Origin of large gulls in the North Sea

Analysis based on ring recoveries

S. Duijns
M. Helberg
H. Verstraete
E.W.M. Stienen
R.C. Fijn

UiO : Universitetet i Oslo

INSTITUUT NATUUR- EN BOSONDERZOEK

Vlaanderen is wetenschap

Bureau Waardenburg
Ecologie & Landschap

Bureau Waardenburg
Ecology & Landscape

Origin of large gulls in the North Sea

Analysis based on ring recoveries

Commissioned by: Rijkswaterstaat Zee en Delta

4 March 2020
report nr 19-257

Origin of large gulls in the North Sea

Analysis based on ring recoveries

S. Duijns, M. Helberg, H. Verstraete, E.W.M. Stienen, R.C. Fijn

Status:	final report
Report nr:	19-257
Project nr:	19-0290
Date of publication:	4 March 2020
Photo credits cover page:	Daniel Beuker / Bureau Waardenburg bv
Project manager:	R.C. Fijn *MSc.*
Second reader:	drs. T.J. Boudewijn
Name & address client:	Rijkswaterstaat WVL Postbus 2232 3500 GE Utrecht
Reference client:	Zaaknummer 31135909, SAP-bestelnummer 4500271358
Signed for publication:	Team Manager Bureau Waardenburg bv drs. H.A.M. Prinsen
Signature:	

Please cite as: Duijns, S., M. Helberg, H. Verstraete, E.W.M. Stienen, R.C. Fijn, 2020. Origin of large gulls in the North Sea. Analysis based on ring recoveries. Bureau Waardenburg Rapportnr.19-257. Bureau Waardenburg, Culemborg.

Keywords: Colour ring, darvic, wind energy, EIA, offshore, Larus

Bureau Waardenburg
Ecology & Landscape

Bureau Waardenburg, Varkensmarkt 9, 4101 CK Culemborg, the Netherlands
+31 (0) 345 512 710, info@buwa.nl, www.buwa.nl

Preface

The Dutch North Sea is home to large numbers of various gull species. The construction of offshore windfarms is predicted to cause collision victims among these species. Knowledge on the origins of these gulls is a prerequisite for a legal assessment whether this mortality can have significant effects on protected populations. Since capturing birds at sea was not possible in a previous project, this study focuses on recoveries of ringed gulls at sea.

We thank Delta Safari for organizing three ring-reading trips offshore to search for colour ringed individuals in proposed and existing wind farms. Bouwman Sport visserij and the skipper of the Neeltje Jans as well as Rederij Vrolijk and the skipper of the Estrella are thanked for safe transport.

All collaborators of the various ringing programmes around Europe are greatly acknowledged for sharing their data. Oskar Bjørnstad (Norwegian Gull ringing – www.ringmerking.no), Paul Roper (North Thames Gull Group and Southern Colour Ringing Group), Roland-Jan Buijs (Buijs Eco Consult), Kees Camphuysen (Royal Netherlands Institute for Sea Research), Håvard Husebø (Norwegian Bird Ringing Scheme), Neil Calbrade (British Trust for Ornithology) and Marcel Klootwijk all contributed existing resightings of colour ringed birds offshore.

This project was commissioned by Rijkswaterstaat (Dutch ministry of Infrastructure and Water Management) and benefitted greatly from the enthusiastic guidance and input of Maarten Platteeuw, Suzanne Lubbe, Dagmar van Nieuwpoort and Ingeborg van Splunder.

Table of contents

Summary

Aim
To gain insight in the natal and breeding origin of three large gull species at sea and more specifically within offshore wind farms. The species that were considered are great black-backed gull (GBBG) *Larus marinus*, herring gull (HG) *Larus argentatus* and lesser black-backed gull (LBBG) *Larus fuscus*.

Methods
We collected offshore (> 5 km) colour ring resightings from various collaborators in the UK, the Netherlands, Norway and Belgium. Data were filtered and analysed to identify per species the birth and breeding colony at the time of the resighting. In addition, we participated in six offshore trips to actively search for colour ringed individuals.

Results
The dataset contained 628 offshore resightings from 562 individuals of the three gull species involved (172 GBBG, 179 HG and 211 LBBG). From these 562 individuals, we could determine the birth colony of 445 individuals (79%), and most individuals were born in Norway (57%), followed by the UK (27%), the Netherlands (6%) and relative small percentages (< 5%) from other countries such as Belgium, France, Germany, Finland, Russia, Sweden and Denmark. We were able to assess the most likely breeding locations of 100 individuals, and most individuals (65%) were breeding in Norway, followed by the Netherlands (18%), Belgium (8%), the UK (6%) and Denmark (3%).

From all resightings, we identified 41 individual birds that were observed in a (proposed) wind farm. Almost half of these individuals (46%) were born in Norway and 12% were breeding in Norway, followed by 15% of this sample that were born in the UK and 2% were breeding in the UK, while the birth country was unknown for 25% of the resightings. A small percentage of this sample was born in the Netherlands (2%), while 12% were breeding in the Netherlands. Assuming our dataset is a representative sample, this implies that overall 7% of the three large gull species enter (proposed) offshore wind farms. The natal origin of the individuals that were observed in (proposed) offshore wind farms varied per species.

Conclusions
Based on our results we conclude that a relatively low percentage of gulls were observed in offshore wind farms. However, as only a relatively small area in the North Sea is currently being used for offshore windfarms, it actually suggests that a relatively large number of large gulls visits the areas used for offshore windfarms. Most individuals that were resighted on the North Sea area originated from Norway and the UK and to a lesser extend from the Netherlands. This makes Norwegian and UK populations particularly vulnerable for interactions with offshore windfarms, because they cross the North Sea on migration, while other (sub)populations do not have to cross the ocean and are more likely to follow the coastline while migrating, hence avoiding these possible interactions with offshore windfarms.

1 Introduction

Large gulls are at risk of colliding with wind turbines and the numbers of collision victims from wind farms can be predicted using a collision rate model. Rijkswaterstaat (2019), estimated the numbers of collision victims from offshore wind farms planned in the North Sea until 2030 using the SOSS Band model (Band 2012). These predicted collision numbers are modelled using turbine-related parameters (turbine size, rotor height, speed) and species-related parameters (bird density, flight height distribution, flight speed, percentage of time in flight, night activity, wingspan, size, avoidance rate).

Based on Rijkswaterstaat (2019), the planned large-scale development of offshore wind farms in the North Sea may impact populations of large gulls. This mainly concerns great black-backed gull (GBBG) *Larus marinus*, herring gull (HG) *Larus argentatus* and lesser black-backed gull (LBBG) *Larus fuscus*.

Before the construction of a wind farm is permitted, an environmental impact assessment (EIA) is required. Within this EIA, the expected impact as a result of the construction of the wind farm is assessed. Potiek *et al.* (2019) studied whether population models can be used to get a reliable insight of the impact of additional wind farm related mortality at population level and concluded this is a more reliable method than using the previously used metric Potential Biological Removal (PBR). In order to get a reliable impact assessment using population models, the input data need to be of sufficient quality. Potiek *et al.* (2019) defined various knowledge gaps. One of those knowledge gaps is that the origin of the large gulls using the North Sea is currently unclear. This makes the definition of a population challenging. It is likely that birds from certain breeding colonies make more use of the North Sea than individuals from other colonies. Impact assessments often study the impact on a breeding colony. Hence, it is crucial to understand the origin of the collision victims.

In this study we aimed to answer the main question:
What is the natal origin and most likely breeding location of large gulls present at the Dutch North Sea in different periods of the year?

To get more insight in the breeding locations and birth colonies of large gulls in the North Sea we used a combined approach, using existing data on (colour)ring resightings, and newly collected field observations.

2 Materials and methods

The main goal of this project was to collect a large sample of resightings of colour ringed gulls in the (Dutch) North Sea and more specifically within proposed and existing windfarm locations. Ring reading is attracting an increasing number of birdwatchers during pelagic birding trips. A proven method to allow reading rings and colour rings offshore is by taking high quality digital pictures and identify the rings from the screen.

2.1 Existing data

We contacted nine colour ring programmes around Europe to participate in this analysis. Eight of these programs responded positively and seven of these programs did have resightings of birds offshore (Table 2.1). We asked each contributor for the complete life histories of all birds with resightings further than 5 km offshore in their respective datasets in the North Sea.

Table 2.1 *Summary of number of offshore resightings separated by source (i.e. colour ring program) and species. GBBG = great black-backed gull, HG = herring gull, LBBG = lesser black-backed gull*

Source	GBBG	HG	LBBG	Total resightings
NGRG[1]	136	24	103	263
BEC[2]	-	6	22	28
BTO[3]	37	139	32	208
NIOZ[4]	-	1	7	8
INBO[5]	-	10	16	26
NTGG[6]	16	6	4	26
Dhr. Klootwijk	25	7	37	69
Total	214	193	221	628

2.2 Fieldwork

We participated on three trips to identify colour rings of birds within (proposed) offshore wind farms at 14 May and 26 June 2019 from Neeltje Jans to Windenergiegebied Borssele and on 10 September 2019 from Scheveningen to Windenergiegebied Hollandse Kust Zuid. The resightings (n = 8), from these trips are included in the data analysis. Furthermore, we participated in three additional pelagic birding trips in autumn (14-09, 13-10, 09-11 all departing from Neeltje Jans) to collect colour ring sightings near windenergiegebied Borssele, which resulted in an additional 20 resightings.

[1] Norwegian Gull Ringing Group
[2] Buijs Eco Consult
[3] British Trust for Ornithology
[4] Royal Netherlands Institute for Sea Research
[5] Instituut voor Natuur- en Bosonderzoek
[6] North Thames Gull Group

2.3 Analysis

All data that we received from our collaborators were stored in a R database, supplemented with our own observations from the different field trips. We could identify the birth colony when an individual was ringed as pullus. In order to identify a breeding colony, we collated all life histories of adult birds and checked for multiple sightings (>3) between April and August over multiple years (>2) at the same site to identify a potential breeding location. Whenever we identified these sightings, we searched for consistent resightings at a potential breeding site for at least three years, and the resightings at a site was considered a breeding site whenever the elapsed time of last observation was within a three-year window. For the Norwegian birds, the resighting data contained a status variable, including nesting. Thus, for these birds it had been verified that they were actually breeding at that site.

Next, for all breeding locations identified, we also checked whether these were located within a Natura 2000 SPA. In addition, all offshore resightings were checked for proximity to (proposed) wind farms. Due to the (sometimes) inaccuracy of coordinates from our collaborators we used a 5 km barrier around windfarms at sea. Thus, resightings within a 5 km radius around a (proposed) windfarm are included as a sighting within a wind farm.

In order to better understand the origin of large gulls observed offshore, we also explored the distance (km) from the resighting location to their breeding and birth colonies of the three species involved. We used the deg.dist function in R, to calculate the distance between the different coordinates. This function calculates the shortest distance (i.e. Great Circle) in kilometers between two points on the Earth. We used a linear model (LM), with distance as the response variable, species as an explanatory variable and age as a covariate.

3 Results

3.1 Natal origin

In total we obtained 628 offshore resightings of 562 individuals of the three gull species involved. Of these individuals we had hatching locations of a large part of the sample (*n* = 445; 78%), because they were caught and ringed as pullus. For graphical purposes and the amount of resightings, we have grouped them into season. The seasons are defined as: spring (March - April), summer (May - August), autumn (September - October) and winter (November - February).

Great black-backed gull

In our dataset of offshore resightings we have hatching locations of 175 individual GBBG (Table 3.1). Most great black-backed gulls (75%) originate from breeding colonies in southern Norway, followed by the UK (8.6%), while 12% was unknown. The offshore resighting locations per season are given in Figure 3.1, Figure 3.2, Figure 3.3 and Figure 3.4; with the links to breeding and birth colonies in different colours and colonies in Natura 2000 special protected areas are marked red. In spring there are only a few offshore resightings (Figure 3.1), while in autumn there is a relatively high number of individuals resighted near Neeltje Jans (Figure 3.4), probably due to an increased intensity of pelagic trips for birders and the fact that GBBG are wintering in these areas. A small percentage originates from Scotland. There are no clear seasonal patterns in hatching locations over the different times of the year.

Table 3.1 Birth country of resighted great black-backed gulls

Birth country	Number	Percentage
Denmark	3	1.7
France	1	0.6
Germany	2	1.2
Norway	129	75
Russia	1	0.6
United Kingdom	15	8.7
Unknown	21	12.2
Total	172	100

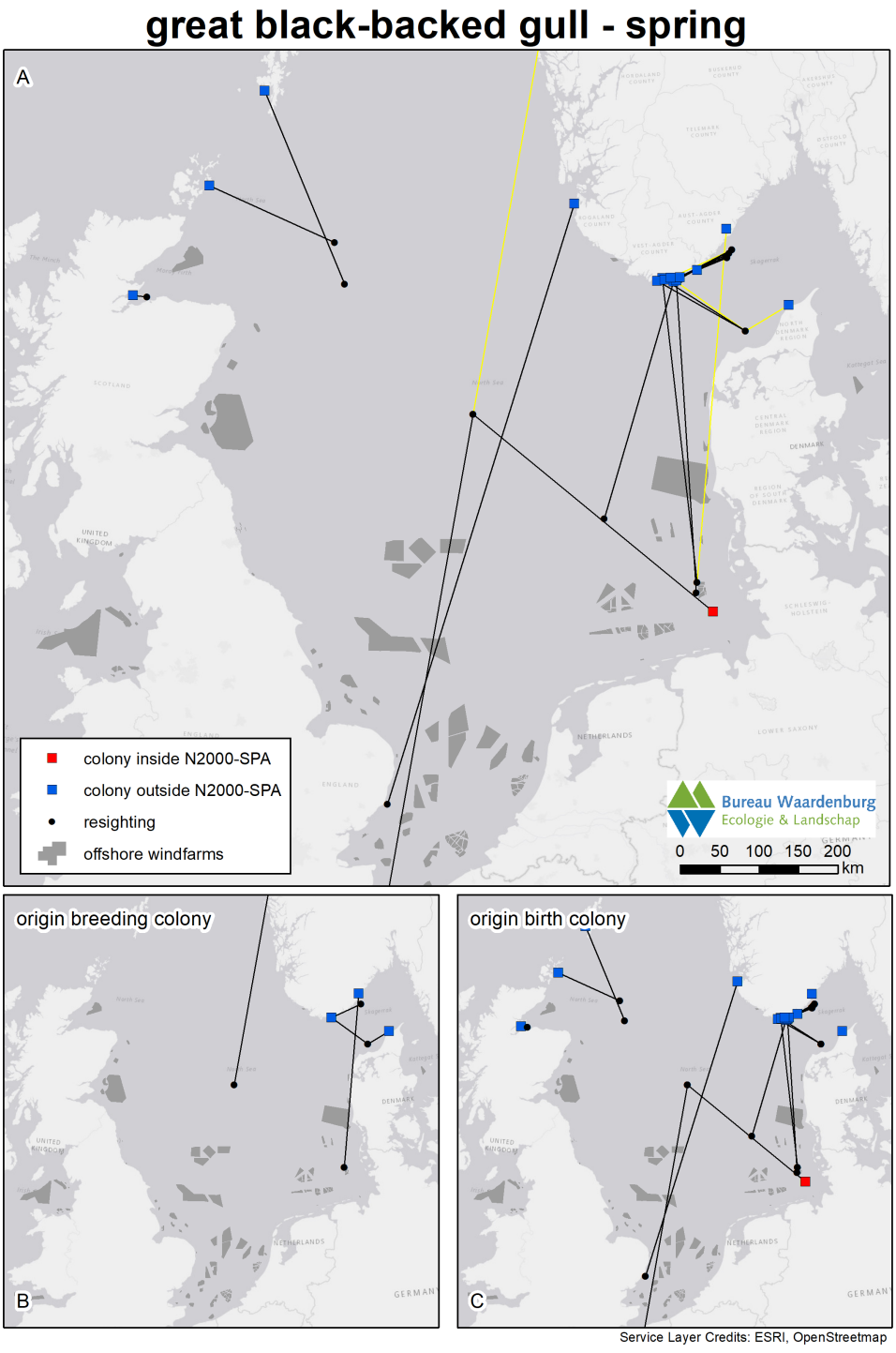


Figure 3.1 *The offshore resighting locations (black dots) of great black-backed gulls in spring. The different colours represent whether the colony was in a N2000 SPA was located for great black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

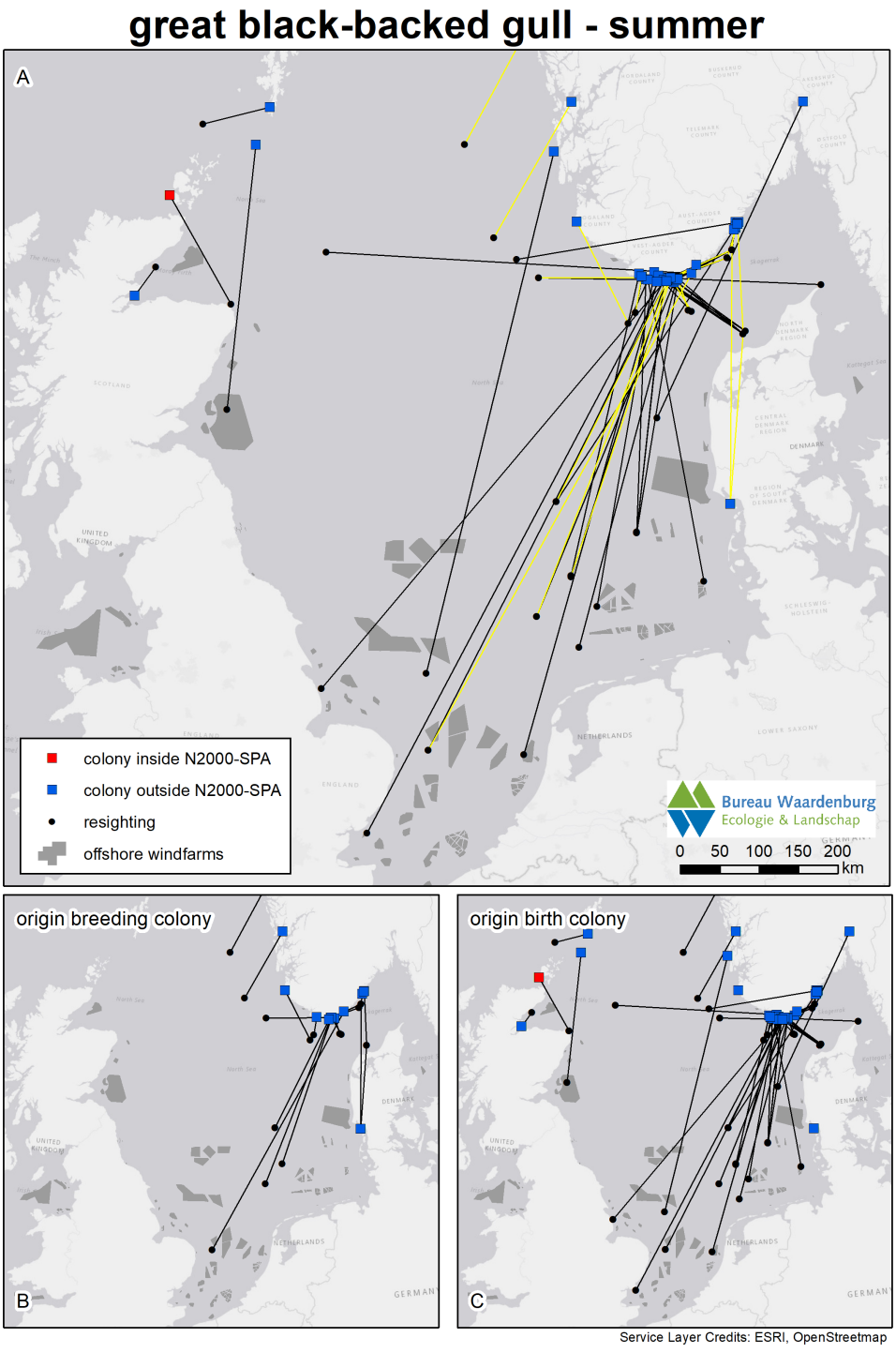


Figure 3.2 *The offshore resighting locations (black dots) of great black-backed gulls in summer. The different colours represent whether the colony was in a N2000 SPA was located for great black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

