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Lesser Black-backed Gulls nesting at Texel

Foraging distribution, diet, survival, recruitment and breeding biology of birds carrying advanced GPS loggers

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Front cover: Lesser Black-backed Gulls Kelderhuispolder (CJ Camphuysen)

Title page: Lesser Black-backed Gull with GPS logger (CJ Camphuysen)

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Summary

- Lesser Black-backed Gulls breeding at Texel return from wintering areas in March and have migrated away from Texel in September.
- The breeding success of Lesser Black-backed Gulls at Texel amounted to 0.46 fledglings pair^{-1} (range 2006-2010 0.26 – 0.71 fledglings pair^{-1}).
- Lesser Black-backed Gulls breeding at Texel foraged predominantly at sea (78% of the foraging time in males, 33% of the time in females) and to the SW, S, and SE of the breeding colony. Females spent 44% of their long-trip time within 10km from the nest, males only 23%. A feeding range of over 100km was unusual in actively breeding females (3.5% of trip time) and males (0.9%).
- Lesser Black-backed Gulls from Texel regularly moved through existing windfarm areas, but spent only a small amount of total trip time within the park areas.
- The total time spent within or near windfarm areas was twice longer in males than in females.
- The only possible behavioural response of Lesser Black-backed Gulls near windfarms recorded was a slightly higher altitude of flight. Area avoidance (or area attraction) could not be demonstrated.
- The main prey for Lesser Black-backed Gulls breeding at Texel were *Merlangius merlangus, Pleuronectes platessa, Liocarcinus holsatus, Trachurus trachurus, Limanda limanda, Nereis longissima, Pleuronectes / Limanda, Solea solea,* Coleoptera sp. and *Ammodytes* sp. (mostly discarded demersal fish).
- The effect of loggers on individual reproductive success was negligible in the year of GPS deployment, but few birds that returned the next season would breed. Returned birds carrying loggers were not used in the analysis.
- The annual survival of adult Lesser Black-backed Gulls was estimated at 95%.
- Recruitment levels of Lesser Black-backed Gulls at Texel are very low or delayed. None of the fledglings ringed in 2006 or 2007 is known to have established a breeding territory in later seasons.

Nederlandstalige samenvatting

- Kleine Mantelmeeuwen die op Texel broeden keren in maart terug uit de overwinteringsgebieden en zijn in september weer vertrokken.

- Het broedsucces van Kleine Mantelmeeuwen op Texel bedroeg 0.46 jongen paar^{-1} (range 2006-2010 0.26 – 0.71 jongen paar^{-1}).

- Kleine Mantelmeeuwen die op Texel broeden foerageerden hoofdzakelijk op zee (78% van de foerageertijd door mannetjes, 33% door vrouwtjes) en dan vooral ZW, Z, en ZO van de kolonie. Wijfjes besteedden 44% van de tijd op foerageertrips op minder dan 10km afstand van het nest, mannetjes slechts 23% van hun tijd. Voedseltrips over meer dan 100km afstand waren zeldzaam bij actieve broedvogels (3.5% van de totale triptijd bij wijfjes; 0.9% van de tijd bij mannetjes).

- Kleine Mantelmeeuwen die op Texel broeden komen regelmatig in of in de buurt van de windparken voor de kust van Egmond, maar de totale verblijfstijd aldaar was gering.

- De totale hoeveelheid tijd gespendeerd in de omgeving van bestaande windparken was voor mannetjes tweemaal zo groot als voor vrouwtjes.

- Kleine Mantelmeeuwen in de windparken vlogen gemiddeld wat hoger dan meeuwen in de omringende gebieden.

- De voornaamste prooidieren van Kleine Mantelmeeuwen broedend op Texel waren *Merlangius merlangus, Pleuronectes platessa, Liocarcinus holsatus, Trachurus trachurus, Limanda limanda, Nereis longissima, Pleuronectes / Limanda, Solea solea,* Coleoptera sp. and *Ammodytes* sp. (meest overboord gegooide bodemvissen).

- Het effect van de GPS loggers op individueel broedsucces was te verwaarlozen in het jaar waarin de loggers warden aangebracht, maar terugkerende vogels in een volgend seizoen kwamen vaak niet tot broeden. Teruggekeerde vogels met actieve loggers zijn niet bij de analyse betrokken.

- De jaarlijkse overleving van gekleurringde adulte Kleine Mantelmeeuwen bedroeg ongeveer 95%.

- Nieuwe deelnames van jonge Kleine Mantelmeeuwen op Texel aan het broeden zijn zeldzaam of vertraagd. Geen enkele van de in 2006 en 2007 gekleurringde jonge vogels heeft tot dusverre tot broeden kunnen komen

1. Introduction

Birds may end up in conflict with wind turbines in their feeding area at sea or on their way to their foraging grounds (Boon *et al.* 2010). This could lead to problems with the conservation of these birds in (breeding) areas that are protected by Natura 2000. In the Netherlands, the focus is on Lesser Black-backed Gulls *Larus fuscus*, the only marine species that is thought to reach existing and planned wind farms from colonies protected by Natura 2000 in the Netherlands (Arends *et al.* 2008, Camphuysen *et al.* 2008). Field studies to investigate the risks imposed could be based on visual observations near turbines at sea and elsewhere, or on telemetry data: tagging individual birds from known colonies that fly out over the sea to feed.

Studies have been commissioned to be conducted at Texel, to expand and continue a much larger project in which the ecological effects of offshore windfarms in Dutch offshore waters are evaluated. The Lesser Black-backed Gull was studied at Texel (Kelderhuispolder, part of De Geul colony) in summer 2010 (April-August), under the assumption that this colony could be seen as representative for a number of colonies in the Natura 2000 areas of the Western Wadden Sea. Advanced GPS loggers were deployed in order to investigate the area usage and at-sea time during foraging trips, notably relative to the existing windfarms off Egmond aan Zee (OWEZ (former NSW) and Princess Amalia windfarm (former Q7)).

As noted by Boon *et al.* (2010), monitoring the breeding status of birds carrying data loggers is important to control for any possible adverse effects of these devices. Failed breeders would likely behave very differently from successful breeders and thus yield less useful or even misleading data. Food samples were collected and analysed to provide a back-up in case the logger studies would fail (to calculate or estimate sea-time from prey deliveries) and to try and explain the types of activities and, hence, the likely foraging habitats at sea. Finally, a colour-ringing programme was continued to collect data on site-fidelity, long-term survival and recruitment.

The data collected in 2010 were an extension and otherwise unplanned continuation of earlier studies in the same colony (2006-2009). The earlier data were simply added to this new project, in order to enlarge the sample size and in order to allow for some preliminary analyses of the ringing data (2006-2010). We have mixed these data freely, because the methods were the same through the years, under the assumption that larger datasets are always better than smaller datasets; thus enhancing the quality of the output in this particular project. The key questions addressed are listed below.

2. Research questions

- What is the breeding success of Lesser Black-backed Gulls within ‘t Lage land van Texel?
- Where do Lesser Black-backed Gulls from Texel forage (foraging range)?
- Do Lesser Black-backed Gulls from Texel move through existing windfarm areas?
- How much time do these gulls spend within the risk zone?
- Is there a behavioural response of Lesser Black-backed Gulls near windfarms?
- Which are the main prey resources for Lesser Black-backed Gulls?
- Is there an effect of the loggers on the reproductive success?
- What is the annual survival of adult and young birds?
- What is the level of recruitment of Lesser Black-backed Gulls within ‘t Lage land van Texel?

3. Methods

Ecological data were collected during April to August, 2006-2010 in Kelderhuispolder, Texel (53°00'N, 04°43'E), W Waddensea, The Netherlands (**Fig. 1**). Within the area, during 2003-2008, approximately 11,500 pairs of Lesser Black-backed Gulls and just over 5000 pairs of Herring Gulls *Larus argentatus* are breeding (database SOVON, courtesy Lieuwe Dijksen). Potential marine feeding areas are the North Sea to the SW, W, NW, and N of the breeding colony, the island of Texel itself (mostly to the NE and E of the breeding grounds), the Marsdiep area and deeper waters of the Wadden Sea (E and SE of the colony), and the mainland (S and SE of the colony). Bathing places and popular roosting sites on beaches occur within *c.* 3 km around the study colony. This area is referred to as the 'home range' and few suitable feeding areas are situated within it, except feeding opportunities within the colony itself (e.g. cannibalism), and crowberry *Empetrum nigrum* stands in the surrounding dunes.

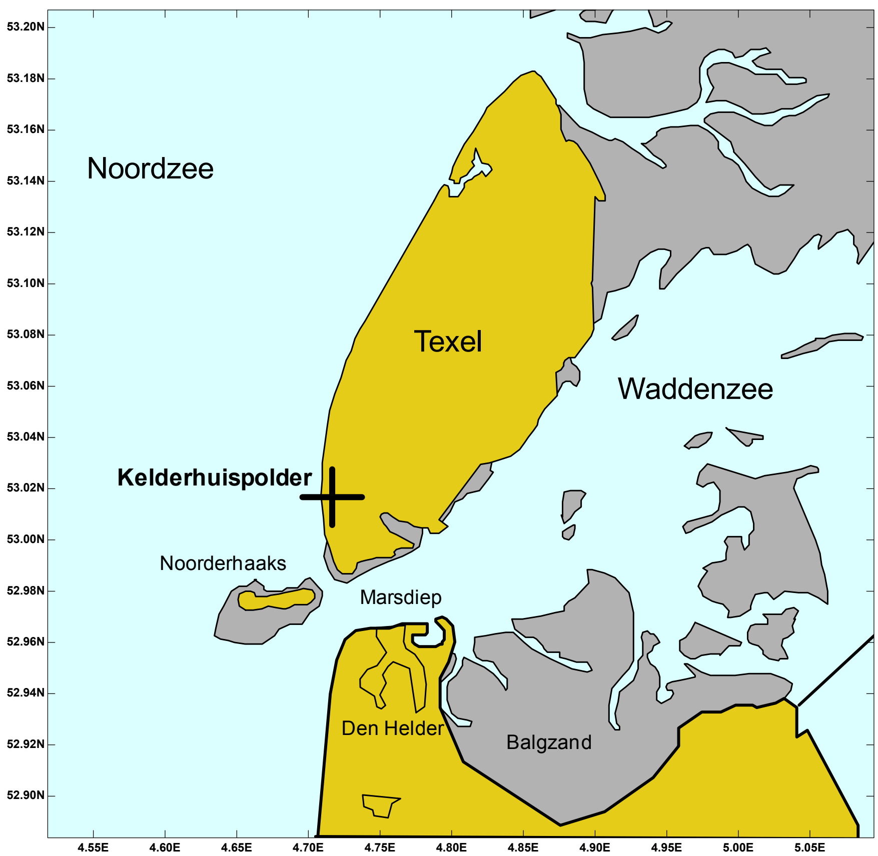


Figure 1. Kelderhuispolder colony at Texel, western Wadden Sea

Half-way incubation (with completed, incubated clutches), adult breeding individuals were trapped at the nest, ringed and colour-ringed with a green 35mm polymethylmethacrylate (PMMA) ring (10mm diameter), on the left tarsus, engraved with a white inscription of 4 characters (F.xxx for females, M.xxx for males). These birds had been sexed by the head and bill length (Coulson et al. 1983, a 95% accuracy in sexing is expected with this method; **Fig. 2**) and were weighed (g) during handling only.

Figure 2. Male (left) and female (right) Lesser Black-backed Gulls differ in structural size and overall body mass. During the field-work, this sexual dimorphy was used to sex live birds, preventing the need for invasive action (such as e.g. blood samples and DNA analysis) (CJ Camphuysen).

In 2008 (6), 2009 (6), and 2010 (15), a total of 27 individuals were tagged with a GPS logger. The device consists of a GPS tracker that was mounted with a harness on the back of a bird (**Figs. 3-6**). The data acquisition system consisted of a base station including a computer and an antenna (**Fig. 56**). The tracker stored GPS positions and additional measurements and periodically checked whether the transceiver could contact the antenna network, with wireless connection to a base station. If so, the data was transmitted automatically and the integrity of the data was checked. The tracker initiated contact to the base station at intervals set by the user. The base station sorted out all data sent by the various GPS-trackers into separate files. These were transmitted through (mobile) internet to the central data warehouse where the data was loaded into a database. The data processing is fully automated. The tracker is powered by four triple-junction solar cells (27% efficiency), with a surface of 9.1 cm^2 in total, a loading circuit, and a 65 mAh Lithium Polymer battery. The solar yield determines the power on the long run while the battery capacity determines the size of the buffer to overcome the nights or other short periods with little or no radiation. The GPS and the transceiver are switched off when the battery is depleted beyond thresholds of 3.5V and 3.4V and switches on at 3.5V and 3.8V respectively. Data is stored in 4MB flash memory implemented as a ring buffer. The GPS-tracker enables flexible measurement schemes; different measurement intervals can be set for different times of the day (e.g. day and night), different areas (e.g. inside or outside a breeding colony), status of memory (e.g. switch off if the memory is filled to a certain threshold) or battery voltage (e.g. increase measurement frequency if the battery is fully charged). This maximizes the different types of behaviours that can be measured while minimising gaps in data due to power shortage.

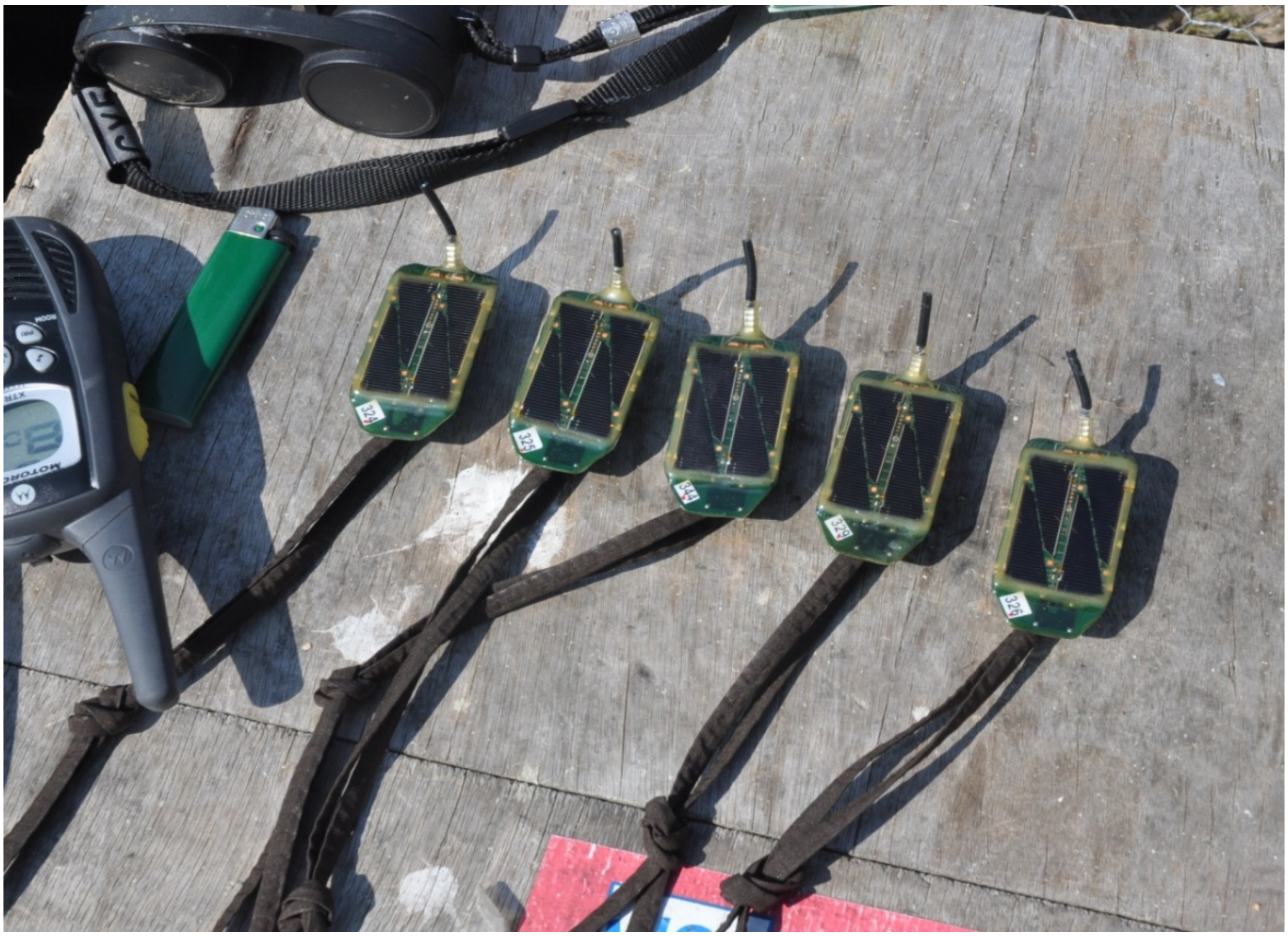


Figure 3. GPS loggers lined up prior to deployment (CJ Camphuysen)

In poor (clouded) weather, or with high-resolution settings, power shortage led to incomplete recordings of 6.3% of 4975 ‘activity bouts’ (unbroken periods at the nest site or trips away from the colony. The time interval between consecutive GPS positions was attributed to the first of two consecutive GPS locations. This interval and respective GPS position was then used to calculate the presence of birds (hours) within 2’N x 3’E rectangles. Time intervals longer than 60 minutes indicated a gap in the data, generally due to low battery power and were excluded from analysis. Individual rectangles were assigned to either North Sea (open water), North Sea coastal areas (*c.* 500m from the shoreline on either side of the coast), the Marsdiep and deeper parts of the Western Wadden Sea, the island Texel, and the mainland. The analysis was confined to an area between 51° and 54°N, and 2°30′ to 6°E, with uploads further away labelled as 'extra-limital'. Of completely recorded trips, the direction of departure and home flight was calculated as the mean (degrees) of the first five, resp. last five positions logged during each trip.

Figure 4. Deployment of the instruments, with (left) Arnold Gronert and (right) Kees Camphuysen (Judy Shamoun Baranes)

Diets were studied from spontaneously regurgitated matter (pellets, large chunks of regurgitated matter, partly eaten food remains), from food boluses produced during handling of adults and chicks, from chick-feed sub-sampled within the territories and from stomach contents of animals found dead. During colony visits, marked territories were inspected for the presence of discarded prey items, and each of these were individually bagged, numbered, and kept frozen for later analysis. Additional prey samples were collected from study plots, to enhance the overall sample in each of the phases of breeding. With pellets, boluses and regurgitated matter, some easily and fully digested prey is overlooked, but the microscopical inspection of prey samples ensured that even very small remains (such as earthworm setae and minute otoliths) were detected.

Breeding success was assessed with standard techniques, by monitoring nests from laying to hatching and after random selection of a subset of nests from hatching to fledging[1]. Individual nests were marked and checked every third day, recording egg laying, egg predation, hatching success, chick growth (mass and size), chick mortality, and fledging rates. To assess fledging rates with high accuracy, nests or small groups of nests were enclosed with 50cm high chicken wire. Eggs were checked for bursts and damage during nest visits and chicks were rounded up, removed from the enclosures during visits (to minimise disturbance during the work), measured, weighed, and put back at the territory.

Figure 5. Instrumented bird in flight (CJ Camphuysen)

Figure 6. Instrumented bird in the colony near nest site (CJ Camphuysen)

[1] Chicks at 40d of age are considered "fledglings", and the fledging period is thus reached when a majority of the surviving chicks have reach that age.

Chicks were marked immediately after hatching with a numbered aluminium ring around the tibia. When sufficiently large (usually around 30d of age) the aluminium ring was replaced by a permanent stainless steel ring at the right tibia, plus a green 35mm PMMA colour ring (as in the adults, 10mm diameter), on the left tarsus, engraved with a white inscription of 4 characters (K.xxx). These birds were still growing and could not be sexed on the basis of biometrics. No blood samples were taken: no invasive action, and the handling therefore did not qualify as animal experiments.

Considerable time was spent in each breeding season to study return rates of (colour-ringed) adults and (colour-ringed) potential recruits , in particular in April and early May, but also in July and August, when the workload was slightly lower than during the phases of egg-laying, hatching and chick-growth. These sightings data were used to evaluate annual survival (the data series is simply too short for a meaningful MARK-analysis) and return rates. Colour-rings were also read outside the colony (throughout the entire migration and wintering range), but the results of this work are not considered part of the present project.

Figure 7. Approaching an enclosure in tall grass, in search for chicks (CJ Camphuysen).

4. Results

4.1 The annual cycle of Lesser Black-backed Gulls breeding at Texel

Lesser Black-backed Gulls are seasonal migrants, wintering in South England, France, Portugal, Spain, and NW Africa south to *c.* The Gambia and Senegal. From colour-ring-readings it is clear that most birds breeding at Texel have abandoned The Netherlands by September and have returned in March (**Fig. 8**). The effective period of potential conflict with (Dutch) offshore windfarms in The Netherlands is therefore restricted to a period of six months (Mar-Aug). The first two months are the prospecting phase (pre-laying to early laying), the next three months are the breeding season, whereas the month of August is a month of fledging and early wing-moult.

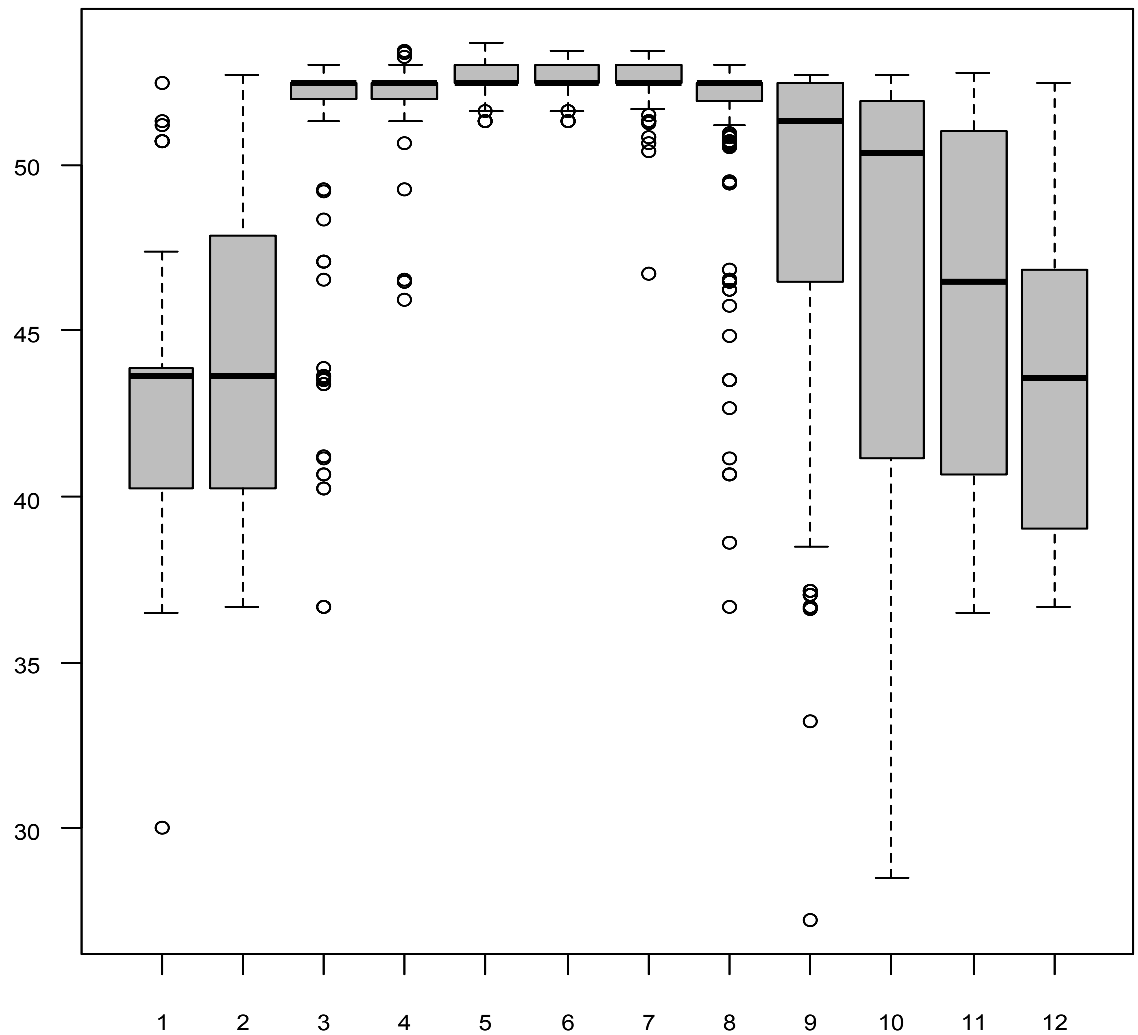


Figure 8. Box plot of mean latitudes (°N) of sightings of adult Lesser Black-backed Gulls colour-ringed at Texel during breeding (both sexes combined) from January (1) through December (12). See Tables 1-2 for differences between the sexes.

Table 1. Min, max, mean ± SD and median latitudes (°N) of sightings of male adult Lesser Black-backed Gulls colour-ringed at Texel during breeding.

	J	F	M	A	M	J	J	A	S	O	N	D
Min	36.7	36.7	36.7	48.3	52.9	51.9	50.4	39.2	37.1	37.1	36.7	36.7
Max	50.7	52.7	53.0	53.0	53.0	53.0	53.0	53.0	50.7	52.4	50.7	50.7
Mean	40.0	42.1	47.2	52.9	53.0	53.0	53.0	51.6	39.8	43.4	40.7	40.1
Median	40.3	40.3	48.3	53.0	53.0	53.0	53.0	53.0	38.6	40.7	40.3	40.3
SD	3.5	5.4	6.0	0.5	0.0	0.1	0.3	3.5	4.0	6.1	4.1	4.2

Table 2. Min, max, mean ± SD and median latitudes (°N) of sightings of female adult Lesser Black-backed Gulls colour-ringed at Texel during breeding.

	J	F	M	A	M	J	J	A	S	O	N	D
Min	36.5	40.3	36.7	51.8	53.0	52.7	51.3	37.0	36.6	37.1	36.7	36.7
Max	51.2	50.2	53.0	53.0	53.0	53.0	53.0	53.0	52.7	52.6	51.9	51.5
Mean	42.6	44.7	48.2	53.0	53.0	53.0	53.0	51.3	43.6	48.6	46.5	44.6
Median	40.5	43.6	53.0	53.0	53.0	53.0	53.0	53.0	43.6	51.3	47.5	47.5
SD	5.6	5.1	6.9	0.1	0.0	0.0	0.2	3.3	6.8	6.0	5.7	5.8

Male Lesser Black-backed Gulls travel on average further to the south than females (**Tables 1-2**), but there is no clear evidence that the latter return any earlier than the former on the breeding grounds. GPS logger data spanned the active breeding period only, after laying (incubation to fledging, *i.e.* May to August).

A single dataset covering the entire year for a tagged individual indicated that long inland trips were performed prior to autumn migration and that a stop-over site was used for several months in northern France prior to the final move to wintering areas in southern Spain. The foraging trips following the return of this animal and during it's second (presumed) breeding season is described in **Chapter 4.6.** The individual variation between individuals found in Lesser Black-backed Gulls fitted GPS loggers (this report), just as the individual variation between individuals fitted with Argos satellite PTTs (SOVON *unpublished data*; http://www. sovon.nl /default.asp?id=408) is such that such isolated data cannot be used as a description of the population at large and should be considered with some reservations. New data, expected in spring 2011 when the birds that were tagged in 2010 may return, could shed further light on autumn migration and spring return routes in Lesser Black-backed Gulls tagged at Texel.

4.2 Breeding success, 2006-2010

The breeding populations of Lesser Black-backed Gull have increased markedly in the Netherlands in the 20th century. Given the population increase, contrary to expectation, the reproductive success of Lesser Black-backed Gulls turned out to be very low. From the collected data on breeding success (2006-2010), it is suggested that the Wadden Sea population is now at the brink of a collapse (Camphuysen & Gronert 2010).

The Kelderhuispolder colony is part of and thought to represent more extensive colonies on the southern tip of Texel, totalling c. 11,500 pairs of Lesser Black-backed Gulls and c. 5060 pairs of Herring Gulls during the most recent survey. The number of breeding pairs of Lesser Black-backed Gulls in The Geul colony (of which the Kelderhuispolder is part), estimated year by year, gradually declined from c. 12,000 pairs in 2003-2005 to c. 10,000 pairs in 2006-2008 (2003 12,000 2004 11,757 2005 12,000 2006 10,775 2007 10,020 2008 9900; database SOVON, courtesy Lieuwe Dijksen & Joost van Bruggen). New census techniques were introduced in 2010 (nest counts, assessing species composition during random plots or transects walked through colonies), results of which have not yet been published (SOVON/Staatsbosbeheer nest monitoring project Wadden Sea).

Transect counts within the 8.3ha study colony Kelderhuispolder revealed that in 2009 and 2010 approximately 1985 nests of LBBG were built (240 Apparently Occupied Nests ha^{-1}) and 1025 nests of HG (123 AON ha^{-1}, totalling 363 pairs ha^{-1}).

Table 3. Number of Lesser Black-backed Gull nests monitored from egg-laying to hatching and number of nests monitored until fledging, Kelderhuispolder, 2006-2010.

	egg laying to hatching						**egg laying to fledging**					
	2006	2007	2008	2009	2010	Total	2006	2007	2008	2009	2010	Total
Entry dunes	1	3	6	4	2	16	1	1	2	-	2	6
Foot sea dunes	41	40	46	39	35	201	21	14	16	16	21	88
Roughs/Lookout	5	4	-	20	20	49	1	-	-	9	17	27
Sea dunes	-	-	-	3	-	3	-	-	-	-	-	0
Valley/ridge	16	36	46	50	34	182	12	22	16	24	25	99
Total	63	83	98	116	91	451	35	37	34	49	65	220

In total 451 Lesser Black-backed Gull nests were monitored from laying to hatching, while a subset of 220 nests were enclosed and monitored until fledging (**Table 3**). Basic breeding biology parameters are summarized in **Table 4**. Lesser Black-backed Gulls commenced laying in early May (median first egg date 10 May), with no sign of advance over time. The reproductive success of Lesser Black-backed Gulls declined through the season (the earliest, central two and latest quartiles of pairs fledged 0.69, 0.57 and 0.21 young $pair^{-1}$, respectively). Differences in breeding success of Lesser Black-backed Gulls between nesting areas were mostly caused by different levels of chick predation (cannibalism). Chick predation overall was particularly high in 2006-2009 (>60%), but much reduced in 2010, leading to a higher reproductive success in that last year.

Clutch size and egg volumes were compared with historical data, showing that Lesser Black-backed Gull egg volumes were similar to those in the 1990s. The high level of chick predation may have been caused by a shortage of suitable resources. Future work (at-sea studies coupled with logger data analyses) will reveal whether the foraging grounds are shared with competing species and if inter-specific foraging competition is an issue.

Figure 9. Alarmed Lesser Black-backed Gull, slightly oiled, colour-ringed M.AMZ, defending a territory (CJ Camphuysen).

Table 4. Breeding parameters for Lesser Black-backed Gull in the Kelderhuispolder, 2006-2010. The four sections describe (1) breeding phenology, (2) size, volume and fates of clutches, (3) fates of eggs, and (4) fates of chicks and overall breeding output. Laying and hatching dates are given for the very first eggs/chicks and for the dates on which 25%, 50% (median), and 75% of the total was reached. The duration of incubation is the difference between median hatching and median laying dates, while the chick period extended for 40 days following the peak of hatching (from: Camphuysen & Gronert 2010).

