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Wild bird mortality in the Dutch Delta in 2023

The resurgence of avian influenza in breeding colonies

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Content

Summary

Highly pathogenic avian influenza (HPAI) H5N1 was detected the first time in colonies of coastal breeding birds in the Netherlands in May 2022, leading to significant mortality among tern and gull species throughout the breeding season. Following sporadic cases during the winter, H5N1 reemerged in the spring of 2023, affecting several colonies in the Dutch Delta. Once again, terns and gulls were the primary victims, with particular impact on species such as the sandwich and common terns, black-headed and Mediterranean gulls. During the breeding season, 17 413 birds were reported dead, a number similar to the 17 872 found in 2022. A significant contrast compared to the previous year was the relatively low proportion of impacted adult birds. The majority of the victims were young birds (78%), approximately three to four weeks old. The chicks were in good condition until the outbreak started. Under normal circumstances, likely they would have successfully fledged. No other significant causes of mortality were observed during the breeding season. The authors of this report conducted a sampling campaign, focusing on the most affected species as part of the 'Zoonosis Project' coordinated by the Vogeltrekstation (Dutch Centre for Avian Migration and Demography) and the Erasmus Medical Center. Monitoring of circulating variants of avian influenza in apparently healthy birds is important, even during periods with low mortality to be able to assess the risk of future outbreaks.

Mass mortality of common terns on a breeding raft, Oesterput 7 August 2022, photo: Mónika Ballmann

Introduction

Following the outbreak of HPAI H5N1 in 2022 affecting numerous breeding colonies in the Dutch Delta, the virus made a return in 2023. Deltamilieu Projecten (DMP) has been requested by the Province of Zeeland to prepare a comprehensive report by consolidating data from multiple sources on bird mortality during the period from May to September, 2023. This report provides a summary of wild bird mortalities recorded by various entities and provides an overview of the outbreak's progression in the Delta area during 2023. The Dutch Delta-area is located in the southwestern part of the Netherlands and is formed by the confluence of the Rhine, Meuse and Scheldt rivers. A few years ago, the Dutch Centre for Avian Migration and Demography, in partnership with Erasmus MC, launched the Zoonosis Project. The project's objective is to systematically monitor diseases in migratory bird species that could pose potential risks of transmission to humans. The team members of DMP participated in this initiative, contributing to the collection of samples for avian influenza surveillance, focusing on the most affected species. The efforts and initial findings are described in this report.

The content of this report

This report serves as a follow-up to the 2022 report on bird mortality in the Dutch Delta, incorporating certain sections that overlap between the two publications:

- the worldwide spread of avian influenza
- an overview of all registered mortality among waterfowl in the Dutch Delta, in the period May to September 2023, with a description of the most important species affected
- information about avian influenza monitoring in the Dutch Delta during the breeding season of 2023
- recommendations for further research

Acknowledgement

Several people have been actively involved in the removal of the victims of the avian influenza outbreak, providing guidance, or contributing in various ways throughout the outbreak in the Dutch Delta: Matthijs Broere, Roland-Jan Buijs, Andre Hannewijk, Jan Kleijer, Merijn Loeve, Marion Pross, Wouter Stempher, Fred Schenk, Ronald in 't Veld, employees of Stichting Het Zeeuwse Landschap, Brabants Landschap, Zuid-Hollands Landschap, Staatsbosbeheer, Vereniging Natuurmonumenten, Waterschap Scheldestromen, Rijkswaterstaat, Veiligheidsregio Zeeland.
The fieldwork - in addition to the authors - was carried out by Mark Hoekstein, Wendy Janse, Maarten Sluijter, Dirk van Straalen and Pim Wolf.
Many thanks to the virologists and staff at Erasmus MC for their excellent collaboration: Ron Fouchier, Beatriz Bellido Martin, Oanh Vuong, Sanne Thewessen and to the staff of the Dutch Centre for Avian Migration and Demography: Henk van der Jeugd and Natasja van Nijen.
The avian influenza sampling of large gulls was carried out in collaboration with Buijs EcoConsult.
Part of the sandwich tern sampling was carried out in collaboration with Eric Stienen, Hans Matheve, Wouter Courtens (Institute for Nature and Forest Research), Ruben Fijn and Youri van der Horst (Waardenburg Ecology).

Maarten Sluijter produced the distribution maps. Dirk van Straalen, Wendy Janse and Mayro Pattikawa provided valuable commentary on the report.

1. The global spread of HPAI H5N1

General information about HPAI, potential modes of transmission, and public health risks have been described in the previous report (Ballmann & Lilipaly, 2023) and will not be reiterated in this document.

Highly pathogenic avian influenza H5N1 emerged in 1996 on a goose farm in China, in Guangdong province. After sporadic cases, the first outbreak in wild birds occurred during the spring of 2005, leading to the death of over 6000 birds at Qinghai Lake, China, primarily impacting bar-headed geese (*Anser indicus*) (Liu et al., 2005). The Qinghai Lake is an important breeding and stopover site for migratory waterfowl. After entering the wild bird populations, HPAI H5N1 quickly reached Europe and North Africa during the autumn bird migration of 2005. Since then, the virus has been circulating among wild birds and poultry (Reperant et al., 2012).
The ongoing outbreak is attributed to one of the descendants of this HPAI H5N1: specifically, clade 2.3.4.4b. This emerging panzootic variant has resulted in the fatalities of hundreds of thousands of wild birds globally since 2021. Clade 2.3.4.4b has become widespread in Asia, Africa, Europe, and the Middle East. The virus reached Canada and the United States through migratory birds at the end of 2021 (Caliendo et al., 2022). During the subsequent migration season, the virus spread across the American continent. By October 2023, it reached Antarctica, where its presence was identified first in brown skuas (*Stercorarius antarcticus*) (Scientific Committee on Antarctic Research, 2023).

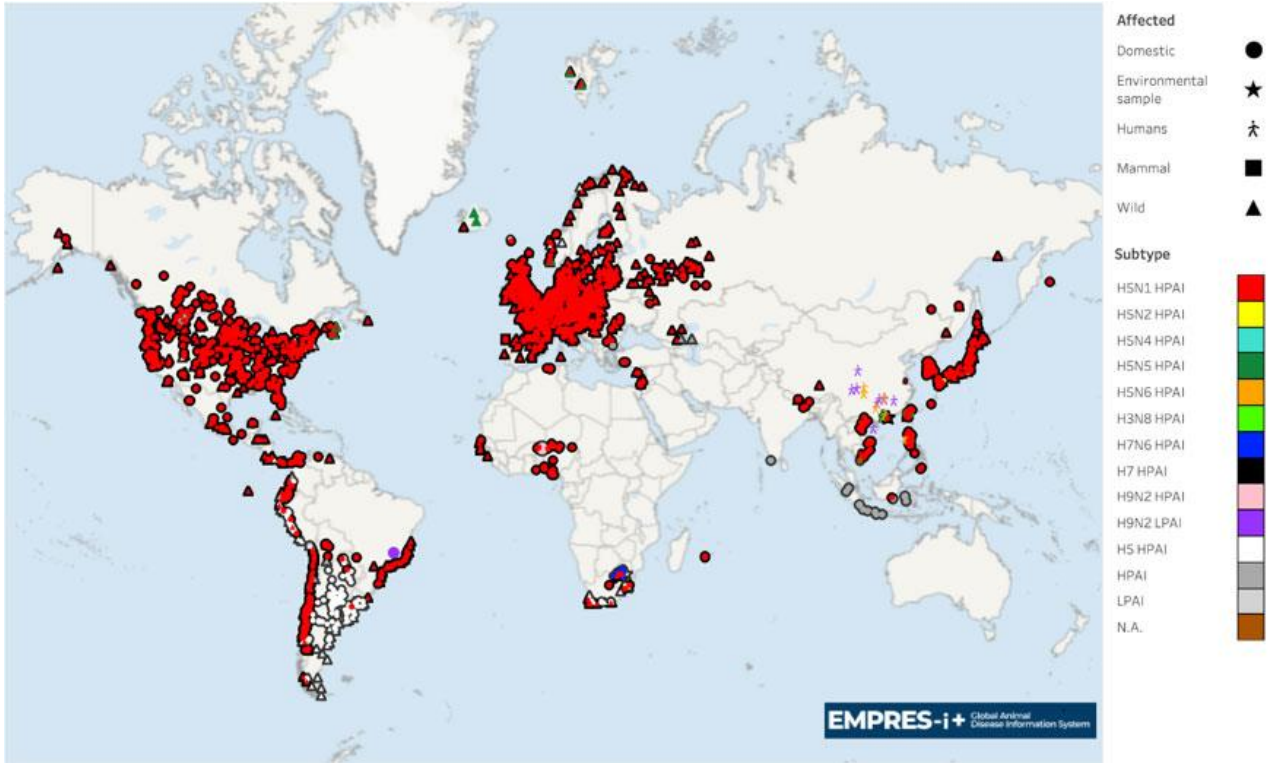

Figure 1. Global spread of AIV with zoonotic potential observed in the period October 1, 2022 to September 30, 2023. Source: Food and Agriculture Organization of the United Nations - Global Avian Influenza Viruses with Zoonotic Potential situation update - 28 December 2023

In previous years, avian influenza outbreaks in Northwestern Europe showed a seasonal pattern. Cases typically rose in October and November, reaching a peak in February, primarily impacting wintering duck and geese

populations. In 2022, for the first time, avian influenza deviated from this pattern being present during the breeding season in the Northern Hemisphere (Figure 2). The outbreak resulted in mass mortality among several species of colonial birds, and led to very low breeding success.

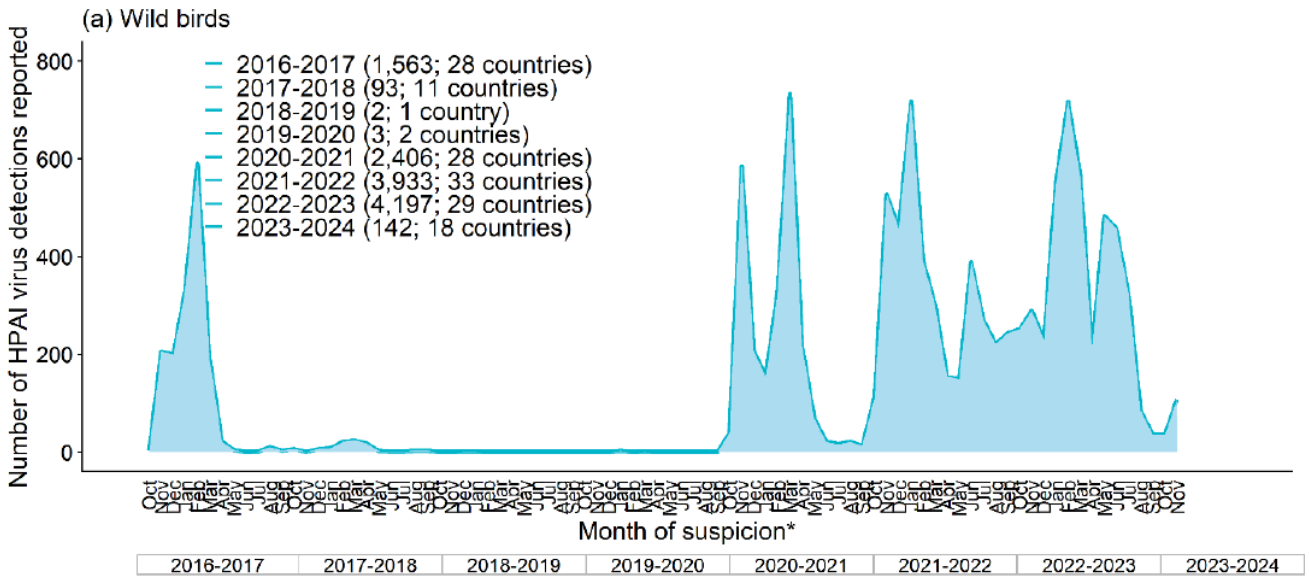

Figure 2. Distribution of the number of HPAI virus detections in wild birds reported in Europe in the epidemiological years 2016-2022/2023, by month of suspicion, from October 1, 2016 to April 28, 2023 (17 626) Source: Adlhoch et al., 2023. Avian influenza overview March – April 2023. EFSA Journal. 21. 10.2903/j.efsa.2023.8039.

