September 2018 working across the 41 most important seabird SPAs in the UK. The project aims to a) reduce the frequency of incursion by invasive mammalian predators onto seabird island SPAs around the UK, and b) improve the speed and quality of response to any incursions that do occur. The project will look to change this by:

- Providing training and support for Site Managers of SPAs to enable the production of biosecurity plans for each SPA;
- Running biosecurity training courses to enhance capacity of residents, businesses and local authorities to support biosecurity plans and measures
- Establishing rapid response hubs in eight locations from which trained and equipped volunteers can launch responses to potential incursions

- Installing equipment to detect rats, mink or stoats on key SPAs and training a rodent detection dog
- Raising awareness within island communities, including land managers and marine businesses, visitors and recreational users and the wider public about the threat of INNS and biosecurity best practice
- Ensuring transfer of information and resources to aid replication in other EU countries including establishing a central online resource and a European Eradication, Biosecurity and Incursion Response Advisory Group (EBIRAG).

There are clear links between the long-term objectives of the Roseate Tern LIFE project and the work being carried out by the Biosecurity for LIFE project and we will ensure close cooperation to maximise the benefits from this work after the project.

Away from the UK, RoI and Brittany, although there is less data available, the same principles apply. We have identified appropriate strategies for the key islands which are currently or could be colonised by common terns.

Within the UK, there are limited conservation benefits to be achieved for roseate or common terns through eradication of invasive species on islands. Many of the islands where the biggest conservation benefits could be achieved are in N and W Scotland and therefore lie outside of the range of roseate tern. The one potential area is the Isles of Scilly which is discussed in more detail below. However, eradications could play a significant role in the RoI (Dublin Bay islands) and Brittany, but further assessment of these options is required.

Biosecurity planning does though play a very significant role in the future conservation strategy for roseate terns. The most important extant island populations (Rockabill and Coquet) are on rat free islands, and roseate terns could colonise other islands/island groups if they remain predator free. Specifically, our aim is to secure the following outcomes with biosecurity.

- Northumberland Islands: Coquet and The Farnes- biosecurity planning and implementation. The Farnes will become one of the Demonstration Sites to be established as part of the LIFE Biosecurity.
- Anglesey Islands – biosecurity planning and implementation.
- Copeland islands NI - biosecurity planning and assessment of habitat suitability for terns.
- Brittany: Further assessment of islands, develop eradication, control and biosecurity strategy
- Dublin Bay islands – further assessment of islands, develop eradication, control and biosecurity strategy. Consider future options for Dalkey Island in this context.
- NI Loughs and Islands – further assessment of options, biosecurity planning for islands.

The Isles of Scilly

This archipelago of islands supported roseate terns in the past amongst a colony of common terns. The islands lie geographically between the colonies in Brittany and the RoI and support a range of island habitats closely resembling those used by roseate terns in Brittany. Although the islands are widely colonised by brown rats, a successful rat eradication project was recently completed for St Agnes and Gugh (LIFE11 NAT/UK/000387), and plans for further eradication of rats on Tresco, Bryher, St. Martins and associated uninhabited islands. Therefore, in many ways the Isles of Scilly, would appear to present a great opportunity for roseate terns in the longer term, particularly if further rat eradication plans progress. However, numbers of common terns breeding in Scilly have been erratic but have shown

a clear and sustained decline since a maximum count of 210 pairs in 1983. In the last nine years common terns have been arriving to the islands later each year and showing low interest in breeding with no breeding attempts at all recorded in 2010 and 2014 (Heaney 2017). Roseate terns have declined from a maximum of 20 pairs in 1969 to the last recorded attempt in 1995, which is typical for many sites in the UK. But with the apparent decline of common terns towards extinction, long term prospects look bleak despite the potentially improving nesting habitat suitability. The issue may be food availability. Productivity has been consistently low in recent years and although data is limited, the results from the diet study would suggest a potential lack of food for terns. On this basis, we have not suggested that the Isles of Scilly represents a key potential site for roseate tern. But further investigations of prey are recommended to clarify if this is limiting the potential of the archipelago for terns. The potential of this site should be kept under review.

