Satellite tracking of the migratory pathways of first-year Lesser Black-backed Gulls *Larus fuscus* departing from the breeding grounds of different subspecies

Klemens Pütz, Carsten Rahbek, Pertti Saurola, Kjeld T. Pedersen, Risto Juvaste & Andreas J. Helbig

K. Pütz, K., C. Rahbek, P. Saurola, K. T. Pedersen, R. Juvaste & A. J. Helbig 2007: Satellite tracking of the migratory pathways of first-year Lesser Black-backed Gulls *Larus fuscus* departing from the breeding grounds of different subspecies. Vogelwelt 128: 141 – 148.

The migratory behaviour of two Lesser Black-backed Gull *Larus fuscus* subspecies, *fuscus* and *intermedius*, was studied using satellite telemetry. To this end, first-year birds were equipped with satellite transmitters and released either at their natal site, or after transferring to a breeding site of the other subspecies. In addition, first-year birds from cross-breeding experiments between the two subspecies (*fuscus* x *intermedius*) were also equipped with satellite transmitters. In total, eleven first-year birds were successfully tracked during their initial autumn migration, at least one from each study group. First-year birds from the Danish *intermedius* subspecies migrated either southwest along the coast of the North Sea or through central Europe to Algeria. By contrast, first-year birds from the Finnish *fuscus* subspecies migrated on a south-southeastern course towards Ukraine and the Bosporus, Turkey. Only one of the transferred gulls could be tracked long enough to accurately determine the migratory behaviour: this bird from the *intermedius* subspecies left Finland on a south-southeasterly course towards the Ukraine, where transmission ceased. Thus, this gull resembled the migratory behaviour of the *fuscus* subspecies. One bird from the cross-breeding experiments wintered in Libya, but the migratory behaviour remained unknown due to the lack of positional data.

Key words: Lesser Black-backed Gull *Larus fuscus*, satellite telemetry, migratory direction of subspecies.

1. Introduction

Research into bird migration began mainly with Aristotle (for review see Berthold 2001) and was based exclusively on observation. It was not until the early 20th century that a new era started with the first ringing programme, which significantly advanced our understanding of migratory behaviour of birds. However, it was with the advent of satellite telemetry in the late 20th century that a new chapter in the study of bird migration has been opened. Researchers can now continuously and more comprehensively monitor the movements of individual birds compared with ringing, which is subject to considerable bias and observation gaps on an individual and even population scale (e. g. Gauthier-Clerc & Le Maho 2001; Irsch 2006).

It seems that many important parameters of bird migration are based on genetic factors. For example, most passerines crossing the Sahara migrate nocturnally and solitarily, and even first-year birds find their wintering sites in Africa without adult guidance (for review see Berthold 2001). However, also behavioural plasticity almost certainly plays a significant role in the migratory behaviour of birds, in particular unexperienced ones. By tracking first-year birds of different subspecies with different migratory pathways, the individual response to different environmental cues might provide insights into the interaction between genetical determination and behavioural plasticity of birds.

Lesser Black-backed Gulls *Larus fuscus* breed, in four subspecies, throughout the northern parts of the western Palearctic (del Hoyo *et al.* 1996). The two subspecies investigated in this study differ in their migratory behaviour: birds from the *intermedius* subspecies migrate predominantly southwest along the European coast to winter along the Atlantic coast from France to Mauritania, western Africa (Bakken *et al.* 2003; Malling Olsen & Larsson 2004; Bønløkke *et al.* 2006). Birds of the *fuscus* subspecies migrate along the eastern flyway inland and mostly via the Bosporus to their wintering sites in eastern Africa (Kilpi & Saurola 1984; Urban *et al.* 1986; Malling Olsen & Larsson 2004). The aim of this study was to investigate the migratory behaviour of these subspecies using satellite telemetry. To this end, a number of first-year birds was equipped with satellite transmitters and released either at their natal site, or after transferring them to a breeding site of the other subspecies. Additionally,