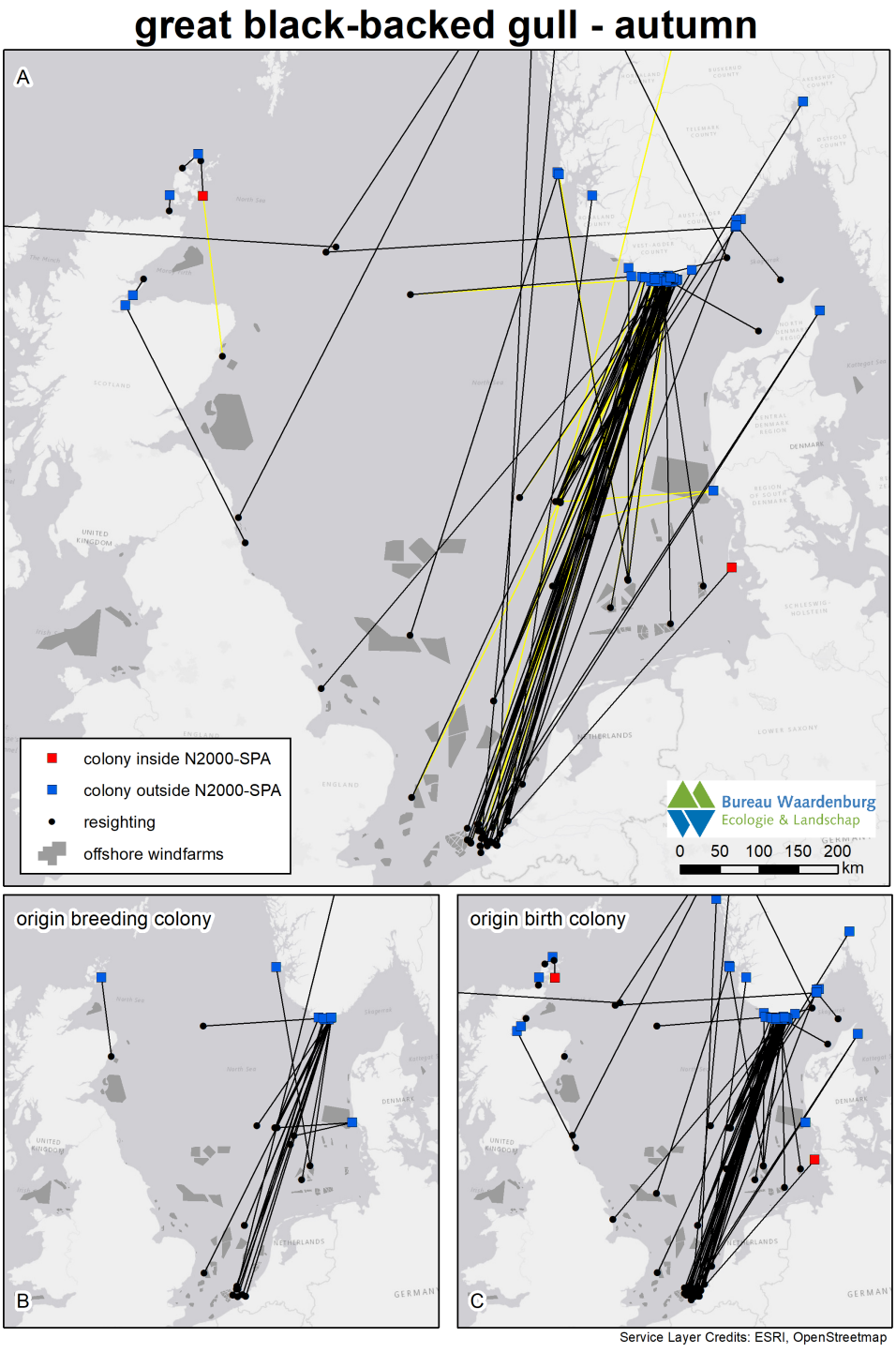


Figure 3.3 *The offshore resighting locations (black dots) of great black-backed gulls in autumn. The different colours represent whether the colony was in a N2000 SPA was located for great black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

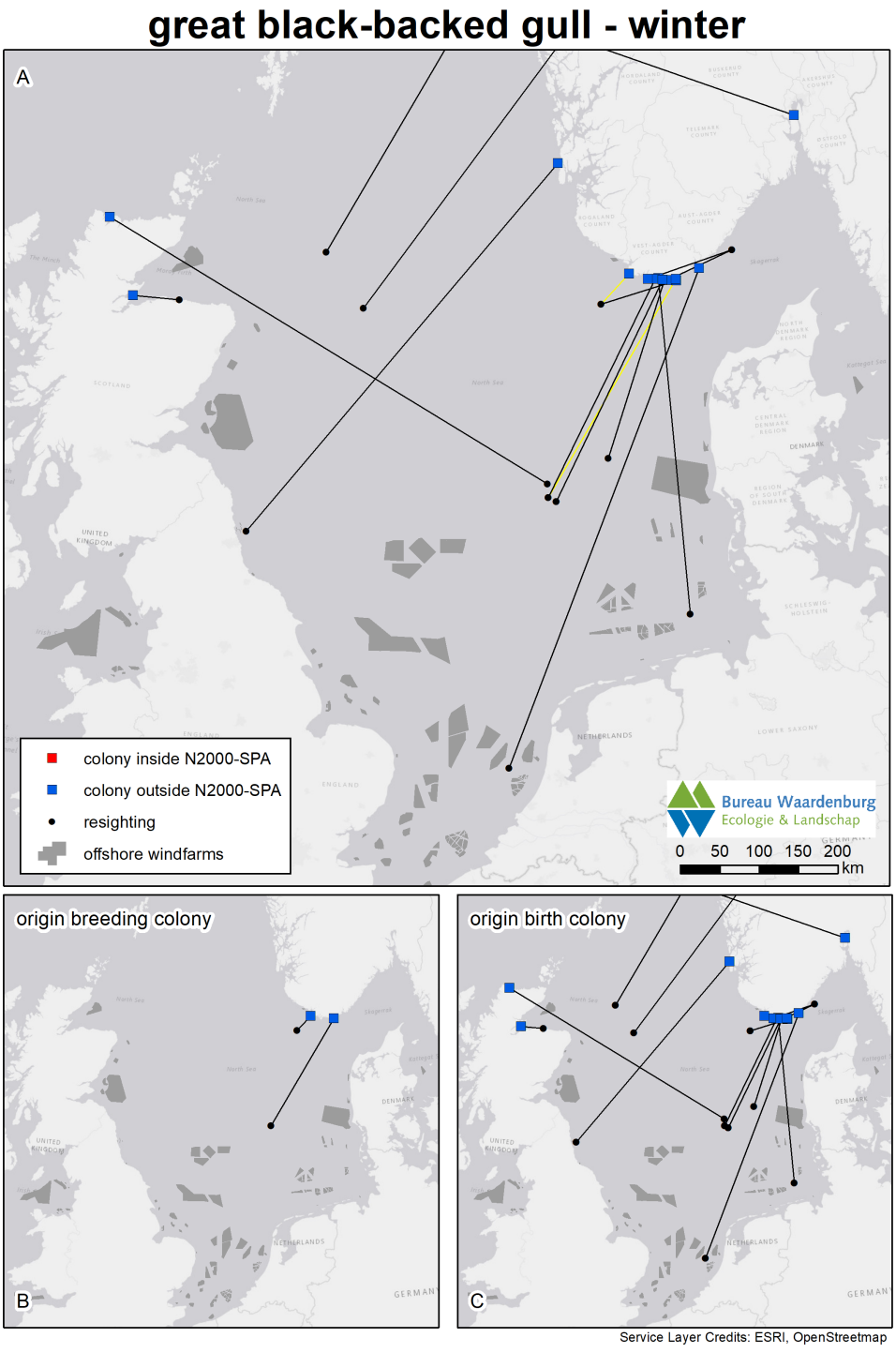


Figure 3.4 *The offshore resighting locations (black dots) of great black-backed gulls in winter. The different colours represent whether the colony was in a N2000 SPA was located for great black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

Herring gull

In our dataset of offshore resightings we have hatching locations of 119 individual HG (Table 3.2). Most resightings from herring gulls are from individuals born in the UK, followed by Norway. However, from about a third of our resightings (33.5%) we could not determine the birth country. There was one remarkable resighting in the Netherlands of an individual that was born in Russia. Most spring and summer resightings (Figure 3.1, Figure 3.1), were made close to shore, and after the breeding season (autumn and winter; Figure 3.1, Figure 3.1), the resightings are slightly further offshore.

Table 3.2 *Birth country of resighted herring gulls divided in number of individuals and percentages.*

Birth country	Number	Percentage
Belgium	8	4.5
Finland	1	0.6
Germany	2	1.1
Netherlands	5	2.8
Norway	23	12.8
Russia	2	1.1
United Kingdom	78	43.6
Unknown	60	33.5
Total	179	100

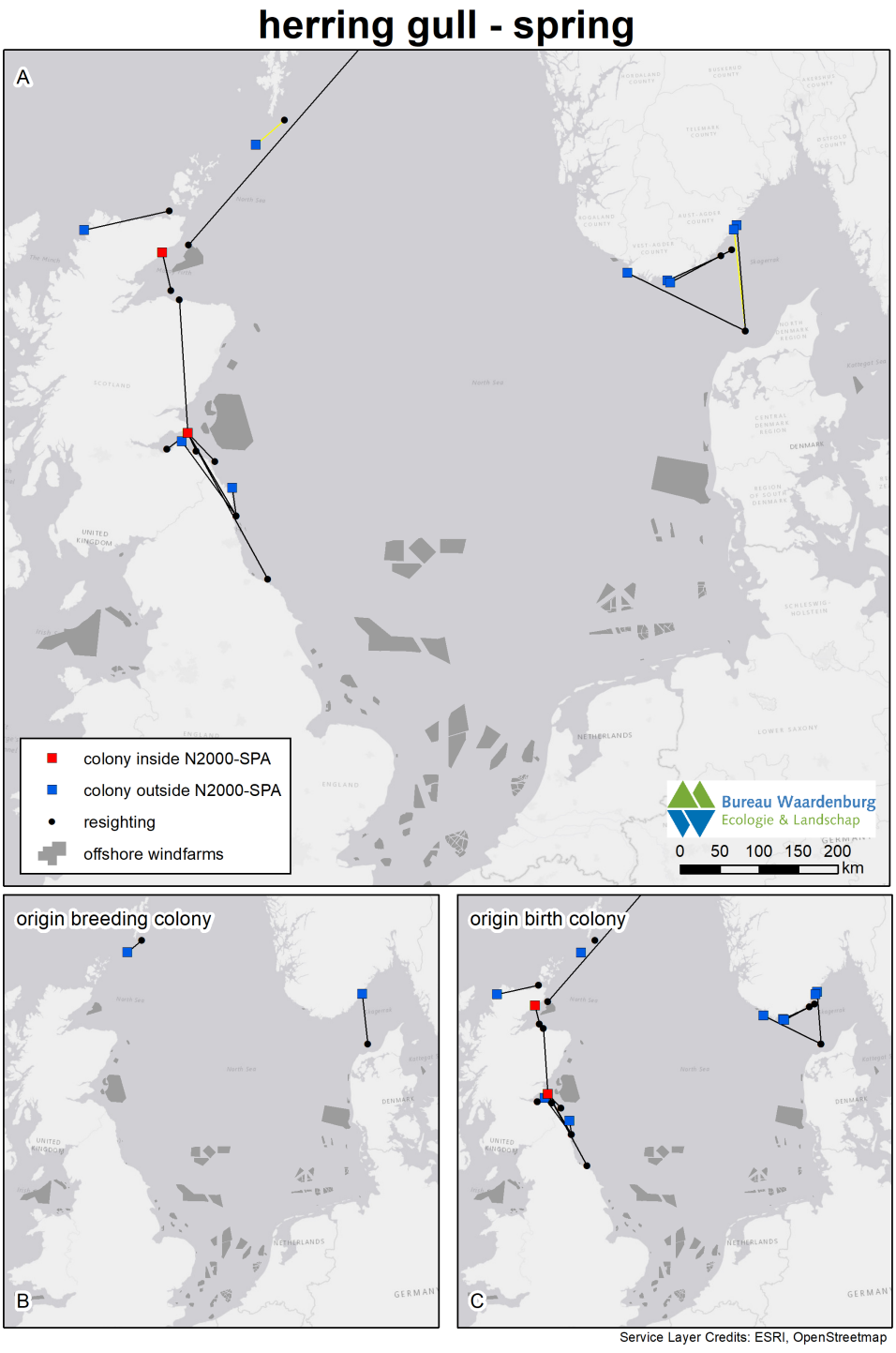


Figure 3.5 *The offshore resighting locations (black dots) of herring gulls in spring. The different colours represent whether the colony was in a N2000 SPA was located for great herring gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

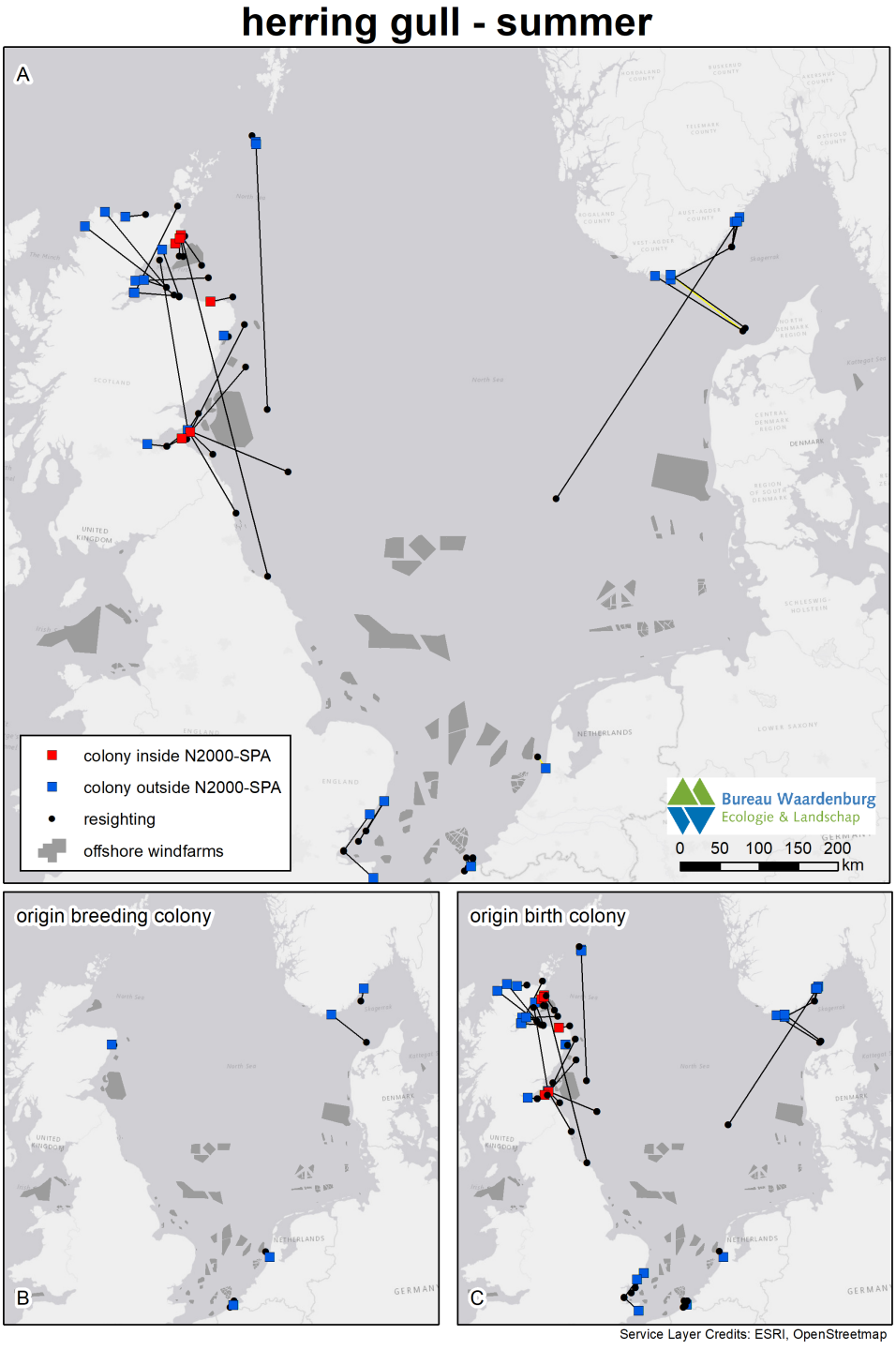


Figure 3.6 *The offshore resighting locations (black dots) of herring gulls in summer. The different colours represent whether the colony was in a N2000 SPA was located for herring gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

