

FORTY YEARS OF ACTIVITY OF THE WATERBIRD RESEARCH GROUP KULING RINGING TEAM

Włodzimierz Meissner¹, Szymon Bzoma³, Agnieszka Ożarowska¹, Zenon Rohde²,
Piotr Rydzkowski³, Marta Witkowska¹, Anna Włodarczak-Komosińska³,
Cezary Wójcik³

Abstract

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Over the years, long-term operating bird ringing schemes based on standardized methods proved to be very useful in providing insights into avian biology. On the Polish Baltic Coast, the Waterbird Research Group KULING is one such program, with a 40-year-long history of ringing birds for the purpose of studying their movements, site fidelity, morphometric changes, and monitoring their population trends. Our efforts focused mostly on non-passerine birds associated with aquatic habitats. Since 1983, WRG KULING ringed 153 746 individuals from 189 species, with 66% of those being waders of 35 species, 19% gulls and terns of 22 species, and 6% of other waterbirds such as ducks and rails representing 49 species. Among passerines, only wagtails and pipits were extensively studied, with 9,941 individuals from 10 species ringed in that time. A total of 6,195 ring recoveries from outside of Poland present an insight into migration patterns, as well as wintering and breeding ecology of captured species. An even larger number of 14617 ring recoveries from within Poland largely comes from a citizen science program 'LOOP' developed by WRG KULING in 2013. This program allowed for studying different aspects of avian ecology on a more local scale. WRG KULING is an example of a student's initiative, which developed into a large project connecting academics, naturalists, conservation managers, and bird enthusiasts in a common goal of studying and protecting birds in this region of Europe.

¹ Ornithology Unit, Department of Vertebrate Ecology & Zoology, Faculty of Biology, University of Gdańsk, Poland;

² Ornithological Station, Museum and Institute of Zoology, Polish Academy of Sciences, Nadwiślańska 108, 80-680 Gdańsk, Poland;

³ Waterbird Research Group KULING, Al. Jana Pawła 23b/2, 80-462 Gdańsk;

* Corresponding Author: Włodzimierz Meissner: w.meissner@ug.edu.pl

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INTRODUCTION

The Waterbird Research Group KULING (later referred to as WRG KULING) was launched in 1983 by a group of students active in the Biology Student Club at the Department of Vertebrate Ecology and Zoology of the University of Gdańsk and was registered

in the Polish Bird Ringing Centre as an official bird ringing team. In 1996, KULING was registered as a non-governmental organisation with its constitution and a democratically elected board. As a result, two institutions exist under the name WRG KULING: the ringing team and the non-governmental society. This has allowed activities to be significantly expanded beyond bird ringing, and the association has included statutory tasks in the field of active protection of birds and their habitats, as well as environmental education. The financial resources for bird ringing activities have also increased.

WRG KULING from the very beginning has cooperated with the Department of Vertebrate Ecology and Zoology of the University of Gdańsk, as the main activists of the WRG KULING were first students and later some of us were employed by the University. Our conservation actions and research projects focused on a wide range of bird species associated with aquatic habitats. From the beginning, our main study area has been the Gulf of Gdańsk region, where, besides bird ringing activity, we conduct projects on waterbirds staging there during the non-breeding season, with regular counts of those birds which started in 1984 (Meissner 1993). Up to now, 176 scientific papers have been published with the affiliation “This is Waterbird Research Group KULING contribution no.”

Our ringing team includes people who have previously completed a training, in which special attention is paid to the repeatability in taking morphometric measurements. In this way, we try to minimise errors resulting from differences in measuring techniques. During 40 years of our activity, 69 bird ringers have helped us in our studies.

In this paper, we would like to summarise 40 years (1983-2023) of the WRG KULING ringing team activity by presenting the number of birds ringed, ringing recoveries, and some data on recovery rates obtained in our studies.

METHODS OF RINGING DATA COMPILATION

In this paper, all results were divided into four groups of bird species we focused on in various scientific projects conducted by our ringing team, i.e., waders, gulls and terns, waterbirds other than mentioned beforehand, and finally wagtails and pipits (Table 1). We showed the numbers of all species ringed in each group by WRG KULING. However, we omitted 73 species (mainly Passerines) that were outside our research scope and do not belong to any of the four groups.

Table 1
Total number of birds ringed by WRG KULING between 1983 and 2023
with the number of species given in brackets

Group of species	Number of individuals ringed
Waders (Charadrii) (35)	102 351
Gulls and terns (22)	29 543
Other waterbirds (49)	9 259
Wagtails and pipits (10)	9 941
Other species (73)	2 652
Total (189)	153 746

We use the term ‘foreign ring’ to refer to rings that were put on birds by other bird ringers or ringing teams, including those from Poland. When presenting the number of recoveries of birds ringed by WRG KULING in foreign countries and in Poland, we have assumed that in such a compilation, each individual can only be represented once, as some individuals were seen many times in a given country. We did the same for birds with foreign rings that were recovered by our ringing team. In the case of Poland, we excluded individuals ringed by WRG KULING and recovered by us.

To show the advantage of using alphanumeric plastic tags over metal rings, we provided the recovery rate, i.e., the number of birds that needed to be ringed to achieve one recovery outside of Poland. For this comparison, we selected eight species with different body sizes from different taxonomic groups. The significance of differences between metal rings and alphanumeric plastic tags recovery rates was assessed using the G-test. We also provided maps presenting ringing recoveries’ geographical distribution separately for four species to which the research project was dedicated.

During our 40 years of work, there have been major changes in bird taxonomy, including the subdivision of the former Herring Gull *Larus argentatus sensu lato* into 6 species, 3 of which nest in Europe, and the former Bean Goose *Anser fabalis*, which nowadays consists of two species that occur in Poland during the non-breeding season. As we are unable to allocate individuals that had been ringed or observed before this division to new species, in this study, we treat them jointly.