(1) Phenology	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
First eggs laid	4 May	29 Apr	1 May	30 Apr	4 May	29 Apr
Median egg laying	11 May	8 May	9 May	11 May	11 May	10 May
25-75% laying dates	9-13 May	4-15 May	7-12 May	9-15 May	9-15 May	7-14 May
Incubation period	14 May-5 Jun	16-31 May	13 May-2 Jun	16 May-5 Jun	16 May-5 Jun	15 May-4 Jun
Incubation duration (d)	28	28	28	28	29	29
First chicks hatched	1 Jun	22 May	29 May	28 May	30 May	22 May
Median hatching	8 Jun	5 Jun	6 Jun	8 Jun	9 Jun	8 Jun
25-75% hatched	6-11 Jun	1-11 Jun	3-13 Jun	6-13 Jun	6-12 Jun	5-11 Jun
Chick care period	12 Jun-22 Jul	12 Jun-22 Jul	14 Jun-24 Jul	14 Jun-24 Jul	13 Jun-23 Jul	12 Jun-22 Jul
First fledglings	17 Jul	10 Jul	10 Jul	14 Jul	11 Jul	10 Jul
(2) Clutches	2006	2007	2008	2009	2010	Total
clutch size ± SD	2.75 ± 0.54	2.73 ± 0.52	2.84 ± 0.49	2.80 ± 0.46	2.80 ± 0.51	2.79 ± 0.50
N nests[1]	(57)	(79)	(98)	(114)	(88)	(436)
three egg clutch volume (cm^3) ± SD	226 ± 17	224 ± 17	224 ± 15	221 ± 18	227 ± 16	224 ± 17
N nests	(46)	(61)	(87)	(94)	(73)	(361)
Failed nests	7.9%	7.2%	10.2%	7.8%	7.7%	8.2%
Relaying	9.5%	4.8%	-	1.7%	3.3%	3.3%
N nests	(63)	(83)	(98)	(116)	(91)	(451)
(3) Fate of eggs	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
Egg predation	29.0%	15.0%	14.4%	14.9%	9.8%	15.8%
Other mortality	7.1%	5.6%	11.9%	7.9%	6.6%	8.0%
Hatched	61.2%	78.1%	73.4%	77.1%	83.6%	75.5%
N eggs	(183)	(233)	(278)	(328)	(256)	(1278)
(4) Fate of chicks, breeding success	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
Chicks predated	60.3%	66.7%	63.4%	62.3%	35.4%	53.9%
Other mortality	25.4%	12.3%	15.5%	17.9%	34.8%	23.2%
Fledged	14.3%	21.0%	16.9%	17.0%	28.6%	21.2%
N hatchlings	(63)	(81)	(71)	(106)	(161)	(482)
Fledged young/pair	0.26	0.46	0.35	0.37	0.71	0.46
N nests	(35)	(37)	(34)	(49)	(65)	(220)

[1] excluding replacements.

4.3 Movements around the colony

Lesser Black-backed Gulls travelling to and from foraging areas have produced impressive 'spaghetti'-like distribution patterns over the season (**Fig. 10**). As uncorrected data, it appears that the majority of the trips are mostly in SW-S-SE directions. There are frequent visits of the Noord-Holland mainland, but for example the northern half of the island Texel itself (a much shorter distance) is rarely visited. We note some utilization of the deeper gullies of the western Wadden Sea (but not the Balgzand area), and a most frequent utilization of marine habitats, including the coastal waters south to *c.* IJmuiden and further away from the coast. Between years, this qualitative image is the same and the movements are considered being representative for the large colonies at the south tip of Texel.

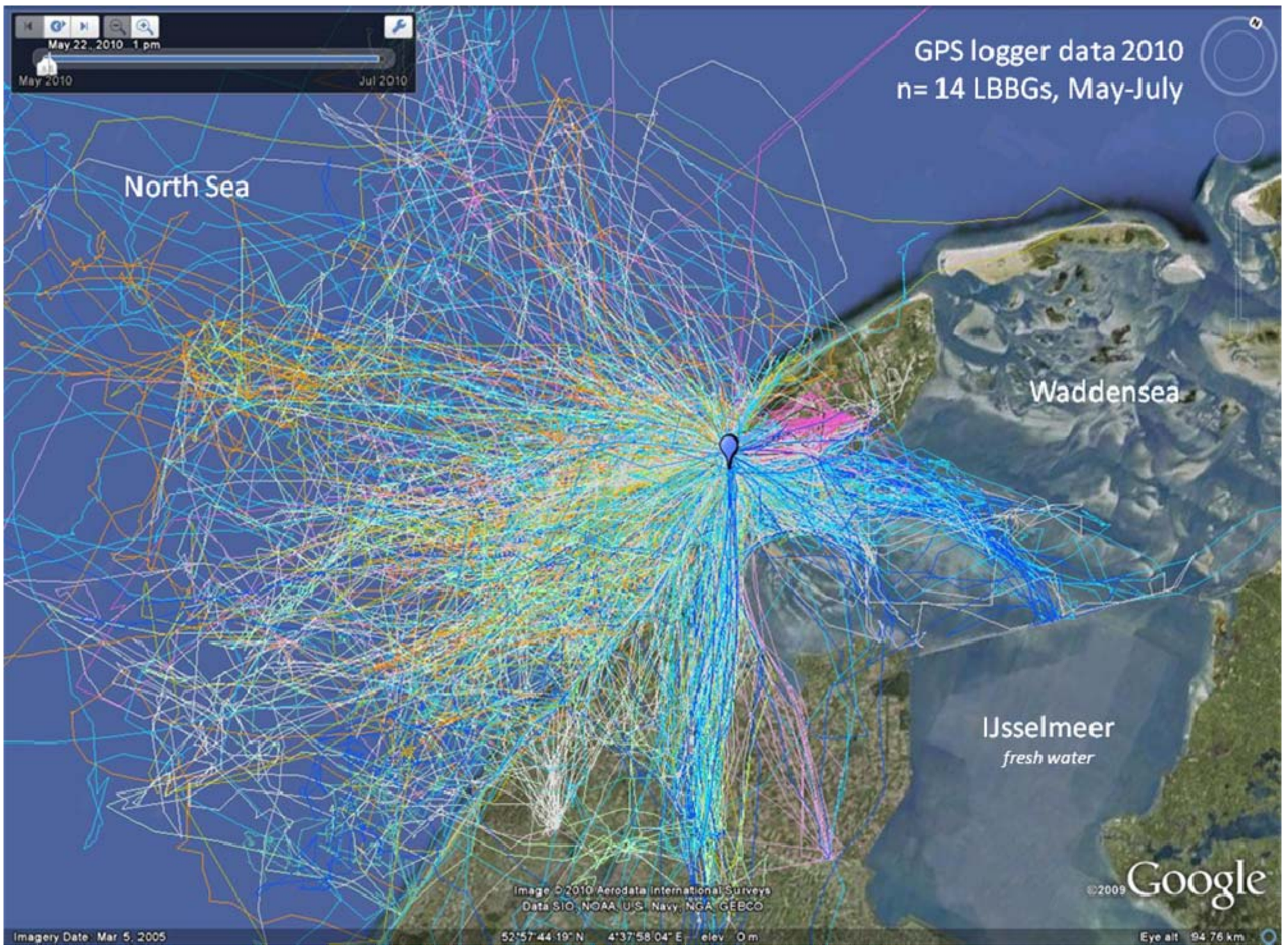


Figure 10. Spaghetti plot of all recorded trips in 2010, with colours representing individual birds. Frequent use of Texel, the Western Wadden Sea and certain inland sites by at least some individuals is indicated, plus the widespread utilisation of marine areas, notably to the SW of Texel by many birds.

In total, 4975 activity bouts were recorded (i.e. periods at the nest or periods on transit or otherwise outside the colony area). Excluding incomplete or otherwise unreliable activity bouts (e.g. due to battery failure), the material comprised 2261 periods at the nest sites (within 150m from the nest; 26 individuals), 769 short trips (>150m from the nest, maximum distance <3km away from the territory, 26 individuals), and 1222 long trips (>150m from the nest, maximum distance >3km away from the territory, 25 individuals; **Table 5**). A composite map of all these activity bouts combined (hours of time spent per 2'x3' rectangle) is provided in **Fig. 11.**

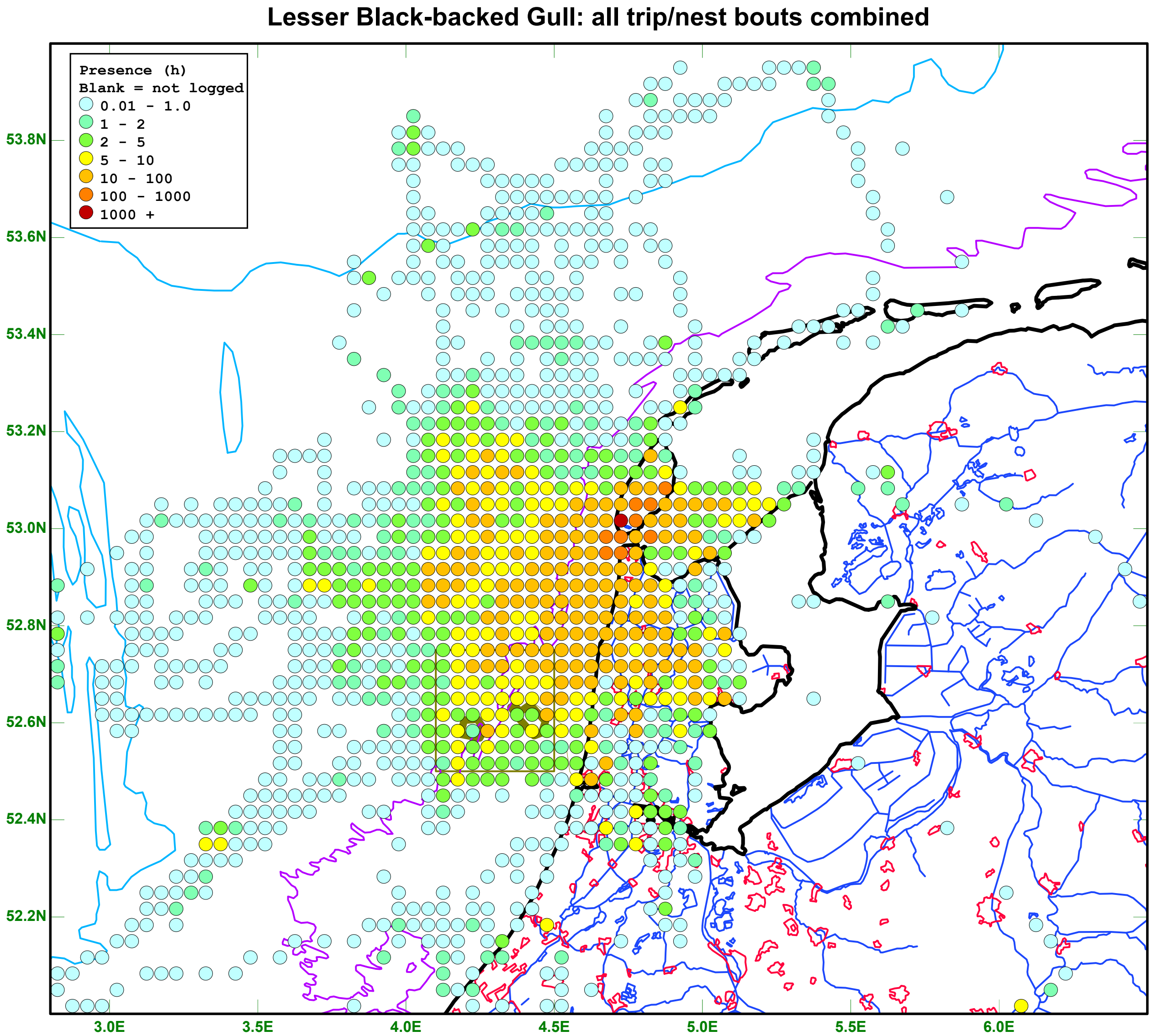


Figure 11. Composite of all data collected from uninterrupted activity bouts (breeding birds as well as failed breeders), 2008-2010, showing relative amount of time (h) spent in 2'x3' rectangles within 52-54°N, 2.8-6.5°E (see a split in residence time per rectangle for different phases of breeding and separated for males and females in later chapters).

Non-interrupted periods at the nest averaged 6.0 ± 5.5 hours (n= 680 bouts; mean ± SD) in males, and 3.7 ± 3.6 hours (n= 1581 bouts) in females. Short trips averaged 1.0 ± 1.3 hours in males (n= 218 bouts) and 1.0 ± 1.0 hours in females (n= 551 bouts), and none or very few of these trips were thought to be foraging excursions: logger positions pointed at the use of roosts and bathing places (fresh or brackish water pools) in varying directions around the colony (**Fig. 12**). Typical roosting sites were the beach, immediately to the southwest of the colony, and a large sand flat south of the colony (De Hors). The key bathing places were the western Horsmeertjes and a pool in Grote Vlak, where later in the season a large number of failed breeders accumulates to rest and preen. Loggers tended to perform for longer periods in females than in males, which may have been related to differences in strength (males are larger) and their associated capacity to destroy devices.

The analysis in this report was based on the remaining trips, the 1222 "long-trips" (examples in **Figs. 13-15**), which were thought to primarily represent feeding trips. Long-trips during active breeding averaged 6.8 ± 6.1 hours (378 trips) in duration in males and 6.7 ± 7.6 hours (n= 713) in females (**Table 6**) and ranged up to 359 km away from the colony during breeding (**Table 7**).

Table 5. Duration of completely recorded activity bouts (periods in with battery failure occurred were excluded from the analysis) of 25 Lesser Black-backed Gulls carrying GPS loggers in 2008-2010.

Activity bouts	**Sex**	**Mean duration ± SD**
Nest attendance	males	6.0 ± 5.5 hours
(n= 2261 trips)	females	3.5 ± 3.6 hours
Short trips	males	1.0 ± 1.3 hours
(n= 769 trips)	females	1.0 ± 1.0 hours
Long trips	males	6.8 ± 6.1 hours
(n= 1222 trips)	females	6.7 ± 7.6 hours

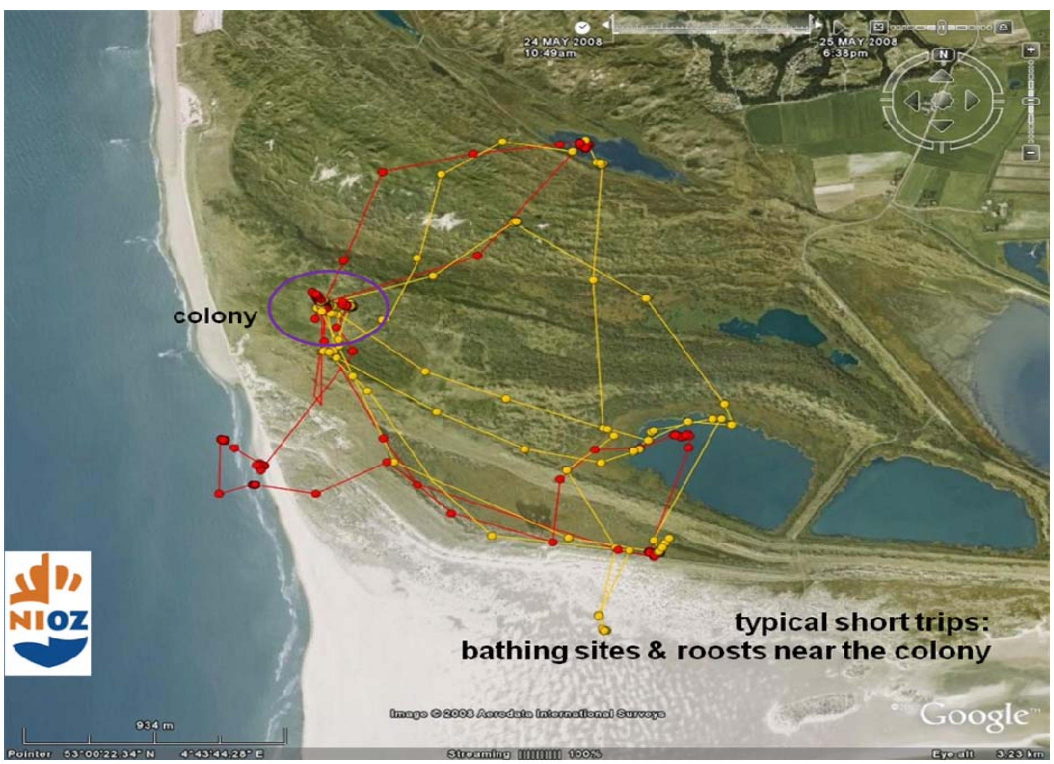


Figure 12. Typical short trips: visits to roosts and bathing places around the colony rather than feeding trips.

Table 6. Number of recorded complete long-trips in different phases of the breeding season (mean ± SD and maximum trip duration, h, mean ± SD and maximum distance away from the nest site (km) in female and male Lesser Black-backed Gulls during breeding and when the nesting attempt had failed (n= 1222 uninterrupted long trips).

			Duration of trips			**Max distance from nest**		
		n=	Mean	SD	Max	Mean	SD	Max
Female	All breeding	713	6.7	7.6	113	23.7	27.0	422
	Incubation	123	7.4	5.5	42	20.1	12.1	65
	Hatching	79	5.0	4.0	19	20.3	13.7	69
	Chick care	471	6.0	6.3	50	23.5	20.7	169
	Fledging	40	15.4	19.2	113	33.9	55.6	359
	Failed	105	6.9	12.9	130	24.8	40.4	409
Males	All breeding	378	6.8	6.1	40	33.1	19.4	115
	Incubation	82	7.5	6.7	40	28.0	14.8	75
	Hatching	26	8.7	9.5	38	33.4	12.9	59
	Chick care	233	5.7	5.0	30	33.8	21.4	115
	Fledging	37	11.1	5.8	26	39.8	16.1	75
	Failed	26	23.6	23.2	78	62.3	62.9	314

Table 7. Long trip distance (km) in female and male Lesser Black-backed Gulls in different parts of the foraging range; failed breeders excluded. Shown are mean ± SD, median distance and 1st and 3rd quartiles, maximum distance and number of trips in each area. Note that virtually all trips were in more than one area, so that the number of trips (reading horizontally) should not be summed up.

Females	North Sea	Coastal	Wadden Sea	Mainland	Texel
Number of trips	301	339	556	156	614
Mean distance	34.0	16.7	12.1	38.5	5.6
SD	32.6	13.6	8.9	37.2	4.0
1st quartile	12.7	6.7	2.8	23.7	1.6
Median distance	23.7	15.7	10.7	31.4	5.4
3rd quartile	44.5	20.6	19.1	42.9	7.6
Max distance	359	220	49	353	19
Males	North Sea	Coastal	Wadden Sea	Mainland	Texel
Number of trips	327	315	195	76	264
Mean distance	36.0	13.0	3.6	30.4	1.9
SD	21.1	11.7	2.5	14.5	2.1
1st quartile	20.8	4.5	1.8	24.2	0.7
Median distance	35.1	8.8	3.6	32.0	1.3
3rd quartile	41.9	17.3	4.1	35.0	1.5
Max distance	115	108	22	93	18

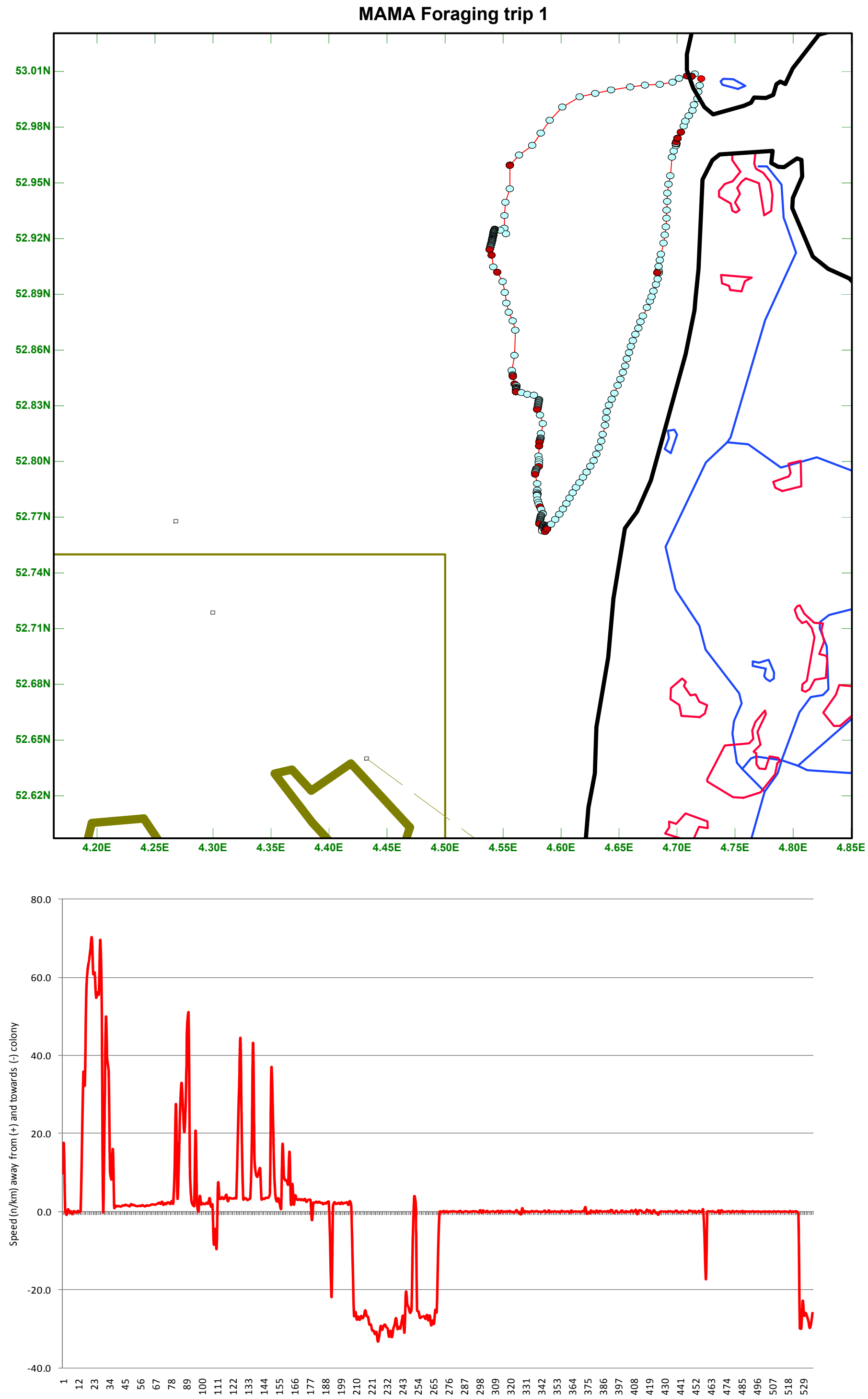


Figure 13. Typical "long trip": straight flight in S-SW direction parallel to the mainland coast and meandering return flight with frequent temperature drops (red dots), probably indicating shallow plunge diving events. Prior to return, some time is spent bathing and preening on the beach near the colony (colour ring M.AMA, trip#1, 2 June 2008, logger 45, male bird). The lower panel indicates flight speeds (km h^{-1}) away from the colony (above the x-axis) and towards the colony (below the x-axis). Substantial periods of inactivity while at sea were recorded in the second half of the trip.

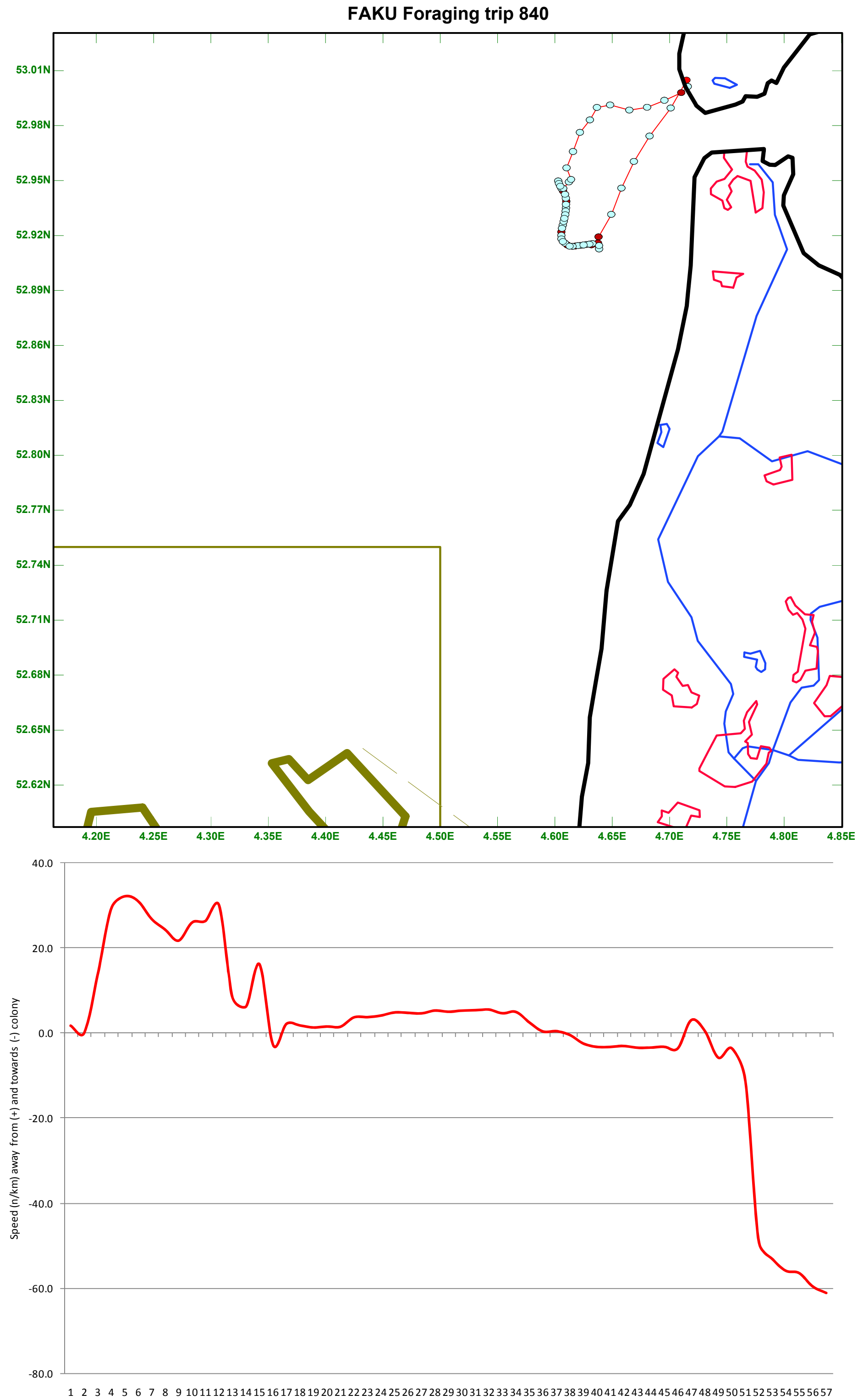


Figure 14. A rather short "long trip": straight flight in SW direction and meandering return flight with frequent temperature drops (red dots), probably indicating shallow plunge diving events. Prior to return, some time is spent bathing and preening on the beach near the colony (colour ring F.AKU, trip#840, 1 July 2010, logger 327, female bird). See **Fig. 13** for explanation of lower panel.

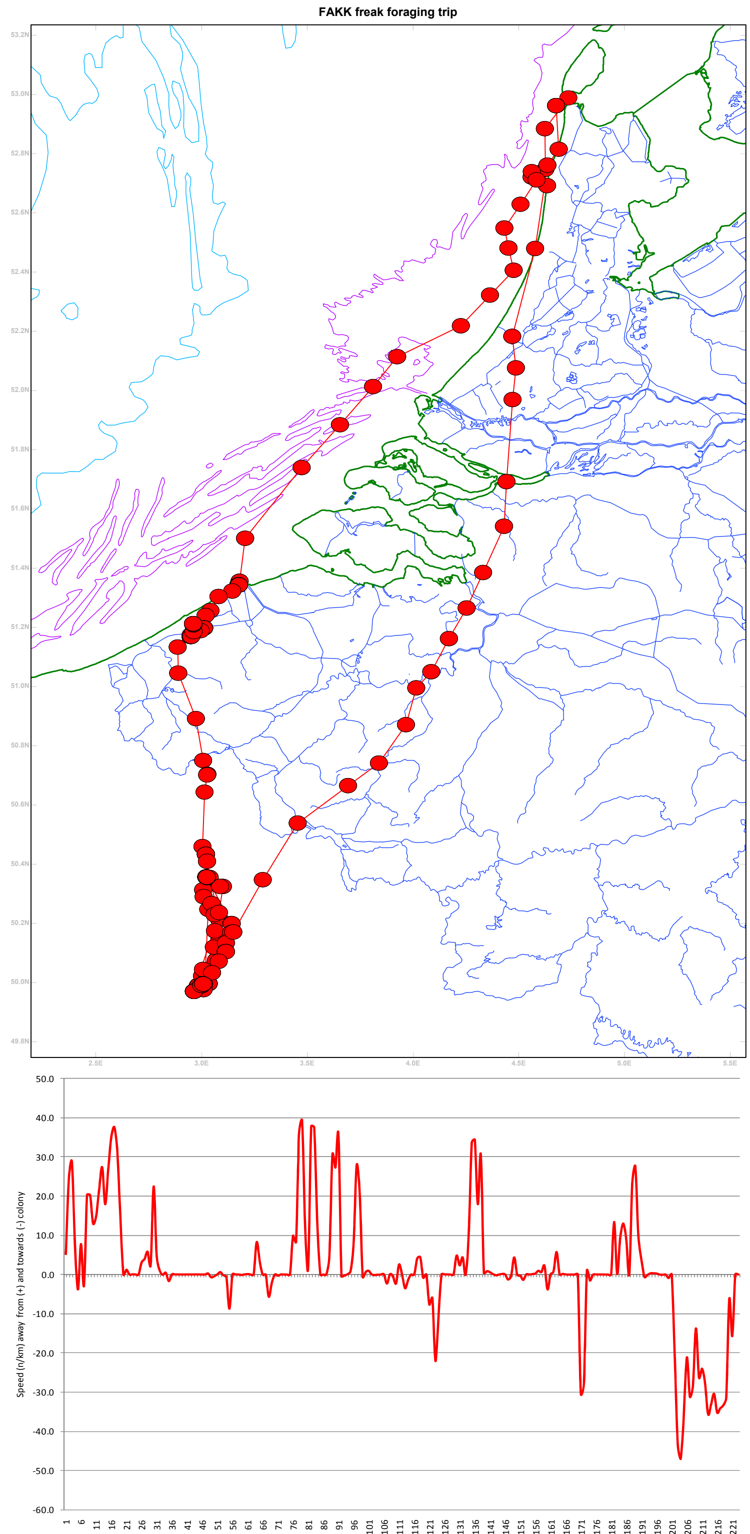


Figure 15. An exceptionally long "long trip": straight flight in S direction, largely over land, towards landfill areas in northern France and a fairly direct return flight with stops at the coast of Belgium and near Petten (NH) (colour ring F.AKK, trip#1060, 24-29 July 2010, logger 344, female bird). See **Fig. 13** for explanation of lower panel.

Between the sexes, the course (°) of departure and arrival from long-trips differed considerably. Mean departures by males were in a SW direction (mean ± SD, 216 ± 59°, n= 404), while female departures were mostly to the SE (149 ± 75°, n= 818; t_{1220}= 15.77, P< 0.0001), with single birds notably different from the total number of individuals in either sex (**Table 8**). Return flights showed a similar difference, but with males arriving more from the south (190 ± 19°), and with females arriving with even more easterly courses (142 ± 38°; t_{1220}= 15.11, P< 0.0001).

Table 8. Direction of departure and return (circular mean ± SD, °), mean vector length (r) and total number of long trips (n) for 25 individual Lesser Black-backed Gulls, breeding season 2008-2010. Male birds have ringing coded starting with M, female codes start with F. Directions are based on the five first and last GPS locations of each trip.

		Departure				Return						Departure				Return			
Ring	n	Mean	SD		r	Mean	SD		r	Ring	n	Mean	SD		r	Mean	SD		r
F.AAD	50	123	57.1	**SE**	0.61	114	63.5	**SE**	0.54	**M.ACN**	11	210	43.5	**SW**	0.75	204	73.2	**SW**	0.44
F.AAU	60	135	65.0	**SE**	0.53	127	69.7	**SE**	0.48	**M.ACS**	6	211	40.0	**SW**	0.78	183	66.5	**S**	0.51
F.AAW	81	64	75.2	**NE**	0.42	54	58.8	**NE**	0.59	**M.ACT**	4	248	66.0	**W**	0.51	236	71.3	**SW**	0.46
F.ABN	66	153	75.5	**SE**	0.42	150	62.1	**SE**	0.56	**M.AKM**	8	237	43.2	**SW**	0.75	216	50.5	**SW**	0.68
F.AJK	15	200	85.6	**S**	0.33	188	66.9	**S**	0.51	**M.AKT**	2	215	16.7	**SW**	0.96	182	7.3	**S**	0.99
F.AJT	13	99	64.1	**E**	0.53	116	55.9	**SE**	0.62	**M.AMA**	6	243	41.7	**SW**	0.77	196	34.8	**S**	0.83
F.AKJ	118	85	62.7	**E**	0.55	67	61.3	**NE**	0.56	**M.AMJ**	104	226	52.2	**SW**	0.66	218	54.8	**SW**	0.63
F.AKK	79	140	61.0	**SE**	0.57	131	52.6	**SE**	0.66	**M.AMK**	84	222	52.5	**SW**	0.66	204	55.8	**SW**	0.62
F.AKL	47	53	32.4	**NE**	0.85	47	28.9	**NE**	0.88	**M.AML**	49	220	64.6	**SW**	0.53	195	72.2	**S**	0.45
F.AKN	59	203	60.8	**S**	0.57	182	51.3	**S**	0.67	**M.AMM**	40	225	52.4	**SW**	0.66	187	40.7	**S**	0.78
F.AKS	49	232	54.9	**SW**	0.63	219	65.2	**SW**	0.52	**M.AMN**	9	78	83.6	**E**	0.34	166	80.6	**S**	0.37
F.AKU	85	196	67.3	**SE**	0.50	180	53.0	**S**	0.65	**M.AMP**	78	257	66.7	**W**	0.51	230	82.0	**SW**	0.36
F.AKV	96	157	87.4	**SE**	0.31	151	75.9	**SE**	0.42										

If a southwesterly course of departure was sustained further a field, this would lead to foraging grounds at sea (the North Sea shoreline or further offshore). In contrast, a more easterly direction of flight at departure would lead to foraging grounds at Texel, within the Wadden Sea and on the mainland. Sustained flight is seemingly confirmed when the individual time budgets are calculated from 1222 long-trips (*c.* 7785 hours of total trip time) over the five different foraging areas for 25 individuals (**Fig. 16, Table 9**). In this graph, trip information has been excluded when the nesting attempt had failed, for reasons illustrated in **Fig. 17. Table 10**).