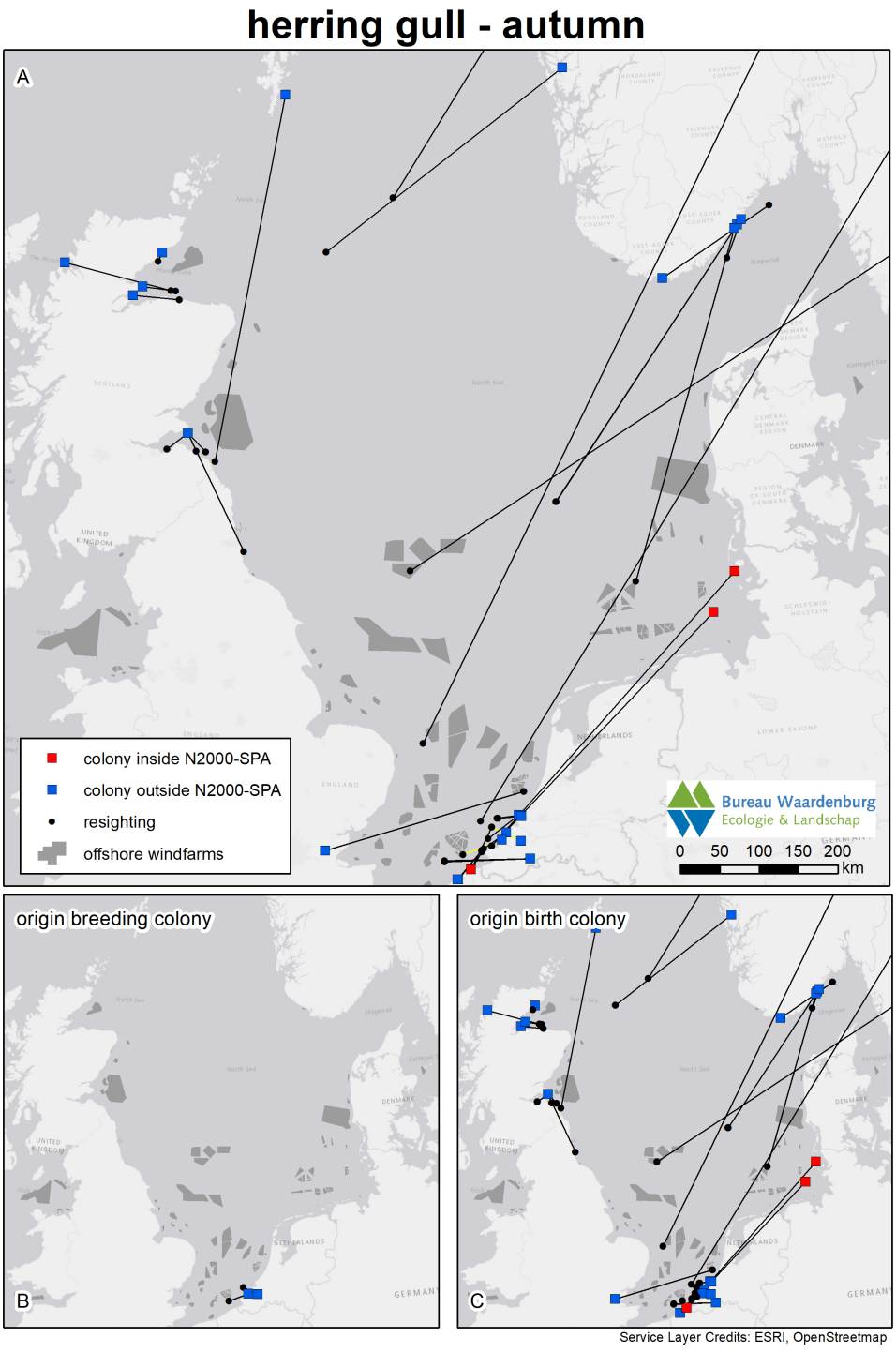


Figure 3.7 *The offshore resighting locations (black dots) of herring gulls in autumn. The different colours represent whether the colony was in a N2000 SPA was located for herring gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

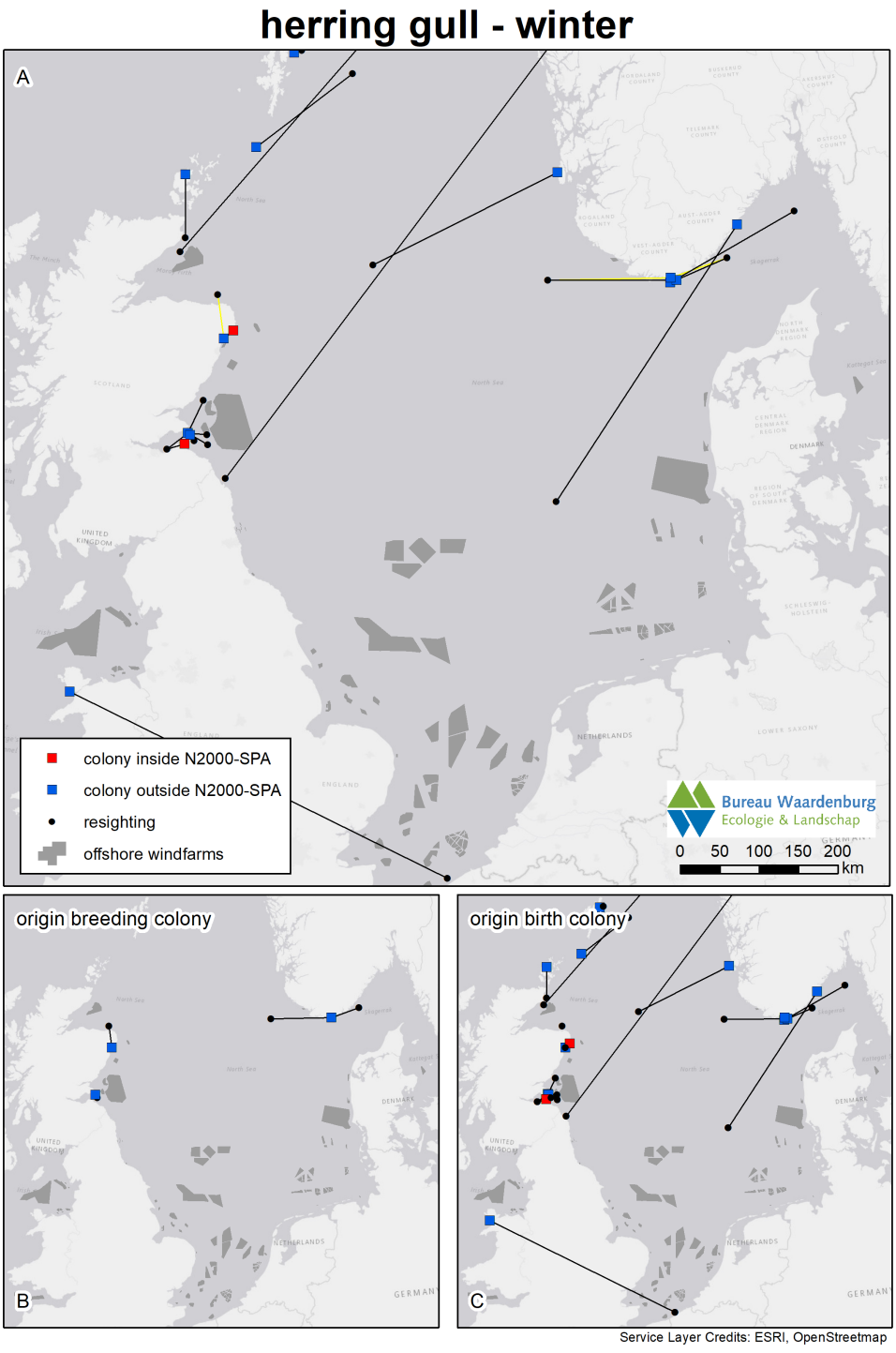


Figure 3.8 *The offshore resighting locations (black dots) of herring gulls in winter. The different colours represent whether the colony was in a N2000 SPA was located for herring gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

Lesser black-backed gull

In our dataset of offshore resightings, we have hatching locations of 175 individual LBBG (Table 3.3). Two of these individuals were born in the dunes on the Wadden Sea Island of Texel, which is a Natura 2000 SPA for this species (Duinen en Lage land Texel; NL3009008). Despite the fact that this species breeds in a number of countries including the Netherlands and the UK, almost half of the birds that were resighted originated from southern Norway.

Most resightings were realized in autumn (Figure 3.11), a period that coincides with the increased occurrences of pelagic trips for birders to spot rarities in the Dutch Delta region. In addition, during this period this species is migrating southward, which increases the chance to encounter colour ringed individuals at sea (which is their most likely route southwards). In winter most of them have left the North Sea area, and resightings are scarce (Figure 3.12)

Table 3.3 *Birth country of resighted lesser black-backed gulls divided between number of individuals and percentages.*

Birth country	Number	Percentage
Belgium	15	7.1
Denmark	7	3.3
Germany	6	2.8
Netherlands	23	10.9
Norway	102	48.3
Sweden	1	0.5
United Kingdom	21	10
Unknown	36	17.1
Total	211	100

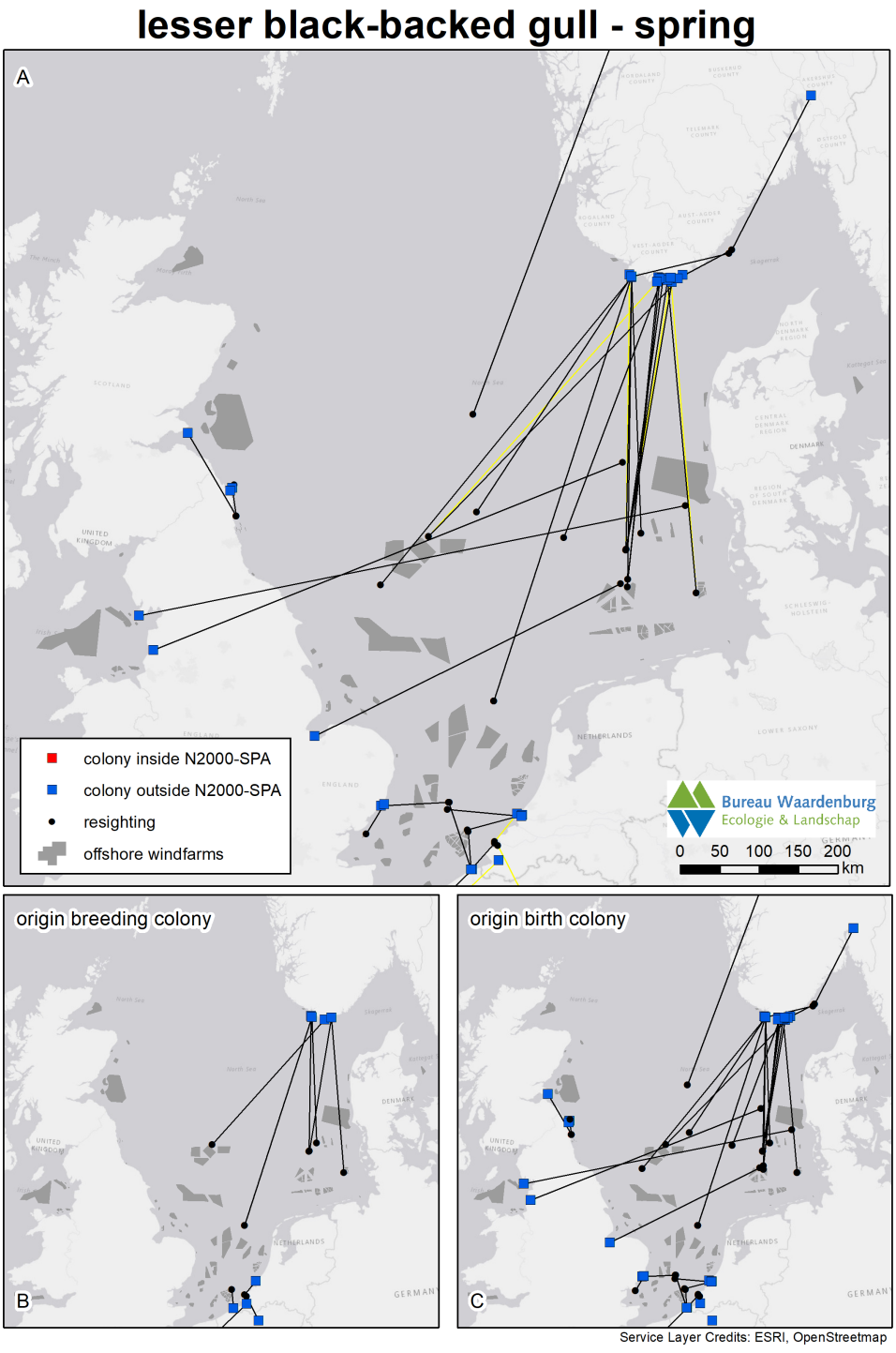


Figure 3.9 *The offshore resighting locations (black dots) of lesser black-backed gulls in spring. The different colours represent whether the colony was in a N2000 SPA was located for lesser black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

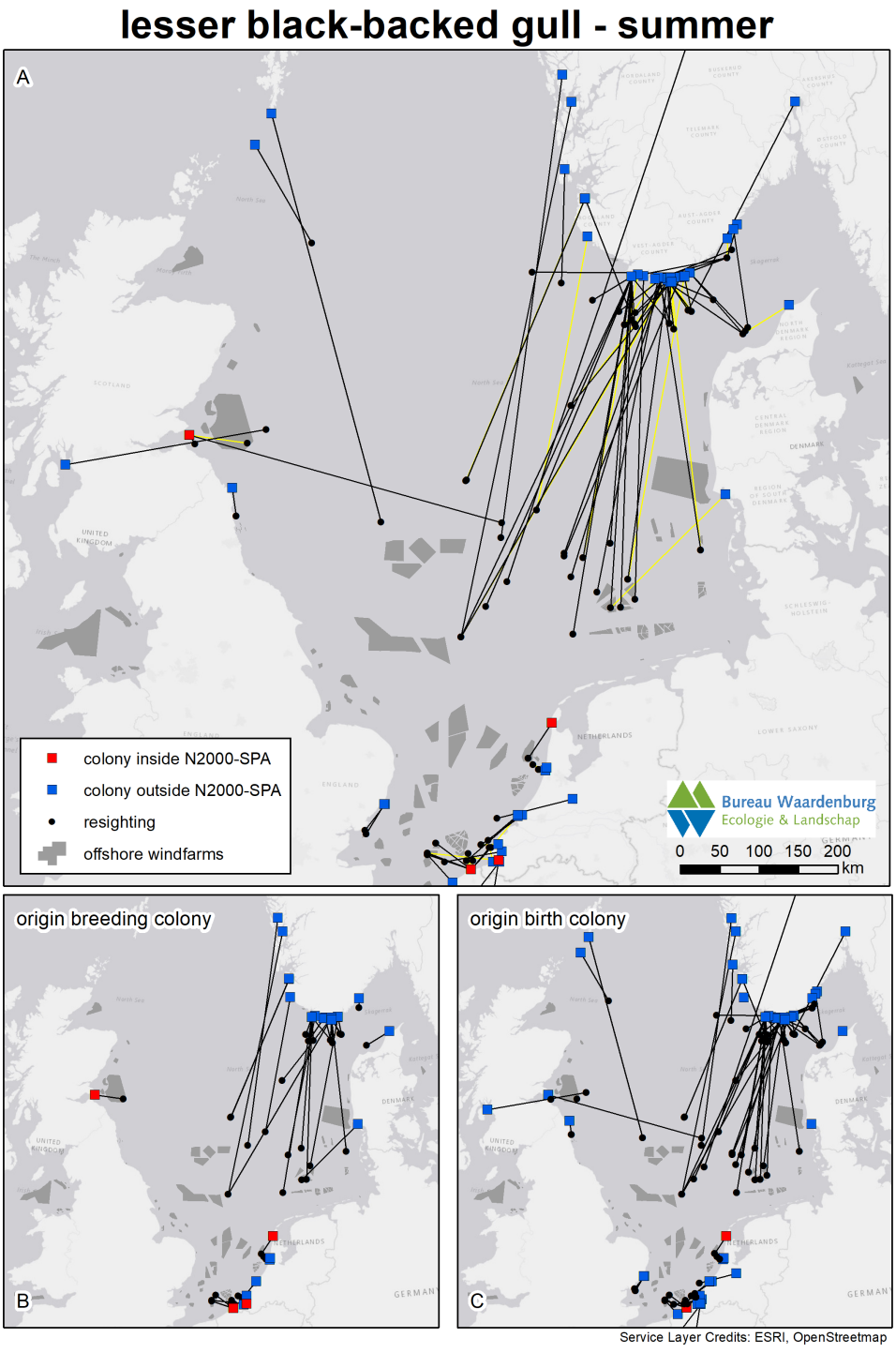


Figure 3.10 *The offshore resighting locations (black dots) of lesser black-backed gulls in summer. The different colours represent whether the colony was in a N2000 SPA was located for lesser black-backed gulls. (A) shows the links to breeding (white lines) and birth colonies (green lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

