

## Current distribution, abundance and trends of the Caspian Gull *Larus cachinnans* in Poland

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**Abstract:** Caspian Gull *Larus cachinnans* started to nest in Poland in the early 1980s. Since 1989 this species has started to nest regularly, but no complete survey of breeding population has been done so far. To describe abundance trend, we collected data on numbers and distribution of breeding Caspian Gulls until 2020 from the whole country. The census in 2021 allowed to estimate complete or near-complete breeding population at 5,554 pairs nesting in 44 places in total. Nesting sites held from 1 to 1,924 breeding pairs. About 91% of pairs bred in 9 colonies with more than 100 pairs. There were 21 nesting sites with  $\leq 10$  pairs, including 10 single-pair sites. 66% of the sites were located in southern part of the country, but increasingly more pairs started to settle in new places, including central Poland. The average annual population growth rate in 1989–2021 was estimated at 14.8% (95% confidence intervals: 12.3–17.3%); the Caspian Gull is characterized by the strongest increase among all breeding bird species in Poland. We predict that the abundance of Caspian Gulls in Poland will further increase, as many potentially suitable breeding areas are not yet colonized, particularly in the northern and western part of the country. This spectacular increase is also probably linked to multiple factors, including availability of landfills as important foraging places, which may affect high productivity and survival. The case of the Caspian Gull

population increase is a good example of large-scale changes in bird populations in the period of Anthropocene in Europe.

**Keywords:** Caspian Gull, *Larus cachinnans*, abundance, population trend, distribution, breeding pairs

### **Aktualne rozmieszczenie, liczebność i trend mewy białogłowej *Larus cachinnans* w Polsce.**

**Abstrakt:** Mewa białogłowa *Larus cachinnans* zaczęła gniazdować w Polsce na początku lat 80. XX w. Od 1989 gatunek ten gniazduje w kraju corocznie, ale jak dotąd nie przeprowadzono kompletnego cenzusu populacji lęgowej. By scharakteryzować trend, zebraliśmy dane dotyczące liczebności i rozmieszczenia lęgowych mew białogłowych do 2020 roku od obserwatorów z całego kraju. W roku 2021 zorganizowaliśmy cenzus, mający na celu najbardziej kompletną ocenę liczebności populacji. W roku 2021 stwierdzono w Polsce gniazdowanie 5554 par w 44 miejscach. W poszczególnych miejscach gniazdowało od 1 do 1924 par. Prawie 91% par było skoncentrowanych w 9 dużych koloniach, liczących >100 par. W 21 miejscach stwierdzono do 10 par, a w 10 z nich gniazdowały tylko pojedyncze pary. 66% miejsc lęgowych było zlokalizowanych w południowej części kraju, ale coraz więcej par zasiedla nowe miejsca, m.in. na Pojezierzu Gnieźnieńskim. Średni roczny przyrost populacji w latach 1989–2021 został oszacowany na 14,8% (95% przedział ufności: 12,3–17,3%). Jest on najsilniejszym wzrostem stwierdzonym wśród wszystkich gniazdujących w Polsce ptaków. Przewidujemy, że liczebność mewy białogłowej w Polsce może nadal rosnąć z uwagi na liczne, nadal niezasiedlone, optymalne dla tego gatunku miejsca lęgowe, szczególnie w północnej i zachodniej części kraju. Ten spektakularny wzrost ma przypuszczalnie swoje źródła także w dostępności do składowisk odpadów komunalnych będących ważnym źródłem pokarmu, co może wpływać na wysoką produktywność gatunku oraz przeżywalność populacji. Wzrost liczebności populacji lęgowej mewy białogłowej jest dobrym przykładem wielkoskalowych zmian w populacjach ptaków w okresie antropocenu w Europie.

**Słowa kluczowe:** mewa białogłowa, *Larus cachinnans*, liczebność, trendy, rozmieszczenie, pary lęgowe

The Caspian Gull *Larus cachinnans* is a large white-headed gull species whose glacial refugee was placed in the Aral-Caspian Seas area (Collinson et al. 2008). Thus, its original breeding range extended from the Lake Balkash in Kazakhstan in the east to the Black Sea coastlines in the west. Protection introduced in many countries in Europe in the 20th century (Spaans 1971) allowed it to colonize new areas to the north and west of the original range (Neubauer et al. 2007). Furthermore, the cessation or restriction of egg collection for consumption by humans could also have influenced demography by higher productivity which could further enhance expansion (Neubauer 2005). The colonization is still ongoing and the Caspian Gull expands into new areas, being now a regular breeder in the Netherlands (Litwiniak et al. 2021). The total number of breeding pairs in Central and Western Europe is currently estimated at least at 7,600–8,600 (Litwiniak et al. 2021).