RINGING RESULTS

In total, during 40 years of our activity, we ringed 153,746 birds from 189 species (Table 1). Waders were the most numerous, as this was our target group, and we organised ringing camps every year during their migration period. The high number of ringed gulls and terns resulted from the ringing of chicks in breeding colonies, which accounted for about 60% of the ringed individuals in this group. The total number of birds ringed every year by WRG KULING varied between 2,005 and 8,023, depending on our research projects, the number of birds present in the studied area, and the activity of individual ringers. In 1987, we ringed only 228 birds. This was an exception, after which our research activity returned to its previous level.

Studies on waders

From the very beginning, our research focused on wader migration; therefore, we organized wader ringing stations working both during spring and autumn migration (Fig. 1). Between 1983 and 2001, we carried out the projects at stopover sites in the western part of the Gulf of Gdańsk. Since 1997, we have launched and run the international research programme “*Tringa glareola* 2000” affiliated to the International Wader Study Group. Between 1998 and 2008, we organized seven seminars on wader migration in Poland, where scientists and bird enthusiasts presented the results of their work, including the number of birds ringed at ringing stations. Most results presented in these seminars were published in the journal *The Ring*. In 2001, we started the research projects

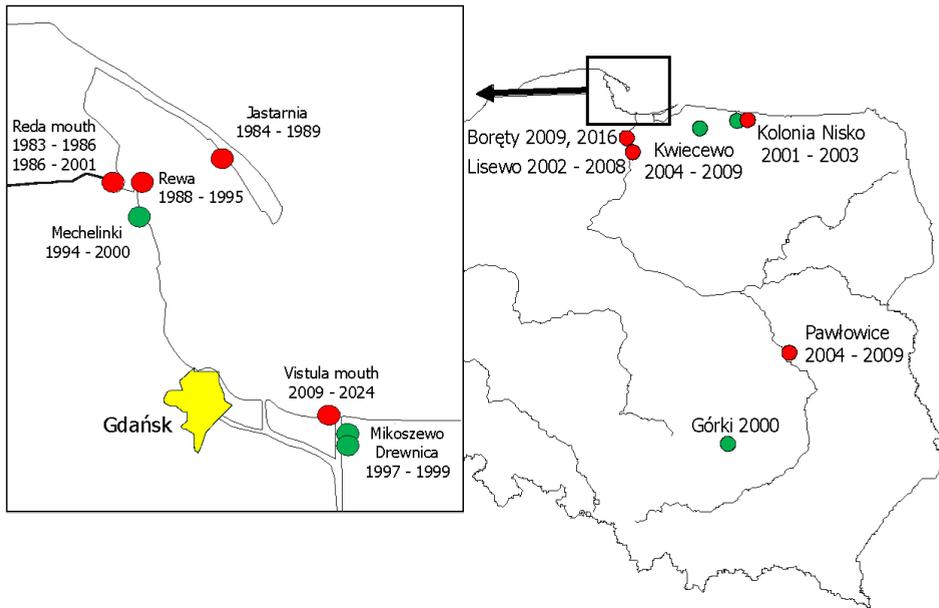


Fig. 1. Locations and years of the WRG KULING wader ringing station activity during autumn (red dots) and spring (green dots) migration

on the Wood Sandpiper *Tringa glareola* and the Common Sandpiper *Actitis hypoleucos* that migrate extensively through the Polish inland. In 2002, to facilitate collecting data on those species, our wader ringing activity moved off the Baltic coast into the riverine habitats of the Vistula River. After finishing these projects, our ringing stations moved back to the Gulf of Gdańsk, and from 2009 onwards, our main wader ringing site is the Vistula Mouth (Fig. 1). Since 2017, we have started ringing of ringed plovers breeding on the Polish Baltic coast, as part of an active conservation project of this species.

In total, 102,351 waders from 35 species were ringed by the WRG KULING ringing team (Table 2). The most numerous was Dunlin *Calidris alpina*, as this is the most common species staging on the Baltic coast during autumn migration (Kube and Struwe 1994, Meissner et al. 2009). The high numbers of the Common Sandpiper and Wood Sandpiper were due to the work of the autumn ringing stations located off the sea coast, between 2002 and 2008, as well as the spring ringing station organised within the international project “*Tringa glareola* 2000” (Remisiewicz 1997, Meissner and Krupa 2017). We also caught 2242 waders with foreign rings, including 651 individuals ringed outside Poland (Table 3). Large numbers of wader species, primarily Dunlins, recaptured with Polish rings were due to the work of a bird ringing station organised by the Polish Academy of Sciences and the Operation Baltic in the Vistula Mouth, i.e., about 45 km eastwards from our ringing stations located in the eastern part of the Gulf of Gdańsk (Brewka *et al.* 1987, Gromadzka 1998). Every year, dozens of dunlins moved between these sites within a few days after ringing. Most non-Polish recoveries came from the sites located on the flyway running along the Baltic coast and the North Sea southern coast. Still, large numbers of

Table 2
Numbers of waders ringed by WRG KULING between 1983 and 2023.

<i>Calidris alpina</i>	63 117	<i>Arenaria interpres</i>	1037	<i>Lymnocyptes minimus</i>	48
<i>Actitis hypoleucos</i>	6 334	<i>Calidris alba</i>	902	<i>Pluvialis apricaria</i>	38
<i>Tringa glareola</i>	5 764	<i>Pluvialis squatarola</i>	769	<i>Phalaropus lobatus</i>	28
<i>Calidris ferruginea</i>	3 926	<i>Calidris temminckii</i>	447	<i>Limosa limosa</i>	11
<i>Calidris canutus</i>	3 307	<i>Calidris falcinellus</i>	359	<i>Gallinago media</i>	7
<i>Charadrius hiaticula</i>	3 187	<i>Numenius arquata</i>	270	<i>Scolopax rusticola</i>	7
<i>Gallinago gallinago</i>	3 092	<i>Tringa erythropus</i>	198	<i>Tringa stagnatilis</i>	3
<i>Tringa totanus</i>	2 756	<i>Tringa ochropus</i>	178	<i>Xenus cinereus</i>	3
<i>Calidris minuta</i>	1 966	<i>Tringa nebularia</i>	174	<i>Calidris maritima</i>	1
<i>Calidris pugnax</i>	1 850	<i>Vanellus vanellus</i>	118	<i>Calidris pusilla</i>	1
<i>Charadrius dubius</i>	1 172	<i>Haematopus ostralegus</i>	108	<i>Charadrius leschenaultii</i>	1
<i>Limosa lapponica</i>	1 074	<i>Numenius phaeopus</i>	98	<i>Total number</i>	102 351