Active breeding males spent 78% of their long-trip time in marine areas (North Sea and North Sea coastal waters), females used these areas only 34% of their time (t_{23}= 7.92, P< 0.001). In males, the amount of time at sea declines gradually through the breeding season (from >80% during incubation to *c.* 70% when chicks are fledging, **Fig. 17**). When nesting attempts failed, birds from both sexes shifted their attention markedly, and sex differences faded away: males focused more on land, females travelled more often to the North Sea and North Sea coastal waters (at-sea time 61% in two males, 54% in four females; t_4= 0.52, n.s.; Fig. 4).

“Freak-trips” (very long time, or exceptional distances) occurred occasionally in parent birds during fledging (e.g. **Fig. 15**), but more typically in failed breeding birds and these included trips into the United Kingdom and deep inland, to the SE of the Netherlands and occasionally even into Germany, Belgium and Northern France.

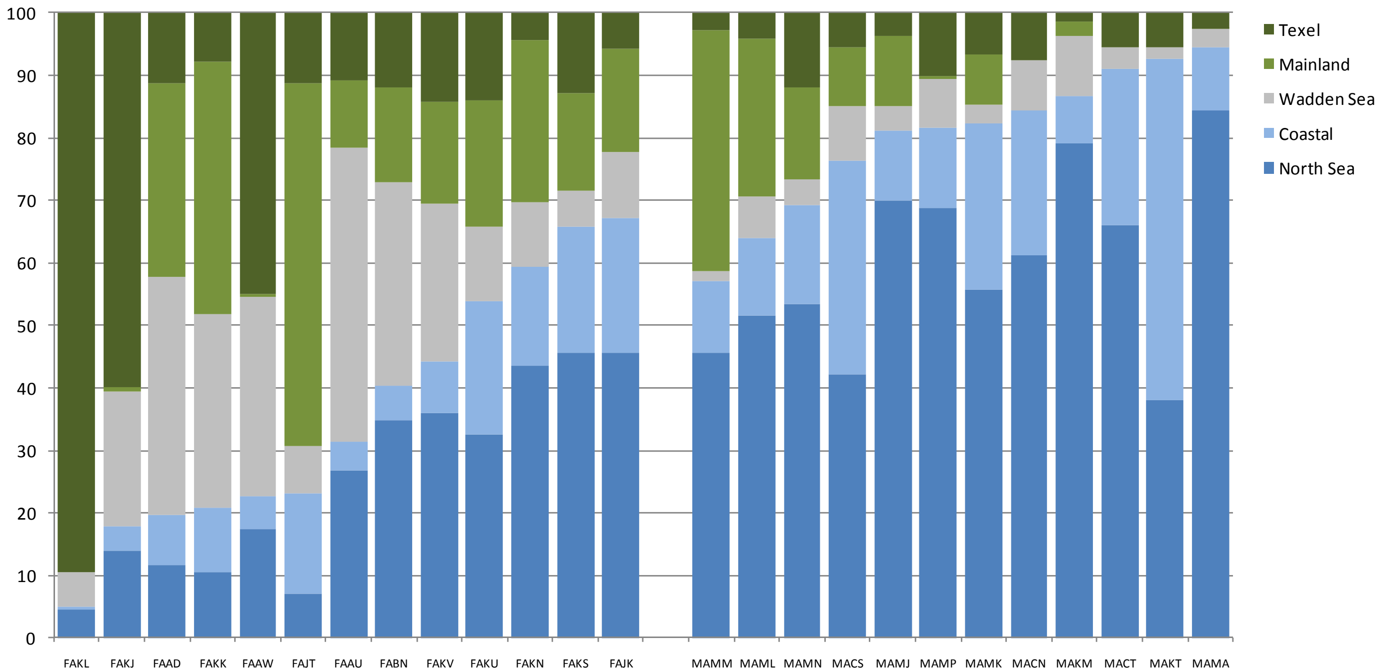


Figure 16. Time (% of all hours) spent by 25 individual Lesser Black-backed Gulls (females left, indicated by ring codes starting with F, males right, indicated by codes starting with M) in five potential feeding habitats on long-trips (*c.* 7785 hours of trip time), individuals are sorted by the relative amount of time spent in the North Sea and North Sea coastal waters (combined) in increasing order. Trips of failed breeders have been excluded from this analysis (Figure tabulated in **Table 9**).

Table 9. Time (% of all hours) spent by 25 individual Lesser Black-backed Gulls (females left, indicated by ring codes starting with F, males right, indicated by codes starting with M) in five potential feeding habitats on long-trips (*c.* 7785 hours of trip time) Trips of failed breeders have been excluded from this analysis (Tabulated data of **Figure 16**).

Ring	North Sea	Coastal	Wadden Sea	Main-land	Texel	Ring	North Sea	Coastal	Wadden Sea	Main-land	Texel
FAKL	5	0	6	0	89	**MAMM**	46	11	1	39	3
FAKJ	14	4	22	1	60	**MAML**	52	12	7	25	4
FAAD	12	8	38	31	11	**MAMN**	53	16	4	15	12
FAKK	11	10	31	40	8	**MACS**	42	34	9	9	5
FAAW	17	5	32	1	45	**MAMJ**	70	11	4	11	4
FAJT	7	16	8	58	11	**MAMP**	69	13	8	0	10
FAAU	27	5	47	11	11	**MAMK**	56	27	3	8	7
FABN	35	5	33	15	12	**MACN**	61	23	8	0	8
FAKV	36	8	25	16	14	**MAKM**	79	8	10	3	1
FAKU	33	21	12	20	14	**MACT**	66	25	3	0	6
FAKN	44	16	10	26	4	**MAKT**	38	55	2	0	6
FAKS	46	20	6	15	13	**MAMA**	84	10	3	0	3
FAJK	46	22	11	16	6						

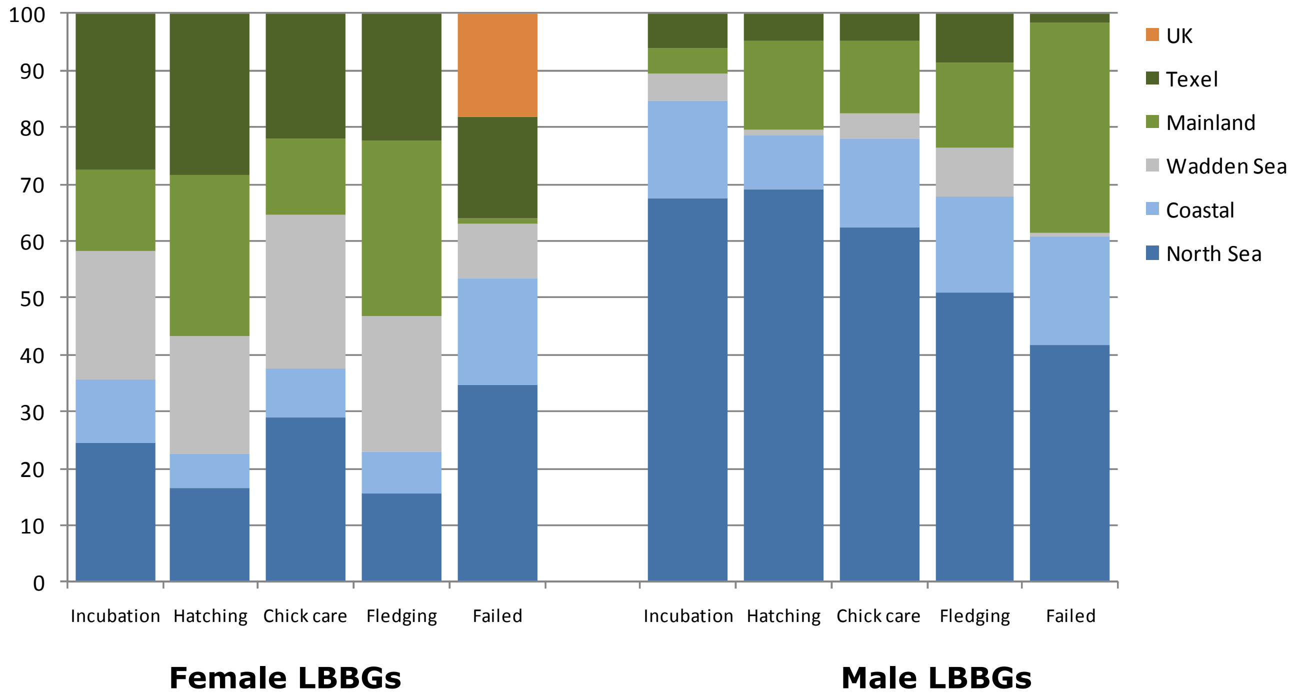


Figure 17. Time (% of all hours) spent by female (left) and male (right) Lesser Black-backed Gulls on long-trips in five potential feeding areas (*c.* 9011 hours of trip time), or in the UK, throughout the breeding season (incubation to fledging, activities when the nest attempts that had failed separated. In **active breeders** (Failed birds excluded), the amount of time spent in marine habitats (North Sea and Coastal waters) during long trips amounted to 34% in females and 78% in males. In **failed breeders** the at-sea time amounted to 54% in females and 61% in males.

Table 10. Time (% of all hours) spent by female (F, top) and male (M, bottom) Lesser Black-backed Gulls on long-trips in five potential feeding areas (*c.* 9011 hours of trip time), or in the UK, throughout the breeding season (incubation to fledging, activities when the nest attempts that had failed separated. In **active breeders** (Failed birds excluded), the amount of time spent in marine habitats (North Sea and Coastal waters) during long trips amounted to 34% in females and 78% in males. In **failed breeders** the at-sea time amounted to 54% in females and 61% in males. (Tabulated data of **Figure 17**).

		North Sea	Coastal	Wadden Sea	Mainland	Texel	UK
F	Incubation	25	11	23	14	28	0
	Hatching	17	6	21	28	28	0
	Chick care	29	9	27	14	22	0
	Fledging	16	7	24	31	22	0
	Failed	35	19	10	1	18	18
M	Incubation	68	17	5	4	6	0
	Hatching	69	10	1	16	5	0
	Chick care	62	15	5	13	5	0
	Fledging	51	17	8	15	9	0
	Failed	42	19	1	37	2	0

The course of departure from the colony (failed breeders excluded) was a strong indicator of the overall at-sea time (**Fig. 18**), with only a single outlier (M.AMN). The correlation between direction of flight at departure and time spent at sea is even stronger when this outlier is omitted ($y = 5.86e^{0.0113x}$, $R^2 = 0.84$)

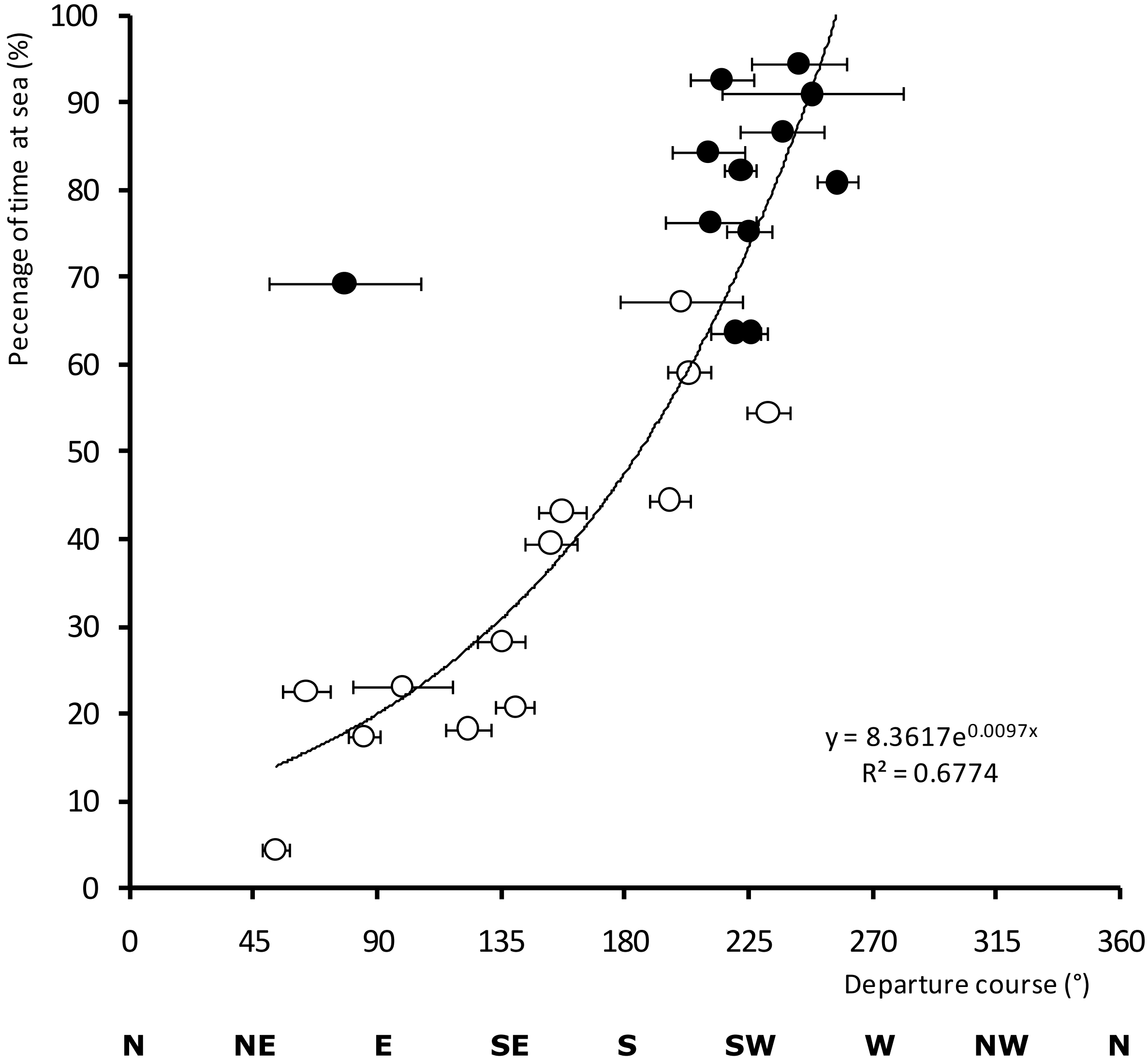


Figure 18. Direction of departure (circular mean, °, as in **Table 8**), in relation to the time spent at sea and in North Sea coastal waters (% of all hours during trips; as in Fig. 1) by 25 individual Lesser Black-backed Gulls on long-trips. Females in white, males in black symbols. The outlier male is M.AMN. Departure directions are based on the first five positions received per trip, irrespective of differences in device settings (*i.e.* the time between uploads). Departure directions for most birds were variable between trips, but overall, departure directions were a fairly accurate predictor of the intention of birds to engage in a foraging trip to the North Sea or to North Sea coastal waters (departures S, SW, and W), or to forage inland or within the Wadden Sea (departures NE, E, SE). The outlier bird, male M.AMN, regularly performed circular routes, setting out in an easterly course, but then travelling towards the mainland, turning west in a later stage, and spent most of the trip time at sea as most males did.

4.4 Foraging range through the breeding season

To illustrate how the foraging range gradually expanded through the breeding season, the time spent on long trips within 2x3' rectangles around the colony was calculated for bird engaged in the incubation phase (*i.e.* immediately after they were captured; **Fig. 19**), during hatching of the eggs (**Fig. 20**), chick care (**Fig. 21**), and fledging (**Fig. 22**). It appeared that the foraging range was most restricted during incubation and hatching, but that foraging trips became progressively further ranging in later stages of active breeding (chick care and fledging). It is interesting to note that in the latter phase of breeding, foraging trips out to the Bruine Bank area and up north towards the Frisian Front occurred. This range expansion occurred during a phase in which the energetic demands within the colony were increasing (developing, larger chicks). The sex difference in the utilization of different foraging habitats (notably the difference in tendencies to move to either marine or terrestrial areas) was maintained during each of these phases (**Fig. 17**), but details are included below:

During **incubation** (**Fig. 19**), 123 long-trips for females were recorded with a mean duration of 7.4 ± 5.5 hours (max. 42 hours) and with a mean distance of 20.1 ± 12.1 (max 65) km from the nest. Of 934 hours total trip-time, 28% was spent at Texel, 23% in the western Wadden Sea, 14% on the mainland, and 36% at sea (either in North Sea coastal waters, or further at sea; **Fig. 17**). The 82 long-trips recorded for males in this phase of breeding were similar in duration (7.5 ± 6.7, max. 40 hours), but on average slightly further away from the nest (28.0 ± 14.8, max 75 km). Males however, spent 85% of their long trip-time at sea (n= 633 hours of trip-time) and only fairly trivial amounts of time at Texel (6%), within the western Wadden Sea (5%) and on the mainland (4%; **Fig. 17**). Both sexes concentrated on foraging opportunities to the SW, S and SE of the breeding colony.

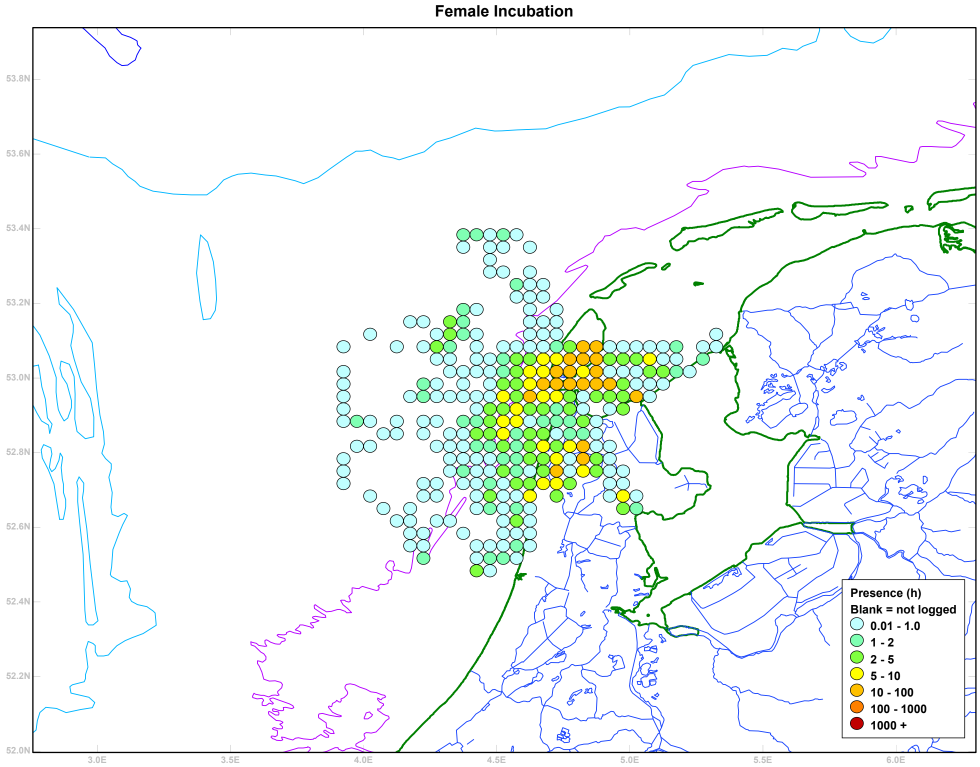
When the **eggs** were **hatching** (an entire clutch would normally hatch within 3-5 days), one would expect that at least one of the parents, possibly both, would spend considerable time at the nest, reducing the sample size for long-trips (**Fig. 20**). For females, 79 long-trips were logged, and these trips were on average rather shorter in duration (5.0 ± 4.0, max 19 hours), but fairly similar in maximum distance (20.3 ± 13.7, max 69 km) away from the nest. The at-sea time during long-trips was further reduced (23%) during hatching, while the mainland had gained importance (28%). The amount of time spent at Texel (28%) and within the western Wadden Sea (21%) was fairly similar as during incubation (n= 413 hours of total trip-time; **Fig. 17**). In males, the mean trip duration during hatching was not reduced (8.7 ± 9.5, max 38 hours; n= 26 trips), but they ranged on averaged slightly further away from the colony (33.4 ± 12.9, max 59 km). Of a total trip time of 233 hours during hatching, 79% of the time was spent at sea, and fairly trivial amounts at Texel (5%), within the western Wadden Sea (1%; Marsdiep only; **Fig. 17**). As in females, foraging conditions at the mainland had gained importance (16%).

The long phase of **chick-care** generated 471 logged long-trips for female Lesser Black-backed Gulls (**Fig. 21**), of a fairly similar duration as in the preceding phases of breeding (6.0 ± 6.3, max 50 hours), ranging on average slightly further away from the colony (23.5 ± 20.7 km), but including some much more distant foraging trips (max 169km from the nest). Of a total of recorded trip-time of 2986 hours, about 38% was spent at sea, 27% within the western Wadden Sea, 22% at Texel, and only 14% at feeding opportunities at the mainland

(**Fig. 17**). The distribution map shows some lengthy trips towards the central Southern Bight and an isolated trip to the NW. Again, much of the foraging time is spent to the south (SW, S, SE) of Texel. For male Lesser Black-backed Gulls, mean trip duration had declined (5.7 ± 5.0, max 30 hours, n= 233 trips), while the range remained on average the same, but with greater variability between trips (33.8 ± 21.4, max 115 km distance). Habitat utilization was similar to the earlier phases of breeding, with 77% of the time at sea, 5% at Texel, 5% within the western Wadden Sea, and 13% of the time at the mainland (n= 1392 hours of total trip-time; **Fig. 17**).

The phase of **fledging** (in fact any chick-care after mid-July) is covered in 40 long trips performed by females (total duration 756 hours) and 37 trips by males (621 hours; **Fig. 22**). Very lengthy "freak-trips" occurred, including a 4.7 days excursion by female F.AAW, 24-29 July (**Fig. 15**), towards some landfill areas in northern France and back. These freak-trips have contributed to a considerable variability in trip duration by females (15.4 ± 19.2, max 113 hours) and range (33.9 ± 55.6, max 359 km). The overall time spent within different key habitats was fairly similar to the earlier phases of breeding, but with only 23% of at-sea time, 22% of time at Texel, 24% in the western Wadden Sea and 31% at mainland sites (**Fig. 17**). In males, trips were on average both longer in time (11.1 ± 5.8, max 26 hours) and in mean range (39.8 ± 16.1, max 75 km). Freak-trips have not been observed, but the amount of time spent at sea declined to 68%. Both Texel (9%) and the western Wadden Sea (8%) had gained importance in comparison with earlier phases of breeding, whereas the time spent on the mainland (15%) remained more or less the same (**Fig. 17**).

Failed breeders performed very different trips and for as far as failed breeders did not promptly leave the colony area (meaning, contact with the GPS loggers was lost), they conducted trips to the United Kingdom, deep inland in The Netherlands, into Germany, Belgium and Northern France (**Fig. 23**). With regard to the foraging habitats around the colony, male and females performed highly similar trips and the sexual difference in the tendency to use marine versus terrestrial habitats was lost (**Fig. 17**). Male birds increased the amount of time on the mainland from 15-16% during the entire period of chick care (from hatching to fledging) to 37%, at the expense of time spent at sea (now only 61%; **Fig. 17**). Freak trips included trips towards the United Kingdom (female) and circular routes through much of The Netherlands and into Germany and Belgium (male).



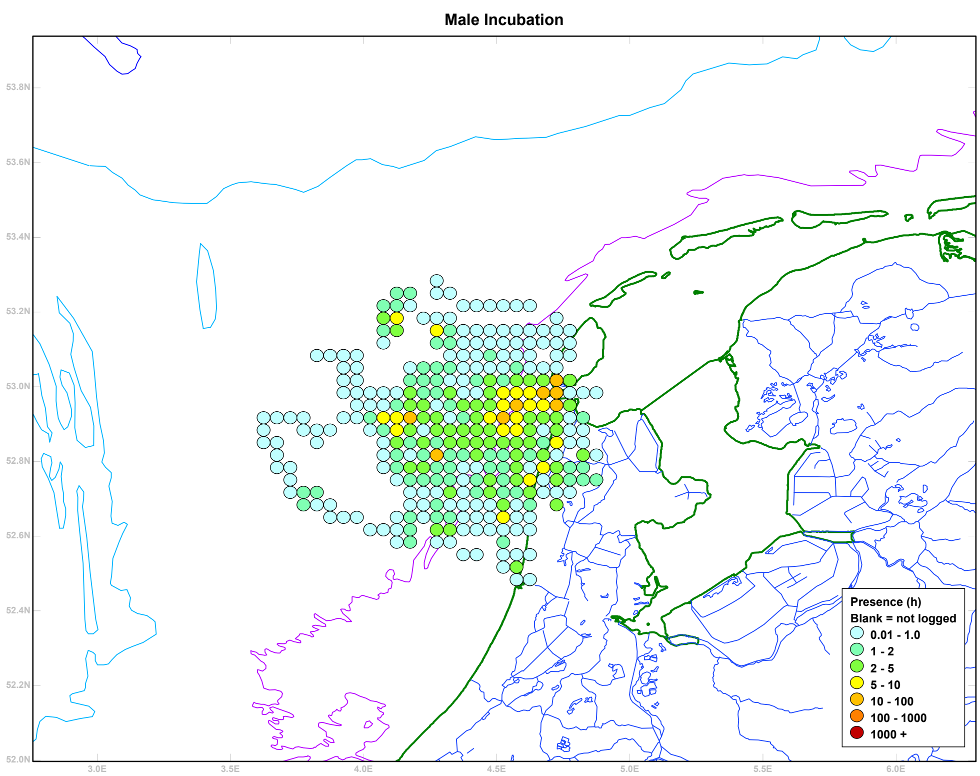
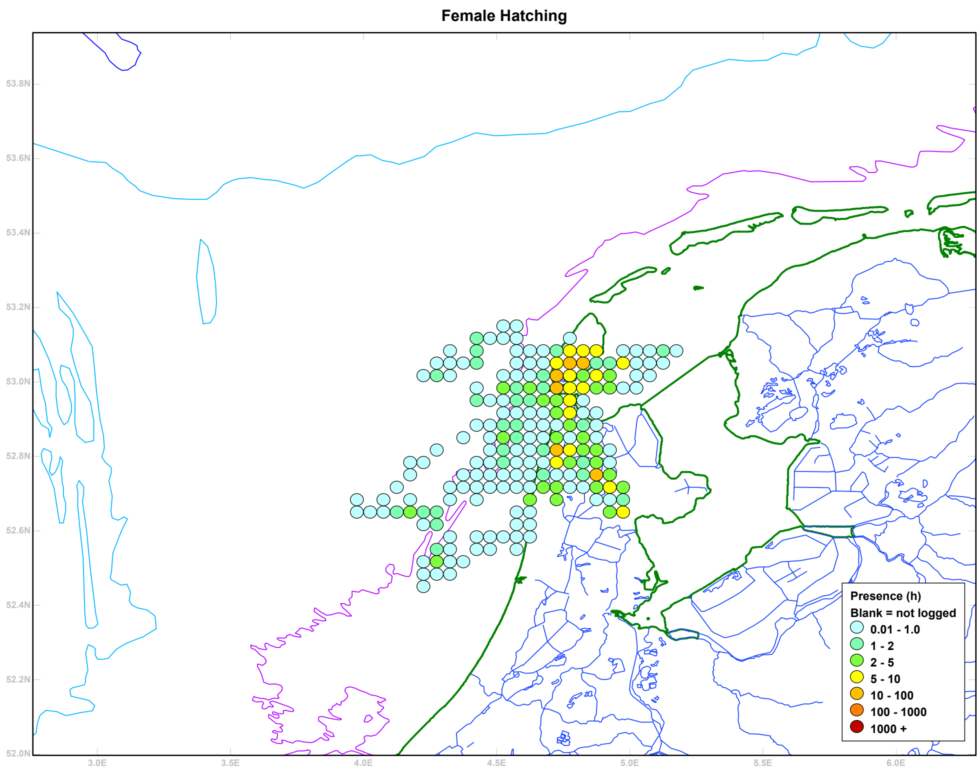


Figure 19. Time (h) spent per 2x3’ rectangle in and around the breeding colony during long-trips for female (top) and male (bottom) Lesser Black-backed Gulls engaged in **incubation** (all data combined; 2008-2010).



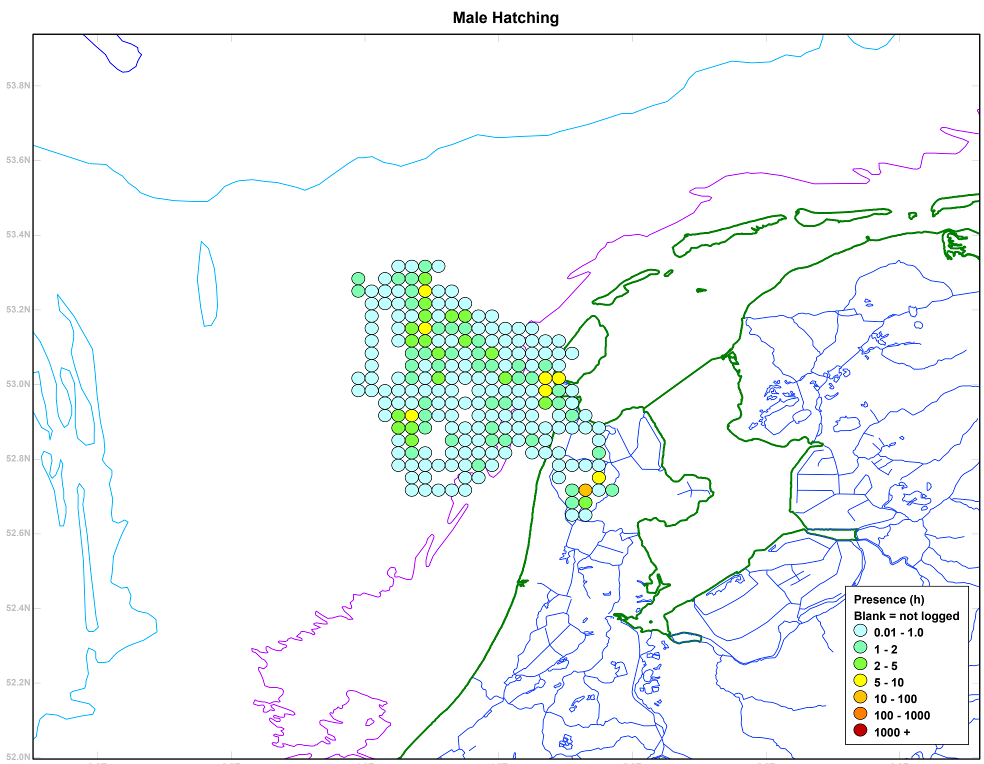
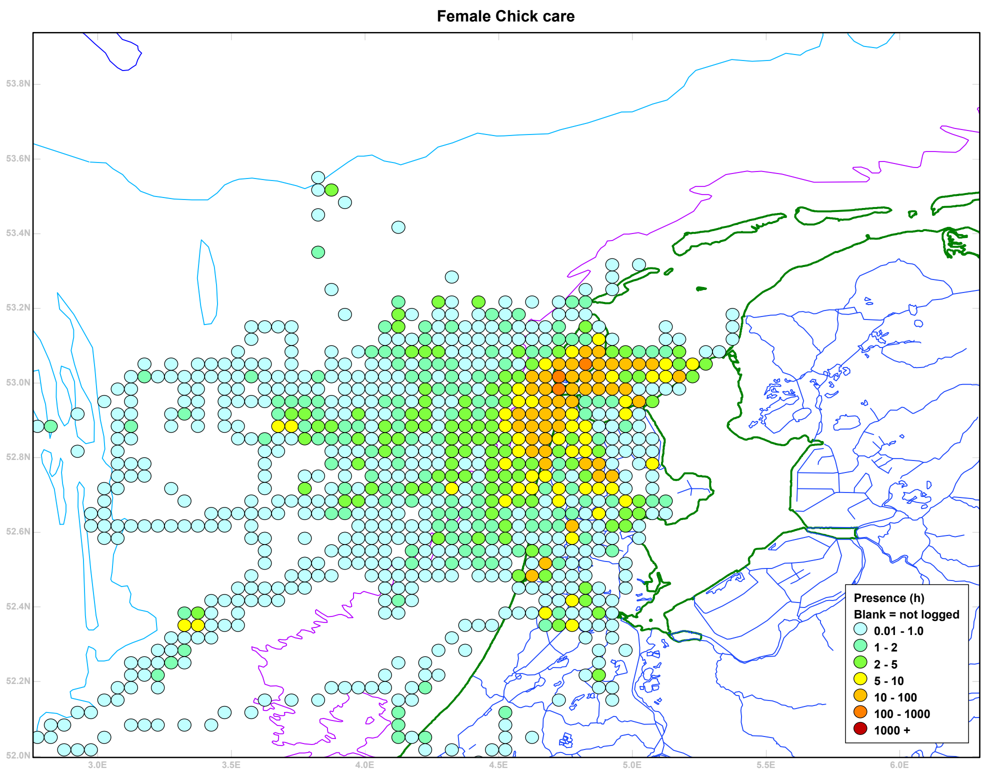


Figure 20. Time (h) spent per 2x3' rectangle in and around the breeding colony during long-trips for female (top) and male (bottom) Lesser Black-backed Gulls with **hatching eggs** (all data combined; 2008-2010).