Until 2021, HPAI H5Nx had been identified in 227 wild bird species worldwide. However, since then, this number has more than doubled and currently stands at 502. Despite mammals being less susceptible to HPAI, the number of affected species has almost tripled since 2021, reaching 61 species (FAO situation updates, 28 December 2023). Beyond its impact on wildlife populations, the increased number of affected species raises concerns about the potential emergence of new variants, and as such increasing the risk of potential transmission to human.

2. Materials and methods

Colony monitoring and cooperation

Visits to colonies were often conducted as part of other ongoing coastal breeding birdmonitoring projects (such as the ones commissioned by Rijkswaterstaat Centrale Informatie Voorziening) or regular visits within the context of breeding success research commissioned by the Province of Zeeland and Zuid-Holland. Staatsbosbeheer requested DMP to clear avian influenza victims in their areas of operation in the Haringvliet and Grevelingen. Natuurmonumenten gave a similar assignment for their areas in Zeeland. Additionally, Staatsbosbeheer employees cleared carcasses in several areas in Zeeuws-Vlaanderen, including the major outbreaks in the Autrichepolder and the Margarethapolder. Employees of Stichting Het Zeeuwse Landschap cleared avian influenza victims in their areas in Zeeuws-Vlaanderen and Zuid-Beveland (Waterdunen, Nummer Een, Koude & Kaarspolder, Sophiapolder, Blikken). Part of the avian influenza sampling and the compilation of this report was funded by the Province of Zeeland.

Fieldwork and safety measures

Handling potentially avian influenza infected carcasses or live birds requires comprehensive safety measures to avoid personal infection and prevent further spread of the virus. Safety protocols were implemented each time when entering breeding colonies where the potential presence of avian influenza was suspected. The safety measures implemented and the method of carcass disposal have been detailed in a previous report (Ballmann & Lilipaly, 2023). The removal of bird carcasses in the colonies involved the use of comprehensive personal protective equipment, including biohazard suits (covering the body, arms, and legs) disposable coveralls, gloves, safety glasses, FFP2 face masks, and plastic boot covers. Except for safety goggles, all the mentioned items were placed in garbage bags and transported to the nearest hazardous waste collection center along with the carcasses. Non-disposable items, such as binoculars, pens, telephones and tools, underwent thorough cleaning and disinfection to prevent cross-contamination in other colonies. For disinfection purposes, Virkon was dissolved in a bucket of water (1% solution for washing boots) or used in a spray bottle to disinfect gloves and tools. Carcasses were placed in three layers of garbage bags, using clean gloves for handling the outermost bag to minimize exposure to the virus. Hands were cleaned using a skin-friendly disinfectant.

Sample collection for avian influenza surveillance

To monitor the presence of HPAI and to estimate the percentage of wild birds developing antibodies in response to the infection with avian influenza, apparently healthy individuals of the most affected species were captured and sampled. Additionally, sick and dead birds were occasionally tested for avian influenza (Table 1).

Table 1. Number of birds sampled per species (adult includes subadult)

Species	Healthy		Sick	Dead	Total
	Adult	Juvenile			
Great cormorant	0	0	0	1	1
Common ringed plover	3	0	0	0	3
Little tern	18	1	0	0	19
Sandwich tern	105*	121	8	6	240
Greater black-backed gull	1	0	0	2	3
Lesser black-backed gull	41	0	0	3	44
Pied avocet	6	1	0	0	7
Mute swan	0	0	0	1	1
Black-headed gull	0	16	0	3	19
Gadwall	0	0	0	1	1
Arctic tern	5	0	0	0	5
Oystercatcher	2	0	0	0	2
Eurasian wigeon	0	0	0	1	1
Kentish plover	2	0	0	0	2
Common tern	47	19	3	1	70
White-tailed eagle	0	7	0	0	7
Herring gull	32	0	0	4	36
Grey plover	0	0	1	0	1
Mediterranean gull	5	11	3	1	20
Total	**267**	**176**	**15**	**24**	**482**

** including 60 adult birds sampled in Zeebrugge*

Adult birds were captured on the nest using walk-in traps near the end of the incubation period to minimize the risk of nest abandonment due to disturbance. Chicks were caught by hand. To prevent virus transmission the birds were handled individually, and both hands and tools were disinfected after each handling. At the time of the outbreak, chicks were no longer collected in crates, but were collected and handled one by one. Ringers wore personal protective equipment during sample collection in impacted colonies. Throat and cloacal swabs were obtained to detect active viral infections in the birds (those carrying and shedding the virus). Blood samples were taken to monitor seroprevalence in the population, indicating how many individuals carry antibodies against avian influenza. Trained ringers from DMP collected blood samples from the brachial vein of the birds (under the wing) using a syringe. After coagulation the serum was separated by centrifugation. The samples were kept cool during transport and sent to Erasmus MC for analysis. Additionally, each sampled individual received a colour ring for long-term traceability.

Blood collection from the brachial vein of a sandwich tern chick – 24 June 2024, Bliek, photo: Pim Wolf

3. Results

Between the end of February and the end of August a total of 17 413 dead birds were registered and collected. Small dead chicks (< two weeks old) were not included in the counts as due to natural mortality the majority of the hatched chicks die in this period in most of the involved species (terns and gulls).
The peak of the outbreak occurred more than two weeks later than in 2022. After the breeding season around mid-July, the number of birds found dead decreased rapidly (figure 3). The most affected species were the black-headed gull, mediterranean gull, sandwich tern and common tern (table 2). A significant difference compared to 2022 was that the majority of the carcasses found were chicks of three or four weeks old, an age at which they usually fledge. Losses in the adult population of black-headed gulls, mediterranean gulls and common terns were also high. In contrast to the mass mortality of sandwich terns in 2022, 'only' 91 adult individuals were found dead this year.

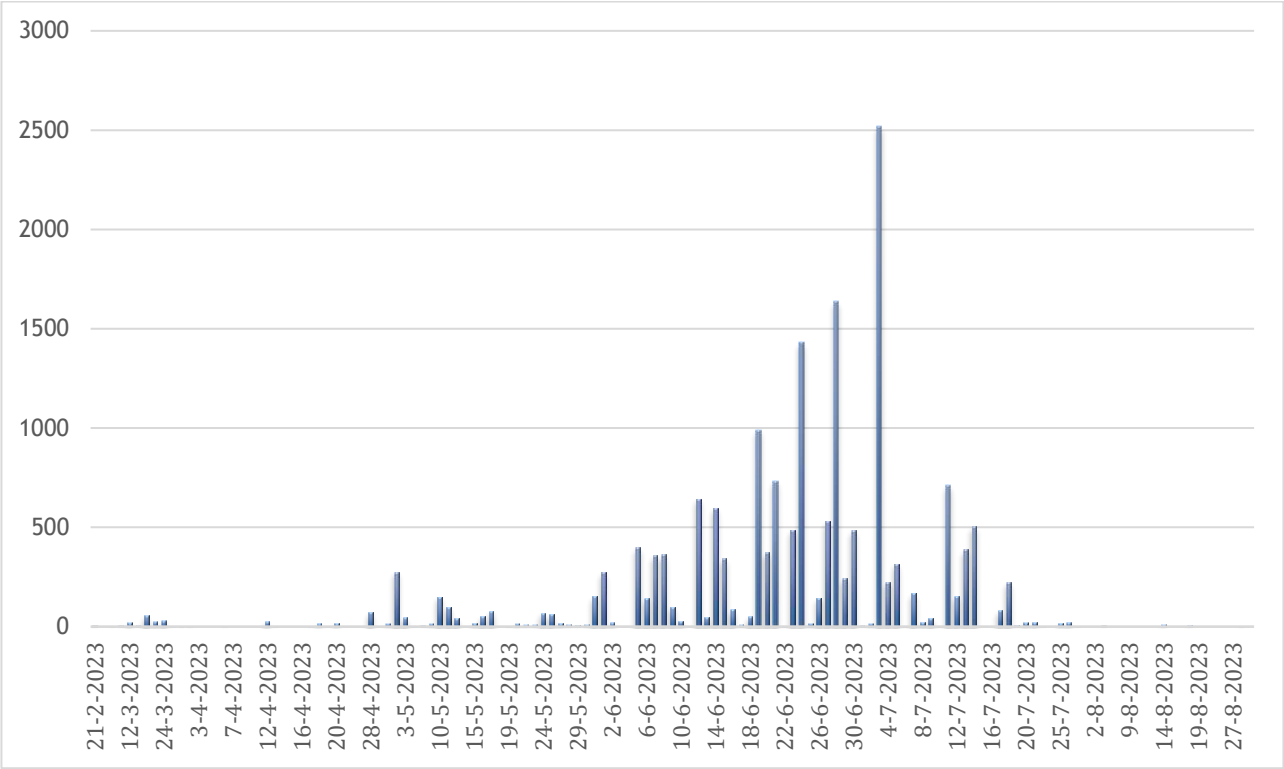

Figure 3. Total number of dead birds found per day

Table 2. Number of birds found per species (adult includes subadult)

Species	Adult	Juvenile	Age unknown	Total
Black-headed gull	2466	9480	19	**11965**
Mediterranean gull	416	1728	2	**2146**
Common tern	309	1092	25	**1426**
Sandwich tern	91	1195		**1286**
Lesser black-backed gull	50	189	1	**240**
Herring gull	71	31	8	**110**
Common shelduck	26	10		**36**
Barnacle goose	32	3		**35**
Oystercatcher	7	1	9	**17**
Pied avocet	3	9	4	**16**
Mute swan	6		9	**15**
Greater black-backed gull	11			**11**
Gadwall	8		3	**11**
Common coot	3	1	6	**10**
Common gull	6	4		**10**
Greylag goose	6	3		**9**
Great egret	8			**8**
Undetermined	6		1	**7**
Northern gannet	6			**6**
Northern lapwing	4	1	1	**6**
Mallard	2		3	**5**
Little egret	1		3	**4**
Tufted duck	2		2	**4**
Common redshank	2		2	**4**
Ruff	4			**4**
Eurasian spoonbill	3			**3**
Great cormorant	1		1	**2**
Dunlin	2			**2**
Little tern	2			**2**
Eurasian wigeon	1		1	**2**
Eurasian curlew	2			**2**
Grey plover	1			**1**
Canadian goose	1			**1**
Jackdaw			1	**1**
Egyptian goose			1	**1**
Bar-tailed godwit	1			**1**
Brent goose	1			**1**
Northern shoveler	1			**1**
Eurasian teal	1			**1**
Common scoter	1			**1**