6 Target Areas for long-term management

Figure 15 shows target areas for potential recolonization of roseate terns and therefore the long-term management. These areas were selected based on the following factors:

1. Current and historical distribution of roseate tern.
2. Distribution of more than one prey species (A3)
3. Presence of common tern colonies (>50 pairs in the last 10 years)

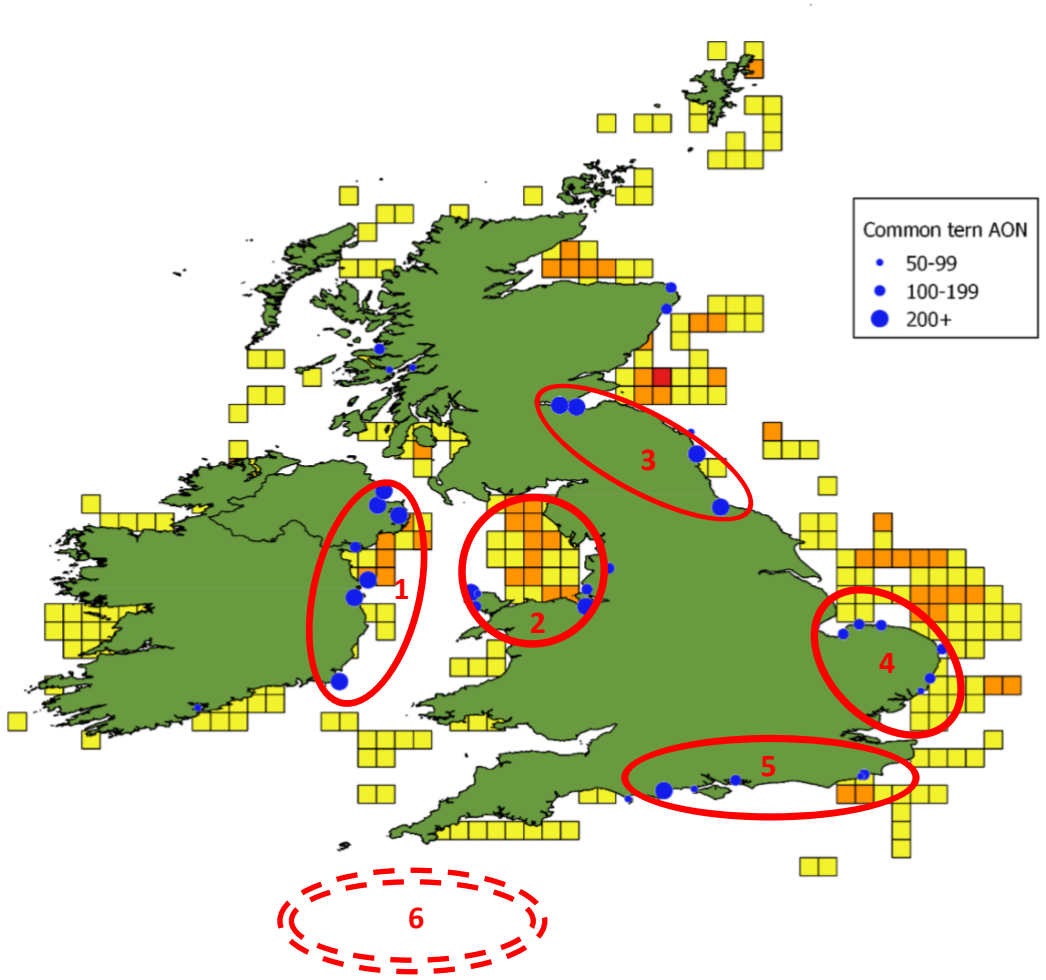

Figure 16 Target Areas for potential future recolonization of roseate terns. 1 – East coast of Ireland; 2 – Anglesey to Cumbria; 3 – Firth of Forth to Northumberland; 4 – Norfolk to Thames; 5 – South Coast (Kent to Dorset) and 6 – Brittany (FR)

6.1 East coast of Island of Ireland

This area comprises the two largest roseate tern colonies (Rockabill and Lady's Island Lake), one site where roseate terns breed annually (Blue Circle Island within Larne Lough SPA) as well as medium and large common, Arctic and Sandwich tern colonies (Tables 1 and 2). The main colonies comprise all of the above sites, but also Dalkey Islands and Dublin Port (artificial platform) in Republic of Ireland, and Carlingford Lough (Green Island), Strangford Lough and Belfast Harbour in Northern Ireland.

