Tracking lesser black-backed and herring gulls in the Dutch Delta and data on breeding success and foraging ecology

Progress Report 2020

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WOZEP
DUTCH GOVERNMENTAL OFFSHORE WIND ECOLOGICAL PROGRAMME

BEC
Buijs Eco Consult B.V.

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PROJECTEN

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Preface

The research described in this report was initiated by Rijkswaterstaat within the framework of the Wozep program and is carried out by Bureau Waardenburg, in collaboration with the Research Institute Nature and Forest (INBO), Buijs Eco Consult and Deltamilieu Projecten.

This report describes the first year of fieldwork carried out in 2020, and focuses on the practical aspects of catching, marking and obtaining tracking data, as well as information about diet and breeding success on herring and lesser black-backed gulls in the Dutch Delta. These aspects are critically examined with the aim of outlining clear steps to maximise the chances of successful delivery of project objectives in future years. All results in this report are preliminary and should be treated as such. The final report at the end of this study will encompass more detailed answers to the research questions outlined in the Plan of Action of this project.

Fieldwork was carried out by Nicolas Vanermen, Wouter Courtens, Hilbran Verstraete en Eric Stienen (all INBO) Ruben Fijn, Mark Collier, Sjoerd Duijns, Elisa Bravo Rebolledo, Bas Engels (all Bureau Waardenburg), Roland Jan Buijs (Buijs Eco Consult) en Sander Lilipaly, Pim Wolf, Wendy Janse en Maarten Sluijter (Deltamilieu Projecten).

The work would not have been possible without the help and assistance of Wannes Castelijns and Gerard Wösten (Het Zeeuwse Landschap) and Tijmen den Hollander and Aart Goedhart (Natuurmonumenten). Camiel Heunks (Bureau Waardenburg) provided helpful comments on a previous version of this report. This project is supervised by Maarten Platteeuw and Jos de Visser (RWS), whom we thank in advance for their help and commitment.

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1 Introduction

Lesser black-backed gulls *Larus fuscus* and herring gulls *Larus argentatus* occur throughout the Delta area. Both species have large breeding colonies on the Maasvlakte, Haringvliet, Hollands Diep Schouwen, Neeltje Jans and Sloegebied. The number of breeding pairs of herring gull declined between 1980 and 2005, after which the numbers stabilized around 14.500 breeding pairs (data RWS). The number of breeding pairs of lesser black-backed gull increased in the early 2000s, after which their numbers also remained relatively stable at around 40.0000 breeding pairs (data RWS).

Lesser black-backed gulls and herring gulls are among the 18 species of seabirds and shorebirds identified as susceptible to collisions and avoidance due to offshore wind farms (Buij *et al.* 2018; van Kooten *et al.* 2019; Potiek *et al.* 2019). Based on previous studies (e.g., Camphuysen *et al.* 2015, Stienen *et al.* 2016, Thaxter *et al.* 2015 and 2018), it is expected that home ranges of these birds breeding in the Dutch Delta could overlap with wind energy area Borssele, where the first wind turbines will be operational by the end of 2020.

In addition to direct mortality as a result of collisions, avoidance of wind farms in Borssele may also have consequences for diet choice and breeding success (so-called carry-over effect, e.g. Harrison *et al.* 2011; Betini *et al.* 2013).

In order to assess the impact of windfarm Borssele on these two related gull species, GPS tracking devices have been deployed to herring and lesser black-backed gulls in the colony on the Island Neeltje Jans at the Oosterschelde. Based on previous studies and diet remains around the nest (e.g., Duijns *et al.* 2019, Lilipaly *et al.* 2020), an unknown fraction of individuals in this colony are known to forage within the Voordelta and thus within reach of the wind energy area Borssele.

The aim of this study is to gain insight into offshore habitat use, diet and breeding success of lesser black-backed gulls and herring gulls in colonies potentially affected by the wind energy area Borssele.

2 Fieldwork

In order to gain more insight in the effects of offshore wind farms (OWFs) in general and the Borssele wind farm in particular, the offshore habitat use and foraging behaviour of herring gulls *Larus argentatus* and lesser black-backed gulls *Larus fuscus* breeding on Neeltje Jans was studied using GPS-tracking devices.

2.1 Trapping, ringing and tagging

During the breeding season of 2020, 25 herring and 25 lesser black-backed gulls were caught on their nest during incubation, using walk-in traps. All birds were ringed with a metal ring and a colour ring (Table 2.1). Lesser black-backed gulls were equipped with a black-coloured Ornitela OT-15-3GCT tracker (15 g), while herring gulls received a white-coloured OT-20-3GCT tracker (20 g). Trackers were attached using a body harness of Teflon ribbon threaded with a nylon string (Stienen *et al.* 2016).

At Neeltje Jans – Westduinen (51.6238° latitude - 3.6841° longitude), we caught and tagged 40 birds on two different days (May 20 & 28). The remaining 10 birds were caught and tagged on June 2 at Neeltje Jans – Oosterduinen (51.6278° latitude - 3.7028° longitude; Figure 2.1). Both locations were chosen on the basis on indications of marine foraging habits such as marine prey items in the nest.

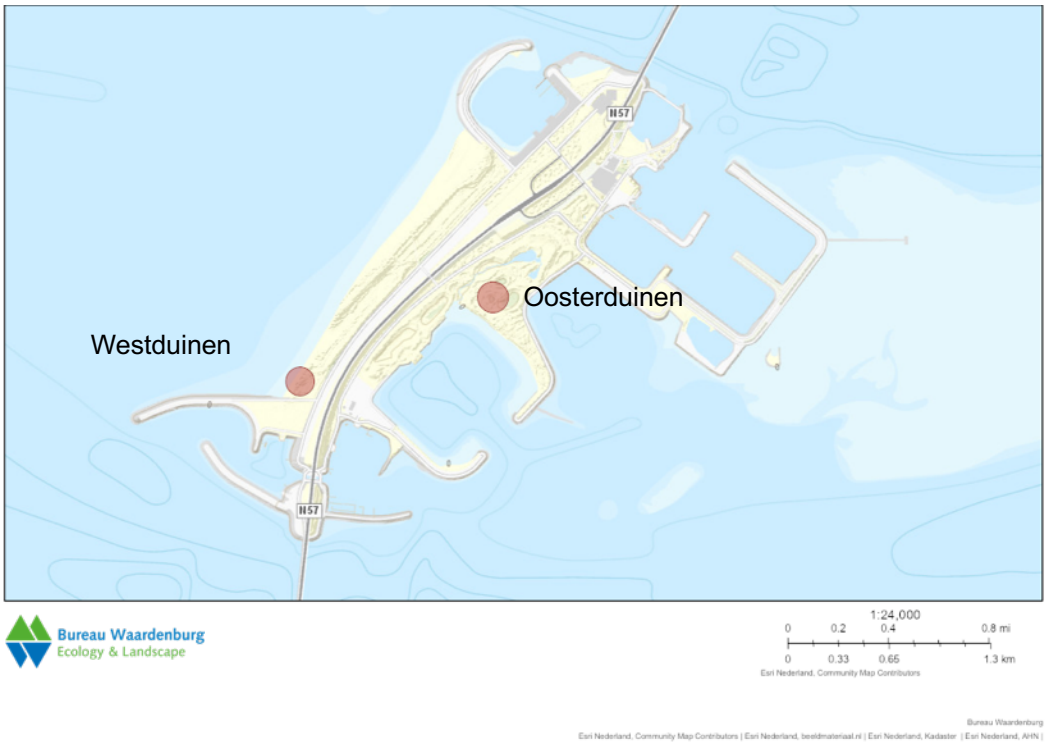

Figure 2.1 *Map with indication of the two locations on Neeltje Jans where gulls were caught and tagged.*

Research team in colony at Westduinen (Photograph R. Fijn, Bureau Waardenburg)

Lesser black-backed gulls near walk-in trap at Westduinen (Photograph R. Fijn, Bureau Waardenburg)

Table 2.1 *Metadata of the tagged birds, totalling 25 Herring and 25 Lesser Black-Backed Gulls.*