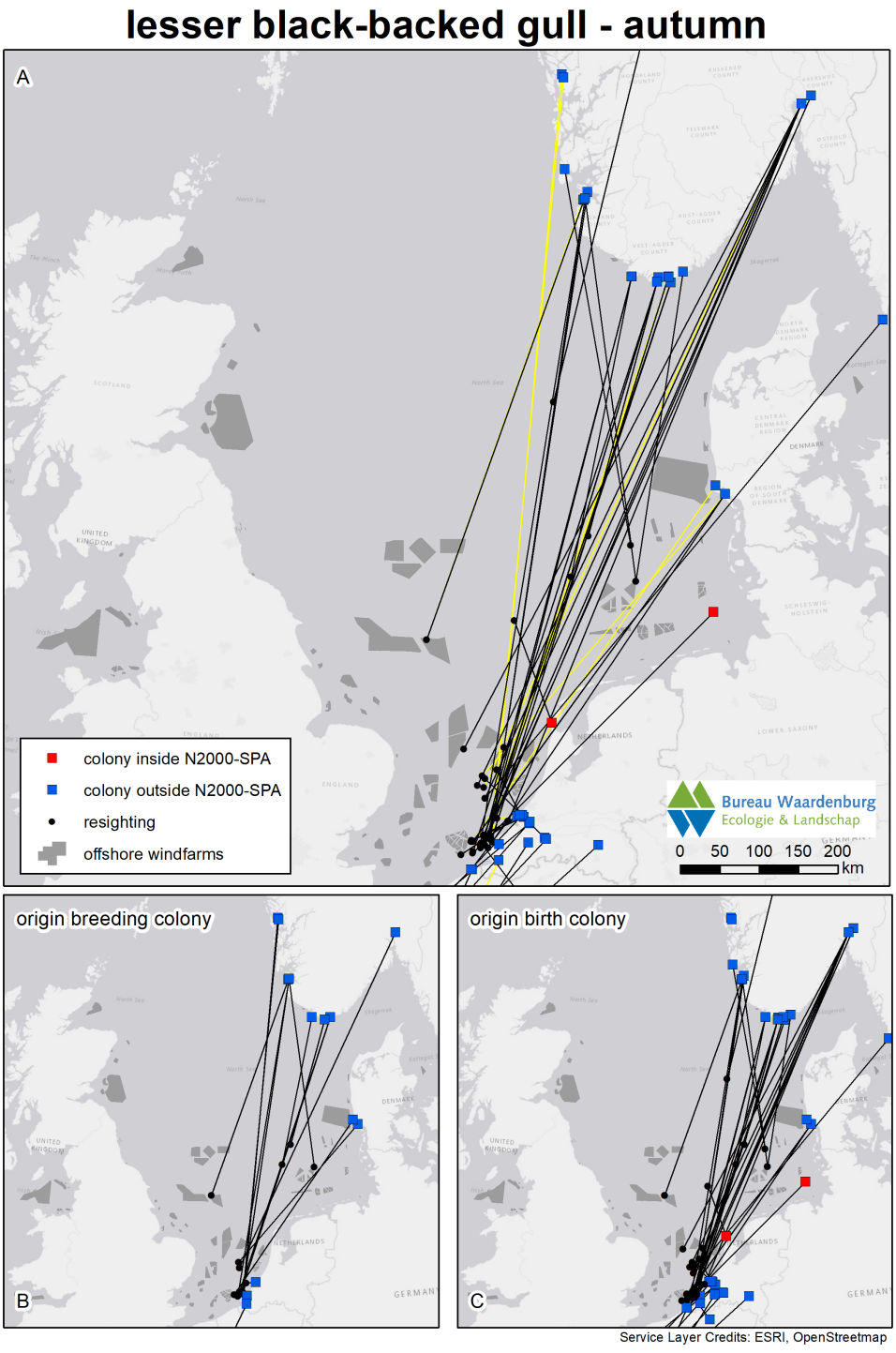


Figure 3.11 *The offshore resighting locations (black dots) of lesser black-backed gulls in autumn. The different colours represent whether the colony was in a N2000 SPA was located for lesser black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

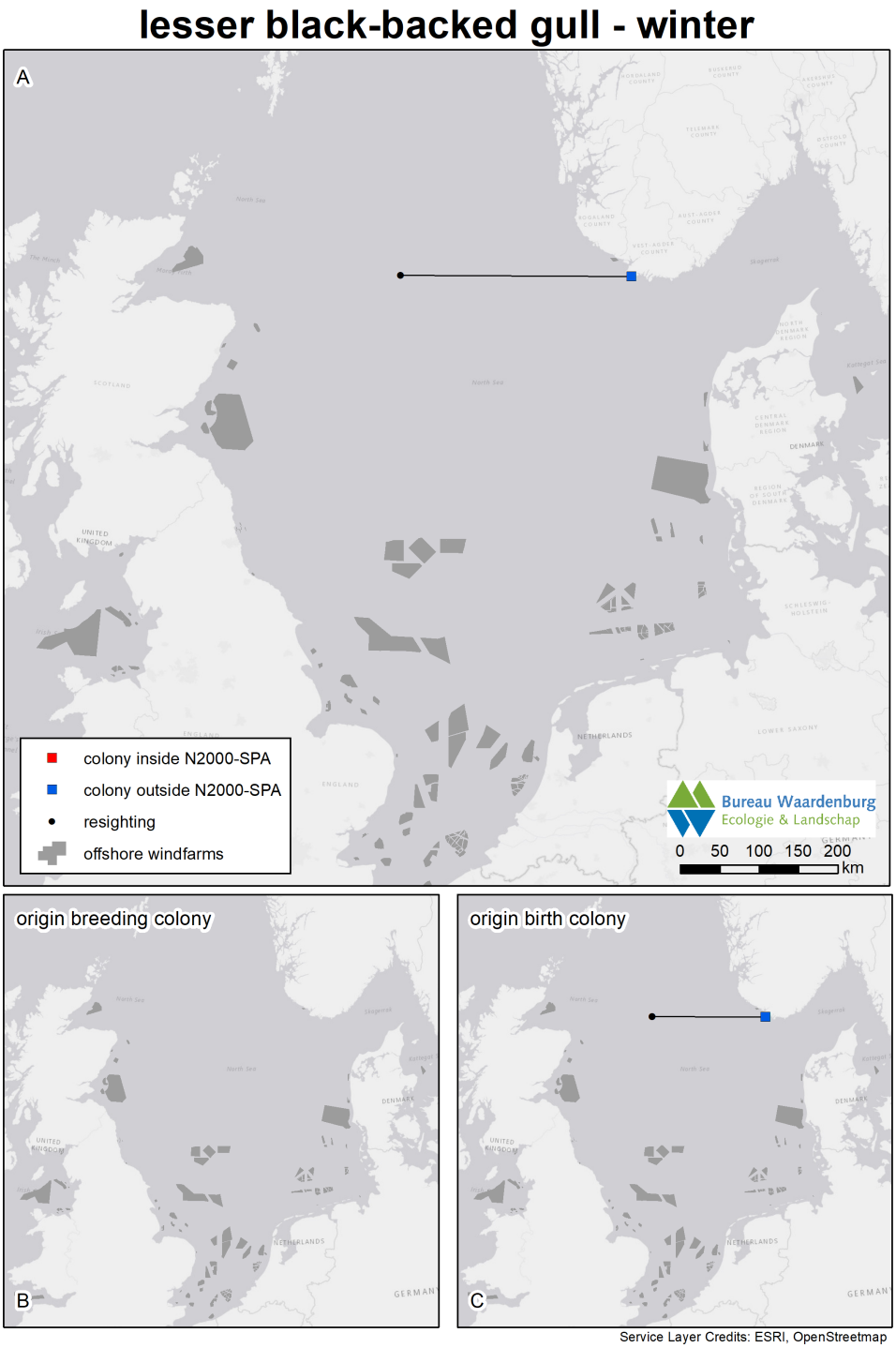


Figure 3.12 *The offshore resighting locations (black dots) of lesser black-backed gulls in winter. The different colours represent whether the colony was in a N2000 SPA was located for lesser black-backed gulls. (A) shows one link to the birth colony (black line), while (B) only shows no links to the breeding colony and (C) shows one link with the birth colony.*

3.2 Breeding origin

We could deduce the most probable breeding locations of 109 individual birds from our resighting database. In the next paragraphs we describe our results per species.

Great black-backed gull

In our dataset of offshore resightings we assessed the actual breeding locations of 31 individual GBBG (Table 3.4). Almost all breeding locations were located in Norway and one in Scotland.

Table 3.4 *Most likely breeding country of great black-backed gulls with offshore resighting in the North Sea separated between number of individuals and percentages.*

Breeding country	Number	Percentage
Norway	30	96.8
United Kingdom	1	3.2
Total	31	100

Herring gull

In our dataset of offshore resightings we assessed the actual breeding locations of 13 individual HG (Table 3.5). There was one individual breeding in Belgium, but the other breeding locations were evenly divided over countries bordering the North Sea.

Table 3.5 *Most likely breeding country of herring gulls with offshore resighting in the North Sea separated between number of individuals and percentages.*

Breeding country	Number	Percentage
Belgium	1	7.7
Netherlands	4	30.8
Norway	4	30.8
United Kingdom	4	30.8
Total	13	100

Lesser black-backed gull

In our lesser black backed gull dataset we identified the most probable breeding locations of 56 individual LBBG, and 4 (7%) were breeding within 3 years of the offshore observation in a Natura 2000 SPA designated for this species. Most breeding locations were located in Norway (55%), but also a substantial percentage from the Netherlands and Belgium (Table 3.6).

Table 3.6 *Most likely breeding country of lesser black-backed gulls with offshore resighting in the North Sea separated between number of individuals and percentages.*

Breeding country	Number	Percentage
Belgium	7	12.5
Denmark	2	3.6
Faroe Islands	1	1.8
Netherlands	14	25
Norway	31	55.4
United Kingdom	1	1.8
Total	56	100

3.3 Origin of large gulls observed in windfarms

Of all 562 individual resightings, 41 individual birds were observed in a (proposed) wind farm. It is difficult to determine whether these data comprise a representative sample, but when we assume it is, our results imply that 7% of the three large gull species enter (proposed) offshore wind farms.

Great black-backed gull

Of the 172 individual offshore resightings of GBBG, 17 (10%) were observed in offshore windfarms (Table 3.7). The majority of these birds originate from Norway (Figure 3.13).

Table 3.7 *Birth country and most likely breeding country of lesser black-backed gulls resighted within an offshore windfarm in the North Sea.*

Birth country	Breeding country	Number	Percentage
Unknown	Unknown	2	11.8
Norway	Norway	3	17.6
Norway	Unknown	11	64.7
UK	Unknown	1	5.9
Total		17	100

Herring gull

We received 179 resightings of HG, of which 11 (6%) were observed in offshore windfarms (Table 3.8). Most of these individuals were born in the UK, but their current breeding sites are unknown (Figure 3.14).

Table 3.8 *Birth country and most likely breeding country of herring gulls resighted within an offshore windfarm in the North Sea.*

Birth country	Breeding country	Number	Percentage
Unknown	Unknown	3	27.3
Finland	Unknown	1	9.1
Norway	Unknown	1	9.1
UK	Unknown	4	36.4
Unknown	Netherlands	2	18.2
Total		11	100

Lesser black-backed gull

In total we recieved 211 resightings of LBBG, of which 13 (6%) were observed in offshore windfarms (Table 3.9). Of these 13 individuals, 4 birds were born in Norway, 3 in Belgium and 2 in the Netherlands (Figure 3.15).

Table 3.9 *Birth country and most likely breeding country of herring gulls resighted within an offshore windfarm in the North Sea.*

Birth country	Breeding country	Number	Percentage
Belgium	Belgium	1	7.7
Belgium	Netherlands	1	7.7
Belgium	Unknown	1	7.7
Netherlands	Netherlands	1	7.7
Netherlands	Unknown	1	7.7
Norway	Norway	2	15.4
Norway	Unknown	2	15.4
UK	Unknown	1	7.7
Unknown	Netherlands	1	7.7
Unknown	UK	1	7.7
Unknown	Unknown	1	7.7
Total		11	100

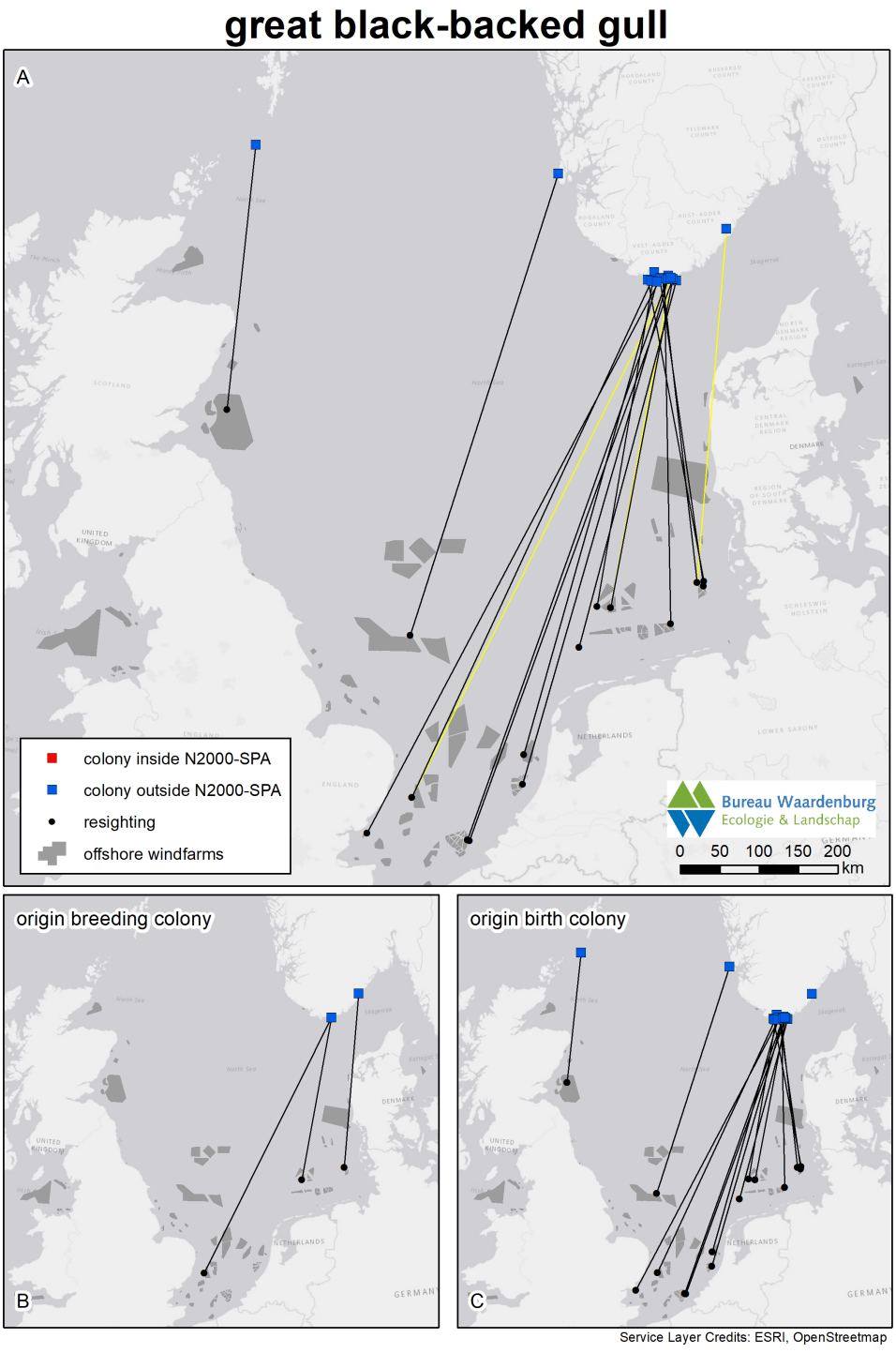


Figure 3.13 *The offshore resighting locations (black dots) of great black-backed gulls in offshore wind farms. The different colours represent whether the colony was in a N2000 SPA was located for great black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

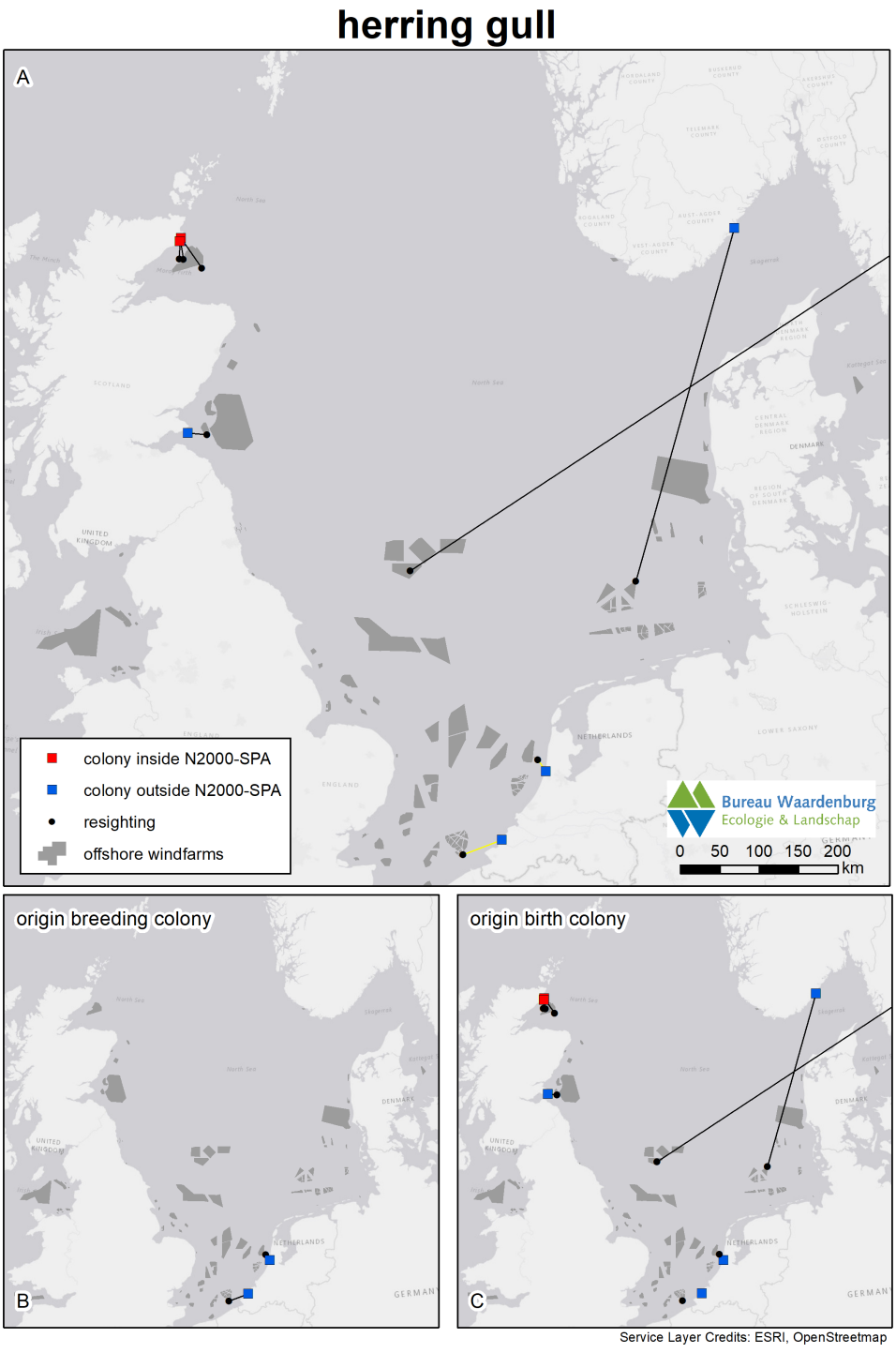


Figure 3.14 *The offshore resighting locations (black dots) of herring gulls in offshore wind farms. The different colours represent whether the colony was in a N2000 SPA was located for herring gulls. (A) shows the links to breeding (green line) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

