International (East Atlantic) Species Action Plan for the Conservation of the Roseate Tern *Sterna dougallii* (2021-2030)

With the financial support of the European Union's LIFE Nature Programme

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This plan uses evidence-based guidance principles. The following databases were checked on 11.03.2021: Conservation Evidence www.conservationevidence.com, the library of systematic reviews of Collaboration for Environmental Evidence https://environmentalevidence.org and the CEE Database of Evidence Reviews (CEEDER) database **https://environmentalevidence.org/ceeder** (using search terms “tern” and “seabirds”).

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Front cover illustration: Roseate tern *Sterna dougallii* © Brian Burke

Glossary of acronyms

ALL	All principal states
AEWA	African Waterbird Agreement
BR	All breeding range states
BTO	British Trust for Ornithology
CACEM	Centre d'Appui au Contrôle de l'Environnement Marin
CAW	Centre for African Wetlands
CCLME	Canary Current Large Marine Ecosystem
CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species (Bonn Convention)
COQ	Coquet Island
CR	Critically Endangered
DOCOB	Document d'objectif (purpose document)
DRAM	Azores Regional Directorate of Maritime Affairs
EJF	Environmental Justice Foundation
EU27	Member States of the European Union
FR	France
GCLME	Guinea Current Large Marine Ecosystem
GES	Ghana Education Service
GH	Ghana
GPS	Global Positioning System
ICBP	International Council for Bird Preservation
IE	Ireland
IMAR	Institute of Marine Research (Azores)
INNS	Invasive Non-native Species
IUCN	International Union for Conservation of Nature
LC	Least Concern
LIL	Lady's Island Lake
MISEN	Mission Interservices de l'Eau et de la Nature
MPA	Marine Protected Area
MSFA	Multi-Species Foraging Association
NGO	Non-governmental Organisation
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PIT	Passive Integrated Transponder
PT	Portugal
ROC	Rockabill
RSPB	Royal Society for the Protection of Birds (UK)
SPA	Special Protection Area
SPEC	Species of European Conservation Concern
SSBP-G	Save the Shorebirds Project Ghana
SST	Sea Surface Temperature
UK	United Kingdom

Executive summary

The first International Action Plan for the East Atlantic population of roseate tern was developed in 1999 but has never been revised (Newbery 1999). Since the original publication, considerable advances have been made in the colony management, biosecurity and scientific knowledge of the species.

This action plan applies to the East Atlantic colonies of Azores and NW Europe, which form separate metapopulations but come under a single plan as part of the EU adopting framework. Most of the East Atlantic population (95% of the 2,679 pairs in 2019) breeds in the EU27, namely in Portugal (Azores) (PT), Ireland (IE) and France (FR), with the remaining population in the United Kingdom (UK). Former breeding colonies on Madeira (PT) and Canary Islands (ES) are extirpated. Hence for the purpose of this plan, the Principal Range States for breeding populations are PT, FR, IE and the UK. Within the wintering range, Ghana (GH) has been selected as a Principal Range State due to its special importance for wintering birds.

Historically, throughout the 1970s and 1980s, the roseate tern suffered catastrophic declines and shrinking distribution across all its colonies in Western Europe from a peak of over 3300 pairs (14 colonies) in 1968 to just 467 pairs (11 colonies) in 1989 (Cabot & Nisbet 2013).

Currently, the entire East Atlantic population breeds in 11 viable, stable colonies. 66% of the total of 2,679 pairs breeds in just two colonies in IE, 27% in 7 colonies in Azores and the remaining 7% in two viable colonies in the UK and FR.

In Europe, the roseate tern has been assessed as a species of Least Concern (LC) because the population is increasing, and range maintained. However, the population status and range remain far below historic levels, and the species is still facing multiple threats, hence a revision of the species' threat status can be justified. The roseate tern is a Species of European Conservation Concern (SPEC 3) because of its rarity and is listed on Annex 1 of the Birds Directive. The species is also listed in Annex II of, respectively, the Bern and Bonn Conventions, and is accorded 1c status under the AEWA Agreement as the population is below 10,000 individuals. The OSPAR Convention includes roseate tern in its list of threatened and/or declining species and habitats (OSPAR agreement 2008-6).

There are two major risks associated with the concentration of the majority (58%) of the population in just one colony at Rockabill Island (IE):

a. there are signs of density dependent effects on Rockabill (the largest colony) with lower-than-average productivity in the last five years, meaning that the site is producing fewer individuals to sustain the recent growth rate of the metapopulation. We can expect that the growth will therefore slow down or plateau.
b. in the case of a stochastic event affecting Rockabill, the colony may disperse to less suitable sink sites where productivity might be below the population maintenance level (so-called buffer effect).

The following threats have been linked to reduced productivity on the breeding grounds:

- Predation by large gulls and other avian predators, native and invasive non-native mammals
- Disturbance through uncontrolled human access and egg collecting
- Climate change related threats
  - Extreme weather events
  - Loss of nesting sites to coastal change
  - Long-term impacts of climate-driven environmental change

- Shortages of food
- Development of offshore windfarms
- Lack of sufficient protection of foraging areas
- The impact of commercial fishing

The following threats have been linked to reduced survival of adults and fledged juveniles at wintering grounds and during migration:

- Tern trapping
- Overfishing and climate change impacts on cold water upwelling systems

The overall goal of the Action plan (2021-2030) is to **maintain the growth of the East Atlantic roseate tern population, while securing suitable sites for colonisation within a coherent network of European colonies.**

While it is necessary to maintain or introduce intensive management of the key roseate tern colonies (Objective 1), it is also important to provide safe nesting conditions at large common tern *Sterna hirundo* colonies in preparation for roseate tern expansion (Objective 2), either through the growth of the NW European metapopulation, or more likely, dispersal caused by deterioration of one of the key extant colonies. Target areas have been selected for potential colonisation in NW Europe, based on the distribution of multiple prey species, and historic and current key roseate and common tern colonies. Furthermore, protection of key coastal sites and forage fish stocks along the migration routes and on the wintering grounds will be secured through research, policy and advocacy work (Objective 3). Awareness raising, further scientific advances and improvement of monitoring methods (Objective 4) will be based on regional cooperation via knowledge and best practice sharing (Objective 5). The implementation of the plan will be coordinated and reported by a lead organisation under supervision of the Working Group and in collaboration with national authorities, statutory agencies and partners (Objective 6).

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1 Introduction

The roseate tern *Sterna dougallii* is “probably” the most beautiful tern species in Europe with very pale plumage, long tail streamers and a delicate pink “blush” on the underparts, from which the species takes its name. Historically, throughout the 1970s and 1980s, the roseate tern suffered catastrophic declines and shrinking distribution across all its colonies in Western Europe from a peak of over 3300 pairs (14 colonies) in 1968 to just 467 pairs (11 colonies) in 1989 (Cabot & Nisbet 2013). Because the declines occurred simultaneously across the whole breeding range, it was thought that the limiting factors acted in coastal areas of West Africa (Cabot 1996), first trapping and, more recently, concerns about human overexploitation of forage fish. It had been established that a relatively high proportion of ring recoveries (around 82%) from roseate terns came from Ghana, the majority from trapped birds (Mead 1978, Dunn & Mead 1982, Avery et al. 1995). The decline prompted intensive conservation and education programmes, both at the breeding and wintering grounds (Avery et al. 1995), which has halted and reversed the downward population trend since the early 1990s. However, the distribution of active colonies has shrunk, and the species is still confined to only four colonies supporting >10 pairs in Western Europe and sensitive to potential stochastic events, predation and predicted shortages of food caused by climate change.

The first census of the Azorean breeding population was carried out only in 1984, followed by regular counts from 1989 (del Nevo et al. 1993) and since then the population there has fluctuated dramatically but is considered stable. Nisbet & Ratcliffe (2008) attributed these fluctuations to extensive but variable non-breeding and there is no evidence that the birds bred anywhere else in the low years.

The first international action plan for the East Atlantic population of roseate tern was developed in 1999 but has never been revised (Newbery 1999). Since the original publication, considerable advances have been made in the colony management, biosecurity and scientific knowledge of the species. This action plan aims to outline the up-to-date threats and set the objectives and actions for the species for the period 2021-2030.

2 Basic data

The global distribution of roseate tern is highly fragmented as it is primarily a tropical species breeding on numerous islands of the Indian and Pacific Oceans, SE Africa, Madagascar, Seychelles, Mascarenes, Oman, India, Sri Lanka, Australia, Central America and the Caribbean (Figure 1). There are at least five roseate tern subspecies in the world (Gochfeld 1983), with the nominate race comprising of the temperate (North Atlantic and South Africa) and the Caribbean populations.

All temperate populations of roseate terns have limited distribution and historically have probably always been relatively small, despite consistently good breeding success (Cabot & Nisbet 2013). In the North Atlantic temperate zone, there are three distinctive metapopulations, i.e. (a) NE coast of the US/ SE coast of Canada, (b) Azores and (c) NW Europe. There are very few documented exchanges of individuals between these metapopulations (Nisbet & Cabot 1995, Hays at al. 2002, Cabot & Nisbet 2013, Nisbet 2014) with only one proven record (Azores) of a bird breeding on the opposite side of the Atlantic to which it fledged (Cabot & Nisbet 2013). This pattern calls on each metapopulation to be managed as a separate conservation unit.

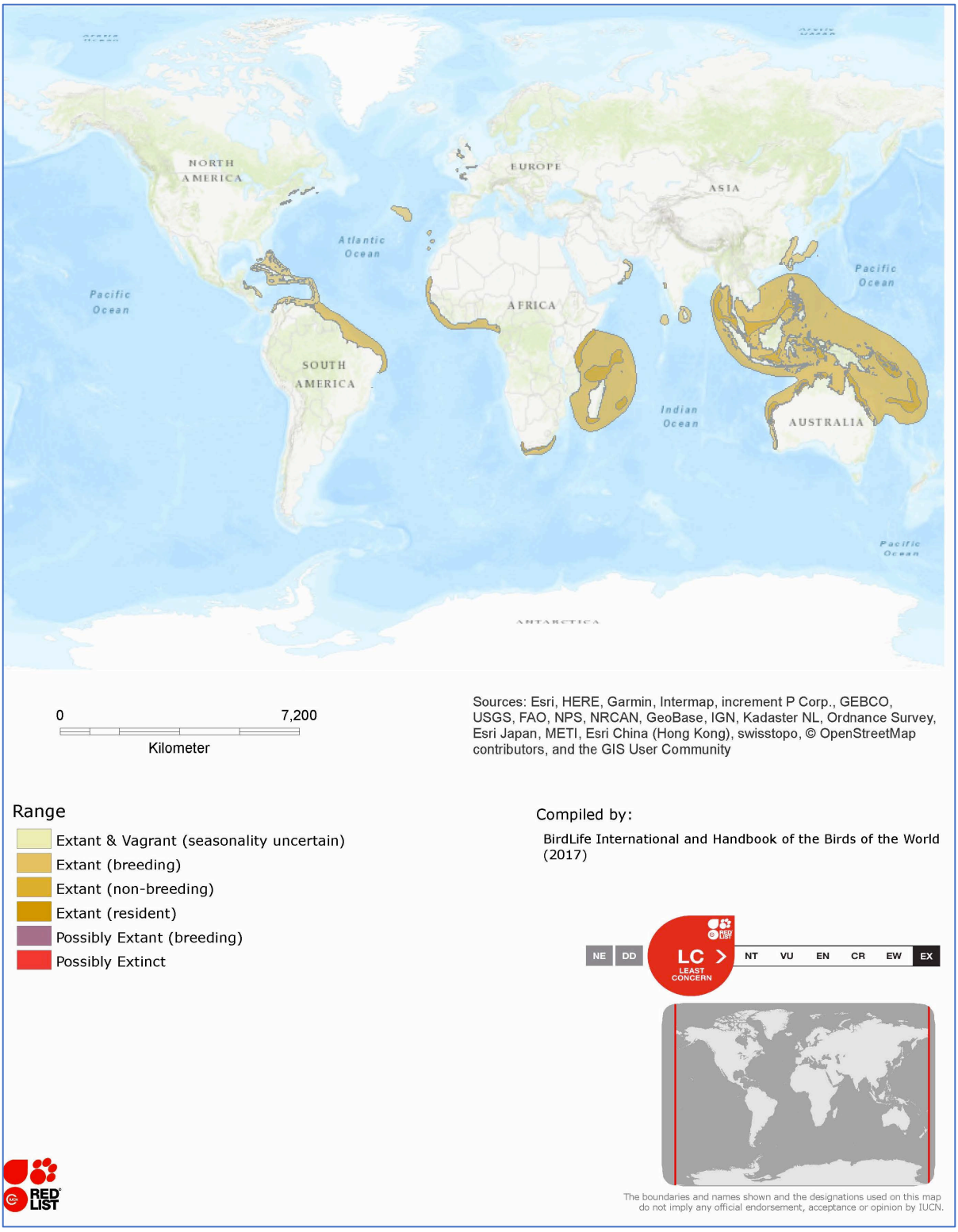

Figure 1: Global distribution of the roseate tern (The IUCN Red List of Threatened Species: *Sterna dougallii* – published in 2018).

This action plan applies to the East Atlantic colonies of Azores and NW Europe, which form separate metapopulations but come under a single plan as part of the EU adopting framework. Most of the East Atlantic population (95% of the 2,679 pairs in 2019) breeds in the EU27, namely in Portugal (Azores) (PT), Ireland (IE) and France (FR), with the remaining population in the United Kingdom (UK). Former breeding colonies on Madeira (PT) and Canary Islands (ES) are extirpated. Hence for the purpose of this plan, the Principal Range States for breeding

populations are PT, FR, IE and the UK. Within the wintering range, Ghana (GH) has been selected as a Principal Range State due to its importance for wintering birds, although some of them spend winter off the coasts of Togo, Ivory Coast, Liberia and Sierra Leone (Ratcliffe & Merne 2002, Redfern et al. 2021). Several stopover areas have been identified along coastal West Africa (Guinea-Bissau, Senegal, Mauritania) and north of the Canary Islands - Spain (Redfern et al. 2021). This pattern derived from a geolocator study (see 4.1 below) reinforces the distribution shown by ringing recoveries (Ratcliffe & Merne 2002). Conservation strategies in these areas will be addressed through the East Atlantic Flyway Initiative[1], rather than directly through individual states.

Globally, the roseate tern has been assessed as a species of Least Concern (LC) due to its very large population range and size, which is not believed to be declining rapidly enough to approach the Vulnerable status threshold, although the trend is largely unknown (Birdlife International 2018). The global population is estimated as c. 200,000-220,000 individuals (Wetlands International 2015).

In Europe, the roseate tern is also considered as a species of Least Concern (LC), because its range is not shrinking, and the population is increasing. However, its population status and range remain far below historic levels, and the species is still facing multiple threats, hence a revision of the species' threat status can be justified. The roseate tern is a Species of European Conservation Concern (SPEC 3) because of its rarity and is listed on Annex 1 of the Birds Directive. The species is also listed in Annex II of, respectively, the Bern and Bonn Conventions. The species is accorded 1c status under the AEWA Agreement as the population is below 10,000 individuals. The OSPAR Convention includes roseate tern in its list of threatened and/or declining species and habitats (OSPAR agreement 2008-6). Subsequently, OSPAR issued "Recommendation 2011/6 on furthering the protection and conservation of the Roseate tern *Sterna dougallii*"[2] and "Background Document for Roseate Tern"[3].

Table 1: International conservation and legal status of the roseate tern.

Legal framework	**Status**
IUCN Globally	Least Concern
IUCN Europe	Least Concern
Birds Directive	Annex 1
Species of European Conservation Concern	SPEC3
Bern Convention	Annex II
Bonn Convention (CMS)	Annex II
OSPAR	List of threatened species
AEWA	1c
CITES	Not listed

As the roseate tern is listed in Annex I of the Birds Directive, the species should be the subject of special conservation measures concerning its habitats, in order to ensure survival and reproduction in its area of distribution. EU Member States should classify the most suitable colonies in number and size as Special Protection Areas (SPAs) for the conservation of the species. Under the Directive, Member States shall also take the requisite measures to establish a general system of protection for the roseate tern, prohibiting in particular deliberate killing or capture by any method or keeping birds; deliberate destruction of, or damage to, species nests and eggs or removal of nests, taking eggs in the wild and keeping these eggs, even if empty (blown specimens); deliberate disturbance particularly during the period of

[1] http://datazone.birdlife.org/userfiles/file/sowb/flyways/4_East_Atlantic_Factsheet.pdf
[2] OSPAR 11/20/1, Annex 13: https://www.ospar.org/documents?d=32894
[3] OSPAR Background Document for Roseate Tern: https://www.ospar.org/documents?v=7180

breeding and rearing, insofar as disturbance would be significant having regard to the objectives of this Directive. Derogations from these provisions may be possible in the absence of other satisfactory solutions, for reasons specified in the Directive.

Within the Principal Range States, roseate tern is red listed in the UK (Eaton et al. 2015), amber in Ireland (Colhoun & Cummins 2013) and vulnerable in Portugal (Cabral et al. 2005). In France, the species is critically endangered (CR) (IUCN France et al. 2016).

3 Framework for Action

For background information, see the following:

- Annex 1. Biological Assessment, page 25
- Annex 2. Problem Analyses and Limitations, page 38
- Annex 3. Justification of Conservation/Management Objectives, page 48

Goal (2021-2030):
To maintain the growth of the East Atlantic roseate tern population, while securing suitable sites for colonisation within a coherent network of European colonies.