Taxon	Deploy date	Mass	Nickname	Ring-ID	Sex	Location
Larus argentatus	2020-05-20	975	ZM Floor	N.6|2	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-20	861	ZM Ann	N.6|X	F	Neeltje Jans, Westduinen
Larus argentatus	2020-05-20	778	ZM Hadewych	N.6|Z	f	Neeltje Jans, Westduinen
Larus argentatus	2020-05-20	871	ZM Mimi	N.6|4	f	Neeltje Jans, Westduinen
Larus argentatus	2020-05-20	835	ZM Tine	N.6|W	f	Neeltje Jans, Westduinen
Larus argentatus	2020-05-20	1100	ZM Torkild	N.6|1	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-20	819	ZM Meta	N.6|3	f	Neeltje Jans, Westduinen
Larus argentatus	2020-05-20	850	ZM Marijke	N.6|Y	f	Neeltje Jans, Westduinen
Larus argentatus	2020-05-20	1030	ZM Pim	N.6|V	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-20	1028	ZM Marc	N.6|0	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	1025	ZM Hubert	8|N	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	1002	ZM Martin	8|R	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	919	ZM Arie	8|W	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	776	ZM Mingtje	8|P	f	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	1035	ZM Timo	8|L	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	978	ZM Jos	8|M	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	863	ZM Griet	8|J	f	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	946	ZM Arjen	8|T	m	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	741	ZM Brechtje	8|U	f	Neeltje Jans, Westduinen
Larus argentatus	2020-05-28	1012	ZM Maarten	8|K	m	Neeltje Jans, Westduinen
Larus argentatus	2020-06-02	1109	ZM Luis	9P	m	Neeltje Jans, Oosterduinen
Larus argentatus	2020-06-02	1067	ZM Mark	9L	m	Neeltje Jans, Oosterduinen
Larus argentatus	2020-06-02	1013	ZM Sander	9J	m	Neeltje Jans, Oosterduinen
Larus argentatus	2020-06-02	977	ZM Dirk	9Z	m	Neeltje Jans, Oosterduinen
Larus argentatus	2020-06-02	1013	ZM Renaud	9E	m	Neeltje Jans, Oosterduinen
Larus fuscus	2020-05-20	819	KLM Jolanda	P.D4	f	Neeltje Jans, Westduinen
Larus fuscus	2020-05-20	977	KLM Eric	P.D1	m	Neeltje Jans, Westduinen
Larus fuscus	2020-05-20	845	KLM Ruben	P.D7	m	Neeltje Jans, Westduinen
Larus fuscus	2020-05-20	940	KLM Sjoerd	P.D2	m	Neeltje Jans, Westduinen
Larus fuscus	2020-05-20	901	KLM Nicolas	P.D9	m	Neeltje Jans, Westduinen
Larus fuscus	2020-05-20	884	KLM Roland-Jan	P.D6	m	Neeltje Jans, Westduinen
Larus fuscus	2020-05-20	626	KLM Naomie	P.D5	f	Neeltje Jans, Westduinen
Larus fuscus	2020-05-20	736	KLM Wilma	P.D0	f	Neeltje Jans, Westduinen
Larus fuscus	2020-05-20	821	KLM Abel	P.D8	m	Neeltje Jans, Westduinen
Larus fuscus	2020-05-20	892	KLM Wouter	P.DY	m	Neeltje Jans, Westduinen
Larus fuscus	2020-05-28	838	KLM Kees	HC	m	Neeltje Jans, Westduinen
Larus fuscus	2020-05-28	691	KLM Halina	G8	f	Neeltje Jans, Westduinen
Larus fuscus	2020-05-28	737	KLM Jelena	DZ	f	Neeltje Jans, Westduinen
Larus fuscus	2020-05-28	973	KLM Willie	G=	m	Neeltje Jans, Westduinen
Larus fuscus	2020-05-28	758	KLM Miranda	G6	f	Neeltje Jans, Westduinen
Larus fuscus	2020-05-28	901	KLM Matias	G5	m	Neeltje Jans, Westduinen

Taxon	Deploy date	Mass	Nickname	Ring-ID	Sex	Location
Larus fuscus	2020-05-28	671	KLM Jacintha	G7	f	Neeltje Jans, Westduinen
Larus fuscus	2020-05-28	653	KLM Maureen	G+	f	Neeltje Jans, Westduinen
Larus fuscus	2020-05-28	730	KLM Marloes	G9	f	Neeltje Jans, Westduinen
Larus fuscus	2020-05-28	924	KLM Jarno	HA	m	Neeltje Jans, Westduinen
Larus fuscus	2020-06-02	892	KLM Hilbran	H4	m	Neeltje Jans, Oosterduinen
Larus fuscus	2020-06-02	670	KLM Sophie	H5	f	Neeltje Jans, Oosterduinen
Larus fuscus	2020-06-02	688	KLM Nora	H6	f	Neeltje Jans, Oosterduinen
Larus fuscus	2020-06-02	763	KLM Astrid	H2	f	Neeltje Jans, Oosterduinen
Larus fuscus	2020-06-02	771	KLM Anke	H3	f	Neeltje Jans, Oosterduinen

Herring gull at marked nest at Westduinen (Photograph R. Fijn, Bureau Waardenburg)

2.2 GPS settings

The settings of the GPS trackers vary depending on the time of day and the birds' location. From dawn till dusk, the resolution is set at every 900 s when inside the colony area, every 180 s when outside the colony area and every 20 s when close to the wind farm concession zone (a so-called geo-fence). This geo-fence for the wind farm concession zone was delineated by a north-south orientated rectangle with the following coordinates: 51.828° latitude - 2.659° longitude (northwest corner) and 51.464° latitude - 3.172° longitude (southeast corner). Stepwise lower resolutions (and thus intervals) are obtained when the tracker's battery is down to 75%, 50% and 25% of its maximal capacity. Three-dimensional accelerometer data are gathered after each GPS-log for 1 second with a frequency of 20 Hz.

2.3 Data retrieval

All data was collected using the mobile network and uploaded to a webserver, where it can be viewed and downloaded directly.

2.4 Monitoring of the breeding colonies

In April 2020, a suitable study area was selected within the colony of Neeltje Jans. Besides the presence of a high density of breeding gulls, the possibility of constructing an enclosure around the nest was also important for this selection. After visiting the colony, the Westduinen was selected as most suitable. In addition to the high density and accessibility, this area is closest to wind farm Borssele. Within this area, data loggers were attached to part of the breeding adults (only one individual per nest), and breeding success was monitored.

A reference colony was selected in the Oostduinen, where the breeding success was monitored, but no data loggers were deployed. This reference colony is a large enclosure, set up in 2019 by Buijs Ecoconsult and Stichting Zeeuwse Landschap. Within this enclosure, chicks walk around freely, and could not be related to specific nests.

During the field season, the number of enclosures and hence, the disturbance in Westduinen was getting relatively high. Therefore, Oostduinen was selected as an additional location to deploy GPS devices, which is close to the reference colony (Figure 2.1).

During the first week of May, 50 nests were marked (24 lesser black-backed gull, 24 herring gull and 2 unknown), and an additional 27 nests were marked on May 28. These nests were individually marked with a labelled bamboo stick for visual recognition. Within a few days, nests that were still being used were enclosed with a 50 cm high chicken wire, resulting in enclosures with a diameter of about 4 m. The enclosures provided sufficient space for chick movement. In open locations with little shelter, pipes were added to the enclosure in order to provide protection against predation or harsh weather conditions.

The nests were checked twice a week to register the number of eggs and/or chicks per nest, and to search for pellets and regurgitates. In all occupied enclosures we searched for regurgitated food and pellets, which were collected and stored in a freezer. New-born chicks were aged and marked individually with coloured plastic tape around the tarsus, and their body mass and head size were measured during each visit. Later in the breeding season, when the chicks were large enough, the tapes were replaced by a metal scientific ring from the Dutch Vogeltrekstation and a colored plastic ring with an individually recognizable inscription.

The gull colony at Westduinen (Photograph R. Fijn, Bureau Waardenburg)

Herring gull breeding in an enclosure at Westduinen (Photograph R. Fijn, Bureau Waardenburg)

2.5 Diet sampling and collection

In 18 enclosures, pellets were collected for diet analysis. This concerns 6 herring gull enclosures from which 20 pellets were collected and 12 lesser black-backed gull enclosures from which 29 pellets were collected. Table 2.2 shows an overview of collected pellets per nest.

Table 2.2 *Overview of number of collected pellets per nest, separated by day and species (LBBG = lesser black-backed gull; HG = herring gull).*

Nest nr.	Species	20-05-20	28-05-20	02-06-20	19-06-20	23-06-20	27-06-20	29-06-20	30-06-20	03-07-20	06-07-20	09-07-20	13-07-20	28-07-20	30-07-20	N per nest
2	LBBG			1	1		1		1	1		1				6
5	HG				1											1
6	HG				1						1	1		1	1	5
7	LBBG				1					1						2
8	HG				1	1			1							3
9	LBBG				1	1										2
11	HG				1				1					1		3
14	LBBG		1													1
15	LBBG	1		1					1			1				4
23	LBBG	1														1
28	LBBG	1														1
35	HG									1						1
38	LBBG	1														1
43	HG	1			1	1	1		2	1						7
44	LBBG							1								1
49	LBBG				1	1					1	1				4
54	LBBG		1			1			1	1			1			5
68	LBBG		1													1

The pellets were individually collected in plastic bags and then stored in the freezer at -20 °C until further processing. Pellets containing a lot of soft prey residues (meat, fat, liquid, etc.) were put in mesh bags (separate bags per pellet), made of nylon gauze, and washed following the method described by Bravo Rebolledo *et al.* (2013). These washed samples were then air-dried and checked for prey residue. These samples consisted of a mixture of prey residue, vegetable matter and human-related material. In total, 28 of the 49 pellets were washed following this method, while the other pellets could be checked for prey remains immediately.

Vegetable material was not included in the diet composition, as this was probably included during pellet collection and mainly concerned types of plants growing in dune areas. Prey remains were divided into 7 categories; fish, mussel, crab, bird (with its own feathers omitted), starfish, nereis and shrimp. Human-related material consists of kitchen waste and litter. To identify the species of ingested fish, the collected otoliths were identified.