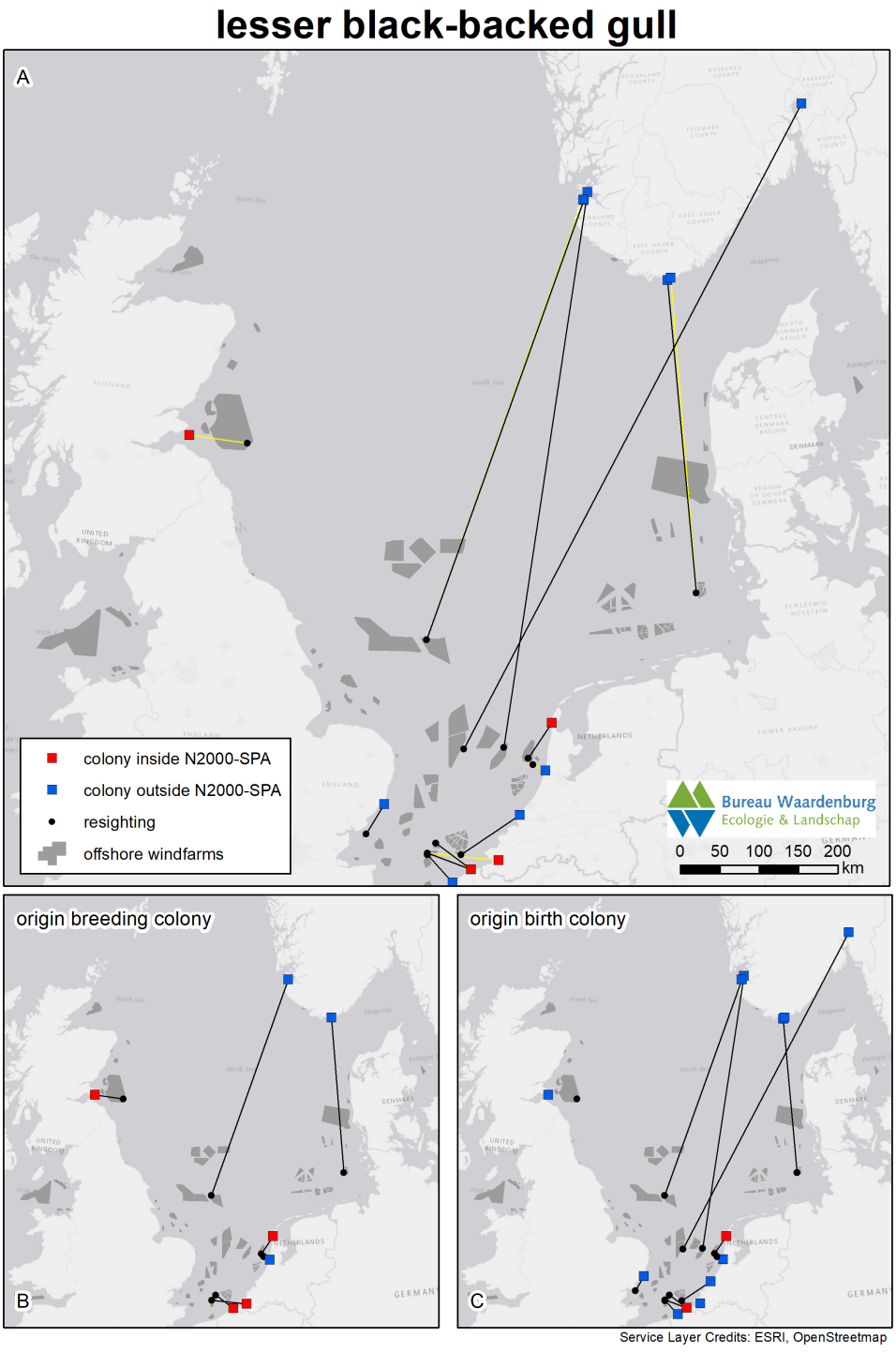


Figure 3.15 *The offshore resighting locations (black dots) of lesser black-backed gulls in offshore wind farms. The different colours represent whether the colony was in a N2000 SPA was located for lesser black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony.*

3.4 Distance from birth colony

The three gull species were resighted at different distances from their birth colonies ($F_{3,473}$ = 20,9, P < 0.001, R^2 = 0.11; Figure 3.16) with HG being recorded the closest (median distance: 48 km for adults and 90 km for immatures), LBBG at intermediate distances (median distance 81 km for adults and 389 km for immatures) and GBBG furthest away (median distance: 129 km for adults and 438 km for immatures). In general, immature birds were resighted further from their birth colony, compared to adult birds (P < 0.001).

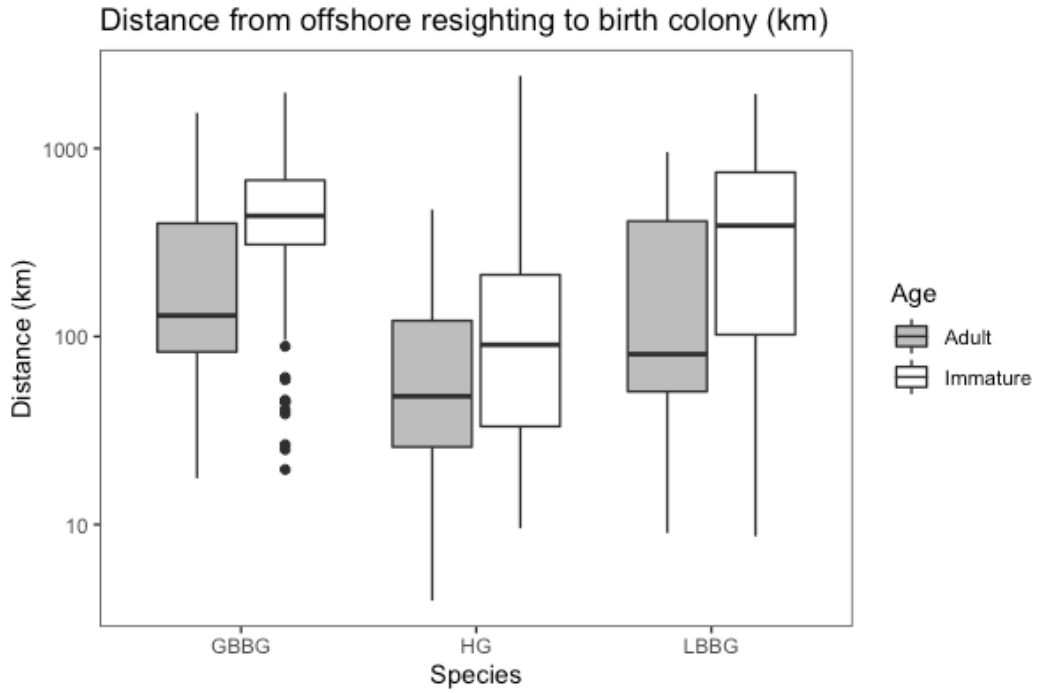


Figure 3.16 *The distance (km) from the offshore resighting to their birth colony for three large gull species (GBBG = great black-backed gull, HG = herring gull and LBBG = lesser black-backed gull), separated by adult and immature. Note the log scale on the y-axis.*

3.5 Distance between birth and breeding colony

There was no difference in the distance between the birth and breeding colony within a species ($F_{3,75}$ = 1,9, P = 0.134, R^2 = 0.03; Figure 3.17), and neither for the different age classes (P = 0.123). Overall their dispersion distance was rather low (70, 50 and 25 km respectively for GBBG, HG and LBBG), suggesting that all the three species involved are relatively site faithful.

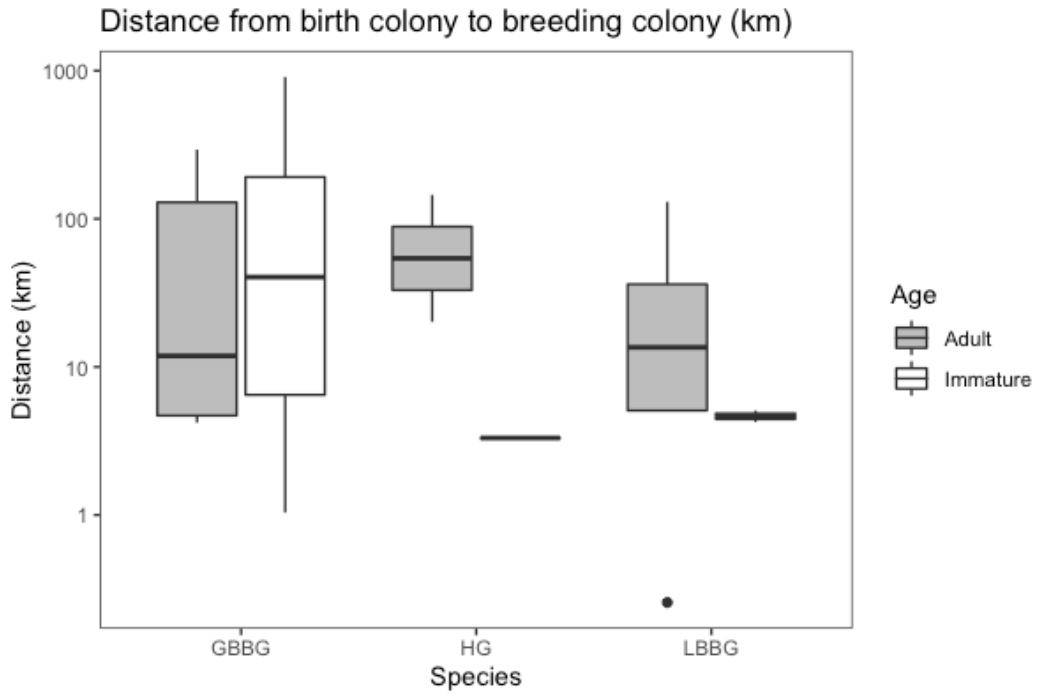


Figure 3.17 *The distance (km) between the birth colony and breeding colony for three large gull species (GBBG = great black-backed gull, HG = herring gull and LBBG = lesser black-backed gull), separated by adult and immature. Note the log scale on the y-axis.*

3.6 Distance between offshore resighting and breeding colony

We also explored the distance between an offshore resighting and their breeding colony, to get an estimate for foraging distances from the colony and found no difference between the species ($F_{2,48}$ = 1,2, P = 0.31, R^2 = 0.008; Figure 3.18). Herring gull had on average the lowest distance between the offshore resighting location and breeding colony (58 km) and lesser and great black-backed gulls had relatively the similar distanced (199 and 157 km respectively for GBBG and LBBG). Due to an unequal sample size distributed over the seasons, we pooled all the data.

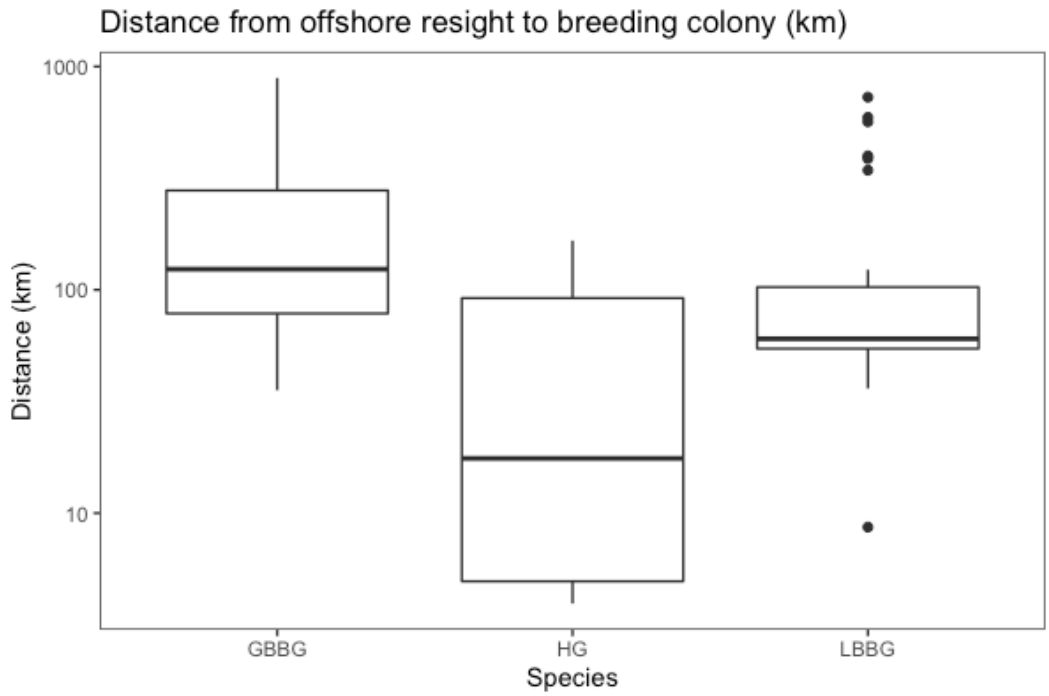


Figure 3.18 *The distance (km) between the offshore resighting location to the most recent breeding colony for three large gull species. Note the log scale on the y-axis.*

4 Discussion

In this study we identified that most large gulls that were resighted in the North Sea region, originated (either born or breeding) from Northern Europe and more specifically Southern Norway. This is likely due to the fact that most have to cross the North Sea while moving south to their wintering areas. In contrast, individuals breeding in the Netherlands tend to follow the coast while migrating south (Ens *et al.* 2009; Shamoun-Baranes *et al.* 2017), which lowers the chance to resight them offshore.

Great black-backed gulls have a large breeding range, yet our data and resightings only represent a small geographical range. This may influence our results, as their migration strategies might differ at different spatial scales. This is not well known, because there is not an even effort to capture and ring this species across their range. In autumn they migrate south and reside in north-western Europe. This coincides with the increased activities from pelagic birding trips in the Dutch Delta area, which partly explains the relatively high number of individuals being resighted in this time and area.

Herring gulls are generally found closer to shore and on land compared to the other two species, especially during spring and summer (Ens *et al.* 2009). This is also what we observed during these seasons (Figure 3.5 and Figure 3.6). Consequently, the relative proportion of resighted herring gulls at sea is relatively small (across all seasons).

Similar to great black-backed gulls, many lesser black-backed gulls originate from Norway and migrate south by crossing the North Sea. This might explain that we identified a large proportion of the resightings in autumn. They are virtually absent in winter, as most of the population winters south of France. The lesser black-backed gulls that breed in the Netherlands, UK, Germany and Belgium also migrate south, but do not need to cross the North Sea. These gulls migrate relatively quickly out of our ‘study area’ which was bound roughly by the entrance of the Channel. Moreover, they also migrate along the coast (Shamoun-Baranes *et al.* 2017), which reduces the chance to resight them offshore outside the migration season.

In this study we show that from our sample a relatively small percentage of large gulls were observed within a (proposed) offshore wind farm. However, only 0,25% of the North Sea is currently being used for offshore windfarms (van der Walle 2018). Assuming a random distribution, this suggests that a relatively large number of large gulls visits the areas used for offshore windfarms. On the basis of a smaller sample, the origin of current breeding colonies was determined and a small percentage (5%) were breeding in Natura 2000 SPAs. Most great and lesser black-backed gulls breed in Norway, but because Norway is not part of the European Union, they have no Natura 2000 SPA. This explains why we hardly found any breeding colonies of this species in Natura 2000 SPA.

Most collision victims with offshore wind farms amongst large gulls are expected in spring and summer, yet most offshore trips for birders to spot rarities and other seabirds take place in the autumn, as this is the best time to spot these (migrant) rarities. This temporal

mismatch led to the conclusion to do additional surveys in spring, but it also means that a relatively large proportion of juvenile birds are in the sample. This increases the chance to identify the birth colony but limits our ability to correctly identify the breeding colony.

In this study we did not separate between proposed and current offshore wind farms. Many resightings were done years ago, which would require the exact spatial and temporal construction information of all European offshore wind farms and was beyond the scope of this study.

The analysis of colour ring resightings provides new insights in the origin of birds present in specific offshore areas. Another advantage is that it is much easier to distinguish between species that are very much alike such as herring, caspian and yellow-legged gulls which are difficult to identify at a species level during aerial surveys. However, due to the attractive nature of observation vessels, or platforms from where most observations are done, it does not provide a good measure of abundance and spatial distribution of birds. A combination of methods can provide a more complete insight in whether spatial patterns occur in birds from different origins.

The distance individual birds move from their breeding and birth colonies is in accordance with data generated by satellite tracking of herring and lesser black-backed gull in the Netherlands (Ens *et al.* 2009). Considering the relatively small dispersal distance between birth and breeding colony, it seems unlikely there will be a conflict between great black-backed gulls breeding in Natura 2000 SPAs and offshore wind farms, as they almost exclusively breed in Norway, which lacks any Natura 2000 SPAs. For herring and lesser black backed gulls this is more likely to cause conflicts on their foraging trips, but to a lesser extent during the migration season.

References

Band, W., 2012. Using a collision risk model to assess bird collision risks for offshore windfarms. March 2012. SOSS, The Crown Estate, UK.

Ens, B.J., F. Bairlein, C.J. Camphuysen, P. de Boer, K.-M. Exo, N. Gallego, R.H.G. Klaassen, K. Oosterbeek & J. Shamoun-Baranes, 2009. Onderzoek aan meeuwen met satellietzenders. Limosa 82(1): 33-42.

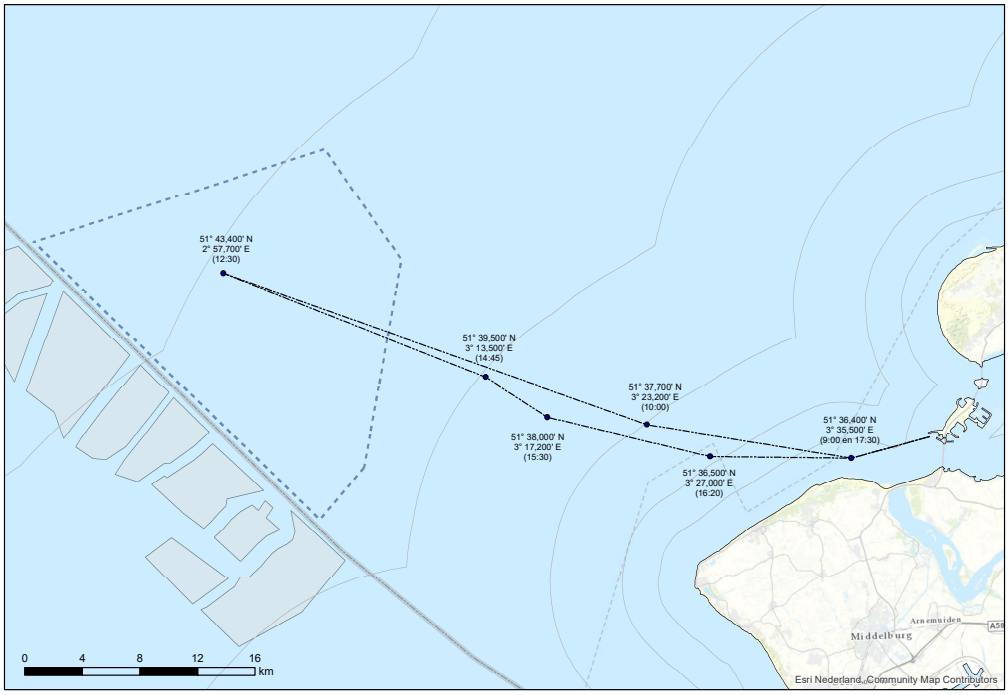
Potiek, A., M.P. Collier, H. Schekkerman & R.C. Fijn, 2019. Effects of turbine collision mortality on population dynamics of 13 bird species. Bureau Waardenburg Report 18-342, Bureau Waardenburg, Culemborg.