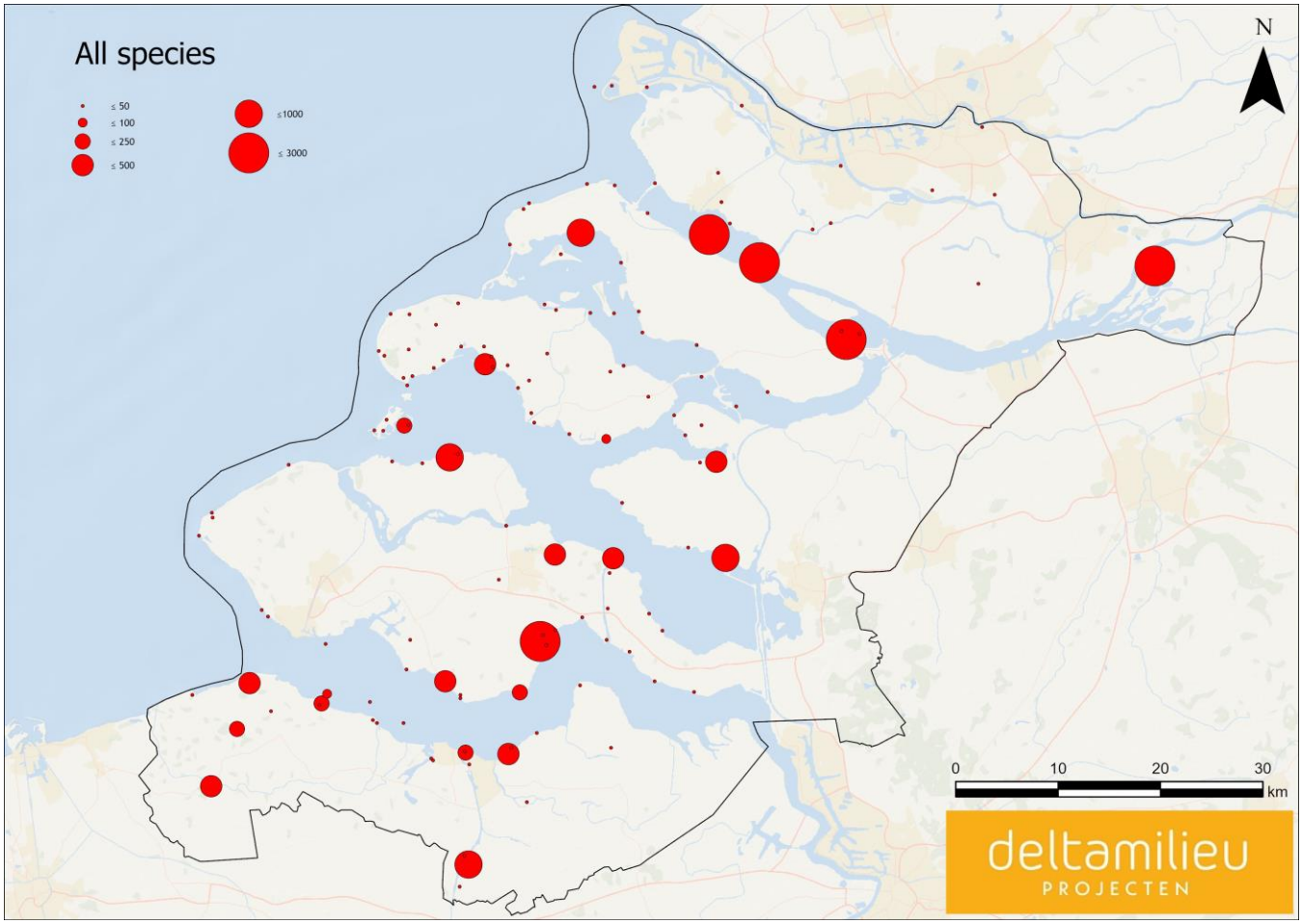

Figure 4. Overview of locations where dead birds were found in the Dutch Delta in the period between February and August 2023.

Highlighted species

Black-headed gull

Breeding population NL: 100 000 - 107 000 (2020), Delta area 23 000 (2023)
Conservation objective for Delta area: na
Red list: no
Ramsar 1% norm: 29 200

The black-headed gull is common throughout the year as a breeding and wintering bird in the Dutch Delta. In the Netherlands, the breeding population has decreased significantly since 1990 Kokmeeuw | Sovon Vogelonderzoek. In the Delta, a similar trend was observed, with a significant decrease in the 1990s. However, since the beginning of the 21st century, the number of breeding pairs has remained stable, with a slight increase starting from 2018 (Lilipaly & Sluijter, 2022). The long-term trend of the black-headed gull population wintering in the Netherlands is stable (Sovon.nl). Several avian influenza outbreaks were reported during the winter of 2022/2023 (Update kokmeeuwen sterfte | Dutch Wildlife Health Centre (DWHC)). Most breeding colonies are occupied in March and April, and many colonies encountered HPAI H5N1 outbreaks early in the season. The disposal of carcasses in these colonies was primarily handled by contractors and local rangers. In some areas outside the Delta, bird species were not identified, exact counts are unavailable, and birds were not checked for the presence of rings.

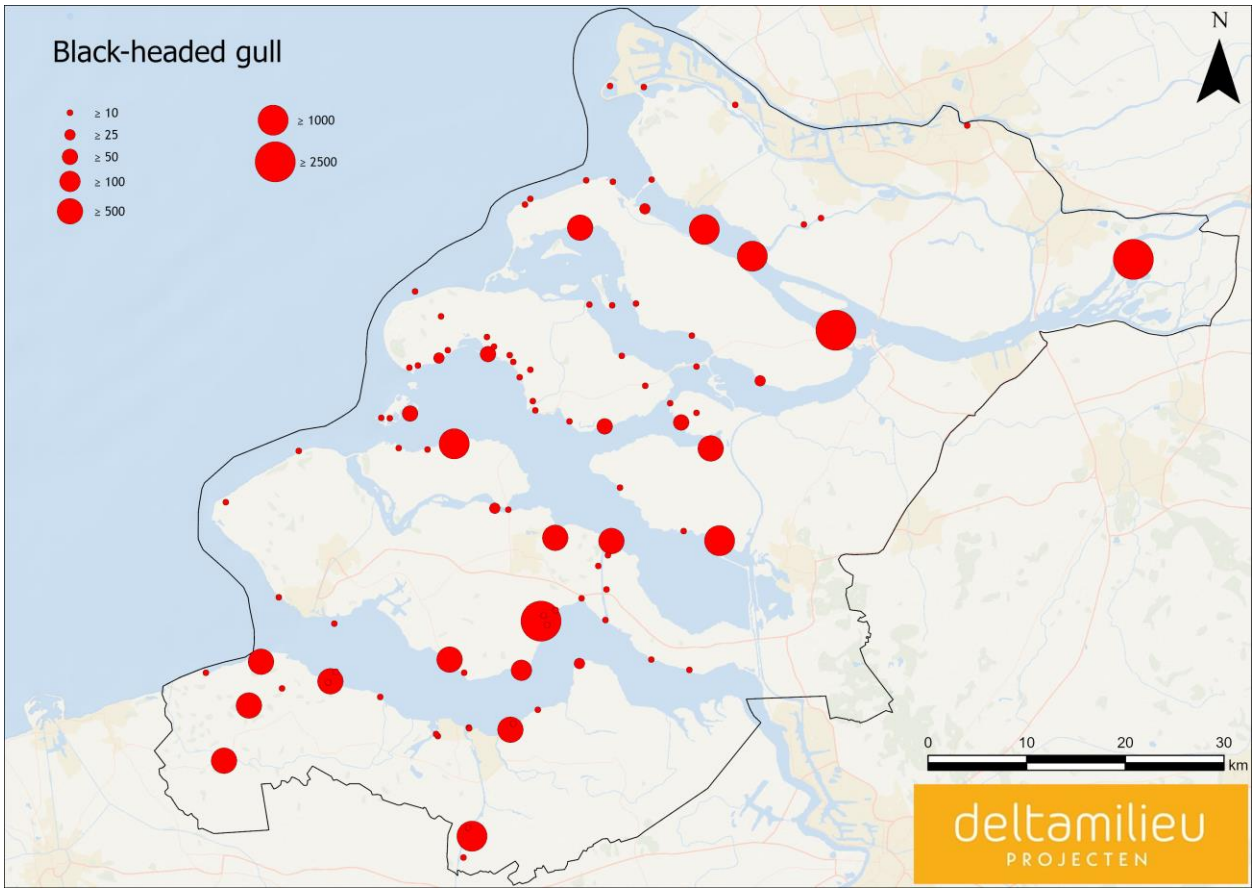

Figure 5. Locations where dead black-headed gulls were found between February and August 2023.

In the Delta, the first dead black-headed gulls were found in the breeding colonies at the end of February. In March and April, several hundred adult black-headed gulls were cleared from the Sophiapolder near Oostburg

and the Autrichepolder near Westdorpe. Part of the local breeding population had died before the breeding season started. The mortality during these months was primarily concentrated in Zeeuws-Vlaanderen. From the beginning of May, increased mortality in adult birds was reported across the entire Delta. The colonies that experienced their first major outbreak in 2023 were hit the hardest. This includes the previously mentioned colonies in Zeeuws-Vlaanderen, as well as the Hoedekenskerkepolder (with 273 dead adult black-headed gulls) and particularly Polder Hardenhoek in the Brabantse Biesbosch (with 624 adult individuals). In other areas, the mortality rate in adult birds was relatively low. For instance, only 21 and 39 adult black-headed gulls were found on Slijkplaat and Bliek (out of 2688 and 635 breeding pairs, respectively), despite the virus being prevalent among chicks in these areas in 2023. It is likely that many adult birds in these colonies had antibodies against the virus due to the outbreak that occurred in 2022 at these locations, but further research is needed to confirm this theory.

Table 3. Mortality in a selection of black-headed gull colonies in the Delta in 2023

Colony	Breeding pairs	Fledged chicks	Breeding success	Dead adults	Dead chicks	Chick mortality*
Haringvliet, Bliek	635	0	0	39	676	100%
Haringvliet, Slijkplaat	2688	650	0,24	21	959	60%
Haringvliet, Ventjagersplaten	1562	225	0,14	43	1221	84%
Yerseke, Inlaag Kaarspolder	1577	400	0,25	39	276	41%
Markenje	1221	520	0,43	22	188	27%
Biesbosch Hardenhoek	2460	962	0,39	624	1928	67%
Prunje Noord	1289	540	0,42	6	3	1%
Neeltje Jans	83	42	0,51	2	35	45%
's-Gravenhoek Inlaag	694	14	0,02	60	601	98%
Westdorpe, Autrichepolder	473	34	0,07	471	165	83%
Hoedekenskerkepolder	756	22	0,03	273	1587	99%
Margarethapolder	169	66	0,39	23	293	82%
Sophiapolder	265	0	0	144	139	100%
Schakerloopolder	1333	125	0,09	49	508	80%

** Chicks younger than 20 days old are excluded as they often experience natural mortality in the first two weeks even in normal circumstances.*

In 2023, a total of 2466 dead adult black-headed gulls were removed from all breeding colonies. Assuming a breeding population of 46 000 breeding pairs, at least 5.3% of the breeding population is estimated to have been killed by avian influenza in a single year. In typical years, approximately 40 to 60 dead adult black-headed gulls are found during colony visits throughout the Dutch Delta (DMP archive).
In colonies where the virus was present, chick mortality was generally very high, ranging from 80% to 100%. In colonies with lower mortality, a considerable number of chicks had already fledged before the virus became widespread, as observed on Markenje, Kaarspolder, and Neeltje Jans. This explains the relatively lower mortality in those colonies. However, the long-term survival of these fledged young birds is uncertain, as they may have died elsewhere after fledging.

A total of 9480 dead black-headed gull chicks were registered and collected. Notably large, almost-fledged chicks of around three to four weeks old were found in otherwise good physical condition (not thin) dying from the disease. In years without avian influenza, the majority of these young birds would have been likely fledged. Certain colonies were heavily affected by avian influenza, such as Slijkplaat and Hardenhoek, still several hundred young birds successfully fledged. Across the entire Dutch Delta, 5687 fledged black-headed gulls were registered in 2023 in 61 out of the 87 breeding colonies of black-headed gulls. This averages to approximately 0,26 young per breeding pair. In usual years, the breeding success in the Delta tends to remain stable at around 0,4 young per pair (Figure 6).