3 Tracking results lesser black-backed gulls

3.1 Movement and distribution

Out of the 25 tagged lesser black-backed gulls, 13 birds were categorised as 'unsuccessful breeders', as no chicks were observed inside their enclosure. For five birds, no nest info was collected. The remaining seven birds had chicks between 11/06/2020 and 10/07/2020 ('chick-rearing'). These birds were categorised as 'post-breeding' after chicks no longer appeared to be present in their enclosure (due to fledging or dying).

The dataset holds 547 085 GPS records of lesser black-backed gull with a varying resolution from 20 to 1 800 seconds. After selecting GPS records within a geographical box of 51.0–52.5° latitude and 1.5–4.5° longitude and resampling the database to a 30-minute resolution, 69 129 records remained. Of the latter, 52% represent 'unsuccessful breeders', opposed to 22% 'chick-rearing', 10% 'post-breeding' and 16% with no info.

GPS records of unsuccessful breeders show a widespread and offshore oriented pattern, with limited binding to the colony location (Figure 3.1). During chick-rearing however, most birds stayed within 40 km from the colony (Figure 3.2), although two individuals regularly flew to Brussels (Vilvoorde), located 85 km from Neeltje Jans. The post-breeding category (Figure 3.3) is clearly under-represented, at least within the selected geographical area, due to south or west-bound movements shortly after the fledging (or dying) of their chick(s). Lesser black-backed gull Sophie for example, still had one chick on the 10th of July, and spent most of her time close to Charleroi between the 19/07 and 18/09/2020. Another bird, named Marloes, still had two chicks on the 10th of July, crossed the channel the 12th, after which she spent most of her time just north of London until the end of September.

Tagged lesser black-backed gull at Westduinen (Photograph S. Duijns, Bureau Waardenburg)

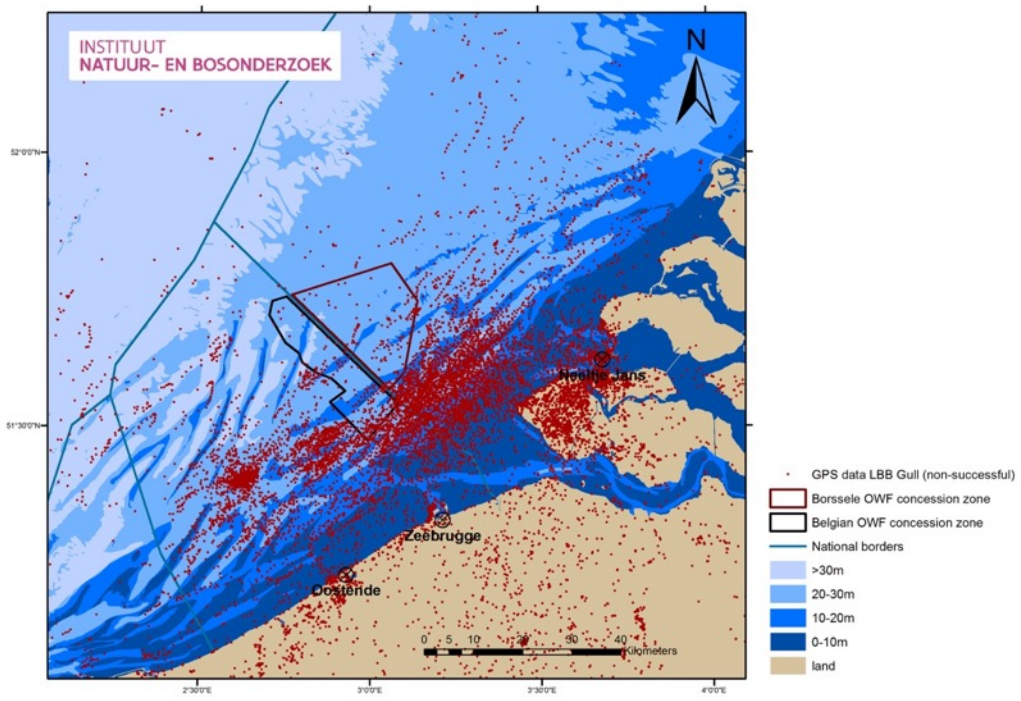

Figure 3.1 *GPS records of non-successful breeding lesser black-backed gulls in the period 21/05/2020–17/09/2020.*

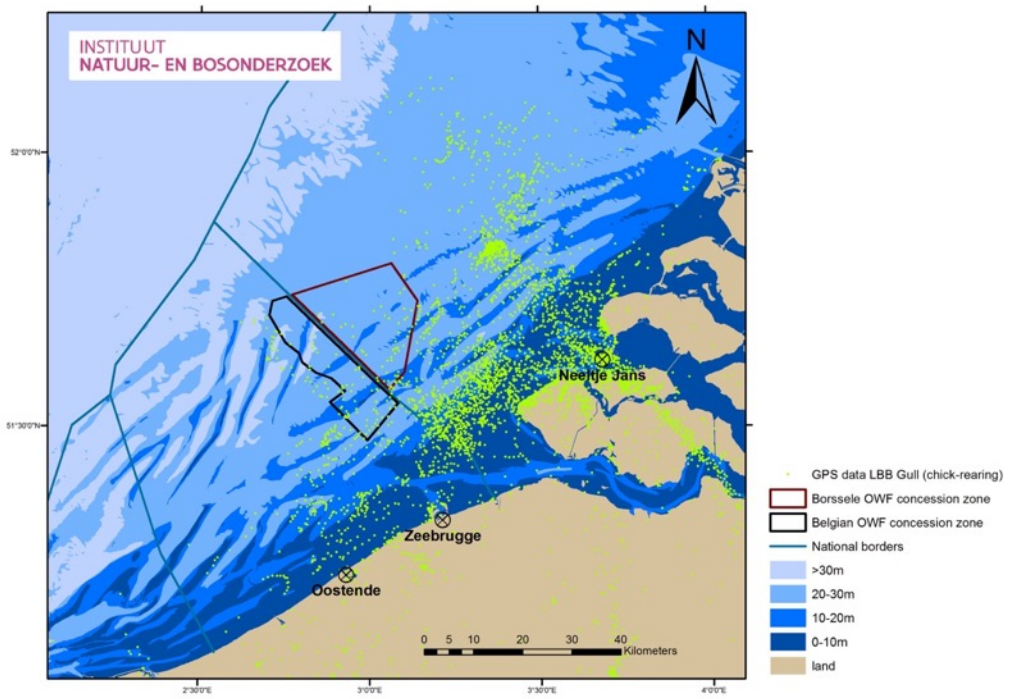

Figure 3.2 *GPS records of chick-rearing lesser black-backed gulls in the period 21/05/2020–16/07/2020.*

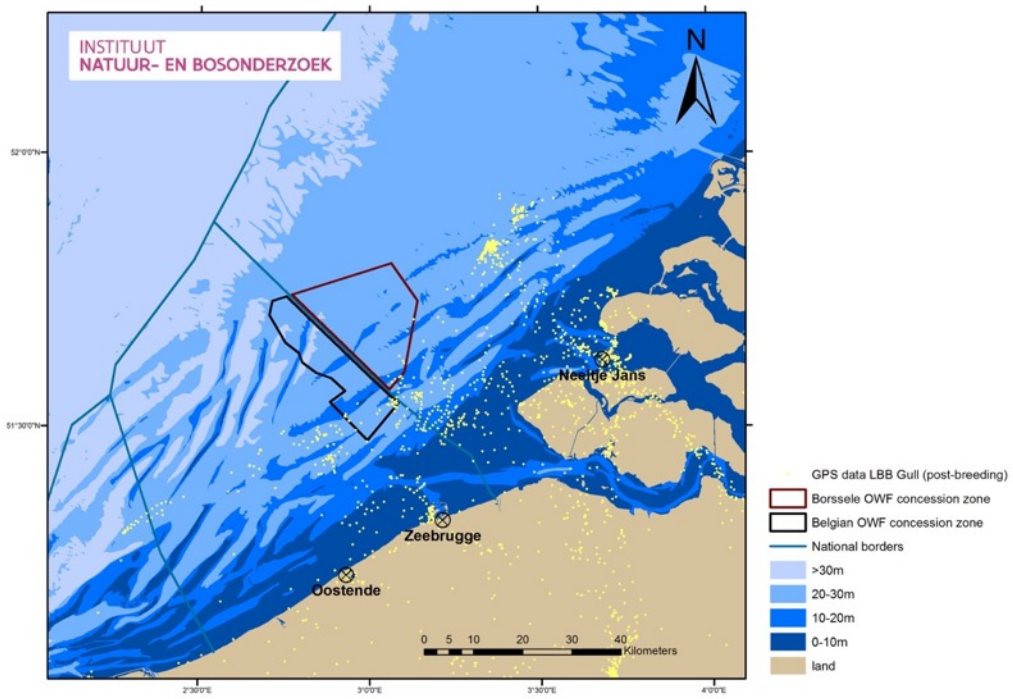

Figure 3.3 *GPS records of post-breeding lesser black-backed gulls in the period 13/07/2020–04/09/2020.*

3.2 Offshore distribution in relation to offshore wind farms

Within the geographical area considered (51.0–52.5° latitude, 1.5–4.5° longitude), the tagged Lesser black-backed gulls spent 27% of their time offshore, and most intense offshore activity occurred to the southeast of the two zones designated for wind energy. Fishing activity likely plays an important role in this overall offshore distribution. It is remarkable how often relatively high densities of lesser black-backed gulls were found along the slopes and in the troughs of the sandbanks just outside the concession zones where fishing is allowed. Interestingly, the two distinct concentrations of records at sea about 20 km northeast and southwest of the OWF zones are due to the presence of two individuals each spending prolonged periods, often day and night. These findings illustrate strong offshore site fidelity. One of these individuals successfully raised chicks and revisited this area after fledging, while the other was unsuccessful.