Rijkswaterstaat, 2019. Kader Ecologie en Cumulatie t.b.v. uitrol windenergie op zee Deelrapport B - Actualisatie van KEC vogelaanvaring berekeningen volgens Routekaart 2030. Ministerie van Economische Zaken en Ministerie van Infrastructuur en Milieu, Den Haag

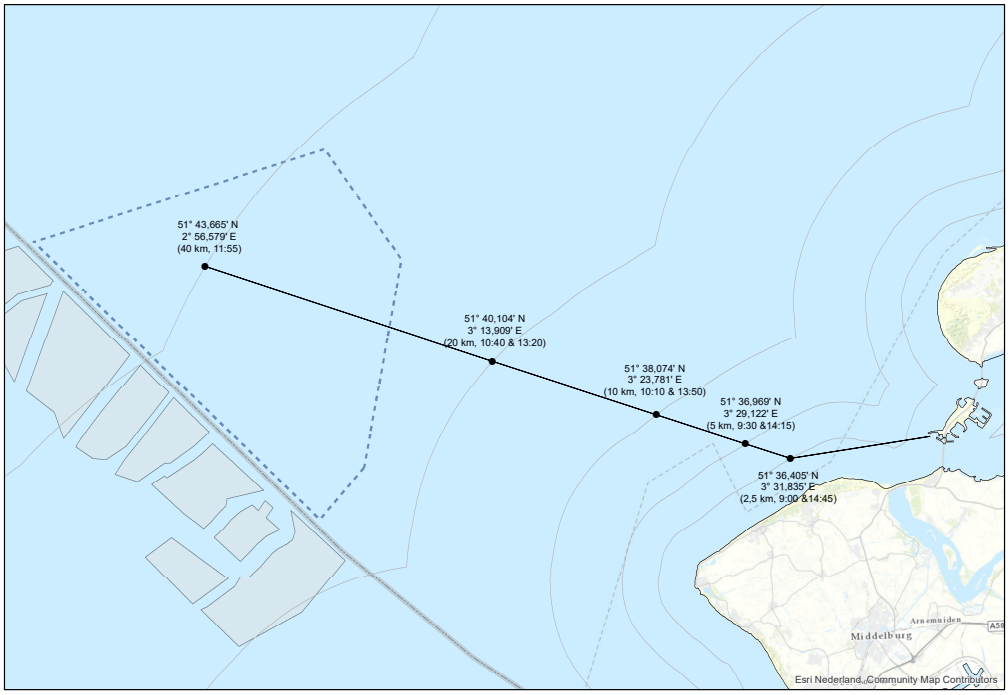
Shamoun-Baranes, J., J.B. Burant, E.E. van Loon, W. Bouten & C.J. Camphuysen, 2017. Short distance migrants travel as far as long distance migrants in lesser black-backed gulls *Larus fuscus*. Journal of Avian Biology 48(1): 49-57.

van der Walle, E. (2018, january 30). Straks staat de Noordzee vol met windmolens. *NRC*. retrieved from http://www.nrc.nl

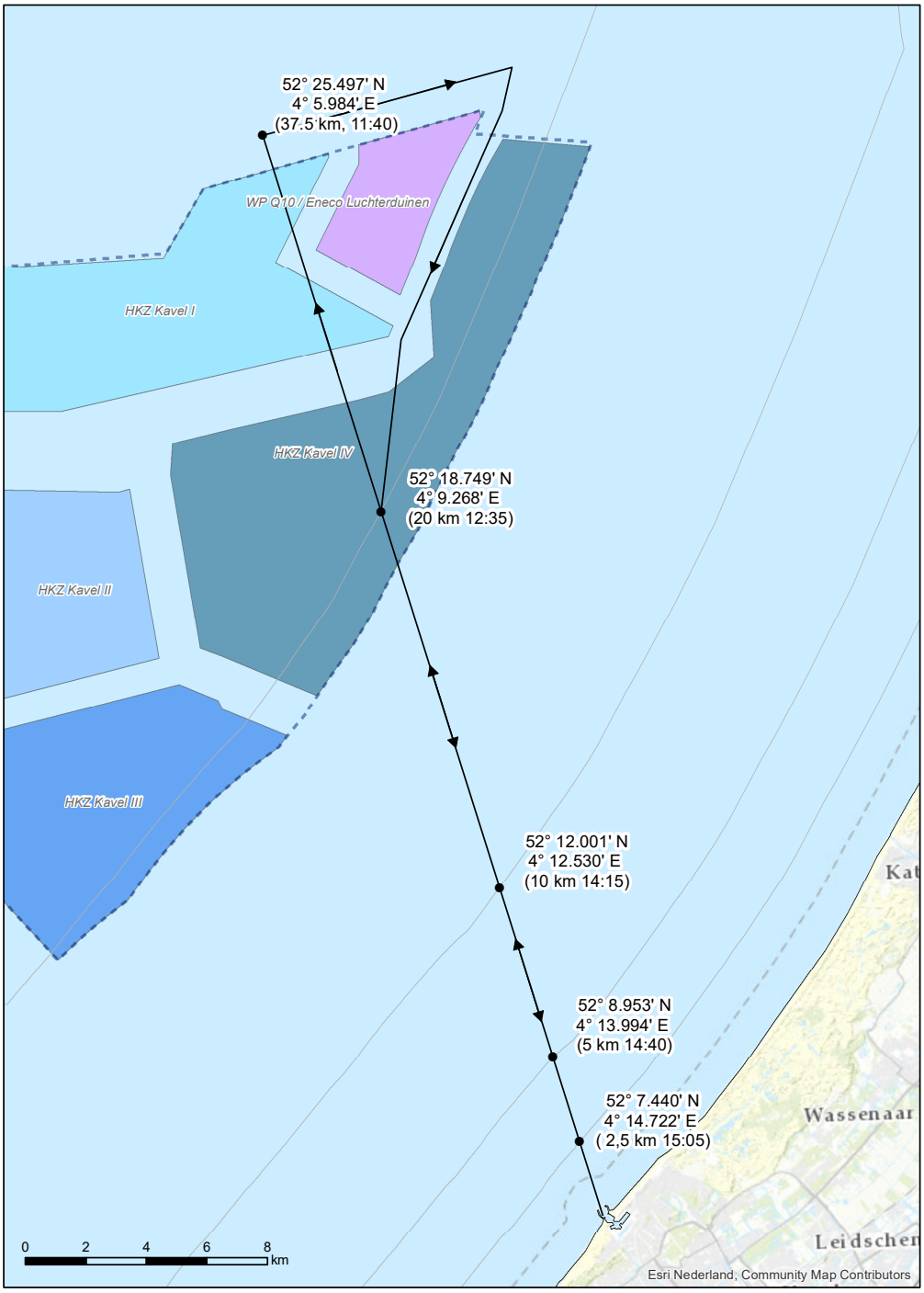
Appendix I Routes of dedicated fieldtrips to obtain colour ring resightings



Route from Neeltje Jans to Windenergiegebied Borssele om 14-05-2019

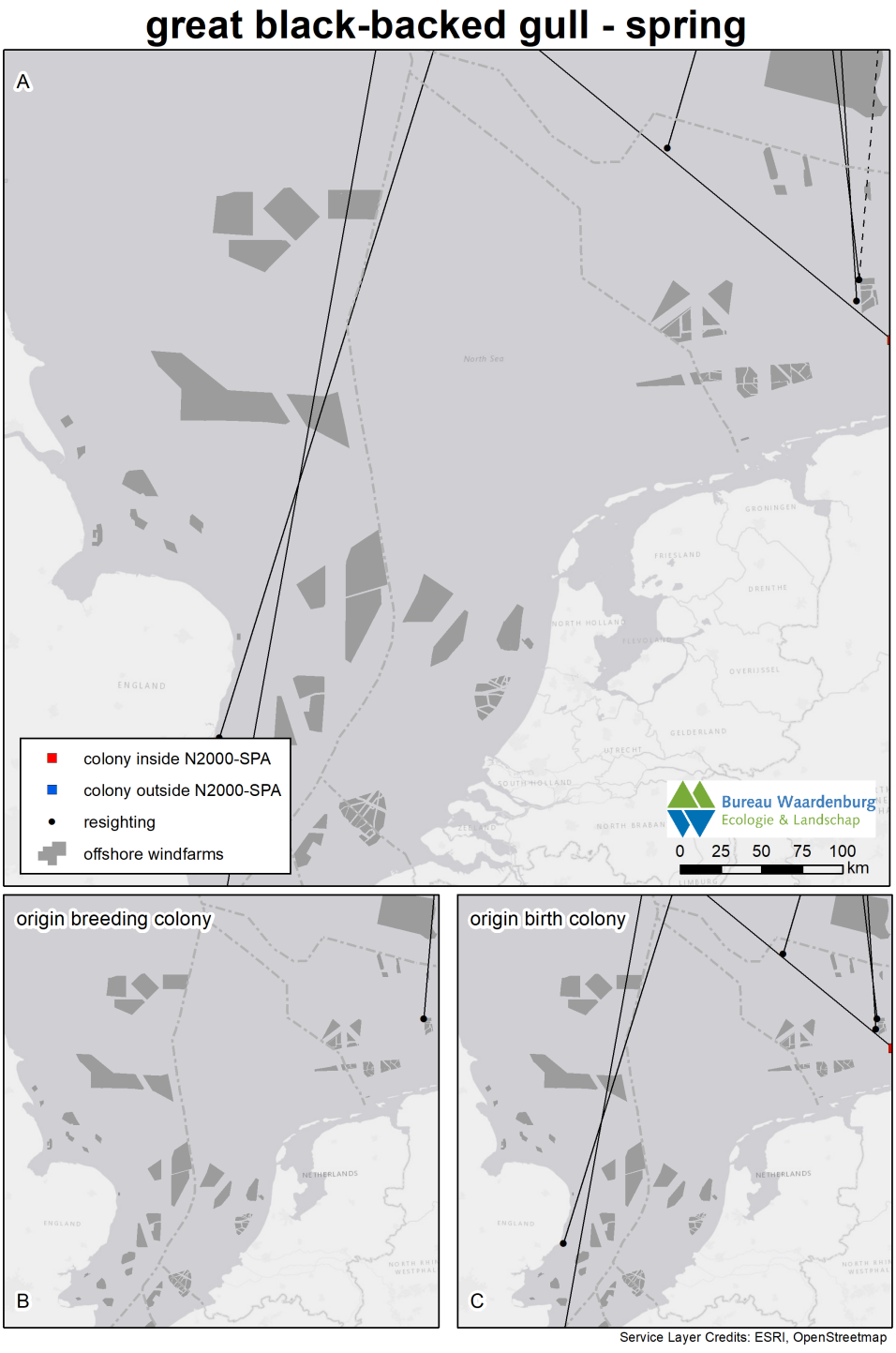


Route from Neeltje Jans to Windenergiegebied Borssele om 26-06-2019

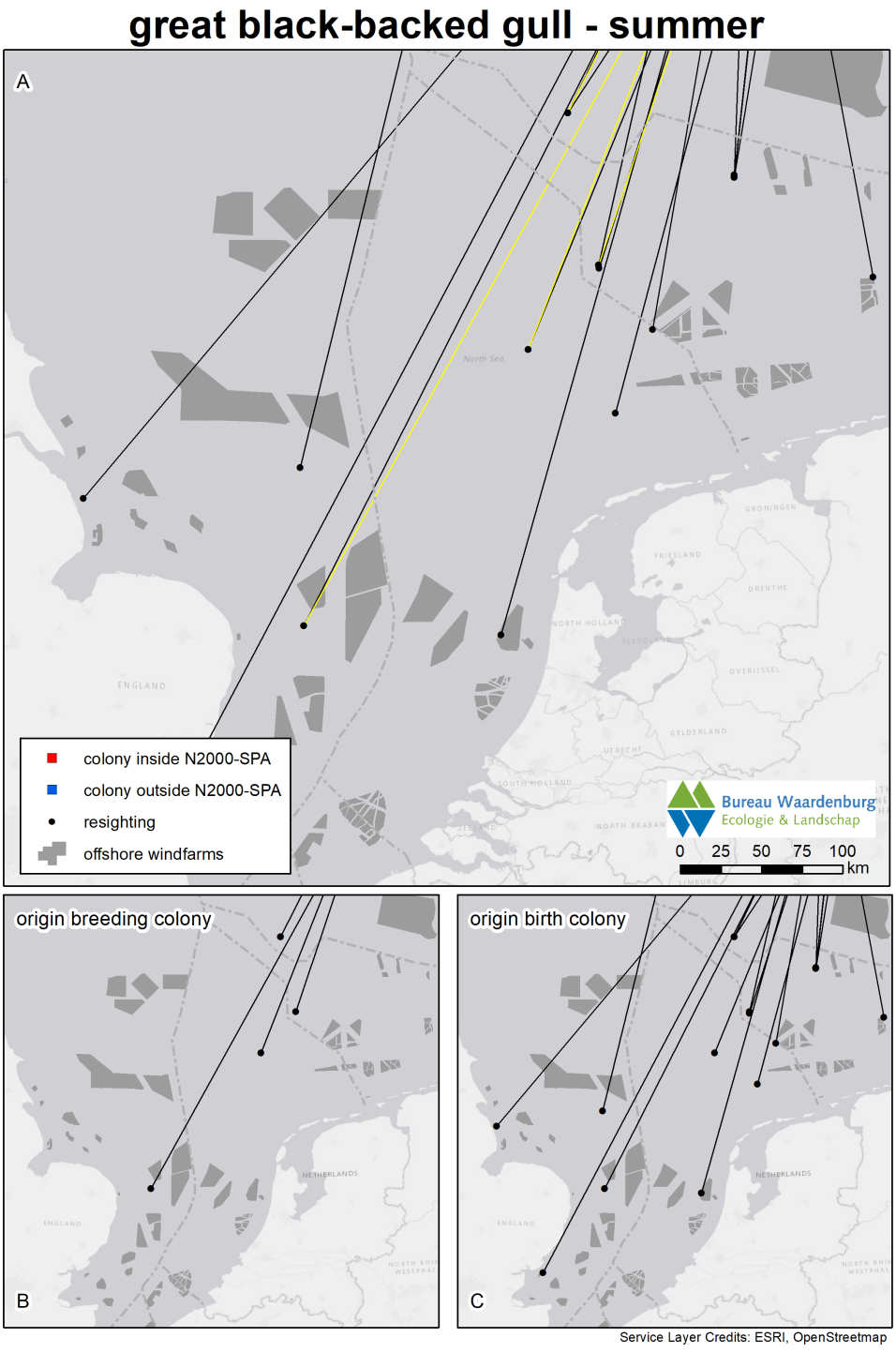


Route from Scheveningen to Windenergiegebied Hollandse Kust Zuid on 10-09-2019

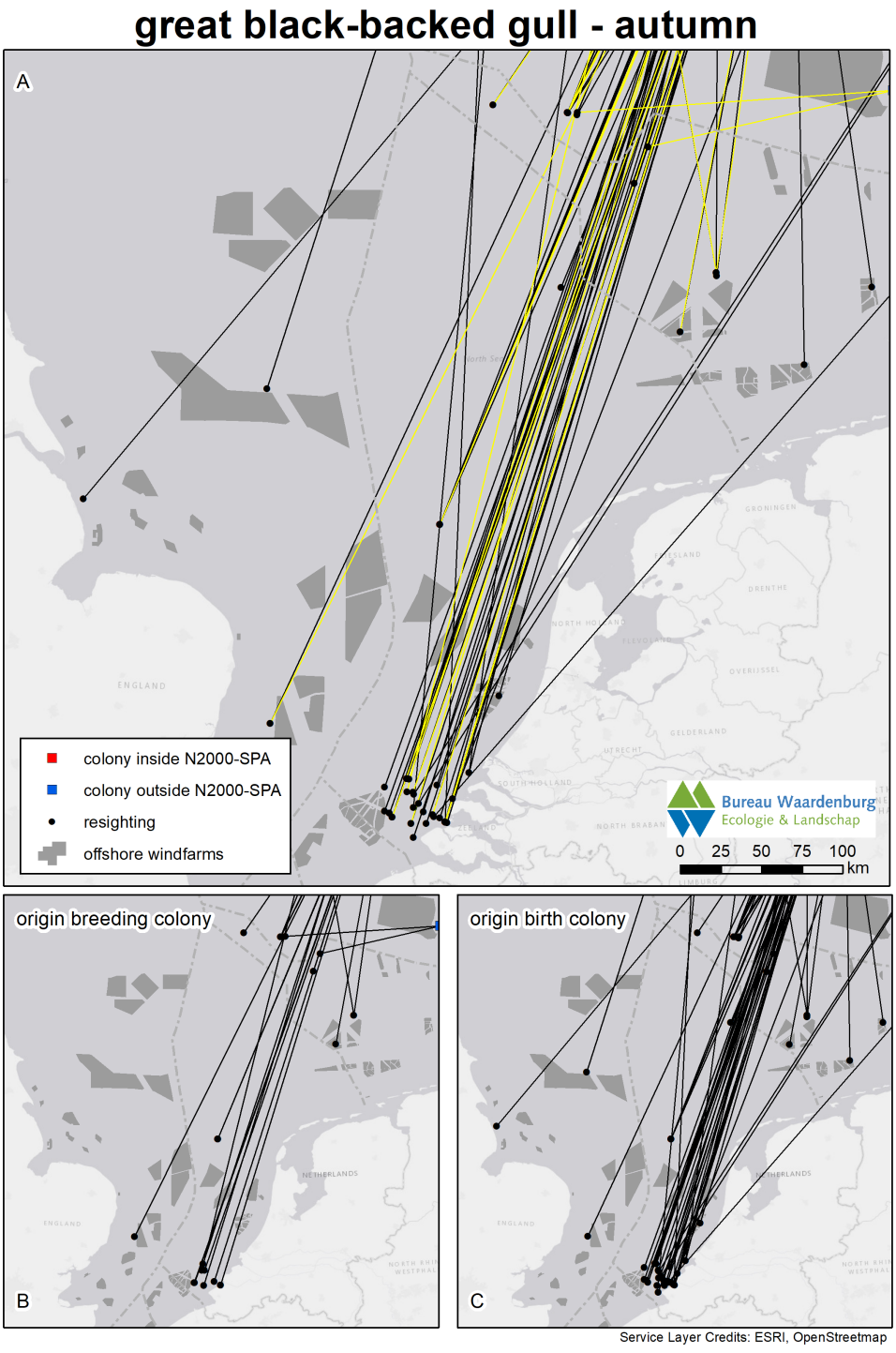
Appendix II Resightings of within the Dutch part of the continental shelf (DCS)