Long-term high level objectives (2031-2040):
Western Europe: To increase the roseate tern population to at least 2500 pairs distributed across at least 4 key colonies (min. 5-year mean 50 pairs) and 2-3 smaller, but stable colonies.

Azores: To increase the 10-year average population size of roseate tern to 1000 pairs distributed across at least 8 key colonies (min. 5-year mean 10 pairs) and several smaller intermittent[4] colonies.

Threat level assessment	Action priority	Action timescale
Critical - causing or likely to cause very rapid declines and/or extinction	**Essential**	**Immediate** - to commence within the next year
High - causing or likely to cause rapid decline leading to depletion	**High**	**Short** - to commence within the next 3 years
Medium - causing or likely to cause relatively slow, but significant, declines	**Medium**	**Medium** - to commence within the next 5 years
Low - causing or likely to cause fluctuations or minimal change	**Low**	**Long** - to commence within the next 10 years
Local - causing or likely to cause negligible declines in small parts of the population		**Ongoing** - currently implemented and should continue
Unknown - likely to affect the species, but extent unknown		**Completed** - completed during preparation of the Action Plan
Limitation - knowledge deficiency which, while not posing a threat to populations, calls for better understanding in order to implement more effective conservation strategies		

Applicability of action to countries: Ireland (IE), United Kingdom (UK), Brittany, France (FR), Azores Autonomous Region, Portugal (PT), Ghana (GH), All breeding range states (BR), All principal states (ALL).

[4] Sites which are occupied infrequently or for a number of years with one or more years of nesting cessation.

Objectives and results

Corresponding threats	Result	Action and scope	Priority	Timescale	Responsibility
Objective 1: Maintain or improve productivity through intensive management of all key colonies[5]					
A. Predation and displacement by large gulls (high) B. Predation by mammals (high) C. Predation by invasive non-native species (high) D. Predation by other bird species (medium) E. Human disturbance, including egg collecting (medium) F. Loss of nesting habitat (medium) G. Extreme weather events (medium)	**1.1 Average 5-year mean productivity maintained at a level sufficient to compensate for or exceed losses from the population due to natural mortality at all key colonies through management of predation, biosecurity, disturbance, nesting habitats and species competition**	**Action 1.1.1 Develop and update management strategies for key roseate tern colonies (BR)**	High	Immediate/ ongoing	• National and regional statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs • Landowners
		Action 1.1.2 Maintain and, if possible, introduce seasonal wardening Wardening is essential to enable habitat protection, predation control, biosecurity, disturbance management and monitoring. Emphasis should be put on employing experienced wardens and developing a training programme for beginners. Further investments in wardening infrastructure and equipment should be made. *a. Residential wardening (IE, UK, FR)* This action requires at least two full-time seasonal wardens per colony with additional wardening support depending on management requirements needed to effectively deliver conservation targets outlined in management strategies (see 1.1.1). Colonies for which funding level should at least be maintained are Rockabill (IE), Lady's Island Lake (IE) and Coquet Island (UK). Ile aux Moutons (FR) requires more support for full-time residential wardening. b. *Regular wardening (FR, PT)* For colonies where residential wardening is not possible due to the lack of infrastructure, a team of dedicated tern wardens should be available to attend the colonies on a regular basis	Essential	Short/ ongoing	• National and regional statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs • Landowners

[5] See long-term high level objectives for a definition of key colonies

		during the season. These colonies often suffer from human disturbance, avian predation and rat *Rattus* incursions. This is particularly important on Flores (PT), given that it hosts several important colonies. More specifically this applies to: • La Colombière (FR) • Chausey (FR) • Praia, Graciosa (PT) • Contendas, Terceira (PT) • Ponta do Burguilhão, Flores (PT) • Baixa do Moinho (Ilhéu), Flores (PT) • Ilhéu do Portinho, Flores (PT)			
		Action 1.1.3 Manage predation *1.1.3.1 Native avian predators (BR)* Where necessary, follow best practice guidance to implement and maintain: a. Gull *Larus*-free zones through removal of nests (under licence) to discourage nesting in the vicinity of the colony. This measure can also be applicable to oystercatchers *Haematopus ostralegus*, where necessary. b. Laser hazing, audio scarers and warden presence to discourage large gull roosts near the colony. c. Licensed humane lethal control of individual 'rogue' gulls (i.e. those specializing in predation of roseate or other terns). d. Removal of nests and individuals of crows *Corvus* predating colonies. e. Implement measures to reduce/control predation by Starlings *Sturnus vulgaris* on tern eggs during the tern breeding season on Praia (Graciosa, PT). If successful, apply the measure to Contendas (Terceira, PT) and Vila islet (Santa Maria, PT) as required. *1.1.3.2 Native mammalian predators (IE, UK, FR)* Where necessary, follow best practice guidance to implement and maintain: a. Installation of otter *Lutra lutra* fences b. Monitoring and prompt humane lethal control of other mammals such as stoats *Mustela erminea* or foxes *Vulpes vulpes* during the breeding season.	Essential	Immediate/ ongoing	• National competent authorities • Statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs • Landowners • Local communities/ boat users • Farmers and coastal fishermen (Azores)

		1.1.3.3 Non-native mammalian predators (BR) All roseate tern colonies require biosecurity surveillance to detect non-native mammalian predators. Depending on results of biosecurity monitoring, colonies located near the mainland or main Azorean (PT) islands may require periodic control of non-native rodents (especially rats and house mouse *Mus musculus*) to protect terns during the breeding season. There might be sites where eradication of other invasive non-native species, such as American mink *Neovison vison* and domestic cats *Felis domesticus*, is needed. Specifically: a. Develop predator management/ biosecurity plans for all the key roseate tern colonies, following biosecurity best practice guidance and including site-specific plans for routine surveillance, intensive monitoring in response to suspected sign of non-native mammals, and plans for dealing with incursions. Each site's plan should include all non-native mammalian species at risk of reaching the site. Sites are likely to be at risk of being reached by rats and house mice (either by stowing away, or by swimming) and multiple sites are likely to be at risk of being reached by American mink (by swimming). b. Provide training of key site managers in biosecurity methods, in particular the necessary surveillance techniques for the risk species at their site(s) and safe and effective use of traps (for mink) and as part of incursion response measures rodenticides (note that anyone buying or handling products sold for professional use has to undertake an accredited training course). c. For each site, purchase and make available the necessary surveillance equipment for all risk species as well as 'rapid response kit' necessary for responding to incursions. Refer to the above-mentioned biosecurity best practice guidance for a list of equipment. d. Raise biosecurity awareness amongst local communities and stakeholders such as boat owners, farmers and coastal fishermen. e. Sites with a high risk of rodent (re)invasion (especially those joined to the mainland at low tides or separated only by narrow channels of water) may require annual rodent control in the run up to (and possibly during, if safe to do so) the bird breeding season. This should be carried out only once rodent presence has been confirmed and in			

		accordance with best practice guidelines (for the UK and Ireland the protocols of the Campaign for Responsible Rodenticide Use (CRRU) should be followed, and we recommend these principles are also followed in other jurisdictions. f. Create buffer zones on islets adjacent to nesting colonies in Azores to monitor and control predators in order to prevent incursions (PT). g. Assess the feasibility and undertake measures to reduce mortality caused by domestic cats at affected colonies in Azores (PT).			
		Action 1.1.4 Manage habitats and improve nesting conditions The aims of habitat management are to achieve suitable nesting conditions and spatial separation of roseate terns from competing species. a. Control excess of vegetation where it reduces nesting space and increases chick mortality by chilling within roseate tern nesting areas without nest boxes (BR). b. Introduce experimental plots on Praia, Graciosa (PT) to aid productivity monitoring. c. Continue improving shingle areas and provision of nest boxes in colonies where the approach has been successful, i.e. IE, UK and Contendas islet (PT). d. Offer a choice of open ground with natural shelter and shingle areas with nest boxes in colonies where roseate terns traditionally nest on the ground or where uptake of nest boxes is low, i.e. in Brittany (FR) and, where practicable, in Azores (PT). e. Maintain common tern nesting habitat in suitable condition to keep the two species separate but adjacent to each other (BR). f. Provide suitable nesting conditions for other tern species and black-headed gulls *Chroicocephalus ridibundus* where they occur, in order to support the assemblage to increase collective defence against, and spread the risk from, avian and mammalian predation (IE, UK, FR).	High	Immediate/ ongoing	• Statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs • Landowners

		Action 1.1.5 Manage disturbance Most colonies are on islands/ islets, however some are located near the mainland and those further offshore, especially in FR and Azores (PT), might be landed from boats. Apart from more regular wardening (Action 1.1.2), further actions should be taken to minimise impact of human disturbance: a. Liaise with the planning authorities to mitigate tern disturbance caused by high densities of human populations on the coast near the FR colonies of Ile aux Moutons, La Colombière, and the Chausey Archipelago. i. Recruitment and supervision of seasonal rangers (1 at Ile aux Moutons, 2 at La Colombière) to raise awareness of ground nesting birds amongst local communities ii. Assist local authorities in utilising compensatory funding from coastal development schemes to protect ground nesting birds against increasing anthropogenic pressure iii. Liaise with policy authorities MISEN (Mission Interservices de l'Eau et de la Nature) et le CACEM (Centre d'Appui au Contrôle de l'Environnement Marin) to carry out regular patrols of the colonies b. Where possible, restrict landing through national nature protection legislation during the breeding season (ALL). i. While local orders are in place, regulatory protection should be strengthened at Ile aux Moutons (see 1.2.1c) and La Colombière in the form of national or regional 'nature reserve' status to further restrict access based on legislative orders (FR) c. Carry out educational/ information campaigns amongst local communities and particularly boat users (BR). d. Install interpretation signage and prevent access to the colony with fencing (BR). e. Continue to keep in place the Species Protection (night watch) Warden on Coquet Island (UK) to combat egg collectors. f. Provide monitoring hides and ensure the minimum regime required to deliver effective colony surveillance (BR).	Medium	Immediate/ ongoing	• National competent authorities • Statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs • Landowners • Local authorities • Local communities/ boat users

H. Inadequate protection of foraging areas around colonies (Medium)	**1.2 Protection of foraging areas around the breeding colonies secured**	**Action 1.2.1 Ensure adequate protection of foraging areas around colonies using established methods such as kernel density estimation and maximum curvature of either empirical or modelled distribution** a. Collect spatial utilisation distribution data at all key colonies where insufficient data exist, across the breeding season, and preferably over several years (IE, UK, FR). i. Consider a northern scale study of the Bay of Biscay and the Glénan Archipelago on spatial-temporal variations in the abundance of prey species caught by terns (FR). b. Where not already considered sufficient to protect the foraging areas of roseate tern colonies (see 1.2.1 and 1.2.1a), revise existing SPA/MPA boundaries or ensure other forms of effective protection through planning process or other local orders (IE, FR, PT). c. Expand the boundary of Glénan National Nature Reserve to include Ile aux Moutons and the surrounding foraging areas (FR). d. Integrate the conservation of roseate tern in the Conservation Objectives Document (fr: DOCOB) for La Colombière (FR) and the Chausey Archipelago (FR).	Medium	Short/ ongoing	• National competent authorities • Statutory agencies • NGOs • Environmental consultancies and independent experts
I. Potential impacts of offshore renewable energy and other coastal/ marine developments (Medium)	**1.3 Spatial planning and coastal/ marine development projects fully consider offsite-direct and indirect impact pathways on roseate tern food resources and foraging areas**	**Action 1.3.1 Require impact assessments which adequately evaluate and monitor direct and indirect ecosystem impacts of windfarms, nuclear power plants and other large-scale coastal/marine developments near roseate tern colonies, especially those potentially affecting forage fish and roseate tern foraging area use** a. Ensure that the assessment guidance of competent authorities includes the need to assess offsite impact pathways, and indirect impact pathways – especially through direct effects on food resources and foraging area use of roseate terns (IE, UK). b. Ensure applicants for coastal and offshore developments undertake to provide the information on forage fish and roseate tern foraging areas necessary to carry out the analysis for informing the impact assessment (IE, UK).	Medium	Ongoing	• National competent authorities • Statutory agencies • Applicants seeking development consent • Environmental consultancies and academic institutions • NGOs

		Action 1.3.2 Undertake strategic impact assessments for long-term offshore wind energy development plans for offsite and indirect impact pathways on key current and potential roseate tern colonies to be used by spatial planning authorities early in the development application process (IE, UK) a. Review and identify gaps in data on spawning/nursery grounds, dispersal capabilities and stocks of forage fish utilised by roseate terns for early consideration in the planning process.	Medium	Short	• National competent authorities • Statutory agencies • Applicants seeking development consent • Environmental consultancies and academic institutions • NGOs
J. Reduction in abundance and availability of forage fish due to climate change and local overfishing (Medium)	**1.4 Protection of forage fish stocks implemented through ecosystem-based fisheries management**	**Action 1.4.1 Promote ecosystem-based fisheries management for forage fish utilised by roseate terns (BR)** a. Advocate that the process of advising on setting annual fishery catch limits for sandeel *Ammodytes* and other forage fish is amended such that a greater biomass is 'set aside', sufficient to support the productivity of the population of roseate terns (and other seabird species dependent on these forage fish) required to compensate for or exceed losses in the tern population due to natural mortality.	Medium	Ongoing	• European Commission • National competent authorities • Statutory agencies • ICES • Fisheries organisations • Environmental consultancies and academic institutions • NGOs
Objective 2: Maintain, create or restore safe alternative sites for eventual expansion within target areas					
K. Vulnerability to stochastic events due to limited range in NW Europe (High) L. Loss of nesting habitats due to sea level rise (Medium)	**2.1 Population and productivity of key current common tern colonies increased**	**Action 2.1.1 Identify and improve management of those colonies of common tern *Sterna hirundo* (a 'carrier' or 'associated' species) which have high productivity, provisioning rates and diets that would indicate suitability for colonisation within the expected roseate tern range (BR)** a. Review and undertake management of the key coastal common tern colonies within the target recolonisation areas. b. Develop and deploy a training programme of colony management and monitoring for site managers, wardens and volunteers. c. Share best practice through a programme of local exchange visits and regional tern conservation forums (see Objective 5 in support of this action).	High/ ongoing	Immediate	• Statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs • Landowners

	2.2 New sites established through restoration or creation	**Action 2.2.1 Eradicate invasive non-native species (INNS) and ensure habitat and predation management on islands supporting former common and roseate tern colonies in order to encourage recolonisation (BR)** a. Carry out opportunity scanning for the eradication of INNS from former large colonies and where: • eradication is feasible • it is feasible to manage native predators • good foraging resources exist • suitable habitat can be provided • long-term commitment and funding for colony management and biosecurity is secured b. Carry out eradication projects and create suitable habitat following best practice guidance.	Low	Short	• Statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs • Landowners
		Action 2.2.2 Create new potential breeding sites where opportunities arise as part of the larger managed realignment projects and habitat- or flood-prevention compensation schemes (IE, UK) a. Develop regional opportunity maps for potential large-scale habitat creation/ restoration projects. b. Ensure tern habitats are incorporated into existing or planned large-scale habitat creation schemes.	Medium	Short	• Statutory agencies • NGOs • Local authorities • Landowners
		Action 2.2.3 Advocate wider uptake of beneficial use of dredgings and other soft engineering techniques to increase resilience of existing coastal sites against sea level rise and storm surges (IE, UK) a. Develop best practice guidance and case studies. b. Advocate for reduction of procedural complexity in obtaining disposal licences, for the benefit of nature conservation.	Medium	Short	• Statutory agencies • NGOs • Local authorities • Harbour authorities • Industry
Objective 3: Maintain and improve survival rates through identification, protection and management of key staging, stopover and wintering sites					
M. Lack of knowledge on the current conditions of staging sites and	**3.1 Key staging sites and threats within the Irish, Celtic and North Seas assessed**	**Action 3.1.1. Identify and assess potential threats to key post-breeding migratory roosting sites within the Irish, Celtic and North Seas (IE, UK, FR)**	Low	Short	• Statutory agencies • NGOs • Birdwatching community

impact of disturbance leading to spatially deficient action (Limitation)		a. Initiate a regional review and study of key tern roosting sites around the Irish and Celtic Seas and along the North Sea route to identify important sites vulnerable to disturbance, coastal change and other potential threats.			
N. Lack of knowledge on the current pressures on coastal wintering sites and their impact on roseate terns in W Africa and NE South America (Limitation)	**3.2 Improved protection and management of key wintering sites along the coasts of West Africa and NE South America**	**Action 3.2.1 Collaborate with East Atlantic Flyway Initiative and BirdLife International Marine Programme partners (ALL)** a. Identify and assess the condition and conservation status of wintering sites in Ghana, Liberia and Sierra Leone (see action 4.1.2 in support of this action). b. Support the Centre for African Wetlands (CAW) with the annual monitoring of terns on key coastal sites in Ghana. c. Support increased deployment of Wildlife Division staff (GH) at wintering areas outside the Ramsar sites (high trapping areas)	Medium	Short	• BirdLife International partners • Wetlands International • Centre for African Wetlands (CAW) • Wildlife Division of Ghana Government • NGOs
		Action 3.2.2 Collaborate with West Atlantic conservationists in relation to protecting shared wintering grounds for the Azorean population (PT) a. Identify key stopover and wintering areas for the Azorean roseate tern population in South America using telemetry studies (Action 4.1.2). b. Undertake a review of threats to coastal sites and fish resources in key wintering areas.	Low	Short	• Statutory agencies (Azores Autonomous Region) • Island Natural Parks (Azores Autonomous Region) • NGOs • Academic institutions • US colony managers and researchers
O. Tern trapping in Ghana (Medium)	**3.3 Tern trapping in Ghana eradicated**	**Action 3.3.1 Restore the education and outreach programme in Ghana to further reducing tern trapping (GH)** a. Select important sites with a high rate of tern trapping based on the available data as a focus for launching an educational campaign. b. Carry out monitoring of tern trapping at a maximum interval of 5 years, using an effective, standardised methodology. c. Appoint and inaugurate community tern conservation volunteers at sites with high trapping rates.	Medium	Short	• Ministry of Education (Ghana) • Ghana Education Service (GES) • Wildlife Division of Ghana Government • Ghana Wildlife Society • International NGOs