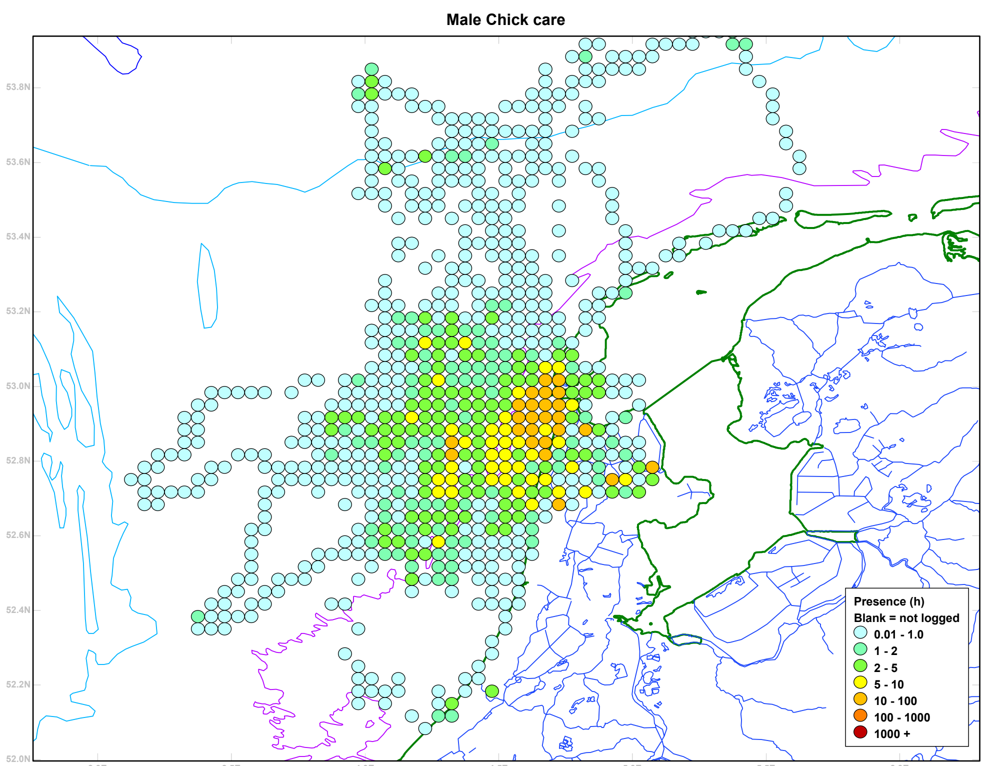
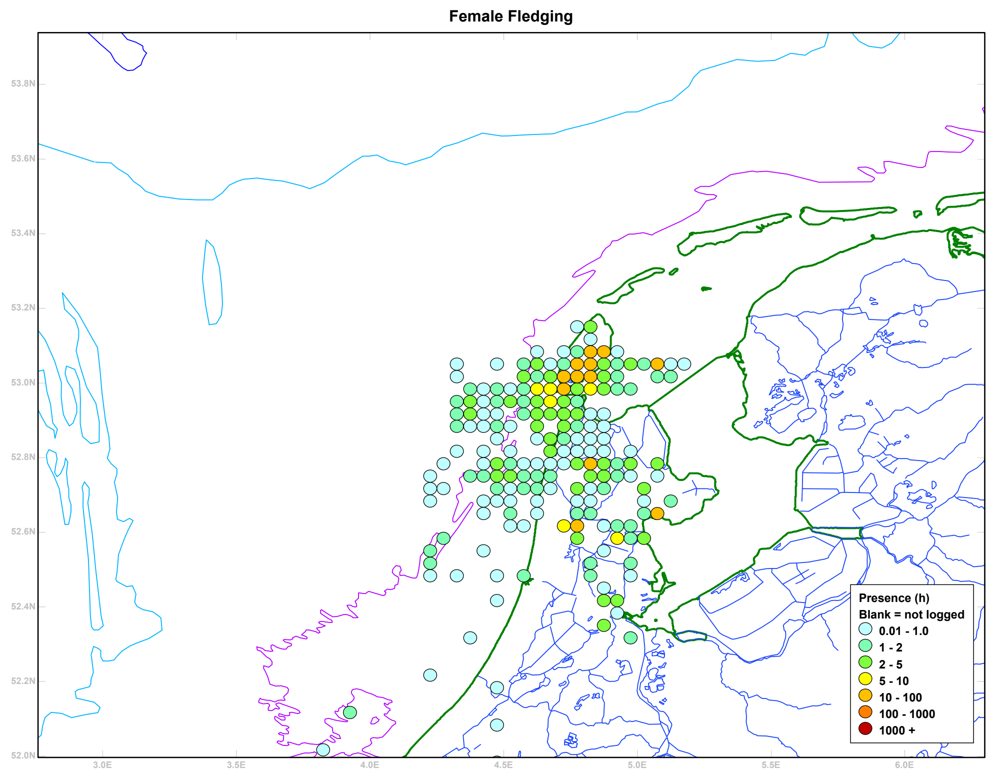


Figure 21. Time (h) spent per 2x3’ rectangle in and around the breeding colony during long-trips for female (top) and male (bottom) Lesser Black-backed Gulls during **chick care** (all data combined; 2008-2010).



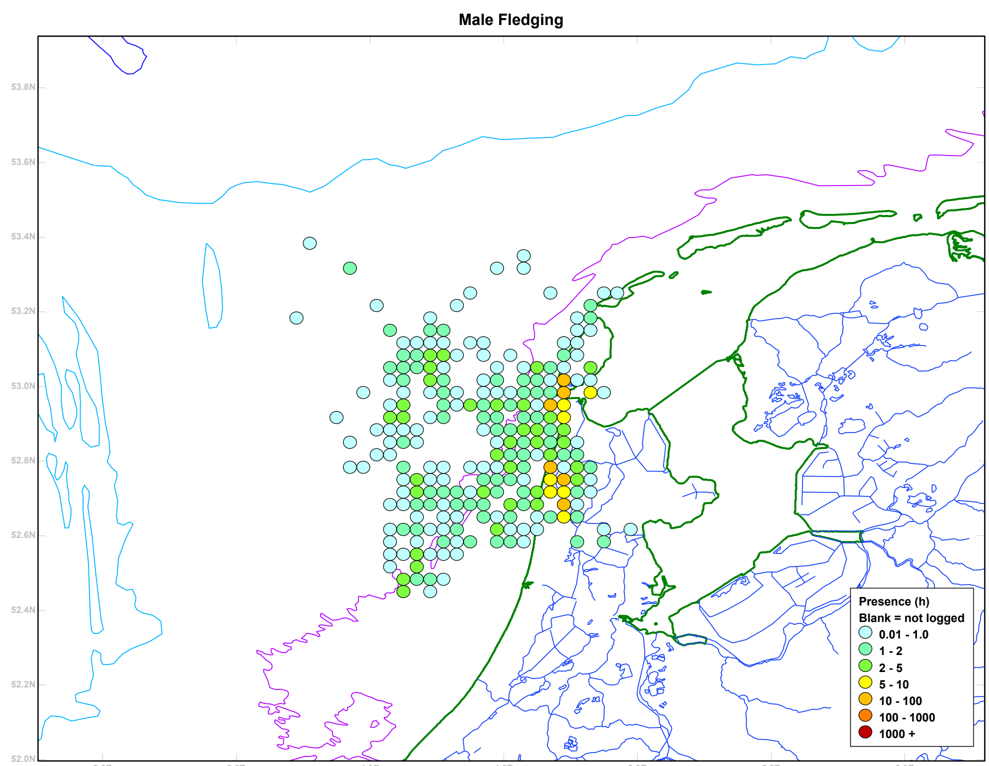
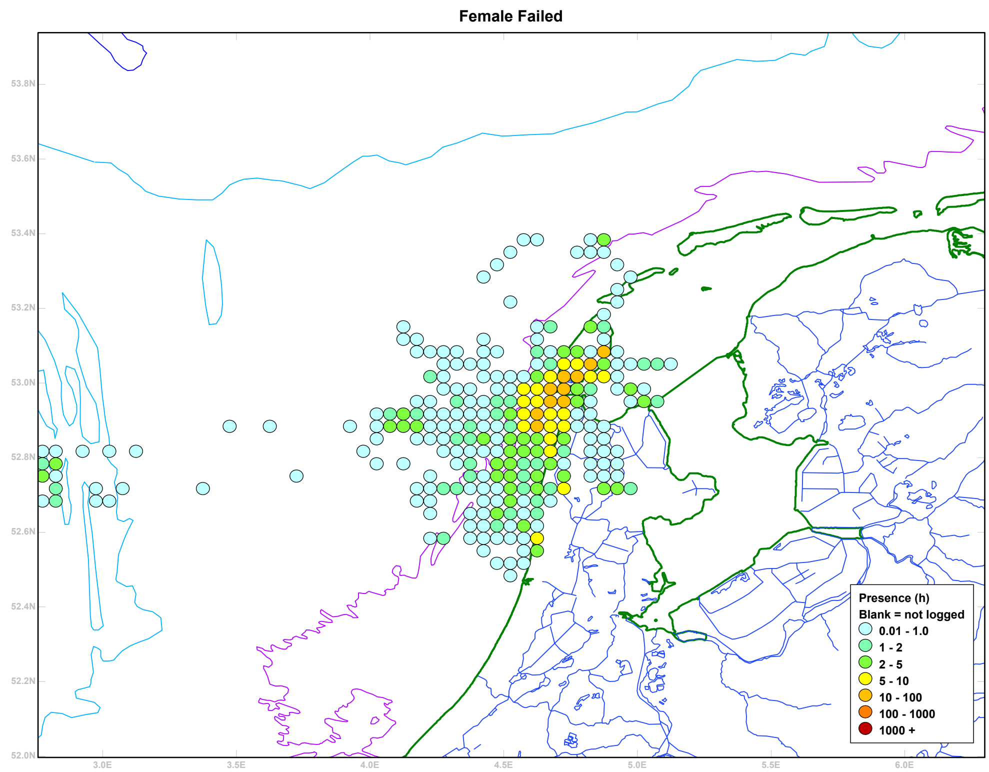


Figure 22. Time (h) spent per 2x3’ rectangle in and around the breeding colony during long-trips for female (top) and male (bottom) Lesser Black-backed Gulls caring for chicks during **fledging** (all data combined; 2008-2010).



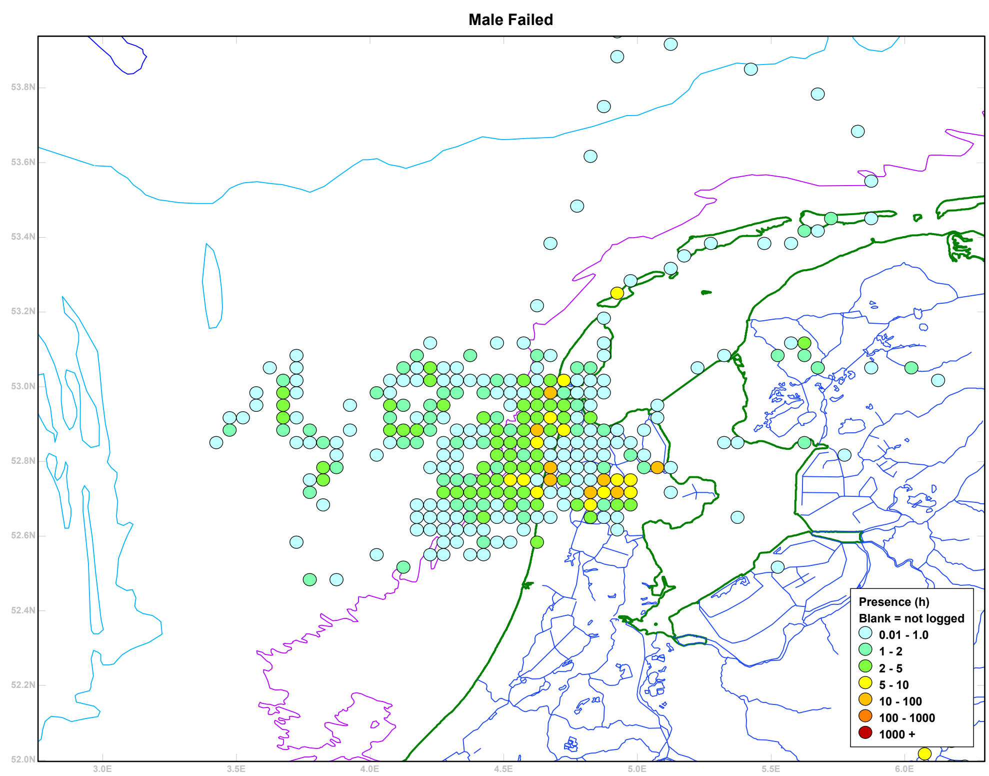


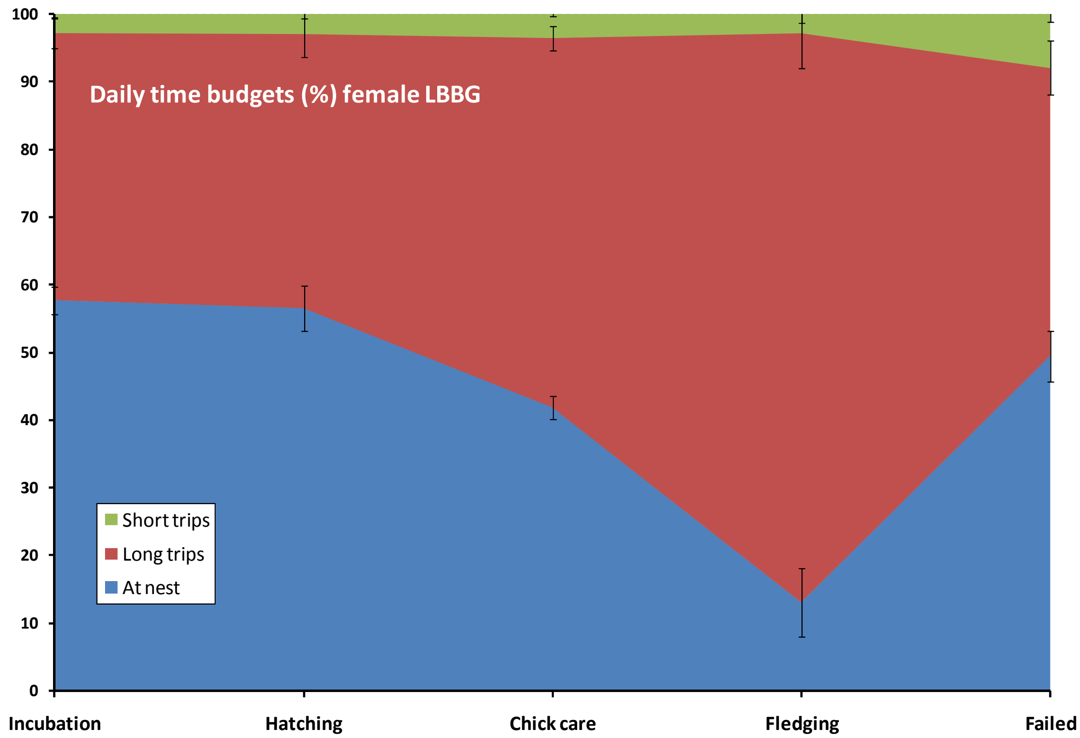
Figure 23. Time (h) spent per 2x3' rectangle in and around the breeding colony during long-trips for female (top) and male (bottom) Lesser Black-backed Gulls when a **breeding attempt had failed** (all data combined; 2008-2010).

4.5 Time budgets and daily patterns

Total individual time-budgets are difficult to achieve in instrumented animals when the devices undergo phases of battery loading and unloading (solar panels feed the batteries, but periods of dull weather or high resolution settings or indeed even other factors may make batteries to run empty at times). However, a fairly large number of complete days (*i.e.* 24 hour periods) have been logged that could provide information on daily budgets (403 'bird-days' for females, 268 'bird days for males). Time budgets have been calculated representing the percentage of time with 24 hour periods during breeding (4 phases) or when failed, engaged in nest attendance, on short trips, or on long (e.g. foraging) trips (**Table 11**). Both sexes show progressively shorter bouts of nest attendance from incubation via chick care to fledging (**Fig. 24**), the time spent on short-trips is fairly constant through the season. Nest attendance increased markedly in failed females, but not i failed males.

Table 11. Time budgets (% of day) of female and male Lesser Black-backed Gulls throughout the breeding season. The sample size represents the total number of days with complete, non-interrupted, logger data. See **Fig. 24** for a graphical representation of the material presented within this table.

		Females				Males			
		Mean		SD	n=	Mean		SD	n=
Incubation	at nest	57.7	±	19.1	87	65.7	±	22.3	64
	short trip	2.8	±	4.4	87	1.2	±	2.6	64
	long trip	39.5	±	20.7	87	33.1	±	23.0	64
Hatching	at nest	56.5	±	19.6	35	58.9	±	23.4	23
	short trip	2.9	±	3.7	35	1.9	±	2.4	23
	long trip	40.5	±	20.4	35	39.2	±	24.7	23
Chick care	at nest	41.9	±	24.5	211	52.6	±	17.3	122
	short trip	3.5	±	5.0	211	2.9	±	5.2	122
	long trip	54.6	±	25.8	211	44.5	±	18.4	122
Fledging	at nest	13.1	±	23.0	21	33.0	±	23.1	18
	short trip	2.8	±	5.9	21	4.2	±	5.4	18
	long trip	84.1	±	23.4	21	62.8	±	25.8	18
Failed	at nest	49.5	±	26.3	49	35.5	±	28.2	41
	short trip	8.0	±	8.3	49	2.3	±	5.9	41
	long trip	42.5	±	28.1	49	62.3	±	30.7	41



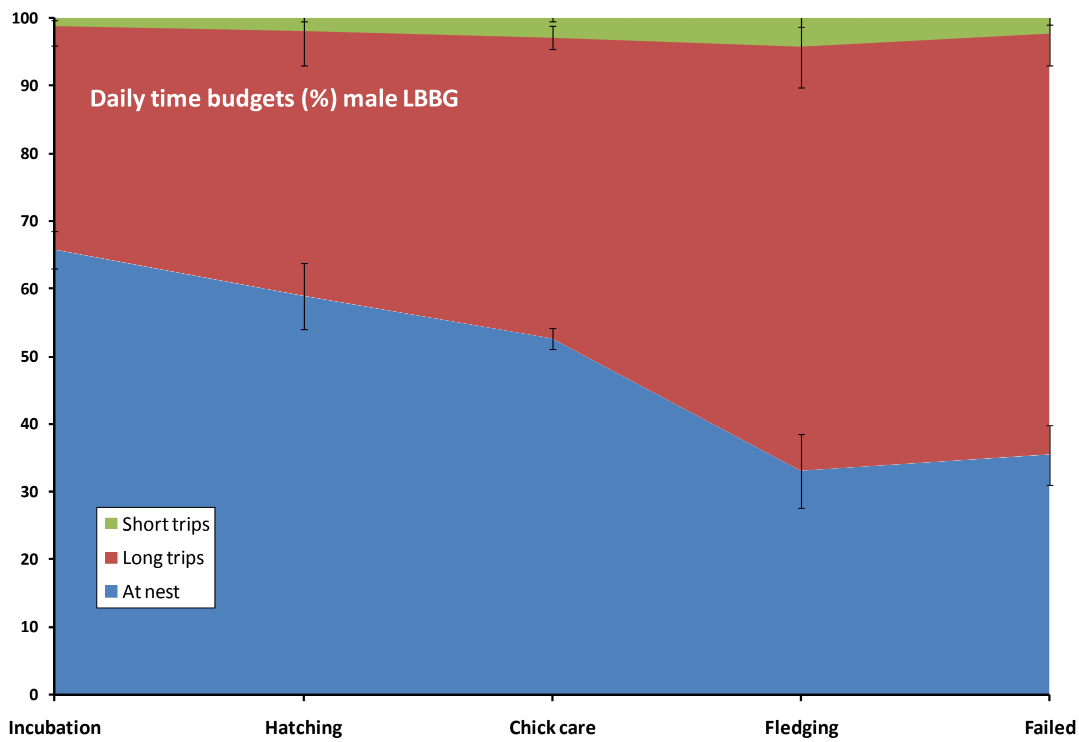


Figure 24. Time budgets (% of 24-hour periods, ± SE) of female (top and male (bottom)) Lesser Black-backed Gulls throughout the breeding season and when failed as a breeder. The sample size represents the total number of days with complete, non-interrupted, logger data (n= 403 'bird days' for females, 268 'bird days' for males, see tabulated underlying data **Table 11**).

For the unbroken activity bouts, this being the either the unbroken periods at the nest, short trips, or long-trips (potentially feeding) mentioned earlier, it was calculated *when* (time of the day) they occurred, for either sex, during breeding or when the nesting attempts had failed. When foraging trips would be restricted to daylight hours, the long-trips would be typically between 04:00 and 23:00. Similarly, when bathing trips have some diurnal pattern, this would be found by plotting the percentage of time spent on short trips relative to the time of the day. This is what is shown below, separately for active breeders (incubation to fledging) with obvious ties to the colony and for failed breeders, males and females apart (Figs. 21-32).

With regard to time spent in continuous bouts at the nest, actively nesting females had a higher tendency to be present during day time, males peaked at night (**Fig. 25**). After failure, night time nest attendance became more prominent in females (also **Fig. 25**), whereas in males, an early morning peak in nest attendance (05-10:00h) was followed by a noon dip and rather stable attendance levels in the evening and during the night (**Fig. 26**).

Short trips, that are interpreted mostly as trips to the roost or bathing place (feather maintenance, rest; **Fig. 12**). Visual observations in the field suggest a peak in activity in the afternoon and increasing numbers through the breeding season (mostly as a result of failed breeders, non-breeders, and immature birds that spend more and more time outside the colony in roosts). For active breeders, unexpectedly, it is clear that short-trips occur at night just as well as during the day, but males have a distinct dip in the morning hours, when females spend considerable time on short trips (**Fig. 27**). It is only in failed breeders that the night is abandoned as period for short trips and both sexes peak in the early afternoon (**Fig. 28)**.

Long trips during breeding occur through the day and night, with subtle differences between the sexes. Males tend to be at the colony at night, more than females, and seem to concentrate their efforts on long-trips during daylight hours (**Fig. 29**). In failed breeders, this pattern is slightly weakened, indicating that foraging activities (or at least the time spent on long trips) occur around the clock (**Fig. 30**).

Arrivals within the colony (the start of uninterrupted nest bouts) have a bimodal pattern in both sexes, with a distinct peak around sunrise and a second peak in the afternoon **(Fig. 31)**. When birds have failed, this bi-modal pattern is maintained (**Fig. 32**). Departures for short-trips occurred through the day, but with a distinct peak in the afternoon and rather fewer departures during the night (**Figs 33-34**).

Long trip departures during breeding occurred throughout the 24hour period, but with declining frequencies from the earlier morning hours and on in both sexes (**Fig. 35**). Males had a slightly stronger tendency for early morning departures than females, which is consistent with their predominantly day-time long-trip activities. In failed breeders, too few long-trips were recorded to present a meaningful departure plot, but the existing data are similar as in actively breeding individuals (**Fig. 36**).

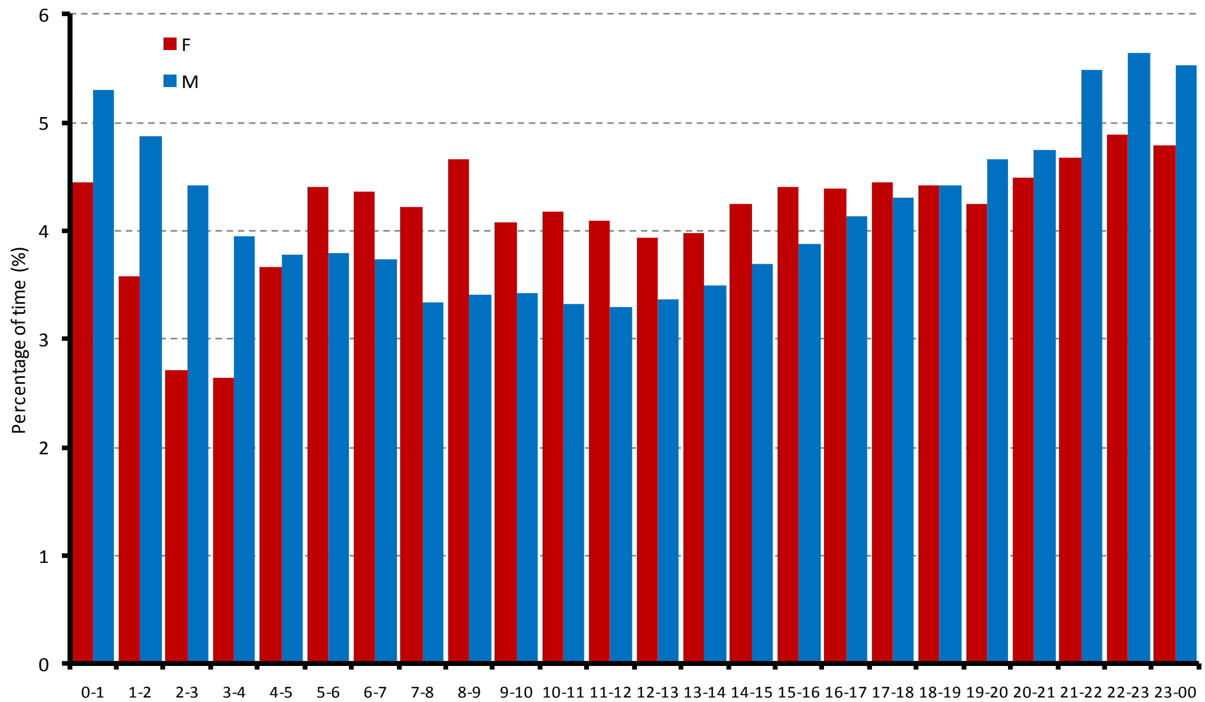


Figure 25. Time spent at the nest (%) relative to time of the day in male (blue) and female (red) Lesser Black-backed Gulls (Failed breeding birds excluded)

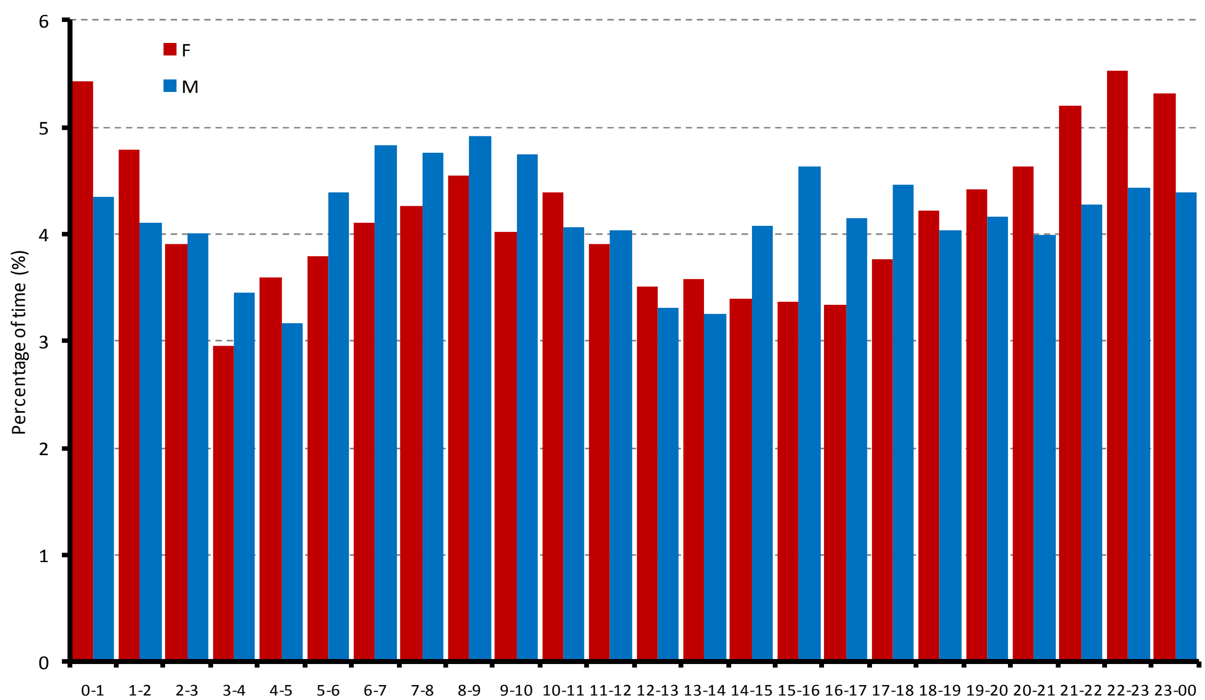


Figure 26. Time spent at the nest (%) relative to time of the day in male (blue) and female (red) Lesser Black-backed Gulls (Failed breeding birds only)

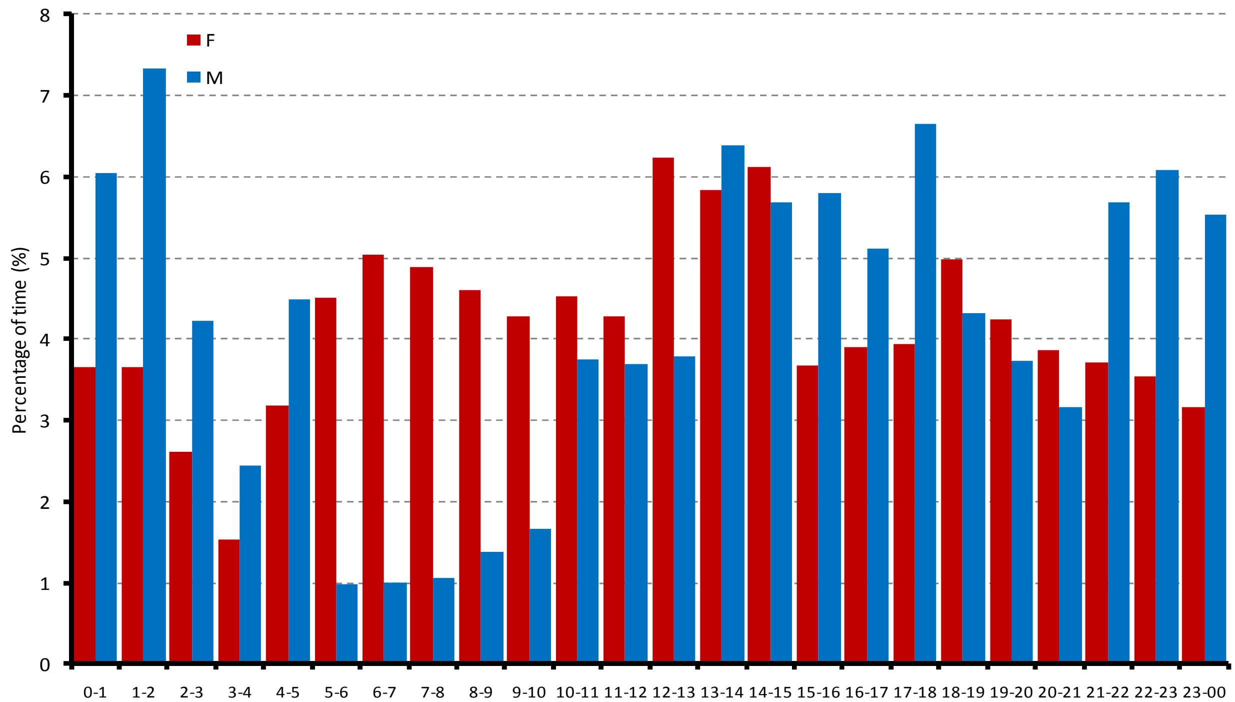


Figure 27. Time spent on short trips (%) relative to time of the day in male (blue) and female (red) Lesser Black-backed Gulls (Failed breeding birds excluded from the analysis)