The overall spatial pattern of GPS records seems to suggest an avoidance of the OWF concession zones (Figure 3.4). A calculated 0.3% of the records fall inside the Borssele OWF concession, while 0.7% fall within the Belgian OWF concession zone. At least for the Belgian concession zone, an estimated 35% of the gulls' time within the concession boundaries was spent perching on turbine bases. Birds tagged in the Belgian colonies of Ostend and Zeebrugge were found to spend 56% of their time inside the Thornton Bank OWF on the jacket turbine foundations (Vanermen *et al.* 2019a).

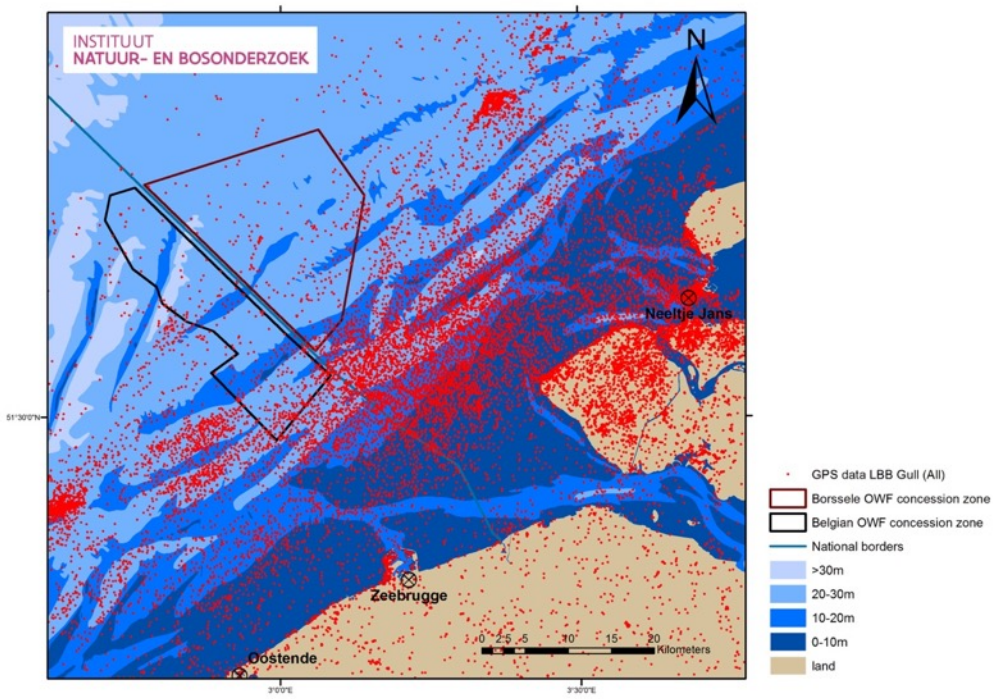

Figure 3.4 *GPS records of lesser black-backed gulls in relation to the OWF concession zones, for the period 21/05/2020–17/09/2020.*

4 Tracking results herring gull

4.1 Tracking: movements and distribution

Nine out of the 25 tagged herring gulls were categorised as successful breeders as their enclosures held chicks for at least part of the period between 11/06/2020 and 10/07/2020. Ten birds were unsuccessful (no chicks observed), while for six birds no information on nest success is available.

The dataset holds 498 566 GPS records of herring gull positions. Similar to the lesser black-backed gull analysis, we performed a selection of GPS records within a geographical box of 51.0–52.5° latitude and 1.5–4.5° longitude and resampled the data to a 30-minute resolution, after which 145 852 records remained. Of the latter, 41% represent 'unsuccessful breeders', opposed to 13% 'chick-rearing', 23% 'post-breeding' and 23% with no information. Contrary to lesser black-backed gulls, the 'post-breeding' category is well represented within the geographical area considered, as the herring gulls tended to stay closer to the colony after the breeding season.

During the chick-rearing phase, herring gulls mostly foraged within 20 km from the colony, and distribution was concentrated along the coast and on land (Figure 4.2). Only 6% of their time was spent at sea (>1 km away from the coast). After fledging or dying of their chicks, birds dispersed over a much wider area both to the northeast as to the southwest and were encountered offshore more often (13% of the records). However, at-sea distribution was still limited to shallow near-shore waters (Figure 4.3). Non-successful breeders occurred more dispersed compared to chick-rearing birds, though records were more concentrated more to the southwest. There seems to be high degree of site fidelity, based on the high concentration of records between Ostend & Nieuwpoort along the Belgian coast, which is due to the prolonged stay of two individuals, i.e. Jos & Floor (Figure 4.1). The same goes for herring gull Maarten, who had two chicks until at least until the 11th of June, and resided in and in front of Bray-Dunes (FR) from the 24th of June on (Figure 4.3).

Tagged herring gull at Westduinen (Photograph R. Fijn, Bureau Waardenburg)

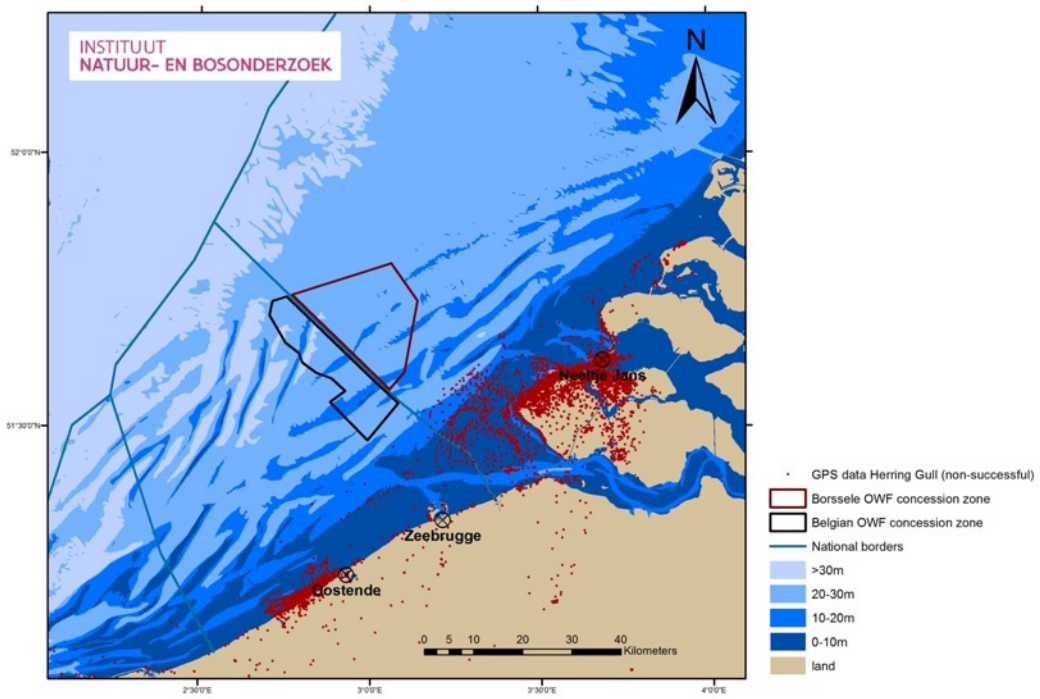

Figure 4.1 *GPS records of non-successful breeding herring gulls in the period 21/05/2020–23/09/2020.*