waders that stopover on the Gulf of Gdańsk coast in autumn continue their migration inland in the directions from south-west to south-east. Among these birds, the recoveries from Italy, Ukraine, the Czech Republic, and Hungary are the most numerous. The remarkable difference in the number of recoveries from these two flyways results from a different recovery probability influenced by a high activity of ornithologists and hunters in the western European countries and a limited ornithological activity in the countries of south-eastern Europe (Kania and Busse 1987). Up to now, ringing recoveries obtained by the WRG KULING ringing team were analysed for the Common Sandpiper (Meissner 1997), Redshank (Meissner 2000), Turnstone (Meissner and Koziróg 2000), Common Snipe (Meissner 2002, Minias *et al.* 2010), and partly for the Red Knot (Meissner and Gromadzka 2006). Due to the cooperation with the Royal Netherlands Institute for Sea Research (NIOZ), the data on juvenile red knots collected during our field projects were included in the scientific paper on the body shrinkage and reduced fitness of this species due to Arctic warming published in Science in 2016 (van Gils *et al.* 2016).

Studies on gulls and terns

The vast majority of fully grown gulls were ringed using a loop trap (Table 4; Meissner and Fischer 2007). The main aim of this study was to track short-distance movements and site fidelity of these species in the Gulf of Gdańsk region in the non-breeding season. From the winter season 2008/2009 onwards, all gull species were ringed with an alphanumeric coloured plastic ring apart from a metal one, which substantially increased the number of resightings. Another recently finished project concerns adult black-headed gulls captured in their breeding colonies located in the four distant parts of Poland. The aim of this project was to evaluate the differences in migratory direction of individuals originating from these colonies and the location of their wintering grounds. In addition, we ringed gull chicks in the colonies near the Gulf of Gdańsk and occasionally chicks of the Mediterranean Gull *Ichthyaeetus melanocephalus* with the ringing of tern chicks in mixed colonies.

BY-Minsk						6											6
TR-Ankara						5											5
BE-Bruxelles				1		3											4
PT-Lisboa			1	1		2											4
EE-Matsalu	1					2											3
ZA-Safring			3														3
LV-Riga			1			1									1		3
NO-Oslo				1		2											3
JE-Jersey						1											1
DE-Radolfzell	1																1
HR-Zagreb						1											1
SL-Ljubljana	1																1
Total	10	24	59	86	4	1 935	1	20	3	56	2	1	2	5	33	1	2 242

Moreover, we ringed the Herring Gull chicks in the colony in the Gdynia harbour to compare their survival rate with chicks reared at the nearest wildlife rehabilitation centre.

Since 2006, we have monitored breeding success of the Sandwich Tern *Thalasseus sandvicensis* in the only Poland colony and ring hatched chicks every year (Table 4). The other tern species, whose chicks are ringed numerously, is the Common Tern *Sterna hirundo* (Table 4). We focused on the colony in the Vistula River region and in the lower Vistula near Świecie, where birds nest on specially prepared barges. We also catch terns with mist nets at night during autumn migration, recently with tape-luring (Meissner 1999). The main idea behind these ringing projects is to gain knowledge about the timing and directions of tern migration and the location of their wintering grounds, as well as the analysis of their flight feather moult (Meissner and Krupa 2007).

Table 4
Number of gulls and terns ringed by WRG KULING between 1983 and 2023.

Species	Number	Species	Number
<i>Chroicocephalus ridibundus</i>	11 266	<i>Ichthyaetus melanocephalus</i>	40
<i>Sterna hirundo</i>	6 174	<i>Larus fuscus</i>	13
<i>Larus argentatus sensu lato</i>	4 221	<i>Chlidonias leucopterus</i>	8
<i>Thalasseus sandvicensis</i>	3 496	<i>Sterna paradisaea</i>	6
<i>Larus canus</i>	2 802	<i>Larus hyperboreus</i>	4
<i>Sternula albifrons</i>	795	<i>Chroicocephalus ridibundus</i> X <i>Ichthyaetus melanocephalus</i>	2
<i>Chlidonias niger</i>	290	<i>Larus glaucoides</i>	1
<i>Chlidonias hybrida</i>	157	<i>Larus michahellis</i>	1
<i>Larus marinus</i>	144	<i>Hydroprogne caspia</i>	1
<i>Hydrocoloeus minutus</i>	70		
<i>Larus cachinnans</i>	52	Total	29 543

About 60% of recovered gulls were ringed in Poland, and the vast majority of them in the eastern part of the Gulf of Gdańsk region, which is WRG KULING's main study area (Table 5). A large number of gulls with foreign rings came from the eastern and northern Baltic countries. The Black-headed Gull, Herring Gull, Common Gull, *Larus canus*, and Great Black-backed Gull, *Larus marinus* are abundant in the Gulf of Gdańsk as they migrate in high numbers through this region, as well as some of them winter there (Meissner and Nitecki 1999, Meissner *et al.* 2007). Similar to waders, gulls with foreign rings also came from western and southern locations. This pattern is particularly clear in the Black-headed Gull and Herring Gull *sensu lato*. In the former species, migrants crossing the southern Baltic during autumn continue their migration towards the wintering grounds in a wide range of directions (Fransson *et al.* 2008, Valkama *et al.* 2014). The latter taxon includes the southern species, the Caspian Gull *Larus cachinnans* and the Yellow-legged Gull *Larus michahellis*, which reach central and northern Poland during post-breeding dispersion (Neubauer *et al.* 2001, 2005, WRG KULING – unpublished data). Moreover, the Caspian Gull extends its breeding range northwards, and nowadays its colonies are in Central Poland (Przymencki *et al.* 2022).

Table 5

Number of gulls and terns with foreign rings recaptured or observed by WRG KULING in 1983-2023. Listed according total numbers.