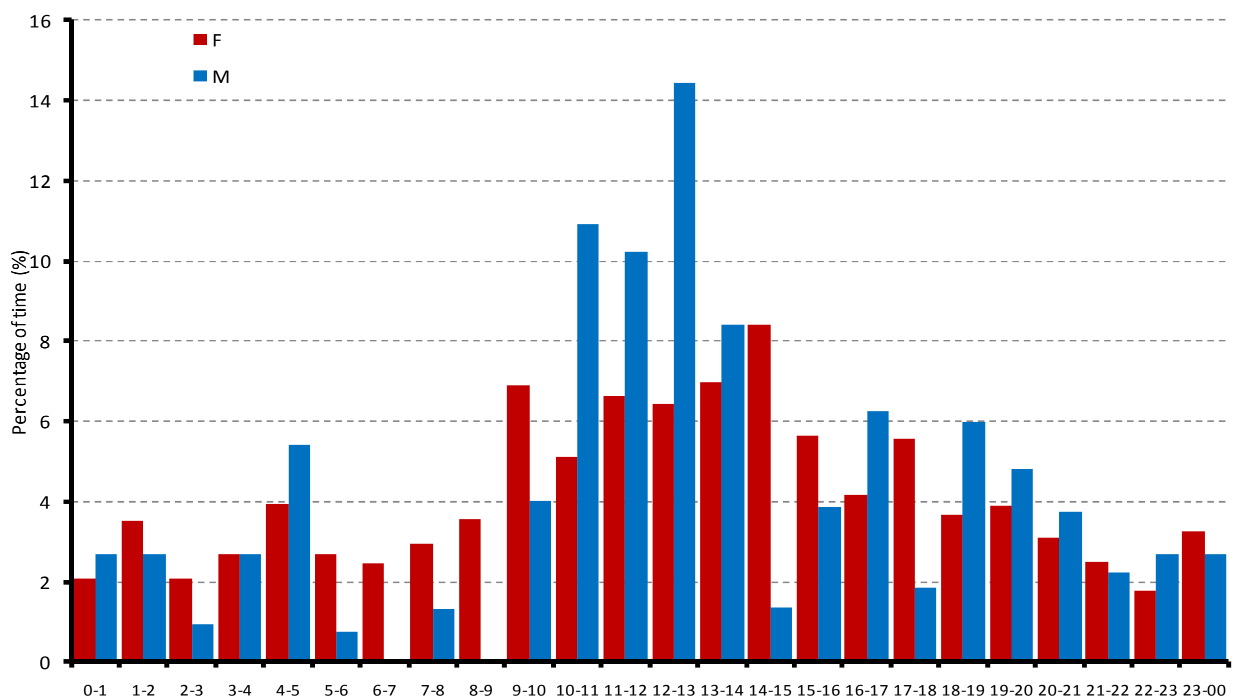


Figure 28. Time spent on short trips (%) relative to time of the day in male (blue) and female (red) Lesser Black-backed Gulls (Failed breeding birds only)

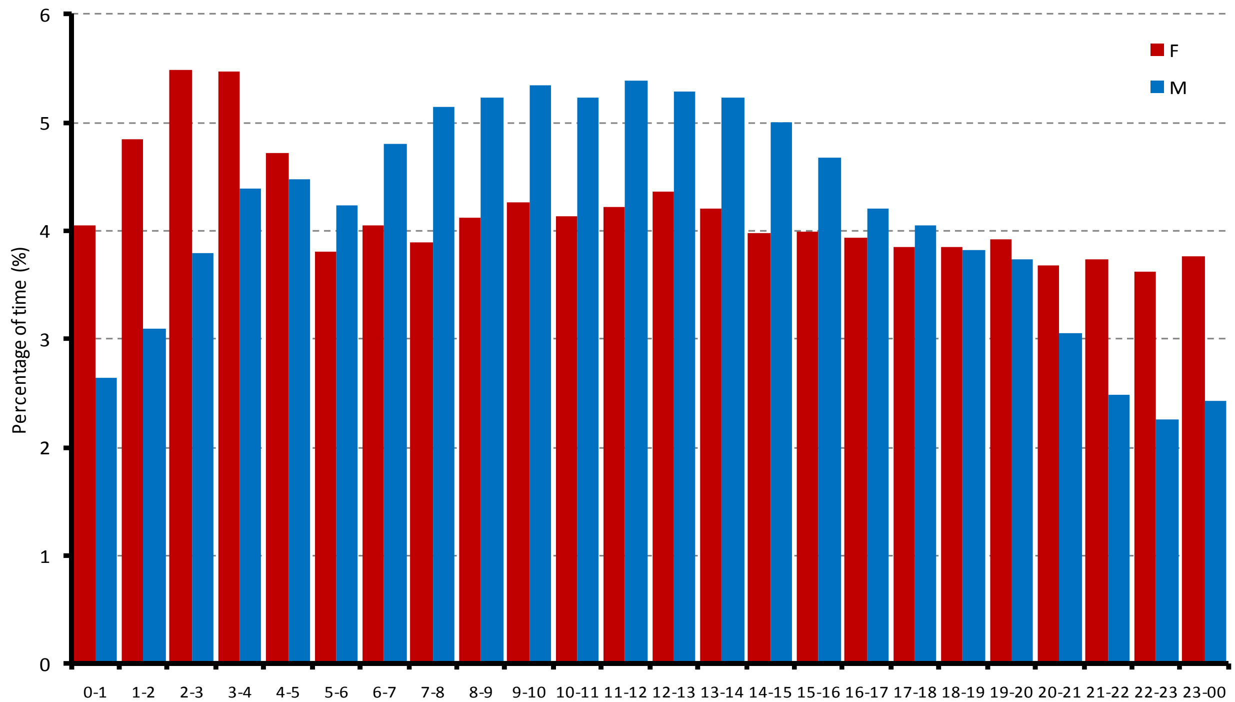


Figure 29. Time spent on long trips (%) relative to time of the day in male (blue) and female (red) Lesser Black-backed Gulls (Failed breeding birds excluded)

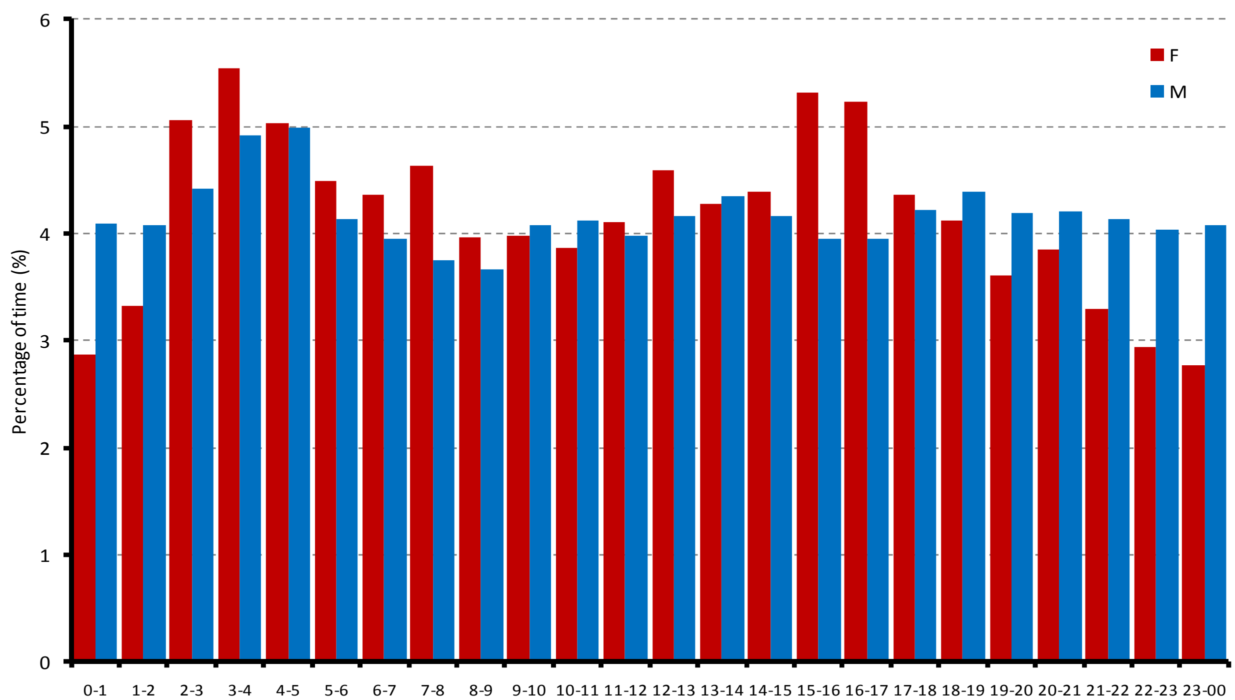


Figure 30. Time spent on long trips (%) relative to time of the day in male (blue) and female (red) Lesser Black-backed Gulls (Failed breeding birds only)

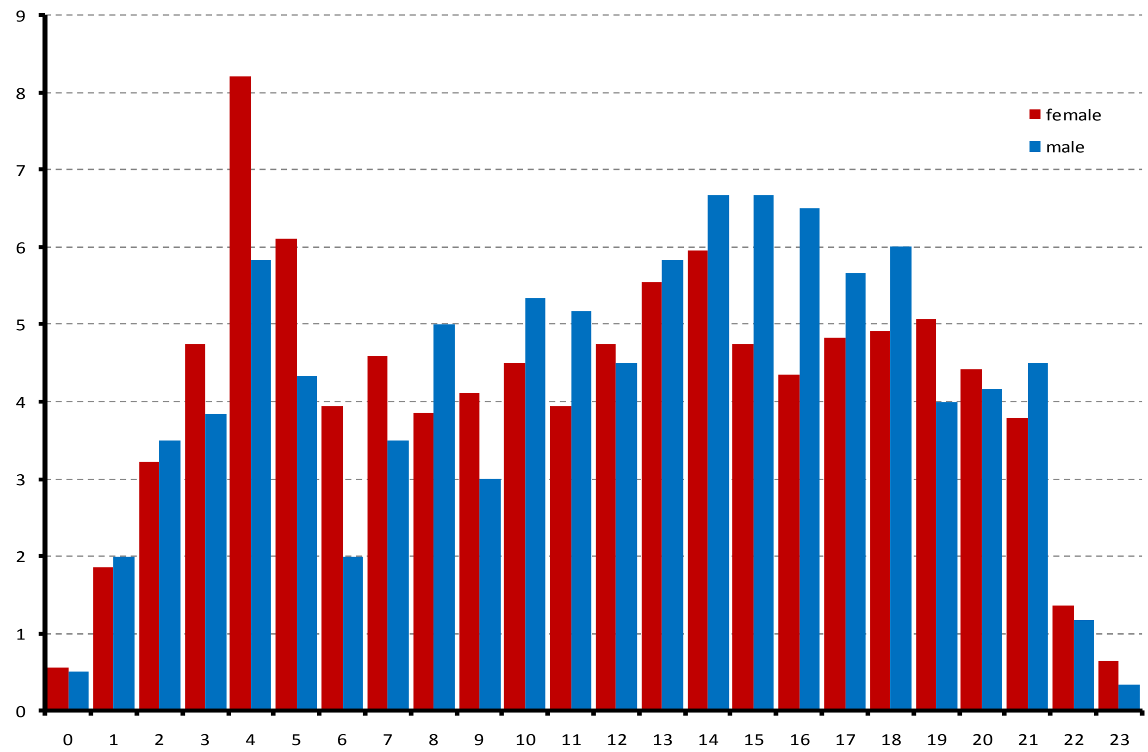


Figure 31. Arrivals within the colony (start of uninterrupted nest attendance bouts) in active breeding birds.

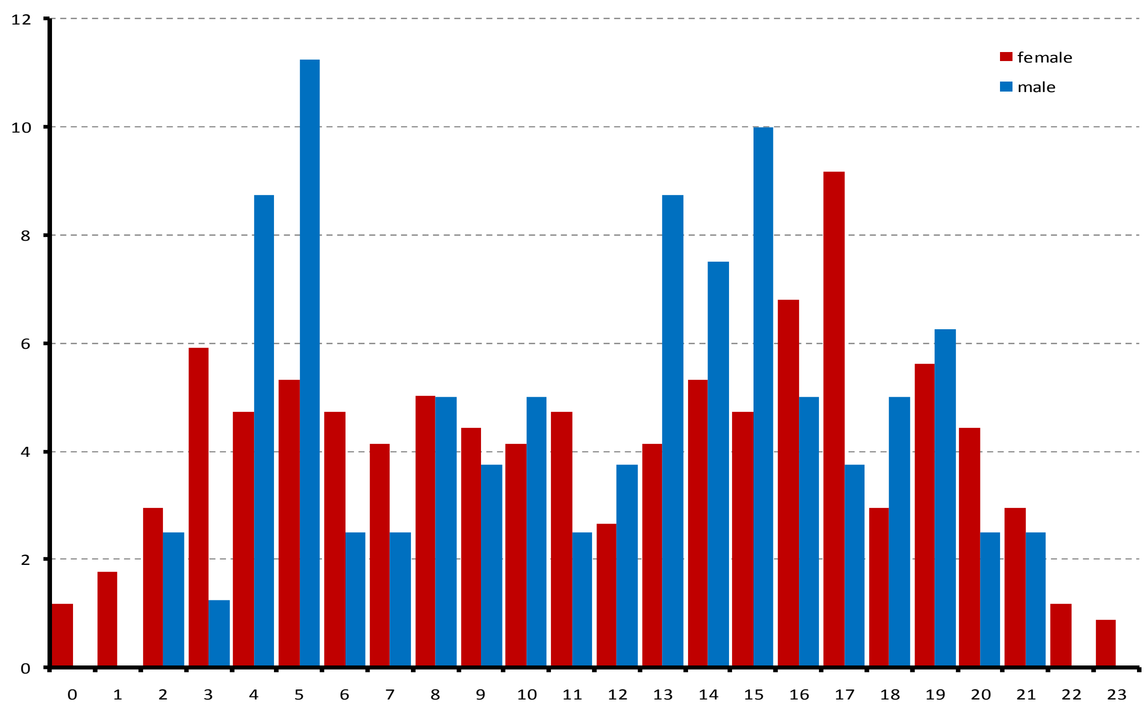


Figure 32. Arrivals within the colony (start of uninterrupted nest attendance bouts) in failed breeding birds.

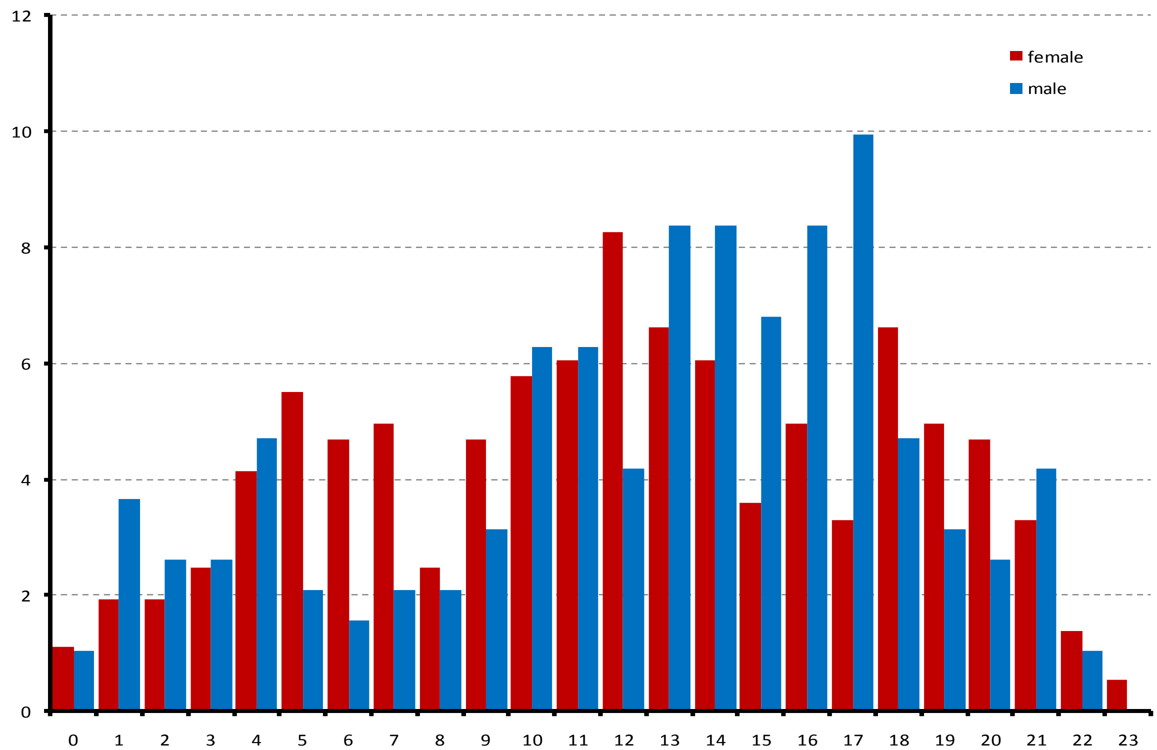


Figure 33. Departures for short trips (not leading any further than 3km from the nest) in active breeding birds

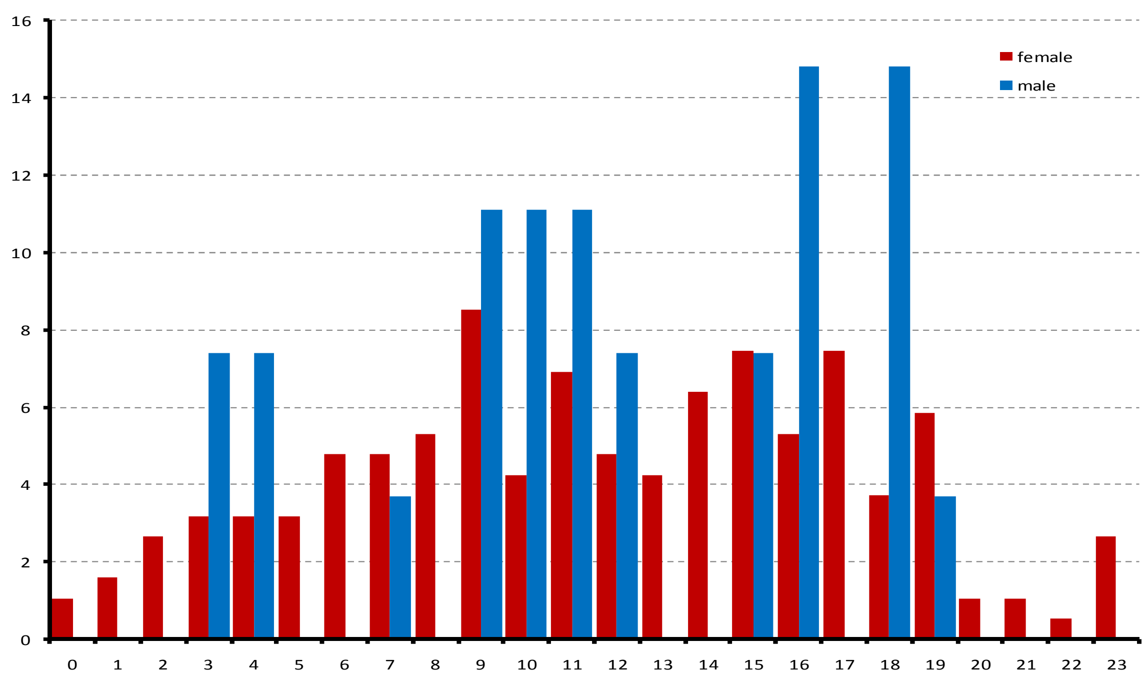


Figure. 34. Departures for short trips (not leading any further than 3km from the nest) in failed breeding birds.

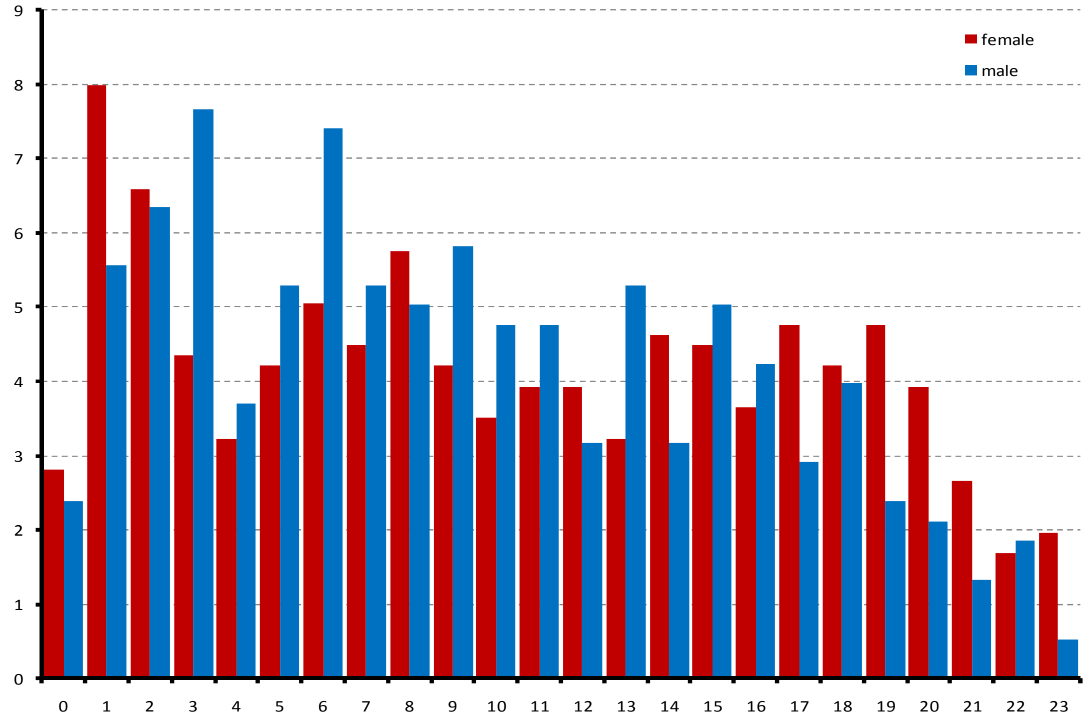


Figure 35. Departures for long trips (not leading any further than 3km from the nest) in active breeding birds

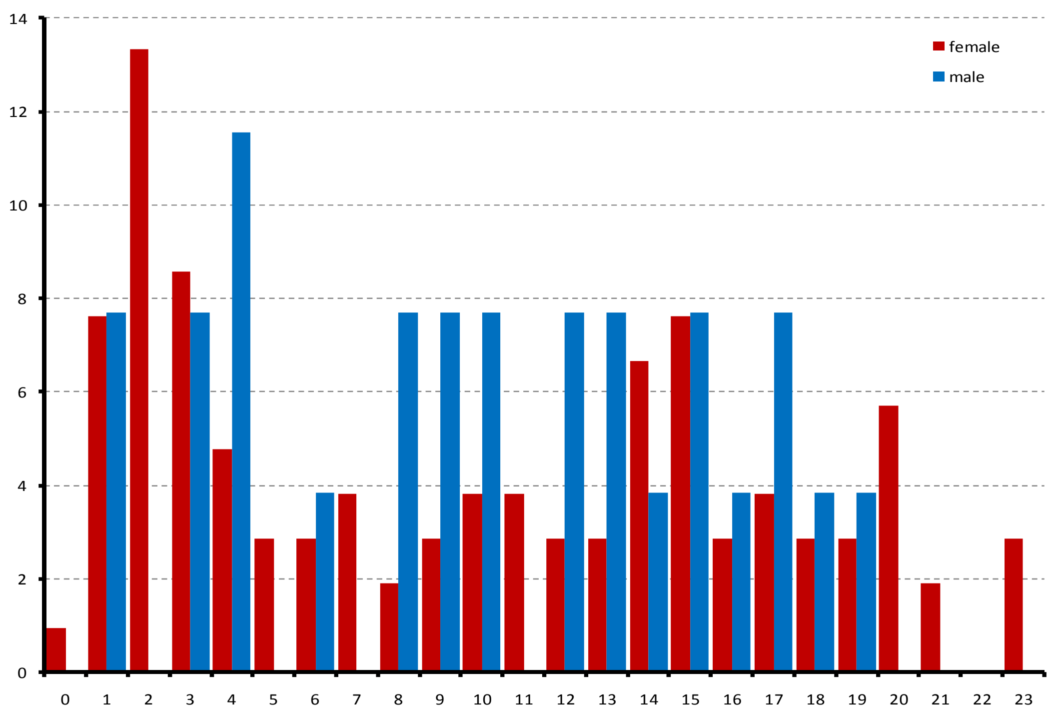


Figure 36. Departures for long trips (not leading any further than 3km from the nest) in failed breeding birds.

4.6 Some evidence for flight patterns in the prospecting and pre-laying phase

The data provide information on flight patterns around the colony during breeding and for failed breeders that have lost their eggs or chicks within the year of tagging. That means that, from the moment of arrival (somewhere in March; **Fig. 8**) until mid-incubation (in May usually), we have no information on area usage. There is one exeption: a female bird tagged in 2008 (F.AJK) returned with a fully operational logger in 2009, and although a breeding attempt could not be visually confirmed, the collected data suggest that the bird had a nest (or was territorial) until somewhere in June, after which rather lengthy inland trips became part of the trip routines performed (**Fig. 37-41**). These data suggest that prospecting birds (when just returned from the wintering area) perform foraging trips that are not dissimilar to breeding birds, but n = 1(!).

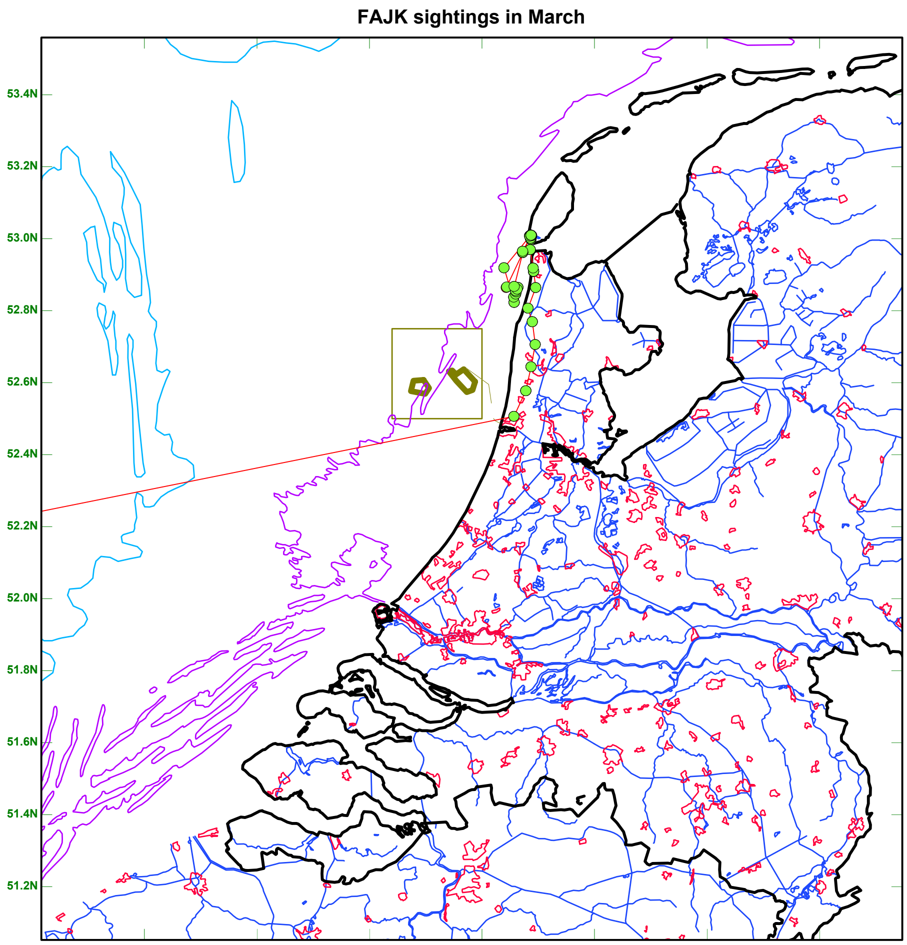


Figure 37. All data from female Lesser Black-backed Gull **F.AJK in March 2009** after her return from a wintering area in Spain. Shown is the last bit of return from the United Kingdom and some southward foraging trips from the colony ranging south to IJmuiden.[2]

[2] The dot colours in **Figs 37-41** have no meaning (green in March, greenish in April, Yellow in May, oange in June, dark orange in July).

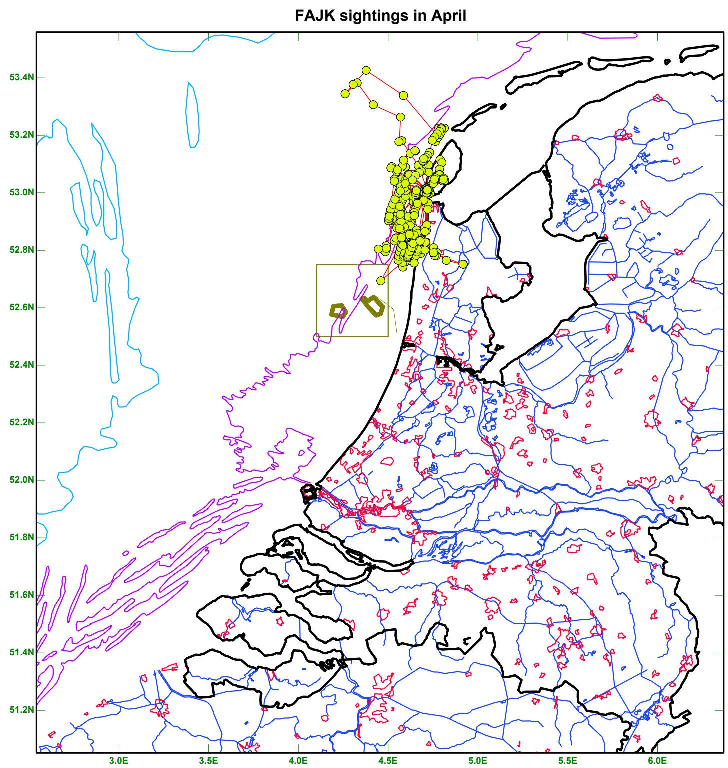


Figure 38 All data from female Lesser Black-backed Gull **F.AJK in April 2009** (the second season of this bird with a tag). Shown are frequent foraging trips to nearshore sea areas and one slightly more distant trip at sea to the northwest. The frequent returns into the colony suggest territoriality.

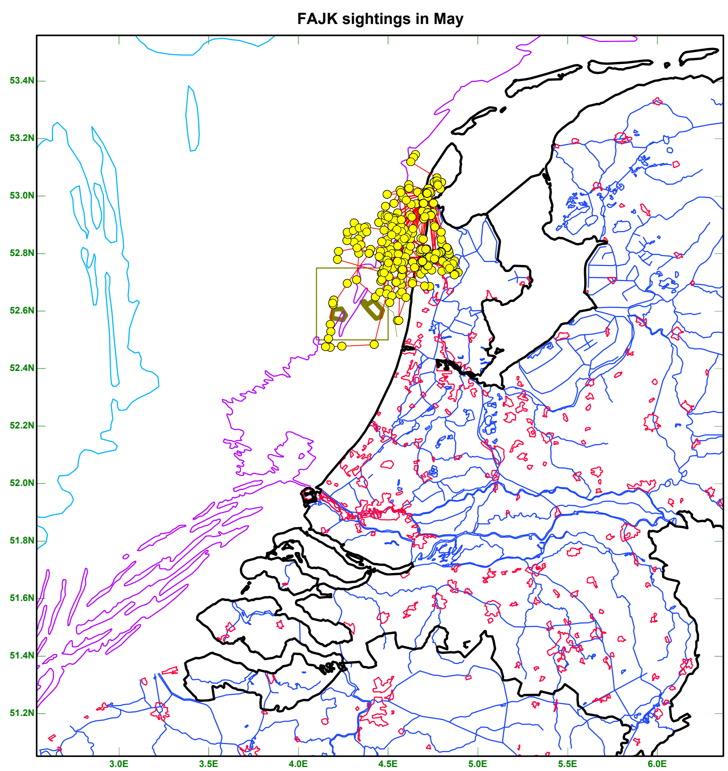


Figure 39 All data from female Lesser Black-backed Gull **F.AJK in May 2009** (the second season of this bird with a tag). Shown are frequent foraging trips to nearshore sea areas, the mainland and the southern tip of Texel. The frequent returns into the colony suggest territoriality.