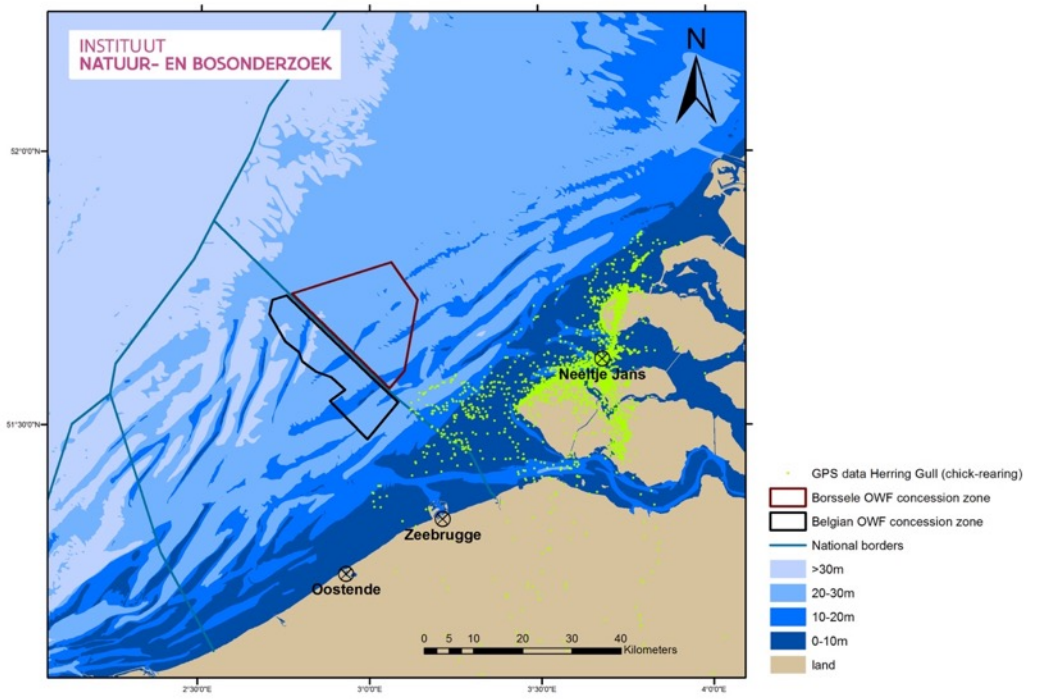

Figure 4.2 *GPS records of chick-rearing herring gulls in the period 21/05/2020–16/07/2020.*

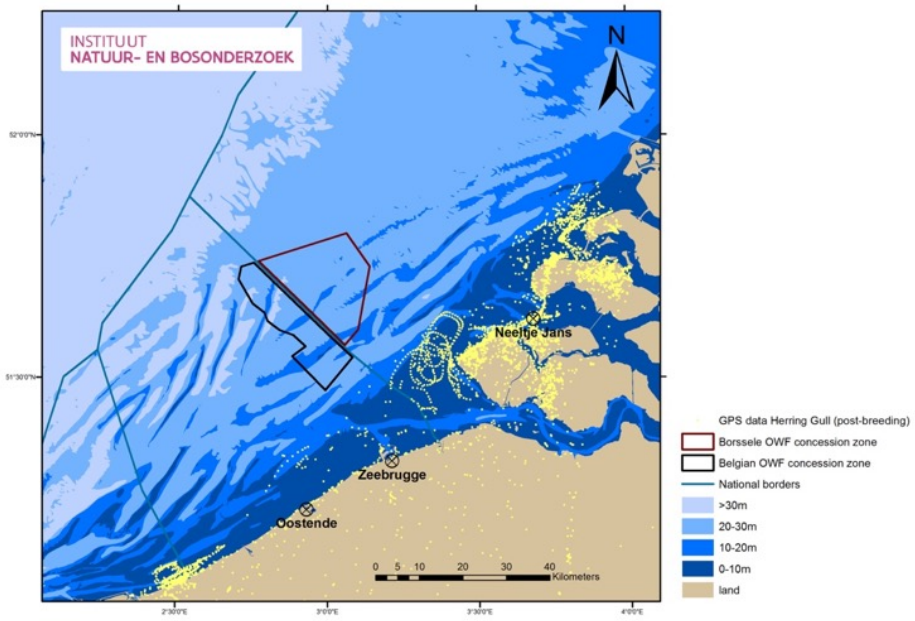

Figure 4.3 *GPS records of post-breeding herring gulls in the period 19/06/2020–23/09/2020.*

4.2 Tracking: offshore distribution in relation to offshore wind farms

The herring gulls tagged in this study spent only 6% of their time at sea (>1 km from the coast). When going out to sea, they were mostly confined to the nearshore shallow waters and stayed within 15 from the coast. None of the tagged herring gulls were recorded within the OWF concession zone boundaries (Figure 4.4).

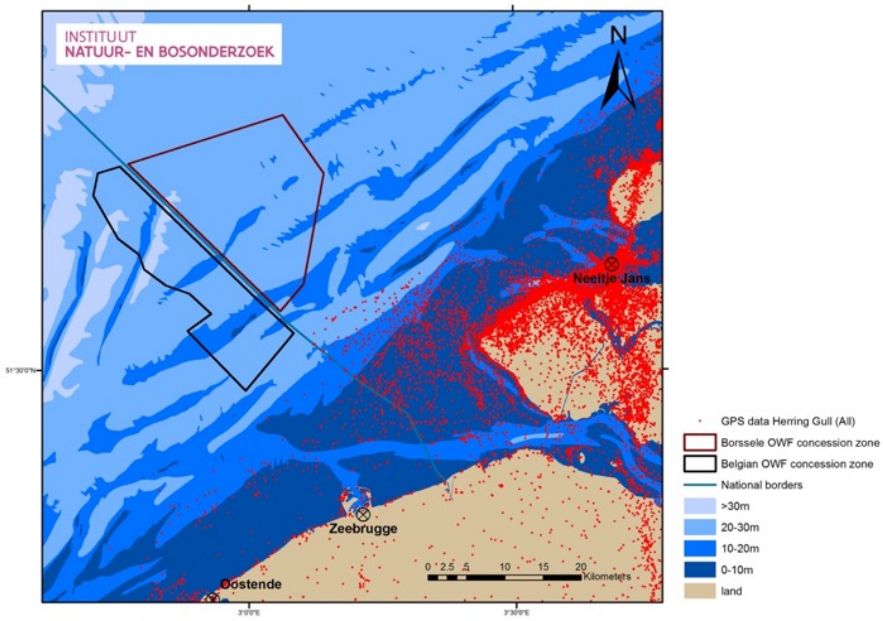

Figure 4.4 *GPS records of herring gulls in relation to the OWF concession zones, for the period 21/05/2020–23/09/2020.*

5 Diet based on pellets and regurgitates

5.1 Lesser black-backed gull

In total 29 pellets were collected from 12 different enclosures (Table 5.1). Remains of fish, mussel, crab, bird, starfish, nereis and shrimp have been found. In addition, plastic waste was found in the pellets.

Table 5.1 *Overview of number of collected pellets per nest and date for lesser black-backed gull, where + indicates whether this type of prey item was found in the pellet.*

Date	Nest nr.	Fish	Mussel	Crab	Bird	Starfish	Nereis	Shrimp	Waste	Plastic
02-06-20	2	+						+		
19-06-20	2		+	+						
27-06-20	2		+							
30-06-20	2		+							
03-07-20	2		+	+		+				
09-07-20	2		+	+						
19-06-20	7	+								
03-07-20	7	+						+		
19-06-20	9	+	+	+						+
23-06-20	9		+							
28-05-20	14	+					+			
20-05-20	23	+								
20-05-20	28	+								
20-05-20	38	+								
29-06-20	44	+								
28-05-20	68	+								
20-05-20	15	+								
02-06-20	15					+				
30-06-20	15			+						
09-07-20	15			+						
19-06-20	49	+								
23-06-20	49			+						
06-07-20	49			+						
09-07-20	49			+	+					
28-05-20	54	+								
23-06-20	54	+								
30-06-20	54	+								
03-07-20	54	+								
13-07-20	54	+								
	Total	**17**	**7**	**9**	**1**	**2**	**1**	**2**	**0**	**1**

In total, fish remains were found in 17 pellets, and 12 pellets contained identifiable fish parts, which were otoliths of 3 whiting, 12 sandeels, 2 cod, 1 goby, 1 plaice, 1 herring, 2 flounder and 1 hooknose. In addition to the otoliths of the 2 flounders, a whole flounder has also been found (Figure 5.1).

Most common prey species were fish, mussel and crab. In 7 pellets crab remains were found, mainly shields and scissors. An unidentifiable bird was found in one pellet. Two pellets contained remains of starfish: one common brittle star and one common starfish. Jaws of nereis have been identified in one pellet (nest 14). The same pell*et al.*so contained otoliths of plaice and whiting, which suggests that the nereis jaws were secondary prey items and ingested by plaice or whiting. Two pellets contained shrimps, which were likely secondary prey items as well, as otoliths of whiting and cod were founds in these pellets as well. One pellet contained plastic, and none contained kitchen waste.

Figure 5.1 *Complete flounder found in an enclosure of a lesser black-backed gull.*

5.2 Herring gull

A total of 20 pellets were collected from 6 different enclosures (Table 5.2). Remains of fish, mussels, crabs and birds have been found. In addition, kitchen waste and plastic were found in the pellets.

Table 5.2 *Overview of number of collected pellets per nest and date for herring gull, where + indicates whether this type of prey remains was found in the pellet.*

Date	Nest	Fish	Mussel	Crab	Bird	Starfish	Nereis	Shrimp	Kitchen waste	Plastic
19-06-20	6			+						
06-07-20	6									
09-07-20	6				+					
28-07-20	6								+	
30-07-20	6	+	+	+	+					
19-06-20	11		+		+					+
30-06-20	11		+							+
28-07-20	11		+							
19-06-20	5		+	+						
03-07-20	35								+	+
19-06-20	8		+	+	+					
23-06-20	8		+							
30-06-20	8		+							
20-05-20	43	+								
19-06-20	43	+								
23-06-20	43	+								
27-06-20	43	+								+
30-06-20	43	+								
30-06-20	43	+	+							
03-07-20	43	+								
	Total	**8**	**9**	**5**	**4**	**0**	**0**	**0**	**2**	**4**

The most common prey species in pellets of herring gulls were fish and mussels, followed by crab and (song)birds. Fish were found in 8 pellets and three pellets contained identifiable fish parts (nest 43). These were the body of a mackerel (Figure 5.2), otoliths from 1 whiting and otoliths from 3 herring.