Table 1: Details of the migration of first-year Lesser Black-backed Gulls. Study groups refer to (1) Danish *intermedius* birds released at their natal site, (2) Finnish *fuscus* birds released at their natal site, (3) Danish *intermedius* birds released in Finland, (4) Finnish *fuscus* birds released in Denmark, and (5) birds from cross-breeding experiments released in Germany. Due to the fact that locations were received quite irregularly (see methods), only the distance between the site of release and the final location was calculated. For the same reasons, the flight direction was only calculated between these two locations. The onset of the migration of bird 23790-04 could not be determined, because the first position away from the release location, as well as all subsequent locations, were obtained in Libya. – *Details zum Zugverhalten der untersuchten erstjährigen Heringsmöwen. (1) Vögel der Unterart* intermedius, *die in ihrem dänischen Brutgebiet aufgelassen wurden, (2) Vögel der Unterart* fuscus, *die in ihrem finnischen Brutgebiet aufgelassen wurden, (3) dänische Vögel der Unterart* intermedius, *die in Finnland aufgelassen wurden, (4) finnische Vögel der Unterart* fuscus, *die in Dänemark aufgelassen wurden, und (5) Vögel aus Kreuzungsexperimenten, die in Deutschland aufgelassen wurden. Da Positionen nur unregelmäßig erhalten wurden, bezieht sich die berechnete Wegstrecke nur auf die Distanz zwischen Start- und Endpunkt. Auf der gleichen Grundlage wurde die Zugrichtung berechnet. Der Zugbeginn der Heringsmöwe 23790-04 konnte nicht bestimmt werden, da alle Positionen abseits des Auflassungsortes aus Libyen erhalten wurden.*

Bird-No. – *Ind. Nr.*	Study group – *Gruppe*	Breeding site – *Brutgebiet*	Date of equipment – *Datum der Besenderung*	Date of release – *Auflassdatum*	Start of migration – *Zugbeginn*	End of transmission – *Ende der Datenübertragung*	Duration [d] – *Dauer [Tage]*	Final position – *letzte Ortung*	Distance – *Entfernung*	Direction – *Richtung*
23761-00	1	Saltholm, DK	13.07.2000	13.07.2000	21.09.2000	05.11.2000	45	France – *Frankreich*	1090 km	220°
23761-01	1	Fyns Hoved, DK	19.08. 2001	22.08. 2001	30.10. 2001	28.05. 2002	210	Algeria – *Algerien*	2100 km	190°
23753-02	1	Fyns Hoved, DK	09.07. 2002	10.07. 2002	09.09. 2002	30.09. 2002	21	Netherlands – *Niederlande*	490 km	235°
35217-02	2	Mallasvesi, FIN	12.07. 2002	12.07. 2002	04.08. 2002	09.12. 2002	127	Ukraine – *Ukraine*	1330 km	165°
35227-02	2	Mallasvesi, FIN	12.07. 2002	12.07. 2002	26.08. 2002	22.10. 2002	57	Turkey – *Türkei*	2260 km	175°
23713-02	3	Fyns Hoved, DK	16.07. 2002	24.08. 2002	14.09. 2002	29.06. 2003	288	Ukraine – *Ukraine*	1150 km	170°
23788-02	3	Fyns Hoved, DK	16.07. 2002	24.08. 2002	30.10. 2002	14.11. 2002	15	Poland – *Polen*	850 km	220°
35219-02	3	Fyns Hoved, DK	16.07. 2002	24.08. 2002	02.09. 2002	26.10. 2002	54	Poland – *Polen*	800 km	220°
35222-02	4	Mallasvesi, FIN	16.07. 2002	21.08. 2002	24.08. 2002	03.10. 2002	40	Germany – *Deutschland*	200 km	125°
23711-03	5	Marlow, D	12.08. 2003	02.10. 2003	09.10. 2003	10.10. 2003	1	Germany – *Deutschland*	320 km	165°
23790-04	5	Marlow, D	13.08. 2004	04.10. 2004	<23.11. 2004	07.11. 2005	457	Libya – *Libyen*	2540 km	165°

first-year birds from cross-breeding experiments of the two subspecies were also satellite tracked. Satellite telemetry was used here in a novel experimental setup rather than in a purely descriptive way.