The first breeding pairs in Poland were recorded in 1981–1982 in the Middle Vistula (Bukaciński et al. 1989, Dubois et al. 1990). In the late 1990s, the species started to colonize inland Poland, establishing breeding colonies predominantly at dams and other man-made reservoirs or fishpond islands (Neubauer et al. 2006). The population increased exponentially, reaching >500 pairs in 2005 (Skórka et al. 2005; Neubauer et al. 2006), 1,400–1,500 pairs in 2011 (Chodkiewicz et al. 2015), 2,000–3,000 pairs in 2013–2018 (Chodkiewicz et al. 2019) and 3,000–3,500 pairs in 2019 (Litwiniak et al. 2021). Despite the fact that the Caspian Gull is relatively straightforward to census, there are hardly any reports on its exact numbers, both in Poland and Europe. The first and only study summarizing current abundance of the species in Central and Western Europe is very recent and covers 2018–2020 period (Litwiniak et al. 2021), but the numbers

provided there for Poland are still only estimates. In this paper we report distribution and abundance of breeding Caspian Gulls in Poland in 2021, and a trend analysis since the species became a regular breeder in 1989.

## Material and methods

**Distribution and abundance in 1989–2020.** We collected data on breeding Caspian Gulls in Poland from 1989 to 2020. We prepared a list of all known breeding localities in the whole Poland, occupied in at least one year, based on published (Neubauer et al. 2006, Lenkiewicz et al. 2021, Litwiniak et al. 2021, Przymencki et al. 2021, Rapczyński et al. 2021) and unpublished data (earlier collected by GN and JB, and updated by the authors for the current paper). Most of breeding sites of Caspian Gulls in Poland have been regularly surveyed by both professional and amateur ornithologists associated with the Caspian Gull Research Group (CGRG hereafter; <https://www.researchgate.net/lab/Polish-Caspian-Gull-Group-Jacek-Betleja>) since the colonies were discovered. We also contacted active ornithologists from different areas of the country via e-mails or phone calls with a request to share the information about confirmed and potential breeding localities of Caspian Gulls. Since larger colonies are well known, we were searching for small ones and single-pair sites in particular. In addition, we announced the information about planned survey on Facebook and ornitho.pl to encourage observers to look for not yet discovered breeding sites.

**2021 census.** Surveys took place in the spring, during incubation – mostly in the second part of April, which is optimal period to count nesting gulls in the whole Poland. Only in few cases, e.g. at the Mietków Reservoir, we counted nests later (in May). The number of pairs in the colonies was estimated in standard and widely-used methods described in Zagalska-Neubauer & Neubauer (2015): (i) counting nests with eggs, (ii) counting each incubating individual observed from a distance if the colony could not be entered or (iii) counting adult birds present in the colony, when the nests were hidden in vegetation and incubating gulls could not be sighted. In most cases data were collected with the preferred, first of the above-mentioned methods. To make census results as complete as possible, further information on small colonies and single nesting pairs not monitored by CGRG, we searched data at ornitho.pl. Also some ornithologists provided us directly with the data.

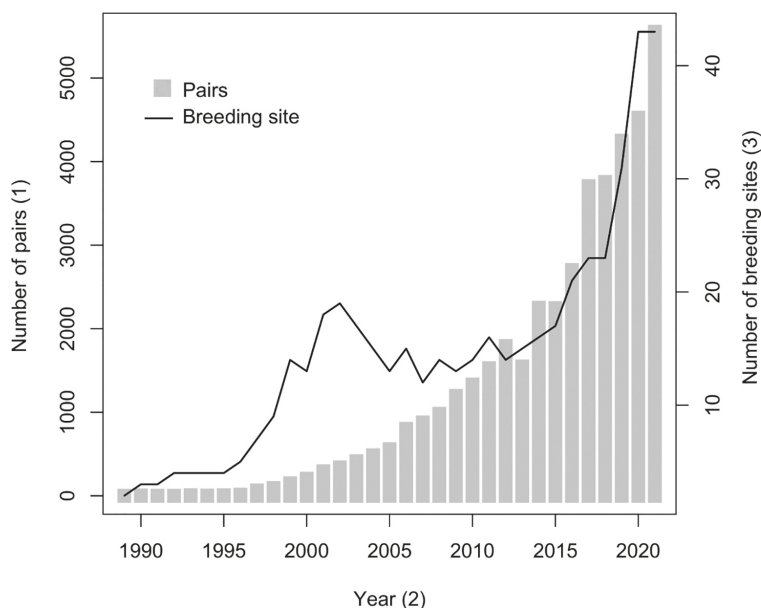
There are three species of large gulls breeding in Poland: Caspian Gull, Herring Gull *L. argentatus* and Yellow-legged Gull *L. michahellis*, where Caspians and Herrings are the most abundant and Yellow-leggeds are scarce breeders (Neubauer et al. 2006, Chodkiewicz et al. 2019). The two commoner species have established mixed colonies in many sites (Faber et al. 2001, Neubauer et al. 2006, Zagalska-Neubauer & Neubauer 2012, Neubauer et al. 2014, Orłowski & Kołodziejczyk 2014) and to identify the species observers followed Malling Olsen & Larsson (2004) and Gibbins et al. (2010, 2011). In general, in the analysis we included colonies where >90% of observed birds could be identified as *L. cachinnans*. At Przykona Reservoir both Caspians and Herring Gulls breed, but the ratio remains unknown (presumably Caspian dominates). We excluded the colony at the Włocławek Reservoir for 2020–2021, since the gulls, formerly breeding in an easily accessible area, switched to a new, roof-top colony nearby (Rapczyński et al. 2021), unavailable to observers. In 2003–2009 up to 30 pairs of Caspian Gulls bred annually in this colony (Zagalska-Neubauer & Neubauer 2012). Till today, Caspian Gulls breeding on roofs has not been confirmed.

