Table S1. Sampling effort (n; in brackets) and mean (±SD) Hg concentrations (µg g^{-1} dw) per species and sampling site for the three winters studied in the present study: $winter_t$ (November and December 2014, January 2015), $winter_{t+1}$ (November and December 2015, January 2016), $winter_{t+2}$ (November and December 2016, January 2017). NA: no data available

Species	Sampling site	GPS coordinates of sampling site	$Winter_t$	$Winter_{t+1}$	$Winter_{t+2}$
Black-legged kittiwake	Anda	69.07°N, 15.17°E	3.29 ± 0.54 (2)	3.29 ± 2.84 (3)	2.88 ± 1.19 (3)
	Hornøya	70.39°N, 31.16°E	NA	0.85 ± 0.04 (2)	1.36 ± 0.71 (2)
	Langanes	66.18°N, 15.99°W	4.36 ± 1.23 (4)	4.16 ± 0.79 (4)	NA
	Rost	67.45°N, 11.91°E	NA	3.55 ± 2.20 (3)	2.11 ± 1.23 (3)
Brünnich's guillemot	Alkefjellet	79.58°N, 18.51°E	NA	1.85 ± 0.49 (5)	1.57 ± 0.82 (5)
	Bjørnøya	74.50°N, 18.96°E	2.45 ± 1.42 (13)	3.50 ± 2.26 (9)	2.52 ± 1.15 (6)
	Grimsey	66.54°N, 18.00°W	NA	5.89 ± 1.24 (5)	5.87 ± 1.04 (5)
	Hornøya	70.39°N, 31.16°E	2.73 ± 1.38 (17)	2.31 ± 1.32 (12)	2.59 ± 1.14 (16)
	Isfjorden	78.25°N, 15.51°E	6.36 ± 1.43 (2)	5.97 ± 1.21 (2)	NA
	Jan Mayen	71.03°N, 8.29°W	5.58 ± 1.12 (11)	6.77 ± 2.36 (22)	5.19 ± 0.97 (17)
	Langanes	66.18°N, 15.99°W	4.33 ± 0.98 (4)	5.67 ± 0.64 (3)	4.69 ± 0.41 (3)
Common eider	Breidafjordur	65.08°N, 22.74°W	NA	0.82 ± 0.23 (8)	1.03 ± 0.37 (8)
	Faroes	61.98°N, 6.65°W	NA	0.65 ± 0.13 (4)	0.49 ± 0.16 (4)
	Kongsfjorden	79.00°N, 11.67°E	0.72 ± 0.13 (4)	0.98 ± 0.21 (4)	NA
	Solovetskiy archipelago	65.05°N, 35.79°E	0.82 (1)	NA	1.44 (1)
	Tromsø	69.64°N, 18.85°E	0.80 ± 0.24 (2)	0.74 ± 0.13 (3)	0.46 ± 0.00 (2)
Common guillemot	Bjørnøya	74.50°N, 18.96°E	2.72 ± 0.95 (13)	1.85 ± 0.31 (17)	1.91 ± 0.56 (16)
	Hjelmsøya	71.11°N, 24.73°E	4.29 ± 1.18 (4)	2.35 ± 0.39 (5)	2.94 ± 0.90 (4)
	Jan Mayen	71.03°N, 8.29°W	3.23 ± 1.46 (3)	3.71 ± 1.86 (5)	2.25 ± 1.17 (4)
	Langanes	66.18°N, 15.99°W	3.84 ± 0.55 (8)	4.31 ± 0.98 (6)	2.79 ± 1.14 (4)
Little auk	Bjørnøya	74.50°N, 18.96°E	4.12 ± 0.33 (2)	2.35 ± 0.41 (3)	3.34 ± 1.41 (5)
	Hooker Island	80.23°N, 53.02°E	NA	1.67 (1)	1.52 (1)
Northern fulmar	Bjørnøya	74.50°N, 18.96°E	1.57 ± 0.84 (11)	1.93 ± 1.34 (6)	1.09 ± 0.60 (8)
	Eynhallow	59.14°N, 3.12°W	NA	3.49 ± 0.42 (5)	3.06 ± 1.14 (5)
	Jan Mayen	71.03°N, 8.29°W	3.35 ± 0.78 (3)	2.95 ± 1.15 (3)	1.79 ± 0.84 (6)
	Langanes	66.18°N, 15.99°W	2.87 ± 1.42 (11)	2.79 ± 0.86 (12)	2.28 ± 0.88 (13)