2. Methods

In order to investigate the migratory behaviour of Lesser Black-backed Gulls, five different study groups were equipped with satellite transmitters and their movements monitored: (a) first-year birds of the *intermedius* subspecies were released from a native breeding site (Denmark), (b) first-year birds of the *intermedius* subspecies (Denmark) were released in Finland, (c) first-year birds of the *fuscus* subspecies were released from a native breeding site (Finland), (d) first-year birds of the *fuscus* subspecies (Finland) were released in Denmark, and (e) captivity-bred first-year birds from cross-breeding experiments between the two subspecies were released within the breeding range of the *intermedius* subspecies (Germany).

Field work was conducted between 2000 and 2002 in Saltholm (55.63 °N, 12.76 °E) and Bogø, Lillestrand, Fyns Hoved (55.59 °N, 10.61 °E) in Denmark, and at Lake Mallasvesi (61.28 °N, 24.13 °E) near Valkeakoski in Finland (Table 1). Release locations for translocated birds were Fyns Hoved, Denmark, and Korkeasaari near Helsinki, Finland (60.17 °N, 24.98 °E). Cross-breeding experiments were conducted in the "Vogelpark Marlow" (54.14 °N, 12.57 °E), a large bird sanctuary in northern Germany. In 2001, ten adult birds of each subspecies were captured in Saltholm, Denmark, and at Tampere refuse dump (61.54 °N, 23.98 °E), Finland, and kept in an aviary with dimensions of 35 x 10 x 10 m. The aviary was further subdivided into two compartments, one holding males from Denmark and females from Finland and the other vice-versa. The first successful breeding occurred in 2003 with three chicks from one pair, followed by another five chicks from two pairs in 2004. First year birds from the cross-breeding experiments were released in Rostock harbour, Germany (54.17 °N, 12.08 °E; Table 1).

In total, 34 birds were equipped with solar-powered PTT-100 18 g satellite transmitters (Microwave Telemetry Inc., USA). However, the onset of the winter migration could be monitored in only

