Appendix A

Software settings of the GPS/GSM collars used in this study.

Appendix B

Overview of the summary statistics used in this study.

Appendix C

Time budget graphs based on SS-data and the raw ACC data for the Bewick's swans included in the study (n = 10).

Appendix D

Potential data reductions that can be achieved by using summary statistics with different settings of ACC sensors.

Appendix E

Pearson correlation coefficients for the average daily proportions of the different behaviours.

Appendix A

Software settings for the different sensors in the biologging device.

Different settings were used in different seasons to suit the energy availability. Settings were also dependent on energy level of the device itself, with four different energy levels being considered (E0-E3; boundaries specified below the table). Once the device would move from one to another energy level, the sampling regime changed accordingly. In case multiple measurements had to be taken at the same time point, the water sensor was given priority since this sensor measures every second and the energy and time for taking the measurement is negligible. Second in line is the ACC sensor, followed by GPRS (= transmission). The GPS is last in line as this sensor takes the most time and energy to collect a sample. In the current study, only data collected in spring was used.

During ACC sensor measurements, data is temporarily stored into the processor's memory (RAM). When the measurements are finished, either the raw data is logged onto the onboard non-volatile Flash memory, or the SS are calculated and then logged instead. The calculations for the SS are exactly the same as if it would have been during post processing of raw data for classification (see Appendix B).

The internal codename for this collar is GNSSlogGPRS v6. Firmware is custom-made and proprietary.

Season settings:
Winter: 16 Nov – 28 Feb / Spring: 1 Mar – 15 Jun / Summer: 16 Jun – 31 Aug / Autumn: 1 Sept – 15 Nov

GPS (1 position per fix)		
Winter	E3	Every 60 minutes (3600 sec)
	E2	Every 2 hours (7200 sec)
	E1	Every 12 hours (43200 sec)
	E0	Disabled
Spring	E3	Every 15 minutes (900 sec)
	E2	Every 60 minutes (3600 sec)
	E1	Every 12 hours (43200 sec)
	E0	Disabled
Summer	E3	Every 15 minutes (900 sec)
	E2	Every 60 minutes (3600 sec)
	E1	Every 12 hours (43200 sec)
	E0	Disabled
Autumn	E3	Every 15 minutes (900 sec)
	E2	Every 60 minutes (3600 sec)
	E1	Every 12 hours (43200 sec)
	E0	Disabled

ACC* (SS = Summary statistics, RAW = raw data)		
Winter	E3	RAW: 15 minutes (900 sec). SS: every 2 minutes (120 sec).
	~~E2~~	-
	~~E1~~	-
	E0	Disabled
Spring	E3	RAW: 15 minutes (900 sec). SS: every 2 minutes (120 sec).
	~~E2~~	-
	~~E1~~	-
	E0	Disabled
Summer	E3	RAW: 60 minutes (3600 sec). SS: every 15 minutes (900 sec).
	~~E2~~	-

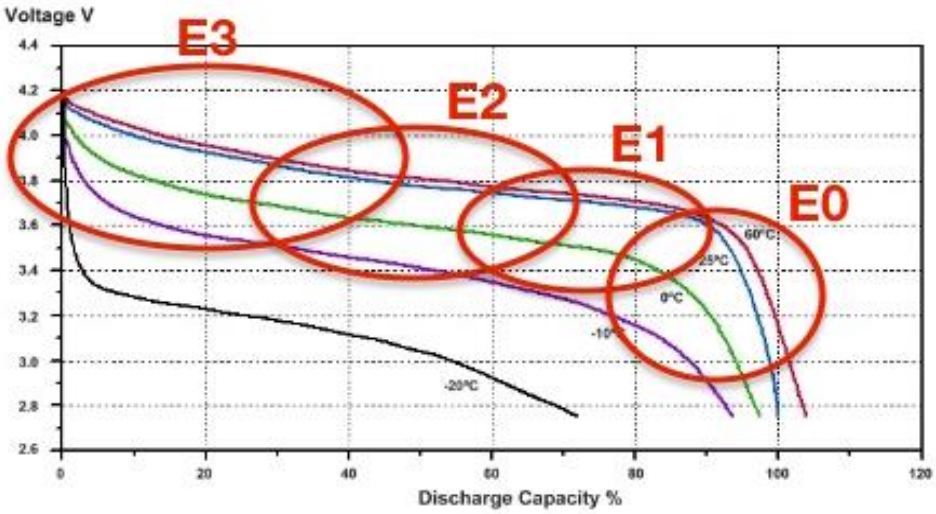
	~~E1~~	-
	E0	Disabled
Autumn	E3	RAW: 15 minutes (900 sec). SS: every 2 minutes (120 sec).
	~~E2~~	-
	~~E1~~	-
	E0	Disabled