Table S2. Geolocator models used in this study sorted by species and producer. Models were produced by Biotrack (Cambridge, UK), Migrate Technology (Cambridge, UK) and British Antarctic Survey (BAS, Cambridge, UK). The number of each geolocator model per species used in this study is shown in parentheses

Species	Producer	Geolocator models		
Common guillemot	Biotrack	mk3006 (n = 53)		
	Migrate Technology	c250 (n = 34)		
Northern fulmar	Biotrack	mk4083 (n = 48)	mk4093 (n = 4)	mk3006 (n = 3)
	Migrate Technology	c65 (n = 1)	c250 (n = 27)	
Brünnich's guillemot	Biotrack	mk4083 (n = 6)	mk3006 (n = 88)	
	Migrate Technology	c65 (n = 1)	c250 (n = 62)	
Black-legged kittiwake	Biotrack	mk4083 (n = 22)	mk4093 (n = 4)	
Common eider	BAS	mk15 (n = 1)		
	Biotrack	mk3006 (n = 16)		
	Migrate Technology	c250 (n = 24)		
Little auk	Migrate Technology	c65 (n = 7)	f100 (n = 5)	

Table S3. Number of geolocators deployed, retrieved and downloaded per species, sampling site and year. The number of individuals used in the present study, per year and in total is also mentioned. The data available for downloading represents the three studied winters: winter$_t$ (November and December 2014, January 2015), winter$_{t+1}$ (November and December 2015, January 2016), winter$_{t+2}$ (November and December 2016, January 2017). "<2015" includes geolocators deployed before 2015 and retrieved from 2015 to 2016. NA: no data available.

		No. deployed per year			No. retrieved per year			No. available for downloading			Studied individuals			
Species	Sampling site	<2015	2015	2016	2015	2016	2017	Winter$_t$	Winter$_{t+1}$	Winter$_{t+2}$	2015	2016	2017	Total
Black-legged kittiwake	Anda	48	30	42	25	14	36	17	13	32	2	3	3	4
	Hornøya	37	30	30	30	19	21	25	18	19	NA	2	2	2
	Langanes	20	30	30	8	15	15	8	14	12	4	4	NA	4
	Røst	51	30	31	26	25	23	26	22	23	NA	3	3	3
Brünnich's guillemot	Alkefjellet	NA	20	29	NA	14	15	NA	14	14	NA	5	5	5
	Bjørnøya	32	29	30	19	24	9	18	16	9	13	9	6	13
	Grimsey	2	10	16	1	8	14	0	8	11	NA	5	5	5
	Hornøya	53	40	39	35	34	31	27	26	29	17	12	16	18
	Isfjorden	34	16	13	8	8	6	7	5	6	2	2	NA	2
	Jan Mayen	58	20	41	14	32	31	14	23	28	11	22	17	22
	Langanes	38	21	11	14	4	8	14	4	4	4	8	3	5
Common eider	Breidafjordur	37	39	46	20	0	27	17	NA	21	NA	8	8	8
	Faroes	8	32	40	NA	12	17	NA	10	16	NA	4	4	4
	Kongsfjorden	47	31	NA	19	14	NA	12	13	NA	4	4	NA	4
	Solovetsky archipelago	40	30	30	4	6	18	2	5	11	1	NA	1	1
	Tromsø	37	36	40	12	14	15	10	9	11	2	3	2	3
Common guillemot	Bjørnøya	31	30	30	20	32	18	19	28	17	13	17	16	20
	Hjelmsøya	34	35	26	20	12	22	17	7	11	4	5	4	6
	Jan Mayen	49	23	30	15	11	21	13	7	16	3	5	4	5
	Langanes	36	30	33	21	18	19	17	9	10	8	6	4	8
Little auk	Bjørnøya	31	16	30	8	13	21	8	12	17	2	3	5	5
	Hooker Island	35	30	29	22	8	11	17	7	10	NA	1	1	1
Northern fulmar	Bjørnøya	48	35	19	17	13	14	17	11	13	11	6	8	11
	Eynhallow	42	28	55	NA	20	13	NA	13	11	NA	5	5	5
	Jan Mayen	30	18	27	11	17	22	11	14	22	3	3	6	6
	Langanes	30	27	30	14	18	27	13	18	26	11	12	13	16