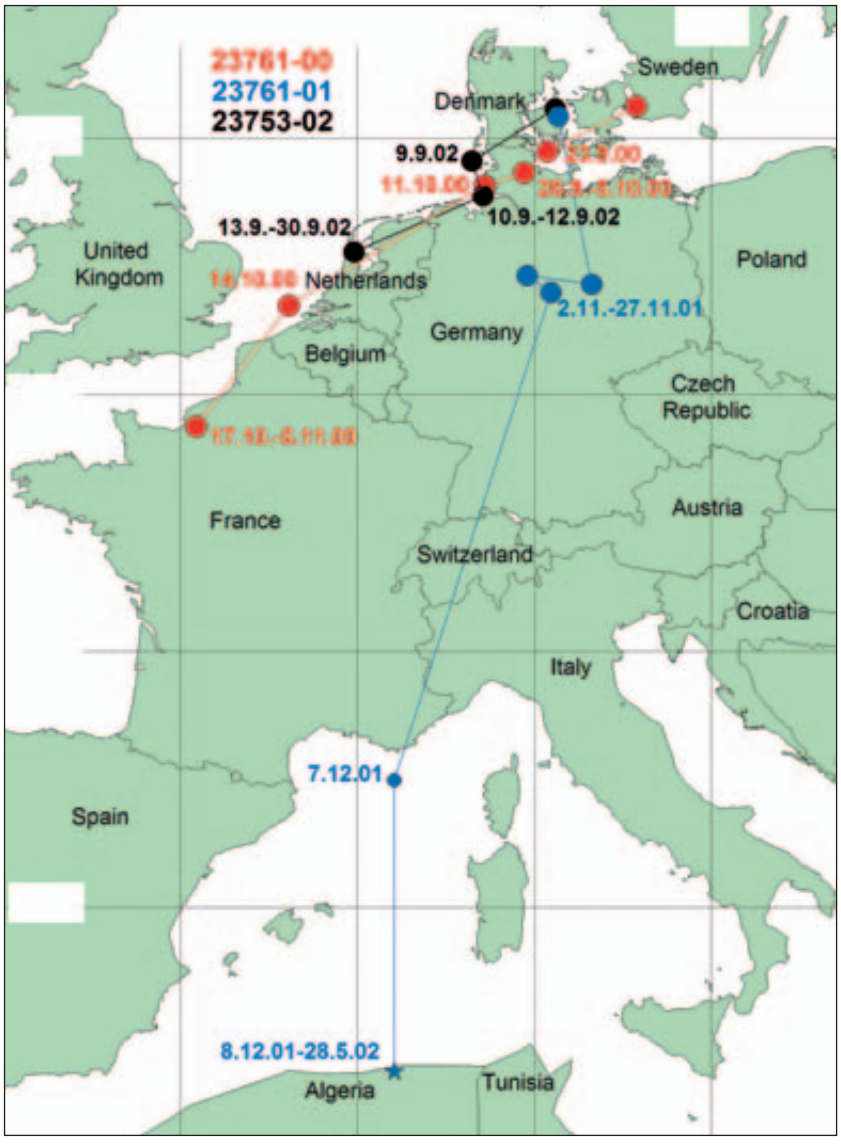

Fig. 1: Migration routes of first-year Lesser Black-backed Gulls *Larus fuscus intermedius* released from a natal site in Denmark. – *Zugwege von erstjährigen Heringsmöwen* Larus fuscus intermedius*, die in ihrem Brutgebiet in Dänemark aufgelassen wurden.*

eleven gulls, since transmission from the remaining birds ceased before they had left the release area. We therefore focus here on the birds that were successfully tracked at least during the onset of their winter migration.

Satellite transmitters were harnessed on the back of the birds using 6 mm Teflon ribbons with loops around wings and neck and fastened over the sternum (Berthold *et al.* 1992). Transmitters were programmed to transmit with a duty cycle of 10 hrs on/20 hrs off at a repetition rate of 60 s. Location data were received through the Argos satellite system and were categorised into seven Location Classes (LC) with increasing accuracy: Z, B, A, 0, 1, 2 and 3. Of the 1861 coordinates received from the eleven gulls, for which the onset of autumn migration could be monitored, less than 9% were accurate to 1 km (LC 1, 2 and 3); all the others were associated with unknown errors in location classes 0 (18.3%), A (28.5%), B (41.9%) and Z (3.0%). The low number of high quality locations was mainly due to the comparatively low transmission power of the satellite transmitters and the high amount of electromagnetic pollution over northern Europe. As over 90% of all locations were thus associated with a non-random error of unknown extent, all locations received during one particular duty cycle were averaged. A more rigid approach to validate individual positions was impossible due to the generally low-quality data, the fact that transmissions incorporated a duty cycle and the complete lack of positional data for a number of duty cycles, which left quite large gaps in the tracks, especially when the birds were migrating. Therefore, no specific behavioural parameters, such as flight speeds, could be calculated. Data received from an integrated activity sensor enabled the separation between 'active' (i. e. birds alive) and 'in-active' (i. e. birds dead or device lost) transmitters.

3. Results

Information on breeding sites, dates of release and migratory parameters is given in Table 1. Timing of the onset of migration varied widely between years,