Population trend, or the population growth rate, was estimated with Poisson generalized linear mixed model with lme4 package (Bates et al. 2015) in R (R Core Team 2019). The model included no intercept, a single fixed effect – the numeric year (scaled to help convergence and get growth rate) – and an interaction of two random factors: year (33 levels) and site id (75 levels). After excluding sites not surveyed in some years (NAs in the data, which provide no information), 2395 observations (year-colony combinations) were used to estimate the growth rate. The map was prepared in QGIS software (version 3.14).

## Results

Since 1989 both the number of breeding pairs and nesting sites have been growing constantly in Poland. Between 1989 and 2020, Caspian Gulls bred at 70 different sites at least once. In 2021 there were 5,554 breeding pairs counted in 44 colonies or single-pair sites (on average 0.14 colonies per 1,000 km<sup>2</sup>; Tab. 1). Nesting sites held from 1 to 1,924 breeding pairs. Almost 91% of pairs bred in 9 large ( $\geq 100$  pairs) colonies in Poland. There were 21 nesting sites with up to 10 pairs, including 10 single-pair sites. Mean number of breeding pairs in colony was 126. Colonies with  $\leq 50$  pairs were the most frequent (68% of all).

The number of breeding pairs in Poland was growing constantly with average rate of 64.5 pairs a year until 2013 when the decrease occurred (Fig. 1). Since 2014 the number has started to grow exponentially (the average increase by 496 pairs per year). The greatest annual increase was noticed between 2015 and 2016 and was 1,006 pairs. The average annual population growth rate between 1989 and 2021 was estimated at 14.8% per year (95% confidence intervals: 12.3–17.3%; Tab. 2; see Fig. 2 for the observed increase in the largest colonies).



**Fig. 1.** Changes of annual abundance (number of pairs) and number of breeding sites of the Caspian Gull in Poland in 1989–2021

**Rys. 1.** Zmiany liczebności (liczba par lęgowych) i liczby stanowisk mewy białogłowej w Polsce w latach 1989–2021. (1) – liczba par, (2) – rok, (3) – liczba stanowisk lęgowych

**Table 1.** Location and number of breeding pairs of the Caspian Gulls in Poland in 2021

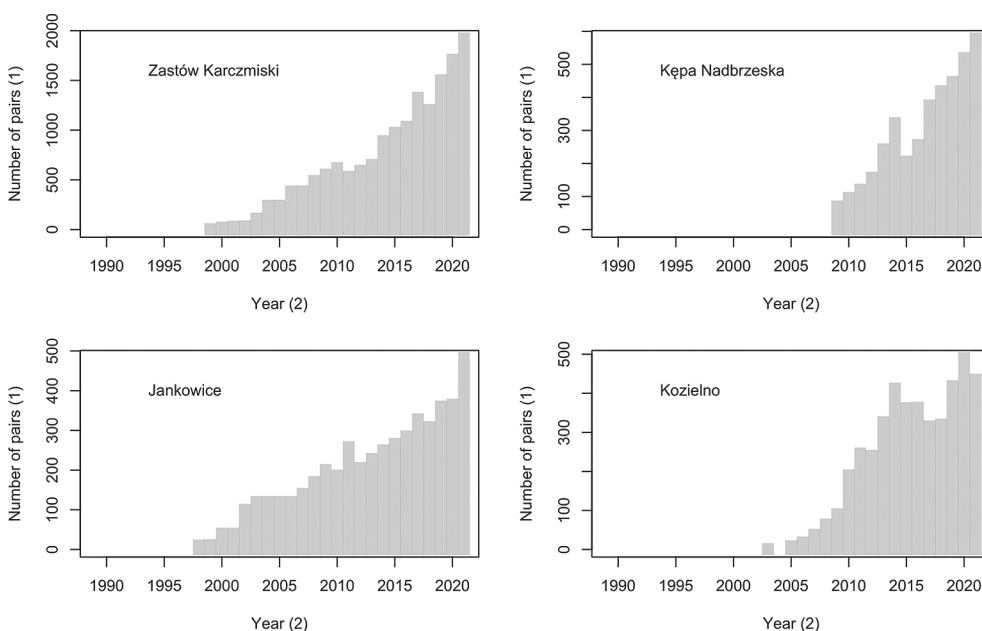
**Tabela 1.** Lokalizacja i liczba par lęgowych mewy białogłowej w Polsce w 2021 roku. (1) – numer kolonii, (2) – lokalizacja, (3) – liczba par, (4) – procent populacji w Polsce, (5) – koordynaty, (6) – suma par