Table S4. Mean number of days with no position per winter median position from November to January. NA: no data available

	November	December	January
Black-legged kittiwakes	0.0	0.1	1.3
Brünnich's guillemots	2.7	4.7	3.5
Common eiders	1.1	2.7	0.9
Common guillemots	0.6	8.8	4.0
Little auks	10.5	12.9	10.9
Northern fulmars	6.5	10.1	NA

Table S5. AIC model ranking for winter [Hg] within species with low fidelity to their wintering ground from one year to the other. LMMs have been run with different thresholds, and results are presented in a decreasing order (lowest AIC and ΔAIC). The table includes the AIC, the ΔAIC and the AIC weight. Individuals (Bird ID) were added as a random effect

Threshold	Model	No. of parameters	AIC	ΔAIC	AIC weight
200 km	~ fidelity + species + (1|Bird ID)	10	290.90	0.00	0.49
	~ species + (1|Bird ID)	9	290.97	0.07	0.47
	~ fidelity + (1|Bird ID)	5	293.42	5.52	0.03
	~ fidelity * species + (1|Bird ID)	15	299.03	8.14	0.01
	~ 1 + (1|Bird ID)	4	302.58	11.68	0.00
300 km	~ fidelity + species + (1|Bird ID)	10	290.30	0.00	0.56
	~ species + (1|Bird ID)	9	290.97	0.67	0.4
	~ fidelity * species + (1|Bird ID)	14	296.94	6.64	0.02
	~ fidelity + (1|Bird ID)	5	297.95	7.66	0.01
	~ 1 + (1|Bird ID)	4	302.58	12.28	0.00
350 km	~ fidelity + species + (1|Bird ID)	10	289.85	0.00	0.62
	~ species + (1|Bird ID)	9	290.97	1.12	0.35
	~ fidelity * species + (1|Bird ID)	14	297.52	7.67	0.01
	~ fidelity + (1|Bird ID)	5	297.68	7.83	0.01
	~ 1 + (1|Bird ID)	4	302.58	12.73	0.00
372 km	~ fidelity + species + (1|Bird ID)	10	287.20	0.00	0.82
	~ species + (1|Bird ID)	9	290.97	3.77	0.13
	~ fidelity * species + (1|Bird ID)	14	294.02	6.83	0.03
	~ fidelity + (1|Bird ID)	5	294.39	7.19	0.02
	~ 1 + (1|Bird ID)	4	302.58	15.38	0.00
450 km	~ fidelity + species + (1|Bird ID)	10	284.01	0.00	0.84
	~ fidelity * species + (1|Bird ID)	14	288.16	4.14	0.11
	~fidelity + (1|Bird ID)	5	290.9	6.89	0.03
	~ Species + (1|Bird ID)	9	290.97	6.96	0.03
	~ 1 + (1|Bird ID)	4	302.58	18.57	0.00
500 km	~ fidelity + species + (1|Bird ID)	10	279.10	0.00	0.97
	~ fidelity * species + (1|Bird ID)	14	284.37	5.27	0.07
	~ fidelity + (1|Bird ID)	5	286.54	7.44	0.02
	~ species + (1|Bird ID)	9	290.97	11.87	0.00
	~ 1 + (1|Bird ID)	4	302.58	23.48	0.00