P. Depletion of forage fish due to overfishing in Ghana and along the migration route in W Africa (Medium)	**3.4 Safe biological limits for forage fish stocks in Ghana and the Large Marine Ecosystems off West Africa assessed and sustainable use of forage fish achieved**	**Action 3.4.1 Advocate sustainable use of forage fish resources in the Canary Current- and Guinea Current Large Marine Ecosystems (ALL)** a. Collaborate in advocacy efforts for sustainable use of forage fish associated with the highly productive Canary Current- and Guinea Current Large Marine Ecosystems, with urgent priority given to the effective regulation of Ghana's fisheries in order to restore sardinella (*S. aurita* and *S. maderensis*) and other forage fish to within safe biological limits.	High	Immediate	• Wildlife Division of Ghana Government • Statutory enforcement agencies • International NGOs • Ghana Wildlife Society • Other BirdLife International Partners (Mauritania, Liberia, Sierra Leone, Ivory Coast)
Objective 4: Fill knowledge gaps and improve monitoring practices					
Q. Deficiency of data for adequate determination of roseate tern conservation status in Europe (Limitation)	**4.1 Phylogeny and migration routes analysed to inform the global and European conservation status**	**Action 4.1.1 Undertake genetic studies of the NW European, Azorean and NE American populations in order to define phylogeny and rates of gene flow between these metapopulations (BR)** a. Initiate international academic cooperation to undertake comprehensive genetic study of the North Atlantic roseate tern phylogeny, further informed by Action 4.1.2.	Low	Short	• Statutory agencies • Academic institutions • NGOs • Island Natural Parks (Azores Autonomous Region)
		Action 4.1.2 Develop a programme in NW Europe to monitor winter distribution, and initiate geolocator and colour-ringing studies in Azores a. Develop a methodology for applying telemetry technology to monitor migration and wintering patterns of NW European population (IE, UK). b. Undertake first ever telemetry study of the Azorean population at well established, large colonies in East, Central and West archipelagos in order to identify migration routes, and wintering grounds in West Africa and South America (PT).	Medium	Short	• Statutory agencies • Academic institutions • NGOs • Island Natural Parks (Azores Autonomous Region)

		Action 4.1.3 Review the IUCN/BirdLife International conservation status assessment of roseate tern for Europe (BR) a. Review the conservation (threat) status of roseate tern in 2025 based on the insights obtained from actions in Objectives 3 and 4.	Low	Medium	• BirdLife International • IUCN • NGOs • Independent experts
R. Lack of standardisation and sufficient quality of monitoring data to inform metapopulation management (Limitation)	**4.2 Standardised monitoring of demography parameters to inform management of the metapopulation in place**	**Action 4.2.1 Continue ringing chicks and resighting adults at the four main colonies in NW Europe to repeat demography analysis in 2025** a. Allocate more resources to ringing and ring reading, especially at Ile aux Moutons (FR) to include the whole NW European metapopulation in the next series of demography analyses (IE, UK, FR). b. Ensure that repeated sightings of marked individuals are recorded throughout the season (IE, UK, FR). c. Record breeding status of marked individuals where possible (IE, UK, FR).	High	Immediate/ ongoing	• Statutory agencies • Academic institutions • NGOs • Island Natural Parks (Azores Autonomous Region) • Ringers and wardens
		Action 4.2.2 Refine monitoring methodologies to include basic demographic parameters, especially in Azores and, where possible, introduce monitoring of provisioning and chick growth rates a. Initiate and expand productivity monitoring at key sites in Azores (PT). b. Provide ringing training and support to initiate colour ringing of chicks in Azores (PT). c. Consider using PIT-tags for selected Azorean colonies to aid estimation of survival and immigration/ emigration rates (PT). d. Monitor nest box occupancy to determine population, clutch size and productivity annually (BR). e. Assess feasibility of introducing a low-disturbance method of assessing chick condition, carried out on a small sample of chicks as part of the ringing effort (IE, UK, FR). f. Develop a monitoring protocol for predation rates by large gulls on terns (BR). g. Employ camera technology to develop a protocol for monitoring diet and provisioning rates (BR).	Medium	Short	• Statutory agencies • Island Natural Parks (Azores Autonomous Region) • Academic institutions • NGOs • Ringers and wardens

Objective 5: Communication and partnership working towards metapopulation management					
S. Lack of awareness of the threats to coastal and marine environments induced by climate change and human disturbance (Limitation)	**5.1 Raised awareness amongst the general public of coastal and marine issues caused by environmental and human pressures.**	**Action 5.1.1 Use roseate tern as a flagship species to design and promote awareness raising and educational programmes, especially in relation to coastal squeeze and disturbance pressures (BR)** a. Develop annual communication plans. b. Maintain online presence via websites, social media, live streaming. c. Engage online and traditional media. d. Organise local events/ talks/ walks. e. Provide interpretation signage to raise awareness of seabird- and marine environment conservation. f. Carry out educational outreach programmes for schools.	Low	Immediate/ ongoing	• Statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs • Volunteer groups
T. Limited exchange of knowledge and cooperation at the regional and international level with regards to best practice, data standardisation and sharing (Limitation)	**5.2 Best practice and data shared and standardised.**	**Action 5.2.1 Maintain regional tern conservation forums, develop shared regional databases and collaboration with statutory agencies** a. Facilitate/participate in annual meetings of regional tern conservation groups (IE, UK, FR). b. Standardise monitoring protocols and collate data at the regional level, especially for common tern colonies within the target areas for roseate tern colonisation (BR). c. Continue to produce International Roseate Tern Newsletter (UK).	Low	Immediate/ ongoing	• Statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs • Volunteer groups
		Action 5.2.2 Maintain cooperation with NE American colleagues a. Facilitate international participation in the annual roseate tern recovery meetings for the West- and East Atlantic populations (BR). b. Organise biannual North Atlantic Webinar (BR).	Low	Ongoing	• Statutory agencies • NGOs • Academic institutions • Independent experts
Objective 6: Establish structures for the implementation of the Species Action Plan (SAP)					
U. Possible lack of direction and coordination of the implementation	**6.1 Action Plan implementation driven and monitored by the Coordinator and Working Group**	**Action 6.1.1 Appoint a lead organisation and an international coordinator to manage the implementation of the Action Plan (ALL)**	High	Immediate	• European Commission • National competent authorities • Statutory agencies

and review process of the SAP (Limitation)		a. Report annually to the Working Group, European Commission, international conventions (OSPAR, AEWA), IUCN and BirdLife International. b. Actively coordinate and facilitate implementation of actions. c. Apply for funding to implement the actions.			• Island Natural Parks (Azores Autonomous Region) • NGOs
		Action 6.1.2 Establish a SAP Working Group to oversee implementation of the Action Plan (ALL) a. Secure funding for a part-time coordinator. b. Organise an annual Working Group meeting.	High	Immediate	• European Commission • National competent authorities • Statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs
		Action 6.1.3 Review the Action Plan in 2025 and 2030 (ALL)	High	Medium	• European Commission • National competent authorities • Statutory agencies • Island Natural Parks (Azores Autonomous Region) • NGOs

4 Annex 1. Biological Assessment

4.1 Distribution through the annual cycle

The breeding area of the Western European biogeographical population is confined to a few colonies in Ireland, France and the United Kingdom. In 2015-19, the species occurred on just four currently viable colonies, i.e. Rockabill (IE), Lady's Island Lake (IE), Coquet Island (UK) and Ile aux Moutons (FR). There are two regular smaller colonies, below 20 pairs, i.e. La Colombière (FR), Iles Chausey (FR). Single pairs nest regularly at Larne Lough (UK) and returned breeding to The Skerries (UK) from 2018 (Figure 2). Finally, there are sites in Brittany used only once by <5 pairs during the above period, i.e. Kemenez and Banneg in the Molène Archipelago, Ile Rikard in the Bay of Morlaix.

Figure 2: Distribution of roseate tern colonies in Western Europe by the 5-year mean of breeding pairs (2015-2019).

In 2020, two pairs of roseate terns nested amongst 45 pairs of common terns at Les Ecrehous reef on a rock called Marmotier, seven miles off the north-east of Island of Jersey but, due to gull predation, unfavourable weather and human disturbance, only one chick hatched (N. Jouault, pers. comm.). Efforts by conservationists to limit disturbance to the terns resulted in conflict with local people who maintained they had rights to access their holiday huts on this small island.

The Azorean population is distributed across all nine islands divided into Western (Corvo and Flores), Central (Faial, Pico, Graciosa, São Jorge and Terceira) and Eastern Group (São Miguel and Santa Maria). In 2015-2019, roseate terns nested regularly at 19-27 sites across

the Azores archipelago (out of the total of 52 sites where they have bred at least once), however the bulk of the population breeds on Flores, Graciosa and Terceira (Figure 3).

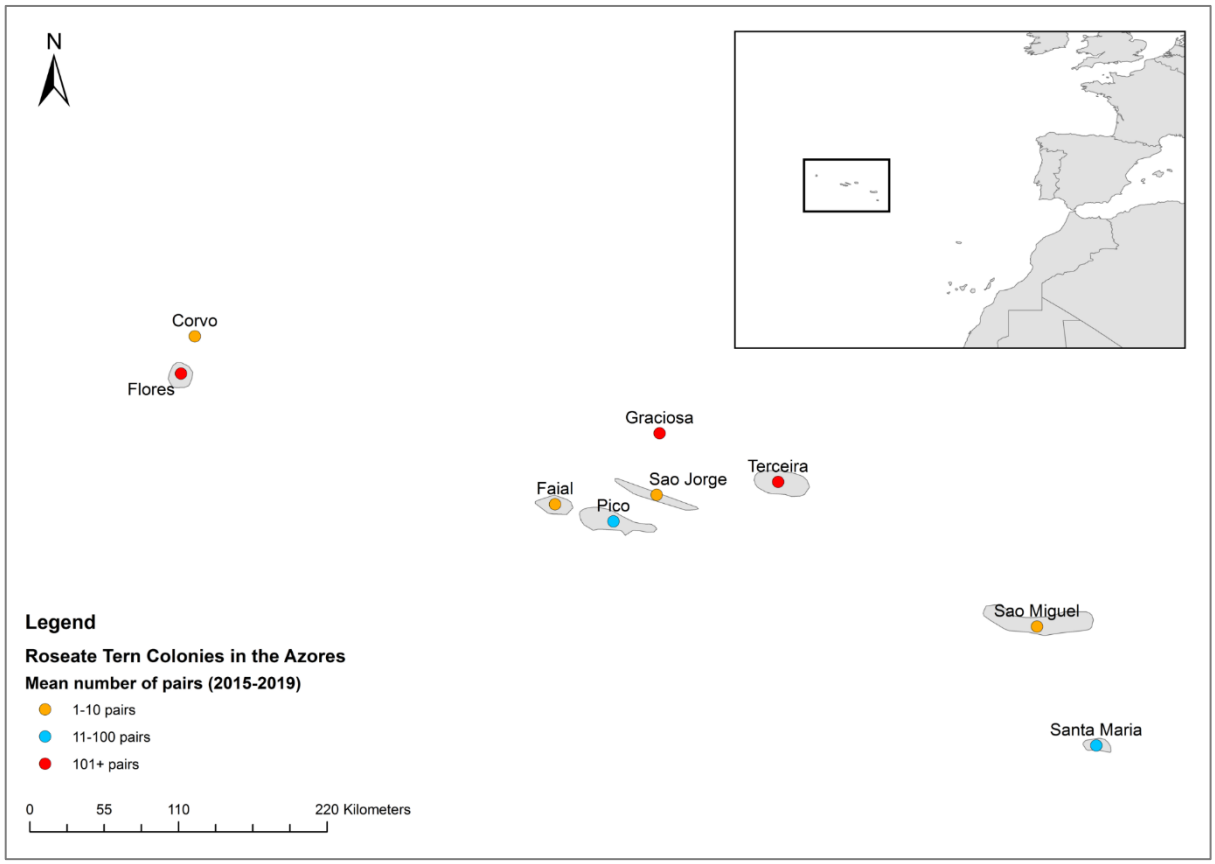

Figure 3: Islands supporting breeding roseate terns in Azores by the 5-year mean of the total breeding pairs for each island (2015-2019). There are multiple colonies, occupation of which can change between years, on each of the islands.

Most roseate terns from Ireland and the UK, including birds breeding on the North Sea coast, leave their colonies in August and concentrate at a few staging sites along the Irish coast before autumn migration. The geolocator study of 16 birds which bred on Coquet Island (Northumberland, UK) suggests that most birds go overland to the Irish Sea. Two birds initially moved further north and only one bird went south along the east coast of England and probably through the English Channel (Redfern et al. 2021). These patterns confirm those found from ringing returns (Ratcliffe & Merne 2002). Staging areas are key for fuelling before energetically demanding migration and for young birds to practise foraging for themselves in the company of adult birds, therefore disturbance-free staging sites with an abundance of food are important for survival and recruitment (Warnock 2010). All the staging sites are located on the east coast of Ireland, most notably at Dublin Bay, where a peak of over 2,100 roseate terns was counted amongst thousands of common, Sandwich *Thalasseus sandvicensis* and Arctic terns *Sterna paradisaea* during a study in 2016-2018 (Burke el al. 2020). Other sites of note listed in Burke et al. (2020) were Crossfintan Point (Wexford) with a peak count of 750 birds, Wexford Harbour & Slobs (275 birds), Skerries Coast (115 birds) and Dundalk Bay with a peak count of 80 birds. Dunany Point – Clogher Head supported a peak count of 4000 terns, where roseate terns were not recorded, but were possibly included in counts of "Comic"[6] terns. Staging sites have also been identified in Brittany (FR), especially in the Gulf of Morbihan, Bay of Lancieux and the Loire estuary (Fortin & Mahéo 2010).

[6] Mixed flock of common and Arctic terns.

Based on a sample of 30 retrieved geolocators from Rockabill (14 birds) and Coquet Island (16 birds), the median date of departure for autumn migration falls around 10-12 September, ranging from 31 August to mid-October. The date of departure might be affected by storm fronts, if they occur in this period around the Irish and Celtic Seas (Redfern et al. 2021). The southward migration is characterised by predominantly northerly tailwinds and is shorter than the spring migration with short stationary periods (periods with movements of < 45 km between twilight intervals) for a median duration of 4 days, mostly below latitude 30°N off the coast of Western Sahara, Mauritania, Senegal, Guinea-Bissau, Sierra Leone, Liberia and Ivory Coast (Redfern et al. 2021).

Wintering has been defined as stationary periods of >50 days south of latitude 45°N from the geolocation data (ca. 45 km error encoded). All the tracked birds spent winter in the Gulf of Guinea, mainly in Ghana (23 of the 30 birds tracked). Five birds spent the winter off the coast of Sierra Leone and Liberia and three birds translocated from Ghana to Sierra Leone and Liberia during the winter. Dates of arrival ranged from 11 September to 27 October and the duration of stay ranged from 152 to 259 days (Redfern et al. 2021). Between November and May, most ringing recoveries come from Ghana, Togo and Ivory Coast. In the annual migration cycle, recoveries are much more numerous during autumn passage (September-October) than in spring (April-May) when records are relatively scarce (Ratcliffe & Merne 2002). Very few first-summer birds come back to the breeding grounds, more so two-year old birds but most of these do not breed until they are three years old (Cabot & Nisbet 2013).

The waters off West Africa, notably the Guinea Current Large Marine Ecosystem (GCLME) and the Canary Current Large Marine Ecosystem (CCLME) are important migratory stopover or refuelling sites, particularly on the return northward migration (Redfern et al. 2021). Birds departed from the wintering areas between 16 March and 10 May, taking longer stops (median 7 days) located along coastal West Africa, similar to southward migration but including north to the Canary Islands – an area characterised by cold-water upwelling of the Canary Current with lower winter sea surface temperature (SST) (Benazzouz et al. 2014). Spring migration was characterised by northerly headwinds, which together with the longer stops, makes the spring migration slower than in autumn. Almost all birds approached the Irish Sea directly from the south and most of the Coquet Island birds arrived from a southwest direction from the Irish Sea or the west of England, suggesting the overland route was used as in the autumn. However, up to five birds took the North Sea route through the English Channel. Dates of arrival ranged between 30 April and 17 May (Redfern et al. 2021).