Ringling Centre	<i>Larus argentatus – sensu lato</i>	<i>Larus canus</i>	<i>Larus delawarensis</i>	<i>Larus fuscus</i>	<i>Larus marinus</i>	<i>Larus melanocephalus</i>	<i>Hydrocoloeus minutus</i>	<i>Chroicocephalus ridibundus</i>	<i>Sternula albifrons</i>	<i>Hydroprogne caspia</i>	<i>Sterna hirundo</i>	<i>Thalasseus sandvicensis</i>	<i>Chlidonias niger</i>	<i>Chlidonias hybrida</i>	Total
PL-Gdańsk	1 780	296	2	1	17	5		3 837	2		40			6	5 980
FI-Helsinki	1 699	28		19	117		1	77		24	9				1 974
LT-Kaunas	356	4						201	1		12				574
DE-Helgoland	17	50				3		499				5			574
EE-Matsalu	254	27			13			13			3	12			322
DK-Copenhagen	70	59		1	3			80				46			259
HR-Zagreb	61							155							216
SE-Stockholm	46	44		1	28		2	29		5		60			215
DE-Hiddensee	102							45			4	35			186
NL-Arnhem	1	22						145			1	3			172
RU-Moscow	64				3			33			2				102
BY-Minsk	64							2							66
HU-Budapest		5						51							56
CZ-Praha	1							51							52

BE-Bruxelles		5						42				2			49
GB-London								45							45
LV-Riga	10							26			2				38
UA-Kiev	30											1			31
IL-Tel-Aviv											13				13
ZA-Safring											11		1		12
IT-Ozzano	6							6							12
ES-Madrid								3			1	4			8
RS-Beograd								5							5
NO-Stavanger	1			2	1										4
SI-Ljubljana	3														3
CH-Sempach								1							1
FR-Paris								1							1
Catalunya								1							1
Total	4 565	540	2	24	182	8	3	5 348	3	29	98	168	1	6	10 977

The most distant recoveries in this group of species were reported in the Common Tern, as its wintering grounds extend to the southern hemisphere. A high number of recoveries on terns were from birds ringed in the Baltic countries, as they migrate through the Gulf of Gdańsk region.

Studies on other waterbird species

In 2005, we began ringing mallards to study their biometric variability, body condition during wintering, and winter site fidelity. Although most mallards were ringed around the Gulf of Gdańsk, large numbers were also marked in other Polish towns, including Warsaw, Olsztyn, Szczecin, and Ełk. The first paper based on this long-term project has already been published (Manikowska-Ślepowrońska and Meissner 2022). Due to this project, the number of ringed mallards is the highest among other species in this group (Table 6). For a few years, we conducted a research project focused on the Coot *Fulica atra* and its biometric variability, resulting in the ringing of several hundred individuals (Meissner 2010). Quite a high number of seabirds (Razorbill *Alca torda*, Common Guillemot *Uria aalge*, and divers *Gavia sp.*) were ringed on fishing vessels operating in the Baltic. These birds were released from fishing nets as part of a project aiming to monitor the Harbour Porpoise *Phocoena phocoena* bycatch in different types of fishing gear. Of the other waterbird species, only the Mute Swan *Cygnus olor* ringing was done during research projects on biochemical parameters and the heavy metal content of the blood of this species (Binkowski *et al.* 2016, Meissner *et al.* 2020). The other species in this group were ringed on various occasions, often when carrying out other scientific projects.

Table 6
Number of other waterbirds ringed by WRG KULING between 1983 and 2023

<i>Anas platyrhynchos</i>	6 956	<i>Tachybaptus ruficollis</i>	23	<i>Podiceps cristatus</i>	6
<i>Fulica atra</i>	714	<i>Branta canadensis</i>	18	<i>Cygnus cygnus</i>	5
<i>Alca torda</i>	258	<i>Gavia arctica</i>	16	<i>Branta leucopsis</i>	4
<i>Phalacrocorax carbo</i>	232	<i>Anser anser</i>	13	<i>Bucephala clangula</i>	4
<i>Cygnus olor</i>	183	<i>Mergus merganser</i>	11	<i>Clangula hyemalis</i>	3
<i>Anas crecca</i>	139	<i>Aix galericulata</i>	10	<i>Aix sponsa</i>	2
<i>Rallus aquaticus</i>	116	<i>Branta bernicla</i>	9	<i>Branta ruficollis</i>	2
<i>Uria aalge</i>	97	<i>Ardea alba</i>	9	<i>Podiceps grisegena</i>	2
<i>Tadorna tadorna</i>	73	<i>Spatula clypeata</i>	8	<i>Zapornia parva</i>	2
<i>Porzana porzana</i>	70	<i>Gavia stellata</i>	8	<i>Aythya marila</i>	1
<i>Gallinula chloropus</i>	48	<i>Ixobrychus minutus</i>	7	<i>Melanitta fusca</i>	1
<i>Spatula querquedula</i>	46	<i>Anas acuta</i>	6	<i>Melanitta nigra</i>	1
<i>Crex crex</i>	38	<i>Mareca penelope</i>	6	<i>Podiceps auritus</i>	1
<i>Anser albifrons</i>	33	<i>Mareca strepera</i>	6	<i>Somateria mollissima</i>	1
<i>Grus grus</i>	29	<i>Anser fabalis sensu lato</i>	6		
<i>Ardea cinerea</i>	24	<i>Aythya fuligula</i>	6	Total	9 259

Table 7

Number of other waterbirds with foreign rings caught or observed by WRG KULING in 1983-2023. Listed according total numbers.