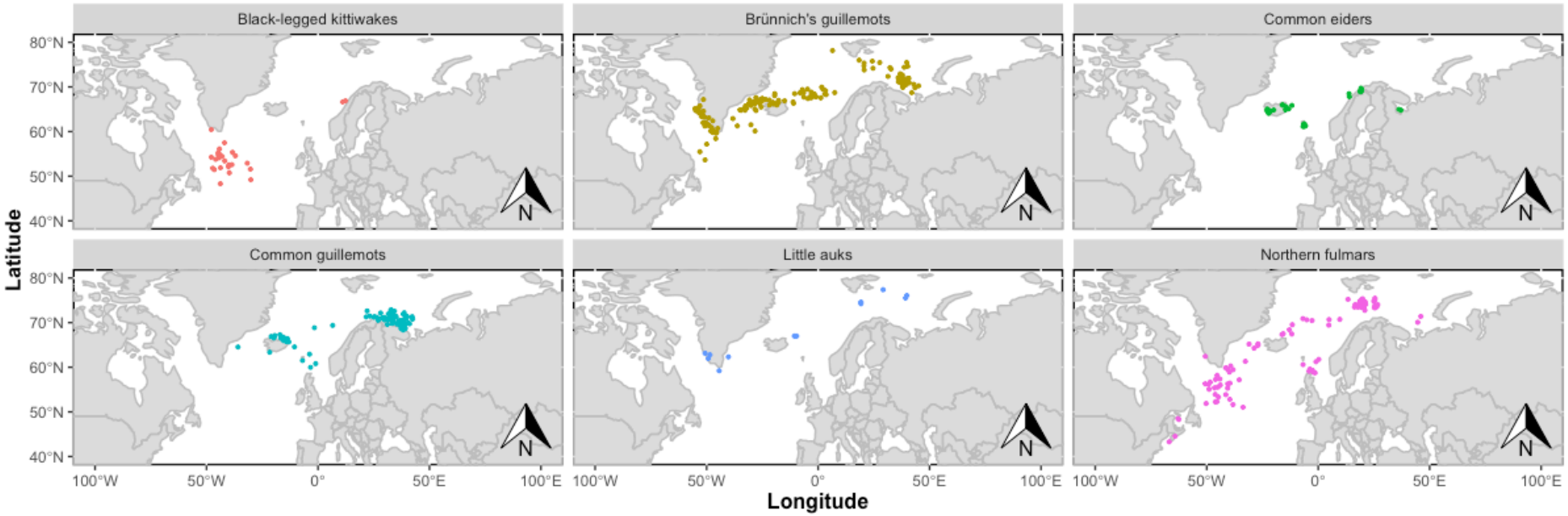

Figure S1. Winter distribution (i.e. median latitude and longitude position) from November to January (for black-legged kittiwakes, Brünnich's guillemots, common eiders, common guillemots, little auks) and from November to December (northern fulmars)