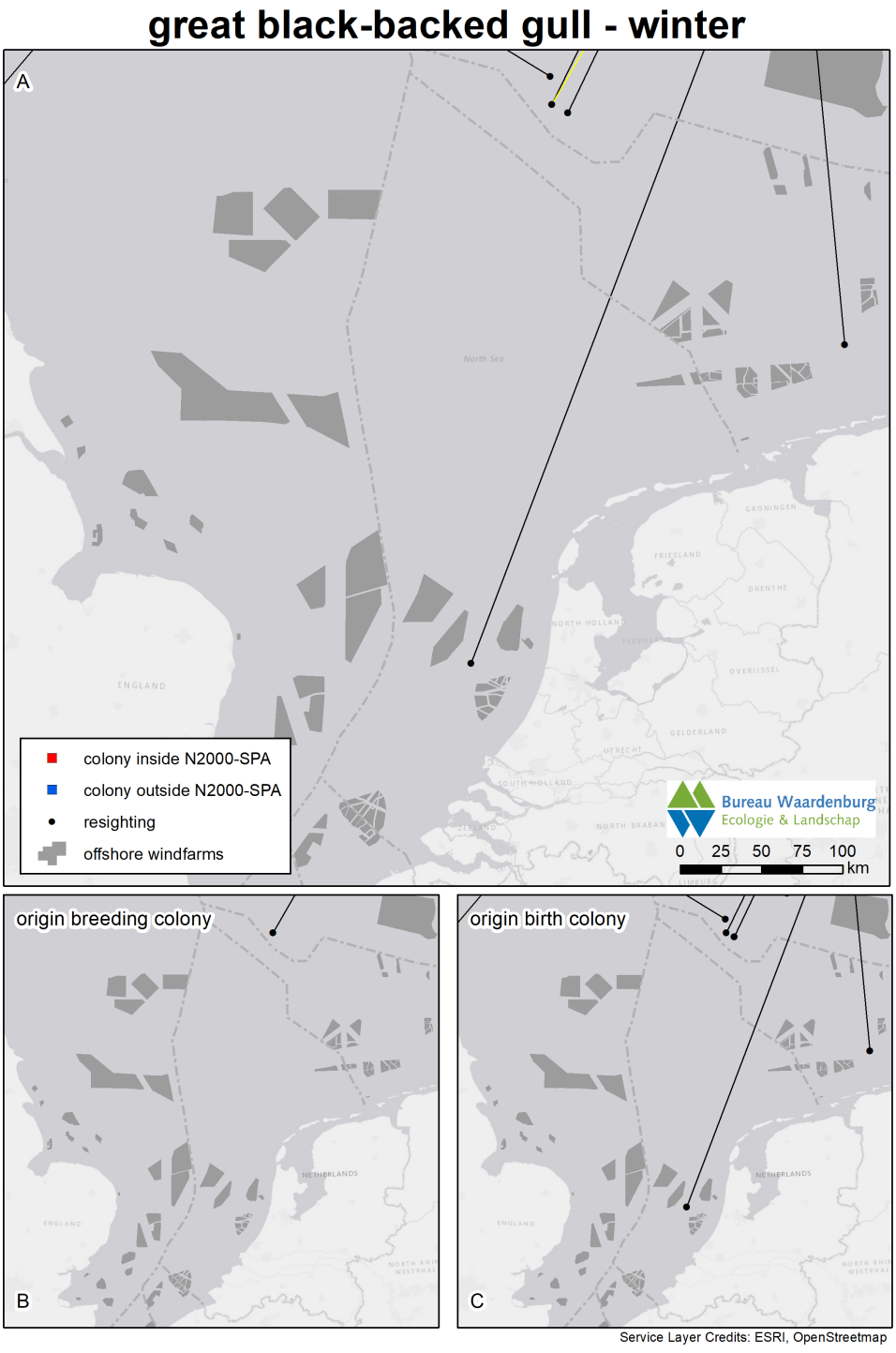
The offshore resighting locations (black dots) of great black-backed gulls in spring. The different colours represent whether the colony was in a N2000 SPA was located for great black-backed gulls. (A) shows the links to birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



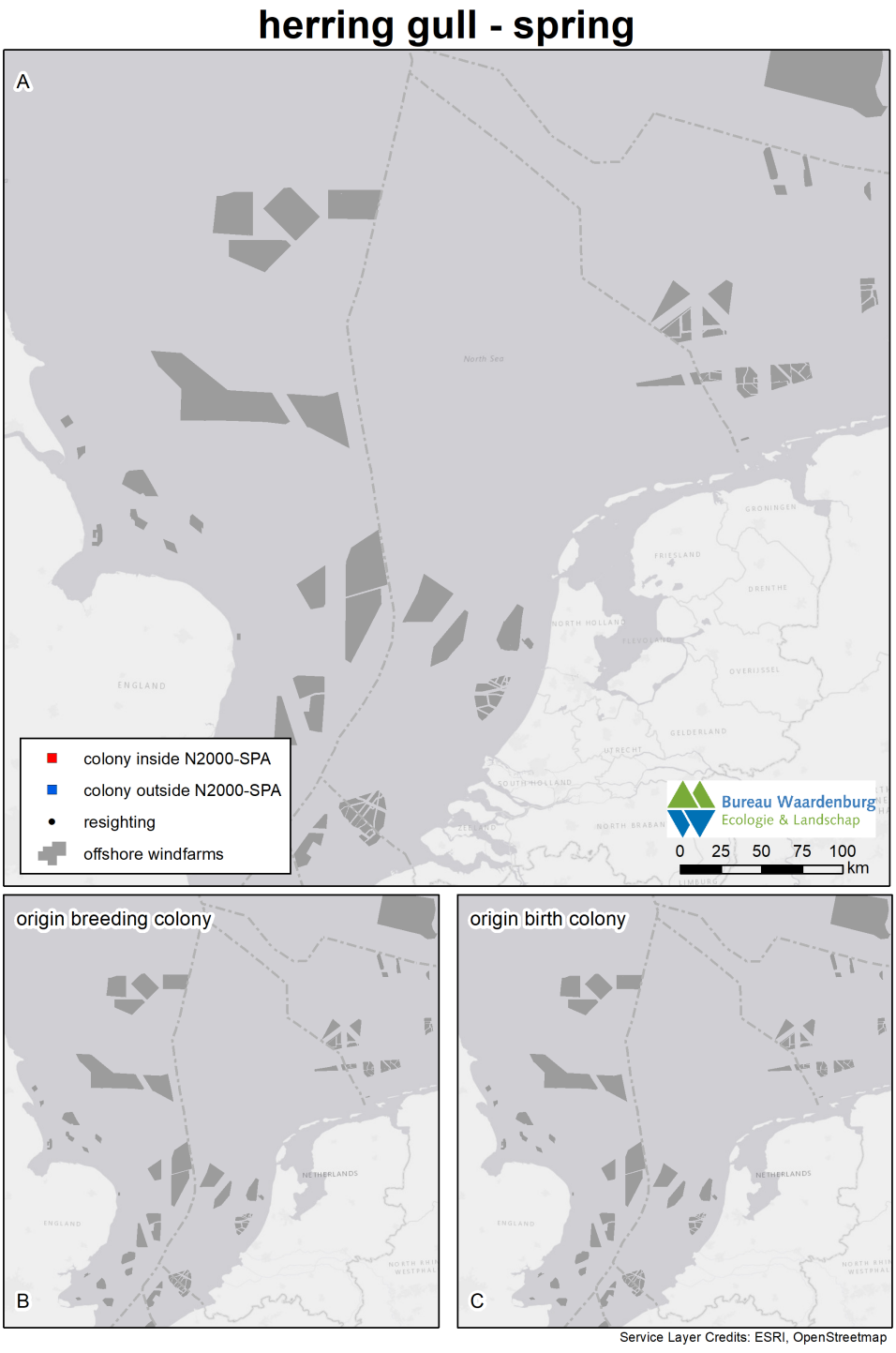
The offshore resighting locations (black dots) of great black-backed gulls in summer. The different colours represent whether the colony was in a N2000 SPA was located for great black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



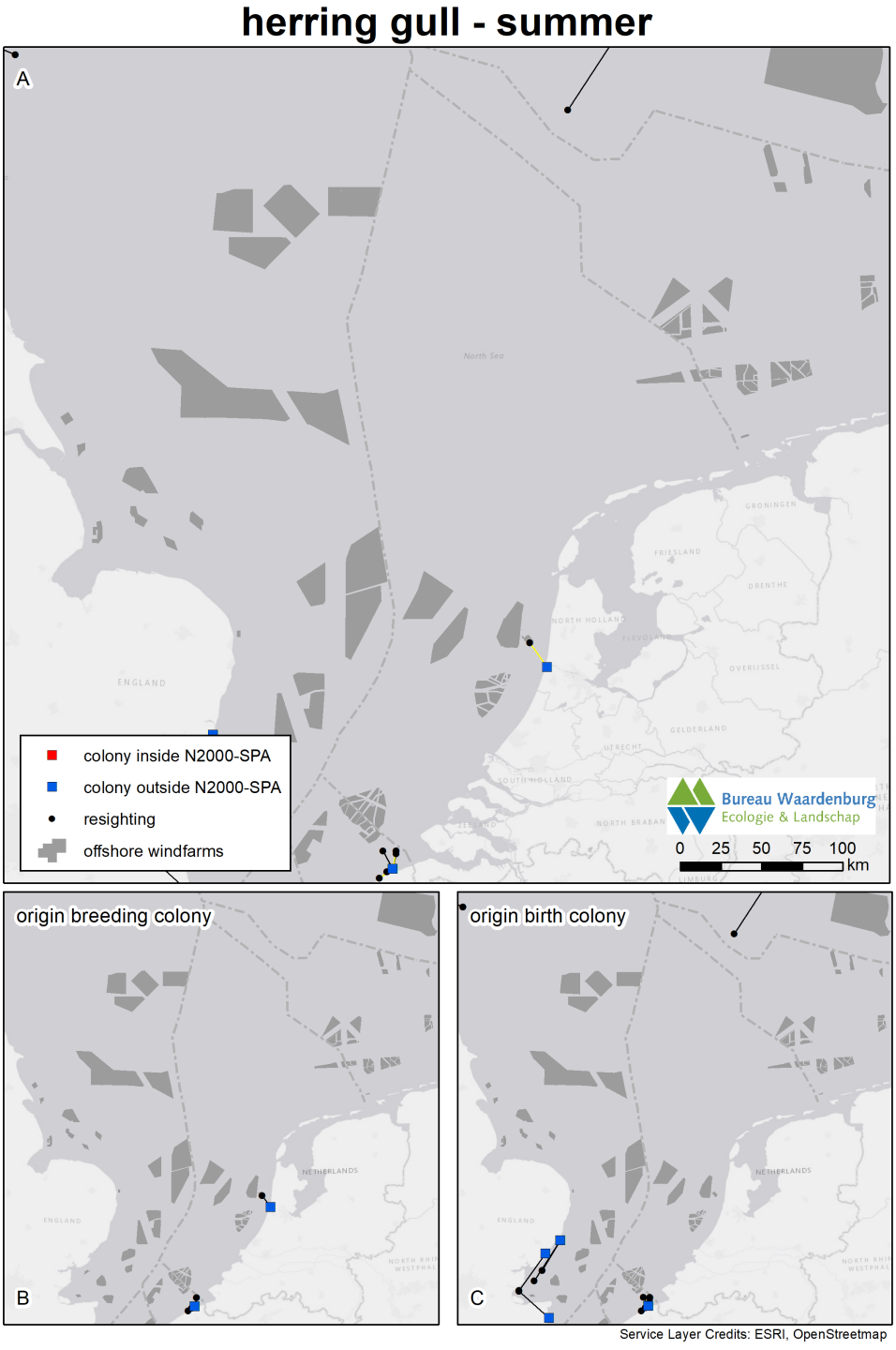
The offshore resighting locations (black dots) of great black-backed gulls in autumn. The different colours represent whether the colony was in a N2000 SPA was located for great black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



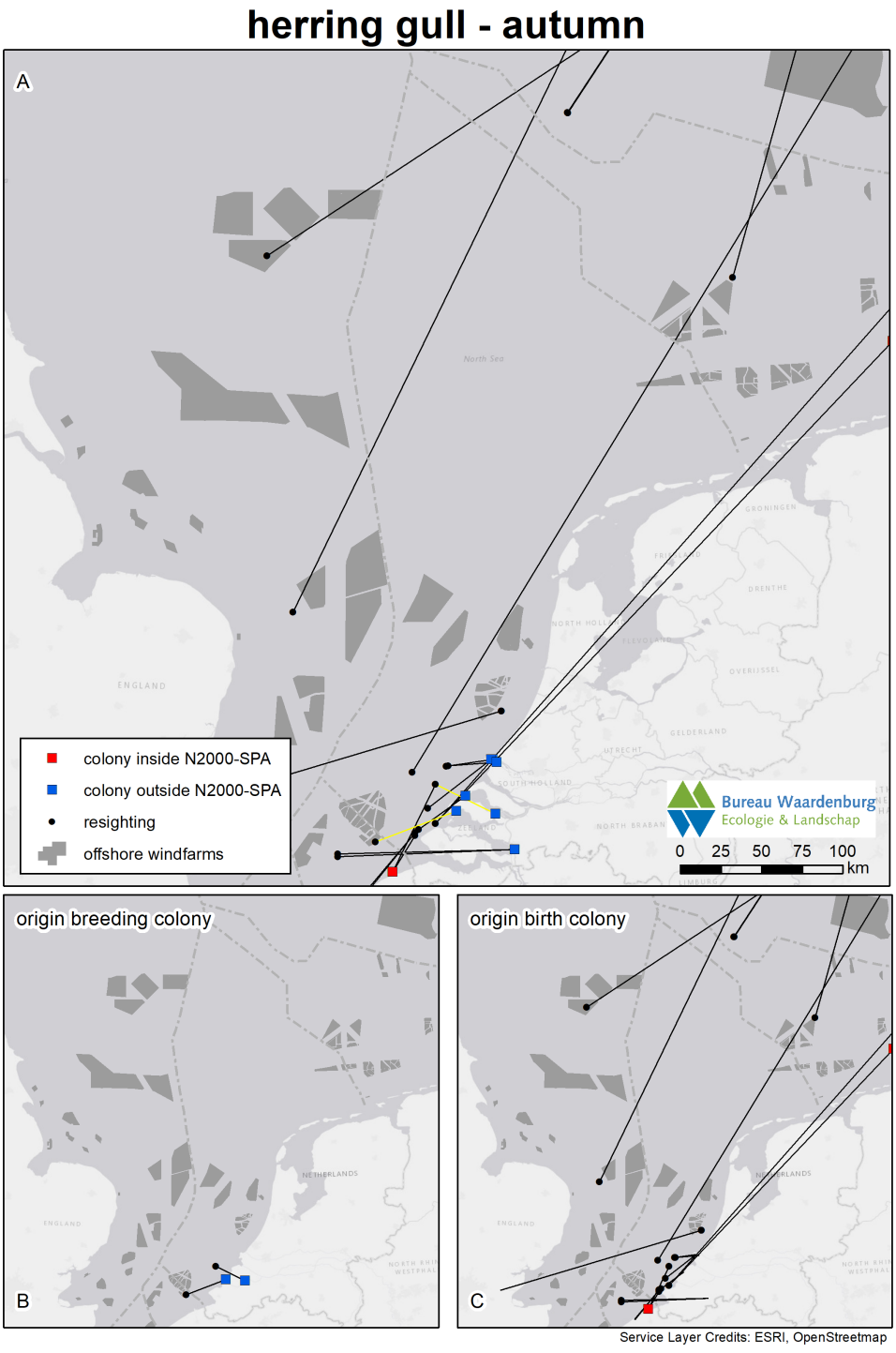
The offshore resighting locations (black dots) of great black-backed gulls in winter. The different colours represent whether the colony was in a N2000 SPA was located for great black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



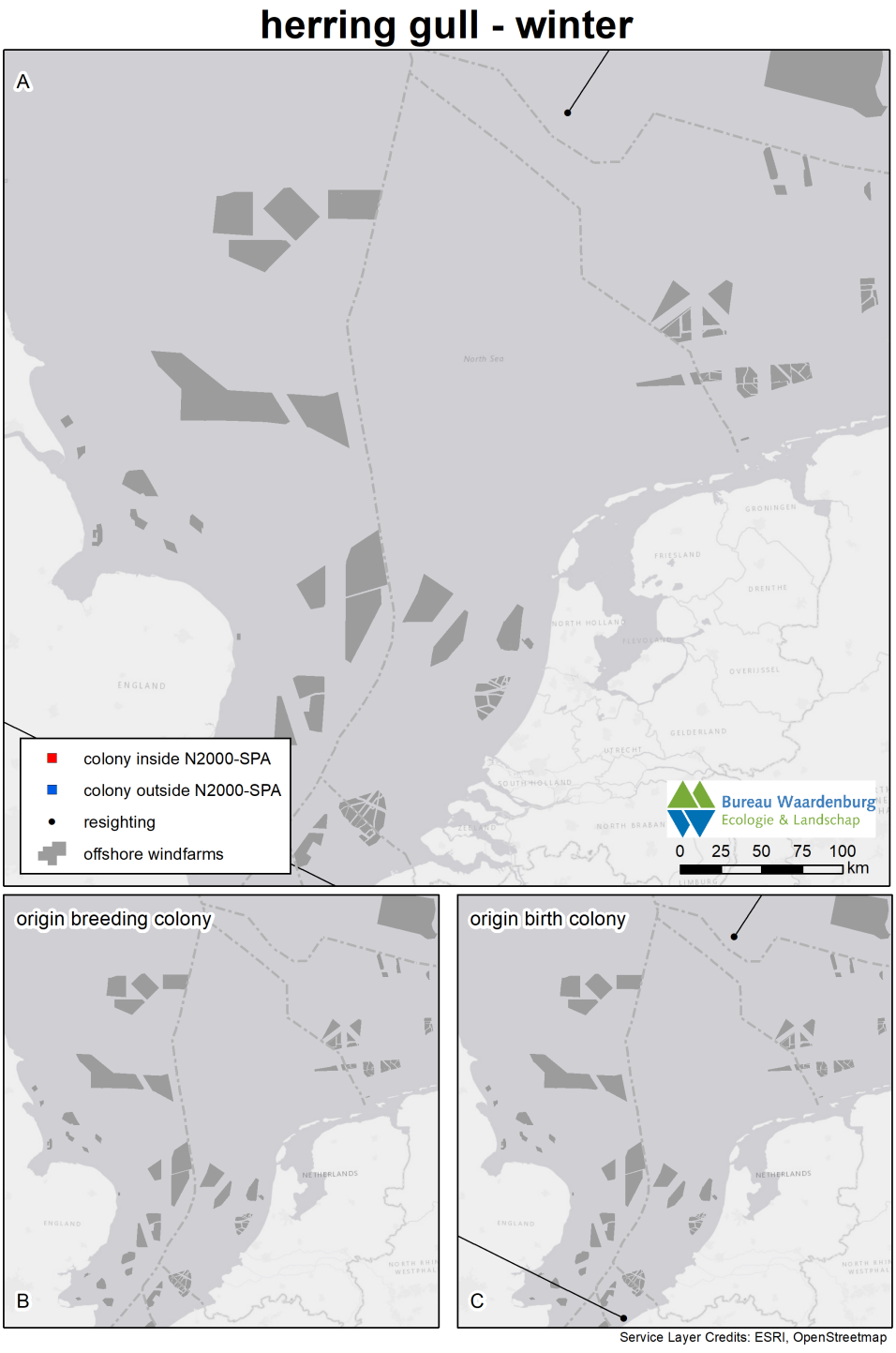
The offshore resighting locations (black dots) of herring gulls in spring. The different colours represent whether the colony was in a N2000 SPA was located for herring gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