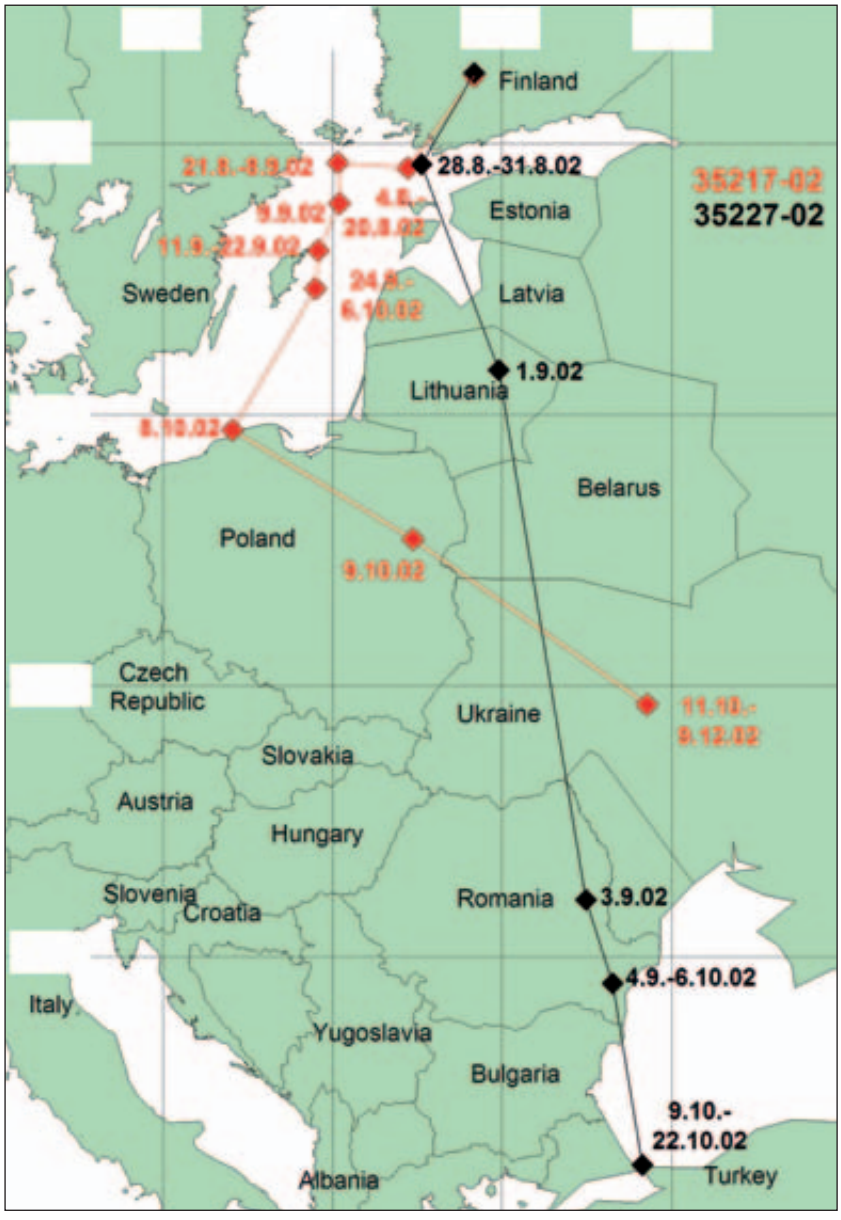

Fig. 2: Migration routes of first-year Lesser Black-backed Gulls *Larus fuscus fuscus* released from a natal site in Finland. – *Zugwege von erstjährigen Heringsmöwen* Larus fuscus fuscus, *die in ihrem Brutgebiet in Finnland aufgelassen wurden.*

breeding sites and individuals of the same study group. Once birds started to leave the release sites, individual migratory patterns became evident.

All first-year Lesser Black-backed Gulls of the *intermedius* subspecies released at their native site in Denmark initially headed southwest (Fig. 1). Two birds flew along the North Sea coast until transmissions ceased in the Netherlands by the end of September and in France by early November. The remaining bird followed a more southerly course towards the regions of Magdeburg and Hannover, Germany, from where it migrated further south by the end of November, crossed the Mediterranean Sea, and arrived in its wintering area in northern Algeria, to the east of the coastal city of Jijel, in early December (Fig. 1).

The overall migration direction of the Finnish first-year birds of the *fuscus* subspecies that were released at their natal site was south-southeast (Fig. 2). However, one bird at first travelled southwest, crossed the Baltic Sea and turned southeast upon reaching the coast of Poland. It remained in central Ukraine for six weeks until transmissions ceased in early December. The other bird flew straight south-southeast after reaching the Finnish coast and was located at the Bosporus, Turkey, when transmissions ceased in late October (Fig. 2).