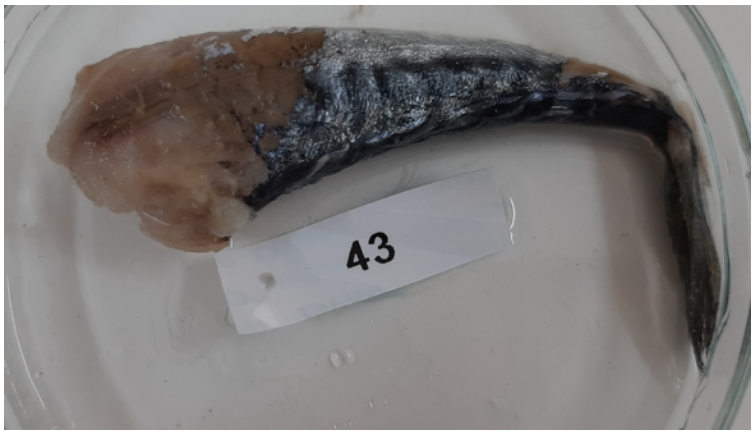

Figure 5.2 Remains of mackerel found in a pellet of a herring gull.

Crab remains were found in 9 pellets, which were mainly shields and scissors. The remains of birds have been found in pellets from nest 6, 11 and 8. In nest 6, pellets with remains of a blackbird and a robin were found. In a pellet from nest 11 had songbird bones, which were no longer identifiable at species-level. The pellet found in nest 8 contained a leg of a duck species, which could not be identified at a species level. Remarkably, no remains of starfish, nereis or shrimp have been found in the pellets of herring gulls on Neeltje Jans.

Kitchen waste was found in two pellets, which were leftovers of spareribs, lamb chops and chicken bones (Figure 5.3). Plastic waste was found in 4 of the 20 pellets.

Figure 5.3 Remains of kitchen waste in a pellet of herring gull.

6 Breeding success

A total count of the breeding pairs on Neeltje Jans in 2020 indicated 2.835 breeding pairs of lesser black-backed gull and 1.439 breeding pairs of herring gull.

The first visit to the colony at Westduinen was on 11 May, when 42 nests of lesser black-backed gulls and herring gulls were marked. Nests had 1 to 3 eggs on that day. The first chick was recorded on May 25 and the last chick fledged out of an enclosure on August 4. After that, the site was visited a few more times to see if there were dead juveniles in the area. During these follow-up checks, no corpses of enclosure chicks were found in the study area.

The nest checks mainly focused on the nests of tagged gulls. From 12 nests out of the first selected group of 50 nests in the Westduinen where no parent birds were tagged, the clutches could be followed until about a week after hatching. When chicks are over a week old, they wonder around freely and without an enclosure are difficult to follow, hence these nests were no longer monitored afterwards. These nests were suitable to measure a possible effect of catching and logger deployment on the clutch content. However, the number of clutches is too limited to show any significant differences.

Of the 27 nests selected on May 28, only those nests where one of the adult birds had been tagged were monitored for the rest of the season (11 nests). The remaining 16 nests were followed until after the hatching of the eggs, but it is uncertain to which of the two species they belonged.

6.1 Lesser black-backed gull in study colony

A total of 28 enclosures with nests of the lesser black-backed gull were monitored (Table 6.1) of which the majority were located in Westduinen. Hatching success of this species was lower than for herring gull. Unfortunately, at the end of May many nests were predated by conspecifics. Disturbance by our presence due to the catching activity will undoubtedly have contributed to the cause of this predation, although in other related colonies a remarkable amount of egg loss was observed during this period. Persistent drought may have played a role during this period, as it leads to increased absence of adult birds, making nests vulnerable for predation. A total of seven juveniles fledged (0.25 young / pair). Similary to the herring gull, the breeding succes in the enclosures in Oostduinen was better than in Westduinen. Out of the 16 nests in the reference colony, almost all eggs hatched, although eventually only three young fledged and a high level of predation was observed in this part of the colony.

Table 6.1 *Breeding results of (GPS-tagged) lesser black-backed gulls in the study colonies in 2020. Hatching success that is the fraction of hatched eggs (in brackets the total number of hatched eggs). Fledgling success is the number of fledged chicks per nest.*

	number of nests	hatching success	fledging success
Westduinen	23	0,43 (n=58)	0,17 (n=4)
Oostduinen	5	0,57 (n=14)	0,6 (n=3)
Without GPS	7	0,54 (n=17)	Unknown
Reference colony	16	0,97(n=36)	0,19 (n=3)

6.2 Herring gull in study colony

A total of 24 enclosures with nests of herring gulls were monitored (Table 6.2) of which the majority were located in Westduinen (n = 18). At this site, almost 75% of the nests the eggs hatched, which is similar to the other monitored sites. The nests of 5 herring gulls were predated or abandoned close after catching, while from the other nests most eggs hatched. The breeding succes (no. of fledged chicks) of the GPS tagged individuals was 0,24 young/pair, where the enclosures in the Oostduinen did better.

Table 6.2 *Breeding results of (GPS-tagged) herring gulls in the study colonies in 2020. Hatching success that is the fraction of hatched eggs (in brackets the total number of hatched eggs). Fledgling success is the number of fledged chicks per nest.*

	number of nests	hatching success	fledging success
Westduinen	18	0,72 (n=35)	0,18 (n=3)
Oostduinen	6	0,71 (n=17)	0,5 (n=3)
Noordduinen	1	0	0
without GPS	5	0,71 (n=14)	Unknown
reference colony	5	0,66 (n=15)	0,4 (n=2)

6.3 Breeding success compared to Neeltje Jans

In order to place these numbers in a larger context, we compared the breeding results in the enclosures with the rest of the colony, since the breeding success of both gull species was measured in a number of sub-areas on Neeltje Jans. At the end of July, the number of near-fledgling young were counted in areas where the exact number of nests was known (Table 6.3, Table 6.4). This method was also used in a number of other colonies spread across the Delta area. The colony on Neeltje Jans is one of the few colonies in the Delta area with a relatively high proportion of gulls (especially lesser black-backed gulls) that forage at sea. Other colonies that are (probably) more pelagic than terrestrial oriented are the Meeuwenduinen near Burgh-Haamstede and the colonies on the Maasvlakte.

6.3.1 Lesser black-backed gull

Breeding success of the lesser black-backed gull in the enclosures (0.25 juveniles / pair) was in accordance with average breeding success on other parts of Neeltje Jans (0.23

juveniles / pair, Table 6.3). There were locally large differences in breeding success locally due to predation. The western side of Neeltje Jans (with a relatively large number of “pelagic-oriented” breeding birds) had better breeding success than the eastern part of Neeltje Jans (0.35 juveniles / pair versus 0.21 juveniles / pair).

Table 6.3 *Breeding results of lesser black-backed gulls at Neeltje Jans in 2020. Breeding success is the number of fledged chicks per nest.*

Sub area	side of Neeltje Jans	number of breeding pair	breeding success
Enclosure Westduinen	west	23	0,17
Enclosure Oostduinen	oost	5	0,60
Noordland	west	143	0,68
Westduinen	west	155	0,34
Noordduinen	west	243	0,17
Poolvoet	west	89	0,26
Haak	oost	216	0,36
Noord van Slufter	west	123	0,11
Oostduinen	oost	480	0,19
Rondom Slufter oost	oost	75	0,54
Werkeiland Roggenplaat	oost	189	0,03

6.3.2 Herring gull

The breeding success in the enclosures (0.24 juveniles / pair) of the herring gull was slightly lower than the average of all areas on Neeltje Jans, where breeding success was recorded (0.31 juveniles / pair). There were large differences between the different parts on Neeltje Jans. The breeding success was particularly high on the plain of Noordland (Table 6.4). The impression in the field was that there was no shortage of food in the area and that the large differences in breeding success are to be contributed to local presence of ground predators such as rats and polecats. This low breeding success in was also observed on Neeltje Jans in 2018 and 2019 (unpubl. data R.J.Buijs).

Table 6.4 *Breeding results of herring gulls at Neeltje Jans in 2020. Breeding success is the number of fledged chicks per nest.*

Subarea	number of breeding pairs	breeding success
Enclosure Westduinen	18	0,18
Enclosure Oostduinen	6	0,5
Noordland	99	1,12
Westduinen	62	0,22
Noordduinen	65	0,73
Poolvoet	36	0,29
Haak	216	0,35
Noord van Slufter	56	0,11
Oostduinen	185	0,16
Rondom Slufter oost	54	0,54
Werkeiland Roggenplaat	241	0,08

6.4 Breeding success compared to Delta population

In July 2020, the breeding success was also recorded in other gull colonies in the Delta. In small colonies generally the entire colony was monitored, while in larger colonies sub samples were taken and several plots for which the exact number of breeding pairs was known were counted throughout the colony.