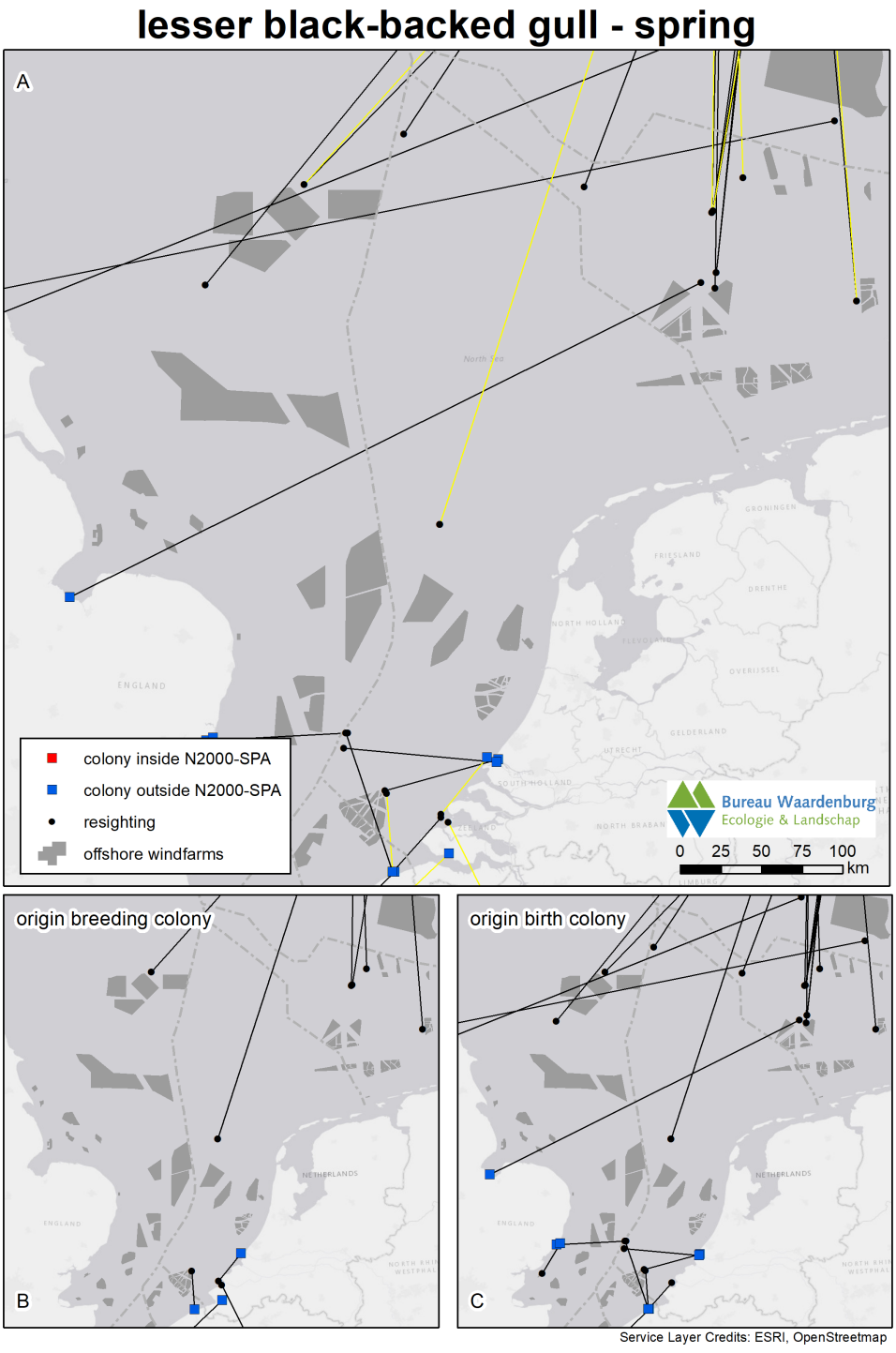
The offshore resighting locations (black dots) of herring gulls in summer. The different colours represent whether the colony was in a N2000 SPA was located for herring gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



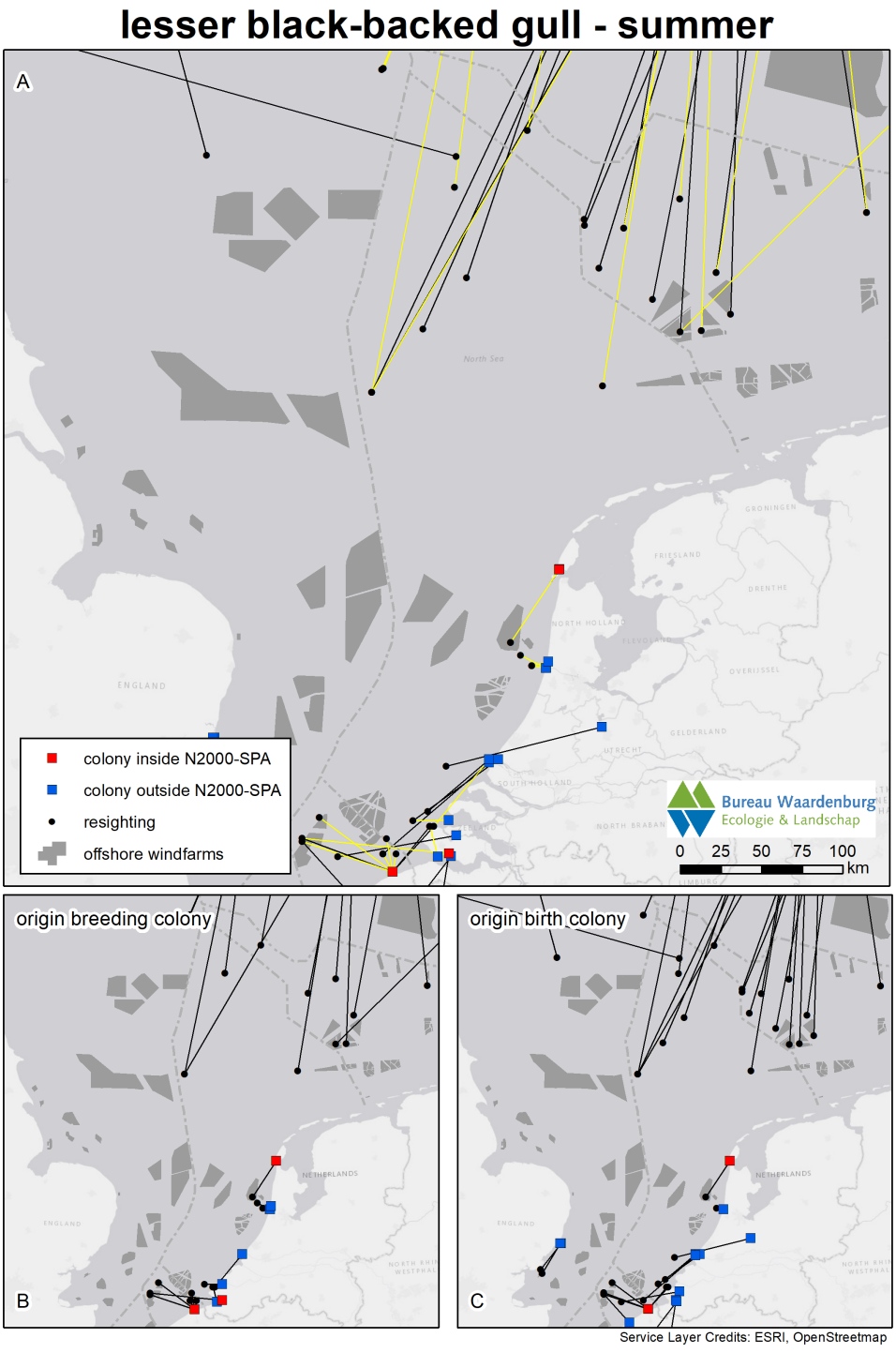
The offshore resighting locations (black dots) of herring gulls in autumn. The different colours represent whether the colony was in a N2000 SPA was located for herring gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



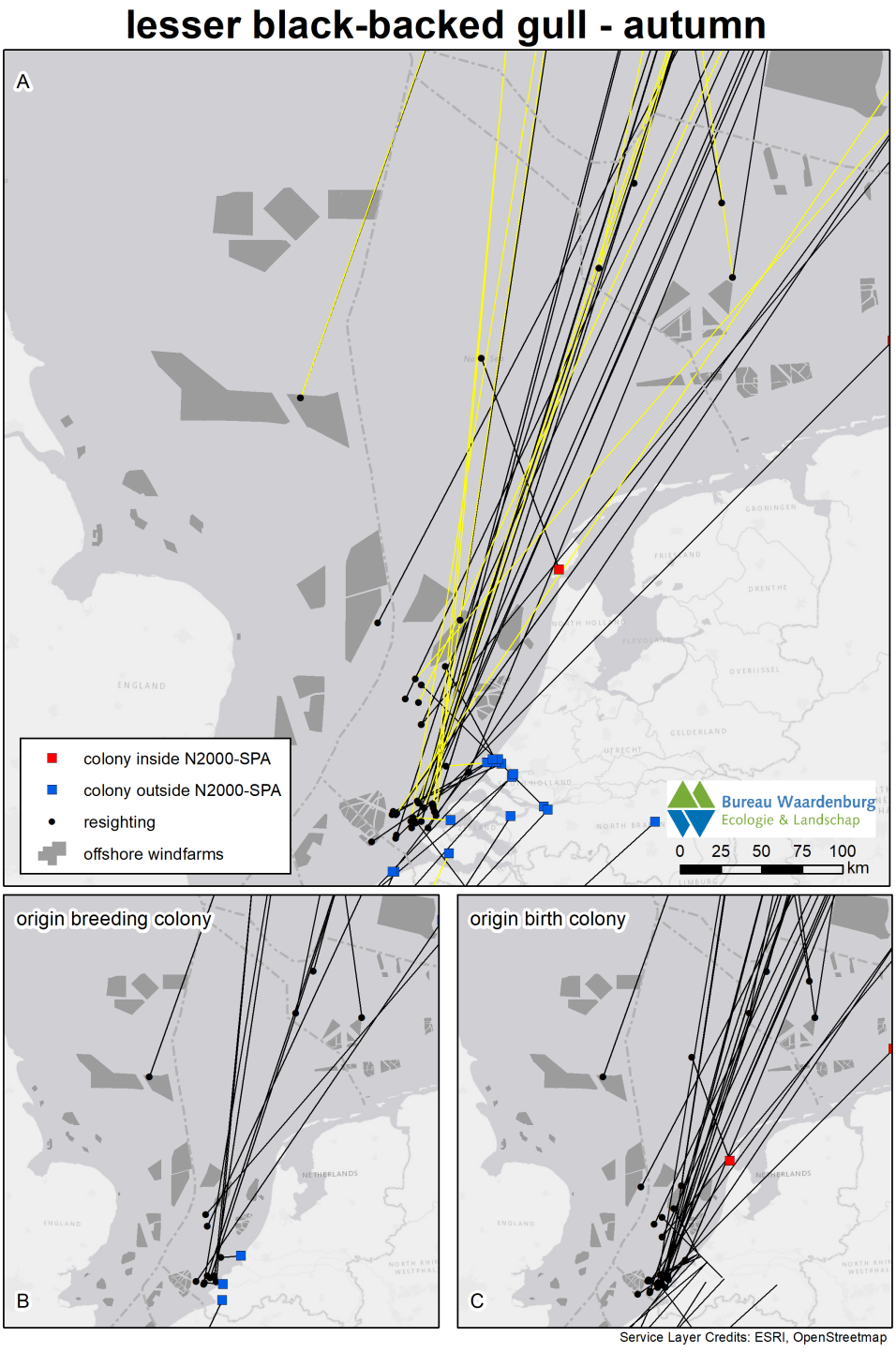
The offshore resighting locations (black dots) of herring gulls in winter. The different colours represent whether the colony was in a N2000 SPA was located for herring gulls. (A) shows the links to breeding (white lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



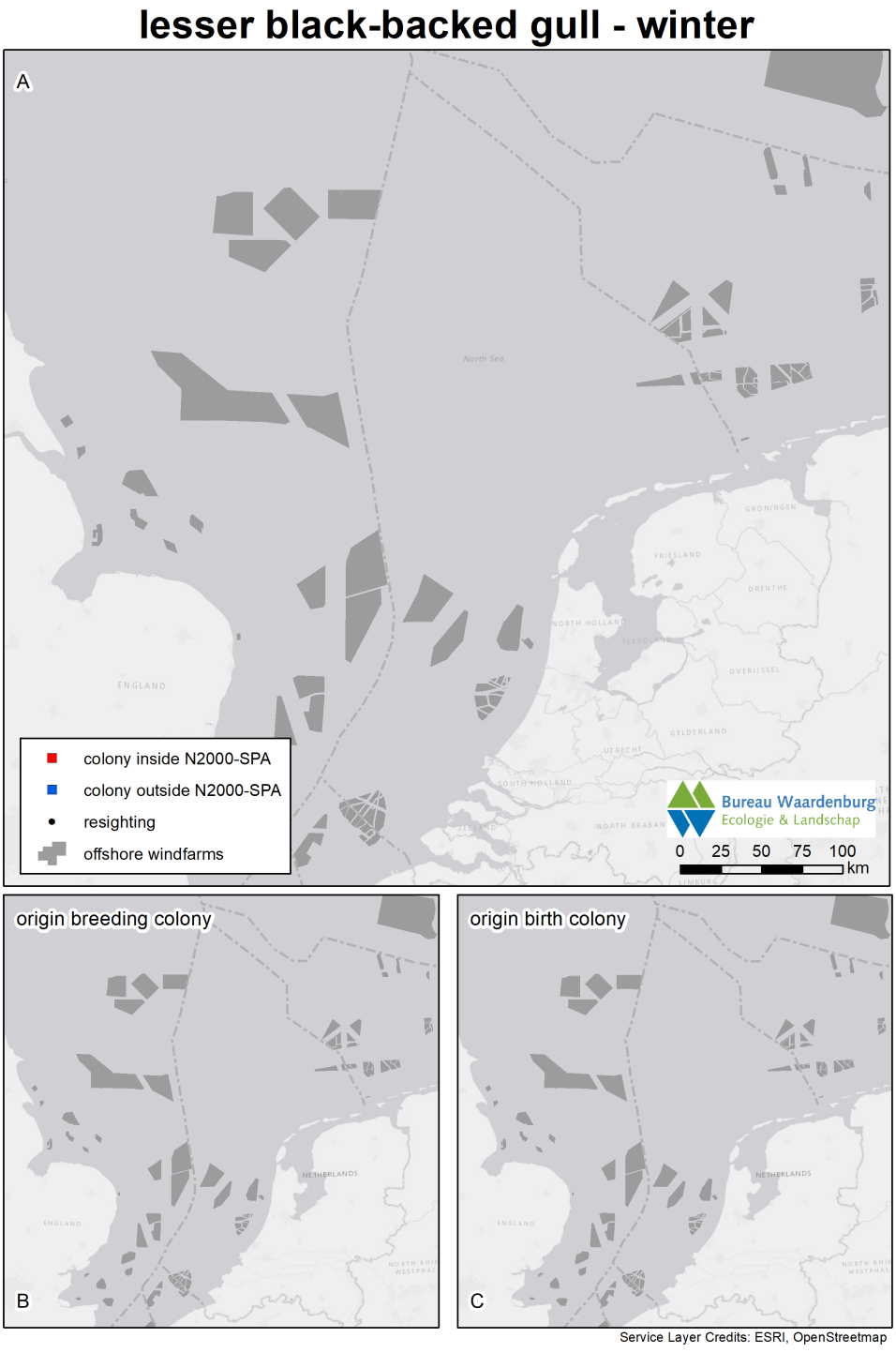
The offshore resighting locations (black dots) of lesser black-backed gulls in spring. The different colours represent whether the colony was in a N2000 SPA was located for lesser black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



The offshore resighting locations (black dots) of lesser black-backed gulls in summer. The different colours represent whether the colony was in a N2000 SPA was located for lesser black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



The offshore resighting locations (black dots) of lesser black-backed gulls in autumn. The different colours represent whether the colony was in a N2000 SPA was located for lesser black-backed gulls. (A) shows the links to breeding (green lines) and birth colonies (black lines), while (B) only shows links to the breeding colony and (C) shows the links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).



No offshore resighting locations of lesser black-backed gulls in winter. (A) shows no links to breeding and birth colonies, while (B) shows no links to the breeding colony and (C) shows no links with the birth colony. The dashed lines refer to the boundaries of the Dutch part of the Continental Shelf (DCS).

Bureau Waardenburg
Ecology & Landscape

Varkensmarkt 9, 4101 CK Culemborg, The Netherlands
Tel. +31 345 51 27 10
www.buwa.nl, info@buwa.nl