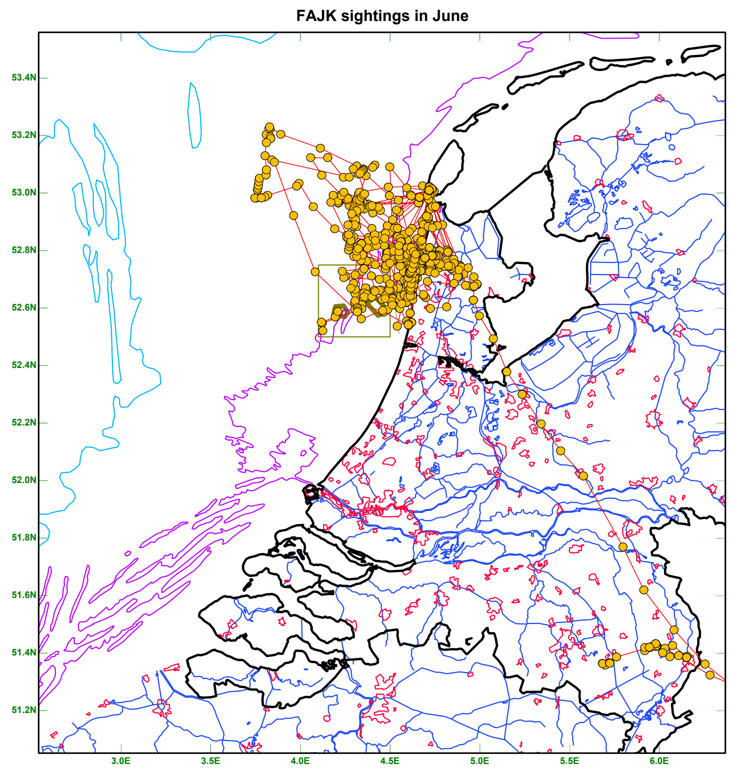


Figure 40 All data from female Lesser Black-backed Gull **F.AJK in June 2009** (the second season of this bird with a tag). Shown are frequent foraging trips to nearshore sea areas, the mainland and the southern tip of Texel. The frequent returns into the colony suggest territoriality, but the freak-trip (28-30June) towards the German border could be indicative for a loss of ties to the territory (a loss of chicks?).

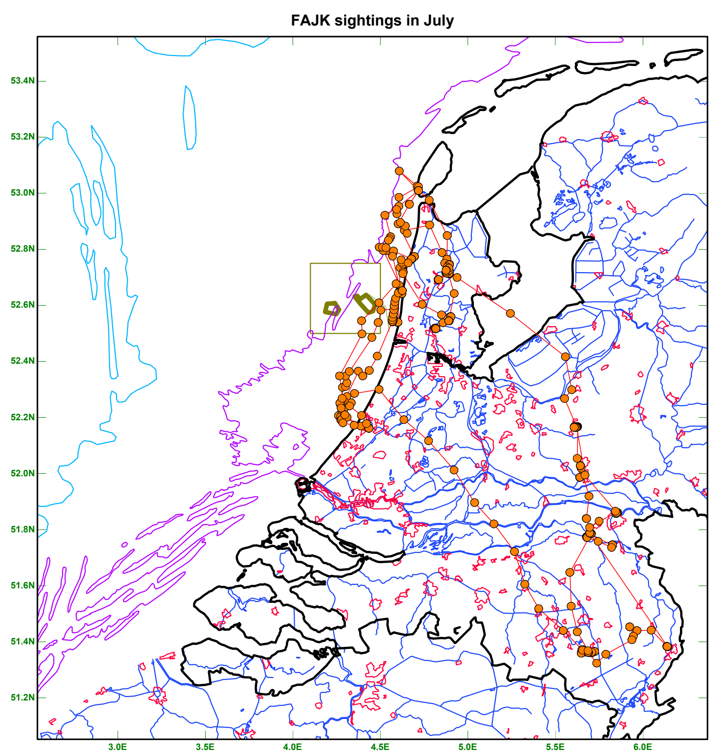


Figure 41 All data from female Lesser Black-backed Gull **F.AJK in July 2009** (the second season of this bird with a tag). Shown are freak-trips with a roughly circular trajectory through most of the country, presumed to be indicative for a loss of ties to the territory (a loss of chicks?).

Note: preliminary observations of five gulls tagged in 2010 that have returned in 2011 confirmed that individual birds immediately fall back to their summer-feeding routines from the previous season, with extra time spent on roosts away from the colony, including mainland locations; *Camphuysen, Bouten, Shamoun-Baranes unpubl./unanalysed material; May 2011.*

4.7 Presence within and around established windfarms off Noord-Holland

To illustrate how the area around established windfarms off the mainland coast was utilised by actively breeding (**Figs 42-43**) and or failed breeders (**Fig. 44**), the next step was to zoom in on the main at-sea area used during long-trips: the time spent in 2x3' rectangles around the colony for birds engaged in the incubation phase (*i.e.* immediately after they were captured), during hatching of the eggs, chick care , and fledging.

Both in females and in males, it appeared that the foraging trips during incubation and hatching were so short, that both windfarms were situated just at the outer edge of their range. Of 321 recorded long-trips of Lesser Black-backed Gulls in the early stage of breeding, only 11 (3%) led to the windfarm areas, where in all 0.4% of the total trip time was spent (n= 2213 hours of trip-time).

Longer trips were recorded in later phases of successful breeding, but of 823 recorded long-trips in that period (Chick care – Fledging), only 5% were trips during which the established windfarms were visited (0.8% of the time spent on long-trips; n= 5421 hours of trip-time).

For failed breeders, the material at hand is slightly less comprehensive, but it is clear that (ignoring freak-trips) the established windfarms were well within travelling range, but with 6% of 139 trips leading through the parks, where in total 1.0% of total trip time was spent within the park areas.

The OWEZ (former NSW) windfarm is situated at *c.* 48km from the colony in a 204° direction, whereas Princess Amalia windfarm (former Q7) is located at *c.* 57km distance at 216° from the breeding area. On some of the maps (Fig. 14-12), the windfarm areas stand out as areas with relatively little time spent within the park, on others such an impression does not emerge (notably during chick care). One need care to judge these patterns as evidence that windparks are in fact avoided by Lesser Black-backed gulls, because one of the most attractive features at sea, commercial trawlers, are banned exactly from these same areas. Ship-based surveys off Egmond revealed that many beamtrawler work the waters immediately around the windfarms, apparently in some believe that "the fish" is hiding within the parks. Extra trawler effort around the parks could lead to slightly higher densities of scavenging gulls around the parks, and lower densities within them. An effect of area avoidance is not immediately obvious, when the amount of time spent during long-trips is plotted in areas with different distances (40-60km) and angle (200-225°) in and around the windfarms is tabulated (**Table 12**)

In order to describe where most of the activities of Lesser Black-backed Gulls were concentrated generally, the presence (% of time) in 10km distance bins in 45° angles around the colony (**Fig. 45**). Females spent during long-trips (that is, uninterrupted activity bouts leading to areas at >3km distance at the colony) 44% of their time within 10 km of the nest, but 3.5% of their time at over 100km distance. Males spent only 23% of their long-trip time within 10km from the nest, but only 0.9% at over 100km. The remaining 53% (females) and 76% (males) of the total long-trip time were spent in highly different areas. Both sexes spent 20% of their time directly south of the colony, but while females spent 14% to the east and northeast of the nest (at over 10km distance), virtually no male activity was recorded in this sector. While males spent 50% in areas west of the colony (SW, W, and NW sectors), females spent only 17% of the time in these areas. It may be concluded, therefore, that males spent on average twice as much of their time during long-trips in distance/angle bins where windfarms currently have been established than females. It is fairly obvious that Lesser Black-backed Gulls nesting in the Kelderhuispolder at Texel utilise the foraging areas to the north of their breeding colony to a very limited extend. This pattern emerged in each of the three tagging seasons and must be typical for birds nesting in this area.

Table 12. Minutes time (n) spent in areas with different angle (°) and distance (km) away from the breeding colony. In grey are areas that are situated within the established windfarms off the coast of Egmond aan Zee.

° \ km	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
200	102	67	63	28	26	97	47	14	44	22	11	23	32	2	41	48		4	25		
201	6	12	36	21	114	169	46	9	5		16	1	12	46	3	39	5	10			
202	1	11	45	72	74	22			5	11	32	20	22	1	8	11	8	9	20	12	
203		45	1	36	7	31	59	20	5	43	20	29	36	57	11		7	0	21		
204	2	21	66	26	6	58	5	15		16	11		34	57			5	0		8	
205	6	20	31	52	22	66	15	1			20	20	7	15	30	34	27	17	1		
206	43	30	13	24	36	39	46		8	12		21	94	20		24		16	18	36	16
207	5	9	5	106	40		5	17	10					10	5	0		6	18	20	10
208	19	28	67			17	10	5	10	24		11		22	7	5		39		31	21
209	5	50	32	10		10	46	20	16	16	10				2	33	18	5			
210	15	1		10	11	10	54	34	42	35	16		5	28	35	65	36	57	58	10	28
211	40	10	1	6	31	16	8	51	41	20	16	20	76	51	62	41		15	9		2
212		17	10	10	22	41	46	22	21	20	30	110	88	30	55	87	81	54	56	91	6
213		15	40	10	41			5	41	42	51	74	39	36	32	41	91	70	80	73	21
214		27	16		31	59	26	50	8	44	5	51	82	72	78	72	8	15		1	20
215		76	41	21	20	15	27	25	83	56	22	20	65	51	10		1			10	20
216	11	30	8	10	10	16	51	10	25	16	57	71	19	25	20		0		18		
217	60	88	46	27	10			36	30	86	59	16	18	13	5	20	1	12		5	
218	11	91	57	33	80	58			67	31		39	42		39	11	20	28	25	27	23
219	50	59	100	35		26		10	78		8	36	23	33	39	30	21	47	35	126	
220	29	41	45	30	21	42	29		21	11	10	10	35	79		22	11	31	12	11	
221		10	31	541	93	96	40					28	83	14	36	40	19	26	1	20	
222	31	31	45	45	68	17	47	13	20	11	41	43	8	37	11	55	33	32	44		16
223	21	102	137	59	41	10	72	37	30	6	7		49	50	10	94	18		1	10	66
224	25	120	51	43	28	27	32	5	76	20	55	52	7	23	34	21			12	34	40
225	45	45	73	108		8	35	66	12	22	81	17	12	25	39	8	10	15	31	30	14

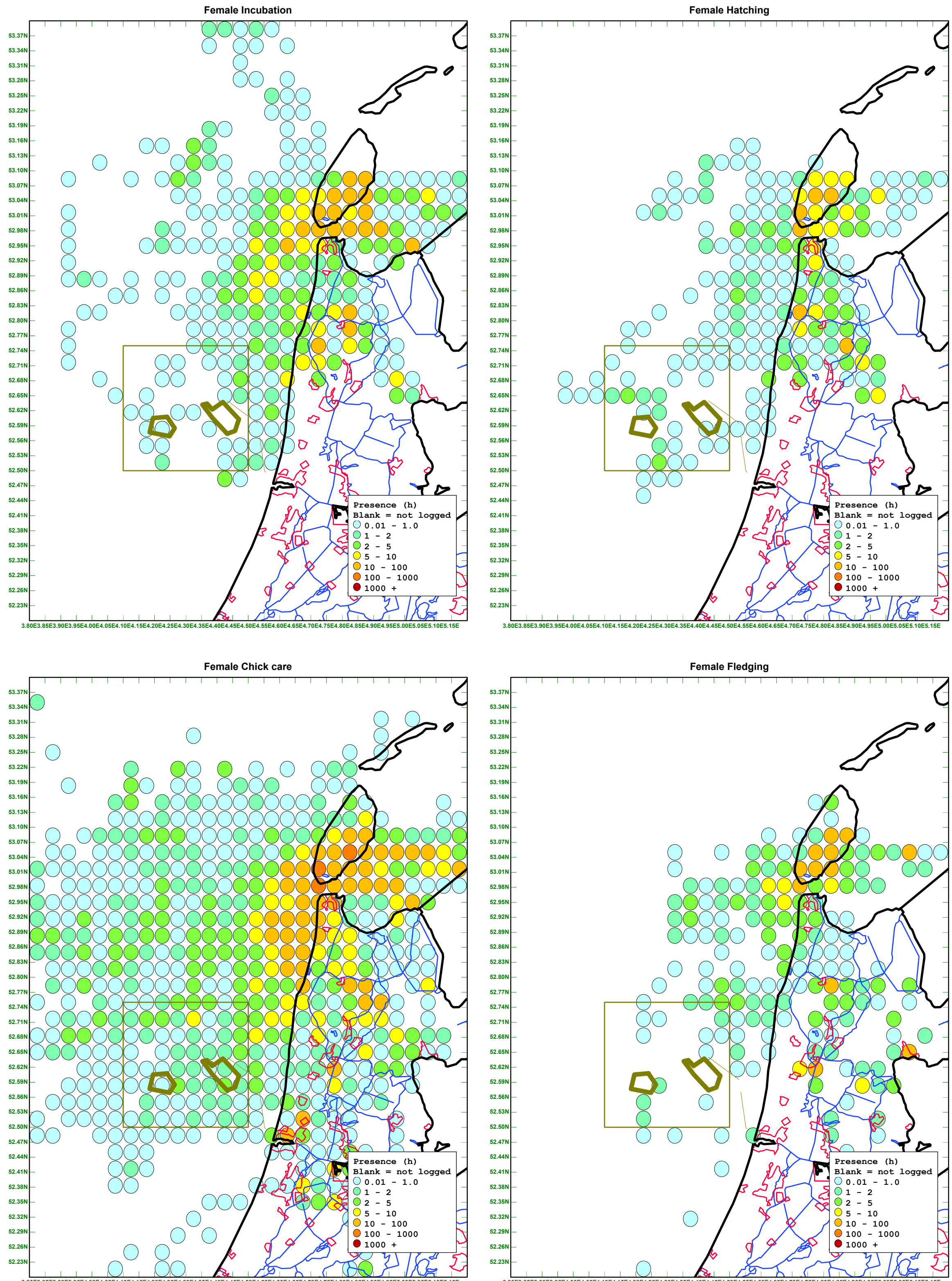


Figure 42. Time (h) spent per 2x3' rectangle around the breeding colony and towards established windfarms during long-trips for female Lesser Black-backed Gulls during incubation, hatching, chick care and fledging (all data combined; 2008-2010).

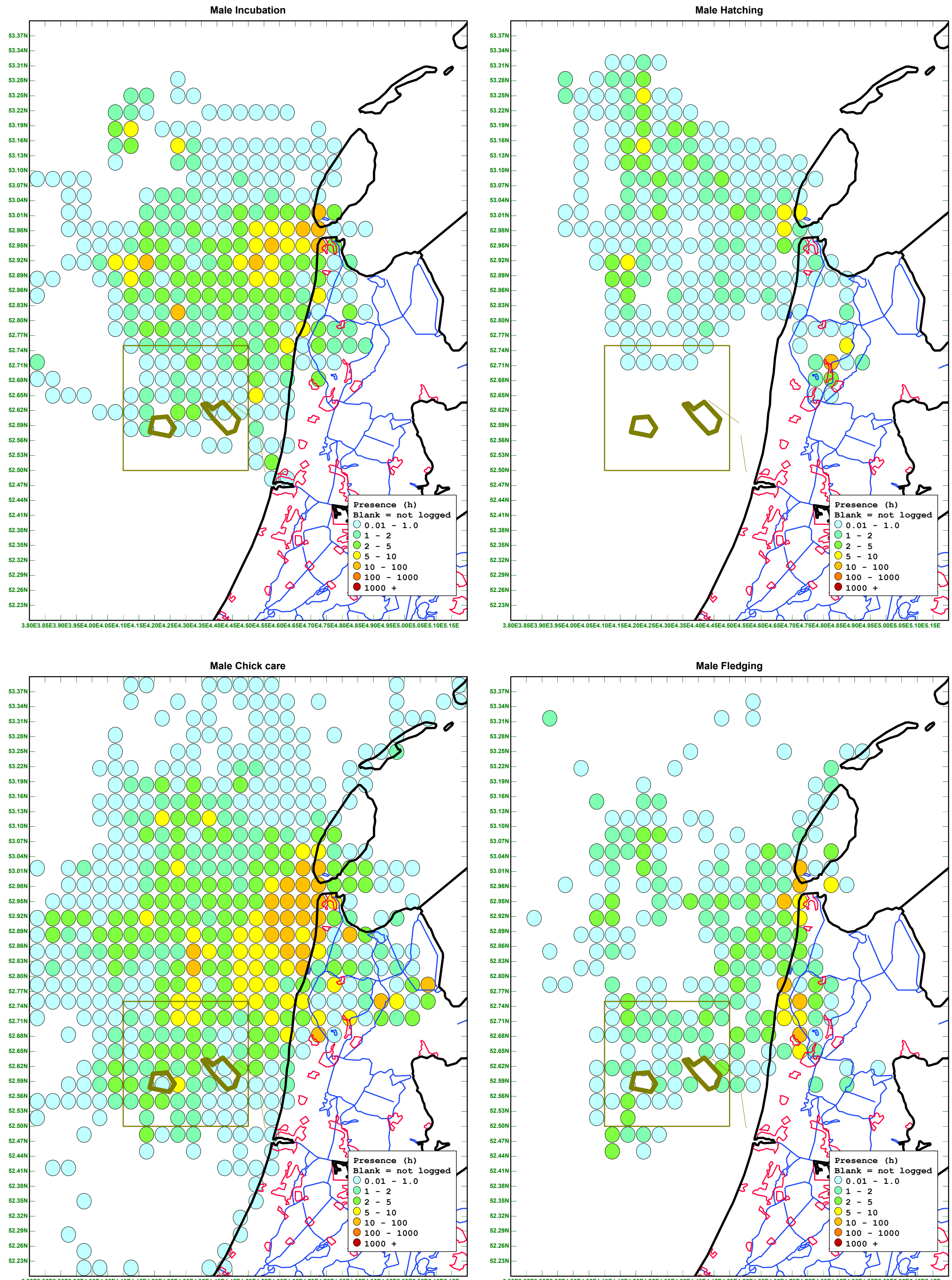


Figure 43. Time (h) spent per 2x3' rectangle around the breeding colony and towards established windfarms during long-trips for male Lesser Black-backed Gulls during incubation, hatching, chick care and fledging (all data combined; 2008-2010).

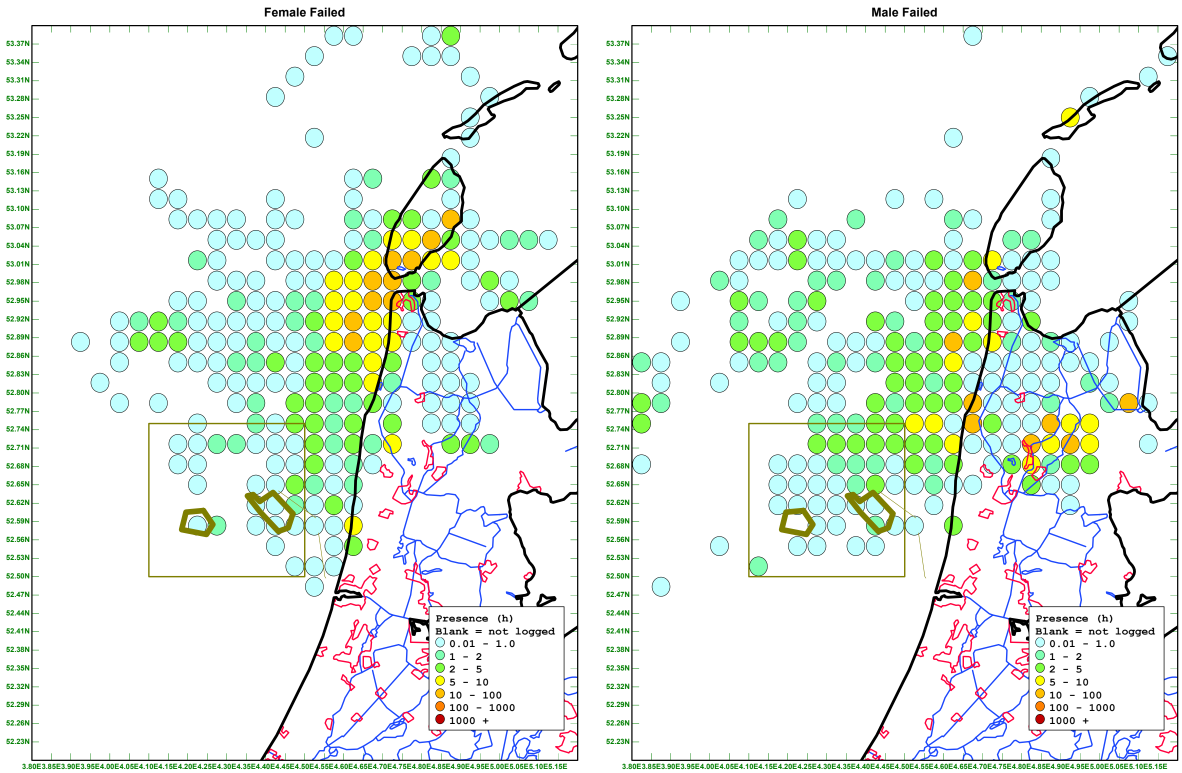


Figure 44. Time (h) spent per 2x3' rectangle around the breeding colony and towards established windfarms during long-trips for male Lesser Black-backed Gulls with failed nesting attempts (all data combined; 2008-2010).

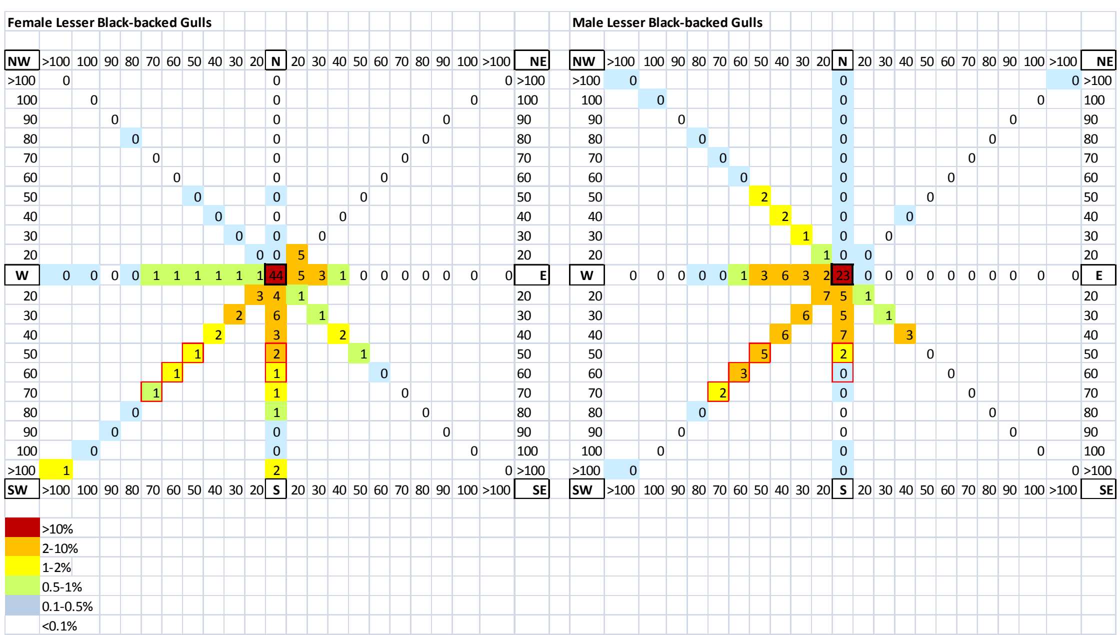


Figure 45. Percent of total long-trip time in 10km bins around the colony during active breeding in female (left) and male (right) Lesser Black-backed Gulls (established windfarm areas indicated by red cell boundaries).

4.8 Potential effects of a windpark at sea → alterations of the altitude of flight within park areas

The altitude of flight is recorded in the GPS loggers, but this is probably one of the least reliable parameters. Yet, 99% of recorded heights were between 25m depth and 200m height and are as such at least 'possible', or close to possible (diving depths of over 2m are unlikely in Lesser Black-backed Gulls and besides, the instruments are by no means dive-depth recorders). Assuming some 10-20m scatter around a genuine altitude value, the values could be used to get some impression of altitude of flight and a comparison between areas could still be valued, assuming that the scatter would be the same throughout.

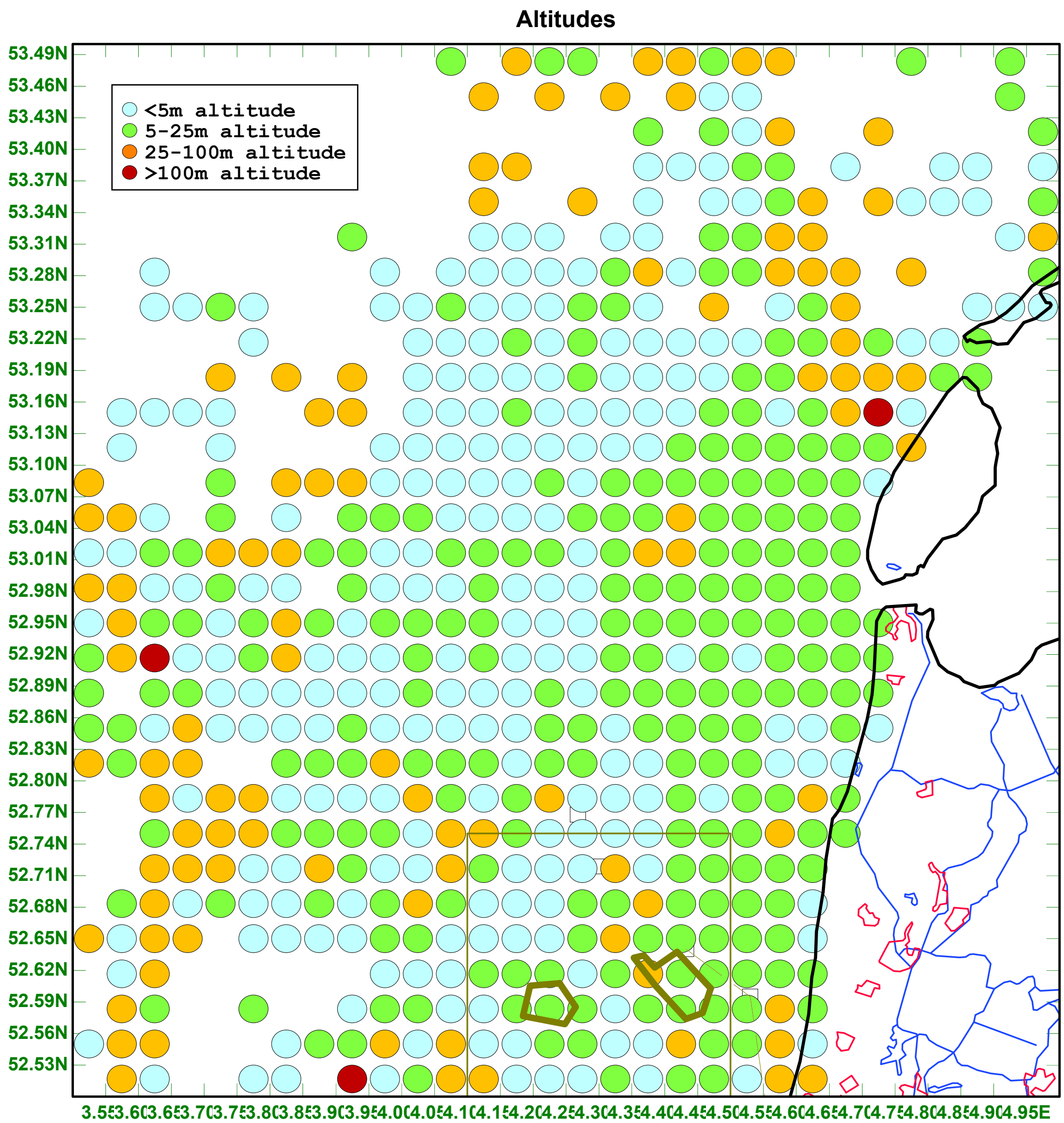


Figure 46. Mean altitude (m) per 2x3' rectangle west and southwest of the study colony for all Lesser Black-backed Gulls recorded as still actively breeding. The boundaries of two existing windfarms are indicated, plus a rectangle from which comparative data were selected.

The altitude of flight was considered most interesting for birds venturing out to sea (North Sea and North Sea coastal waters). An overview of mean values per 2x3' rectangle is provided in **Fig. 46**. Where chaos was expected, a rather neat pattern emerged: a broad zone of 5-25m altitude along the coast (green in **Fig. 46**), followed by a nearly equally wide zone of distinctly lower altitudes (light blue in **Fig. 46**). More extreme values were found at the far end of the feeding range, which are mostly the result of smaller sample sizes (fewer data points per rectangle, fewer birds travelling these distances). This image is interpreted as representing a zone of more-frequent water-contact offshore (the predominantly light blue area). This is indeed an area where large beamtrawlers are to be expected and where many birds stop start with more meandering flight patterns; hence, a suitable and seemingly frequently used feeding area. In the predominantly green area, less frequent water contact has been observed and flight patterns often followed straight lines, apparently at slightly greater height (to be interpreted as the commuting zone, to and from the colony). This green zone is an area parallel to the coast rather than a circular band around the colony. This would suggest that water depth, or distance to the coast rather than distance to the colony are key issues.

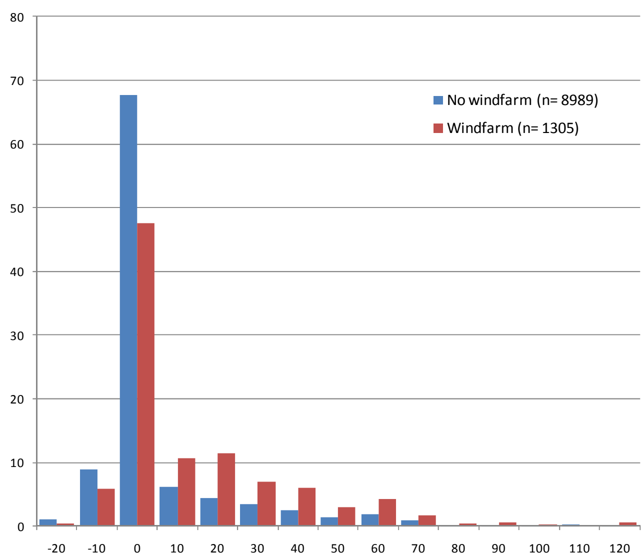


Figure 47. Frequencies (%) of different altitudes of flight of Lesser Black-backed Gulls within the windfarm areas off Egmond aan Zee (red; n= 1305 measured values) and in control areas (blue; n= 8999 measured values); control areas and the windfarms (rectangle and polygons) are indicated in **Fig. 46**.

In order to investigate any possible effects of windfarms on the altitude of flight (visual observations at sea as well as individual GPS tracks suggested that at least some birds fly over the parks), a rectangle of data points was selected around the two windfarms (**Fig. 46**). Within this rectangle, 8999 data points outside the windfarm areas (mean altitude ± SD 5.0 ± 24.2m) were on average at lower altitudes than 1305 datapoints within the windfarm areas (14.8 ± 26.7m) (t_{10292}= -13.45, P< 0.001, two-tailed), perhaps indicating some avoidance response or at least a somewhat different flight behaviour (**Fig. 47**).

4.9 The effect of loggers on reproductive success and chick growth

To study the effect of loggers on breeding performance, control nests were monitored simultaneously in each year. Given the highly different breeding results between seasons (Camphuysen & Gronert 2010), the comparisons were made for 2010 only, when 15 instrumented pairs could be compared with 76 control nests during the egg phase, and 15 instrumented pairs versus 50 control nests during the phase of chick-rearing to fledging. The number of tagged individuals in 2008 and 2009 was too small for meaningful comparisons. In 2010, neither the number of hatched eggs in control versus experimental nests, nor the number of successful versus failed nests differed significantly, and also the number of fledglings pair^{-1} was not significantly different (slightly lower rather than higher in control nests; **Table 13**).