Ringling Centre	<i>Aix galericulata</i>	<i>Alca torda</i>	<i>Mareca penelope</i>	<i>Anas platyrhynchos</i>	<i>Anas sibilatrix</i>	<i>Anser albifrons</i>	<i>Anser anser</i>	<i>Anser fabalis sensu lato</i>	<i>Aythya fuligula</i>	<i>Cygnus bewickii</i>	<i>Cygnus cygnus</i>	<i>Cygnus olor</i>	<i>Fulica atra</i>	<i>Gavia stellata</i>	<i>Uria aadge</i>	Total
PL-Gdańsk	176		1	671	1	3	10	2			11	6 143	28			7 046
SE-Stockholm		11		4											328	343
DK-Copenhagen		19								2		37				58
LT-Kaunas				4							5	41				50
LV-Riga				10							1	17				28
FI-Helsinki		22												1		23
NL-Arnhem						8		7		1						16
HR-Zagreb												7				7
DE-Hiddensee						1						3	1			5
HU-Budapest												5				5
DE-Helgoland															3	3
SK-Bratislava												3				3
GB-London															1	1
CH-Sempach									1							1
DE-Radolfzell													1			1
RU-Moscow						1										1
BY-Minsk												1				1
Total	176	52	1	689	1	13	10	9	1	3	17	6 257	30	1	332	7 592

About 82% of ringing recoveries on waterbirds were on the Mute Swan (Table 7). This species is numerous during the winter season and is ringed in very high numbers by other ringing teams on the municipal beaches. Due to the large size of the ring, the code is easy to read even without binoculars; therefore, mute swans are very often reported. All recoveries of the Mandarin Duck *Aix galericulata* and a high number of the Mallard were from expeditions to Warsaw, where these species are mostly sedentary and are ringed numerous by Warsaw Ringing Group TRIDACTYLUS (Redlisiak *et al.* 2018). Due to the monitoring of seabird bycatch, the number of recoveries of the Auk and Common Guillemot is high, and these species are numerous ringed in the colonies in the Baltic region.

Studies on wagtails and pipits

We used walk-in traps primarily to catch waders; however, this technique results in a substantial number of wagtails and pipits captured (Polak 2004). The number of trapped wagtails distinctly increased when a fieldwork was carried out in the Lisewo ringing station, located on the edge of a pasture by the Vistula riverbank. Due to the large number of captured individuals, we launched a project on their stopover ecology. The two species: Yellow and White Wagtail (*Motacilla flava*, *M. alba*) constituted 91% of all ringed birds from this group (Table 8). Apart from data on their linear body measurements, body mass, and fat score, we collected data on the post-juvenile moult progress. These data were also collected at our next ringing station located near Pawłowice in the Middle Vistula valley (Fig. 1). The aim of this research was to compare migration and post-juvenile moult strategies of the Yellow and White Wagtail, as these closely related species distinctly differ in their migration distance. We developed a new method for sexing juvenile white wagtails according to the discriminant function based on their measurements (Meissner *et al.* 2020) that will be implemented in this project. The high number of ringed citrine wagtails, *Motacilla citreola*, resulted from the ringing of pulli from the first breeding population of this species in Poland - in the nature protected areas 'Beka' and 'Mechelińskie Łąki' located in the Gulf of Gdańsk (Ściborska 2004).

Table 8
Number of wagtails and pipits ringed by WRG KULING
between 1983 and 2023

<i>Motacilla flava</i>	5 173	<i>Anthus cervinus</i>	12
<i>Motacilla alba</i>	3 886	<i>Anthus campestris</i>	2
<i>Anthus pratensis</i>	657	<i>Anthus spinoletta</i>	2
<i>Motacilla citreola</i>	190	<i>Motacilla cinerea</i>	2
<i>Anthus petrosus</i>	16	<i>Anthus trivialis</i>	1
		Total	9 941

The number of ringing recoveries on small-sized Passerines is usually very low (Remisiewicz 2002; Procházka *et al.* 2017). Hence, in the case of wagtails and pipits, WRG KULING captured only 14 individuals with foreign rings, out of which 13 were ringed in Poland. The only non-Polish recovery is a Yellow Wagtail ringed in Malta during spring migration and recaptured 14 days later in the WRG KULING ringing site.

RINGING RECOVERIES

In the 80s and 90s of the last century, most ringing recoveries were from individuals recaptured or birds found dead. Use of coloured alphanumeric plastic rings resulted in a distinctive increase in the number of recoveries, as they enabled reading the code from a distance without the necessity to catch the bird (Meissner and Bzoma 2011). Moreover, the rapid development of digital photography allowed easy reading of rings even from a large distance. WRG KULING ringing team started to use coloured plastic rings in 2008 and has been using this kind of tags in gulls, terns, mallards, and several wader species. In addition, to increase the recovery rate, we have organised a citizen science project 'LOOP', in which amateur ornithologists compete in the number of rings read on birds. Each year, prizes are awarded to the participants with the highest points for the number of resightings of rings. The results of this competition are published online monthly, and most of the recovered rings have photographic documentation, which is important in the case of such projects based on citizen science.

The recovery rate from alphanumeric coloured plastic tags was significantly higher than that from metal rings in all eight species we analysed (G test, $p < 0.004$ in all cases; Table 9). However, the difference between these two rates is the lowest in the Mallard. In Poland, metal rings for ducks are oval in shape, which allows reading the whole inscription by taking a single photo from one side only, whereas getting the whole inscription on a circular ring requires at least two or three photos (Photo 1).

Table 9

Comparison of ringing recovery rate obtained from metal and colour rings in eight species. Species have been arranged in descending order of recovery rate obtained from metal rings.

Species	Only metal ring			Additional colour ring			Difference
	Ringed	Ringing recoveries	Recovery rate*	Ringed	Ringing recoveries	Recovery rate*	
<i>Limosa lapponica</i>	737	22	33.5	337	197	1.7	94.9%
<i>Sterna hirundo</i>	2 348	87	27.0	3 826	855	4.5	83.4%
<i>Charadrius hiaticula</i>	1 691	65	26.0	1 496	623	2.4	90.8%
<i>Calidris alpina</i>	36 734	2 502	14.7	26 383	4 894	5.4	63.3%
<i>Calidris canutus</i>	2 657	182	14.6	650	299	2.2	85.1%
<i>Chroicocephalus ridibundus</i>	6 994	781	9.0	4 272	4 421	1.0	89.2%
<i>Larus argentatus</i>	2 603	413	6.3	1 671	1 696	1.0	84.4%
<i>Anas platyrhynchos</i>	6 138	2 806	2.2	818	450	1.8	16.9%