No. (1)	Location (2)	Number of pairs (3)	% of population in Poland (4)	Coordinates (5)
1	Zastów Karczmiski	1924	34.8	51.268532, 21.830345
2	Kępa Nadbrzeska	579	10.5	52.024955, 21.224601
3	Jeziórko	484	8.8	50.528160, 21.834428
4	Jankowice	482	8.7	50.035073, 19.469061
5	Kozielno Reservoir	435	7.9	50.478606, 16.974229
6	Mietków Reservoir	433	7.9	50.949440, 16.603043
7	Mokrzec Reservoir	304	5.5	49.969413, 21.331326
8	Wytyckie Lake	270	4.9	51.429443, 23.207185
9	Foskowiec Pond	149	2.7	49.943520, 19.079991
10	Czorsztyn Reservoir	80	1.5	49.459273, 20.241400
11	Kuźnica Wareżyńska	66	1.2	50.377329, 19.208538
12	Dwory	51	0.9	50.040490, 19.302744
13	Topola Reservoir	45	0.8	50.494918, 16.934826
14	Zioło Lake	36	0.7	52.706803, 17.635747
15	Przykona Reservoir	33	0.6	52.005646, 18.658222
16	Radłów	25	0.5	50.066738, 20.840341
17	Gopło Lake	25	0.5	52.573500, 18.331444
18	Maciek Pond	20	0.4	49.932191, 18.976309
19	Wincentów	17	0.3	51.046675, 23.173193
20	Starzawa	14	0.3	49.883785, 22.994558
22	Opalenie	12	0.2	53.724966, 18.838366
23	Goczałkowice	10	0.2	49.931522, 18.860343
24	Zabrzeszczak Pond	10	0.2	49.928589, 18.944327
25	Warszawa-Targówek	10	0.2	52.270815, 21.078486
26	Ryńskie Lake	8	0.1	53.920637, 21.509129
27	Smolice	5	0.1	50.010797, 19.448737
28	Dzierżno Małe	4	0.1	50.383393, 18.564470
29	Pilce	3	0.1	50.515929, 16.827127
30	Warszawa-Mokotów	3	0.1	52.176847, 21.054335
31	Wręcza	3	0.1	51.988169, 20.450527
32	Brzeszcze	2	<0.1	50.005909, 19.135707
33	Liszki	2	<0.1	50.028713, 19.816315
34	Chwałów	1	<0.1	50.939791, 16.614663
35	Kruchowskie Lake	1	<0.1	52.603366, 17.805143
36	Zaborze ponds	1	<0.1	50.014737, 19.253035
38	Kraków-Dąbie	1	<0.1	50.053793, 19.976773
39	Górki	1	<0.1	50.344237, 20.733101
40	Arciechów	1	<0.1	52.380879, 20.089192
41	Jedlicze	1	<0.1	49.709579, 21.665938
42	Powidzkie Lake	1	<0.1	52.412642, 17.931729
43	Zakole B	1	<0.1	50.032300, 19.506908
44	Roszków	1	<0.1	49.976272, 18.292719
Total (6)		5554		

**Table 2.** Coefficients from the Poisson generalized linear mixed model fitted to Caspian Gull abundance data in Poland, 1989–2021. The model contains no intercept, fixed effect is a scaled numeric variable and random part consists of interaction of two factors: year and colony id. Estimates are on a log scale

**Tabela 2.** Współczynniki z uogólnionego liniowego modelu mieszanego z rozkładem Poissona, dopasowanego do danych o liczebności mewy białogłowej w Polsce, w latach 1989–2021. Model nie zawiera stałej, efekt ustalony (trend populacji, współczynnik lambda) to wyskalowana zmienna numeryczna (rok), a efekt losowy ma postać interakcji roku i stanowiska, wyrażonych jako czynniki. Oszacowania podano na skali logarytmicznej

Effects	Coefficient ± SE	z	P
Fixed			
Year	0.138 ± 0.011	12.48	<0.001
Random (factors)	Variance	SD	
Year id × site id	14.46	3.80	