The Irish Sea is regarded as one of the richest feeding areas for both breeding and staging terns before migration south. For example, large numbers of birds concentrate around Dalkey Islands, Wexford

Harbour and Carlingford Lough. Arctic terns from Farne Islands (NE England), which were fitted with geolocators, cross overland to feed in Irish sea before continuing south (C. Redfern, pers. comm).

Rockabill is the only source colony of roseate tern "exporting" birds to other sites.

Table 1 Peak number of pairs in the last 10 years and the most recent count of common and roseate terns at main colonies along Eastern coast of Northern Ireland. Project sites are in bold

Site	Common Tern (peak count in last 10 years and most recent count)	Roseate Tern (peak count in last 10 years and most recent count)	Manager
Larne Lough SPA (Blue Circle and Swan Islands)	**743 355 (2017)**	**5 1 (2017)**	**RSPB**
Carlingford Lough SPA (Green Island)	398 147 (2017)	0	RSPB
Strangford Lough SPA (numerous islands)	1174 262* (2017)	0	NT
Belfast Lough	418 367 (2017)	0	RSPB
Outer Ards SPA (Cockle Island)	68 23 (2017)	0	NT
Copeland Islands	62 35 (2012)	0	Copeland Bird Observatory

* Arctic and common terns

Table 2 Peak number of pairs in the last 10 years and the most recent count of common and roseate terns at main colonies along Eastern coast of Republic of Ireland. Project sites are in bold

Site	Common Tern (peak count in last 10 years and most recent count)	Roseate Tern (peak count in last 10 years and most recent count)	Manager
Rockabill	**2191 2035 (2017)**	**1603 1603 (2017)**	**BWI**
Lady's Island Lake	**1010 1010 (2017)**	**219 219 (2017)**	**NPWS**
Dalkey Islands	**70 8 (2017)**	**1 1 (2016)**	**BWI**
Dublin Port (raft)	538 404 (2017)	0	BWI

Historically, roseate terns used to breed in Wexford Harbour (RoI), Carlingford Lough, Swan Island (Larne Lough), Big Copeland, Lighthouse Island and Mew Island and Strangford Lough. These sites should be considered for their potential, if common tern colonies are present.

Long-term opportunities for this region comprise of four projects with beneficial use of dredging. Blue Circle Island within Larne Lough has been restored within the scope of the LIFE project (Table 4).

Recommendations:

1. Continue intensive management on Rockabill and Lady's Island Lake.
2. Restore Blue Circle Island being the only regular breeding site for roseate tern outside of the main colonies and most important Sandwich tern colony in Ireland.
3. Continue ratcontrol-monitor-control trial and develop long term management plan for Dalkey Islands.
4. Investigate restoration of Green Island on Carlingford Lough and creation of tern habitats within Belfast and Strangford Loughs using dredging material.
5. Investigate restoration options on Lambay Island, Irelands Eye and associated islands in Dublin Bay, RoI.
6. Install robust biosecurity measures for Copelands Islands to maximise the chances of the islands remaining rat free and investigate habitat enhancements to make islands more suitable for terns.
7. Develop a working group with main stakeholders: BirdWatch Ireland, National Trust, Northern Ireland Environment Agency, National Parks and Wildlife Service to exchange information and best practice in management and monitoring.
8. Carry out the inventory of colonies, assemblage composition, population size and trends, threats and management challenges and food supply.
9. Carry out the inventory of tern colonies within Carlingford, Strangford, Belfast and Larne Loughs to include assemblage composition, population size and trends, threats and management challenges and food supply. Identify best options for future tern colonies.
10. Develop a list of specific actions for each of the colony.

6.2 Anglesey to Cumbria

This target areas comprises colonies located the nearest to the main roseate tern colonies in the Republic of Ireland, only a short distance across the Irish Sea, which as discussed above, is one of the best feeding areas for terns around British Isles. These colonies are: The Skerries, Ynys Feurig, Cemlyn Bay (Anglesey), Shotton Steel Works (Dee Estuary), Seaforth Nature Reserve (Merseyside) and Hodbarrow, Foulney Island (Morecambe Bay).