*settings of the accelerometer (ACC) sensor: 2 second bouts; 20 Hz; three axes (x y z)

Watersensor		
Winter	E3, E2, E1	Every second, stored per 5 minutes (only when >30 times 1)
	E0	Disabled
Spring	E3, E2, E1	Every second, stored per 5 minutes (only when >30 times 1)
	E0	Disabled
Summer	E3, E2, E1	Disabled
	E0	Disabled
Autumn	E3, E2, E1	Every second, stored per 5 minutes (only when >30 times 1)
	E0	Disabled

GPRS (time slot 13:00-15:00 UTC+01:00; collar is allowed to search for a network max. 3 minutes)		
Winter	E3	1 # /day
	E2	1 # / day
	E1	0.5 # /day
	E0	Disabled
Spring	E3	1 # / day
	E2	1 # / day
	E1	0.5 # / day
	E0	Disabled
Summer	E3	0.5 # / day
	E2	Disabled
	E1	Disabled
	E0	Disabled
Autumn	E3	4 # / day
	E2	1 # day
	E1	0.5 # day
	E0	Disabled

Boundaries between different energy levels (in Voltage) within the device, represented graphically and in numbers. There are no sharp boundaries between the levels to allow for hysteresis.



E3: *4,30V* > Vbat > 3,810V
E2: 3,850V > Vbat > 3,735V
E1: 3,765V > Vbat > 3,690V
E0: 3,720V > Vbat > *3,30V*

Appendix B

List of summary statistics used in this study. For the SS data collection method, the first 20 summary statistics were calculated on-board by the biologging device, the last statistic (water) was measured by the water sensor and later combined with the SS data by down sampling the water sensor data to fit the sampling regime of the ACC sensor. For the raw data collection method, the summary statistics were calculated after transmission of the data. The statistics presented here are well known and often used in accelerometer research (Shamoun-Baranes et al., 2012). An exception being 'sumtrans' which counts the number of times an accelerometer signal (x, y or z) crosses the averages for its direction within that bout. This way it detects some form of rhythmicity in the signal that is useful in detecting certain behaviours.

Table B.1. List of the 21 statistics used in the behavioural classification model (random forest analysis) as predictors for the classification of the acceleration data.

#	Name	Calculation	Description
1, 2, 3	mean_x, mean_y, mean_z	Mean(x|y|z)	Mean of x|y|z; also called 'static acceleration' (Shamoun-Baranes et al., 2012; Watanabe et al. 2005)
4, 5, 6	sd_x, sd_y, sd_z	sd(x|y|z)	Standard deviation of x|y|z
7, 8	min_z, max_z	Min(z), max(z)	Minimum z-value within bout. Only in z-direction as the neck-collars for the swans can turn and therefore we cannot reliably know the orientation of the x and y axis. (Watanabe et al. 2005)
9, 10, 11	odba_x, odba_y, odba_z	∑MA(x|y|z)	Sum of the differences between the x|y|z measurement and the static acceleration, here calculated as the sum of the moving average with a width of 8 (Shamoun-Baranes et al. 2012)
12	ODBA	odba_x + odba_y + odba_z	Sum of odba in all directions (Shamoun-Baranes et al. 2012)
13	meanslope_z	Mean(∑((z[n] – z[n-1])/1)	Mean slope of z between two measurements.
14	sdslope_z	Sd(meanslope_z)	Standard deviation of the slope of z
15	sumslope_z	∑(meanslope_z)	Sum of the slopes of z
16, 17, 18	sumtrans_x, sumtrans_y, sumtrans_z	∑(ifelse(x[n] < mean(x|y|z) & mean(x|y|z) < x[n+1], 1, 0))	Number of times x crosses meanx, proxy for periodicity of signal. Substitute for more demanding (in terms of energy for calculation) Fast Fourier Transformation.
19	meanvectorlength	Mean(sqrt((x[n]^2)+(y[n]^2)+(z[n]^2)))	Mean vector length for x, y and z.
20	sdvectorlength	sd(sqrt((x[n]^2)+(y[n]^2)+(z[n]^2)))	Standard deviation of vector length for x, y and z.
21	water		Binary: 1 for underwater, 0 for not underwater. Measurement frequency 1Hz (not synchronized with ACC sensor).