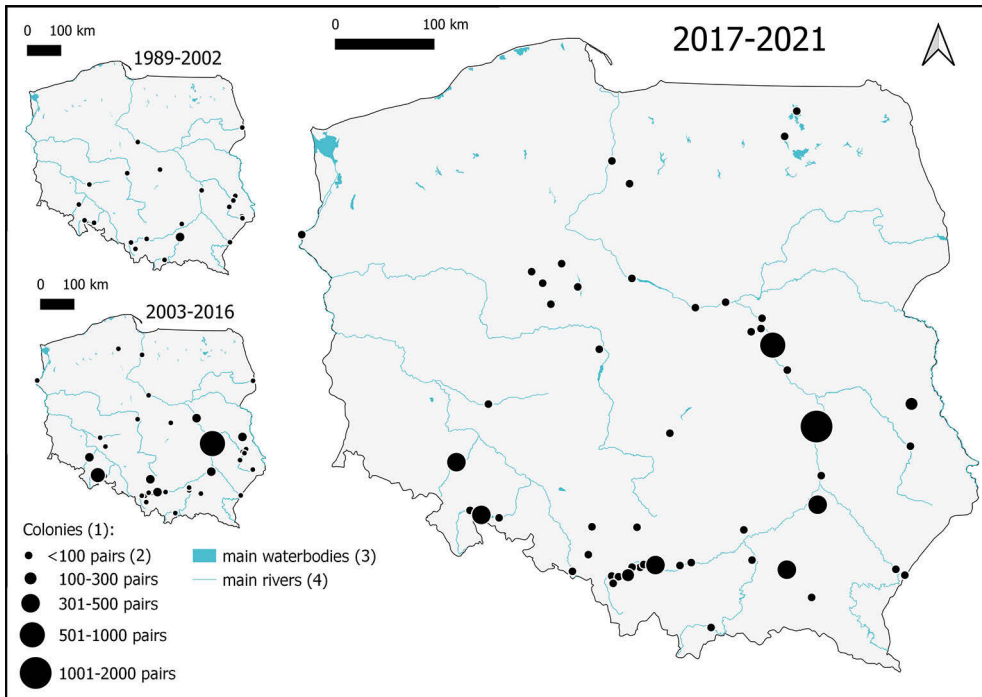


**Fig. 2.** Annual abundance in four large breeding colonies of the Caspian Gull in Poland in the 2000s

**Rys. 2.** Liczebność par w czterech dużych koloniach lęgowych mewy białogłowej w Polsce w latach 2000. (1) – liczba par, (2) – rok

Most colonies (66%) were located in the south of Poland. The largest colonies, at Zastów Karczmiski and Kępa Nadbrzeska, were located at the Middle Vistula. Some of new colonies began to form in the lake district strip in the last 5 years, especially in the regions of Gniezno and Inowrocław. In 2021 the northernmost nesting site was located at Ryńskie Lake, the southernmost – Czorsztyn Reservoir, the easternmost – Wytyckie Lake and the westernmost – Mietków Reservoir. In earlier years the northernmost site was at Kirsajty Lake and the westernmost – at Bielinek gravel-pit (Fig. 3).

In 2021 Caspian Gulls did not breed in 32 out of 76 places where nesting was confirmed since 1989. Most of them were single-pair sites or small colonies with  $\leq 20$  pairs, but



**Fig. 3.** Distribution of the Caspian Gull in Poland in 1989–2002, 2003–2016 (smaller maps on the left) and 2017–2021 (large map). Circle sizes reflect the highest abundances at each site observed during the three periods

**Rys. 3.** Rozmieszczenie mewy białogłowej w Polsce w latach 1989–2002, 2003–2016 (mniejsze mapy po lewej) i 2017–2021 (duża mapa). Wielkość kółek obrazuje najwyższą liczebność na stanowisku lęgowym zaobserwowaną w trakcie wyróżnionych trzech okresów. (1) – kolonie, (2) – pary, (3) – główne zbiorniki wodne, (4) – główne rzeki

few larger ones have also disappeared. The most prominent case was a colony in Tarnów (S Poland), where 177 pairs bred in 2001, but since 2008 no birds have been observed. It was established in 1992, and between 1996 and 2002 it was the largest colony in Poland.

During the survey we also observed another breeding large white-headed gulls in Caspian Gulls colonies. Until 2019, there was a well-known mixed colony in Włocławek (e.g. Zagalska-Neubauer & Neubauer 20212) where Caspian Gulls accounted for about 20% of breeding pairs, with the remainder being mainly Herring Gulls and hybrids. Since they moved to a roof-top in 2020 (Rapczyński et al. 2021), the species composition remains currently unknown. Caspian Gulls constituted half of pairs in the small mixed (with Herring Gulls) colony in Opalenie (the Lower Vistula). Caspian Gulls bred also with Herring Gulls at the Przykona Reservoir, where the former probably dominated. In two roof-top colonies in Warsaw, Caspian Gulls bred mainly with Herring Gulls (Rapczyński et al. 2021). Single pairs or individuals (breeding in mixed pairs) of Yellow-legged and Lesser Black-backed Gulls occurred in other colonies. For example, a pair of *L. fuscus* (probably *graellsii*) was found at Mietków Reservoir; it raised two chicks. At Kozielno Reservoir, a female Yellow-legged Gull paired and bred with Caspian Gull male. At Kępa Nadbrzeska, one pair of Yellow-legged Gulls and 1–2 pairs of Herring Gulls bred there too.