The top priority site in this target area is The Skerries, where year after year there have been a mixed pair(s) of roseate and common tern and one "clean" pair of roseates bred successfully in 2018.

Ynys Feurig is one of the intensively managed project sites, where in the last couple of years managers successfully reduced predation pressure. It is another top candidate for the receptor site.

Cemlyn Bay is also a project site, but it has a small population of common terns at the moment. Considering dynamic population changes of Sandwich terns, which have recently declined, there is a possibility that Cemlyn Bay will become more important for common terns due to more nesting space.

Remaining sites have a role in strengthening the common tern metapopulation, however it is not clear if they are suitable as receptor sites without further assessments. Certainly, roseate tern used to breed on Seaforth Nature Reserve, and Hodbarrow is intensively managed by the RSPB with a recent increase in the Sandwich tern population.

Formerly, roseate tern bred on The Skerries (last record 2006), Ynys Feurig (2012) and Cemlyn Bay (2006), Seaford Nature Reserve (2009) and in Morecambe Bay SPA – South Walney (1969).

Table 3 Peak number of pairs in the last 10 years and the most recent count of common and roseate terns at main colonies in Anglesey to Cumbria Target Area. Project sites are in bold.

Site	Common Tern (peak count in last 10 years and most recent count)	Roseate Tern (peak count in last 10 years and most recent count)	Manager
The Skerries	**386** **386 (2017)**	**1** **1 (2018)**	**RSPB**
Ynys Feurig	**196** **153 (2017)**	**1** **1 (2012)**	**RSPB**
Cemlyn Bay	**194** **20 (2017)**	**1** **1 (2006)**	**NWWT**
Shotton Steel Works (Dee Estuary)	762 407 (2017)	0	Merseyside Ringing Group
Seaforth Nature Reserve (Merseyside)	221 177 (2017)	0	Lancs WT
Hodbarrow (Duddon Estuary Cumbria)	44 40 (2017)	0	RSPB

Recommendations:

1. Continue intensive management at The Skerries and Ynys Feurig as the top priority sites for recolonization.
2. Investigate habitat manipulation on one of the two islands within Cemlyn Bay to encourage more common/ Arctic terns.
3. Continue to engage with Wyfla development to seek compensation/mitigation for any impacts on Cemlyn and opportunities for creation of new tern sites within the Irish Sea.
4. Continue to strengthen protection and management of Hodbarrow as the principle tern colony in Cumbria.
5. Develop specific recommendations to strengthen the metapopulation of common terns on remaining sites in the region through the implementation of best practice on remaining key sites.
6. Explore opportunities for habitat creation within the identified sites.

6.3 Northumberland to Firth of Forth

The area includes Coquet Island in Northumberland – currently the only colony of roseate terns in the UK.

Farne Islands SPA, which has been designated for roseates, supports a large population of Arctic and a medium population of common terns. Two pairs of roseate terns bred there in 2009, and despite being a short distance from Coquet (20 nautical miles) and intensively managed for roseates, there have only been two breeding attempts in the last 10 years. The peak count for the Farne Islands was 71 pairs in 1969. Roseate tern features on Lindisfarne SPA's list of features, but the species has not bred there since 1991, with only 4 pairs in 1990 and the peak number of 31 pairs in 1969. Equally, there have been no common tern breeding since 2009 when only 20 pairs bred.

The Firth of Forth used to be one of the strongholds for roseate terns. There is general agreement that the primary reason for their decline was expansion of large gull species. This forced roseate terns to

"jump" from one island to another including Isle of May (last record 1956), Car Craig (last record 1951 – herring gull), Inch Garvie (last record 1954 – rats), Inchkeith (last record late 1960s – herring gull), Fidra (last record 1972 – large gulls), Inchmickery (last record 1983 – large gulls) and Long Craig (the most recent breeding pair in 2009). Due to persisting populations of large gulls on Inchmickery and Fidra, absence of common tern colonies and deteriorating conservation status of herring and lesser black-back gulls, it would be not feasible to make these islands suitable for terns. Currently, they are managed for other seabird species by the RSPB. Therefore, options for roseate tern are limited – despite the history of occurrence here.

