

This is an electronic appendix to the paper by Watanuki *et al.* Stroke and glide of wing-propelled divers: deep diving seabirds adjust surge frequency to buoyancy change with depth. *Proc. R. Soc. Lond. B* **270**, 483—488.

Electronic appendices are refereed with the text. However, no attempt is made to impose a uniform editorial style on the electronic appendices.

Electronic Appendix A

Values recorded by loggers were converted into accelerations with linear regression equations. In order to obtain the calibration equations, values recorded by each logger set at 90°, 0°, and -90° angle to horizon in 7°C and 20°C waters were regressed on the corresponding accelerations (9.8 m/s², 0 m/s² and -9.8 m/s², respectively). Temperature effects were < 4% and did not require correction. The loggers were attached on the lower back of birds at an attachment angle of α . To measure α , we arbitrary selected 10 samples of 4 s surge acceleration when the birds were at the water's surface between dives, and their trunks were horizontal. The average over 4 s was within 95–104% of the grand average for each bird, suggesting that the attachment angle was stable during the device's deployment. The estimated attachment angle was 17.5° for BG13, 15.7° for BG09 and 0° for BG17.

To obtain the component of the gravity acceleration along the surge axis of the data-logger (YaL), we removed the high frequency component based on wing stroking from the surge acceleration by low-pass filter. We found that videotaped common guillemots (*U. aalge*) swimming horizontally with the speed of 1.00±0.22 m/s (n=27 trial) in 1 m depth in an aquarium tank made 1.1 – 3.3 Hz wing strokes. Therefore, we used the two-band low-pass filter starting at 0.1 Hz and ending at 0.5 Hz, which were well below the minimum stroke frequency. Then wing-stroke based surge (YaH in Fig 1)

and heave (X_{aH}) of the data-loggers were given by subtracting the components of gravity from recorded surge and heave accelerations. Heave (X_{GH}) and surge (Y_{GH}) of birds' body trunk were given by correcting logger attachment angle (α) as follows:

$$X_{GH} = X_{aH} \times \cos\alpha \pm Y_{aH} \times \sin\alpha$$

$$Y_{GH} = Y_{aH} \times \cos\alpha - X_{aH} \times \sin\alpha$$

No correction was needed in BG17 since attachment angle was zero.