Appendix C

Individual daily time budgets of Bewick's swans (including individual tracks in the panel on the left) for spring 2017 (1 February – 31 May). The top figure for each individual is created from the summary statistics dataset, the bottom figure from the raw ACC data collected by the same device, from the same individual and the same spring season.

Time budgets varied considerably among individuals. This was most striking in the amount of aquatic foraging measured. Some individuals show extensive aquatic foraging during their spring migration, especially in the Baltic Sea area (around 58°-59° N) and sometimes also in the White Sea area (64°-65° N), while other individuals seem to only make limited use of aquatic resources.

Appendix D

The lines indicate the size of 1 bout in raw ACC, with different settings for resolution (Fig. D.1) and frequency (Fig. D.2). In Fig. D.1 resolution is fixed at 8 bits, in Fig. D.2 frequency is fixed at 20Hz. The different colours represent different bout lengths (1 – 15 seconds). For the summary statistics (SS) method the data size is not dependent on frequency and equals the amount of statistics one wants to gather and the level of detail in measuring them (resolution). In the example of this paper our data size per bout for the summary statistics was 20 bytes (excluding metadata). Data sizes presented here are excluding metadata such as date, time and column labels etcetera.

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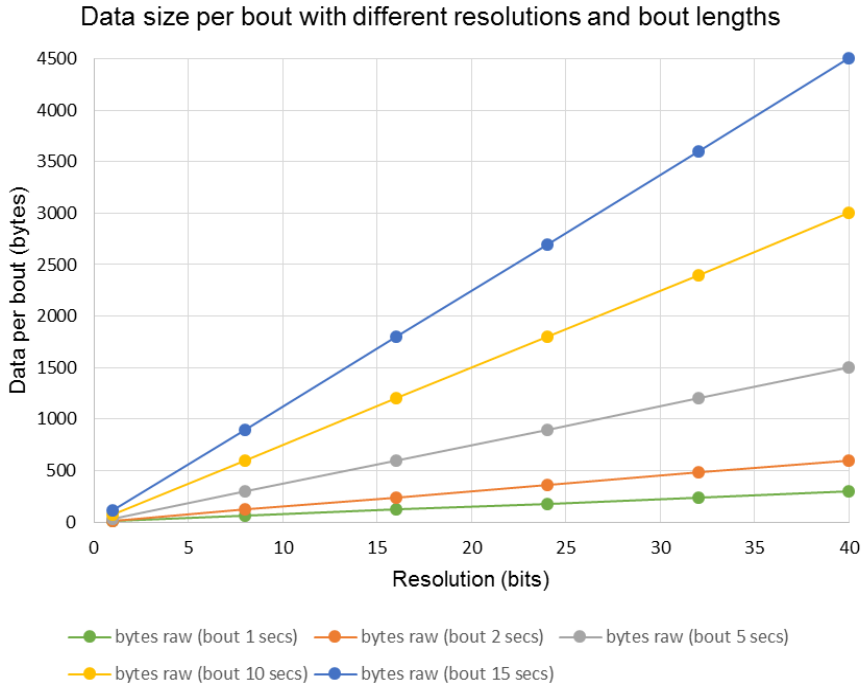
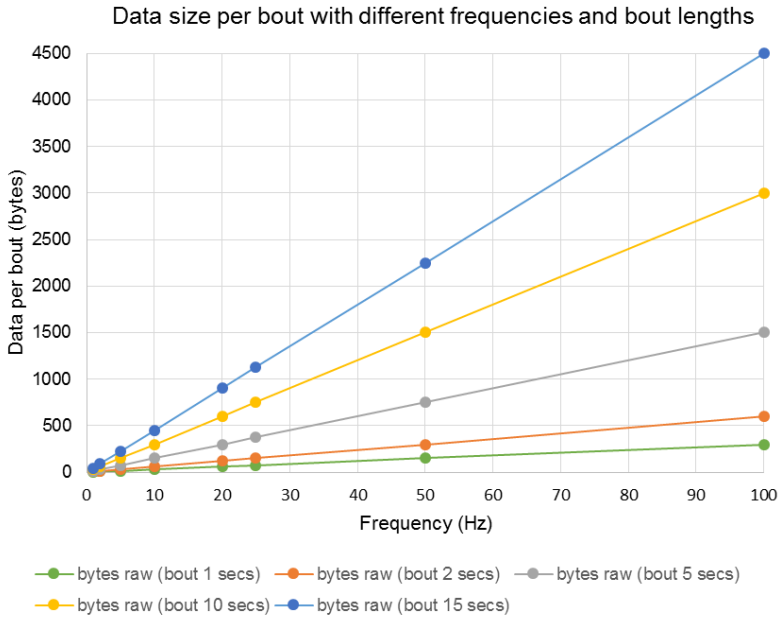
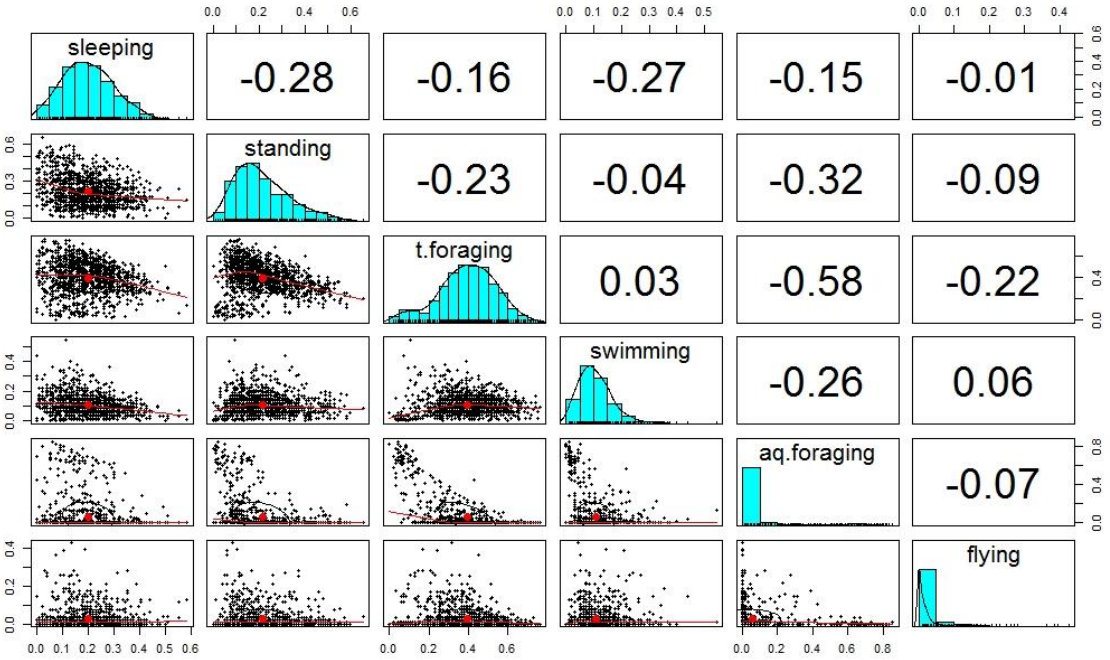




Appendix E

E.1 Pearson correlations between SS-based proportions of the 6 classified behaviours.



E.2 Pearson correlations between raw ACC-based proportions of 6 classified behaviours.