Table 13. Hatching success and the percentage of failed nests (top panel), and number of nests with fledglings, failed nests, and fledglings pair^{-1} in control pairs and pairs with instrumented birds in 2010.

Incubation to hatching	**Control nests**	**Logger bird pairs**	**G -test**
Number of nests	76	15	
Eggs hatched	84%	91%	G_{adj}= 1.58, n.s.
Nests failed	9%	0%	
Chick care and fledging	**Control nests**	**Logger bird pairs**	**G-test**
Number of nests	50	15	
Nests with fledglings	40%	67%	G_{adj}= 3.29, n.s.
Nests failed	60%	33%	
Chicks pair^{-1}	0.66	0.87	t_{63}= 0.8, n.s.

With the breeding output being the same between tagged pairs and control pairs, the only factor remaining was chick growth. Control nests produced between 1 and 3 fledglings, nests with tagged individuals produced 2 chicks as a maximum. Mean daily growth increments were calculated for different litter sizes, suggesting that the growth in chicks from pairs carrying GPS loggers was slightly reduced (**Fig. 48**). Even though none of the differences observed were significant, these data seem to point at a slightly lower rate of provisioning in tagged individuals than in controls. In later stages of chick care, body mass fluctuations are rather strong in chicks of parents carrying a GPS logger (**Fig. 49**), possibly indicating some provisioning problems, but do note that the control sample is three times larger than the sample of chicks with parent s carrying loggers.

In conclusion, breeding success was similar in pairs carrying GPS loggers and control pairs, but there are indications that food provisioning rates have been slightly lower in GPS pairs, leading to more variable growth in the chicks raised by these pairs. The difference in growth rates is not-significant, however, and the stronger fluctuations in body mass increments may have been the result of a smaller sample size.

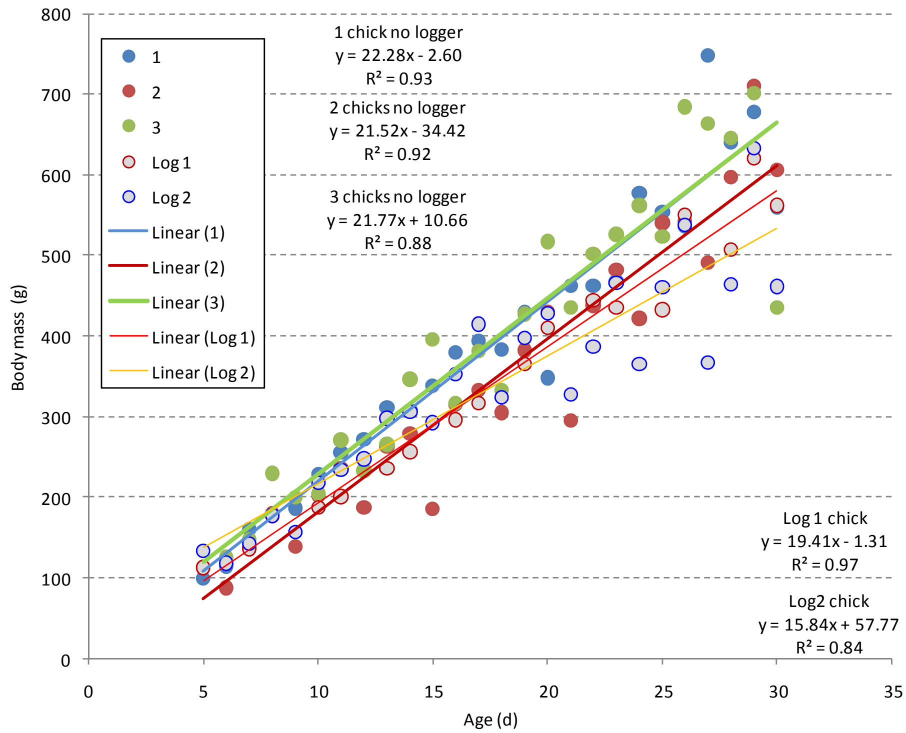


Figure 48. Mean body mass of chicks between 5 and 30 days of age (the period of near linear body mass increase)in litters of different size (1-3 chicks in control pairs, 1-2 chicks in pairs in which one partner carried a GPS logger) with age. The difference between none of these trends is significant.

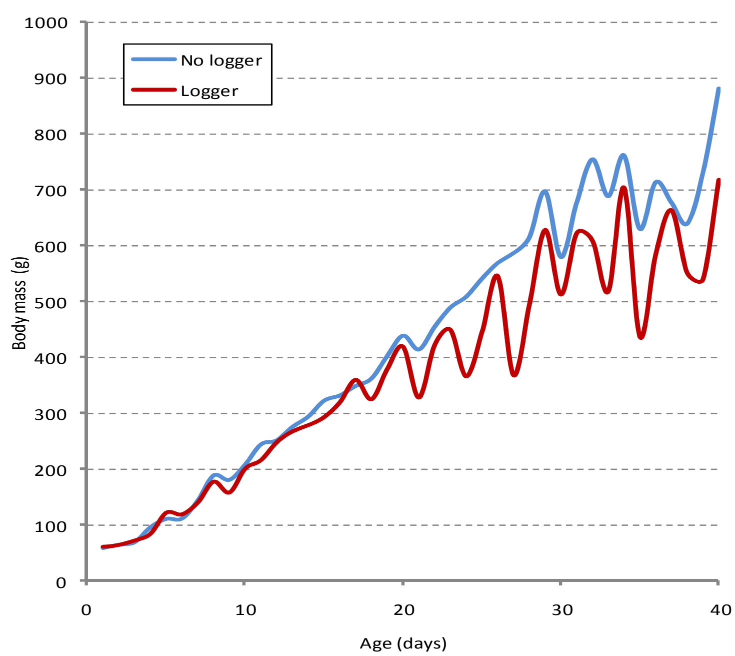


Figure 49. Mean body mass of chicks in control pairs (blue) and chicks in pairs in which one partner carried a GPS logger (red) with age (smoothed line graph)., indicating relatively strong body mass fluctuations in later life, particularly so in chick of parents carrying GPS loggers.

4.10 Feeding ecology

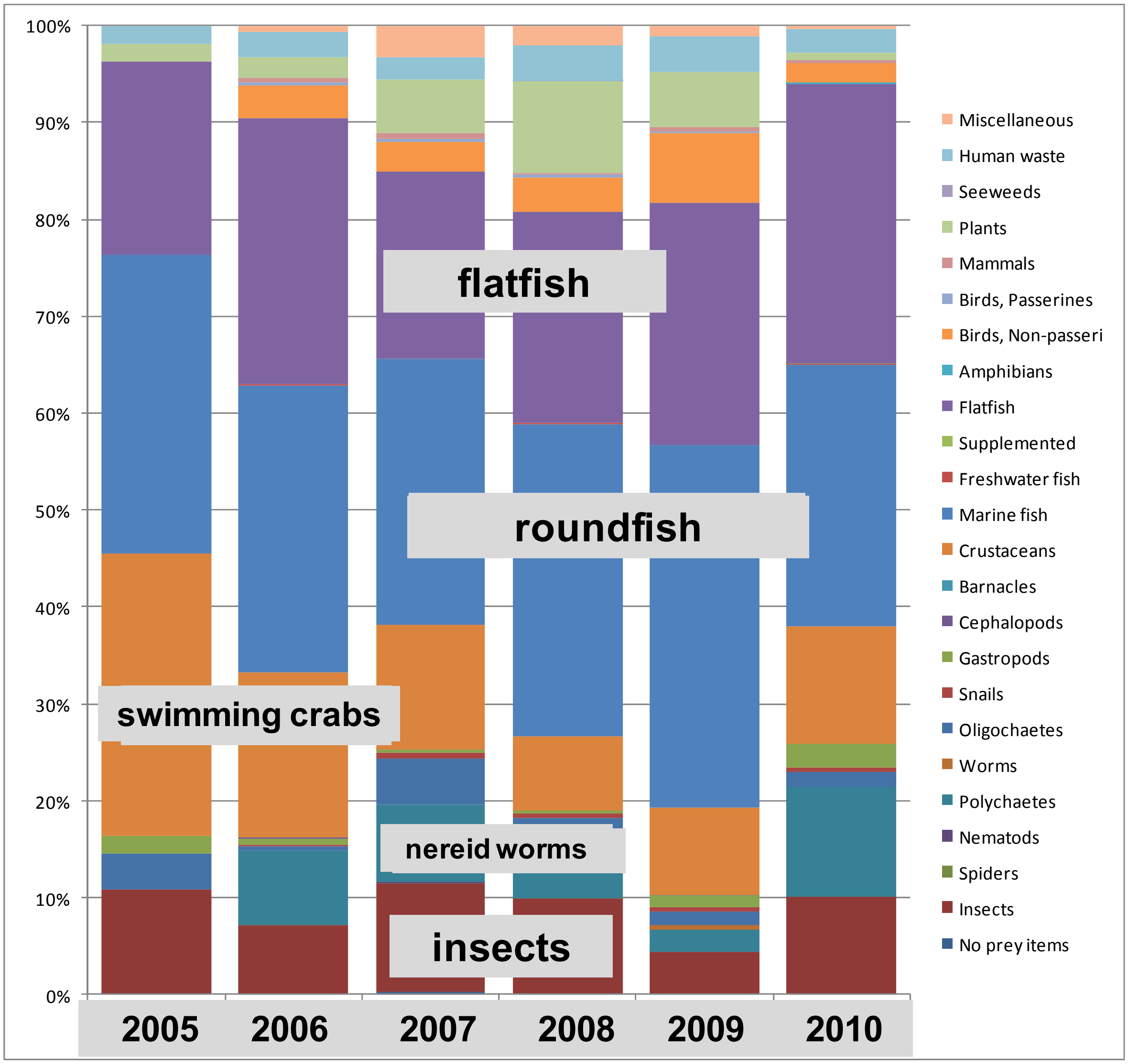


Figure 50. Mondriaan plot of Lesser Black-backed Gull diet based on 5224 food samples collected and analysed between 2005 and 2010 (frequency of occurrence of prey types)

Lesser Black-backed Gulls are generalist feeders and their catholic feeding habits result in a long list of prey items and consumed taxa (Cramp & Simmons 1983). Given the quality of the logger data obtained, no detailed analysis of the diet is in fact required, but it is at least interesting to see if observed prey items match expectations based on the time spent at sea, within the coastal zone, the Wadden Sea, and on land. The Mondriaan-plot of the frequency of occurrence of main prey items points at marine resources in the first place (marine roundfish and flatfish, swimming crabs, and Nereid worms; **Fig. 50**). The frequent occurrence of insect prey and earthworms is consistent with observed behaviour at Texel and on the mainland, while rather hidden in this plot are prey types obtained from restaurants, sheep feeders, sewage plants, and rubbish tips (or rubbish bins).

Table 14. Top 10 prey of Lesser Black-backed Gulls nesting at Kelderhuispolder, Texel, 2005-2010 (frequency of occurrence (n, top panel) and (%, bottom panel) in analysed prey samples, n= 5224 samples).

		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**Totals**	
Sample size		36	1082	743	1350	959	1054	5224	
Roundfish	*Merlangius merlangus*	4	187	114	534	364	341	1544	
Flatfish	*Pleuronectes platessa*	6	218	124	274	186	327	1135	
Crustaceans	*Liocarcinus holsatus*	15	331	183	172	101	232	1034	
Roundfish	*Trachurus trachurus*	7	204	171	286	146	128	942	
Flatfish	*Limanda limanda*		233	132	248	106	186	905	
Polychaetes	*Nereis longissima*		135	111	207	25	262	740	
Flatfish	*Pleuronectes / Limanda*	2	47	48	152	85	198	532	
Flatfish	*Solea solea*	1	135	54	81	53	117	441	
Insects	Coleoptera	1	64	87	127	28	106	413	
Roundfish	*Ammodytes*		37	23	111	46	154	371	
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2005-10**	
Sample size		36	1082	743	1350	959	1054	5224	
Roundfish	*Merlangius merlangus*		17	15	40	38	32	30	%
Flatfish	*Pleuronectes platessa*		20	17	20	19	31	22	%
Crustaceans	*Liocarcinus holsatus*		31	25	13	11	22	20	%
Roundfish	*Trachurus trachurus*		19	23	21	15	12	18	%
Flatfish	*Limanda limanda*		22	18	18	11	18	17	%
Polychaetes	*Nereis longissima*		12	15	15	3	25	14	%
Flatfish	*Pleuronectes / Limanda*		4	6	11	9	19	10	%
Flatfish	*Solea solea*		12	7	6	6	11	8	%
Insects	Coleoptera		6	12	9	3	10	8	%
Roundfish	*Ammodytes*		3	3	8	5	15	7	%

The top-10 most frequently encountered prey types (**Table 14**) point at the frequent use of marine fish prey, including mostly demersal species that must have been obtained as discards when following commercial beamtrawlers offshore (Whiting *Merlangius merlangus*, Plaice *Pleuronectes platessa*, Dab *Limanda limanda*, and Sole *Solea solea*). Swimming Crabs *Liocarcinus holsatus* and Nereid worms *Nereis longissima* are probably mostly captured when these animals are free swimming at the water surface in the North Sea. The origin of Horse Mackerel *Trachurus trachurus* and sandeels *Ammodytes* sp. is not clear, but these are either naturally captured fish, or obtained behind beamtrawlers (both not very common in the discards fraction of commercial beamtrawlers). By biomass, discards comprised 68% of the recorded fish prey, possible discards (mackerel and horse mackerel) 28%, and unlikely discards (clupeids, sandeels, freshwater fish species) only 4%.

A full prey list is reproduced in **Appendix 1**, indicating the fairly frequent presence of freshwater fish and certain mammals (e.g. mole *Talpa europaea*) demonstrating that the mainland feeding areas have been utilised. The Texel ferry is frequented by numerous Lesser Black-backed Gulls and Herring Gulls from the Kelderhuispolder and Geul colonies, but colour-ring sightings indicate that only few specialists are involved mostly, and the logger data did not produce evidence for frequent ferry visits of any of the tagged individuals.

4.11 Annual adult survival and return rates (colour ring data)

Within the Kelderhuispolder colony, between 2006 and 2010, 180 breeding adults were colour-ringed (82 males, 98 females). Within the year of capture (year 0) and in subsequent breeding seasons (year 1-4), it was tried to trace down and record colour-ringed birds, in order to examine the annual survival, return rates and later breeding attempts. For both sexes, it was calculated how many individuals returned in 1-4 years following ringing, and how many would have to be returned assuming annual survival rates of 80-95%.

A longer data series would be required to re-assess annual survival levels (and year-to-year fluctuations), for example by models used within the programme MARK (White & Burnham 1999). However, the return rates suggest that the annual survival in both sexes must have been over 0.95, under the assumption that all surviving birds returned to the colony and that ring-losses did not occur (**Fig. 51**). A five-year period is a rather short period to assess annual mortality rates. Of 137 adult Lesser Black-backed Gulls colour-ringed (birds with GPS loggers excluded), 16 must presumed dead after 4 years (12%), according to the annual survival estimates based on an ever growing sample (**Table 15**).

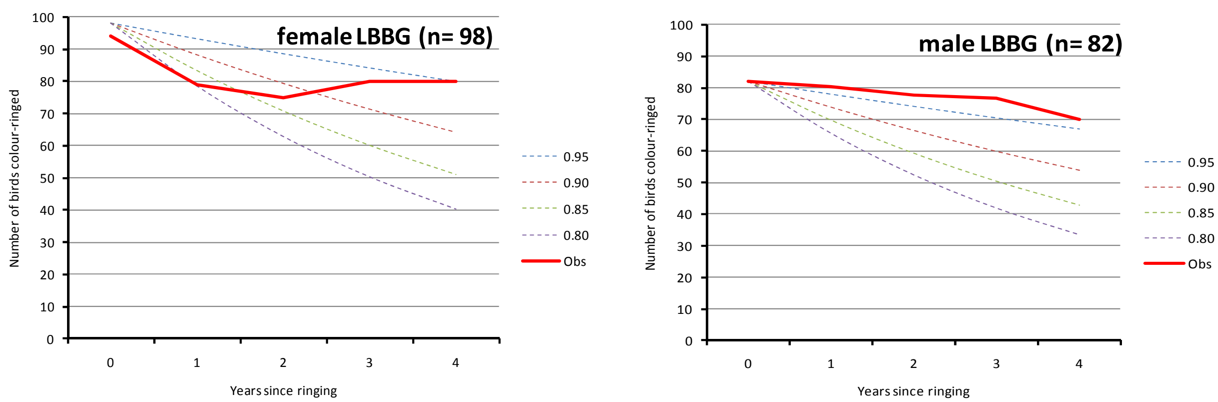


Figure 51. Number of colour-ringed adult Lesser Black-backed Gulls observed within the colony since ringing, and the expectation of return rates based on an annual survival of 95, 90, 85, or 80% (dashed lines). (From: Camphuysen 2010)

Table 15. Percentages (%) of returned and sighted Lesser Black-backed Gulls ringed between 2006 and 2009 in subsequent seasons.

		% Survived			
Ringed	n=	2007	2008	2009	2010
2006	22	100	95	95	85
2007	21		90	100	95
2008	39			92	93
2009	55				87

4.12 Recruitment

Successful recruitment of any of the ringed chicks has thus far not been reported, although some prospecting birds have been seen within the colony.

Of 69 fledglings colour-ringed in 2006, 23 (33%) were seen alive after ringing within the colony. Only one individual returned in 2008 (1x), three different individuals were seen in 2009, two of which returned again in 2010. Proof for breeding, anything other but "prospecting" has not been obtained for any of these birds (**Table 16**).

Of 102 fledglings colour-ringed in 2007, 69 (68%) were seen alive after ringing within the colony. Three individuals returned in 2009, one of these individuals plus four other birds returned again in 2010. Proof for breeding, anything other but "prospecting" has not been obtained for any of these birds, but the individual that was seen in both 2009 and 2010 (K.LAX) was highly territorial (**Table 16, Fig. 52**).

Of 82 fledglings ringed in 2008, 68 (83%) were seen alive within the colony in that same season, but none has been seen anywhere near the colony in 2009 or 2010. Of 83 fledglings ringed in 2009, 63 (76%) were seen alive within the colony in that same season, but none has returned to the colony in 2010.

Four Lesser Black-backed Gulls ringed as fledglings in 2006 (2), 2007 (1) and 2008 (1) at Texel were seen as prospectors or possible breeding birds in other colonies nearby: Vlieland and IJmuiden (**Table 17**).

Table 16. Re-sightings of prospecting Lesser Black-backed Gulls colour-ringed as fledglings in the Kelderhuispolder at Texel, 2007-2010.

2006	2007	2008	2009	2010	2007	2008	2009	2010
P.CBH		2			**K.DAP**			1
P.CCK			1	1	**K.HAW**			1
P.CDB			1		**K.LAN**			2
P.CKH			3	6	**K.LAX**		2	9
					K.NAH		1	
					K.NAR			1
					K.NAV		1	

Table 17. Sightings of Lesser Black-backed Gulls ringed as fledglings at Texel as prospectors or possible breeding birds at Vlieland and in IJmuiden, 2006-2010. Shown are colour-ring code, ringing age (P= pullus), year of ringing, observer in the colony where observed, the year and frequency of observations in that year, and the highest presumed status as a breeding bird (Status: p = prospecting; b = possibly breeding; B = confirmed breeding).

Ring	Age	Year	Observer	Colony	2006	2007	2008	2009	2010	Status
K.KAP	P	2008	Fred Cottaar	IJmuiden, Forteiland					1	p
K.LAC	P	2007	P. de Boer	Vliehors, Vlieland					4	b
P.CBU	P	2006	Fred Cottaar	IJmuiden, Forteiland					4	p
P.CDV	P	2006	P. de Boer	Vliehors, Vlieland					4	b

Figure 52. Territorial behaviour of potential recruit K.LAX, 29 April 2010, Kelderhuispolder Texel (CJ Camphuysen).

Recruits are part of the floater population of seabird colonies (birds that will eventually nest within the colony, but did not yet return or did not yet pair-up with another bird and did not manage to establish and defend a breeding territory with any success). The floater population has been discussed in length during risk assessments of (protected) Lesser Black-backed Gulls nesting in Natura 2000 areas, and the project was foreseen to produce further data on the *size* of the floater population. The idea of the discussions was that, if floaters could fill territories of adult birds that were killed, for example in a windpark, the effect of that extra mortality would be less serious. A replacement factor. How many birds would there be around, 'associated' somehow with the breeding population in Wadden Sea Natura 2000 areas, that could replace adults that were killed by anthropogenic factors?

The project has in fact not been able to produce an estimate of the floater population, and it will be quite difficult to produce anything better than a guess even when more data are gathered. What are 'floaters'?

Potential breeding adults that skip a year

Adults that have thus far not recruited (offspring from the colony, now >5cy)

Immatures that have not yet recruited (offspring from the colony, 3-5cy)

Prospecting birds from other colonies

Juveniles and young immatures *could* be considered floaters, but they will not be capable to swiftly replace an adult breeding bird that dies and the annual survival of juveniles is significantly lower than older immatures and adults.

From colour-ring sightings, it would technically be possible to guess how many birds have skipped a season, but it is very much more difficult to prove that a bird is *not breeding* than to prove that a bird is *breeding*, so that any result will be an overestimate of non-breeders (if not finding a nest would be accepted as proof for non-breeding).

The second category includes birds that can be territorial, but nothing else, but it also includes birds that visit the colony only briefly, or not even that but may do so in future. Colour-ringing of these birds do not help much; the likelihood of meaningful sightings is low.

The third category is the most easy group (discussed in this chapter), when adequate annual survival estimates would be available and when percentages of recruits are measured year by year. For Kelderhuispolder (representing Lesser Black-backed Gulls everywhere at the south tip of Texel), successful recruitment could be expected (certainly the 2006 and 2007 cohorts), but has still to be demonstrated, and must be very low.

The last group can only be recognised from (colour) rings and visits from non-breeding colour-ringed individuals (Camphuysen 2010) suggest that such (potential) prospectors occur in small numbers at Texel.

5. Discussion

- What is the breeding success of Lesser Black-backed Gulls within 't Lage land van Texel?

The breeding success of Lesser Black-backed Gulls at Texel was very low from 2006-2009 as a result of exceptionally high levels of cannibalism (**Table 4**). Breeding success in 2010 was slightly better (cannibalism slightly lower), but still low, perhaps as a result of slightly better foraging conditions. Sandeels were more frequently encountered as prey items in 2010 in comparison with the other breeding season (**Table 14**), but the differences in the dietary spectrum between years are modest, discards were most important in all years, and an explanation for the slightly better breeding success recorded in 2010 therefore remains speculative. With the extremely low levels of recruitment (**Chapter 4.11**), only immigration could cause this population to remain stable in size or increase. There are no accurate recent series of population counts from which robust trends could be derived, but the low breeding success and apparently very low levels recruitment point at a population in distress: if not declining yet, certainly declining in years to come when all factors stay the same. It is beyond the scope of the present report to further explore the reasons for population distress. However, the high levels of cannibalism coincided with substantial, periodic declines in chick growth. Food stress (insufficient provisioning of the chicks) is the main factor that must be considered. In an earlier analysis (Camphuysen *et al.* 2008), it was concluded that the continuing decline in fishing effort of large (offshore) beamtrawlers (**Fig. 53**), coupled with a local decline in fishing effort through the breeding season (highest effort in April, lowest effort in July-August; Camphuysen *et al.* 2008) within the foraging area of Lesser Black-backed Gulls breeding at Texel was an important explanatory factor in the present low reproductive success.

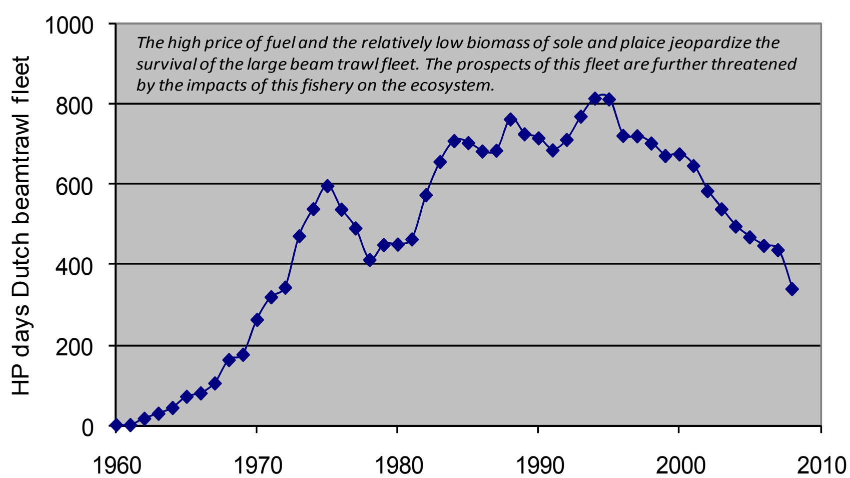


Figure 53. Long-term trend in beamtrawl fishing effort (Horsepower days, Dutch fleet), 1960-2009. From: Rijnsdorp *et al.* 2008; data for 2008-2009 Appended by A.D. Rijnsdorp in 2010.

- Where do Lesser Black-backed Gulls from Texel forage (foraging range)?

This is the first comprehensive analysis of the foraging effort by Lesser Black-backed Gulls nesting at Texel, and the results are considered to be representative for the entire Lesser Black-backed Gull population breeding at the south tip of Texel (Geul colony, Westerduinen) of which Kelderhuispolder is a sector. Previous studies, including ship-based surveys (Camphuysen & Leopold 1994; Camphuysen 1995, Camphuysen *et al.* 2008), have indicated that Lesser Black-backed Gulls utilise mostly a *c.* 30km wide zone off the Dutch coast, distinctly further out to sea than Herring Gulls. It was unknown if birds breeding from different colonies would share certain foraging grounds. For birds nesting at the western Wadden Sea islands (Texel, Vlieland, Terschelling in particular), ship-based surveys seemed to indicate that the rather distant, but predictably rich (natural) feeding grounds at the Frisian Front were of great significance, and that local concentrations of foraging Lesser Black-backed Gulls fund elsewhere were mostly in the vicinity of active fishing vessels.

By using GPS loggers, it was now possible for the first time to evaluate the foraging distribution of birds with a known breeding location. It appeared that birds nesting at the south tip of Texel focused mostly on foraging habitats to the south of the colony (W, SW, S, SE, and E; **Fig. 45**), with occasional trips to the north and fairly rare visits to distant feeding grounds such as the Frisian Front and the Bruine Bank area. During long-trips away from the nest (maximum distance travelled at least 3km from the nest site; all potential foraging flights), actively breeding Lesser Black-backed Gulls (incubation, hatching, chick-care or fledging) spent 37% of their time within a radius of 10km from the nest site, 90% within 50km, 97% within 80km and 98% within 100km from the nest. Females spent 44% within 10km from the nest, males only 23%, but the other values are highly similar between the sexes. It is safe to conclude that virtually all foraging effort is concentrated within 80-100km from the colony.

The main foraging habitats utilised were notably different between the sexes; a totally novel and unexpected finding. Males had a stronger tendency to be at sea (78%), whereas females utilised a large variety of foraging habitats (terrestrial, at sea, and within the Wadden Sea; **Figs. 16-17**). Males hardly utilised foraging opportunities within the western Wadden Sea (5%), where females spent 26% of their time during foraging trips while actively breeding. Terrestrial habitats at Texel were visited by females during 24% of their time spent on long-trips, while males were recorded in these areas for only 6% of their total trip time. Mainland terrestrial habitats were visited by females for 17% of their time, by males for 11% of their time. Such differences in habitat choice are likely to represent differences in chick provisioning by either sex, with males probably contributing mostly fish prey, while females could be expected to deliver a wider variety of prey items as a result of time spent in a mosaic of habitats during breeding.

Figure 54. Control tower in Princess Amalia windfarm (former Q7), providing roosting opportunities for Great Cormorants *Phalacrocorax carbo* and various species of gulls, Lesser Black-backed Gulls included (24 June 2008; CJ Camphuysen).

Failed breeders were different in many respects from individuals with eggs or offspring at the nest, notably in the habitat used (**Fig. 17**), but also in tendencies to engage in "freak-flights" (large distances, circular routes around the country, into Germany, northern France, Belgium and the UK). From Argos satellite PTT studies on Lesser Black-backed Gulls at Vlieland (2007-2010), where the breeding status of tagged birds is less perfectly known, it appeared that long-distance flights were fairly common (http://www.sovon.nl/

default.asp?id=408). In animals with very frequent calls into the breeding colony (presumed territorial birds), however, freak flights were uncommon, as a further indicator that these long-distance flights are more characteristic for failed breeders and/or non-breeders.

- Do Lesser Black-backed Gulls from Texel move through existing windfarm areas and how much time do these gulls spend within the risk zone?

The GPS logger data have demonstrated that the established windfarms OWEZ (former NSW) and Princess Amalia windfarm (former Q7) are both well within range of Lesser Black-backed Gulls breeding at Texel. As a result of sex-differences in foraging habitats, males spent approximately twice more time in potentially risky areas than females (12% versus 6% of total long-trip time at 50-70km, S-SW of the breeding colony). Platforms nearby the windfarms (three in total) are highly attractive for gulls and are frequently used to roost by these species (Lesser Black-backed Gulls included). The central control tower in Princess Amalia windfarm (former Q7) is another object supporting roosting opportunities for gulls, attracting gulls right in the heart of one of windfarms (**Fig. 54)**. A perhaps unexpected phenomenon was the rather intense fishing effort observed directly outside the boundaries of established windparks (C.J. Camphuysen *pers. obs.;* **Fig. 55**), possibly mostly by fishermen expecting a greater yield nearby a "fish reserve" , such as a windfarm from which commercial fisheries are banned.

Figure 55. Hauling beamtrawler just outside OWEZ (former NSW) windpark, 28 June 2007, attracting scavenging seabirds towards a potentially risky zone (CJ Camphuysen).

Fisheries are exceptionally attractive to scavenging species and if fishing vessels would indeed spend relatively more time nearby windfarms rather than in other sea areas, they may enhance the risk for seabirds to come (too) close to windmills. From GPS logger data collected nearby, within and just around the established windfarm areas, there is no obvious pattern of peak presence within rectangles just around the windfarms (**Table 12**), suggesting that this effect, if it exists at all, may not be very strong.

- Is there a behavioural response of Lesser Black-backed Gulls near windfarms?

There is no evidence for avoidance behaviour, other than perhaps slightly higher flights of birds within park areas in comparison with control areas around the park. As stressed within this report, however, height of flight is one of the least accurate measurements of the GPS logger. As a relative measure, it is possible to compare different areas in terms of 'preferred' (or 'performed') altitude of flight. Some individual tracks (not illustrated in this report) did indicate that individual birds performing a straight flight towards and passing an established windfarm changed flying height (slightly higher altitude over the windfarm area), as if to avoid the windmills. In other cases, a change in height of flight was less obvious. Direct field studies would be more appropriate to study the flight height and any behavioural responses within and immediately around established windfarms.

- Which are the main resources for Lesser Black-backed Gulls at sea?

The diet study has demonstrated that discarded fish prey is by far the most important source of food in any one of the study years (at least 65% of the recorded fish *biomass* from prey samples were definitely discards, and only 4% of fish mass was almost certainly *not* obtained at commercial fishing vessels). It is likely that offshore beamtrawlers (for males) and shrimpers in the Marsdiep area and western Wadden Sea (for females) are frequently attended by Lesser Black-backed Gulls in intense intra-specific competition. In nearshore situations, the species has to compete with Herring Gulls for prey at trawlers. There is no evidence for the utilisation of intertidal prey (shellfish and shore crabs) and as such, the prey choice of the two sympatrically breeding gull species is highly different. The diet study is in full agreement with the GPS logger data now produced. Unfortunately, few diet samples were individual specific (most were collected at nest sites), but those that were confirmed that male contributed mostly fish and females a rather wide spectrum of prey items.

- Is there an effect of the loggers on the reproductive success?

The effect of a logger on an actively breeding adult Lesser Black-backed Gull has been very small in the first year of deployment. Of 12 birds on which loggers were attached in 2008 and 2009, only 4 were observed to attempt to breed again in later years (despite a larger number of birds that returned to the colony), suggesting some adverse effects in the long run. The results in 2010 - tagged birds compared with controls – are seen as firm evidence that the behaviour of logger birds was largely unaffected and the results are therefore considered representative for normally breeding individuals.