The Firth of Forth area benefits from the isolated sprat population, which serves as an alternative food supply for seabirds, compensating to a varying extent (depending on the species) for apparent declines of sandeels in this area. Terns feed almost exclusively on sprat in Firth of Forth.

The main common tern colonies are Leith Docks (a separate SPA), Long Craig Island with a supporting tern raft in Port Edgar Marina, Isle of May and a number of small East Lothian colonies (Eyebroughy, The Leithies and Great Car) (Table 4).

Long Craig is vulnerable to flooding and recolonization should not be encouraged. The Isle of May has a very small population of common terns and roseate terns have been absent here since mid-1950s despite continuous management, but the island is well managed by SNH, including for predation and disturbance. The Leith Docks colony is located on a discussed dock and within a fully operating dock site. However, in recent years a mixed pair of roseate and common tern has been breeding in Leith Docks.

Table 4 Peak number of pairs in the last 10 years and the most recent count of common and roseate terns at main colonies in Firth of Forth to Northumberland area. Project sites are in bold.

Site/ Species	**Common Tern (peak count in last 10 years and most recent count)**	**Roseate Tern (peak count in last 10 years and most recent count)**	**Manager**
Coquet	**1358** **1257 (2017)**	**111** **111 (2017)**	**RSPB**
Farne Islands	118 87 (2016)	2 2 (2009)	NT
Lindisfarne SPA (Holy Island Sands)	20 20 (2009)	0	NE
Long Craig/ Port Edgar	**165** **165 (2017)**	**1** **1 (2009)**	**SWT**
Isle of May	**101** **29 (2017)**	**0**	**SNH**
Leith Docks	1004 1004 (2017)	0	FSG/ Lothian Ringing Group
East Lothian Colonies	- 28 (2018)	0	FSG, County Council

Recommendations:

1. Maintain intensive management of Coquet Island.
2. Review threats for common terns on the Farne Islands and propose remedial measures. Install robust biosecurity measures

3. Liaise with NE over Lindisfarne management.
4. Maintain and improve biosecurity measures on Isle of May.
5. Continue expansion of terraces, provision of nest boxes and predation control on the Isle of May.
6. Continue small scale habitat improvements on Long Craig and maintain the tern raft in Port Edgar as a back-up site.
7. Engage with SNH to facilitate a better relationship with the managers of Leith Docks and allow the provision of nest boxes for roseate tern and more frequent monitoring. Prevent unnecessary disturbance at the disused dock.
8. Engage East Lothian colony managers from the County Council and Forth Seabird Group to exchange good practice.

6.4 Norfolk to Thames

This area has been selected for good food resources, existence of medium common tern colonies within some of the most important breeding tern assemblages in the UK. There has been historical breeding of roseate terns, but never a viable colony here, with peak counts of only up to 3 pairs at Blakeney Point in 1996. The last single breeding pairs nested at RSPB Titchwell Marsh and Scolt Head NNR in 2000, within the North Norfolk Coast SPA, and a single pair bred at Minsmere RSPB reserve in 2009.

Another reason for identifying this area is the potential for creation of major new sites for nesting terns which would include common tern and therefore potentially roseate tern.

There are large common tern colonies in the region, most of them within North Norfolk Coast SPA (Table 5).

Table 5 Peak number of pairs in the last 10 years and the most recent count of common and roseate terns at main colonies in Norfolk to Thames target area.

Site/ Species	Common Tern (peak count in last 10 years and most recent count)	Roseate Tern (peak count in last 10 years and most recent count)	Manager
The Wash (Snettisham RSPB)	174 174 (2016)	0	RSPB
North Norfolk Coast SPA (Blakeney Point)	135 60 (2017)	0	NE
North Norfolk Coast SPA (Holkham NNR)	95 21 (2015)	0	NE
North Norfolk Coast SPA (Scolt Head Island NNR)	290 142 (2016)	0	NE
Minsmere Scrape & Beach (Minsmere)	191 76 (2017)	1 1 (2009)	RSPB

Recommendations:

1. Continue to manage important tern colonies. Monitor population of common terns in the area and increase focused management on roseate terns if they appear and look to breed.