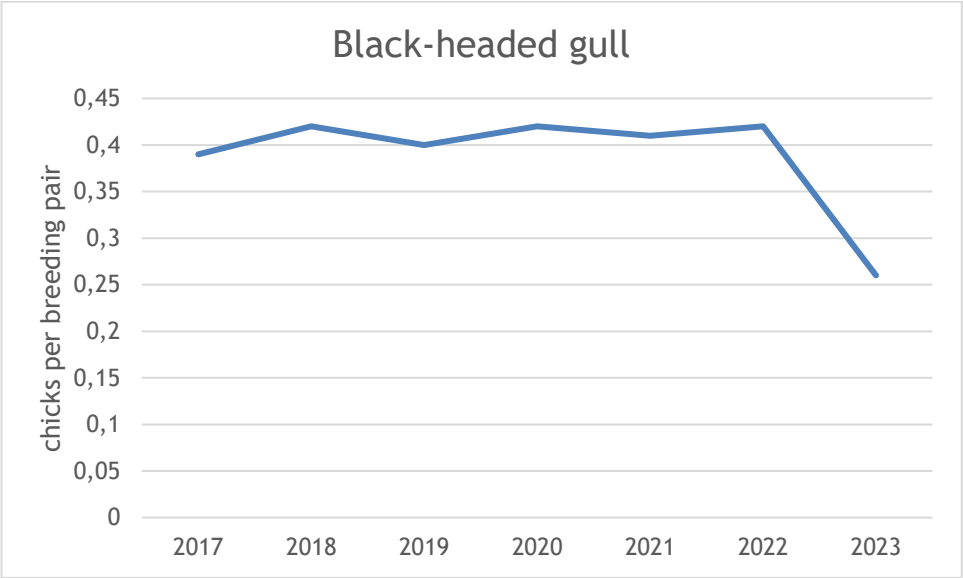

Figure 6. Average breeding success of black-headed gulls in the Delta 2017 to 2023.

Mediterranean gull

Breeding population NL: 3200 - 6700 (2022), Delta area 5895 (2023)
Conservation objective for Delta area: na
Red list: no
Ramsar 1% norm: 2400

The Mediterranean gull has become a distinctive breeding bird in the Dutch Delta, showing a positive trend. The population has been on the rise, although there are variations between years. This species displays low colony loyalty and often settles in a location shortly before egg laying. After low numbers of breeding birds in the Delta in 2022, a new peak of 5895 pairs was reached in 2023. The largest colonies are located in the northern Delta and in Zeeuws-Vlaanderen.

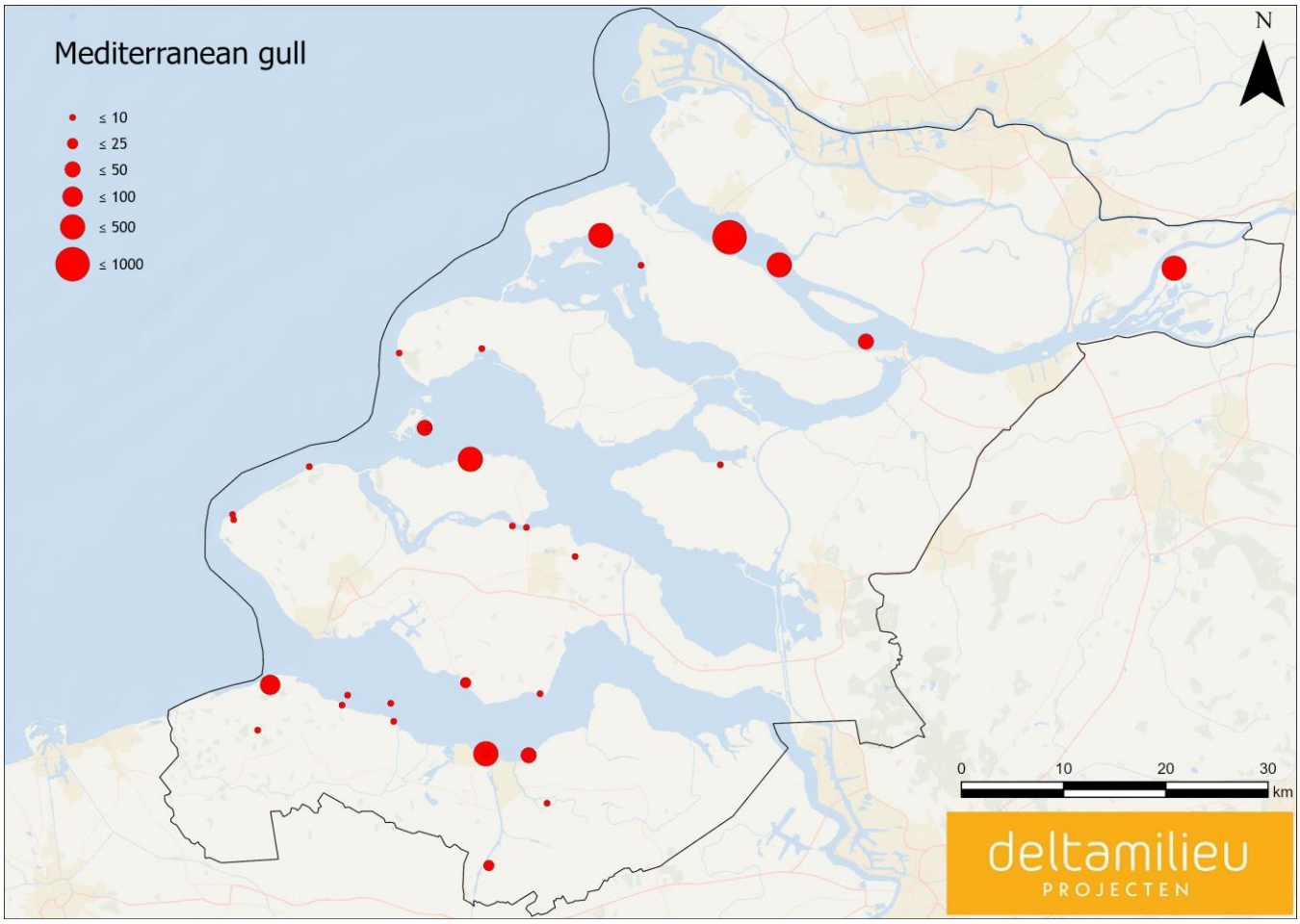

Figure 7. Locations where dead Mediterranean gulls were found between February and August 2023.

In 2022, 'only' 43 Mediterranean gulls were found dead, while in 2023 this increased to a number of 2146 registered individuals. Categorized by age, there were 416 adult birds and 1728 juvenile birds (table 2). A relatively high number of dead adult Mediterranean gulls were found in Polder Hardenhoek (129) and Waterdunen (81). The distribution was different for young birds, with a significant number of dead chicks found on Slijkplaat (989), Bliek (179) and Markenje (181). Unfortunately, there is no available mortality data for the largest colony in the Delta, situated on the Hooge Springer in the Western Scheldt.

Table 4. Mortality in a selection of Mediterranean gull colonies in the Delta in 2023.

Colony	Breeding pairs	Fledged chicks	Breeding success	Dead adults	Dead chicks	Chick mortality*
Haringvliet, Bliek	193	0	0	26	179	100%
Haringvliet, Slijkplaat	1247	500	0,40	16	989	66%
Biesbosch, Hardenhoek	340	196	0,58	129	8	4%
Terneuzen, Merel	99	0	0	8	126	100%
Hoofdplaat, Nummer Een	26	7	0,27	3	2	22%
Neeltje Jans	61	20	0,33	5	40	67%
's-Gravenhoek Inlaag	316	7	0,02	45	150	96%
Markenje	748	490	0,66	36	181	27%
Hooge Springer	2050	600	0,29	?	?	?
Waterdunen	226	53	0,23	81	0	0%

** Chicks younger than 20 days old are excluded as they often experience natural mortality in the first two weeks even in normal circumstances.*

Drone image of breeding raft 'Merel' near Terneuzen with dozens of dead Mediterranean gulls, 18 July 2023, photo: Maarten Sluijter

The mortality of adult Mediterranean gulls was at least 3,5% of the breeding population in 2023. As mortality data is not available for all colonies and it is not known how many individuals died outside of the colony this

number is likely an underestimation. A large number of young Mediterranean gulls died of avian influenza. A total of 1728 chicks were found dead and just like the black-headed gulls, mainly the three to four weeks old age group was impacted. These are significant losses since a large part of the Western European Mediterranean gull population breeds in the Dutch Delta. In some colonies relatively many young fledged thanks to the good food availability in 2023. The average breeding success in the entire Delta was 0,43 young per pair. This number is lower than the long-term average of 0,61 young per pair, but is higher than the breeding success in 2022 (figure 8). That year, due to flooding and drought, hardly any Mediterranean gulls fledged (Lilipaly et al., 2023).

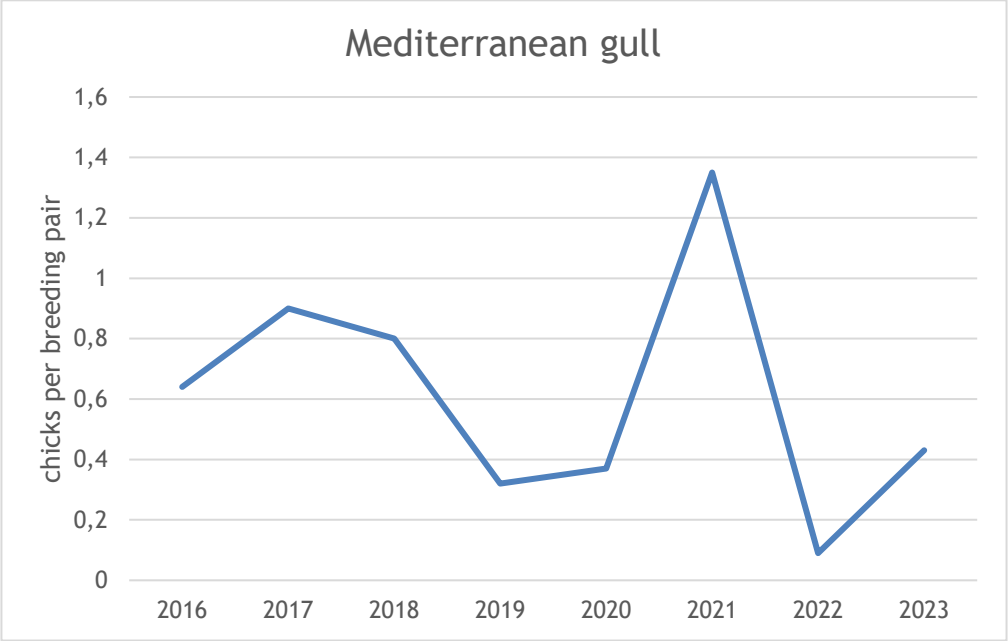

Figure 8. Average breeding success of the Mediterranean gull in the Delta from 2016 to 2023.

Lesser black-backed gull

Breeding population NL: 75 000 - 90 000 (2019), Delta area 30 684 (2023)
Conservation objective for Delta area: na
Red list: no
Ramsar 1% norm: 5800

The population of lesser black-backed gull has declined relatively sharply in the Dutch Delta over a short timeframe. The species increased in numbers in the 1990s, reaching a peak in 2010 (46 535 pairs). In the following seasons there was a gradual decline, but the number of breeding pairs remained at a high level with an average of more than 39 000 pairs in the years between 2017 and 2021. Due to combination of environmental pressure factors (foxes in several large colonies, poor food availability due to drought, the legal collection of eggs in harbours throughout several years and the increasing development of fallow fields in industrial areas where large numbers of gulls breed), the number of breeding pairs decreased rapidly in 2022 and 2023. In 2023, 30 684 breeding pairs were counted.