Two of the three first-year birds of the *intermedius* subspecies released at a breeding site of the *fuscus* subspecies in Finland migrated on a southwesternly course, crossed the Baltic Sea and reached the Polish coast where transmissions ceased in late October and mid November,

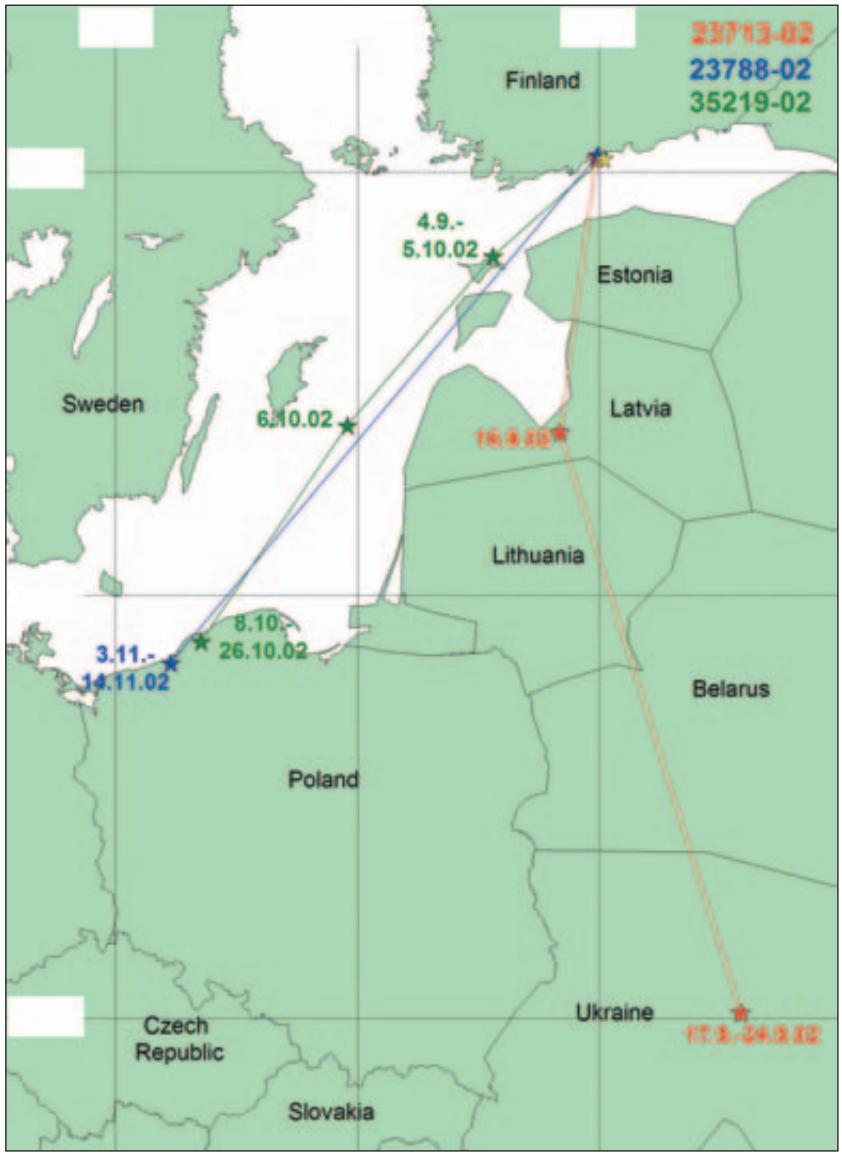

Fig. 3: Migration routes of first-year Lesser Black-backed Gulls *Larus fuscus intermedius* transferred to and released from Finland. – *Zugwege von erstjährigen Heringsmöwen* Larus fuscus intermedius*, die nach Finnland verfrachtet und dort aufgelassen wurden.*

respectively (Fig. 3). The other *intermedius* gull headed straight south-southeast towards central Ukraine, where transmissions ceased in late September.

Only one first-year bird of the *fuscus* subspecies released in Denmark could be tracked to estimate its possible migratory direction (Fig. 4). At the end of August the bird migrated to the northern coast of the island of Rügen in northeastern Germany, where it remained for five weeks until transmissions ceased in early October.