* the number of individuals that needed to be ringed to achieve one recovery

Geographical distribution of ringing recoveries

Most recoveries of birds ringed by the WRG KULING ringing team are from Western Europe (Figs 2-6), since many wader and waterbird species that we study in Poland migrate

through or winter in that part of the continent, as well as the activity of bird observers and ringers is very high there. Therefore, migration from Poland to the south is also more pronounced in the south-west than in the south-east direction (Figs 2-6). The most distant ringing recoveries in the East were from mallards (2,764 and 2, 274 km from the ringing site) and the Dunlin (2,391 km from the ringing site) (Fig. 2). Two recoveries from the North Atlantic came from the Red Knot (Fig. 2) and were the furthest recoveries to the

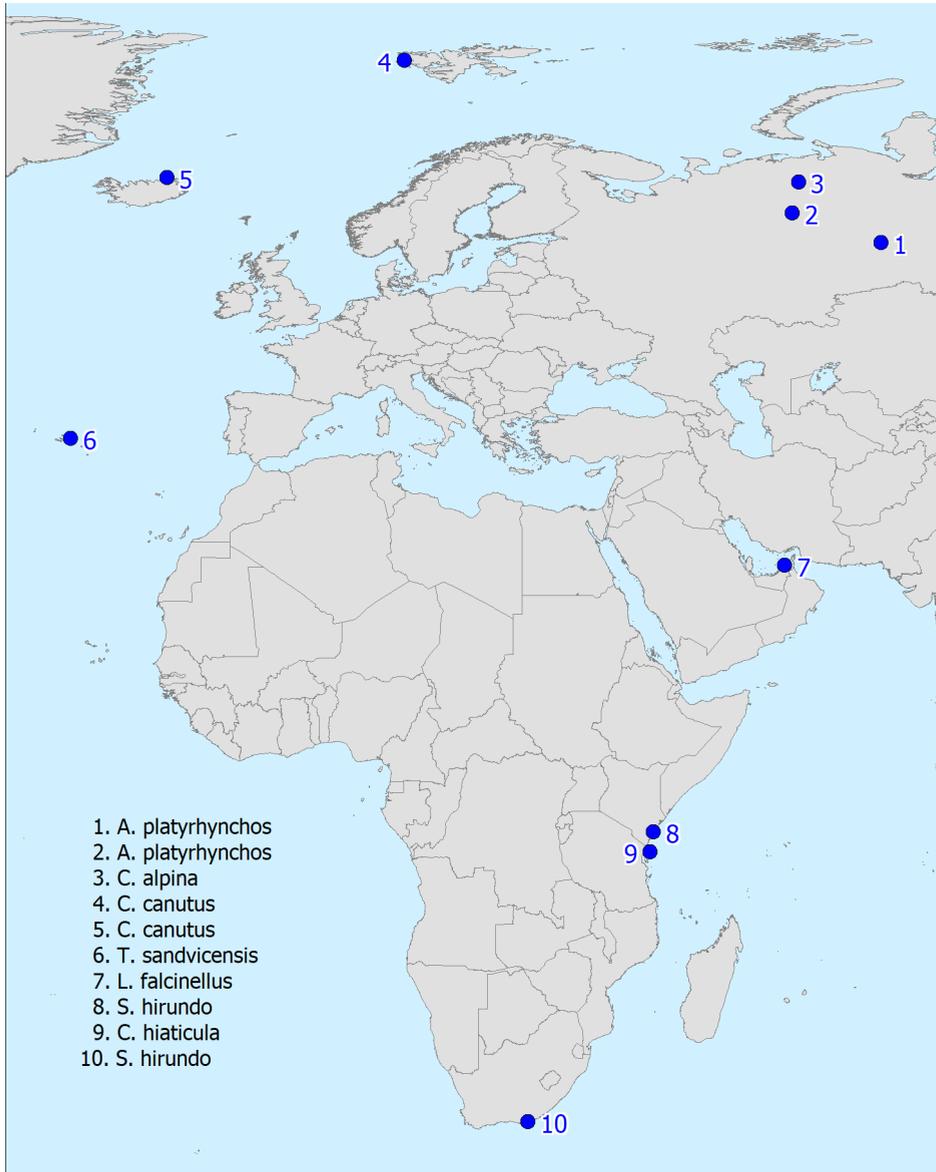


Fig. 2. The most distant ringing recoveries of birds ringed by WRG Kuling

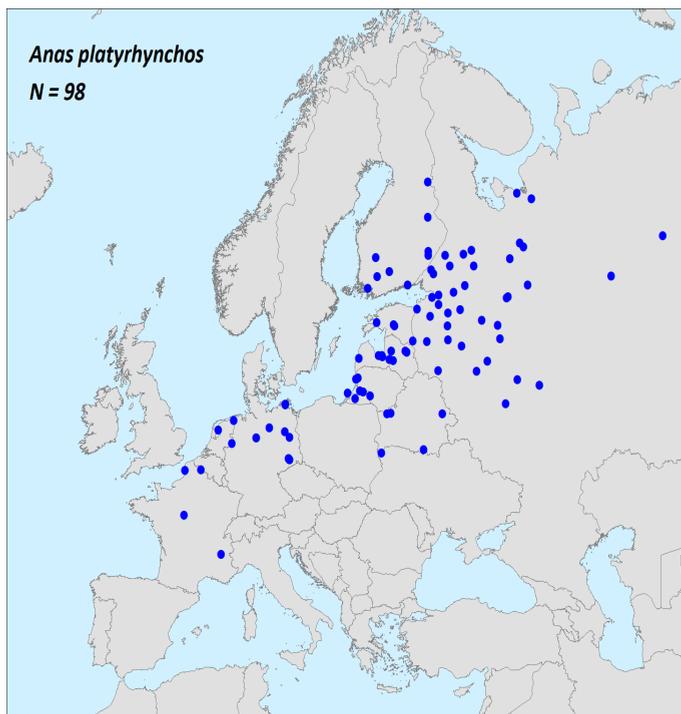


Fig. 3. Ringing recovery distribution of the Mallard caught by WRG KULING in Poland. For simplicity birds recovered in Poland were omitted