Migration routes of the Azorean population are known only from ringing recoveries, so our understanding of them is less detailed, albeit equally fascinating. Birds from Azores winter together with the western European birds in the Gulf of Guinea, especially Ghana, but some of them migrate to Brazil where they join Caribbean and North-eastern American birds (Hays et al. 2002, Ratcliffe et al. 2004, Nisbet 2014). Geolocator studies conducted on the western North Atlantic population identified several wintering areas along a 5000 km stretch from Guyana/Suriname to eastern Brazil, these areas being located within the highly productive North Brazil Shelf Large Marine Ecosystem (Mostello et al. 2014). It is likely that roseate terns from Azores share those wintering areas with the western Atlantic population although further geolocator studies of this rare dichotomous migration pattern would be required to confirm this hypothesis.

4.2 Breeding habitat requirements

In Europe, most roseate terns breed on islands up to 15km offshore and ranging from rocky outcrops to coastal islets, rather than on the mainland. However, this might be an effect of mammalian predation at inshore sites, where foraging conditions are better (shallow calm seas and lower gull competition), rather than a preference for offshore islands as such (N.

Ratcliffe, pers. comm.). In Azores, most of the largest stable colonies are located on uninhabited islets near the main islands. In NW Europe, currently only Lady's Island Lake (IE) is located inshore, but some of the largest historic colonies were located on coastal sites such as Tern Island (Co. Wexford, IE) or Ynys Feurig and Cemlyn Bay on Anglesey in Wales. There are historic records of breeding attempts on dunes in Norfolk (SE England), but there has never been a viable colony in such a habitat. Some colonies can be located on islands within saline coastal lagoons (Lady's Island Lake and formerly Cemlyn Bay).

Another key factor for colony selection is the presence of the common tern as a carrier species at all but one colony (the Baixa do Moinho, Flores) in the East Atlantic population. The common tern acts as a carrier species in the sense of having a greater aggression level than the roseate tern, which provides a protective shield for the latter against the threat from aerial and ground predators, thereby facilitating the successful colonisation and breeding of roseate terns.

Roseate terns prefer to nest in shelter, often under overhanging rocks or under clumps of tall vegetation such as stinging nettle *Urtica dioica*, marram *Ammophila arenaria* or lyme grass *Leymus arenarius*, sea beet *Beta vulgaris*, bladder campion *Silene vulgaris* and fescue *Festuca petraea*. Early conservation efforts focused on planting tree mallow *Lavatera arborea* to provide the cover, but as this approach progressively impeded the birds' access to the ground, it was abandoned in favour introducing nest boxes which provided cover in open areas for landing and take-off.

In the UK and Ireland, artificial nest boxes have been introduced and successfully adopted by roseate terns in many cases, reducing the need for tall vegetation (Morrison & Gurney 2007). This has opened the possibility of providing suitable nesting conditions in common tern colonies to facilitate expansion of the roseate tern in Western Europe, regardless of the vegetation height. Almost all roseate pairs breed in nest boxes at Coquet Island (UK) and Lady's Island Lake (IE), but only c. 50% at the largest colony at Rockabill (IE). In the past, nest boxes made with dry stones have been provided in France, and most of the pairs bred inside these structures, especially at Isle aux Dames. Wooden nest boxes were introduced only in 2018 at Ile aux Moutons and La Colombière, but the uptake has so far been slow (Y. Jacob, pers. comm.). Nest boxes provide protection from predators and the elements, and birds which choose to nest in artificial shelters have significantly higher breeding success than those in the open (Figure 4). A study in North America suggested that some or all of the difference in productivity between nest boxes and natural sites is due to differences in parental quality; laying is earlier in boxes but, when laying date is controlled for, much of the difference in productivity disappears (I.C.T. Nisbet, pers. comm.).

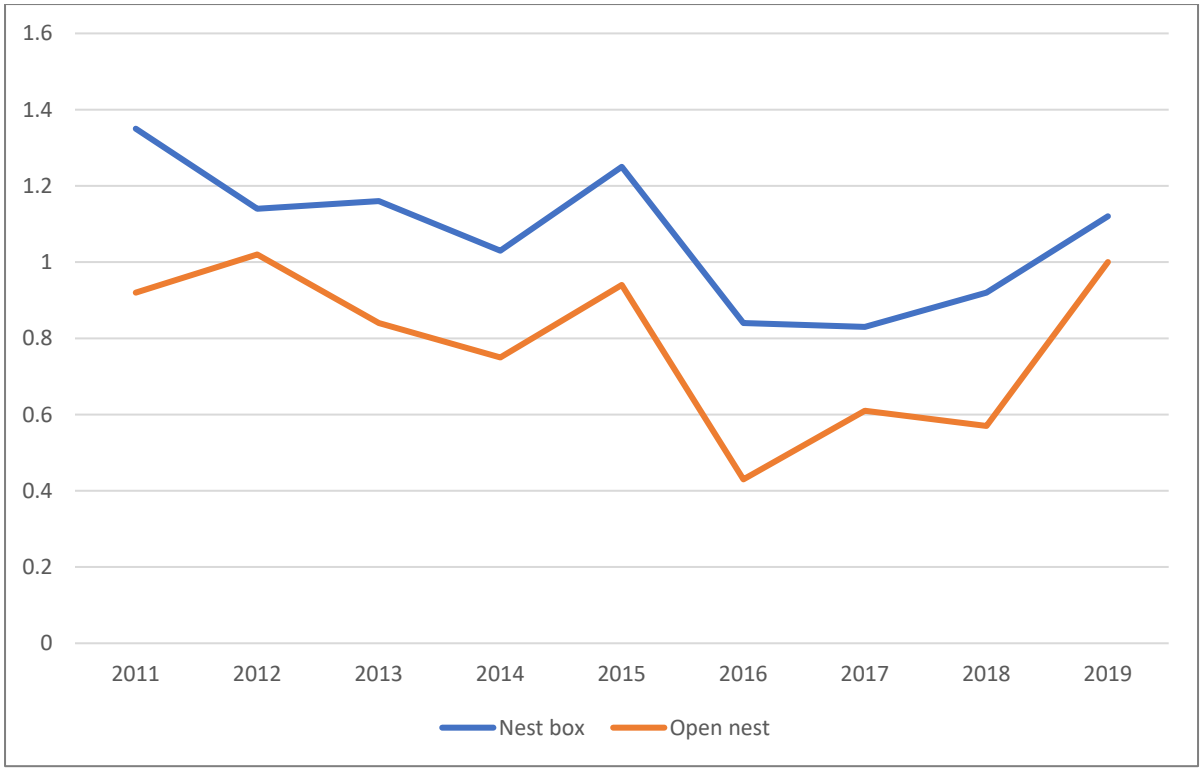

Figure 4: Productivity (mean number of chicks fledged per pair) of roseate terns breeding in nest boxes and open nests at Rockabill (IE) between 2011-2019. Source: BirdWatch Ireland Annual Rockabill reports.

In Azores, roseate terns typically breed in mixed colonies with common terns, and rarely on their own. There are several stable colonies, but the birds are much more widely dispersed with over 90 sites used at least once between 1989 and 2019. Most birds breed on rocky islets with sedimentary plateaux, sea stacks and cliffs. Nest boxes have been deployed on Praia islet (Graciosa) but have rarely been used by adults (Bried & Neves 2015), and on Contendas Islets (Terceira) only 6 out of 45 were occupied in 2019 (M. Pietrzak, pers. comm.). Ramos & del Nevo (1995) assessed nest-site selection based on twelve variables. Roseate terns selected sites that were surrounded by walls, had a relatively high density of neighbours within 2m and were less visible from above (greater cover). However, significant variation existed between colonies, probably due to habitat availability rather than selection as the Azorean sites vary from dense vegetation to bare rock (N. Ratcliffe, pers. comm.).

4.3 Diet and foraging

The diet of roseate terns and their offspring in UK and Irish colonies is principally made up of lesser sandeel *Ammodytes marinus* and clupeids (European sprat *Sprattus sprattus* and herring *Clupea harengus*), presumably these being the preferred prey owing to their known, high calorific value (Hislop et al. 1991). However, inter-annual variation in diet composition indicates that the availability of these can vary markedly between years (Green 2017). Throughout the European breeding range, proportions of prey species at colonies may change within a single season, driven by reproductive phenology and brood requirements, seasonal movements and even the daily behavioural cycle of individual prey species. Such shifts are demonstrated by long term monitoring of chick diet at Rockabill (IE) (Figure 5, S. Newton, pers. comm.) where sandeels and clupeids have alternated over the years as the main prey item, although in some years other species, notably gadoids *Gadus* and rockling *Gaidropsarus*, also featured. The great majority of the clupeids carried to Rockabill during a tracking study in 2018 were juvenile Atlantic herring rather than European sprat (Perrow et. al. 2019) and further work is planned to confirm if this is the current norm for the colony. On

Coquet Island (UK) in 2011, the prey delivered to chicks comprised exclusively sandeel (86%) and sprat (14%) (Robertson et al. 2014), with sandeels typically predominating in recent years (P. Morrison, pers. comm.).

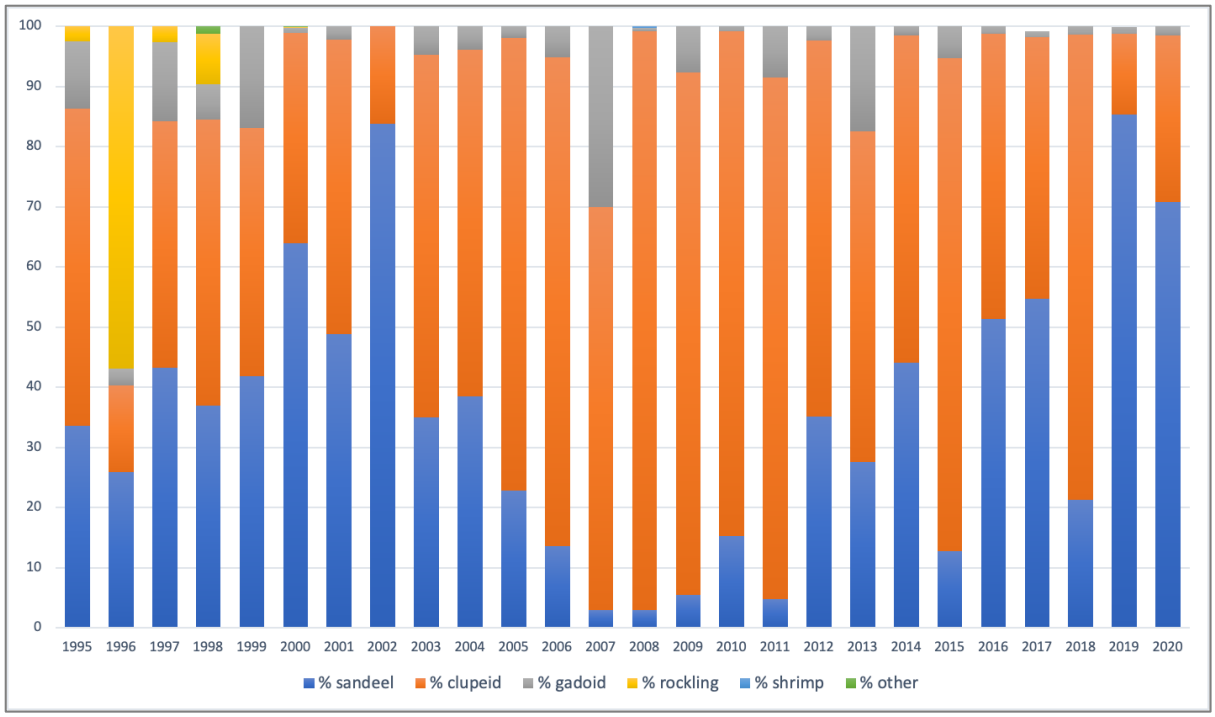

Figure 5: Percentage of prey species fed to chicks on Rockabill (IE) between 1995 and 2020.

At Ile aux Moutons (France) chicks are fed mainly on European pilchards *Sardina pilchardus*, whereas the other clupeids Clupeidae that feature so prominently at the UK and Irish colonies are very uncommon; the diet at Ile aux Moutons also includes sandeels (but not lesser sandeel), sand smelt *Atherina presbyter*, anchovy *Engraulis encrasicolus* and various gadoid species (B. Cadiou, pers. comm).

In Azores, the diet of roseate tern chicks was dominated by six prey species, most of which inhabit waters near the surface ('epipelagic') but, as the season progressed, species originating from greater ('mesopelagic') depths became increasingly frequent, a pattern reflecting both relative availability and changes in the adults' selection criteria as their chicks grew (Ramos et al. 1998).

Dunn (1972, 1973a) observed that some roseate terns on Coquet Island (UK) provisioned their chicks by systematically robbing fish from other tern species (mainly common terns) returning to the colony. Such kleptoparasitic terns tried to snatch fish from the hosts' beaks both in mid-air and on the ground and relied on an element of surprise rather than persistent pursuit. During 15 days of systematic observations, only 7.5% of 2498 attacks were successful and most were aborted before making physical contact. Roseate terns have not manifested this behaviour on Coquet Island in recent years (P. Morrison, pers. comm.). Kleptoparasitism in roseate terns was also studied at Falkner Island, Connecticut, USA (Shealer & Spendelow 2002), where this specialised behaviour was exhibited regularly by only a few individuals and with varied success although, overall, kleptoparasites obtained food at a significantly higher rate, and consistently raised young more successfully, than did 'honest' birds which foraged for themselves offshore.

In 2009-2011, tracking showed that roseate terns breeding on Coquet Island tended to confine their foraging to relatively shallow water in Alnmouth Bay about 5 km north-east of the island (Robertson et al. 2014, Wilson et al. 2014). Foraging range and behaviour at sea of roseate

terns were studied at Rockabill, in 2018, by ECON Ecological Consultancy (Perrow et al. 2019). Mean distance of foraging trips from the colony was 8.5 km (median 5.1 km; min. 0.34 km; max. 29.95 km). Birds fed in a wide range of habitats including right along the shore. Most of the foraging trips, however, occurred in deep water, where roseate terns actively searched for multi-species foraging associations (MSFAs) attracted to prey driven to the surface by auks and marine mammals. As more birds joined the MSFA, roseate terns had low foraging success and quickly moved on. In terms of foraging attempts (dives), the mean number of completed attempts was 36.62 per hour (min. 0; max. 209.96). Almost 40% of attempts were aborted (i.e. the aerial diving bird pulled up before entering the water). Most consumed items were relatively small and only larger items were carried to the colony, predominantly clupeids and sandeels. The prey items for provisioning chicks at Rockabill can be carried from a long distance, utilising the whole of the foraging range up to 20-30km from the colony.

4.4 Survival and productivity

Starting from 2002, almost all the chicks in NW Europe have been ringed with special four-digit metal rings and considerable time is dedicated by wardens, volunteers and others to reading the rings at the main three colonies in the UK and Ireland and recently also in France, at Ile aux Moutons. Collecting capture-mark-recapture data allows for analyses of survival, immigration and emigration rates. Detailed population counts and productivity data are also collected annually. This, together with the low abundance and restricted distribution of the roseate tern, allows for uniquely comprehensive demographic analyses.

Seward et al. (2019) carried out analyses for Rockabill (ROC, IE), Lady's Island Lake (LIL, IE) and Coquet Island (COQ, UK) for the period 1992-2016. French colonies were not included in the study because of the sparseness of capture-mark-recapture data. Seward el al. (2019) estimated average demographic rates for productivity, survival, immigration and emigration rates for different age groups, as well as population growth rate for each colony. Despite the similar population growth at all three colonies, average productivity and survival rates were consistently higher for ROC and LIL than for COQ when averaged over the period 1992-2016 (Table 2). It was possible to determine population growth rate without emigration and immigration, which revealed that ROC and LIL were self-sustaining colonies, but productivity and survival rates alone would not be sufficient to maintain the population growth at COQ which relied on immigration from ROC (Table 2). While ROC was a source colony, LIL was migration neutral and COQ acted as a 'cryptic sink' because, despite the positive population trend, birds nesting at COQ had lower productivity and juvenile survival rates when averaged across the whole period. However, natal recruitment at COQ has increased in recent years with almost 60% of nesting birds originating from that colony in 2019, which could indicate that productivity and possibly also juvenile survival have improved (Kinchin-Smith et al. 2019). This trend is reinforced by natal recruitment at COQ reaching 66% in 2020 (P. Morrison, pers. comm.).

Table 2: Posterior[7] mean demographic rates at the three colonies, averaged over the whole study period (1992-2016) (Seward et al. 2019).

Demographic rate	Rockabill	Lady's Island Lake	Coquet Island
Productivity	1.223	1.032	1.018
Survival (juvenile)	0.772	0.751	0.628
Survival (age 3)	0.846	0.883	0.807
Survival (age 4+)	0.840	0.820	0.782
Population growth rate	1.055	1.038	1.057
Population growth rate without dispersal	1.080	1.036	0.930

Historically, poor survival on the wintering grounds was proposed as one of the main reasons behind the declines in 1970s and 1980s (Mead 1978), because most ring recoveries came from birds caught by human trapping activity, especially in Ghana (Dunn & Mead 1982; Avery et al. 1995, Cabot 1996). We now know that birds from Rockabill and Coquet Island winter in the same areas (Redfern, et al. 2021) and there is no reason to suggest that it is different for Lady's Island Lake. Any variation in food availability and trapping on the wintering grounds should therefore equally affect all the colonies.