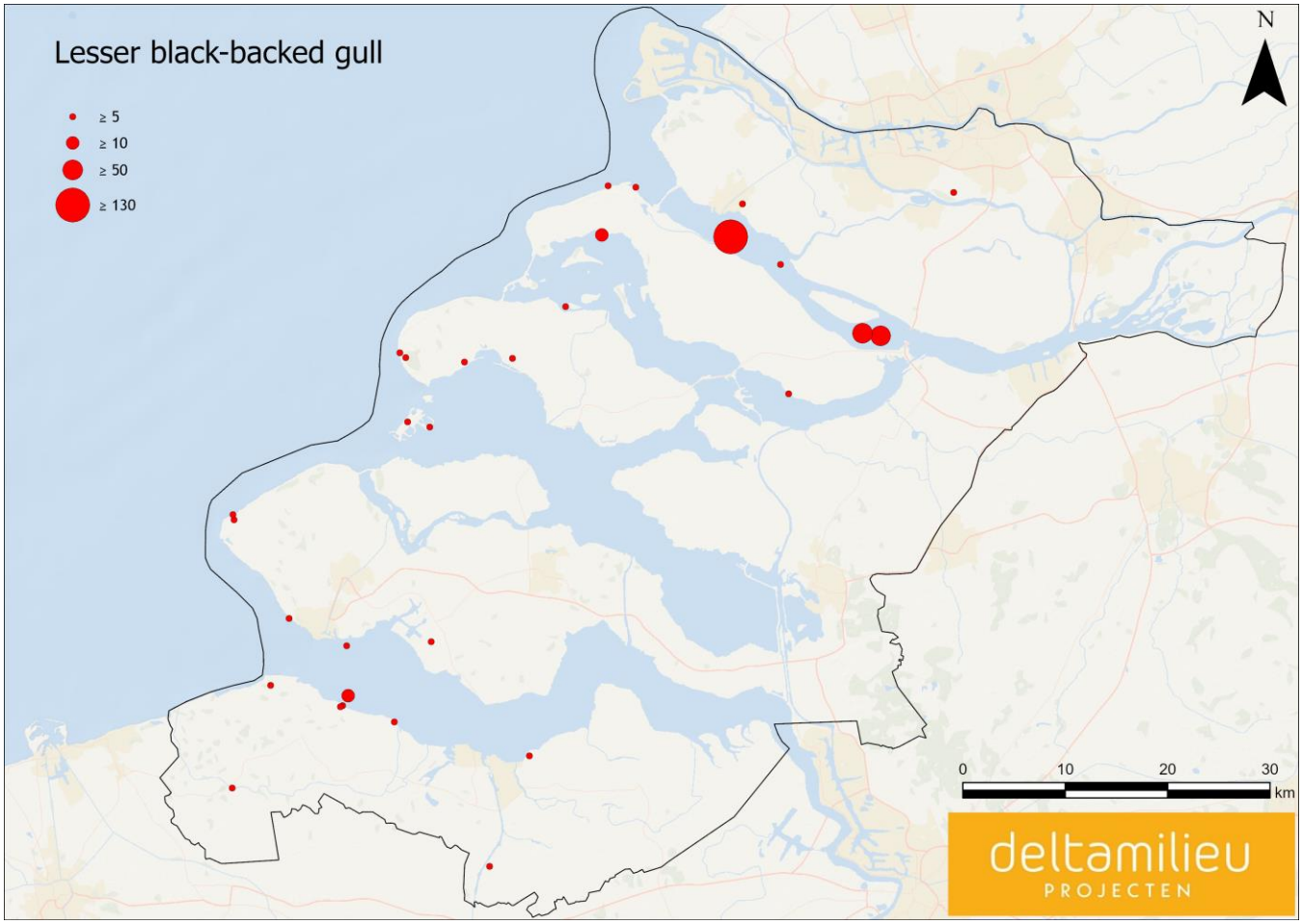

Figure 9. Locations where dead lesser black-backed gulls were found between February and August 2023.

A total of 240 lesser black-backed gulls were found dead between May and August in 2023, which is a relatively low number, but more chicks died compared to 2022 (189). Mortality was mainly observed at locations where lesser black-backed gulls were breeding in the close proximity of black-headed gull colonies. Most dead birds were found on the Slijkplaat and the Ventjagersplaten, where black-headed gulls also breed in large numbers and which were heavily impacted by avian influenza in 2023. A possible explanation is that sick/infected chicks of black-headed gulls could serve as food source for nearby breeding large gulls and thus increased their risk of virus exposure. In the other large colonies of lesser black-backed gulls (Maasvlakte, Europoort, Sasseplaat, Veermansplaten, Ouwerkerk, Neeltje Jans, Hooge Platen, Spuitkop) no increased mortality due to avian influenza was recorded. In almost all cases chicks near the age of fledging were the primary victims, similarly to all other impacted species in 2023. Out of the total number of fledged young in the Dutch Delta <1% died due to avian influenza. However high mortality was observed locally in some colonies, the overall effect of avian influenza on the lesser black-backed gull population of the Dutch Delta is currently minor.

Sandwich tern

Breeding population NL: 15 200-19 500 (2020-2022), Delta area: 4281 (2023)
Conservation objective for Delta area: 6200
Red list: yes (category vulnerable)
Ramsar 1% norm: 1700

After the catastrophic collapse of the sandwich tern population in the 1960s (a decline from 30 000 pairs to just 875 pairs in the Netherlands) the species showed a slow recovery. Numbers stabilized around the turn of the century and since then the breeding population has fluctuated between 15 000 and 20 000 breeding pairs. Until 2022, there were approximately ten colonies along the Dutch coast and in the period between 2018 and 2022, 27 - 61% of the Dutch population bred in the Delta.

During the 2022 HPAI H5N1 outbreak, more than 9500 adult sandwich terns were recorded dead and collected in the Netherlands, corresponding to > 22% of the Dutch breeding population. Out of these, 4728 dead individuals were found in the Delta. The 70-80% decline of the species during autumn migration counts along the Dutch coast suggested an even greater loss than the estimates based on the recorded deaths (www.trektellen.nl). Survivors which fled the affected colonies settled late in the season (July) at two new locations, one in Zeebrugge (Belgium) near the Dutch Delta and one on Texel at the Prins Hendrikzanddijk. The breeding success in these colonies was 0,65 and 0,5 young per pair respectively (personal communication E. Stienen, M. Leopold).

Sandwich terns migrate southwards in September - October and spend the winter along the African coastline, from Mauritania to South Africa. Due to limited surveillance on the African continent, little information was available on the epidemiological situation in the wintering area. In March 2023, an outbreak of HPAI H5N1 was reported from Senegal. Later in April, the authors of this report witnessed an outbreak in The Gambia. The total of 10 500 registered victims in these two countries is likely an underestimation due to the vast area and limited resources available to manage and assess such an outbreak (Dembo Jatta, KBO, The Gambia, personal communication). Mainly West African crested terns (*Thalasseus albididorsalis*) and Caspian terns (*Hydroprogne caspia*) were affected; Sandwich terns accounted for 5% of the total mortality (personal communication, Dembo Jatta, KBO).

Table 5. Mortality in Sandwich tern colonies in the Delta in 2023.

Colony	Breeding pairs	Fledged chicks	Breeding success	Dead adults	Dead chicks	Chick mortality*
Haringvliet, Bliek	2989	600	0,20	33	1167	66%
Haringvliet, Slijkplaat	186	60	0,32	8	12	17%
Yerseke, Inlaag Kaarspolder	82	30	0,37	0	0	0%
Hoofdplaat, Nummer Een	42	35	0,83	5	6	15%
Hooge Platen	980	0	0,00	8	6	100%
's-Gravenhoek Inlaag	2	0	0,00	0	2	100%
Buiten actieve kolonies	NA	NA	NA	37	2	NA
Total	4281	725	0,17	91	1195	62%

** Chicks younger than 20 days old are excluded as they often experience natural mortality in the first two weeks even in normal circumstances.*

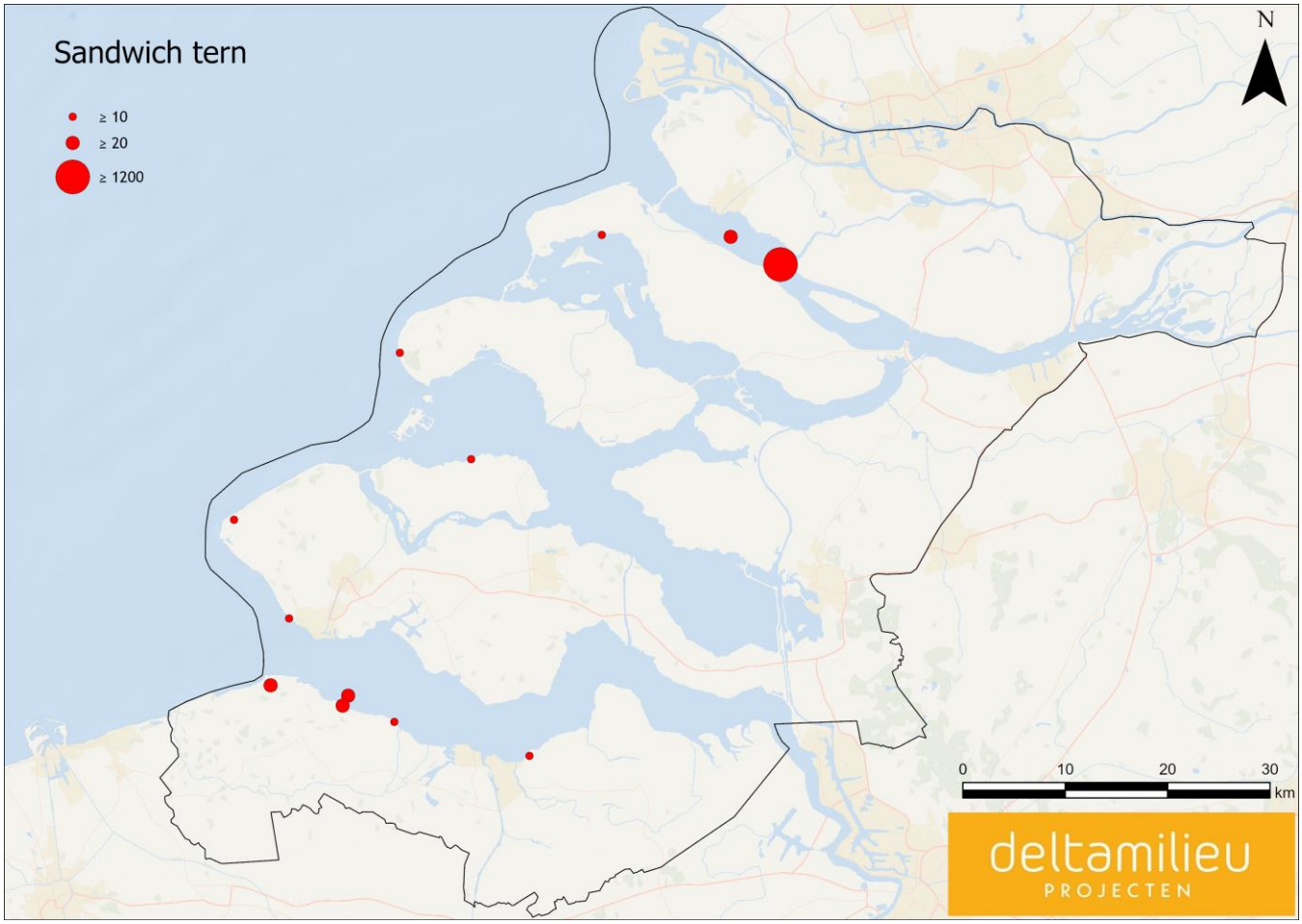

Figure 10. Locations where dead Sandwich terns were found between May and August 2023.