## Discussion

In this paper we report results of the first complete survey of Caspian Gull breeding population in Poland. Since 1989 the number of pairs has been still increasing, on average at nearly 15% rate per year, reaching 5,554 pairs in 2021. It means the species is at top of the successful species in Poland, next to Whooper Swan *Cygnus cygnus* (11.0% annually, 2007–2020) and Green Woodpecker *Picus viridis* (8.6% annually, 2000–2020) (Wardecki et al. 2021). The current figure exceeds the population size estimate from just two years ago (in 2019) by at least 3,000 pairs (Litwiniak et al. 2021). It shows how many pairs might have been missed and by how many the total numbers might have been underestimated when no complete survey was performed. Due to morphological similarity to other large gulls, the Caspian Gull can easily be overlooked if unexpected or when observers do not pay enough attention to identification and detection of the species. A similar situation can be found in Belarus and Ukraine, where the number of breeding pairs is known in few surveyed colonies, but the total population cannot be reliably estimated (I. Samusenko, N. Atamas – pers. comm., Keller et al. 2021). In Germany, due to many mixed colonies, the abundance is also difficult to assess, and the situation in Lithuania is similar (Litwiniak et al. 2021). In the Netherlands, every breeding attempt since the first one is monitored, so exact number of pairs is known (A. de Jong – pers. comm.), like in Czech Republic and Slovakia (Litwiniak et al. 2021).

According to estimates from other countries presented by Litwiniak et al. (2021), Poland holds at least half of the whole population of Caspian Gulls breeding in central and Western Europe and 65–68% of breeding population in European Union. The numbers still increase in Poland and as well as in other countries, but it seems that in Poland Caspian Gulls have colonized inland areas previously unoccupied by other large gulls. It could be one of reasons why the colonization here appeared so highly successful. The only other species with similarly dynamic increase in Poland was the Whiskered Tern *Chlidonias hybrida* (Ledwoń et al. 2014). Large numbers of breeding Caspian Gulls coupled with high breeding success (Neubauer 2005, Przymencki et al. 2021) may also be the source of immigrants that drive the expansion further west.

Caspian Gulls are most numerous in southern Poland, but number of breeding pairs is also increasing in central and northern parts of the country. Only in the last five years, 11 new colonies or single-pair sites were detected, with the biggest at Ziolo Lake in Gniezno lake district. In this area there are also other places where Caspian Gulls breed and we expect further expansion of the species in this part of Poland in the future. New breeding sites are still being discovered in the southern part of Poland. For example, in 2020 at least 8 new places were found, mostly with single pairs. However, at Dzierżno Małe Reservoir the number of pairs increased from 1 in 2020 to 4 in 2021, what was unexpected due to dense vegetation and apparent lack of species-specific sites suitable for building nests (S. Beuch – unpublished data). This indicates that Caspian Gulls can be more flexible and less choosy in breeding habitat choice than was previously thought; it is also confirmed by recently reported increasingly common roof-nesting (Rapczyński et al. 2021).

First recovery data from ringed individuals breeding in Polish colonies revealed that some of them originate from colonies located east of Poland (Neubauer et al. 2007). However, in recent years at Kępa Nadbrzeska (Middle Vistula) some of nesting gulls were dispersers from Gatovo colony in Belarus, but others originated from the west (Germany, MS – unpublished data). Other situation was found at Mietków or Kozielno Reservoirs in southern Poland, where some breeding individuals had hatched in Hungary, Slovakia, Czech Republic, and Germany as well (PG, JPG, KL, MP, JB, JS – unpubl. data). So far, the



key source of expansion remain to be identified but it is evident that south and central Polish breeding colonies are supported by individuals originating from various parts of the range.

Caspian Gulls colonies constitute an attractive breeding places for other large gull species. In a few inland breeding places like Opalenie, Włocławek and Przykona Reservoir or Warsaw roof-top colonies, Herring Gulls had probably started to breed earlier and Caspian Gulls may be treated as a secondary nester. However, colonies newly formed by Caspian Gulls provide an opportunity for some individuals or pairs of Yellow-legged Gulls and Lesser Black-backed Gulls to breed (e.g. Stawarczyk et al. 2017). They often nest in large colonies where these usually single individuals can be easily overlooked, including Yellow-legged Gulls in particular, which can be strikingly similar to more common hybrids between Caspian and Herring Gulls (Neubauer et al. 2010). This is why their annual numbers breeding in Poland remain unknown. Based on observations from western Europe, e.g. from Bavaria in Germany (Litwiniak et al. 2021), we are confident that Caspian Gulls can form pairs with other – including mentioned – species also here.

Despite the fact that most of the Polish population breeds in habitats associated with water, in 2021 two places on roof tops with breeding Caspian Gulls were discovered, both of them were located in Warsaw (Rapczyński et al. 2021). This phenomenon illustrates the species flexibility in respect to habitat choice and will probably become more frequent in the future, as Caspian Gulls breed closer and closer to human settlements (like for example on a dam in Cracow; S. Sendera, P. Morawiec – unpubl. data).