There has been a worrying medium-term (2007-2019) decline of productivity at Rockabill (average 1.05 chicks per pair) (Figure 5) compared to the average 1.37 chicks per pair in 1994-2006. The increase of gull predation at Rockabill had an impact, but possibly also density dependent regulation, such as a possible depletion of food resources throughout the season accelerated by the growing colony, known as Ashmole's halo effect (Ashmole 1963, Birt et al. 1987), including potential competition for food with common terns (1833 pairs in 2019) as suggested by Perrow et al. (2019). Productivity at Lady's Island Lake fluctuated heavily in the period 2007-2019 between 0.72 and 1.57 chicks per pair (average 1.14). This site is located within a coastal lagoon where productivity is affected by difficult to control water level and mammalian (rats, foxes, American mink, pine martens *Martes martes*) and avian predation. Productivity on Coquet Island has on average been lower than at the Irish colonies i.e. 1.02 chicks per pair in 1992-2016 (Seward et al. 2019), although there are recent signs of improvement (Figure 6).

Overall, the average productivity at Ile aux Dames, the main French colony up to 2011, and Ile aux Moutons has been significantly lower than in the UK and Ireland, i.e. 0.37 (2007-2011) and 0.43 (2011-2019) chicks fledged per nesting pair respectively (Y. Jacob, pers. comm.) (Figure 6). Ile aux Dames suffered from heavy mink and peregrine falcon predation (Jacob & Capoulade 2010) and the colony subsequently collapsed in 2011. Most of the birds moved to Ile aux Moutons, where they maintain a small, but relatively stable population (see below). Roseate terns have relatively low adult survival compared to other seabirds, which is compensated for by a relatively high productivity to maintain a stable population (Ratcliffe et al. 2004). Yet, it seems that the level of productivity at French colonies does not compensate for mortality, and immigration must have contributed to maintaining a stable population rate. This is, however, difficult to assess due to sparseness of the capture-mark-recapture data collected there, as only 29 sightings of 23 individuals ringed in the UK and Ireland were recorded between 2007-2014 and there is no resighting data before this period (Seward et al. 2019).

[7] The term 'posterior' comes from Bayesian statistics and is used for describing the mean probability obtained from a multiple statistical modelling fed by 'prior' values.

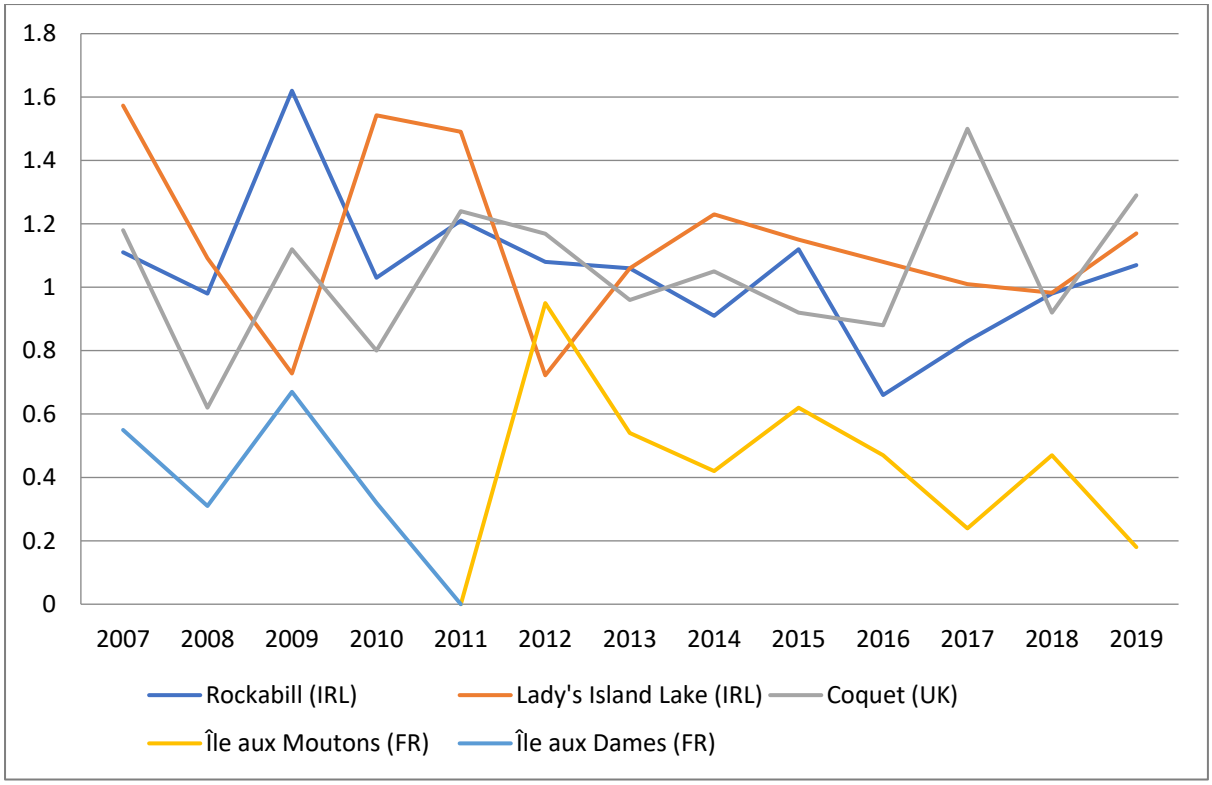

Figure 6: Medium term (2007-2019) trends in productivity (mean number of chicks fledged per pair) for Rockabill (IE), Lady's Island Lake (IE), Coquet Island (UK), Ile aux Dames (FR) and Ile aux Moutons (FR).

Productivity in Azores has been studied only as part of the starling predation study on Vila Islet off the island of Santa Maria (Neves 2006). The fates of 165 and 45 clutches were monitored in 2002 and 2003, with an estimated productivity of 0.42 and 0.17 chicks fledged per pair, respectively.

4.5 Population size and trend

As of 2019, the entire East Atlantic population of 2,679 pairs was confined to Azores (PT) and NW Europe (FR, IE and UK). The status in Madeira (PT) and Canary Islands (ES) is unknown, but it is not believed that there have been recent breeding attempts. The Irish and UK populations are increasing, the French population is stable, and the Azorean population is fluctuating, but stable (Table 3).

Table 3: Population size per country and number of sites with at least 1 breeding pair for at least one year and number of stable* colonies in the period 2015-2019. Trend direction: + (positive), - (negative), F (fluctuating), 0 (stable).

Country	Size (pairs)	Europe (%)	No. of all sites	No. of stable colonies	Quality of data	Year of last census	Trend direction
IE	1759	65.66%	2	2	Good	2019	+
PT: Azores	733	27.36%	27	7	Good	2019	F (0)
UK	125	4.67%	4	1	Good	2019	+
FR	62	2.31%	6	1	Good	2019	0
EU27	2554	95%	35	10			+
Europe	2679	100%	39	11			+

* Stable colony is where >10 pairs of roseate terns bred consistently every year in the period 2015-2019.

The NW European population represents 73% of the entire East Atlantic population, but it is confined to just four stable colonies and a further seven sites supporting fewer than a mean of 5 pairs in the period of 2015-2019 (Table 4). Most of the metapopulation has concentrated on Rockabill Island (hereafter 'Rockabill') after the abandonment of smaller colonies in Scotland, Wales and Northern Ireland. Towards the end of the 1960s, there were 14 colonies in the UK and Ireland, supporting over 3300 pairs of roseate terns. The population subsequently declined to 467 pairs in 1989 (Cabot & Nisbet 2013). The other two main colonies in Ireland and the UK are at Lady's Island Lake and Coquet Island, respectively (Table 4).

While the UK and Irish colonies have been increasing in the last 30 years, the French population has never recovered from the catastrophic decline from a peak of 827 in 1967 to around 100 pairs in the 1980s (Cabot & Nisbet 2013). The only currently viable colony, Ile aux Moutons, has been fluctuating at a low level of 30-65 pairs annually, following a collapse of the previous main colony, Ile aux Dames in 2011 (Figure 7).

Table 4: Roseate tern colonies, number and 5-year mean of breeding pairs in NW Europe in the period 2015-2019. Stable colonies are shown in bold.

Colony/ Year	2015	2016	2017	2018	2019	5-year mean
Rockabill (IE)	**1388**	**1556**	**1603**	**1633**	**1564**	**1548.8**
Lady's Island Lake (IE)	**215**	**209**	**219**	**227**	**195**	**213**
Coquet Island (UK)	**111**	**104**	**111**	**118**	**122**	**113.2**
Ile aux Moutons (FR)	**30**	**49**	**46**	**32**	**39**	**39.2**
La Colombière (FR)	0	0	6	4	8	3.6
Chausey (FR)	1	0	1	0	15	3.4
Larne Lough (UK)	1	1	1	1	1	1
The Skerries (UK)	0	0	0	1	2	0.6
Kemenez (FR)	0	3	0	0	0	0.6
Banneg (FR)	3	0	0	0	0	0.6
Ile Rikard (FR)	0	0	0	2	0	0.4

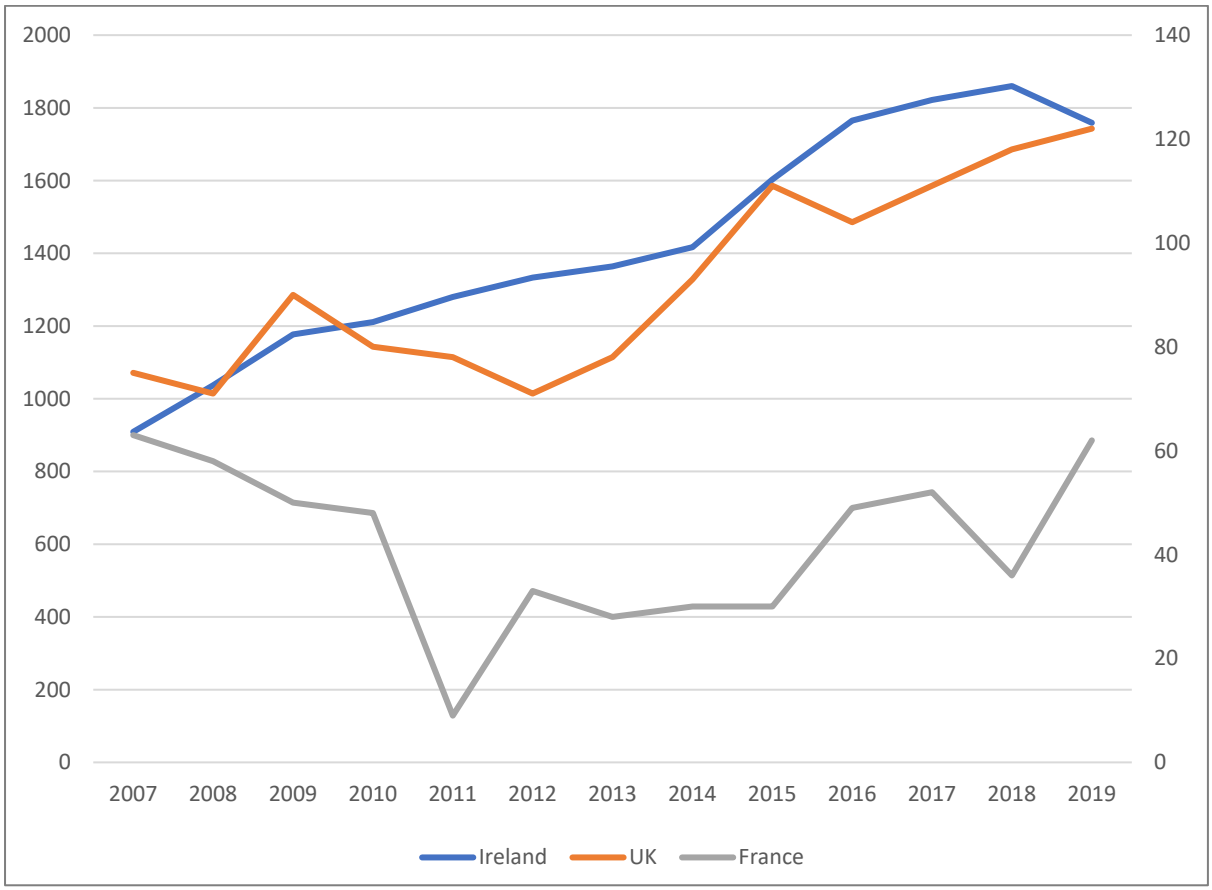

Figure 7: Medium-term (2007-2019) population trends (number of breeding pairs) in Ireland (left axis), France and the UK (right axis).

Roseate Tern colonies in Azores are difficult and expensive to census due to the difficulty of accessing some of the nesting sites and the extent of the archipelago's coastline. Except for 2013, a full annual census was conducted between 2007 and 2016 throughout the archipelago apart from São Miguel where, unlike the other islands, the entire coastline was not covered by boat. Even so, the archipelago census was considered effectively complete because the colonies known to hold roseate terns on São Miguel were monitored every year. Between 1994 and 2006, the annual censuses were only conducted on colonies that traditionally held more than five pairs (Neves 2006). However, since 2016 most colonies are visited annually to count nests and the monitoring is conducted around the whole Azorean coastline (DRAM, pers. comm.).

The first full Azorean census was not carried out until 1984 (del Nevo et al. 1993) and regular surveys started in 1989. The population has fluctuated widely in the last 30 years (from 379 in 1993 up to a peak of 1353 in 2008), but is considered stable (IMAR Azores, unpublished data). The birds have been breeding on up to 9 islands and numerous sites, with Flores, Graciosa and Terceira hosting most of the population in recent years (Figure 8, Table 5).

The dramatic fluctuations of the Azorean population (Figure 8) are difficult to explain just by adult mortality alone, since sudden declines are followed by immediate recovery. Neves (2006) suggested that this is rather due to intermittent breeding, meaning that some birds might defer breeding for one or more years. Intermittent breeding has not been studied extensively in roseate terns, but reduced food availability has been implicated in an increase of non-breeding Arctic terns (Monaghan et al. 1992) and reduced reproductive output of roseate terns in a given season (Safina et al. 1988).

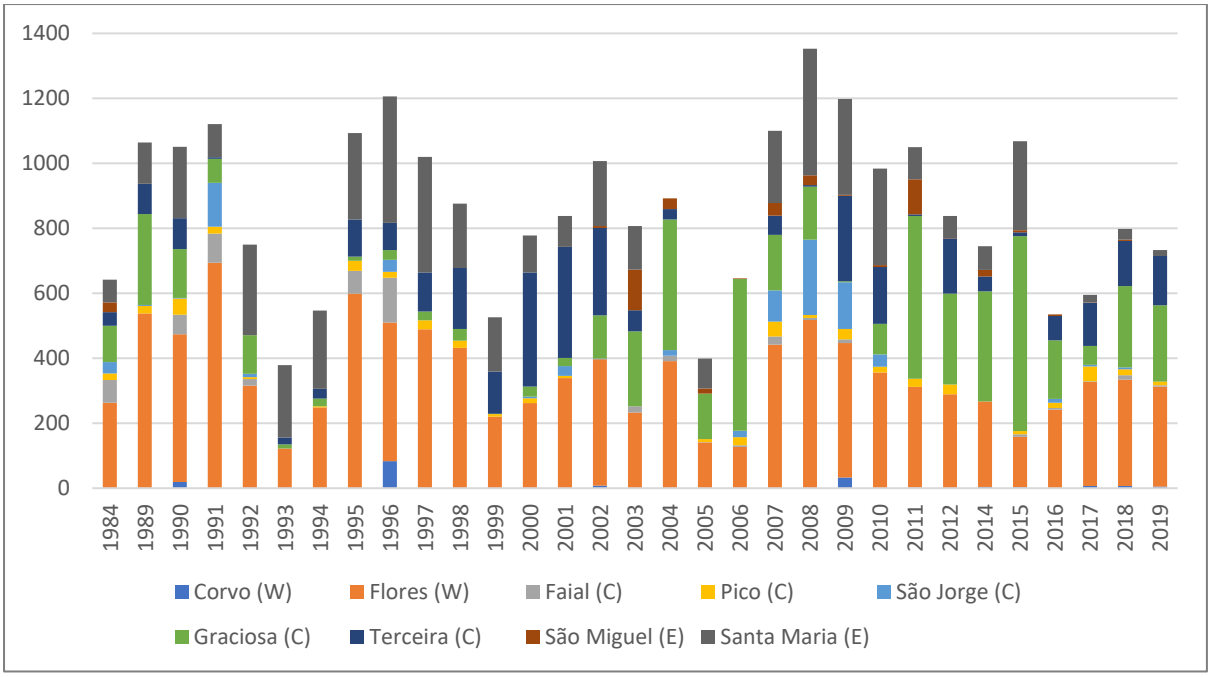

Figure 8: Trends of the Azorean roseate tern population (number of breeding pairs) per island from 1984 (del Nevo et al. 1993), 1989-1993 (Neves 2006) and 1994-2019 (IMAR Azores, unpublished data). There were no surveys between 1985 and 1988 (inclusive), and in 2013.

Table 5: Five-year means (2015-2019) of breeding pairs and number of colonies (in brackets) in Azores; the main breeding islands are shown in bold.