West confirming that individuals of the Nearctic subspecies *C. canutus islandica* appear in the southern Baltic during their autumn migration (see: Meissner and Gromadzka 2006). Overall, the most westward ringing recovery (Fig. 2) was from a Sandwich Tern observed in the Azores (3,834 km from the ringing site). Ringing recoveries in the East African coast and Arabian Peninsula are rare (Bønløkke et al. 2006; Cepák et al. 2008; Bairlein et al. 2014). Only three birds ringed by WRG KULING were found there (Fig. 2), including the Broad-billed Sandpiper *Calidris falcinellus*, a species with a very limited number of recoveries, caught in Dubai (4,400 km from the ringing site). Two common terns found dead in the Red Sea region (3 670 km from the ringing site) and on the Kenyan coast (6 563 km from the ringing site) confirmed, that at least some individuals ringed in Poland use the East African migratory route (Fig. 2). Quite numerous ringing recoveries from South Africa concern 15 sandwich terns, 11 common terns and one turnstone. Among them is the most distant ringing recovery from a bird ringed in Poland (9,887 km) concerning a Common Tern hatched in Gdańsk, observed in Gansbaai harbour, South Africa (Fig. 2).

The Mallard is a medium or short-distance migrant (Cramp and Simmons 1977). However, the most distant recoveries came from the European part of Russia (Fig. 3), more than 2,200 km from the ringing site, which indicates that some mallards arrive to winter in Poland from remote areas, similar to birds ringed in other Central European

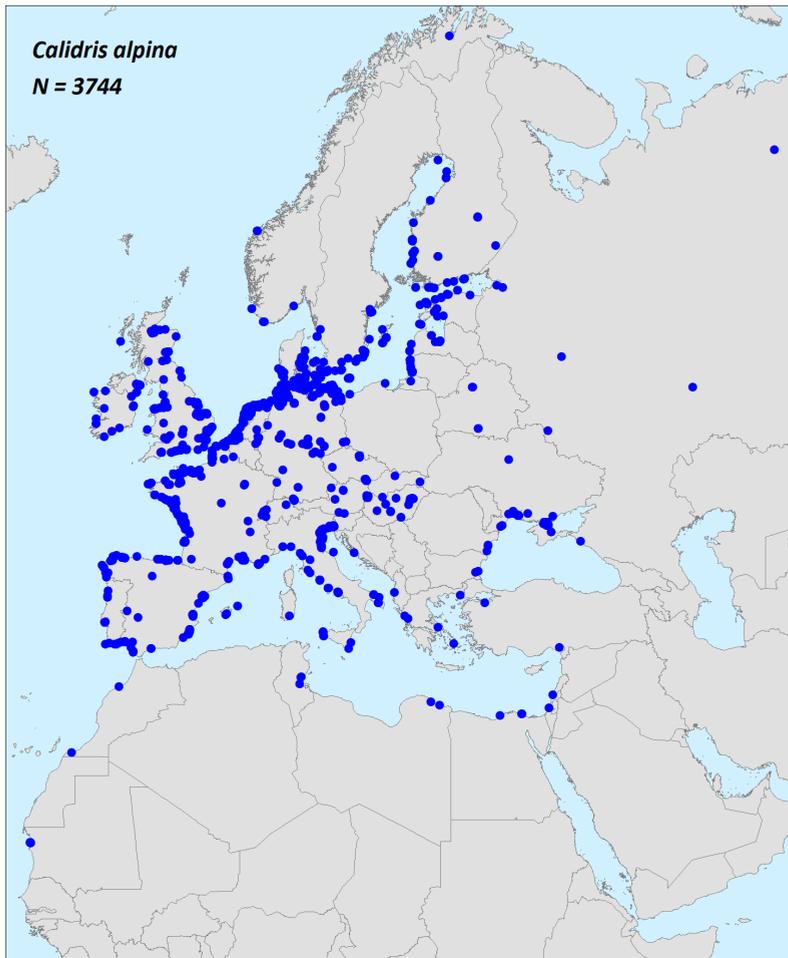


Fig. 4. Ringing recovery distribution of the Dunlin caught by WRG KULING in the Gulf of Gdańsk region (asterisk). For simplicity birds recovered in Poland were omitted

countries (Bønløkke *et al.* 2006, Cepák *et al.* 2008, Bairlein *et al.* 2014). Birds ringed by our team in the non-breeding season have their breeding ground east and northeast of Poland, while a part of our breeding population migrates to wintering sites localized westwards (Fig. 3).

Dunlins departing in autumn from the Gulf of Gdańsk exhibit a wide range of migration directions, from western to south-eastern (Fig. 4). This species winters numerously in the Black Sea northern coasts (Chernicko *et al.* 1991) and previous studies have shown that some birds staging in the Gulf of Gdańsk region passed Central European inland heading to this wintering site (Gromadzka 1983, 1989). Some of them even reach North Africa – documented with one recovery from Mauritania (Fig. 4).

Most Ringed Plover ringing recoveries came from the Polish Baltic breeding population belonging to the subspecies *hiaticula*, which is a short-distance migrant. That is