Two first-year birds that were raised in cross-breeding experiments in Vogelpark Marlow, northern Germany, generally migrated on a south-southeasterly course (Fig. 5). However, in one bird transmissions ceased in the region of Leipzig, Germany, in early October. No migration data from the other bird were received, but first successful transmissions were obtained from northern Libya. This bird remained in the area until transmission ceased in early November the following year.

4. Discussion

The migratory pattern observed in individuals of both Lesser Black-backed Gull subspecies released at their natal site confirmed previous findings on their respective migration. As could be shown by ringing data obtained from *Larus f. intermedius* from Danish breeding colonies (Bønløkke *et al.* 2006), the predominant migration route leads southwest along the northwest coast of Europe, across the English Channel and then

Fig. 4: Migration route of a first-year Lesser Black-backed Gull *Larus fuscus fuscus* transferred to and released from Denmark. – *Zugweg einer erstjährigen Heringsmöwe* Larus fuscus fuscus*, die nach Dänemark verfrachtet und dort aufgelassen wurde.*

further south down the Atlantic coast. However, some individuals may also take a more direct route across the European continent to wintering sites in the Mediterranean (Bønløkke *et al.* 2006) and it has been suggested that these birds make use of refuse dumps for food supply (Deutsch *et al.* 1996; Thye 2006). Both migration paths were evident in our study: two first-year birds chose the coastal route, whereas one migrated on a more southerly route straight across Germany. However, the latter was continuously tracked over subsequent years and it transpired that after the initial autumn migration detailed in this study, the bird migrated further west via northern France and the North Sea coast in subsequent years (K. Pütz *et al.*, unpubl. data). The migratory paths of the two first-year birds of the *fuscus* subspecies that were released at their natal site in Finland also closely matched those exhibited by ringed conspecifics (Kilpi & Saurola 1984; Urban *et al.* 1986; Malling Olsen & Larsson 2004) and two adult birds satellite tracked (J. Kube *et al.*, unpubl. data). Thus, all first-year birds released from their natal breeding site showed the same behavioural pattern as conspecifics that were either ringed or satellite tracked. This also suggests that, in general, harnessing a satellite transmitter to the first-year birds did not prevent the birds from migrating.

However, the results are less unambiguous regarding the first-year birds that were transported into the breeding range of the other subspecies, and also from the birds raised in cross-breeding experiments. At first sight, it appears that all their migratory patterns reflected those exhibited by the Finnish *fuscus* subspecies. For example, one bird from Denmark mirrored exactly the migration routes taken by the *fuscus* gulls from Finland, migrating straight southeast to the Ukraine. However, since the other two gulls travelled to the coast of Poland where transmissions ceased, it remains speculative whether the latter then continued on a southwesterly course like their conspecifics from Denmark or turned southeast like the Finnish subspecies. Also, not much further supportive evidence is gained from the *fuscus* bird that was released in Denmark, and from the birds raised in the cross-breeding experiments. The first-year bird of the *fuscus* subspecies migrated southeast to the island of Rügen, Germany. Such behaviour was not recorded in either subspecies in our study, although it is not unusual for birds of the *intermedius* subspecies (Bønløkke *et al.* 2006). Finally, the migration route of the cross-bred bird that wintered in Libya could not be monitored and thus, although the final destination may indicate a southeasterly course, its exact migratory route remains speculative. It is, however, also worth noting that the second longest transmission period was observed in this bird and that it remained in Libya for about one year.

Given the results obtained, it appears that the migratory behaviour of Lesser Black-backed Gulls is not purely determined by genetical determination but that behavioural factors may play a significant role. Some

of the first-year birds could not be tracked long enough to exclude a juvenile dispersal as has been observed in Lesser Black-backed Gulls from the British isles (Rock 2002). Furthermore, other behavioural factors such as, for example, association with other gulls during migration may play a part. More data on the migratory behaviour of individual birds is necessary to thoroughly investigate the migratory behaviour of Lesser-Black-backed Gulls and its development. Future technological developments will undoubtedly enable researchers to successfully track a larger number of small animals for extended periods, while at the same time better positional fixes will likely be obtained in terms of both number and accuracy. More intensive research, however, should be able to establish life-history parameters on an individual and, provided a sufficient number of individuals have been successfully tracked, on a population basis. This will help researchers to more fully understand migration strategies and ultimately result in better opportunities for more adequate conservation.