Island	2015	2016	2017	2018	2019	5-year Mean
Flores	**155 (9)**	**242 (11)**	**320 (14)**	**328 (13)**	**308 (11)**	**270.6 (11.6)**
Graciosa	**600 (1)**	**180 (1)**	**58 (3)**	**250 (1)**	**235 (2)**	**264.6 (1.6)**
Terceira	**12 (1)**	**75 (1)**	**133 (1)**	**139 (1)**	**152 (2)**	**102.2 (1.2)**
Santa Maria	274 (2)	0	23 (2)	33 (1)	18 (3)	69.6 (2)
Pico	10 (1)	16 (2)	46 (1)	18 (1)	11 (1)	20.2 (1.2)
Faial	8 (1)	5 (2)	2 (1)	14 (2)	4 (2)	6.6 (1.6)
São Jorge	0	12 (3)	5 (2)	6 (3)	0	5.75 (2.7)
Corvo	3 (2)	0	7 (1)	6 (4)	5 (2)	4.2 (2.6)
São Miguel	6 (2)	5 (2)	1 (1)	4 (1)	0	4 (1.5)

Flores supports four regular colonies with the 5-year mean above 10 pairs (Ponta do Burguilhão, Ilhéu Comprido, Baixa do Moinho and Ilhéu do Portinho) and roughly half of all the breeding colonies in Azores with an average of 11.6 colonies per year (range 9-14). However, the best performing colony in the period of 2015-2019 was Ilhéu da Praia located off Graciosa with the 5-year mean 263 pairs, followed by Contendas islets off Terceira regularly supporting above 100 pairs. Ilhéu de Santo António on Pico is another colony of note, but the numbers rarely exceed 20 pairs. There was a large colony on Baía do Cura (E) on Santa Maria between 2008-2015, but since then the colony has moved to the west of the island Baía do Cura (W) (Table 6).

Table 6: Number of pairs of roseate terns in Azorean colonies supporting a mean of above 10 pairs in 2015-2019.

Island	Colony	2015	2016	2017	2018	2019	5-year Mean
Graciosa	Ilhéu da Praia	600	180	50	250	234	262.8
Flores	Ponta do Burguilhão	67	108	120	113	131	107.8
Terceira	Contendas	12	75	133	139	151	102
Flores	Ilhéu Comprido (Alagoa 2)	21	93	78	82	100	74.8
Santa Maria	Baía do Cura (E)*	267	0	0	0	0	53.4
Flores	Baixa do Moinho (Ilhéu)	15	6	53	76	54	40.8
Pico	Ilhéu de Santo António (Nariz de Ferro)	10	13	46	18	11	19.6
Flores	Ilhéu do Portinho	27	15	13	21	3	15.8
Santa Maria	Baía do Cura (W)	0	0	20	33	6	11.8

* Colony inactive since 2015

In the period 2015-2019, there were between 19 and 27 colonies (average 23), of which 7-8 colonies supported 91.8% of the mean number of breeding pairs (Figure 9).

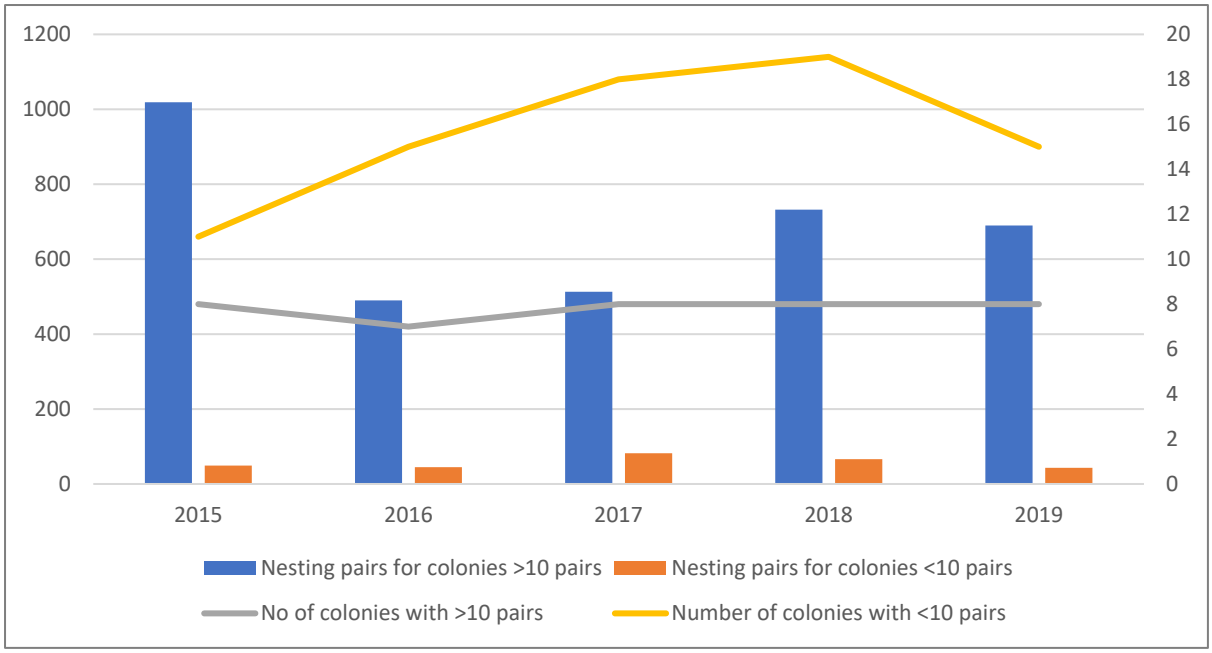

Figure 9: Number of breeding pairs (left axis) and colonies (right axis) of roseate terns in Azores supporting a mean of above and below 10 pairs in the period 2015-2019.

5 Annex 2. Problem analyses and limitations

The high-level problem analyses have been carried out based on the literature and interviews with site managers. The following threat level criteria have been applied:

Threat level assessment
Critical - causing or likely to cause very rapid declines and/or extinction
High - causing or likely to cause rapid decline leading to depletion
Medium - causing or likely to cause relatively slow, but significant, declines
Low - causing or likely to cause fluctuations or minimal change
Local - causing or likely to cause negligible declines in small parts of the population
Unknown - likely to affect the species, but extent unknown

The threats described below have been listed according to their severity within high and medium threat levels. There were no low, local or unknown threats identified.

Knowledge deficiency issues do not affect populations and cannot be classified as threats, but rather as 'limitations'. However, better understanding of these limitations is important for the implementation of more effective conservation strategies.

Generally, the threats affecting roseate tern populations can be divided into two main categories:

- Reduced productivity at breeding sites
- Reduced survival of adults and fledged juveniles

5.1 Reduced productivity

The threats listed below are general and apply at various levels of intensity and frequency on colonies. The threats always occur in some combination, for example gull predation, food shortages and extended poor weather, thus it is difficult to assess the extent of their individual impact on productivity. NW European colonies are subject to detailed monitoring programmes, in the case of Rockabill (IE) including chick growth rates, diet and provisioning monitoring, all of which can be used to understand the impact of food availability and the weather. However, monitoring of other threats such as avian predation is challenging to do and therefore rarely carried out in a standardised and systematic way. While all the listed threats were also mentioned in the first edition of the Action Plan, climate change-related threats such as loss of nesting sites and shortages of food have no doubt intensified in some regions. So far, these factors have not been critical for the core roseate tern colonies, but they limit the scope for recolonisation of former sites, especially in the English Channel and eastern Scotland.

5.1.1 High level threats

Predation by large gulls, native and invasive non-native mammals

Predation and displacement by large gulls (herring gull *Larus argentatus*, lesser black-backed gull *L. fuscus* and great black-backed gull *L.marinus*) remain one of the biggest challenges for most of the colonies in Ireland, the UK and to a lesser extent in France and in Azores (yellow-legged gull *L. michahellis*). Nesting areas for terns without any gull control are usually quickly occupied by breeding gulls as they start to breed earlier than terns and are larger and more aggressive. The expansion of large gull species into the Firth of Forth islands (Scotland) is thought to be the main reason behind the abandonment of tern colonies in this area. Extensive control measures were carried out in the 1980s on many islands, including poisoning and

mass nest raking, but with varying levels of success in deterring gulls. Aversive conditioning was used with methiocarb-treated domestic quails' *Coturnix coturnix* eggs to discourage nest predation by yellow-legged gulls in a mixed colony of roseate and common terns at Vila islet, Azores (PT). No gulls were observed removing eggs over 13-day study period, but European starlings *Sturnus vulgaris* took both treated eggs and tern eggs. Predation of treated eggs declined over time, but there was no corresponding decline in predation on genuine tern eggs (Neves 2006). Currently, the deteriorating conservation status of the herring gull and lesser black-backed gull in the UK prohibits large scale eradication projects. Instead, displacement techniques are used before the tern breeding season, including audio scarers, laser hazing and nest removal, to discourage gulls from occupying tern nesting areas (see Morrison & Allcorn 2006 and Booth & Morrison 2010 for a review of these techniques at Coquet Island – UK). So-called "rogue" gull individuals specialising in predating terns are sometimes lethally controlled. This has been proved an effective method of reducing predation but needs to be carried out with vigilance throughout the season as other gulls increase their predation rate in a manner suggestive of a despotic system after the dominating individual was removed (Guillemette & Brousseau 2001). Yellow-legged gulls were responsible for the destruction of 80% of roseate tern nests within two weeks on Contendas islets (Terceira, Azores) in 2016, which prompted gull nest removal and subsequent recovery of the colony (M. Pietrzak, pers. comm.). Predation on Rockabill (IE) is caused mostly by non-breeding gulls, roosting sometimes in hundreds on a nearby rock (the Bill). Black-headed gulls were seen to predate small common tern chicks at Lady's Island Lake (IE) and Coquet Island (UK) although overall their presence may be beneficial.

Terns can coexist with breeding large gulls on islands providing the gull-free zone is implemented by removing gull nests within at least 100 meters from the colony and using various deterrent methods (laser hazing, audio gull scarers or removing rogue gulls). The level of predation most likely depends on the availability of alternative food sources for the gulls and the size of the tern colony, determining its ability to fend off predators. For example, on the Skerries (UK) a large colony of Arctic terns (2814 pairs in 2019) and common terns (301 pairs) coexists with over 800 pairs of mostly herring- and lesser black-backed gulls, thanks to management of a gull exclusion zone and wardening to monitor predation levels and identify large gulls specialising in predating terns (Baker & Dymond 2019).

A PhD study (Alfarwi 2020) of breeding gull predation on Coquet Island (UK) revealed seasonality of predation by herring- and lesser black-backed gulls on roseate tern chicks. This was prevalent early in the breeding season, before the nests and eggs of these large gulls were removed under licence, and again towards the end of the breeding season when the number of non-breeding loafing gulls increased, and at a time when roseate terns are particularly vulnerable as they generally start breeding later than the other tern species on the island and so lose the full protection afforded by the larger tern colony. Coquet Island was utilised as the main foraging area by breeding large gulls as confirmed by diet analysis, telemetry and direct observations of hunting activity over the roseate tern nest box terraces. There was no relationship between the biomass of alternative prey species available to the gulls and the frequency of predation events on the roseate tern colony throughout the season. Daily interactions were influenced by tidal movements, with the highest predation activity recorded during low and high tides, the former encouraging gulls roosting in the intertidal area overlapping with the study area, the latter pushing the gulls to roost near the roseate tern terraces (Alfarwi 2020).

Predation by native mammals occurs in colonies located on inshore islands, rocky outcrops and coastal lagoons. The Lady's Island Lake (IE) colony has suffered significant losses from rats, American mink, foxes, badgers *Meles meles* and pine martens. A semi-residential male otter was present on Coquet Island (UK) throughout the spring of 2019, resulting in a protective fence being erected around the roseate colony. This is the only possible safeguard against otters in NW Europe as they are fully protected under the EU Habitats Directive (92/43/EEC),

and, moreover, translocations are logistically complex and likely to be ineffective in the context of recovering otter populations. Because roseate terns rely more for protection on ground cover than aerial defence, they are more tenacious to their nests and slower to flee than common terns. This renders roseate terns more vulnerable to nocturnal predation by mammals and also owls Strigidae that hunt by sight (Cabot & Nisbet 2013).

Invasive non-native species can occasionally threaten roseate tern colonies. As mentioned in 4.4 (above), Ile aux Dames (FR) suffered sustained predation from American mink, which prompted the installation of a heavy-duty fence (Jacob & Capoulade 2010). Removal of American mink proved to be successful method in improving breeding success of Arctic terns in Finland (Nordström et al. 2004). Biosecurity plans and monitoring have now been developed for all the current and former Irish and the UK colonies. Rat control is taking place annually before the season on Lady's Island Lake (IE) and 'rapid response' equipment (bait and monitoring stations, trap cameras, etc.) has been made available to all the island sites participating in the Roseate Tern LIFE programme. It allowed a quick response to the 2018 incursion of a rat on Coquet Island (UK), located ca. 1.5 km from the mainland. Rats have been detected on La Colombière (FR), where annual control has been initiated. In some years in Azores, colonies at Capelinhos (Faial island) and Quatro Ribeiras (Terceira) have been decimated by cats, with several adults killed and productivity close to zero (V. Neves, pers. comm.). Breeding populations of roseate and common terns increased significantly after removal of European rabbits *Oryctolagus cuniculus* in 1997 from Praia islet, Azores (PT) (Pitta Groz & Pereira 2005). Successful recolonisation by common and roseate terns was recorded following black rat *Rattus rattus* eradication from Feno Islet of Terceira in Azores (Amaral et al. 2010). Recovery of common and roseate terns was also recorded following rat control on Contendas islets, Terceira (M. Pietrzak pers comm.). Besides rodents, invasive plants are controlled on some accessible islets and coastal areas that include tern colonies on Corvo, Flores, Terceira and São Miguel (V. Carmo, pers. comm.) although there is no evidence that excessive growth of invasive plants is any more harmful to the terns than that of native plants (V. Neves, pers. comm.).

5.1.2 Medium level threats

Predation by other than large gulls bird species such as crows Corvidae, peregrine falcons *Falco peregrinus* or kestrels *F. tinnunculus* can have a significant impact on roseate tern colonies. While crows can be controlled under licence, predation by peregrine falcon (a protected species) can contribute to a collapse of colonies, especially in combination with other predators, as was the case with Ile aux Dames (FR) in 2011 in combination with heavy American mink predation (Jacob & Capoulade 2010, Bretagne Vivante, unpublished data). Although predation by peregrine falcons can be severe, it varies between years. Oystercatchers (Lady's Island Lake (IE), Isle of May (East Scotland), turnstones *Arenaria interpres* (the Skerries – UK, Azores) and even starlings (and lizards *Lacerta dugesii*) on Vila and Praia islets – Azores (Neves et al. 2011) can also predate tern eggs in early spring. Several other bird species were recorded predating chicks in Azores, such as little egret *Egretta garzetta*, cattle egret *Bubulcus ibis*, short-eared owl *Asio flammeus* and common buzzard *Buteo buteo* (Neves 2006). Two ant species identified on Praia islet (V. Neves, unpublished data), namely *Lasius grandis* and *Monomorium carbonarium*, and both native to Azores (Wetterer et al. 2004), have been observed to predate newly hatched chicks and their precise impact is being evaluated (Neves, 2006, V. Neves, pers. comm.).

Disturbance through uncontrolled access is a potential threat on Ile aux Moutons (FR), La Colombière (FR) and some Azorean colonies, for example Contendas islets. Ile aux Moutons is wardened throughout the season and information boards are installed, however thousands of people land on the island during the season. La Colombière is accessible by foot at low tide, though rangers patrol the area on a regular basis. Coquet Island (UK) would also likely

suffer significant recreational disturbance were it not for an intensive residential wardening programme throughout the breeding season.

Egg collecting is a largely British phenomenon based on collecting of wild bird eggs. Because of the limited distribution and rarity of roseate terns, Coquet Island has in most years been targeted by collectors attempting to steal eggs. The RSPB (Royal Society for the Protection of Birds) employs a night watch warden who observes the nesting terraces from a hide located at the jetty. The island also has surveillance cameras and an active police operation protocol.

Extreme weather events. In some years, chicks succumb to chilling or reduced provisioning rates by parents owing to inclement weather. Incidence of extreme weather events will probably increase in the future due to climate change and will affect all colonies. Prolonged periods of bad weather affect the chicks in two ways – direct mortality due to exposure to wet conditions (and therefore chilling) and limited ability of adults to forage successfully and provision chicks with increasing windspeed (Dunn 1972, 1975). Equally, prolonged periods of hot weather combined with flat, calm seas may limit the availability of fish at the surface and improve the ability of fish to evade capture by the terns, impacting negatively on tern foraging success (Dunn 1972, 1973b).

Loss of nesting sites to coastal change applies mostly to colonies located on low-lying coastline areas exposed to the increasing frequency of violent and prolonged storms, which in combination with sea level rise and high spring tides, cause flooding or erosion of colonies. In NW Europe, Rockabill (IE), Coquet Island (UK) and Ile aux Moutons (FR) are rocky island locations, which are safe from flooding. Lady's Island Lake is a coastal lagoon, where the water level is lowered annually through a mechanically made 'cut' in the shingle bar, which makes the level difficult to control. A planning application for constructing the water control infrastructure has been submitted in 2020 (T. Murray, pers. comm.). However, former colonies such as Lymington Marshes (Solent and Southampton SPA, UK), Cemlyn Bay (Anglesey, Wales) and Carlingford Lough (N. Ireland) are all threatened by frequent flooding or coastal change accelerated by sea level rise and increased occurrence of violent storms.