Migration counts (www.trektellen.nl) showed a low number of returning sandwich terns in April, but in May – relative to the estimated losses - large numbers of breeding pairs settled in the Dutch and Belgian colonies, a total of 15 128 pairs. The most populous colonies were those in Zeebrugge, Belgium (4679 breeding pairs) and Texel, Prins Hendrikzanddijk (4021 breeding pairs). In the Delta, Bliek had the largest colony with 2989 breeding pairs. A year after the mass mortality, the high number of returning birds may be explained by recruitment from other, less affected colonies in Northwestern Europe. Another possible explanation is that a large number of "floaters" (not settled, usually young adults) joined the colonies in 2023. In the period between 2019 and 2021 high breeding success was observed (0,7-0,9 young per pair, Figure 11), and these young adults returned to the breeding areas for the first time in 2023. They occupied nest sites vacated by older, experienced birds that died during the 2022 outbreak. Both hypotheses are being investigated through the analysis of observations of colour-ringed individuals and will be published in a scientific journal.

Initially, the breeding season for the sandwich terns was promising. Adult mortality remained relatively low, large numbers of chicks hatched in early June and the food availability was favourable. However, unfortunately during the fledging period, the outbreak still struck among the sandwich tern chicks, resulting in mass mortality. From the beginning of the outbreak, carcasses were removed from the colonies regularly (every four days). The colony at Hooge Platen failed due to flooding. The average breeding success in the Dutch Delta due to high chick mortality caused by avian influenza (and flooding in one colony) was around 0,17 chicks per breeding pair which

is far not sufficient to maintain the population at the current levels, let alone to recover from losses of adult sandwich terns in the 2022 mass mortality event.

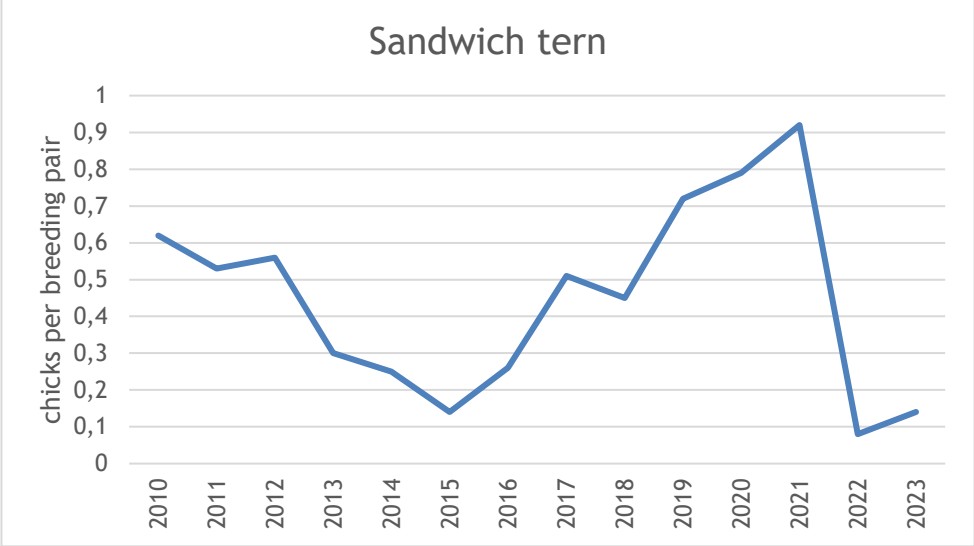

Figure 11. Average breeding success of the Sandwich tern in the Delta from 2010 to 2023

Common tern

Breeding population NL: 13 000-16 750 (2020-2022), Delta area: 5151 (2023)
Conservation objective for Delta area: 6500
Red list: yes (category vulnerable)
Ramsar 1% norm: 14 100

In the Netherlands, 13 000-16 750 pairs of common terns breed annually. In the Delta, the breeding population between 2018 and 2022 consisted of an average of 5234 pairs, which corresponds to approximately 38% of the Dutch population. Unlike the sandwich terns, the common terns are not limited to coastal areas; they also breed far from the sea, usually on islands on rivers and freshwater lakes. In 2022, the coastal colonies were heavily hit by avian influenza, while inland colonies were mostly spared. Worst impacted were the common tern colonies on the artificial breeding rafts, while the natural breeding islands appeared to be less affected. The observed difference in impact was attributed to a slightly different breeding behavior of common terns in these two habitat types. On rafts, the density of common tern nests is generally higher and they also breed in close proximity of other species (gulls); an ideal environment for efficient virus transmission. On natural islands, common terns breed further away from each other and from other species. However, the difference between the two habitat types did not appear to influence the impact of avian influenza in 2023; a large number of birds died in both types of breeding habitat (Table 6).

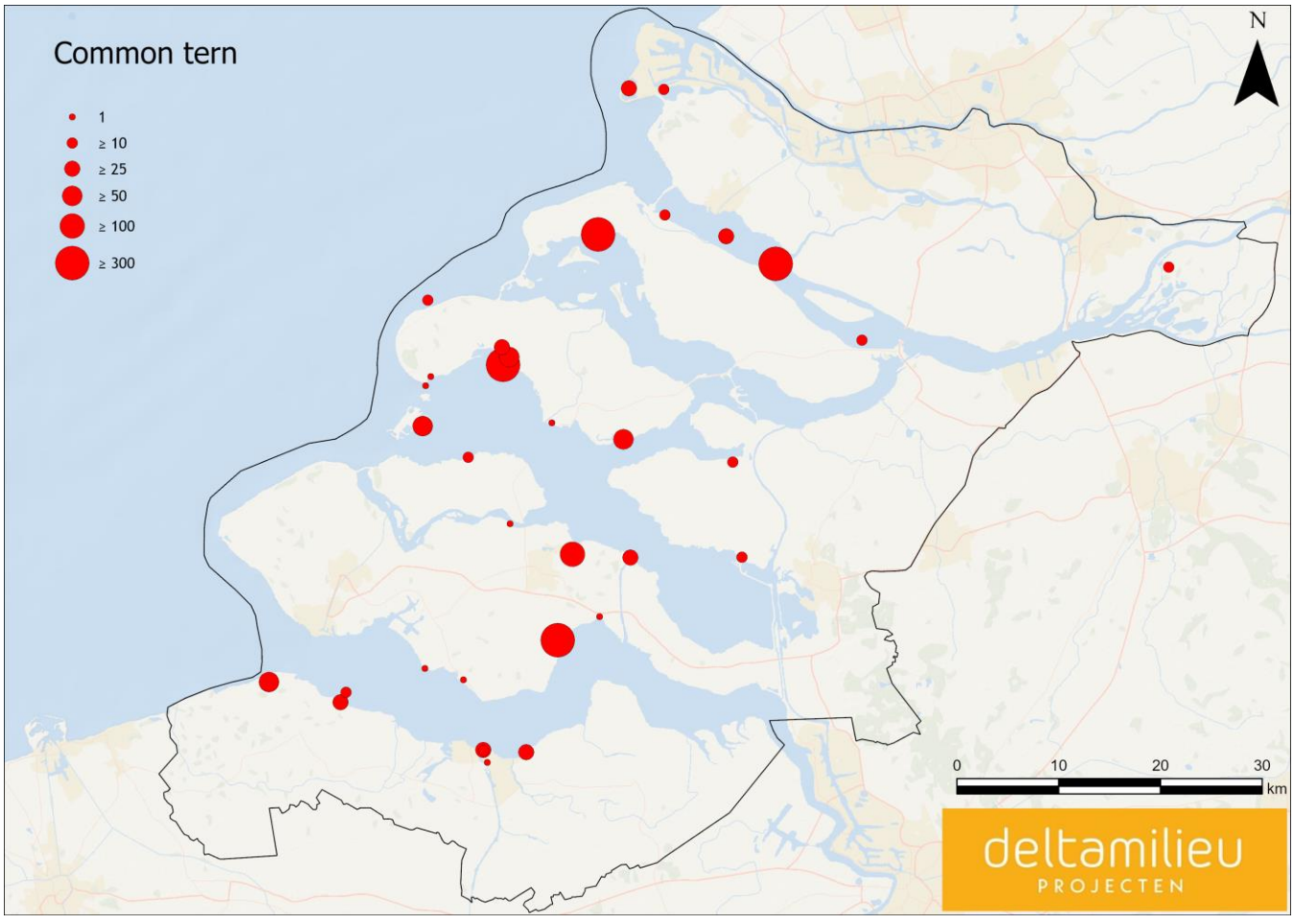

Figure 12. Locations where dead common terns were found between May and August 2023.

It is striking that the mortality among adult common terns was high in both years (in 2022 and in 2023 635 and 309 individuals, respectively). The majority of the dead common terns found were chicks of approximately three weeks old (a total of 1092 chicks were recorded dead). The highest mortality was observed on the islands of Bliek, Markenje, the Hoedekenskerkepolder and at the Weeversinlaag (table 6.)

Table 6. Mortality in a selection of common tern colonies in the Delta in 2023.

Colony	Habitat	Breeding pairs	Fledged chicks	Breeding success	Dead adults	Dead chicks	Chick mortality*
Haringvliet, Bliek	island	130	0	0	11	173	100%
Deessche Watergang	island	58	30	0,52	34	53	64%
Hoedekenskerkepolder	island	166	50	0,30	94	191	79%
Hooge Platen	island	294	220	0,75	7	3	1%
Kaarspolder	island	52	32	0,62	4	20	38%
Kerkwerve, Prunje Noord	island	339	610	1,80	2	15	2%
Kerkwerve, Prunje Zuid	island	69	60	0,87	4	22	27%
Weeversinlaag	island	571	240	0,42	14	307	56%
Slufter Maasvlakte	raft	352	235	0,67	4	10	4%
Margarethapolder	raft	17	0	0	13	3	100%
Markenje	island	395	103	0,26	31	166	62%
Slikken van Flakkee	island	142	165	1,16	0	0	0%
Neeltje Jans	vlot	32	0	0	11	30	100%
Nummer Een	island	404	420	1,04	7	13	3%
Oostvoornse Meer	island	82	100	1,22	3	2	2%
Klein Beijerenpolder	island	76	62	0,82	3	28	31%
Scheelhoek eilanden	island / raft	186	165	0,89	3	6	4%
Slijkplaat	island	20	20	1,00	5	14	41%
Terneuzen, Radarpost	raft	64	?	?	11	18	?
Ventjagersplaten, Zwarts	island	93	35	0,38	5	15	30%
Waterdunen	island	250	200	0,80	11	25	11%
Inlaag 's-Gravenhoek	island	22	0	0	6	1	100%

** Chicks younger than 20 days old are excluded as they often experience natural mortality in the first two weeks even in normal circumstances.*

However avian influenza hit several common tern colonies, this did not lead to mass mortality at all locations and the 2023 season was a favourable year in terms of food availability. An estimated 3650 young common terns fledged in the Dutch Delta, which means that the breeding success in 2023 (0,71 young per pair), despite the avian influenza outbreak is well above the local long term average (0,41 young per pair) (figure 13). The mortality among adult birds is worrying. The population trend of the species has been negative for many years and the regional target of 6500 breeding pairs has not been reached since 2007 in the Delta. After the first avian influenza outbreak, the number of breeding pairs of common terns decreased from 5670 in 2022 to 5168 pairs in 2023. There is a significant risk of a further decline in the common tern population if avian influenza continues to pose as a substantial threat as it did in 2022 and 2023.