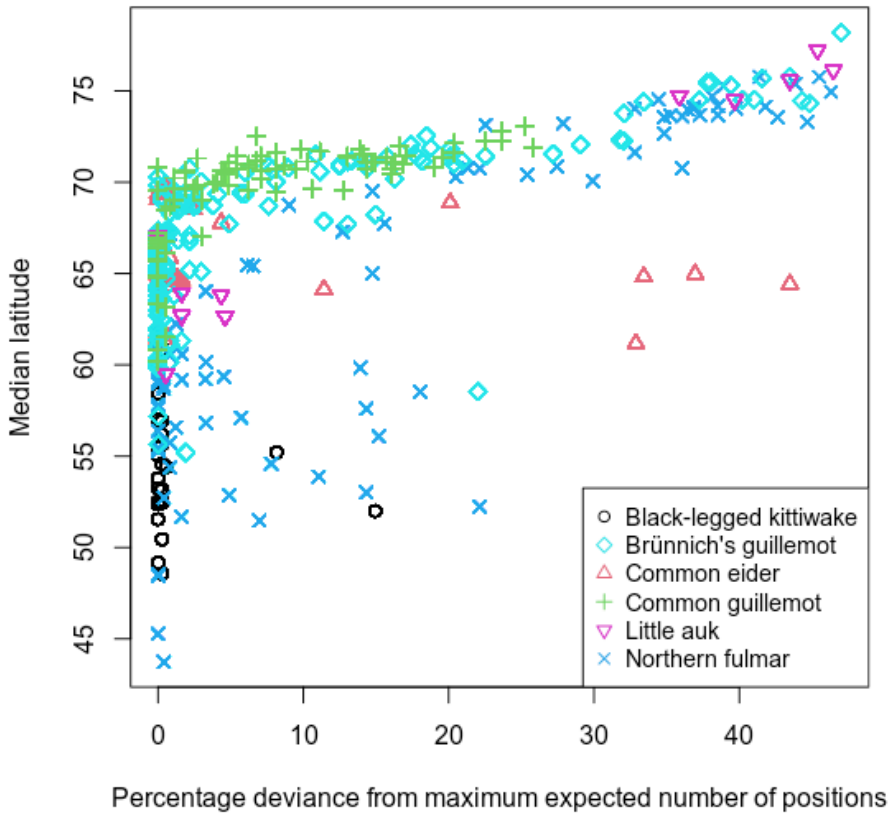

Figure S2. Median latitudes from November to January, and November to December for the northern fulmar specifically, plotted as a function of the deviance from the maximum number of positions that in theory can be calculated from light-level data using the threshold method. The maximum expected number is 2 positions each day, e.g. 122 positions for the Northern fulmar and 184 for the remaining species. As expected, the deviance increases drastically as the median latitude reaches 70°N because the absence of daylight under the polar night. From the plot, especially northern wintering common guillemots, little auks, northern fulmars and Brünnich's guillemots lack positions during the darkest part of the year – with ~43 days without data for the northernmost Brünnich's guillemot, and ~27 days for the northernmost northern fulmar. However, the deviance can also be a result of the removal of unrealistic positions because of disturbance in the recorded light-level data which is likely for some northern fulmars and common eiders that were well below 70°N. Common eiders spend their non-breeding season at the coast and can therefor experience shading from the terrain. Northern fulmars are known to seek out fishing boats with artificial sources of light, in addition to some being coastal for much of the non-breeding season.

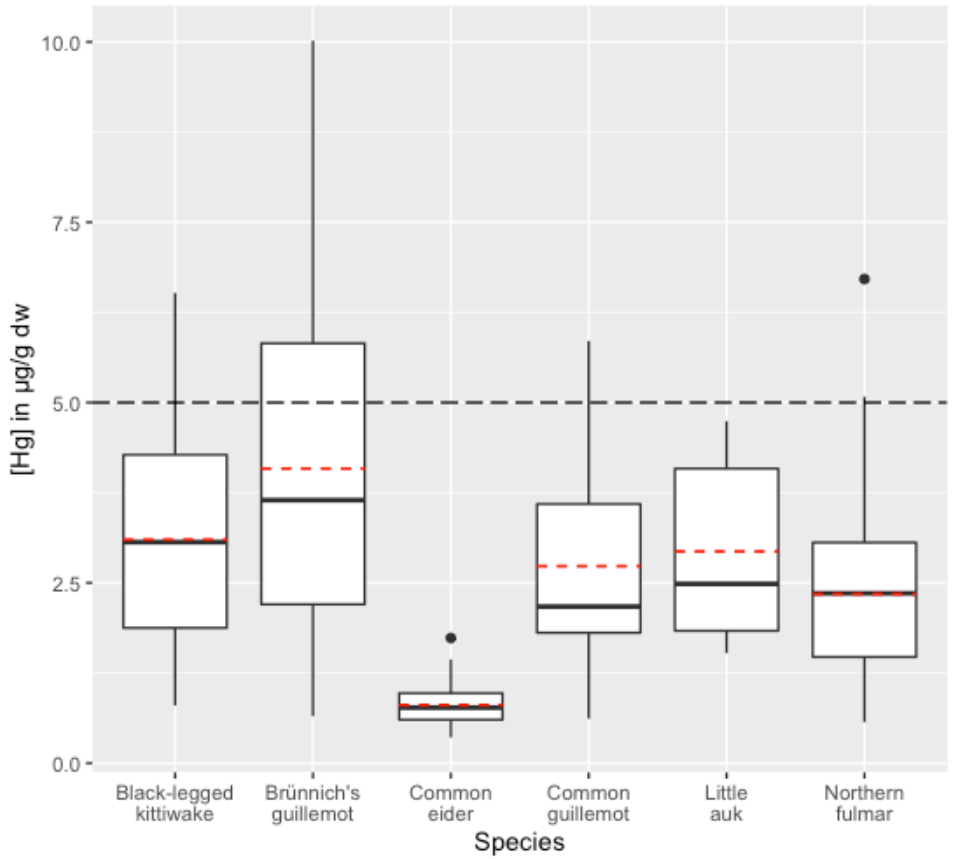

Figure S3. [Hg] in feathers for each species. Mean [Hg] are represented by dashed red lines. The toxicity threshold in feathers of 5 µg g^{-1} (Eisler 1987) is represented by a dashed grey line. Boxplots show the median (horizontal black line within the boxes), 1st and 3rd quartiles (Q1 and Q3), the minimum (Q1 –1.5 × interquartile range) and maximum (Q3 + 1.5 × interquartile range) concentrations (whiskers) and outliers (black dots).