The loss of key colonies can have impact on the whole metapopulation performance. Historically, Tern Island in Wexford (IE) washed away in the early 1970s, which played a role in the initial decline of the NW European population. This would have caused elevated levels of non-breeding mature birds as they sought alternative sites to nest, and consequent weak cohorts for a few years subsequently (N. Ratcliffe, pers. comm.). Reductions in breeding numbers and cohort strength due to intermittent breeding can also arise when sites become full to capacity.

Long-term impacts of climate-driven environmental change, more specifically rising sea temperatures, are manifested through alteration of the food web, affecting the key prey species, albeit not all in the same way, of roseate terns in NW European colonies. A tern diet literature review carried out as part of the Roseate Tern LIFE Project by Green (2017) summarised the future changes in UK waters as follows: *"*Sprat feeds on warm-tolerant zooplankton species such as *Calanus helgolandicus* and *Temora longicornis* and sprat recruitment has been shown to increase with temperature. Thus, the suitability of UK waters is expected to increase for sprat by the mid-21st Century. This is likely to benefit terns, as sprat has the highest energy content of the three prey species. In contrast, herring and sandeels feed preferentially on the large, cold-water species *Calanus finmarchicus* and recruitment of both species is negatively related to temperature. Therefore, the suitability of UK waters is predicted to decline for herring and is likely to decline for sandeels, which are unable to shift their distributions due to strong habitat associations with coarse-grained sandy sediment. A decline in herring and particularly sandeels would have a strong negative impact on populations of breeding terns*".* The range expansion and increasing abundance of sprat (Green 2017) may potentially compensate for declines in these other forage fish species.

Lenoir et al. (2011) attributed a pronounced increase in sprat abundance in the North Sea between 2000 and 2005 to increases in sea temperature.

Shortages of food have so far occurred very rarely at extant roseate tern colonies, but such an event typically manifests itself in poor growth and survival of chicks and consequently high mortality, especially amongst smaller, second chicks in the brood. In 2004, there was a transitory increase in abundance of snake pipefish *Entelurus aequoreus* (of low nutritional value and difficult for chicks to digest: Harris et al. 2008) in the North Sea, which coincided with a poor sandeel year, resulting in mass mortality of chicks of all tern species at Coquet Island (UK) (P. Morrison, pers. comm.). According to Robertson et al. (2014) the stability of the Coquet Island roseate tern population at the time of their study (2011) suggested there was sufficient food available close to the colony, although a progressive decline in both the availability and size of sandeels in the North Sea, associated with sea warming, has adversely affected other seabird species in the UK (Macdonald et al. 2015, Wright et al. 2018).

In Azores at Praia Islet (Graciosa) in 2020, productivity was very low as adult terns had difficulty finding prey small enough for small chicks, and around some nests were up to 30 dropped fish that the chicks could not swallow (V. Neves, pers. comm.).

Development of offshore windfarms is a potential threat for roseate terns, which might have a threefold effect: collision risk, reduction of foraging area and changes to pelagic fish habitat. Collision risk is generally low for terns. Recent visual tracking study of roseate terns undertaken at Rockabill showed that the tracked birds were at 1-15 m above the sea surface 83% of the time and 96% of foraging attempts were made from <15 m (Perrow et al. 2019). However, birds might pass through the windfarm rather than utilising this area for foraging, either because of an avoidance response to turbines or lack of suitable prey items within the windfarm area (M. Perrow, pers. comm.), a possible contributory factor being large predatory fish moving into the resultant reef-like structures and competing for small prey (Dannheim et al. 2019, Gill & Wilhelmsson 2019). In the case of large windfarms, avoidance can effectively deprive birds of significant sections of their foraging area, as was demonstrated in the case of Sandwich terns breeding at Blakeney Point in relation to the Sheringham Shoal offshore windfarm (Harwood et al. 2017). The indirect effects include impacts of construction on pelagic fish. One study linked the decline in foraging success of little terns *Sternula albifrons* with the decline of abundance of juvenile Atlantic herring during the pile-driving operation at Scroby Sands offshore wind farm, which eventually led to the unprecedented abandonment of eggs and very poor breeding success during the two years of construction (Perrow et al. 2011).

The accelerating rate of offshore windfarm developments and other spatially occurring threats is further concerning in the light of the **lack of sufficient protection of foraging areas** around the colonies. This is aggravated by the slowness in the process of reviewing SPA- and other Marine Protected Area (MPA) networks in all principal states within the breeding range of the roseate tern.

The impact of commercial fishing for sandeels on North Sea seabirds highly dependent on this prey species is also acknowledged (Frederiksen 2006, Cook et al. 2014) although there is no evidence so far that this has negatively impacted roseate terns. In the Irish Sea also, concerns have been expressed over commercial exploitation of forage fish, notably sprat, in relation to the long-term viability of colonies of roseate tern and other seabirds (Cummins et al. 2016).

5.1.3 Limitations

Lack of standardisation and sufficient quality of monitoring data to inform metapopulation management affects most importantly the Azorean colonies, partially because of difficulty of access, but where possible at least basic demographic parameters

should be recorded, apart from the number of nesting pairs, such as clutch size and productivity. In NW Europe, those basic parameters are collected at all colonies, but apart from Rockabill (IE) and Lady's Island Lake (IE), no systematic monitoring of a chick condition is in place and diet and provisioning data are only collected at Rockabill (IE). Trials of camera technology for diet studies and development of a chick condition index based on a small sample of chicks to reduce disturbance are needed to be rolled out across all the colonies. French colonies were not included in the demography study by Seward et al. (2019), due to the sparseness of the capture–mark–recapture data collected there. Thus, more effort is required to ring and ring-read roseate terns at Ile aux Moutons.

Lack of knowledge on the current conditions of staging sites within the Irish Sea. Disturbance can affect the roseate tern's staging sites, which play an important role for "refuelling" before the autumn migration, e.g. Dublin Bay, which may be the most important tern staging site in NW Europe (Burke et al. 2020), with thousands of roseate and other terns roosting there during the post-breeding season. Disturbance events from walkers, dogs, kite-surfers, and other recreational users are observed annually throughout this important period, with potentially significant impact. However, the scale and extent of disturbance, as well as the behavioural response of the flock and any associated negative impacts, have not been quantified or critically evaluated (B. Burke, pers. comm.).

Deficiency of data for adequate determination of roseate tern conservation status in Europe arises from a poor knowledge of phylogeny and gene flow rates between NW Europe, Azores and NE America. The genetic status of roseate terns in the North Atlantic is poorly known, with evidence both for differentiation between east and west, and for homogeneity and limited gene flow, depending on the markers used (Lashko 2004). This makes it important to carry out the studies of the migratory ecology of temperate populations on both sides of the Atlantic and Azores, and the potential routes for gene flow (Redfern et al. 2021). This new knowledge, together with fragility of the extant colonies and factors affecting the species on migration and on the wintering grounds should be considered in the next evaluation of the roseate tern's conservation status.

Limited exchange of knowledge and cooperation at the regional and international level impedes the collation of standardised data at the regional level required to assess the performance of the common tern colonies within the target areas for roseate tern colonisation. The lack of networking and sharing experience and good practice between site managers stalls the efforts to create safe alternative sites for the roseate tern. Facilitation of these activities is required at regional and international levels through various communication channels.

Lack of awareness of the threats to coastal and marine environments induced by climate change and human disturbance amongst the public puts additional pressures on the colonies already affected by coastal squeeze deriving from rising sea levels. Information and public engagement campaigns are required locally to increase the level of awareness of the marine environment and induce respect for the species sharing the coastal areas with people.

Possible lack of direction and coordination of the implementation and review process of the SAP might occur in the absence of a committed coordinating organisation, partners and stakeholders. The lead organisation should be responsible for establishing a SAP Working Group, driving the delivery of actions and reporting to the European Commission, national and regional competent authorities and relevant international conventions. Regular reviews and workshops are required for the assessment of the implementation process and the status of the species.

5.2 Reduced survival of adults and fledged juveniles

The Western European populations of roseate tern experienced steep declines from the late 1960s (Cabot & Nisbet 2013) (Figure 10). The decline occurred simultaneously at all colonies and thus has been linked to poor survival on the non-breeding grounds (Cabot 1996). It had been established that many terns were lost through trapping on the Ghana coast (Ntiamoa-Baidu 1988), which was reinforced by a relatively high proportion of ring recoveries (around 80%) of roseate terns from Ghana, the majority from trapped birds (Mead 1978, Dunn & Mead 1982, Avery 1995). Recoveries and direct observations revealed that first-year birds were caught disproportionately often compared to their abundance (Dunn and Mead 1982, Ntiamoa Badiu et al. 1992), while it appeared that the survival of adults remained constant through the periods of stability, decline and recovery, although this latter analysis was based on a small number of recoveries (Green 1995).

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Other factors which might have accelerated the historic decline of the European population throughout the 1970s and 1980s were the erosion and ultimate abandonment of the largest roseate tern colony at the time – Tern Island in Co. Wexford, Ireland – in the early 1970s (as discussed above), competition with large gull species, and the collapse of the sardinella stock in Ghana from 1973 to mid-1980s (Minta 2003). The loss of Tern Island would have resulted in a high level of non-breeding by mature adults and consequently reduced numbers of fledglings in the affected cohorts, while reduced food availability in Ghana may have reduced juvenile survival rates (N. Ratcliffe, pers. comm.).

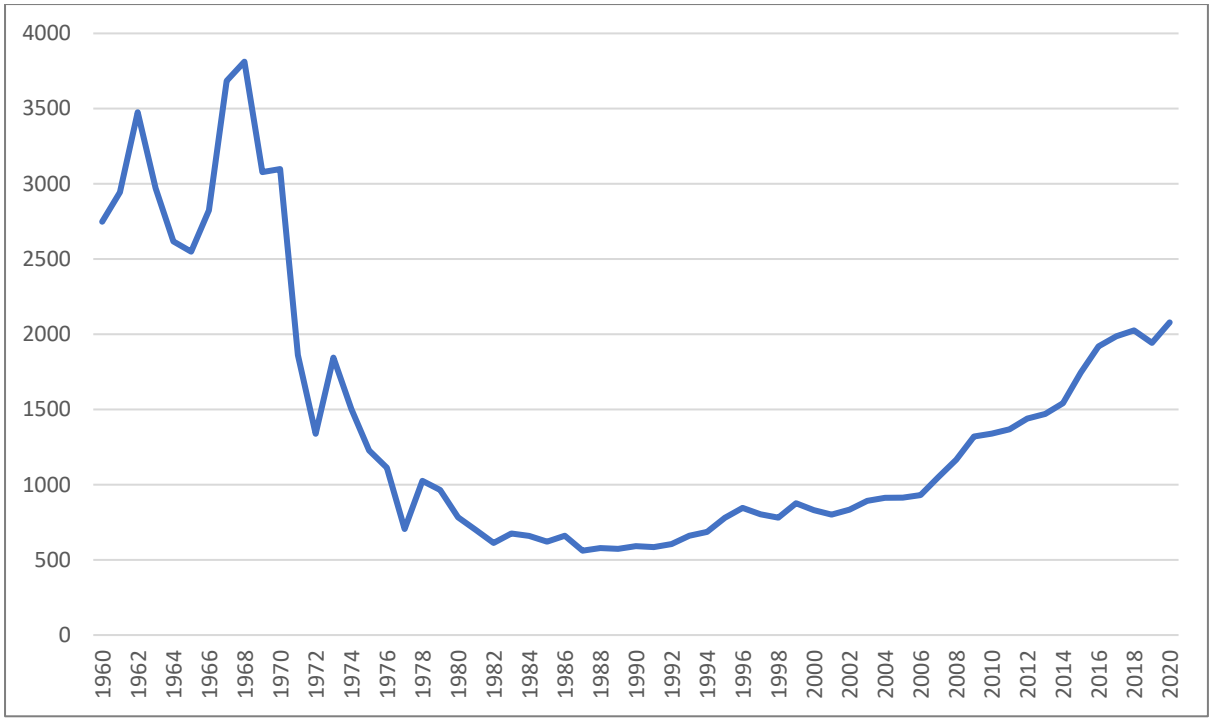

Figure 10. Long-term trend of the Western European (IE, UK, FR) population of roseate tern (number of breeding pairs). Data sources: Cabot, 1996, Annual reports for Rockabill (IE), Lady's Island Lake (IE) and Coquet Island (UK), S. Newton, pers. comm., Y. Jacob, pers. comm.

5.2.1 Medium level threats

Tern trapping in Ghana

A full historic overview of this issue has not previously been presented in the literature; hence we provide a systematic literature review here.

Terns are trapped on the coast by a variety of methods throughout West Africa, from Mauritania to the Gulf of Guinea, and mostly by boys up to teen-age. The main motivation behind trapping in Ghana is to provide an additional source of food or income (when caught terns are sold), or recreation (Quartey et al. 2018). There are few published data on the exact locations and intensity of trapping but Dunn and Mead (1982) reported that on nine days between 5 and 22 October 1979, 128 terns were seen caught on lines with fish-baited hooks at James Town Harbour, Accra, comprising mostly 1st winter common terns (44 birds) and 1st winter Sandwich terns (30 birds). Other species caught were black tern *Chlidonias niger* (11), royal tern *Sterna maxima* (5), Arctic tern (2) and roseate tern (1). The rate of catching was higher during six days of observations when sardine landings from the local fishery were abundant (4.6 terns of all species caught per hour) compared to 2.3 terns per hour during 12 days of observations when sardines were not available, indicating that sardines had to be plentiful in order to (a) attract foraging terns close to the shoreline and (b) facilitate trapping activity, the fish being required as bait for snaring lines (Dunn & Mead 1982). An estimated 20 to 25 terns (all species) were caught per day at James Town Harbour in October/ November 1979, and recoveries of rings from trapped birds showed that 80% were first-year birds (Everett et al. 1987).

The high intensity of trapping of roseate terns led to the establishment of the Save the Seashore Birds Project Ghana (SSBP-G) in the mid-1980s. This project aimed at protecting sea- and shorebirds and their coastal wetland habitat through research, site protection and education. The project was jointly carried out by the Royal Society for Protection of Birds (RSPB), the International Council for Bird Preservation (ICBP) (now BirdLife International) and the Ghana Government. One of the recommendations from the SSBP-G was the regular monitoring of waterbirds along Ghana's coast. In the earlier years these counts established the importance of the Ghana coast for waterbirds and led to designation of five coastal wetlands as Ramsar sites. The four-year survey of sea- and shorebirds, carried out as part of the project between 1985 and 1988, established the relative importance of Densu delta and salt pans, Keta lagoon and Sakumo lagoon for terns. The project also led to tern trapping being made illegal in Ghana in 1988 (Avery et al.1995).

However, despite these efforts, systematic surveys carried out by Adrian del Nevo in 1989 revealed that up to 5 terns per hour were being caught at 11 out of 23 surveyed sites (Avery et al. 1995). During sixteen visits (39 hours of observations) to James Town harbour in October-December 1989, 34 terns were seen to be caught, mostly black terns (70%) and common terns (18%), but also Sandwich tern (6%), royal tern (3%) and roseate tern (3%). Most of the birds were caught during the weekends, particularly on Sundays (Avery at al. 1995). In 1991-1992, a survey was undertaken along the coast of Ghana, to try to quantify the scale of the problem. Six species of terns were involved, with roseate and common terns appearing to be more susceptible to snaring on the beaches than other species. Interviews with the boys involved in setting snares suggested that on some days each boy could catch 12-15 terns, but little other quantitative data were obtained (Ntiamoa-Baidu et al. 1992).

Further study of trapping was carried out in 2002 between September and December (N. Ratcliffe, unpublished report). Trapping activities were observed in the following five beach stretches: Horvi – Adina Hornukope, Woe – Keta, Accra – Bortianor, Winneba – Mankoadze and Abandze – Edumafa. No trapping was observed in the Sekondi – Shama stretch, for no obvious reason other than the fishermen interviewed indicated that tern numbers in the area had decreased with a significant reduction in fish landings. In 2002, out of 66 survey days, trapping was observed 16 times, yielding a total of 51 terns, all of which were either black or

common terns. The intensity at Tetevikope on the Woe – Keta stretch was the highest as one snare caught two birds in 10 minutes (equivalent to 12 birds/snare/hour). This rate was lower than that recorded on the same stretch of coast at Dzelukope in the 2001 and 1991/92 studies (24 and 14 birds per snare per hour, respectively) but still comparable to the intensive 20 birds per snare per hour recorded in 1979 by Euan Dunn and Alistair Smith at Kedzi (also in the Anlo area).