Table 18. Life history table for Lesser Black-backed Gull ringed as adults (n= 103) in The Netherlands, 1991-1995 following methods described in Stearns (1992), from Camphuysen (2010).

Age, x x	Number alive at start n_x	Prop surviving at start l_x	Number dying within x to x+1 d_x	Finite rate of mortality q_x	Finite rate of survival p_x	Number alive in age interval L_x	T_x	S_x	Mean expectation of further life e_x	Expected age	var	SE
0	103	1,000	17	0,165	0,835	95	625	6,56	6,06	6,06	0,059	0,244
1	86	0,835	10	0,116	0,884	81	530	5,56	6,16	7,16	0,034	0,185
2	76	0,738	9	0,118	0,882	72	449	4,73	5,91	7,91	0,028	0,168
3	67	0,650	7	0,104	0,896	64	378	3,99	5,63	8,63	0,019	0,139
4	60	0,583	7	0,117	0,883	57	314	3,34	5,23	9,23	0,017	0,129
5	53	0,515	5	0,094	0,906	51	258	2,76	4,86	9,86	0,010	0,099
6	48	0,466	7	0,146	0,854	45	207	2,24	4,31	10,31	0,011	0,106
7	41	0,398	7	0,171	0,829	38	163	1,78	3,96	10,96	0,010	0,098
8	34	0,330	4	0,118	0,882	32	125	1,38	3,68	11,68	0,004	0,066
9	30	0,291	8	0,267	0,733	26	93	1,05	3,10	12,10	0,007	0,083
10	22	0,214	4	0,182	0,818	20	67	0,76	3,05	13,05	0,003	0,055
11	18	0,175	3	0,167	0,833	17	47	0,54	2,61	13,61	0,002	0,039
12	15	0,146	3	0,200	0,800	14	31	0,37	2,03	14,03	0,001	0,029
13	12	0,117	1	0,083	0,917	12	17	0,22	1,42	14,42	0,000	0,009
14	11	0,107	11	1,000	0,000	6	6	0,11	0,50	14,50		

Table 19. Life history table for Lesser Black-backed Gull ringed as juveniles (n= 343) in The Netherlands, 1984-1996 following methods described in Stearns (1992), from Camphuysen (2010).

Age, x x	Number alive at start n_x	Prop surviving at start l_x	Number dying within x to x+1 d_x	Finite rate of mortality q_x	Finite rate of survival p_x	Number alive in age interval L_x	T_x	S_x	Mean expectation of further life e_x	Expected age	var	SE
0	343	1,000	146	0,426	0,574	270	1569	5,07	4,57	4,57	0,036	0,189
1	197	0,574	11	0,056	0,944	192	1299	4,07	6,59	7,59	0,004	0,061
2	186	0,542	18	0,097	0,903	177	1107	3,50	5,95	7,95	0,005	0,071
3	168	0,490	17	0,101	0,899	160	930	2,96	5,54	8,54	0,004	0,064
4	151	0,440	20	0,132	0,868	141	771	2,47	5,10	9,10	0,004	0,064
5	131	0,382	15	0,115	0,885	124	630	2,03	4,81	9,81	0,003	0,052
6	116	0,338	13	0,112	0,888	110	506	1,64	4,36	10,36	0,002	0,043
7	103	0,300	20	0,194	0,806	93	397	1,31	3,85	10,85	0,002	0,049
8	83	0,242	9	0,108	0,892	79	304	1,01	3,66	11,66	0,001	0,029
9	74	0,216	14	0,189	0,811	67	225	0,76	3,04	12,04	0,001	0,031
10	60	0,175	14	0,233	0,767	53	158	0,55	2,63	12,63	0,001	0,027
11	46	0,134	9	0,196	0,804	42	105	0,37	2,28	13,28	0,000	0,017
12	37	0,108	11	0,297	0,703	32	64	0,24	1,72	13,72	0,000	0,014
13	26	0,076	7	0,269	0,731	23	32	0,13	1,23	14,23	0,000	0,007
14	19	0,055	19	1,000	0,000	10	10	0,06	0,50	14,50		

- Estimates of annual survival

Within the Kelderhuispolder colony, between 2006 and 2010, the annual survival of breeding adults amounted to at least 95%, under the assumption that all surviving birds returned to the colony and that ring-losses did not occur (higher in case of ring losses and/or emigration). This level is on the high side in comparison with published values (Harris 1970, Croxall & Rothery 1991, Wanless *et al.* 1996), but it should be realised that the sample size at Texel was relatively small and only few years of data are available.

Camphuysen (2010) analysed the annual survival of Lesser Black-backed Gulls in The Netherlands as these were ringed as adults 1991-1995 (n= 103) and found an annual survival of *c.* 88% (**Table 18**). For 343 Lesser Black-backed Gulls ringed as chicks in The Netherlands between 1984 and 1996, the first year survival amounted to 57%, followed by high survival rates (86-94%) in subsequent years (**Table 19**). Apparently, despite signals of poor reproductive success caused by lower rates of provisioning than required, the annual survival of adult Lesser Black-backed Gulls at Texel is still very high; certainly not lower than in adult birds ringed in the 1990s in The Netherlands.

- What is the level of recruitment of Lesser Black-backed Gulls within 't Lage land van Texel?

"Het is geen zeldzaamheid een paar met jongen aan te treffen, waarvan een der ouderen, of beide, bruine vleugels en staartband [2e zomerkleed!] hebben, maar de meeste mislukken." (Tinbergen 1936)

In both Herring Gulls and Lesser Black-backed Gulls, occasional first breeding attempts occur at an age of 3 calendar years, but the phenomenon if most common in newly established colonies. Around the time that Lesser Black-backed Gulls became established as a breeding species in The Netherlands (the result of immigration from abroad), breeding birds in immature plumage occurred regularly (Brouwer 1927, Bouma 1929, Tinbergen 1929). Few of these early breeders were successful, however. At Texel, Lesser Black-backed Gulls in immature plumage have only been observed at the club within the colony (social gathering place of off-duty birds, prospectors, and active breeding birds for periods of rest and undisturbed preening) or at roosts and bathing places nearby the breeding colony. Ringing of fledglings commenced in 2006, but in the Kelderhuispolder, to date, no colour-ringed recruits have been observed. A number of sometimes fairly persistent prospectors has been observed, but only one of these (K.LAX) was clearly territorial (**Fig. 52**). Sightings of subadult Lesser Black-backed Gulls were in fact rather rare, even on clubs and roosts, suggesting that few birds at Texel currently breed while younger than 5 years of age. This is another signal that the colony is either full or otherwise in distress and that future population growth is unlikely.

In conclusion, the Kelderhuispolder colony of Lesser Black-backed Gulls experienced in recent years on average very low breeding success (2006-2010 0.46 fledglings pair^{-1}). While annual adult survival (*c.* 95%) was high, apparent recruitment was very low or delayed (no fledglings ringed in 2006 and 2007 recorded as recruits). The colony at Texel is inhabited between March and August (6 months), breeding is concentrated between early May (median laying date 10 May) and late July (first fledglings 10 July). Discarded fish are a prime source of prey in Lesser Black-backed Gulls, but a large number of different prey items was recorded originating from marine or terrestrial foraging areas.

Intertidal prey items (such as bivalves, gastropods, and shore crabs) were scarce or absent in most studied pairs.

During breeding, males spend 78% of their time during foraging flights at sea, whereas females utilise a mosaic of habitats, including Texel, the western Wadden Sea, the mainland and marine areas in almost equal amounts of time. Failed breeders are very different in their habitat choice, with both sexes spending a similar amount of time at sea (males 61%, females 56% of the time). Foraging and feeding was generally south of the breeding colony (W, SW, S, SE, and E), and the established windfarms OWEZ (former NSW) and Princess Amalia windfarm (former Q7) were both within foraging range of male and females, notably during chick care and fledging (June-July). In total, 5% of 823 recorded long-trips in June and July included visits to established windfarm sites, where 0.8% of the trip time was spent (n= 5421 hours). In failed breeding birds, of 139 recorded long-trips, 6% led through anyone of the established parks (1% of total trip time. Males spent on average twice more time than females during long-trips in distance/angle bins where windfarms are currently situated (**Fig. 45**).

Figure 56. "*Houston Control*", solar panels and base station set-up in 2010, Kelderhuispolder colony, Texel. The base station has a central position in the colony, and most birds with GPS loggers attached are within 50m in the background and to the left of the base station. A dongle (small object on a string between the two larger poles) provides internet facilities, so that the data could be downloaded remotely (CJ Camphuysen).

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Uitgebreide Nederlandstalige samenvatting

Het hier beschreven onderzoek aan Kleine Mantelmeeuwen op Texel broeden is uitgevoerd in de zomer van 2010 en sluit aan op ecologisch en demografisch onderzoek dat in 2006 werd opgezet. De meeuwen van Texel broeden in Natura 2000 gebieden (duingebied op Texel) en er bestaat bezorgdheid over de aanvaringsrisico's van hier nestelende Kleine Mantelmeeuwen met windmolens op zee. Kleine Mantelmeeuwen zijn trekvogels, die Nederland in september verlaten om in zuidelijker gelegen gebieden te overwinteren (Zuid-Engeland – The Gambia, hoofdzakelijk op het Iberisch Schiereiland). In maart keren de vogels terug op hun kolonies. Het broedsucces van Kleine Mantelmeeuwen op Texel is al jaren buitengewoon laag, vooral als gevolg van excessieve kuikenpredatie door de meeuwen zelf (kannibalisme). Er zijn redenen om te veronderstellen dat voedselstress de voornaamste achterliggende oorzaak is van het kannibalisme (kuikenpredatie piekt in perioden waarin de groei van de jongen achterblijft). Het langjarige broedsucces van Kleine Mantelmeeuwen op Texel bedroeg 0.46 jongen paar^{-1} (range 2006-2010 0.26 – 0.71 jongen paar^{-1}). Het broedseizoen 2010 was met 0.71 jongen paar^{-1} een gunstige uitzondering in de reeks.

Om de aanvaringsrisico's te kunnen inschatten was het noodzakelijk om het foerageergebied van de op Texel nestelende meeuwen zo precies mogelijk in kaart te brengen en om hun tijdsbesteding (op het nest, op land, op zee) zo nauwkeurig mogelijk te kwantificeren. Hiertoe was de toepassing van nieuw ontwikkelde dataloggers het meest geschikt. De door de Universiteit van Amsterdam ontwikkelde loggers (afgebeeld op de pagina's 8-10) slaan GPS posities op die op afstand kunnen worden uitgelezen (ontvanger in de kolonie; Fig. 56). Ook kunnen de instellingen van de instrumenten op afstand worden aangepast, zonder dat de vogels daarvoor behoeven te worden teruggevangen (tijdsintervallen tussen opeenvolgende posities, accelerometer om bewegingen van vogels in het veld te registreren). De instrumenten worden gevoed door een batterij die door middel van kleine zonnepaneeltjes steeds weer worden opgeladen. Wanneer de batterijspanning tijdens perioden van slecht weer onder een bepaald niveau zakt worden steeds meer functies uitgeschakeld, totdat het instrument bij voldoende oplading weer tot "leven" komt en doorgaat met registreren. Bij de analyses in dit rapport zijn allen "trips" van vogels waarbij de batterij onderweg uitviel terzijde geschoven. Over de jaren 2008-10 resteerden daarna voor 25 geloggerde vogels 2261 perioden van nestaanwezigheid, 769 'korte trips' (vrijwel allemaal bezoekjes aan badplaatsen rond de kolonie; Fig. 12) en 1222 'lange trips' (voedselvluchten). In Tabel 5 is de gemiddelde tijdsduur van deze trips, voor mannetjes en wijfjes apart, weergegeven.

De Kleine Mantelmeeuwen die foerageerden hoofdzakelijk op zee (78% van de foerageertijd door mannetjes, 33% door vrouwtjes) en dan vooral ZW, Z, en ZO van de kolonie. Wijfjes besteedden 44% van de tijd op foerageertrips op minder dan

10km afstand van het nest, mannetjes slechts 23% van hun tijd. Voedseltrips over meer dan 100km afstand waren zeldzaam bij actieve broedvogels (3.5% van de totale triptijd bij wijfjes; 0.9% van de tijd bij mannetjes). De verschillen in tijdsbesteding op zee en op land tijdens 'lange trips' tussen mannetjes en vrouwtjes zijn geïllustreerd in de Figs. 16 en 17. De vertrekrichting uit de kolonie bleek een goede voorspeller van de gemiddelde tijdsduur die op zee werd doorgebracht (Fig. 18), op één geval na (een mannetje dat meestal in oostelijke richting vertrok, maar toch weer vanaf zee terugkwam naar de kolonie). Het bleek dat actieve broedvogels (met eieren of jongenzorg) zich anders gedroegen dan mislukte broedvogels. Waren de verschillen tussen mannetjes en vrouwtjes groot voor zover de broedzorg actueel was, zodra de broedpoging mislukte was er bijna geen verschil meer te zien tussen de sexen in het gebruik ven verschillende habitats (Fig. 17) en bovendien kwamen dan zg. 'freak-trips' vaak voor (meerdaagse trips, soms naar omringende landen waaronder naar Engeland en Duitsland).

De verblijftijd op en rond het nest nam bij zowel mannetjes als wijfjes af vanaf het bebroeden van de eieren tot aan het uitvliegen (Fig. 24). Beide sexen spendeerden weer meer tijd in de kolonie nadat een broedpoging was mislukt; vermoedelijk omdat er geen tijd meer nodig was om voedsel te zoeken voor de jongen. Beide sexen bleken dag- en nacht actief, zelfs voor handelingen zoals badplaatsbezoek waarvan verondersteld werd dat ze vooral overdag plaatsvonden (Fig. 25-36). Omdat de vogels van een logger werden voorzien op het moment dat zij wast op de eieren zaten, was het onzeker of pas in de kolonie gearriveerde vogels zich hetzelfde gedroegen. Op grond van een in 2008 geloggerde en in 2009 teruggekeerde vogel kon voorzichtig worden opgemaakt dat weer teruggekeerde individuen zich hetzelfde gedroegen als het jaar daarvoor (aanvullend onderzoek, grotere steekproef noodzakelijk voor conclusies; Fig. 37-41).

Kleine Mantelmeeuwen die op Texel broeden, komen regelmatig in of in de buurt van de windparken voor de kust van Egmond, maar de totale verblijfstijd daar was gering. De totale hoeveelheid tijd gespendeerd in de omgeving van bestaande windparken was voor mannetjes (6% van de totale tijd gespendeerd tijdens lange trips) tweemaal zo groot als voor vrouwtjes (3% van de totale tijd tijdens lange trips). Kleine Mantelmeeuwen in de windparken vlogen gemiddeld wat hoger dan meeuwen in de omringende gebieden (Fig. 47), maar het is niet zeker dat dit een reactie op de parken zelf was. Veldwaarnemingen rond windmolens zouden beter geschikt zijn om aanpassingen in het vlieggedrag te volgen.

Om zeker te zijn dat representatieve gegevens verzameld werden en dat de instrumenten de vogels niet tot abnormaal gedrag brachten, werden controleparen (76 nesten tot aan het uitkomen van de eieren; 50 nesten tot aan het uitvliegen van de jongen) en paren met een geloggerde partner (15 nesten tot aan het uitvliegen) gevolgd gedurende de gehele broedperiode. Het uitkomstpercentage was gelijk, het aantal nesten met uitvliegende jongen was gelijk en het aantal jongen per paar verschilde niet significant (Tabel 13), en ook de groei van de jongen verschilde niet significant (Fig. 48-49). Op grond van deze resultaten veronderstellen we dat de Kleine Mantelmeeuwen zich ondanks het instrument normaal, en dus representatief, gedragen hebben. Ofschoon het effect van de GPS loggers op individueel broedsucces te verwaarlozen was in het jaar waarin de loggers warden aangebracht, kwamen van de terugkerende vogels in een volgend seizoen maar weinig exemplaren weer tot broeden. Teruggekeerde vogels met actieve loggers zijn daarom niet bij de analyses in dit rapport betrokken.

De voornaamste prooidieren van Kleine Mantelmeeuwen broedend op Texel waren *Merlangius merlangus, Pleuronectes platessa, Liocarcinus holsatus, Trachurus trachurus, Limanda limanda, Nereis longissima, Pleuronectes / Limanda, Solea solea,* Coleoptera sp. and *Ammodytes* sp. (meest overboord gegooide bodemvissen). De lijst van prooidieren is uitputtend lang (Appendix 1), maar zeker omgerekend naar biomassa bestaat het voedsel hoofdzakelijk uit zeevis.

De jaarlijkse overleving van gekleurringde adulte Kleine Mantelmeeuwen bedroeg ongeveer 95%. De tijdserie is nog te kort om goede berekeningen uit te voeren, maar veel van de gekleurringde dieren kwamen jaar na jaar terug, met weinig uitval. Er zijn nog geen aanwijzingen dat er al vogels van de "eigen kweek" (uit 2006 of 2007) terugkeerden om tot broeden te komen, ook niet in omringende kolonies. Nieuwe deelnames van jonge Kleine Mantelmeeuwen op Texel aan het broeden zijn voorlopig zeldzaam of wellicht vertraagd.

Samenvattend wordt vastgesteld dat de Kleine Mantelmeeuwen op Texel de afgelopen jaren een bijzonder laag broedsucces gehad hebben (gemiddeld 0.46 jongen $paar^{-1}$), maar een hoge jaarlijkse overleving van adulte vogels en een geringe neiging tot rekrutering van jonge vogels. De kolonie op Texel is gedurende 6 maanden van het jaar bezet en het broeden duur van 10 mei (mediane legdatum) tot eind juli (eerste uitvliegende jongen 10 juli). Visafval van de visserij is een belangrijke voedselbron, maar ook op het land (zowel op Texel als op het vasteland) wordt naar voedsel gezocht. Hierbij bleek een opmerkelijk verschil tussen de beide sexen te bestaan: mannetjes hoofdzakelijk zeegaand, wijfjes veelvuldig op land en in de Waddenzee. De voornaamste voedselgebieden lagen zuidelijk (zuidwest-zuidoost) van de kolonie en de beide bestaande windparken (OWEZ en Prinses Amalia) lagen binnen de gebruikelijke foerageerafstand in de broedtijd.

Appendix 1. Identified prey items (frequency of occurrence) in 5224 food samples of Lesser Black-backed Gulls nesting at Kelderhuispolder, Texel, 2005-2010.

		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**	
Sample size		36	1082	743	1350	959	1054	5224	%
Insects	unident insect	1	35	48	89	18	127	318	6
Insects	Orthoptera			1				1	0
Insects	Diptera		4	1	3	1		9	0
Insects	emelt		1	1				2	0
Insects	*Eristalis tenax*		1		1			2	0
Insects	Diptera		4	4	5	4		17	0
Insects	Hymenoptera		1		3	1	1	6	0
Insects	Coleoptera	1	64	87	127	28	106	413	8
Insects	Carabidae	2	20	20	7		2	51	1
Insects	Harpalus		2	4	4	1		11	0
Insects	Pterostichus			1				1	0
Insects	Coccinellidae		1	1	5	1	1	9	0
Insects	Elateridae		5	8	24	2	3	42	1
Insects	*Cidnopus aeruginosus*		2				2	4	0
Insects	Curculionidae			1	4	1	2	8	0
Insects	*Phyllopertha horticola*		1				1	2	0
Insects	*Geotrupes stercorarius*		1					1	0
Insects	*Micraspis 16-punctata*					1		1	0
Insects	*Prosternon tessellatum*	2	1		4	1	1	9	0
Insects	Scarabaeidae				4			4	0
Insects	*Melanotus rufipes*			2		1		3	0
Insects	Agonum				1	1		2	0
Insects	Aphodius				1			1	0
Insects	Curculionidae		1		8	1	1	11	0
Insects	Amara aenea		1					1	0
Insects	Formicidae			7	16	3		26	0
Insects	Bembidion	1	2					3	0
Insects	*Phyllopertha horticola*				3	3		6	0
Insects	caterpillars			1	3			4	0
Spiders	unident spider		1	1	1			3	0
Insects	*Aelia acuminate*					2		2	0
Insects	hoverfly					1	1	2	0
Insects	moth						2	2	0
Nematods	Nematoda			1		2		3	0
Polychaetes	*Lanice conchilega*			1		1		2	0
Polychaetes	*Nereis* sp.		7	12		2	2	23	0
Polychaetes	*Nereis virens*		34	2		6	10	52	1
Polychaetes	*Nereis diversicolor*					1		1	0
Polychaetes	*Nereis longissima*		135	111	207	25	262	740	14
Polychaetes	*Nereis succinea*		1	4			1	6	0
Polychaetes	*Nerius pelagic*						8	8	0
Oligochaetes	*Lumbricus terrestris*	2	10	76	34	30	34	186	4
Snails	*Limax maximus*					1		1	0
Snails	unident snail			2	3	1		6	0
Gastropods	*Polinices polianus*	1	12	5	5	16	55	94	2
Gastropods	*Littorina littorea*						1	1	0
Snails	*Lauria cylindracea*			2	1			3	0
Snails	terrestrial snails		1	6	8	2	11	28	1
Snails	*Cepaea nemoralis*				1	1	2	4	0
Gastropods	*Polinices catenus*		1					1	0
Gastropods	*Nassarius incrassatus*				2	1	2	5	0
Snails	*Cornu aspersum*					2		2	0
Bivalves	*Mytilus edulis*			2	1		1	4	0

		2005	2006	2007	2008	2009	2010	Total	
Sample size		36	1082	743	1350	959	1054	5224	%
Bivalves	*Ensis americanus*		1	2	3		1	7	0
Bivalves	*Crassostrea gigas*			2				2	0
Bivalves	Mya truncata		1					1	0
Bivalves	*Donax vittatus*				1		1	2	0
Bivalves	*Chamelea striatula*				1			1	0
Bivalves	pearl				1			1	0
Cephalopods	unident squid		3		1			4	0
Cephalopods	*Sepia officinalis*		1	1				2	0
Cephalopods	*Allotheutis subulata*		1		1		2	4	0
Barnacles	*Balanus crenatus*					1		1	0
Crustaceans	*Idotea balthica*		1		1	1		3	0
Crustaceans	unident woodlice	1	3		5	2	2	13	0
Crustaceans	Gammarus		1					1	0
Crustaceans	Copepod						1	1	0
Crustaceans	parasitic Copepod					2	1	3	0
Crustaceans	unident Decapoda		1	4	12	2	10	29	1
Crustaceans	*Crangon crangon*		8	11	13	10	24	66	1
Crustaceans	*Cancer pagurus*			1				1	0
Crustaceans	*Liocarcinus depurator*		3	1		6	12	22	0
Crustaceans	*Liocarcinus holsatus*	15	331	183	172	101	232	1034	20
Crustaceans	*Pagurus bernhardus*		4		4	1	3	12	0
Crustaceans	*Carcinus/Liocarcinus*	1		11	16	13	6	47	1
Crustaceans	*Liocarcinus arcuatus*				1			1	0
Crustaceans	*Callianassa suberranea*					4	6	10	0
Crustaceans	*Liocarcinus pusillus*					1		1	0
Crustaceans	*Liocarcinus puber*				1			1	0
Crustaceans	*Procambarus clarkii*						1	1	0
Roundfish	unident bony roundfish	4	36	44	67	41	13	205	4
Roundfish	unident clupeid		3	3	1	2	4	13	0
Roundfish	*Clupea harengus*		22	26	31	23	18	120	2
Roundfish	*Sprattus sprattus*		19	37	30	11	34	131	3
Roundfish	*Alosa fallax*		5		1			6	0
Roundfish	*Stizostedion lucioperca*		1		4		2	7	0
Roundfish	*Perca fluviatilis*		1				1	2	0
Freshwater fish	*Rutilus rutilus*		2					2	0
Freshwater fish	*Rutilus erythrophthalmus*				1			1	0
Roundfish	*Osmerus eperlanus*						1	1	0
Roundfish	unident gadoid		4	6	1		2	13	0
Roundfish	*Gadus morhua*	1	13	9	10	3	10	46	1
Roundfish	*Merlangius merlangus*	4	187	114	534	364	341	1544	30
Roundfish	*Trisopterus luscus*		6	9	13	5	8	41	1
Roundfish	*Trisopterus minutus*				3	1	1	5	0
Roundfish	*Belone belone*	3	5	1	1			10	0
Roundfish	*Syngnathus acus*		6	3	1			10	0
Roundfish	*Syngnathus rostellatus*		2	1	4			7	0
Roundfish	*Eutrigla gurnardus*	2	97	26	62	34	72	293	6
Roundfish	*Trigla lucerna*		29	17	42	21	38	147	3
Roundfish	*Myoxocephalus scorpius*		1	3		1	4	9	0
Roundfish	*Agonus cataphractus*		1	1				2	0
Roundfish	*Cyclopterus lumpus*						2	2	0
Roundfish	*Dicentrarchus labrax*				1	2		3	0
Roundfish	*Scomber scombrus*		14	12	30	10	8	74	1
Roundfish	*Trachurus trachurus*	7	204	171	286	146	128	942	18
Roundfish	*Mullus surmuletus*			1				1	0
Roundfish	*Zoarces viviparus*		1				1	2	0
Roundfish	*Pholis gunnellus*					1		1	0

		2005	2006	2007	2008	2009	2010	Total	
Sample size		36	1082	743	1350	959	1054	5224	%
Roundfish	*Echiichthys vipera*		3	2			3	8	0
Roundfish	*Ammodytes* sp.		37	23	111	46	154	371	7
Roundfish	*Ammodytes tobianus*		6	7		3	12	28	1
Roundfish	*Ammodytes marinus*		1	5				6	0
Roundfish	*Hyperoplus lanceolatus*		4	1	2	2	9	18	0
Roundfish	*Callionymus lyra*	2	87	39	53	19	62	262	5
Roundfish	*Callionymus reticulatus*		1					1	0
Roundfish	*Pomatoschistus minutus*		11	1	4		4	20	0
Roundfish	*Entelurus aequoreus*		1	4				5	0
Roundfish	*Trigla/Eutrigla*		16	11	56	64	73	220	4
Roundfish	*Pollachius pollachius*		1				1	2	0
Roundfish	*Pomatoschistus* sp.		1					1	0
Roundfish	*Aspitrigla cuculus*			1				1	0
Roundfish	*Mallotus villosus*				18			18	0
Flatfish	unident flatfish	1	63	25	29	9	29	156	3
Flatfish	*Arnoglossus laterna*		18	8	4	7	13	50	1
Flatfish	*Scophthalmus maximus*		2	5	3	1	1	12	0
Flatfish	*Pleuronectes / Limanda*	2	47	48	152	85	198	532	10
Flatfish	*Pleuronectes platessa*	6	218	124	274	186	327	1135	22
Flatfish	*Limanda limanda*		233	132	248	106	186	905	17
Flatfish	*Platichthys flesus*	1				1		2	0
Flatfish	*Solea solea*	1	135	54	81	53	117	441	8
Flatfish	*Buglossidium luteum*		22	5	12	3	24	66	1
Roundfish	fish eggs				2			2	0
Amphibians	*Bufo calamita*						1	1	0
Birds, Non-passeri	unidentified birds		2	2	1		4	9	0
Birds, Non-passeri	*Phasianus colchius*						1	1	0
Birds, Non-passeri	Goose egg						1	1	0
Birds, Non-passeri	large gull egg		32	32	38	10	26	138	3
Birds, Non-passeri	large gull pullus		35	18	68	100	24	245	5
Birds, Non-passeri	chick *L fuscus*			1	3	9	3	16	0
Birds, Non-passeri	chick *S sandvicensis*		1					1	0
Birds, Passerines	unidentified passerines		4	3	3	1	1	12	0
Birds, Passerines	*Anthus pratensis*		1					1	0
Birds, Passerines	*Sturnus vulgaris*				1	1	1	3	0
Birds, Passerines	*Hirundo rustica*			1	1			2	0
Birds, Passerines	*Curvus monedula*					1		1	0
Birds, Passerines	egg shell				1			1	0
Mammals	unidentified mammal		4		1		2	7	0
Mammals	*Oryctolagus cuniculus*		2			3	7	12	0
Mammals	*Microtus/Arvelicola*		2	5	1	2	4	14	0
Mammals	*Arvicola terrestris*			1				1	0
Mammals	*Microtus oeconomus*		1	5	3	1	5	15	0
Mammals	*Clethrionomys glareolus*			1				1	0
Mammals	*Talpa europaea*		1		1			2	0
Mammals	*Apodemus sylvaticus*					1		1	0
Mammals	*Rattus norvegicus*				1		5	6	0
Mammals	*Mycrotes* spec.						1	1	0
Plants	Plantae	1	4	4	12	5		26	0
Seeweeds	*Sargassum muticum*				1			1	0
Plants	unident plant seed		4	20	37	1		62	1
Plants	Poaceae		4	3	6	18	1	32	1
Plants	unident grass seed		5	8	45		2	60	1
Plants	*Triticum* seed		1					1	0
Plants	Poaceae seed		1	1	1		1	4	0
Plants	*Carex* seed		1					1	0

		2005	2006	2007	2008	2009	2010	Total	
Sample size		36	1082	743	1350	959	1054	5224	%
Plants	*Zea mays*		5	17	44	15	13	94	2
Plants	*Claytonia perfoliata* see		1	4	33	3		41	1
Plants	*Urtica* sp				1			1	0
Plants	Empetrum nigrum berries		1	16	39	49	3	108	2
Plants	*Rubus* sp seed			1				1	0
Plants	sheep pellets						1	1	0
Plants	*Convolvus* sp seed		1					1	0
Plants	*Stellaria media* seed		20	25	132			177	3
Plants	moss				1			1	0
Human waste	unidentified refuse			1	4	3		8	0
Human waste	paraffine	1	4		1			6	0
Human waste	plastic line, thread		11	4	13	3	6	37	1
Human waste	plastic foil		1		10	7	6	24	0
Human waste	plastic packaging		3	2	8	4	4	21	0
Human waste	plastic pellets		12	1	6	8	1	28	1
Human waste	plastic fragments		5	4	11	4	9	33	1
Human waste	aluminum foil		4		3	4	3	14	0
Human waste	wood		2		5		3	10	0
Human waste	balloon		1					1	0
Human waste	lollipop stick				1			1	0
Human waste	pieces of broken glass		3	1	1	3	3	11	0
Human waste	paper			1	2	5	6	14	0
Human waste	polystyrene			3	4			7	0
Human waste	tallow		1				1	2	0
Human waste	rubber band				3	1		4	0
Human waste	china				1			1	0
Human waste	textiles				1		1	2	0
Human waste	metal waste					1		1	0
Human waste	metal waste				2		2	4	0
Human waste	plastic objects			2		1	1	4	0
Human waste	beef						1	1	0
Human waste	chicken egg						1	1	0
Human waste	chicken		2	1	2	2	3	10	0
Human waste	pork		1		2	1	4	8	0
Human waste	mutton				1			1	0
Human waste	meats and sausages				2	1	1	4	0
Human waste	sausage skin		1		1	2	1	5	0
Human waste	crabstick				1			1	0
Human waste	salmon					1		1	0
Human waste	nut shells		1					1	0
Human waste	bread		3	3	15	12	6	39	1
Human waste	bread seeds		7	15	19	1	8	50	1
Human waste	*Vitis vinifera* seed				4	1	2	7	0
Human waste	*Vitis vinifera* fruit			1	1			2	0
Human waste	apple seed			1	2			3	0
Human waste	melon seed				1		2	3	0
Human waste	groente			3	2		3	8	0
Human waste	augurk					1		1	0
Human waste	*Allium cepa*						2	2	0
Human waste	*Zea mays*			1		1	1	3	0
Human waste	*Actinidia deliciosa* seed				2			2	0
Human waste	*Panicum miliaceum* seed						1	1	0
Human waste	apple				1			1	0
Human waste	unidentif fruits				1		1	2	0
Human waste	cheese						1	1	0
Human waste	butter						1	1	0

		2005	2006	2007	2008	2009	2010	Total	
Sample size		36	1082	743	1350	959	1054	5224	%
Human waste	chillipepper seeds			1	1		1	3	0
Human waste	coffee bean				1			1	0
Human waste	rubber						2	2	0
Miscellaneous	road tar					1		1	0
Miscellaneous	fossil shell, grit		3	14	16	11	2	46	1
Miscellaneous	rock, grit		2	46	48	12	5	113	2
Miscellaneous	sheeps wool		1					1	0
Human waste	nylon rope					1		1	0
Plants	plant material						1	1	0
Miscellaneous	organic matter unidentif		1	1	13	1	7	23	0
Miscellaneous	miscellaneous		9	6	9	5	2	31	1

Figure 57. Feeding activities at inland locations, recorded with high resolution GPS logger (June 2008) [*Data example*]