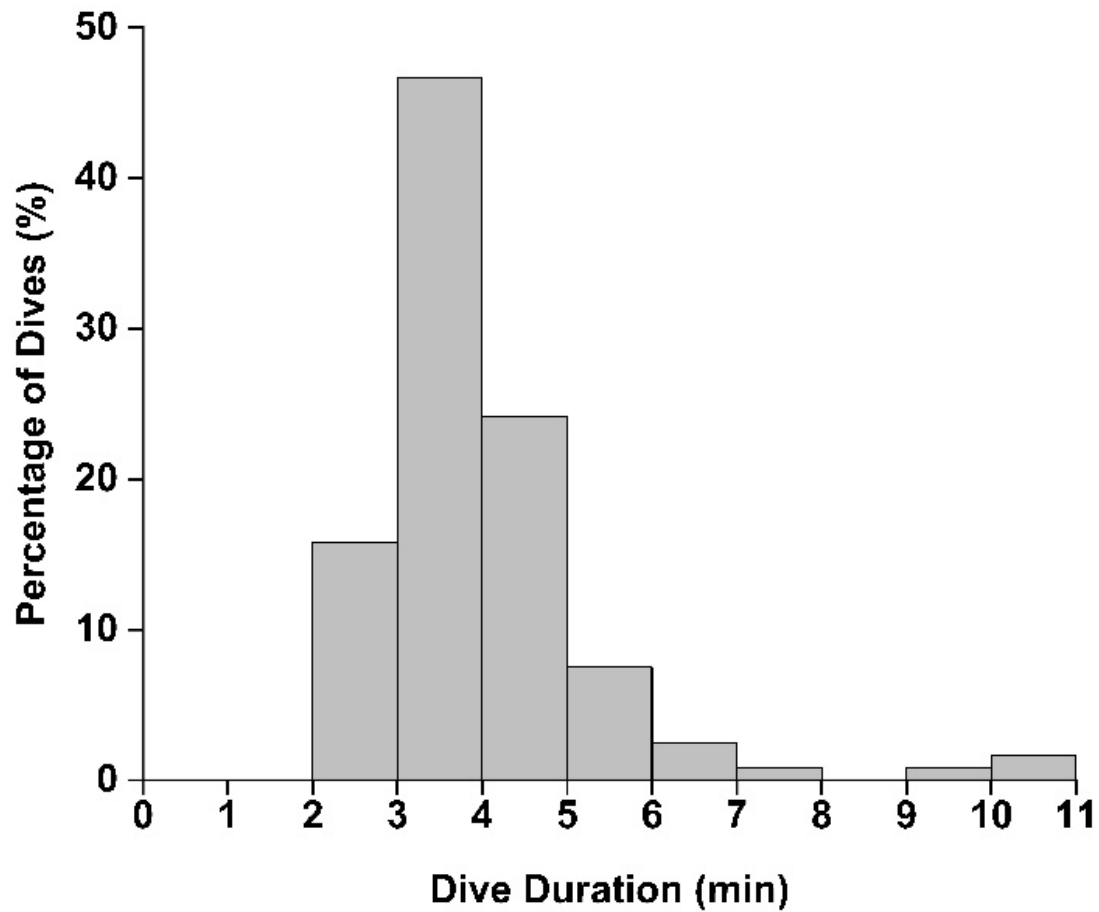
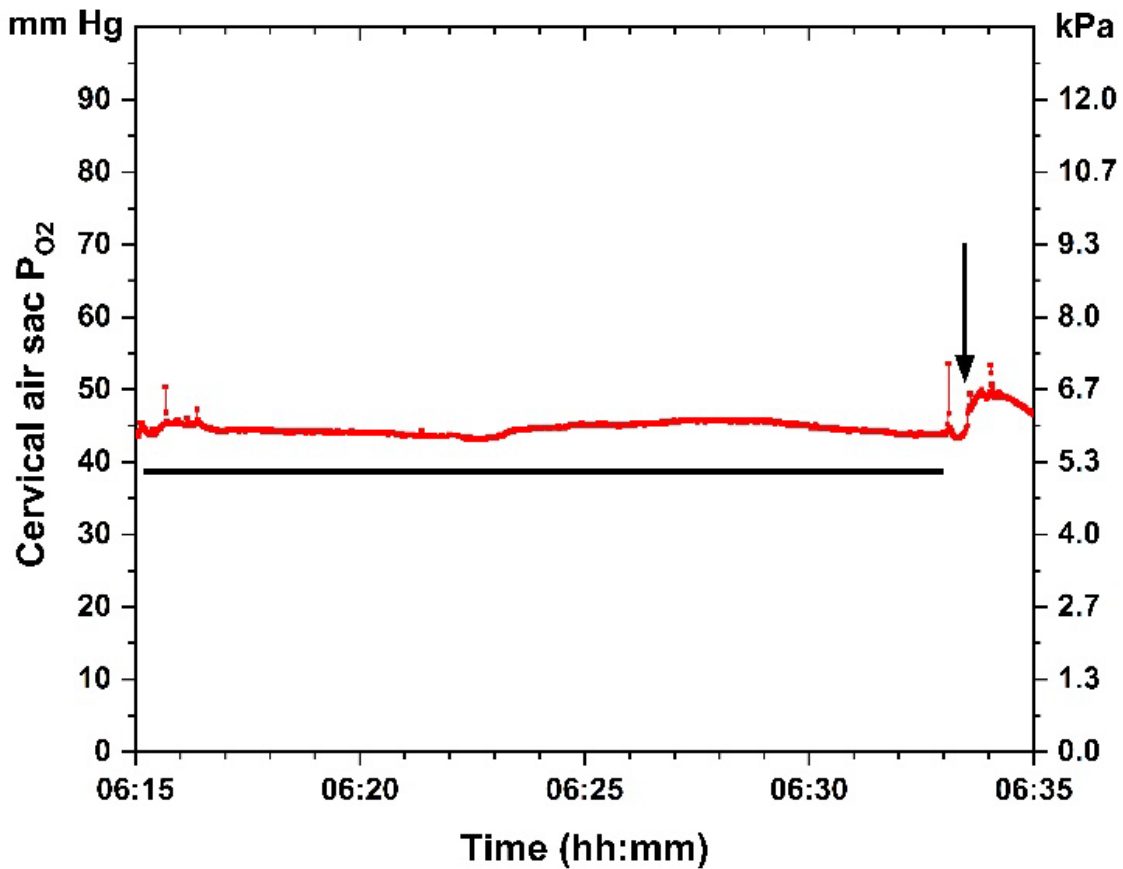