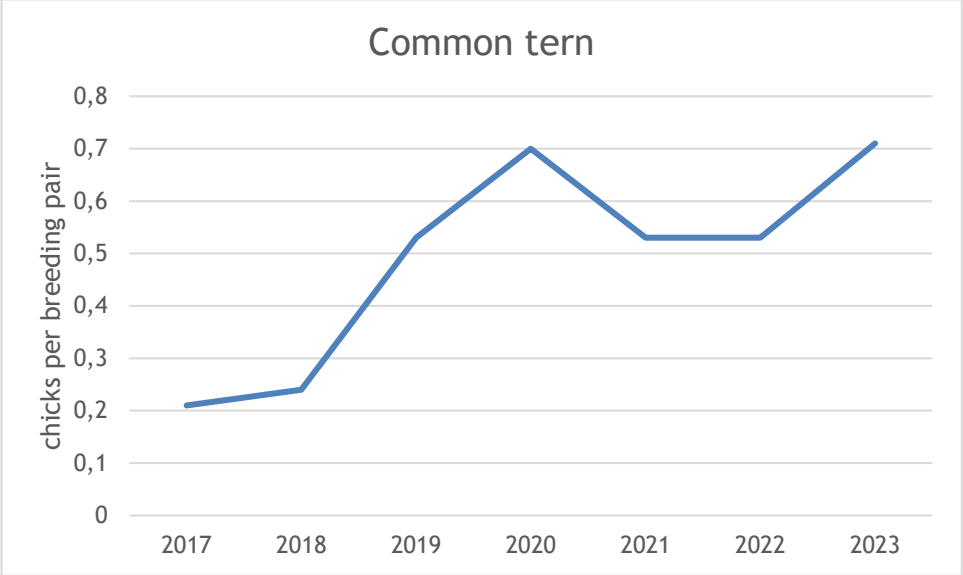

Figure 13. Average breeding success of the common tern in the Delta from 2017 to 2023.

Other species

In addition to the five detailed species descriptions above, mortality was observed in a total of 34 other bird species (Table 2). The five most impacted species all belong to the Laridae family. Other related species found relatively often among the victims were herring gull (110), great black-backed gull (11) and common gull (10). It is striking that hardly any mortality has been detected in little terns both in 2022 (6) and 2023 (2). Apart from species such as shelduck (35) and graylag goose (34), the numbers of ducks and geese found were low. The same holds true for waders. The most commonly found species in this category were oystercatcher (17) and pied avocet (16).

Results of the avian influenza surveillance

The Viroscience Team of Erasmus MC performed the analytical tests on the swab samples using two qPCR methods. The first method is aimed at the general detection of influenza A viruses, while the second qPCR method is specifically aimed at the H5 type. To determine whether the identified virus is a highly pathogenic type, sequencing of the viral genome is necessary. This method can only be applied if the viral load in the sample allows it. Furthermore, full characterization through genome sequencing is limited to a selected number of samples due to its higher costs.

Table 7. Detection of actively infected birds and results of serology.

Species	Active virus infection				Serology
	Number of tested samples	Influenza A positive	H5 positive	HPAI confirmed	HPAI positive/tested
Great cormorant	1	1	0		
Common ringed plover	3	0	0		0/3
Little tern	18	0	0		0/12
Sandwich tern	236	62	47	Yes, in multiple samples	38/189
Greater black-backed gull	2	1	1	No sequence determination	0/1
Lesser black-backed gull	44	1	1	Yes	1/41
Pied avocet	6	0	0		0/6
Mute swan	1	0	0		
Black-headed gull	18	3	3	Yes, in 2 samples	0/11
Gadwall	1	0	0		
Arctic tern	5	0	0		0/5
Oystercatcher	2	0	0		0/1
Eurasian wigeon	1	0	0		0/1
Kentish plover	2	0	0		0/1
Common tern	67	2	2	No sequence determination	2/60
White-tailed eagle	7	0	0		0/7
Herring gull	36	4	4	No sequence determination	2/32
Mediterranean gull	11	2	1	Yes	1/5
Total	**461**	**76**	**59**		**44/375**

The most intensively sampled species was the sandwich tern. Adults sampled at Bliek showed the presence of HPAI H5N1 in the colony as early as May 17, with three apparently healthy individuals found positive. Two of these ringed individuals certainly survived the infection; they were later observed outside the colony, both in good health. The third positive adult showed severe loss of coordination one month after sampling outside of its breeding colony and was unfortunately not seen after this observation. Despite the presence of positively tested adults and chicks in the colony (early June), no abnormal mortality was observed until the 24th of June. In early July, the majority of chicks tested positive and mortality peaked: at least 66% of the chicks died on Bliek. In the colony at Nummer Een, chick mortality remained low at 15%, even though several chicks tested positive for H5N1 just before fledging in this colony too. Of the 41 chicks that tested positive for H5N1 in the Delta in 2023, only nine were found dead during the subsequent clean-up of the Bliek colony, while no dead individuals were reported at Nummer Een that had been tested positive earlier. Five of the H5N1 positive chicks were later

observed outside their natal colony. The long-term survival of the chicks and the fate of the remaining individuals - those not found dead or reported later - remain questions for the future.

Fledged Sandwich tern chick with color ring R-J11, tested positive as a chick for HPAI H5N1 June 22, 2023, Nummer Een. Photo: Maarten Sluijter, 07 July 2023, Neeltje Jans.

The results of the serological assay showed a relatively high seroprevalence in the adult sandwich tern population at the beginning of the breeding season. In the Bliek colony, 42% of the individuals showed detectable levels of antibodies against HPAI in their serum, which could explain the lower adult mortality in the 2023 breeding season. None of the seropositive birds were carrying active virus at the time of sampling, meaning they likely acquired immunity in the previous breeding season or in the wintering area. Female birds can transfer antibodies to their chicks through the egg yolk, but the chicks showed low seroprevalence. In the Bliek and Nummer Een colonies, only four out of the 86 individuals tested showed detectable, but low levels of antibodies. These chicks were also positive for HPAI H5N1 at the time of sampling, meaning the antibodies detected were likely raised in response to the current infection and did not originate from maternal immunity. It is important to note that the chicks were sampled at >~20 days of age and by this time the level of maternally transferred antibodies may have fallen below the limit of detection.

Adult, apparently healthy common terns (47) were sampled during the incubation period in three colonies (Weevers Inlaag, Neeltje Jans, Slikken van Flakkee), and none of these birds showed the presence of active virus infection at the time of sampling. The common terns show a high degree of site fidelity (they breed in the same

location every year). A number of colonies in the Delta were severely affected in 2022. On a closely monitored colony at the Neeltje Jans a high mortality was observed in 2022 (approximately 70% of the adult breeding birds died). Because adult common terns are loyal to their breeding colonies, it was expected that antibodies would be present in a large proportion of surviving, returning adult birds in 2023. Although the sample size does not allow firm conclusions, it is still remarkable that antibodies were detected in only one adult common tern out of forty birds tested. This is consistent with the observation that mortality among adult common terns remained high in 2023. Later in the season, high mortality was observed on the raft on Neeltje Jans; 100% mortality among chicks and eleven adults were found dead out of the 32 pairs breeding there. On this very densely populated raft the common terns breed together with black-headed and Mediterranean gulls. Mortality was also high among these species. Unfortunately, no adult individuals of these gulls were tested for the presence of active infection. It is possible that these gulls introduced the virus into the colony, allowing it to spread further on other species breeding on the raft. Later in the season, a total of twenty common tern chicks were tested, two of which tested positive for H5N1; one apparently healthy and one sick bird. Both chicks found positive came from the same colony (Scheelhoek), which is evidence for the presence of the virus at that location. Nevertheless, mortality in this breeding colony remained exceptionally low (4%) and breeding success was even above the average (0,89 young per pair). Interestingly, the sick bird showed eye discoloration, as it is also known in Northern gannets infected with avian influenza (Lane et al., 2023). Black-headed and Mediterranean gulls were severely affected by avian influenza in 2023, but the sample size unfortunately does not allow for detailed analysis. For the coming breeding season, it is recommended to further investigate these two species in addition to the terns.

The few positive cases of herring gulls (4/34) were all dead specimens found before the start of the breeding season in February. The only lesser black-backed gull that tested positive was also a dead individual, found in a colony at the Maasvlakte. Only one adult lesser black-backed gull and two herring gulls showed low concentrations of antibodies against HPAI in the two colonies examined in the Maasvlakte/Europoort-area. Despite the low seroprevalence and the confirmed presence of the virus in the colony in a dead bird, the mortality rate remained negligibly low. Large gulls breed in looser colonies, the nests are further apart and these species are also more territorial, reducing the frequency of close interactions and therefore the possibility of virus transmission between individuals. In colonies where these large gull species breed in the vicinity of black-headed gulls (on Slijkplaat and Ventjagersplaten), the risk of infection was likely greater because the large gulls use the dead and sick chicks of black-headed gulls as a food source. Unfortunately, no birds have been tested for HPAI in these colonies.

4. Discussion

In 2022, colonial seabird populations in Northwestern Europe experienced a devastating outbreak of avian influenza. The virus killed thousands of birds across all age groups in the Dutch Delta alone. Surviving adult birds abandoned the affected colonies. By late summer, case numbers declined, but the virus persisted. It was primarily circulating within the wintering black-headed gull population, ready to strike again as birds returned to colonies for the 2023 breeding season. Once again, terns and gulls were the most affected species, with black-headed and Mediterranean gulls suffering particularly high mortality rates. In contrast to 2022, adult birds were largely spared, but significant losses were observed among nearly fledged chicks. The breeding results of the above mentioned species were strongly affected with several colonies experiencing close to zero breeding success.

Seabirds, such as gulls and terns, are long-lived species with a low annual reproductive rate and - under normal conditions - low adult mortality. A single breeding season with low breeding success can be compensated for in subsequent seasons, when weather conditions and food availability are more favorable. However, the loss of a significant proportion of adult breeding birds in a single season can impact the population for decades. Anthropogenic environmental changes (loss of habitat, overfishing, increase of predation pressure) have made seabird populations extremely vulnerable. They are slow to respond to adverse developments and the global emergence of HPAI H5N1 is one of the most extreme events to affect these populations in recent history. The breeding success of 0,17 chicks per breeding pair recorded in 2023 among sandwich terns is far from sufficient to maintain the population at current levels, let alone to compensate for the loss of a large part of the adult population in 2022. The high number of adult sandwich terns carrying antibodies against HPAI and the low adult mortality in 2023 offer a glimmer of hope that the population can recover in the future. Unfortunately, similar positive trend was not yet observed in other species, such as common terns. Although certain common tern colonies were also severely affected during the first outbreak, no immunity was found in adult birds during the subsequent season and the losses were comparable to those of 2022. Despite the still relatively high losses due to avian influenza, the breeding success in the Delta among common terns was still above the average in 2023. This was due to the fact that breeding success in the unaffected colonies was exceptionally high. A possible advantage of the breeding behavior of common terns is that they breed in smaller, separate colonies spread across the Delta, and thereby also spreading the risk caused by outbreaks.
Little is known about the seroconversion of wild bird populations, how long the acquired immunity lasts, and whether this immunity provides sufficient protection against potential new virus variants. It is therefore important to continuously monitor the presence of avian influenza and seroprevalence in wild bird populations to expand our knowledge.
Avian influenza has now become endemic in Europe, persisting throughout the year. In addition, the virus is present in wintering areas, posing a perpetual threat to migratory birds and a great challenge for nature conservationists, site managers, researchers and increasingly also for public health. Funding for outbreak management, surveillance, research and education programs remains very limited.

Management challenges

The mass mortality of colony breeding birds in the summer of 2022 was unprecedented. Although avian influenza outbreaks had occurred before, mainly in geese and ducks during the winter season, the scale at which the new variant swept through the population was unexpected. This rapid spread caught site managers and governmental organizations by surprise, leaving little time to make adequate decisions. Colony clearance methods (if chosen) were challenged by limited availability of trained personnel and insufficient personal protective equipment. Although a similar outbreak pattern in colony breeding birds in the summer of 2023 was not unexpected after the catastrophic outbreak in 2022, the preparedness of the national government was still not sufficient. However, in the Dutch Delta, nature reserve managers were better prepared than in the previous year. In the spring of 2023, the nature reserves were regularly checked by the three major organizations (Stichting Het Zeeuwse Landschap, Natuurmonumenten and Staatsbosbeheer). In areas with increased mortality due to avian influenza, the carcasses were removed by local site managers or the specialists of DMP. Some of the black-headed gull colonies were cleared by contractors.