6.4.1 Lesser black-backed gull

From 20 colonies with > 20 breeding pairs, breeding success data were collected from lesser black-backed gulls (Figure 6.1). A breeding success > 1 juvenile / pair was observed in the colonies in the Ouwerkerkse Inlagen and on Krammersche Slikken. The breeding success on Sassenplaat (0.48 juveniles / pair) in the Hollands Diep and in Meeuwenduinen (0.45 juveniles / pair) on Schouwen was also above average. The mean breeding succes of all colonies in 2020 is 0.34 juveniles / pair compared to an average of 0.33 in 2019 (Lilipaly *et al.*, 2020).

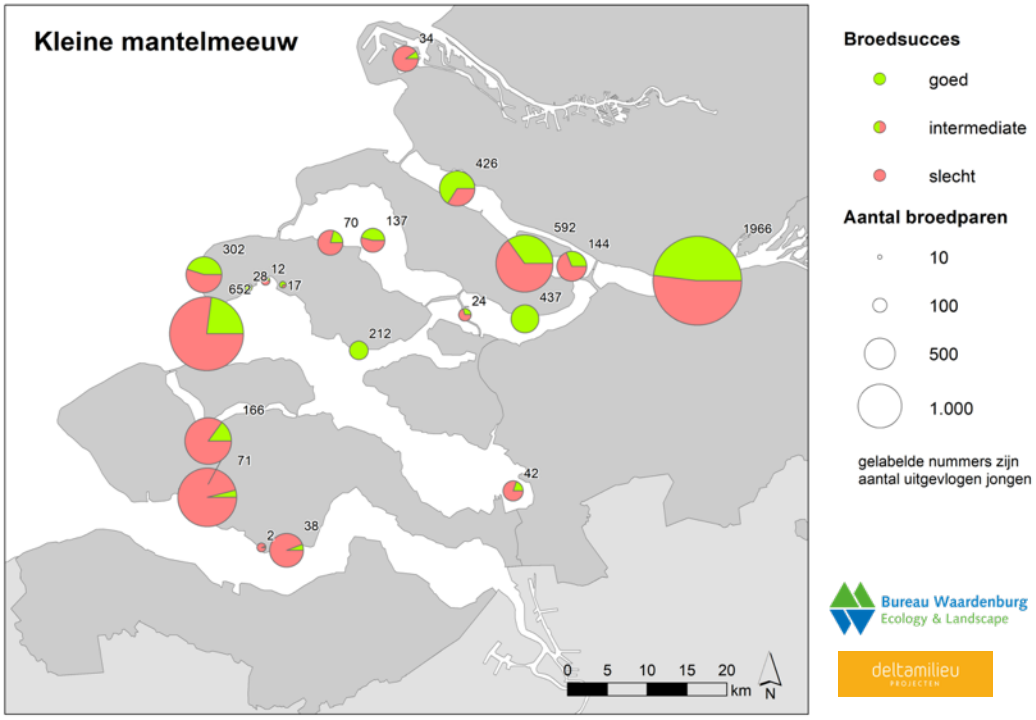

Figure 6.1 Breeding success of lesser black-backed gulls in Delta colonies in 2020.

6.4.2 Herring gull

Data on breeding success were collected in 2020 at 27 colonies with > 20 breeding pairs (Figure 6.2). The highest breeding success (> 1 juveniles / pair) in the Delta area was registered in Ouwerkerkse Inlagen and Krammersche Slikken. No data is yet known about the colony on the Maasvlakte. Colonies with no or very low breeding success in 2020 included the Middelplaat, Quarleshaven, van Cittershaven and the Haringvreter. Fox

predation was found in all of these areas. The mean breeding success of all colonies in the Delta is 0.31 juveniles / pair compared to 0.34 juveniles / pair in 2019 (Lilipaly *et al.*, 2020).

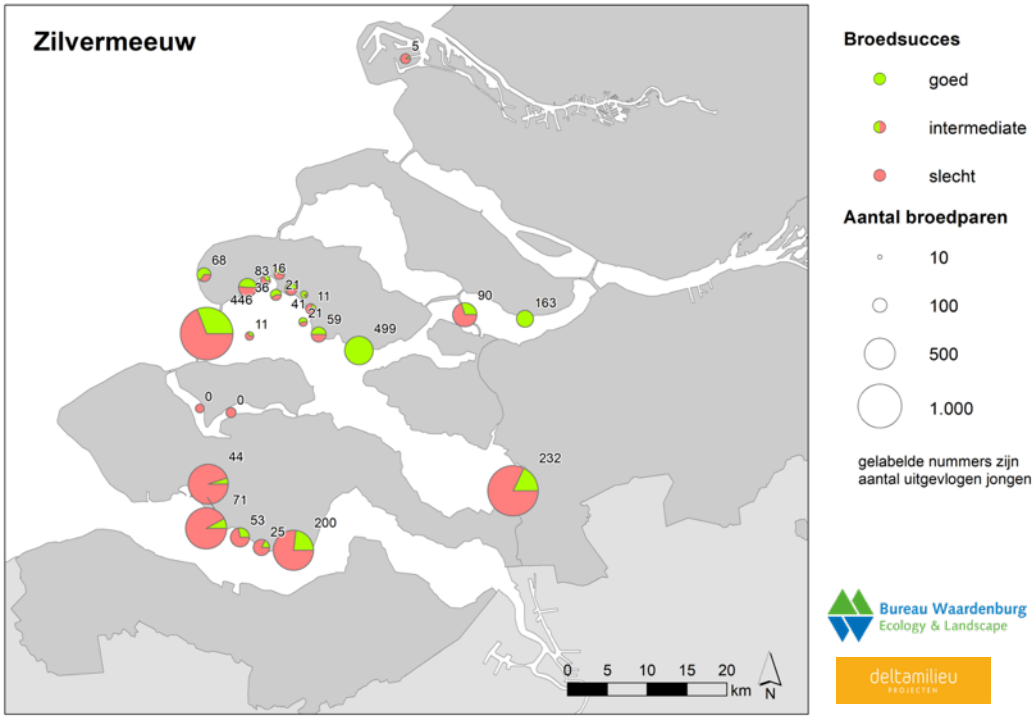

Figure 6.2 Breeding success of herring gulls in Delta colonies in 2020.

7 Offshore gull distribution based on ship-based seabird at sea monitoring

Based on year-round data collected during ship-based surveys, both gull species occur in the OWF concession zones quite frequently. Dedicated displacement studies even found significant attraction effects for herring gull at the Thornton Bank wind farm, while the same was observed at the offshore Bligh Bank wind farm for lesser black-backed gull, which is even further offshore (Vanermen *et al.* 2019b). Overall distribution patterns neither seem to suggest that these gull species avoid the Belgian wind farm zone (Figure 7.2 & Figure 7.1). The strong coastal distribution of the tagged herring gulls as seen in Figure 4.1, Figure 4.2 and Figure 4.3 is much less apparent in the ship-based count data, though the GPS data thus far only represents movements during the breeding season and parts of the post-breeding season.

There is a strong seasonal aspect to the occurrence of both species in the Belgian wind farm concession zone (Figure 7.4 and Figure 7.3). Lesser black-backed gull presence peaks during migration in April and August, but numbers remain high throughout the summer period. Herring gull on the other hand, apart from being much less abundant overall, peak in mid-winter and early spring. A relatively high proportion of the herring gulls encountered in the concession zone appears to be immature (38%Interestingly, based on GPS data we know that herring gulls breeding in Zeebrugge and Ostend do not range that far offshore throughout the year (Vanermen *et al.* 2018). All this seems to suggest that the adult herring gulls encountered inside the Belgian OWFs most probably originate from different, more northern populations. It is thus far unknown whether the immature birds encountered have more local provenance.