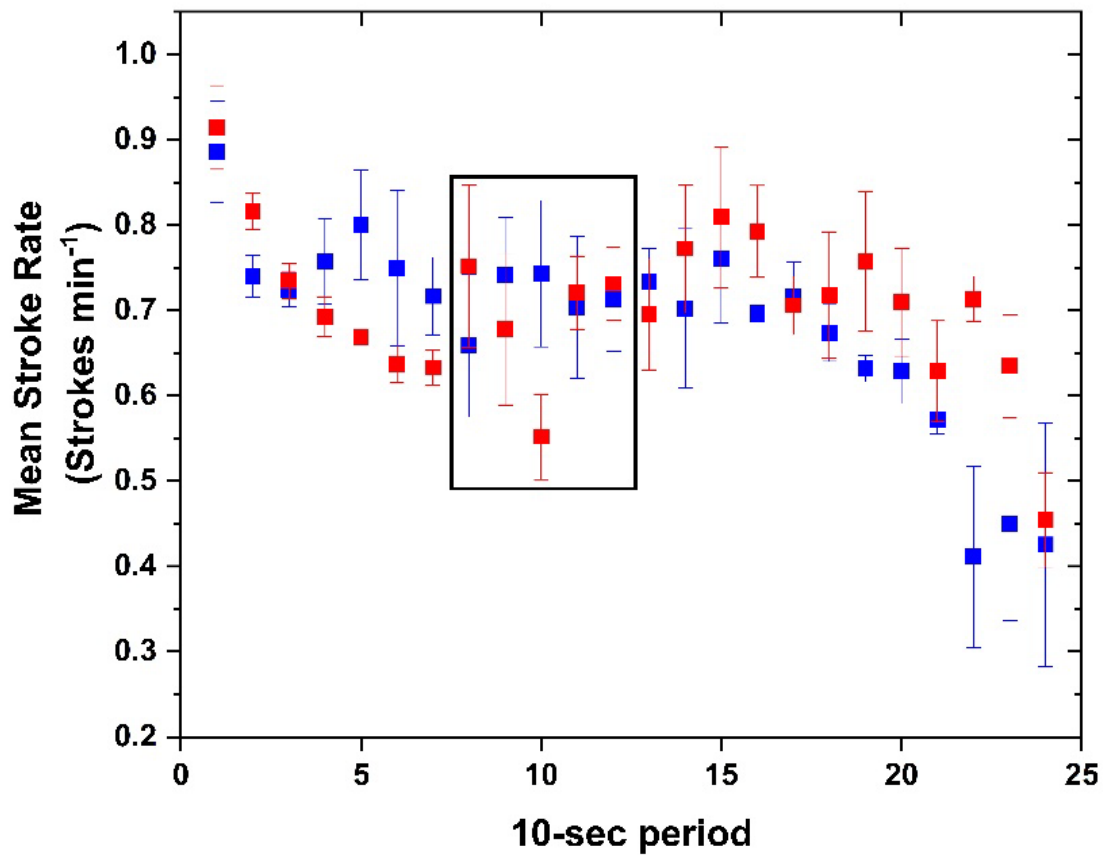
## Supplement



**Figure S1.** Distribution of dive durations. Only submergences greater than 10m and at least 2 mins in duration were considered dives in this study (N=120). Dives beyond 8 mins were completed by a single penguin (EP3).



**Figure S2. Cervical air sac P<sub>O2</sub> in an emperor penguin at rest.** This 20-min profile illustrates cervical air sac P<sub>O2</sub> while EP3 slept prone on the snow (black line), and after it was awakened by researchers opening the dive holes (black arrow). During this 18-min sleep period, P<sub>O2</sub> was  $45 \pm 0.7$  mm Hg. Earlier in the morning, mean P<sub>O2</sub> in the same air sac averaged 33 mm Hg over a 3-h period.



**Figure S3.** Mean $\pm$ s.d. stroke rate in serial 10-sec intervals of five dives with and five dives without overlapping cervical and posterior thoracic P<sub>O</sub><sub>2</sub> profiles in EP5. Dives in which cervical and posterior thoracic P<sub>O</sub><sub>2</sub> profiles overlapped at the bottom of descent are shown in blue and dives with no overlapping profiles are shown in red. The mean stroke rates in blue within the rectangle represent the 10-second periods where overlaps occurred. Dive durations were divided into serial 10-second intervals and mean stroke rates were taken over each 10-second period for 10 dives.