2. Investigate large scale opportunities for coastal habitat creation which includes habitats for breeding terns. These are likely to include flood management schemes in Suffolk Essex and the Thames and beneficial use of dredgings projects throughout the region.

6.5 South Coast (Kent to Dorset)

This area has been selected for the presence of large common tern colonies and historical roseate tern breeding (Solent and Southampton SPA is a designated site for the roseate tern). Roseate terns bred within this SPA on Hurst Spit (last record of 1 pair in 2005), North Solent NNR (1 pair in 2000 and peak count of 3 in 1994). Elsewhere within the target area roseate terns nested at Langstone Harbour (1 pair in 2006), Poole Harbour – Brownsea Island (1 pair in 2009) and Dungeness to Pett Level SPA – Burrowers Pit RSPB reserve (1 pair in 1990).

Unfortunately, our understanding of food resources in the English Channel is relatively poor and further surveys are needed. Here the extract from our assessment: "Based on the prey hotspots map the central Channel is noticeably devoid of high catch rates of sandeels, sprat or herring. A locally abundant population of sprat is known to exist in Lyme Bay (ICES, 2013a), and the map of sprat catch rates in Heessen et al. (2015) shows that a few areas have moderate-high catch rates of up to 100-1000 n/hour. However, when looking over the maps it seems that the Channel has a considerably lower abundance of sandeels, sprat and juvenile herring compared to most other areas" (Green, 2017a).

There are four sites with recent records of common terns within this target area (Table 6), namely Langstone Harbour, Western Solent Saltmarshes (project site), Rye Harbour and Brownsea Island within Poole Harbour SPA. Large colonies which do not exist anymore include North Solent NNR, Hurst Point, and Dungeness.

The uncertainties about the food resources in this area puts into question whether the sites could be promoted to the priority status without further diet and provisioning monitoring. Furthermore, low lying colonies on Lymington Marshes in Western Solent are vulnerable to flooding.

Table 6 Peak number of pairs in the last 10 years and the most recent count of common and roseate terns at main colonies in South Coast target area. Project sites are in bold.

Site/ Species	**Common Tern (peak count in last 10 years and most recent count)**	**Roseate Tern (peak count in last 10 years and most recent count)**	**Manager**
Solent and Southampton SPA (Lymington Marshes)	**371 122 (2017)**	**1 (2005)**	**HCC/ H&IW WT/ RSPB**
Rye Harbour (Dungeness to Pett Level SPA)	341 170 (2017)	0	
Poole Harbour SPA (Brownsea Island)	248 200 (2015)	1 (2009)	NT/Dorset WT
Chichester and Langstone Harbours SPA	181 154 (2017)	1 (2006)	RSPB

Recommendations:

1. Develop methodology and carry our provisioning monitoring for common terns.
2. Continue improving management within Pagham, Langstone and Chichester Harbours Harbour and The Solent.
3. Continue with habitat restoration of islands and beach features at g Dungeness and Rye.
4. Develop new habitat for nesting terns in Poole Harbour (e.g. Arne Moors) to provide alternative nesting sites in anticipation of loss of Brownsea Island.
5. Investigate beneficial use of dredging schemes to support the above and become established as a sustainable long-term option for providing new tern nesting habitats throughout the region.

6.6 Brittany

Brittany hosts a small population of roseate terns, which is more transient than the Irish and UK colonies. L'Ile aux Dames, La Colombière and L'Ile aux Moutons were found to be favourable for the species, with the latter site having successful breeding attempts in 2010 and in 2011. From 2012 onwards, the number of breeding roseate terns on L'Ile aux Moutons and La Colombière increased. These terns were displaced from heavily predated Ile aux Dames in 2011, which had been a main site since 1986. In 2017, La Colombière supported 6 breeding pairs, and Ile aux Moutons 46 pairs of breeding roseate terns and these two sites are currently the main breeding locations in France. However, on the west coast of Brittany, there were 3-5 pairs of roseate terns that attempted to breed on the island of Kemenez in 2016 (per comms, Yann Jacob, 2016).

As part of networking activities, site managers from Ireland and the UK visited both sites in spring 2018 to assist French colleagues in building the first ever terraces and placing nest boxes. During the visit, it became apparent that La Colombière was occupied by rats.