The importance of carcass removal

In our previous report we discussed the advantages and possible disadvantages of removing carcasses from the colonies. Cadavers harbor high viral loads and the virus may survive in them for extended periods of time, making their removal from crowded colonies a possible measure to limit further transmission. However, regular colony disturbance can facilitate the movement of chicks, and people walking through contaminated soil can inadvertently contribute to transmission. Research has shown (Knief et al., 2024) that early initiation of regular carcass removal, especially when the first signs of unusual mortality are observed, is effective in reducing the impact of the outbreak. One of the practical challenges is that certain colonies are only accessible by boat, making daily visits unfeasible.

In certain areas within the Delta, especially on Markenje, severe predation by rats was observed. Part of the island, covered with taller vegetation serves as a breeding ground for gulls and as a habitat for a significant population of brown rats that, even in a healthy colony, exert high pressure on breeding birds through predation of eggs and chicks. Rodents are generally not susceptible to avian influenza infection - at least not to the variants known so far. However, if rats feed to a large extent on the carcasses of birds infected with avian influenza, as has been observed in gull colonies in the Delta (Markenje), the risk of virus transmission and virus adaptation to these mammalian species may increase. Rats may also serve as a potential physical vector between colonies and nearby human settlements. This once again underlines the need to remove carcasses in a timely manner. In addition, any unusual mortality of mammals in the vicinity of bird colonies must be reported.

Young Mediterranean gulls consumed by rats – 14 July 2023, Markenje, Photo: Pim Wolf

Remarks

The avian influenza outbreak primarily affected breeding colonies, making them the most readily identifiable sites for its manifestation. The species and numbers included in this report therefore mainly originate from these areas. Throughout the season, there were no signs of significant bird mortalities washing up on the North Sea beaches in contrast to 2022, when extensive cleanup efforts were undertaken on the shoreline due to a surge in bird deaths attributed to both botulism and avian influenza in the Western Scheldt region.
The reported numbers of victims in this report represent a minimum count. It's important to note that birds that died outside of the colonies or within colonies with dense vegetation may have been overlooked during clean-up efforts. Thanks to the monitoring projects of Rijkswaterstaat, the Province of Zeeland and the Province of Zuid-Holland and a large network of volunteers and administrators, outbreaks could be identified in the Dutch Delta at an early stage. This approach enabled us to gain as comprehensive an understanding as possible of the impact of avian influenza on the populations of coastal breeding birds in the Delta area in 2023.

5. Conclusions and recommendations

- Since 2022, when avian influenza first struck colonial seabird populations in the Netherlands, the national government has yet to devise an adequate plan to address outbreaks in wild birds. Resources to support volunteers and professionals are scarce. Implementing an integrated national or regional strategy would facilitate monitoring and mitigating the impact on coastal breeding bird populations. Testing both healthy and sick individuals and cleaning up carcasses are essential measures.
- There are strong indications that carcass removal in colonies reduces the risk of further virus transmission and as such limits the total mortality in the colony. This is of great importance, especially in case of vulnerable species with a strong negative population trend such as the common tern.
- A lot depends on the willingness of site managers to cooperate in a rapid response to an outbreak in their areas. In the Delta, cooperation between managers and researchers has been generally very good since the outbreak of 2022. Field information is quickly shared, enabling swift intervention.
- Contractors who are tasked to remove carcasses from breeding colonies must be carefully selected and instructed. They must be trained to work in a (bio)hazardous environment and must use personal protection equipment correctly. They must be able to record the number of dead birds and register the exact species. Experience with how to work in a breeding colony is important. People who cannot distinguish between sick and healthy chicks can cause unnecessary damage to the colonies. The cleaning action cannot last long and weather conditions must be taken into account in order to limit the disturbance and damage to the birds that are still breeding in the colony (both hot or cold weather can have a major impact on eggs and/or chicks).
- Sandwich terns settled in 2023 mainly at locations where there had been lower mortality in the previous year, such as Bliek and Zeebrugge. Breeding also took place at new locations, such as at Nummer Een and in the 's Gravenhoekinlaag. The areas that were most affected in 2022 (Waterdunen and Slijkplaat) were virtually deserted in 2023. It is important to create sufficient suitable habitat. Distribution of colonies is important.
- Pestcontrol/rat control is important to reduce predation pressure on ground-nesting birds. In the event of an avian influenza outbreak, these animals can serve as a physical (and if a variant emerges that can infect rodents, also as a biological) vector. Therefore, special attention should be paid to rat control measures in and around the breeding colonies.
- DMP employees devoted their free time and personal resources to voluntarily perform most of the sampling activities. Despite the recognized importance of early warning and surveillance systems for avian influenza by various organizations (FAO - Scientific Task Force on Avian Influenza and Wild Birds statement), funding for field work remains scarce. Securing adequate financing is crucial to ensure the sustainability of these activities in the future.
- Little is known about avian influenza among site managers, administrators and governmental bodies. Awareness of the consequences on wildlife and possible risks for public health is crucial to better anticipate avian influenza outbreaks in the future. Organizing meetings and trainings for these target groups is an important recommendation.

6. Future studies

- There is still limited knowledge about avian influenza in colonial breeding birds. In 2023, the terns were the focus species of the surveillance program in the Dutch Delta. Given the high mortality among the black-headed and Mediterranean gulls, it would be recommended to increase the sampling effort and include these species in the focus groups in the coming years. Investigating the presence of HPAI outside the breeding season in waders, gulls and terns should also be considered.
- Now that avian influenza is present as a significant, new environmental pressure factor, demographic monitoring of the breeding population of various coastal breeding bird species is more important than ever. The assessment of annual survival rates through ringing studies of adult breeding birds and their young should receive more attention (particularly sandwich tern, common tern, black-headed gull, Mediterranean gull and herring gull). It is recommended to expand the collection of demographic data annually for further species in the Delta (e.g. spoonbill, oystercatcher, cormorant).
- Artificial breeding rafts provide a safe breeding opportunity for various species of terns and gulls. In an outbreak situation, the high density of individuals on these breeding rafts may increase the likelihood of virus transmission and as such these rafts can act as an "ecological trap". Although no difference was observed between mortality of birds breeding on rafts and natural islands in 2023, this should be closely monitored in the future.
- The increasing number of mammalian species affected by avian influenza worldwide is raising public health concerns. The surveillance program could be expanded to include mammalian species in the most affected areas. In this way, possible virus transmission to mammalian species could be detected early.
- Birds of prey such as white-tailed eagles and peregrine falcons, which may use infected birds as a food source, are at high risk of becoming infected with avian influenza. In recent years, an increased mortality rate has been observed among peregrine falcons in the Netherlands due to avian influenza (verbal communication, AI Impact meeting). Currently, no research is being conducted on the serological status of this species or other bird-hunting raptor species. This could be relatively easy to conduct during ringing sessions or nest box monitoring.

7. Literature

Adlhoch C, Fusaro A, Gonzales JL, Kuiken T, Mirinaviciute G, Niqueux É, Stahl K, Staubach C, Terregino C, Broglia A, Kohnle L and Baldinelli F (2023) EFSA, ECDC, EURL Scientific report: Avian influenza overview March–April 2023. EFSA Journal 2023;21(5):8039, 45 pp. https://doi.org/10.2903/j.efsa.2023.8039

Ballmann MZ, Lilipaly SJ (2023) Vogelsterfte in het Deltagebied in 2022. Deltamilieu Projecten Rapportnr. 2023-03. DMP, Vlissingen

Caliendo V, Lewis NS, Pohlmann A, Baillie SR, Banyard AC, Beer M, Brown IH, Fouchier RAM, Hansen RDE, Lameris TK, Lang AS, Laurendeau S, Lung O, Robertson G, van der Jeugd H, Alkie TN, Thorup K, van Toor ML, Waldenström J, Yason C, Kuiken T, Berhane Y (2022) Transatlantic spread of highly pathogenic avian influenza H5N1 by wild birds from Europe to North America in 2021. Sci Rep. 12(1):11729. doi: 10.1038/s41598-022-13447-z.

Dutch Wildlife Health Centre; https://dwhc.nl/update-kokmeeuwen-sterfte/

FAO situation update (2023) https://www.fao.org/animal-health/situation-updates/global-aiv-with-zoonotic-potential/bird-species-affected-by-h5nx-hpai/en

FAO (2023) Scientific Task Force on Avian Influenza and Wild Birds statement on: H5N1 High pathogenicity avian influenza in wild birds - Unprecedented conservation impacts and urgent needs. https://www.cms.int/en/publication/h5n1-high-pathogenicity-avian-influenza-wild-birds-unprecedented-conservation-impacts

Knief U, Bregnballe T, Alfarwi I, Ballmann M.Z, Brenninkmeijer A, Bzoma S, Chabrolle A, Dimmlich J, Engel E, Fijn R.C, Fischer K, Hälterlein B, Haupt M, Hennig V, Herrmann C, in 't Veld R, Kirchhoff E, Kristersson M, Kühn S, Larsson K, Larsson R, Lawton N, Leopold M, Lilipaly S, Lock L, Marty R, Matheve H, Meissner W, Morrison P, Newton S, Olofsson P, Packmor F, Pedersen K.T, Redfern C, Scarton F, Schenk F, Scher O, Serra L, Sibille A, Smith J, Smith W, Sterup J, Stienen E, Strassner V, Valle R.G, van Bemmelen R.S.A, Veen J, Vervaeke M, Weston E, Wojcieszek M, Courtens W (2024) Highly pathogenic avian influenza causes mass mortality in Sandwich Tern Thalasseus sandvicensis breeding colonies across north-western Europe. Bird Conservation International (in press).

Lane J.V, Jeglinski J.W.E, Avery-Gomm S, Ballstaedt E, Banyard A.C, Barychka T, Brown I.H, Brugger B, Burt T.V, Careen N, Castenschiold J.H.F, Christensen-Dalsgaard S, Clifford S, Collins S.M, Cunningham E, Danielsen J, Daunt F, D'entremont K.J.N, Doiron P, Duffy S, English M.D, Falchieri M, Giacinti J, Gjerset B, Granstad S, Grémillet D, Guillemette M, Hallgrímsson G.T, Hamer K.C, Hammer S, Harrison K, Hart J.D, Hatsell C, Humpidge R, James J, Jenkinson A, Jessopp M, Jones M.E.B, Lair S, Lewis T, Malinowska A.A, McCluskie A, McPhail G, Moe B, Montevecchi W.A, Morgan G, Nichol C, Nisbet C, Olsen B, Provencher J, Provost P, Purdie A, Rail J.F, Robertson G, Seyer Y, Sheddan M, Soos C, Stephens N, Strøm H, Svansson V, Tierney T.D, Tyler G, Wade T, Wanless S, Ward C.R.E, Wilhelm S.I, Wischnewski S, Wright L.J, Zonfrillo B, Matthiopoulos J, Votier S.C (2024) High pathogenicity avian influenza (H5N1) in Northern Gannets (Morus bassanus): Global spread, clinical signs and demographic consequences. Ibis. https://doi.org/10.1111/ibi.13275

Liu J, Xiao H, Lei F, Zhu Q, Qin K, Zhang XW, Zhang XL, Zhao D, Wang G & other authors (2005) Highly pathogenic H5N1 influenza virus infection in migratory birds. Science 309, 1206

Lilipaly SJ, Sluijter M, Hoekstein MSJ. & van Straalen KD (2023) Broedsucces van kustbroedvogels in het Deltagebied in 2021. Deltamilieu Projecten Rapportnr. 2023-02. DMP, Vlissingen

Reperant LA, Kuiken T, Osterhaus ADME (2012) Influenza viruses. Human Vaccines & Immunotherapeutics, 8:1, 7-16, DOI: 10.4161/hv.8.1.18672

Scientific Committee on Antarctic Research: First report of suspected cases of High Pathogenicity Avian Influenza (HPAI) in the Antarctic treaty area. https://scar.org/scar-news/life-sciences/awhn-news/hpai-antarctic-treaty-area

SOVON, Black-headed Gull https://stats.sovon.nl/stats/soort/5820