Acknowledgements. This article is dedicated to Andreas Helbig, who sadly passed away before the project was finished. We are grateful to Markku Alanko and Lars Hansen for keeping the gulls in captivity, thereby ensuring their sound condition upon release. The authors are grateful to Jan Kube, who was initiative in setting up this study, to Lesley Baxter for language editing and to Heiko Schmaljohann, Volker Dierschke and one anonymous reviewer for their constructive criticism on an earlier draft of the manuscript. The study was supported by the Deutsche Forschungsgemeinschaft (grant DFG HE 1792/5).

Fig. 5: Migration routes of first-year Lesser Black-backed Gulls *Larus fuscus fuscus x intermedius* released from Rostock, Germany. – *Zugwege von erstjährigen Heringsmöwen* Larus fuscus fuscus *x* intermedius*, die in Rostock (Deutschland) aufgelassen wurden.*

5. Zusammenfassung

K. Pütz, K., C. Rahbek, P. Saurola, K. T. Pedersen, R. Juvaste & A. J. Helbig 2007: Satellitentelemetrie der Zugwege junger, aus den Brutgebieten verschiedener Unterarten aufbrechender Heringsmöwen *Larus fuscus*. Vogelwelt 128: 141 – 148.

Zur Untersuchung des Zugverhaltens wurden erstjährige Heringsmöwen *Larus fuscus* der Unterarten *fuscus* und *intermedius* mit Satellitensendern ausgerüstet und entweder in ihrem eigenen Brutgebiet oder nach Transport in das Brutgebiet der anderen Unterart aufgelassen. Zusätzlich wurde das Zugverhalten von erstjährigen Heringsmöwen aus Kreuzungsexperimenten (*fuscus* x *intermedius*) untersucht. Bei insgesamt 11 Vögeln, mindestens einem aus jeder Versuchgsruppe, konnte der Beginn des Herbstzuges verfolgt werden. Erstjährige Heringsmöwen der *intermedius*-Unter-

art aus Dänemark zogen entweder südwestlich entlang der Nordseeküste oder durch Zentral-Europa nach Algerien. Im Gegensatz dazu zogen die finnischen Heringsmöwen der *fuscus*-Unterart mit süd-südöstlichem Kurs in die Ukraine und an den Bosporus, Türkei. Nur bei einer der in dem Brutgebiet der anderen Unterart aufgelassenen Heringsmöwen konnten eindeutige Hinweise auf das Zugverhalten gewonnen werden: Dieser Vogel der *intermedius*-Unterart zog von Finnland mit süd-südöstlichem Kurs in die Ukraine, wo der Sender verstummte. Das Zugverhalten dieser Möwe entsprach daher dem der *fuscus*-Unterart. Eine Heringsmöwe aus den Kreuzungsexperimenten überwinterte in Libyen, wobei während des Zuges in das Winterquartier keine Sendersignale erhalten wurden.

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Manuskripteingang: 30. Aug. 2007
Annahme: 27. Nov. 2007

Klemens Pütz, University of Greifswald, Vogelwarte Hiddensee am Institut für Zoologie, Soldmannstr. 16, D-17489 Greifswald, Germany; present address: Antarctic Research Trust, Am Oste-Hamme-Kanal 10, D-27432 Bremervörde, Germany; E-Mail: *klemens.puetz@ewetel.net*

Carsten Rahbek & Kjeld T. Pedersen, University of Copenhagen, Zoological Museum, Universitetsparken 15, DK-2100 Copenhagen, Denmark

Pertti Saurola, Finnish Museum of Natural History, P.O. Box 17, FIN-00014 University of Helsinki, Finland

Risto Juvaste, North Karelia University of Applied Sciences, Karjalankatu 3, FIN-80200 Joensuu, Finland

Andreas J. Helbig (†), Vogelwarte Hiddensee