We expect further increase in number of the Caspian Gull breeding in Poland. The expansion of this species in Poland depends not only on the availability of suitable habitats to establish a colony, but is probably also linked to multiple factors, including high availability of anthropogenic food on landfills, where these birds commonly forage (Meissner & Betleja 2007, Ledwoń & Betleja 2018), which likely results in high productivity. Additionally, it cannot be excluded, that the observed growth might be related to shortened migration distances and increased survival rates at increasingly warmer wintering areas, but this remains to be studied. In general, the Caspian Gull spectacular expansion and increase might be viewed as the species response to the environmental changes in the Anthropocene (Duhem et al. 2008, Ramos et al. 2009, Frixione et al. 2012, Yoda et al. 2012, Langley et al. 2021, Ouled-Cheikh et al. 2021).

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## References

Bates D., Maechler M., Bolker B., Walker S. 2015. Fitting linear mixed-effects models using lme4. *J. Stat. Soft.* 67: 1–48.

- Bukaciński D., Nawrocki P., Stawarczyk T. 1989. Gniazdowanie mew białogłowych (*Larus cachinnans*) na Śródkowej Wiśle, ich status taksonomiczny oraz problemy z rozpoznawaniem podgatunków *Larus cachinnans michahellis*, *L. c. cachinnans*, *L. c. omissus*. Not. Orn. 30: 1–12. [In Polish with English summary]
- Chodkiewicz T., Chylarecki P., Sikora A., Wardecki Ł., Bobrek R., Neubauer G., Marchowski D., Dmoch A., Kuczyński L. 2019. Raport z wdrażania art. 12 Dyrektywy Ptasiej w Polsce w latach 2013–2018: stan, zmiany, zagrożenia. Biul. Monitoringu Przyrody 20: 1–80. [In Polish with English summary]
- Chodkiewicz T., Kuczyński L., Sikora A., Chylarecki P., Neubauer G., Ławicki Ł., Stawarczyk T. 2015. Population estimates of breeding birds in Poland in 2008–2012. Ornis Pol. 56: 149–189. [In Polish with English summary]
- Collinson J.M., Parkin D.T., Knox A.G., Sangster G., Svensson L. 2008. Species boundaries in the Herring and Lesser Black-backed Gull complex. Brit. Birds 101: 340–363.
- Dubois P., Skakuj M., Stawarczyk T. 1990. Occurrence of Yellow-legged Gull in Poland. Dutch Birding 12: 14–17.
- Duhem C., Roche P., Vidal E., Tatoni T. 2008. Effects of anthropogenic food resources on Yellow-legged gull colony size on Mediterranean islands. Popul. Ecol. 50: 91–100.
- Faber M., Betleja J., Gwiazda R., Malczyk P. 2001. Mixed colonies of large white-headed gulls in southern Poland. Brit. Birds 94: 529–534.
- Frixione M.G., Casaux R., Villanueva C., Alarcón P.A.E. 2012. A recently established kelp gull colony in a freshwater environment supported by an inland refuse dump in Patagonia. Emu 112: 174–178.
- Gibbins C., Neubauer G., Small B.J. 2011. Identification of Caspian Gull. Part 2: phenotypic variability and the field characteristics of hybrids. Brit. Birds 104: 702–742.
- Gibbins C., Small B.J., Sweeney J. 2010. Identification of Caspian Gull. Part 1: typical birds. Brit. Birds 103: 142–183.
- Keller V., Herrando S., Voříšek P., Franch M., Kipson M., Milanese P., Martí D., Anton M., Klvaňová A., Kalyakin M.V., Bauer G.-H., Foppen R.P.B. 2020. European Breeding Bird Atlas 2: Distribution, Abundance and Change. European Bird Census Council & Lynx Editions, Barcelona.
- Langley L.P., Bearhop S., Burton N.H.K., Banks A.N., Frayling T., Thaxter C.B., Clewley G.D., Scragg E., Votier S.C. 2021. GPS tracking reveals landfill closures induce higher foraging effort and habitat switching in gulls. Movement Ecology 9(56).
- Ledwoń M., Betleja J., Stawarczyk T., Neubauer G. 2014. The Whiskered Tern *Chlidonias hybrida* expansion in Poland: the role of immigration. J. Ornithol. 155: 459–470.
- Ledwoń M., Betleja J. 2018. Movements of a pair of Caspian Gulls *Larus cachinnans* during the breeding season tracked by GPS-GSM logger. Conference paper at: Migrant Birds as Indicators of Climate Change, Gdańsk, 13–16 December 2018.
- Lenkiewicz W., Orłowska B., Stawarczyk T., Neubauer G., Smyk B. 2021. Trendy liczebności i stan poznania awifauny doliny Baryczy. Ornis Pol. 62: 259–292. [In Polish with English summary]
- Litwiniak K., Przymencki M., de Jong A. 2021. Breeding-range expansion of the Caspian Gull in Europe. Brit. Birds 114: 331–340.
- Malling Olsen K., Larsson H. 2004. Gulls of Europe, Asia and North America. Bloomsbury Publishing PLC, London.
- Meissner W., Betleja J. 2007. Skład gatunkowy, liczebność i struktura wiekowa mew Laridae zimujących na składowiskach odpadów komunalnych w Polsce. Not. Orn. 48: 11–27. [In Polish with English summary]
- Neubauer G. 2005. Hybrydyzacja i ekologia rozrodu mew z kompleksu mew srebrzystej-białogłowej *Larus argentatus-cachinnans* na Zbiorniku Włocławskim. PhD thesis. Nicolaus Copernicus University, Toruń. [In Polish with English summary]
- Neubauer G., Zagalska-Neubauer M., Gwiazda R., Faber M., Bukaciński D., Betleja J., Chylarecki P. 2006. Breeding large gulls in Poland: distribution, numbers, trends and hybridisation. Vogelwelt 127: 11–22.