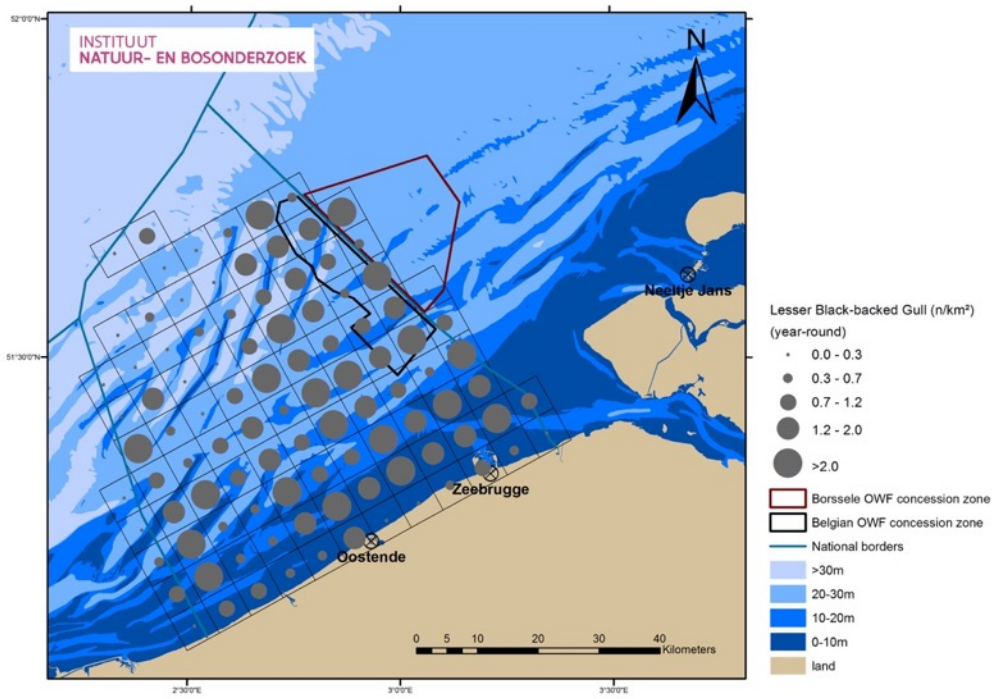

Figure 7.1 *Lesser black-backed gull distribution based on seabird at sea data collected in the period 2010-2019.*

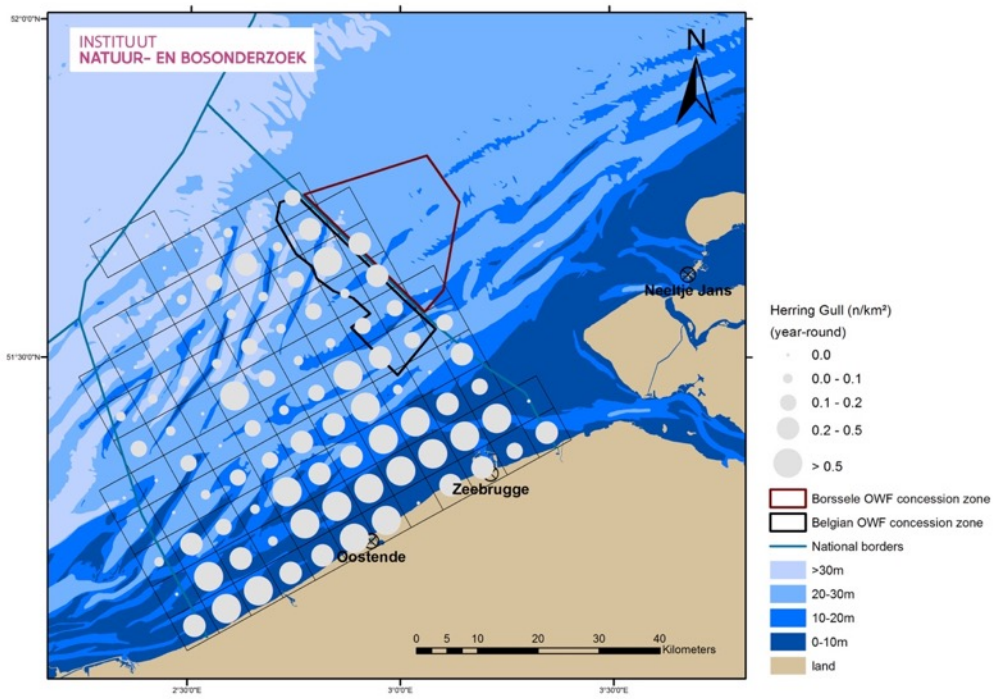

Figure 7.2 *Herring gull distribution based on seabird at sea data collected in the period 2010-2019.*

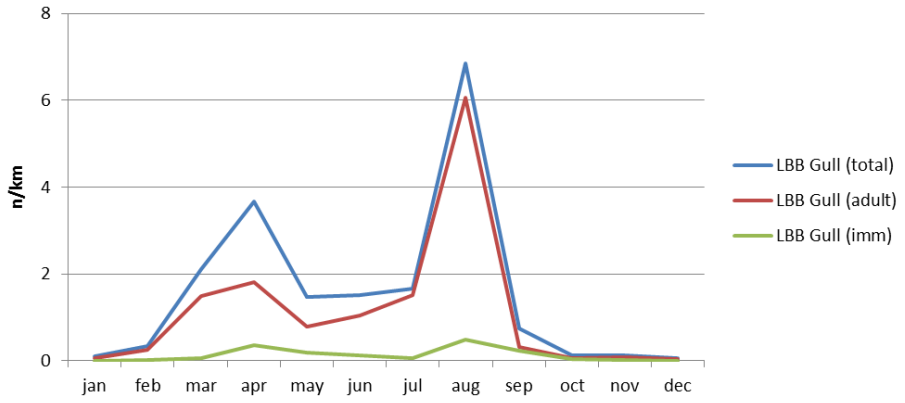

Figure 7.3 *Seasonal occurrence of lesser black-backed gull in the Belgian OWF concession zone in the period 2010-2019.*

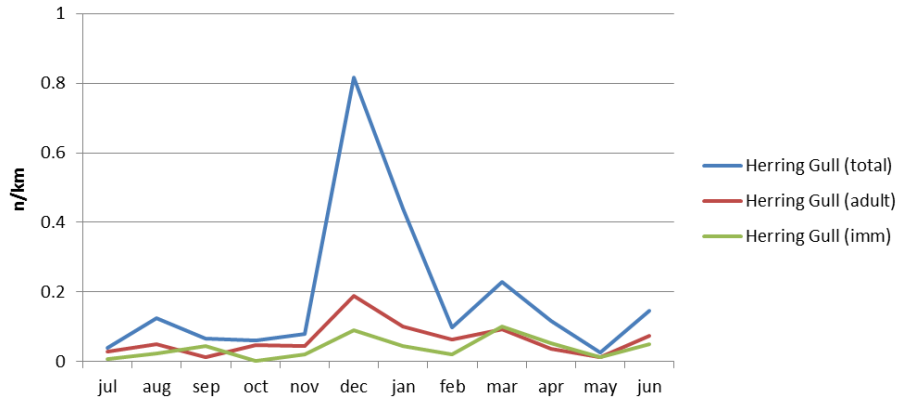

Figure 7.4 *Seasonal occurrence of herring gull in the Belgian OWF concession zone in the period 2010-2019.*

8 Conclusions and recommendations

Data collection in 2020 was executed according to plan with small additional measures to mitigate any restrictions due to Covid-19 regulations. A change of the field work protocol is not needed for the 2021 field season.

Based on the first preliminary results, it seems that during and shortly after the breeding season the distribution of herring gulls is limited to coastal and terrestrial habitats. None of the tagged birds visited the Borssele wind farm area or the operational parks in the adjacent Belgian sector in the course of the short study period between June and September 2020. This pattern is further supported by the relatively low number of adult herring gulls encountered in summer and autumn during ship-based counts performed in the Belgian concession zone. Ship-based surveys further indicate that densities of immature herring gulls were similarly low that time of year. However, during winter high numbers of herring gulls (mostly adults) were encountered in the concession zone. Most likely these individuals originate from more northern colonies wintering in the southern North Sea. Earlier GPS-tracking studies suggest that birds breeding in Ostend and Zeebrugge largely remain coastal or terrestrial throughout the year (Stienen *et al.* 2016). Therefore, we need year-round tracking data to identify whether this accounts for Neeltje Jans breeding birds as well. Currently it remains unclear where the individuals that visit the concession zones originate from and whether or this (partly) concerns Dutch breeding birds.

If year-round tracking indicates that none of the breeding birds from Neeltje Jans have an offshore distribution during any part of their annual cycle, it is questionable whether another cohort of herring gulls should be tagged within the framework of this study at Neeltje Jans in 2021. During an evaluation meeting with RWS in the coming months we will discuss this question, and need to investigate various options for next season. One of the options would be to decide to start tagging herring gulls in a different colony, or maybe to focus on tagging juveniles just before fledging. All of these options need to be discussed during the meeting to maximize the output of this study in light of the research questions in the study at hand.

In contrast to herring gull, this study thus far suggest that local lesser black-backed gulls do use the Borssele concession area as well as its Belgian counterparts. This is in accordance with GPS data from individuals tagged in Zeebrugge and Ostend (Stienen *et al.* 2016). Up to now, their distribution seems largely limited to the south-eastern parts of these areas. The presence of increased numbers in the further offshore oriented parts of the Belgian concession zones, based ship counts, was not yet supported by this study. Nevertheless, despite limited use of the Belgian and Dutch OWF concession zones, the overall distribution of the tagged lesser black-backed gulls rather corresponds to a macro-avoidance pattern.

Overall, there seems to be some discrepancy between GPS- and ship-based studies with respect to the presence, the distribution and avoidance behaviour of lesser black-backed gulls. However, we only have part of the tracking data, and perhaps during winter and per-breeding period, our perspective might change. In the far more in-depth analyses planned

for next year, we will also focus on the behavioural aspects of the tagged individuals. Since logging frequency is set at very high resolution (20 s) near the concession zones and additional data on three-dimensional acceleration and flight height are gathered, detailed information on gull behaviour and flight paths can potentially be linked to environmental characteristics, turbine presence and anthropogenic activities.

Herring gull with GPS-logger at Westduinen (Photograph R. Fijn, Bureau Waardenburg)

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