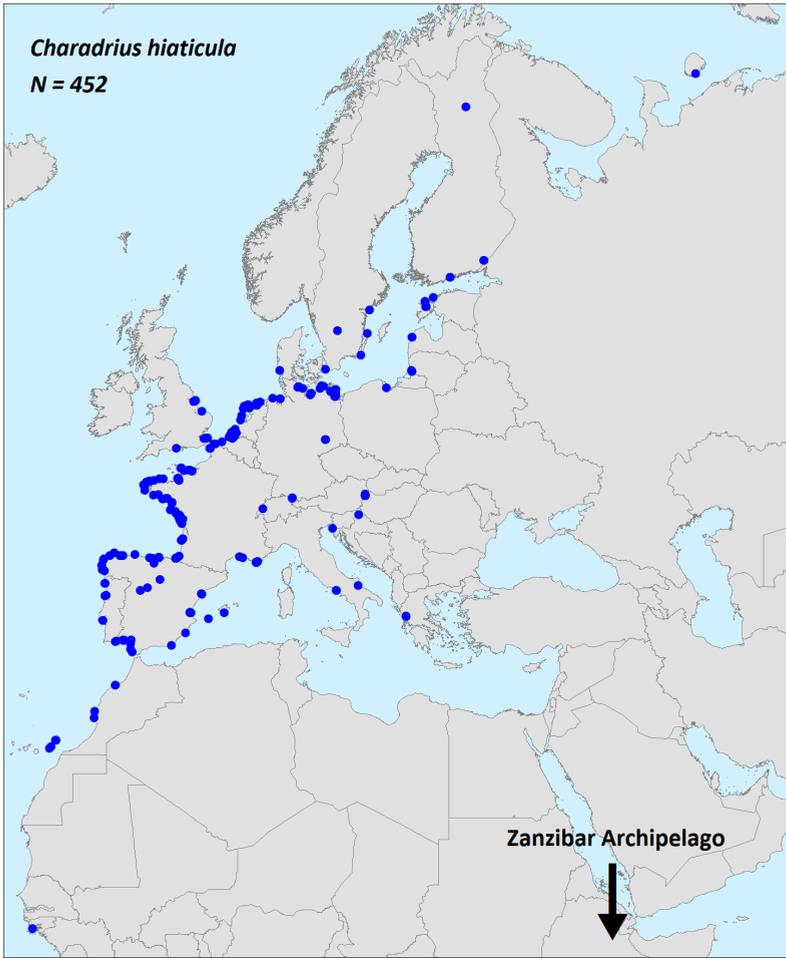


Fig. 5. Ringing recovery distribution of the Ringed Plover caught on the Polish Baltic coast. For simplicity birds recovered in Poland were omitted

why many recoveries were reported from the sea coasts of Western European countries, where these birds spent winter (Fig. 5). The subspecies *tundrae* from northern Europe is a long-distance migrant, which also migrates through the Baltic (Meissner 2007). There are at least four ringing recoveries from this subspecies coming from the Kolguyev Island, Northern Finland, Guinea, and Pemba (Zanzibar Archipelago) (Figs 2 and 5).

The number of Black-headed Gull recoveries has increased substantially since 2008 due to the use of plastic alphanumeric rings. Their geographical distribution in general confirmed our knowledge of the migratory direction of this species through Central Europe (Fransson *et al.* 2008; Valkama *et al.* 2014), but quite a good number of ringing recoveries were obtained from southern and south-eastern Europe, showing that individuals caught in Poland migrate also towards the Black Sea and Eastern Mediterranean regions (Fig. 6).

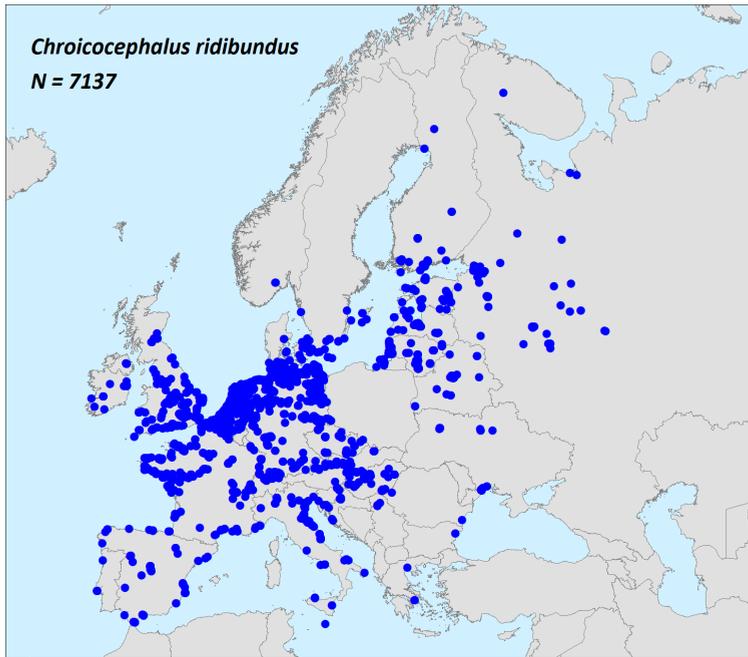


Fig. 6. Ringing recovery distribution of the Black-headed Gull caught in Northern Poland. For simplicity birds recovered in Poland were omitted

CONCLUSIONS

WRG KULING is an example of how a student initiative turned into a well-organised and fruitful cooperation between scientists and amateur ornithologists. While there have been and still are many similar initiatives in Poland and other countries, most of them end after a few years. To sustain these initiatives, it is crucial to obtain support from scientific centres, allowing for the development of proper research methods, scientific supervision of the projects based on the collected material, and finally their subsequent publication in scientific journals. Obtaining a full-time research position at the University of Gdańsk in the Department of Vertebrate Ecology and Zoology by some of the activists enabled carrying out scientific projects and resulted in almost 200 published studies, dozens of bachelor's and master's theses, as well as several doctoral theses. Over the past 40 years, we have collected the long-term dataset on waders, gulls, terns, and waterbirds, and there are still several open scientific questions to answer and exciting research to carry out. Currently, we also collaborate with other well-established European scientific centres and are open to new initiatives, volunteers, and young scientists who would like to join our team.

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Author contributions

Włodzimierz Meissner: Conceptualization, Writing – original draft, Writing – review and editing; head of KULING ringing team; Zenon Rohde: Data curation, Software, Visualization; Szymon Bzoma: ringer and member of KULING ringing team for more than 25 years – review and editing; Agnieszka Ożarowska: Writing – review and editing; ringer and member of KULING ringing team; Piotr Rydzkowski: member of KULING ringing team for more than 25 years – review and editing; Marta Witkowska: Writing – review and editing; ringer and member of KULING ringing team; Anna Włodarczak-Komosińska: ringer and member of KULING ringing team for at least 25 years – review and editing; Cezary Wójcik: member of KULING ringing team for more than 25 years – review and editing.

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