More recently, the RSPB engaged the Centre for African Wetlands (CAW) to assess the status of the wintering population of the roseate tern, ascertain if trapping of terns continues to be a serious conservation issue and to define conservation requirements and priority actions for the species in Ghana. The project was carried out over two seasons: September – November of 2016 and 2017, coinciding with the peak period of waterbird occurrence along Ghana's coast (Quartey et al. 2018). Six important wintering sites were selected for the transect survey representing approx. 550 km of the coast. All six surveyed stretches of the coast supported fishing activities. Only six direct observations of trapping were recorded during two out of 108 survey days at the James Town-Bortianor (1 event) and Woe-Keta stretches (5 events), the latter one also supporting 75% of the 175 confirmed roseate terns recorded during the whole survey[8]. Although this would indicate that trapping activity is not widespread and rarely undertaken, the interviews conducted during the surveys confirmed that trapping was still practised at all the surveyed sites. No roseate terns were observed to be trapped although this could have been an artefact of the relatively small numbers at risk compared with other species of tern; 37 of the 45 trapped birds were common terns and single Sandwich, black and royal terns. The highest rate of trapping (15 terns per snare per hour) was recorded at Faanaa along the James Town-Bortianor beach. On average, 12 terns were caught per snare per hour at two villages along the Woe-Keta stretch. These rates are comparable with previous studies. Most of the trapping was carried out by children, except for one adult trapper who was also the most effective at trapping, with up to 15 common terns trapped per snare per hour. When interviewed, he admitted that he sells the birds for GH₵5 each (approx. 0.75 EUR). One team of trappers deliberately released black terns, apparently targeting the larger Sandwich- and royal terns (Quartey et al. 2018).

Is tern trapping a conservation issue for roseate terns? Whereas trapping continues, it seems that the activity is less common than in the mid-1980s when the Save the Seashore Birds Project was launched, which could partly be explained by a higher proportion of children attending school. Ghana has experienced rapid economic development since around 2000 and the number of out-of-school children decreased from almost 300,000 in 2011 to only 35,000 in 2019[9]. Interrogation of the BTO ringing and recovery data revealed that while a high proportion of ringed birds were recovered towards the end of 1960s and early 1970s in Ghana (mostly from trapping), the number of recoveries has declined in the last 20 years, despite many more birds being ringed since BirdWatch Ireland took over the management of Rockabill in the late 1980s[10]. Most young birds remain in their African wintering grounds until at least age 2 and could therefore be disproportionately affected by variation in food availability or trapping there. However, neither juvenile nor age 3 and age 4+ survival rates were correlated between any pair of colonies (Seward et al. 2019). As the birds from different colonies winter in the same areas (Ratcliffe & Merne 2002, Redfern et al. 2021), we would expect such

[8] The low number of roseate terns could be due to the difficulty with access to and identification within large, mixed flocks of terns. Note that 4176 terns (14.1%) were unidentified. More information: http://roseatetern.org/uploads/3/5/8/0/35804201/caw_-rspb_roseate_project-final_report-_version_nov_14-_2019.pdf

[9] Unesco Institute for Statistics: http://uis.unesco.org/en/country/gh

[10] BTO supplied the full roseate tern ringing/recovery dataset on 23 August 2018. The BTO Ringing Scheme is funded by a partnership of the British Trust for Ornithology, the Joint Nature Conservation Committee (on behalf of: Natural England, Natural Resources Wales, NatureScot and the Department of the Environment Northern Ireland), the National Parks & Wildlife Service (Ireland) and the ringers themselves.

correlations if factors in the wintering grounds had strong impacts on annual variability of survival rates.

More needs to be done to raise awareness amongst school children in Ghana, as the Save the Seashore Birds Project previously stimulated. Monitoring of demographic parameters at breeding colonies needs to continue to detect changes in survival rates. Periodic surveys should continue in Ghana in order to monitor the threat from trapping. The consumption of alternative sources of protein might intensify in poorer rural areas with predicted declines in fish supply (Brashares 2004, EJF 2020), potentially maintaining the incentive to trap terns.

Overfishing and climate change impacts on cold water upwelling systems

As offshore regions of high biodiversity and productivity, the major oceanic upwelling systems off West Africa, namely the Guinea Current Large Marine Ecosystem (GCLME) and the Canary Current Large Marine Ecosystem (CCLME) which includes the cold-water upwelling off Western Sahara and Mauritania (Camphuysen & van der Meer 2005), are significant migratory stopover or refuelling sites for roseate terns (Redfern et al. 2021). Stocks of small pelagic forage fish in the CCLME are important for seabirds (Szostek and Becker 2015, Grecian et al. 2016) but the area has been declining in productivity (Aristegui et al. 2009), and subject to overfishing and pollution in recent decades (Demarcq & Somoue 2015).

Climate change is potentially an aggravating factor in the wider region (Sumaila et al. 2011). Modelling suggests that rising sea temperatures in Ghana's coastal waters are decreasing primary- and fish production, and that this needs to be factored into regulation of the artisanal fishery (see below) (Minta 2003, Akpalu et al. 2015).

Fish stocks in the GCLME have likewise been overexploited (e.g. Senegal: Ba et al. 2019), resulting in declining catch per unit effort by Ghana fishermen (Atta-Mills et al. 2004, Nunoo 2015). According to the Environmental Justice Foundation (EJF 2020), scientists predict the collapse in less than five years of Ghana's small pelagic fishery (especially sardinella but also anchovies *Engraulis encrasicolus* and Atlantic chubb mackerel *Scomber colias*) in the absence of ambitious management interventions. A major contributor to the fishery's decline is the activity of industrial trawlers, mostly linked to Chinese ownership, deliberately taking bycatch of small pelagic fish which are meant to be reserved for artisanal fishers operating inshore canoes. Much of this industrial bycatch is juvenile sardinella below the legal minimum landing size. Sardinella landings in Ghana have declined from 135,628 tonnes in 1996 to 29,111 t in 2016 (EJF 2020). However, overcapacity in the artisanal fishery is also an issue; according to EJF (2020) total fish landings (all species) by the artisanal fleet exceed those of the industrial fleet. It has been recommended to reduce the artisanal sector from the current ca. 13,000 to 9,000 canoes (Cobbina 2018, Akpalu 2020).

5.2.2 Limitations

Lack of knowledge on the current conditions of coastal wintering sites in West Africa and NE South America

Roseate terns rely on coastal wetlands and salt pans for roosting and resting especially in Ghana, but ring recoveries and the recent geolocator study (Redfern et al. 2021) highlight also the importance of Ivory Coast, Liberia and Sierra Leone for wintering, and Senegal and Mauritania during migration. There is a need to identify and assess the conservation status, threats and condition of key coastal sites in these countries through collaboration with local partners. Support and training are needed for the monitoring of terns in collaboration with the Centre for African Wetlands in Ghana and the East Atlantic Flyway Initiative.

There is limited information on threats along the north-east coast of South America, where a proportion of the Azorean population spends the winter (Hays et al. 2002). Mostello et al. (2014) identified several potential environmental threats in this region, including severe overexploitation of fisheries, coastal and offshore oil and gas exploration, pollution from development, industry, agriculture and maritime transport; destruction of mangroves; degradation of coral reefs; and coastal development for human recreation and building of holiday homes. The relationship between these threats and effects on roseate tern remains unknown. Historically, an estimated 1% of juveniles and 2% of adults ringed in the period of 1968-1977 were recovered as trapped for food in a limited area of eastern Guyana although this was not sufficient to account for the 30-40% decline of the north-eastern Atlantic breeding population in this period (Nisbet 1984). Nisbet (2014) and Nisbet et al. (2017) cited other records of tern trapping in the winter quarters of South America and considered that more information is needed.

6 Annex 3. Justification of Conservation/Management Objectives

6.1 Current conservation approach

Roseate terns are protected by law in all the countries covered by the Action Plan and all the colonies are located within Special Protection Areas (SPAs), some of them extending to include foraging areas.

Most of the colonies in NW Europe and some in Azores are intensively managed for the provision of nesting habitat, control of predation and disturbance, competition with other species, biosecurity measures and monitoring. In NW Europe, continuation of this management is likely to sustain the growth of the metapopulation with the average productivity exceeding the mortality rates (see Table 2). Maintaining high productivity (but not necessarily colony growth, given density dependent limitations) is especially important for Rockabill (IE) which, between 1993 and 2016, was the only source colony supporting the population growth rate of Lady's Island Lake (IE) and Coquet Island (UK) (Seward et al. 2019).

There are two major risks with the current situation on the breeding grounds:

c. there are signs of density dependent effects on Rockabill with lower-than-average productivity in the last five years, meaning that the site is producing fewer individuals to sustain the recent growth rate of the metapopulation. We can expect that the growth will therefore slow down or plateau.
d. in the case of a stochastic event affecting Rockabill the colony may disperse to less suitable sink sites, where productivity might be below the population maintenance level (so-called buffer effect).

The situation in France and in Azores is much more dynamic as the level of intensive management of these colonies has been much lower than in the UK and Ireland. As such, the colonies change location more frequently, depending on the local conditions each year. The main consequence of this pattern is higher levels of intermittent breeding and weak cohorts during the years of relocation.

The wintering areas and their condition for the Azorean birds are poorly understood. Moreover, the threats on the known wintering grounds and migration routes of both the Azorean and NW European metapopulations have been largely neglected. The potentially serious issues of overfishing and climate change impacts on forage fish associated with the productive cold

water upwellings of the Canary Current- and Guinea Current Large Marine Ecosystems have only recently been brought to the attention of roseate tern conservationists. This, together with the fragility of the breeding colonies (especially Rockabill as a source colony) might very rapidly reverse the current positive trend of the NW European metapopulation.

6.2 The way forward

The overall goal of the Action plan is to **maintain the growth of the East Atlantic roseate tern population, while securing suitable sites for colonisation within a coherent network of European colonies.**

While it is necessary to maintain or introduce intensive management of the key roseate tern colonies (Objective 1), it is also important to provide safe nesting conditions at large common tern colonies in preparation for roseate tern expansion (Objective 2), either through the growth of the NW European metapopulation, or more likely, dispersal caused by deterioration of one of the key extant colonies. Target areas have been selected for the potential colonisation in NW Europe, based on the distribution of multiple prey species, and historic and current key roseate and common tern colonies (Figure 11).

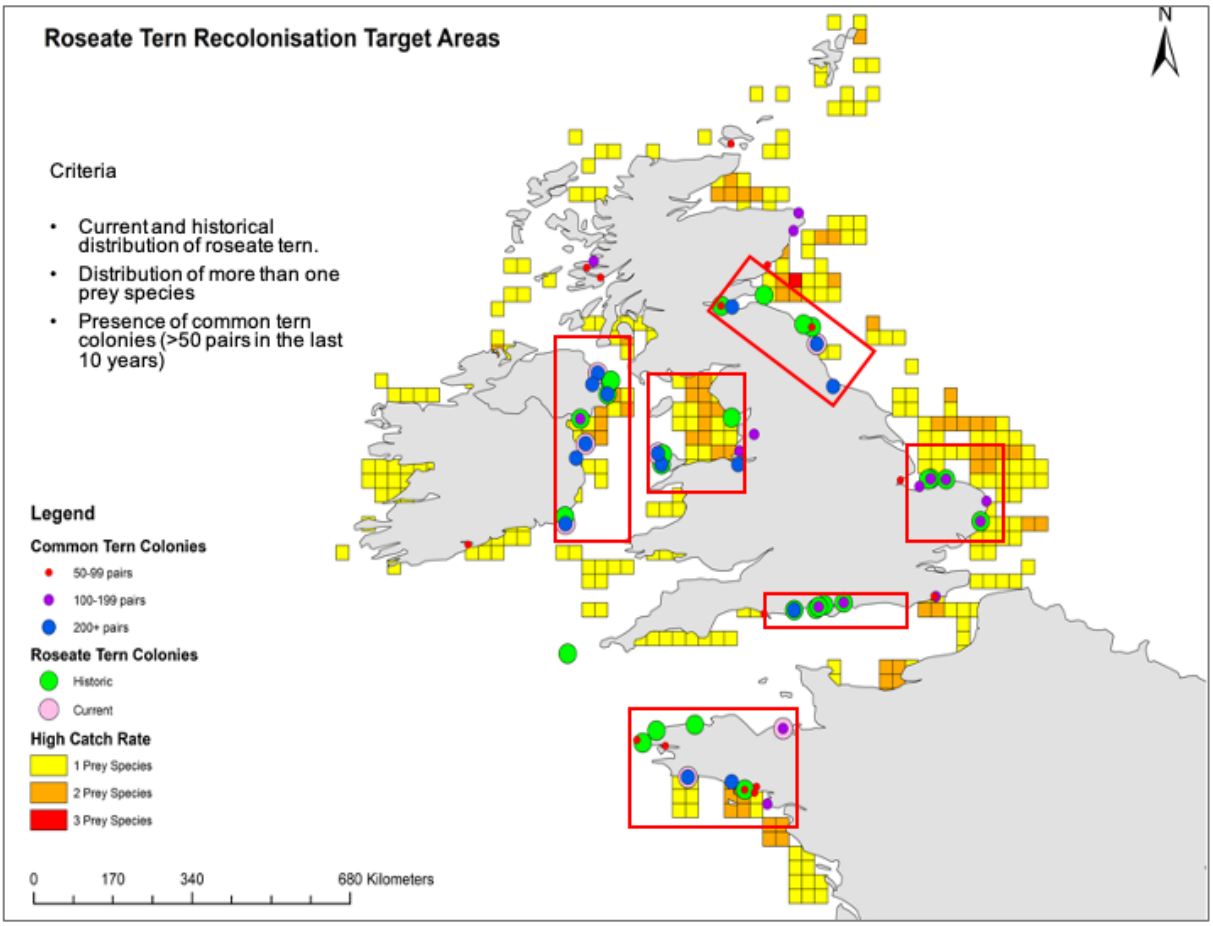

Figure 11. Target areas for the roseate tern colonisation in NW Europe (Green 2017, Miles et al. 2018).

Furthermore, protection of key coastal sites and forage fish stocks along the migration routes and on the wintering grounds will be secured through research, policy and advocacy work (Objective 3). Awareness raising, further scientific advances and improvement of monitoring methods (Objective 4) will be based on regional cooperation via knowledge and best practice

sharing (Objective 5). The implementation of the plan will be coordinated and reported by a lead organisation under supervision of the Working Group and in collaboration with national authorities, statutory agencies and partners (Objective 6).

A detailed list of actions is presented in the Framework for Action on pages 11-26. The main proposed objectives and results of this Action Plan are:

Objective 1: Maintain or improve productivity through intensive management of all key colonies

Result 1.1: Average 5-year mean productivity maintained at a level sufficient to compensate for or exceed losses from the population due to natural mortality at all key colonies through management of predation, biosecurity, disturbance, nesting habitats and species competition.

Result 1.2: Protection of foraging areas around the breeding colonies secured.

Result 1.3: Spatial planning and coastal/ marine development projects fully consider offsite- and indirect impact pathways on roseate tern food resources and foraging areas

Result 1.4: Protection of forage fish stocks implemented through ecosystem-based fisheries management

Objective 2: Maintain, create or restore safe alternative sites for eventual expansion within target areas

Result 2.1: Population and productivity of key current common tern colonies increased.

Result 2.2: New sites established through restoration or creation.

Objective 3: Maintain and improve survival rates through identification, protection and management of key staging, stopover and wintering sites.

Result 3.1: Key staging sites and threats within the Irish, Celtic and North Seas assessed

Result 3.2: Improved protection and management of key wintering sites along the coasts of West Africa and NE South America

Result 3.3: Tern trapping in Ghana eradicated.

Result 3.4: AAssSafe biological limits for forage fish stocks in Ghana and the Large Marine Ecosystems off West Africa assessed and sustainable use of forage fish achieved

Objective 4: Fill knowledge gaps and improve monitoring practices.

Result 4.1: Phylogeny and migration routes analysed to inform the global and European conservation status.

Result 4.2: Standardised monitoring of demography parameters to inform management of the metapopulation in place.

Objective 5: Communication and partnership working towards metapopulation management.

Result 5.1: Raised awareness amongst the general public of coastal and marine issues caused by environmental and human pressures.

Result 5.2: Best practice and data shared and standardised.

Objective 6: Establish structures for the implementation of the Species Action Plan (SAP).

Result 6.1: Action Plan implementation driven and monitored by the Coordinator and Working Group

7 Annex 4. References

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8 Annex 5. The Roseate Tern LIFE Recovery Project (LIFE14 NAT/UK/000394)

The Roseate Tern LIFE Project (www.roseatetern.org) is a partnership between the RSPB, BirdWatch Ireland and North Wales Wildlife Trust. The project focuses on enhancing breeding conditions at the core colonies in Ireland and the UK, while also improving five former roseate tern SPAs in preparation for a potential expansion (Solent and Southampton, Forth Islands, Ynys Feurig, Cemlyn Bay and the Skerries, Larne Lough and Dalkey Islands).

The funds from the LIFE project have enabled partners to increase wardening hours, clear vegetation, create more terraces and increase the number of nest boxes. Wardens have also been able to discourage large gulls from occupying and predating nesting sites through trialling new techniques including gull scarers and Agrilasers (laser technology to deter birds). Biosecurity measures and exclusion fencing were also implemented across certain colonies to deter mammalian predators. The project is also restoring tern nesting habitats that have been degraded by erosion and subsequent flooding to support common tern colonies and consequently increase probability of roseate tern recolonisation. This includes island restoration, shingle recharge, creating nesting bunds on breakwaters and deploying rafts.

The LIFE project has also led on several key areas of research including a demography study which revealed that the population growth at Coquet island (UK) has been driven by immigration from Rockabill (IE), whereas the growth of Irish colonies is driven more by productivity and the survival of juveniles/adults (Seward et al. 2019). Sandeel and alternative prey species reviews led to the development of prey hotspot areas for future management (Green 2017). Additionally, the wintering hotspots in Ghana were surveyed and illegal tern trapping is confirmed to still be ongoing in places (Quartey et al. 2018). Geolocators have also been deployed to understand roseate tern migration patterns (Redfern et al. 2021).