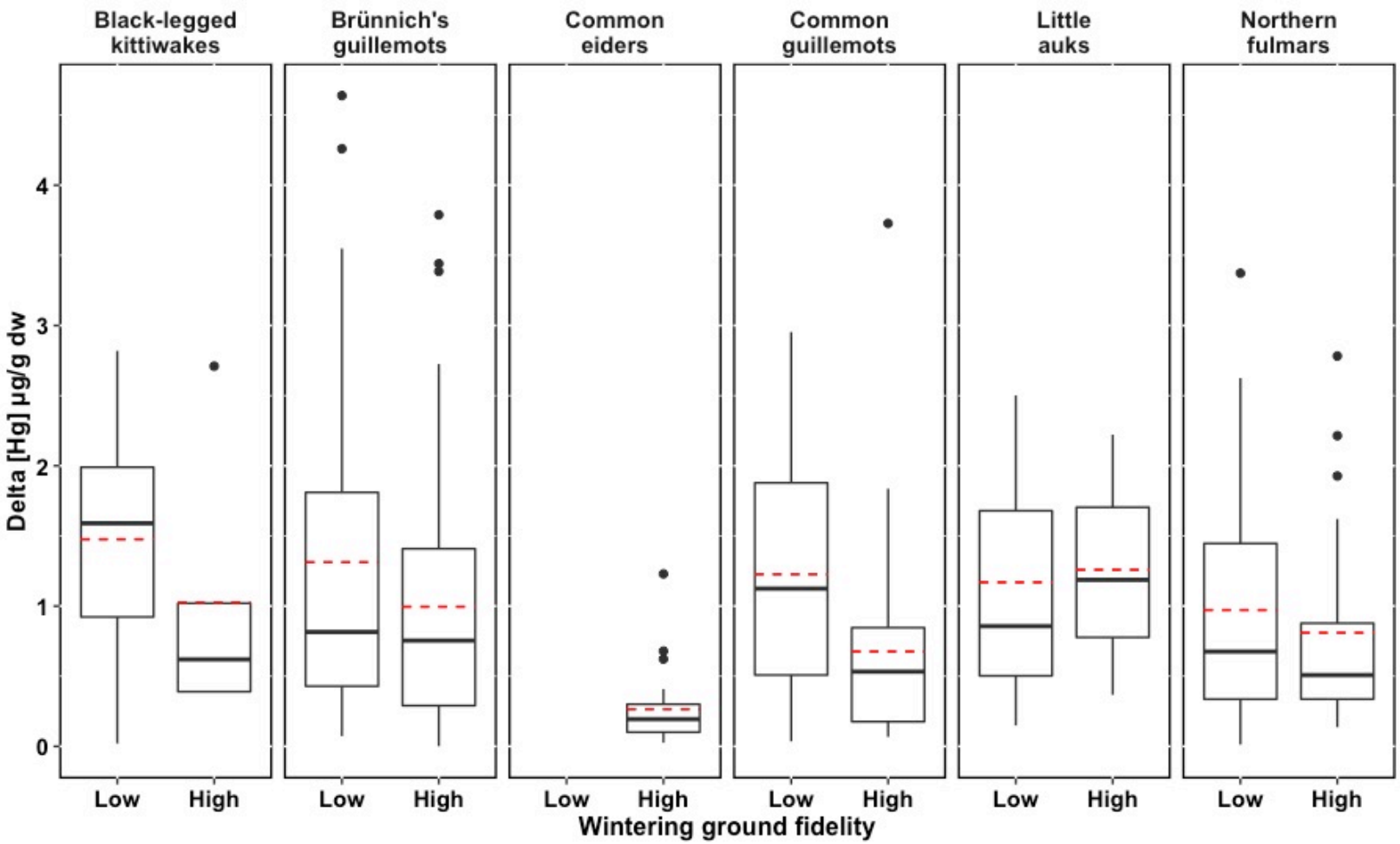

Figure S4. Δ[Hg] (absolute values) from one year to the other for birds with low (<372 km between winter median positions in different years) or high fidelity (>372 km) to their wintering ground, per species. Red dotted line: mean Δ[Hg]. Boxplots as in Fig. S3.