Clearly, the top priority for the French population is to increase the viability of the two colonies, especially Ille aux Moutons. Rat control should be introduced and maintained at La Colombière as soon as possible as a necessary step to safeguard the colony. Without rat control it remains questionable if roseate terns should be encouraged to settle there, as these birds would have had a better chance of breeding success at Ile aux Moutons.

Recommendations:

1. Continue a programme of terrace building, provision of nest boxes and improved monitoring at Ille aux Moutons.
2. Initiate rat control and carry out biosecurity monitoring at La Colombière.
3. Assess options for island restoration and management of former and potential roseate sites in Brittany.

7 Final remarks and recommendations

The conclusions support the importance of delivering site-based work in the established roseate tern colonies and in supporting common tern conservation in potential colonies. The assessment also highlights some important areas of further investigation to inform longer term roseate tern conservation.

The two main RoI colonies and one UK colony are under conservation management and support thriving productive colonies of other tern species. The management of all three will be improved by the C1 and C2 actions in the LIFE project. Maintenance of these existing colonies should remain the top priority. Given the increasing population at Rockabill and Lady's Island Lake, we can anticipate some emigration from these colonies and potential (re) colonisation of sites in the future.

The assessments in this report highlight a number of important areas which are currently or could be important for roseate terns. These priority areas are based on the presence of existing robust common tern colonies broadly within the current range of roseate tern and in suitable feeding areas. This particularly identifies the importance of the Irish Sea with the priority areas for roseate tern targeted action as the east coast of the RoI and Northern Ireland, and the area from Anglesey to Cumbria, along with the other two areas that currently support roseate terns – Northumberland and Brittany.

It is also noted that there are several major coastal habitat creation projects completed (e.g. Wallasea) or in development in Eastern England which could provide significant opportunities for breeding terns in the future, despite this area not being a stronghold for roseate terns in the past. This area is also likely to benefit from increased sprat abundance, so food may be less of an issue than in other parts of the UK. We recognise that building generic tern conservation objectives into these new projects can provide important opportunities for roseate terns in the long term.

It is important to recognise that these colonies are part of a metapopulation and, therefore, a collaborative approach between colony managers is desirable. While it is difficult to determine the boundaries of the metapopulation, working across wider biogeographic areas can facilitate good practice and experience sharing between colony managers. There will be a need for initiating partnership working and there are good examples where this already happens e.g. Northern little tern workshop, South-East Seabird Forum.

There are several strategic recommendations cross-cutting all the target areas, which are listed below.

Establish effective regional networks within each of the key areas

These groups should:

1. Identify management priorities within target areas in partnership with others.
2. Enable good practice sharing, guidance development through organising end-of-season meetings, networking exchanges, workshops, etc.
3. Explore opportunities along the NI and RoI coast. This is the most likely area of range expansion from Rockabill/Lady's Island Lake if suitable conditions could be provided. The proposed colony management work on Blue Circle Island in Larne Lough is a key part of this but a wider assessment of opportunities is required, including discussions with other land managers and agencies
4. Look for opportunities for terns through major coastal management projects. With some large scale/ innovative coastal habitat creation projects in the pipeline, there could be some significant benefits to terns if tern conservation is built into the project objectives and design at

an early stage. It is important to engage with these and establish some important precedent setting principles which can guide further opportunities into the future.

5. **Further assessment of management options for Britany tern sites**. Current population is vulnerable, and it is a priority to (re) establish secure breeding areas with robust populations. This particularly concerns invasive species management and biosecurity on islands, and some habitat enhancement measures.

Further research to inform future conservation strategy

1. Investigate how to maximise the benefit of artificial sites for common/roseate terns – some of the larger common tern colonies are associated with man-made structures within docks e.g. Dublin, Seaforth (Mersey), Leith Docks (Forth) and could offer good opportunities for roseate tern given the pressures on natural habitats. Recommend further exploration of the types of habitat being used by terns, current management and issues with recommendations on wider applicability.
2. Food availability. The availability of food is a potentially limiting factor in some areas. It is noted that data is lacking for southern England and Brittany. Information on diet would inform the priority to be given to tern conservation on, for example, the Isles of Scilly, a former roseate tern breeding site, and inform the long-term prospects for Brittany.

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