- Neubauer G., Zagalska-Neubauer M., Betleja J. 2007. The origin of 'Caspian Gulls' breeding in Poland. *Brit. Birds* 100: 554–557.
- Neubauer G., Faber M., Zagalska-Neubauer M. 2010. Yellow-legged Gulls in Poland: status and separation from yellow-legged Herring Gulls and hybrids. *Dutch Birding* 32: 163–170.
- Neubauer G., Nowicki P., Zagalska-Neubauer M. 2014. Haldane's rule revisited: do hybrid females have a shorter lifespan? Survival of hybrids in a recent contact zone between two large gull species. *J. Evol. Biol.* 27: 1248–1255.
- Orłowski G., Kołodziejczyk P. 2014. Pierwszy przypadek hybrydyzacji mewy żółtonogiej *L. fuscus* z mewą romańską *L. michahellis* w Polsce i kolejne lęgi mieszane mewy żółtonogiej i mewy białogłowej *L. cachinnans*. *Ornis Pol.* 55: 69–72. [In Polish with English summary]
- Ouled-Cheikh J., Morera-Pujol V., Bahillo Á., Ramírez F., Cerdà-Cuéllar M., Ramos R. 2021. Foraging in the Anthropocene: Feeding plasticity of an opportunistic predator revealed by long term monitoring. *Ecol. Indic.* 129: 107943.
- Przymencki M., Litwiniak K., Zagalska-Neubauer M., Neubauer G. 2021. Ekologia rozrodu i liczebność mewy białogłowej *Larus cachinnans* na Zbiorniku Mietkowskim w latach 2019–2020. *Ornis Pol.* 62: 169–188. [In Polish with English summary]
- Ramos R., Ramírez F., Sanpera C., Jover L., Ruiz X. 2009. Diet of Yellow-legged Gull (*Larus michahellis*) chicks along the Spanish Western Mediterranean coast: the relevance of refuse dumps. *J. Ornithol.* 150: 265–272.
- R Core Team. 2019. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing. <https://www.r-project.org/>
- Rapczyński J., Litwiniak K., Przymencki M. 2021. The first records of roof-top nesting by Caspian Gulls *Larus cachinnans* in Poland with reference to other cases in Europe. *Ornis Pol.* 62: 243–249.
- Spaans A.L. 1971. On the feeding ecology of the Herring Gull *Larus argentatus* Pont. in the northern part of The Netherlands. *Ardea* 59: 73–188.
- Stawarczyk T., Cofta T., Kajzer Z., Lontkowski J., Sikora A. 2017. Rzadkie ptaki Polski. Studio B&W Wojciech Janecki, Sosnowiec. [In Polish]
- Wardecki Ł., Chodkiewicz T., Beuch S., Smyk B., Sikora A., Neubauer G., Meissner W., Marchowski D., Wylegała P., Chylarecki P. 2021. Monitoring Ptaków Polski w latach 2018–2021. *Biul. Monitoringu Przyrody* 22: 1–80. [In Polish with English summary]
- Yoda K., Tomita N., Mizutani Y., Narita A., Niizuma Y. 2012. Spatio-temporal responses of black-tailed gulls to natural and anthropogenic food resources. *Mar. Ecol. Prog. Ser.* 466: 249–259.
- Zagalska-Neubauer M., Neubauer G. 2012. Reproductive Performance and Changes in Relative Species Abundance in a Mixed Colony of Herring and Caspian Gulls, *Larus argentatus* and *Larus cachinnans*. *Acta Ornithol.* 47: 185–194.
- Zagalska-Neubauer M., Neubauer G. 2015. Mewy i rybitwy Laridae. W: Chylarecki P., Sikora A., Ceniań Z., Chodkiewicz T. (red.). *Monitoring ptaków lęgowych. Poradnik metodyczny*. Wyd. 2, s. 79–91. GIOŚ, Warszawa. [In Polish].