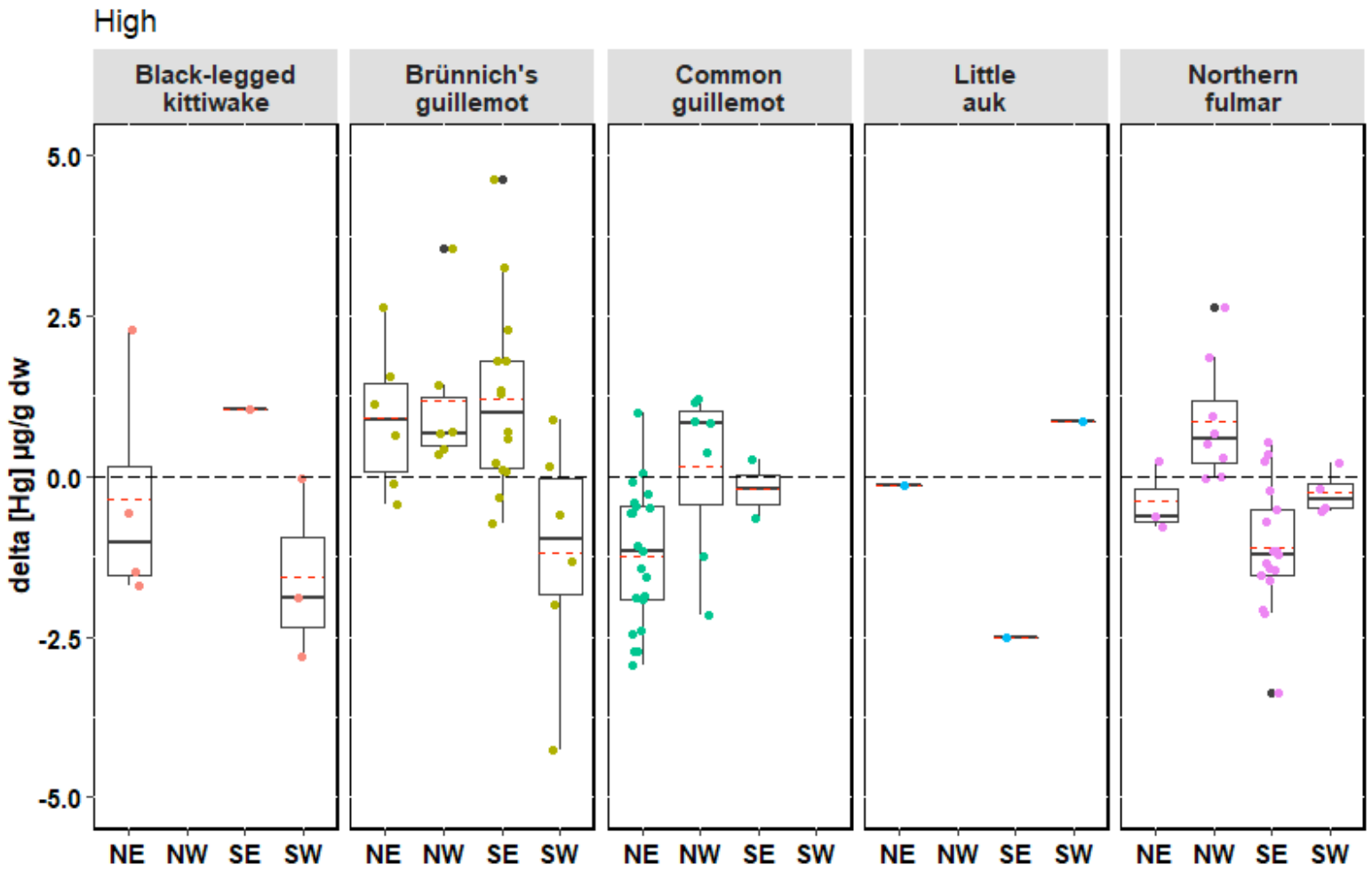

Figure S5. Δ[Hg] (raw values) in the 4 different directions (NE: northeast, NW: northwest, SE: southeast, SW: southwest) per species for individuals with low fidelity to their wintering ground. Red dotted line: mean Δ[Hg]. Black dotted line: zero axis. Boxplots as in Fig. S3.

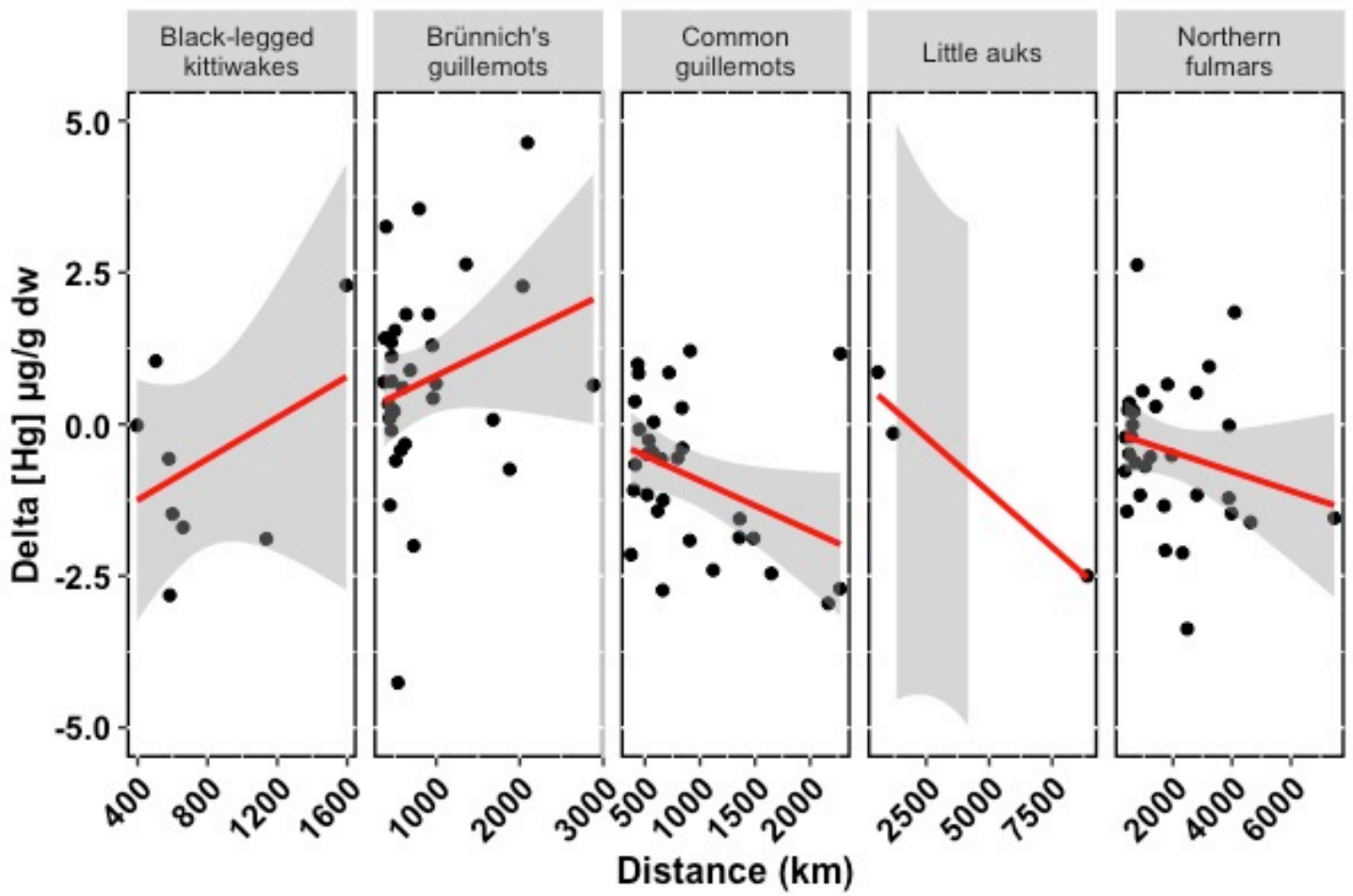

Figure S6. Δ[Hg] in relation to the distance (in km) for the 5 studied species with low fidelity to their wintering ground. Red line: regression line; gray shaded area: confidence limits