

Supplemental Figures and Tables.

Table S1. Feathers tested in this study, sample size in parentheses. Width (chord) measured at  $\frac{3}{4}$  of the length of the feather, i.e. before tapering. See also Fig. 5 for drawings of feather shape.

Species	Feather (N)	Width, <i>w</i> (mm)	Length <i>l</i> (mm)	Feather Mass (mg)	Estimated Added Mass (mg) <sup>1</sup>
Anna's Hummingbird <i>Calypte anna</i> Lesson 1829	R5 (2)	3.5	32	4.4	0.37
Costa's Hummingbird <i>Calypte costae</i> Bourcier 1839	R5 (1)	1.6	22	0.8	0.054
Costa's Hummingbird	R4 (1)	3.9	23	1.4	0.34
Black-chinned Hummingbird <i>Archilochus alexandri</i> Bourcier and Mulsant 1846	R5 (2)	3.8	23	1.5	0.32
Black-chinned Hummingbird	R4 (1)	5.2	25	1.6	0.65
Ruby-throated Hummingbird <i>Archilochus colubris</i> Linnaeus 1758	R5 (1)	3.5	25	1.2	0.29
Allen's Hummingbird <i>Selasphorus sasin</i> Lesson 1829	R5 (1)	1.4	19	0.7	0.036
Allen's Hummingbird	R4 (2)	1.9	19	0.8	0.066
Allen's Hummingbird	R3 (1)	3.4	22	0.9	0.24
Allen's Hummingbird	R2 (1)	3.6	22	1.3	0.27
Rufous Hummingbird <i>S. rufus</i> Gmelin 1788	R5 (1)	2.6	20	0.9	0.13
Rufous Hummingbird	R4 (1)	3.6	24	1.0	0.30
Rufous Hummingbird	R3 (1)	4.7	24	1.3	0.51
Rufous Hummingbird	R2 (1)	6.0	26	1.3	0.90
Broad-tailed Hummingbird <i>S. platycercus</i> Swainson 1827	R2 (1)	6.7	32	2.0	1.4
Scintillant Hummingbird <i>S. scintilla</i> Gould 1850	R2 (1)	5.8	25	1.1	0.80
Volcano Hummingbird <i>S. flammula torridus</i> Salvin 1870	R2 (1)	6.9	26	1.3	1.2
Volcano Hummingbird	R3 (1)	6.5	27	1.6	1.1
Calliope Hummingbird <i>S. calliope</i> Gould 1847	R3 (1)	5.4	19	1.5	0.53
Calliope Hummingbird <i>S. calliope</i>	R2 (1)	5.2	18	1.3	0.47
Calliope Hummingbird <i>S. calliope</i>	R1 (1)	4.6	16	1.2	0.32
White-bellied Woodstar <i>Chaetocercus mulsant</i> Bourcier 1842	R4 (2)	0.88	24	1.7	0.018
White-bellied Woodstar	R3 (1)	3.2	25	0.7	0.25
Magenta-throated Woodstar	R5 (1)	3.5	34	2.5	0.40

<i>Philodice bryantae</i> Lawrence 1867					
Purple-throated Woodstar <i>P. mitchellii</i> Mulsant and Verreaux 1866	R5 (1)	2.4	30	1.8	0.17
Purple-throated Woodstar	R4 (1)	3.5	32	1.7	0.38
Bahama Sheartail <i>Calothorax e. evelynae</i> Bourcier 1847	R5 (1)	4.4	30	2.2	0.56

<sup>1</sup> estimated as a cylinder of air around the feather,  $= \rho w^2 l \pi / 4$ .

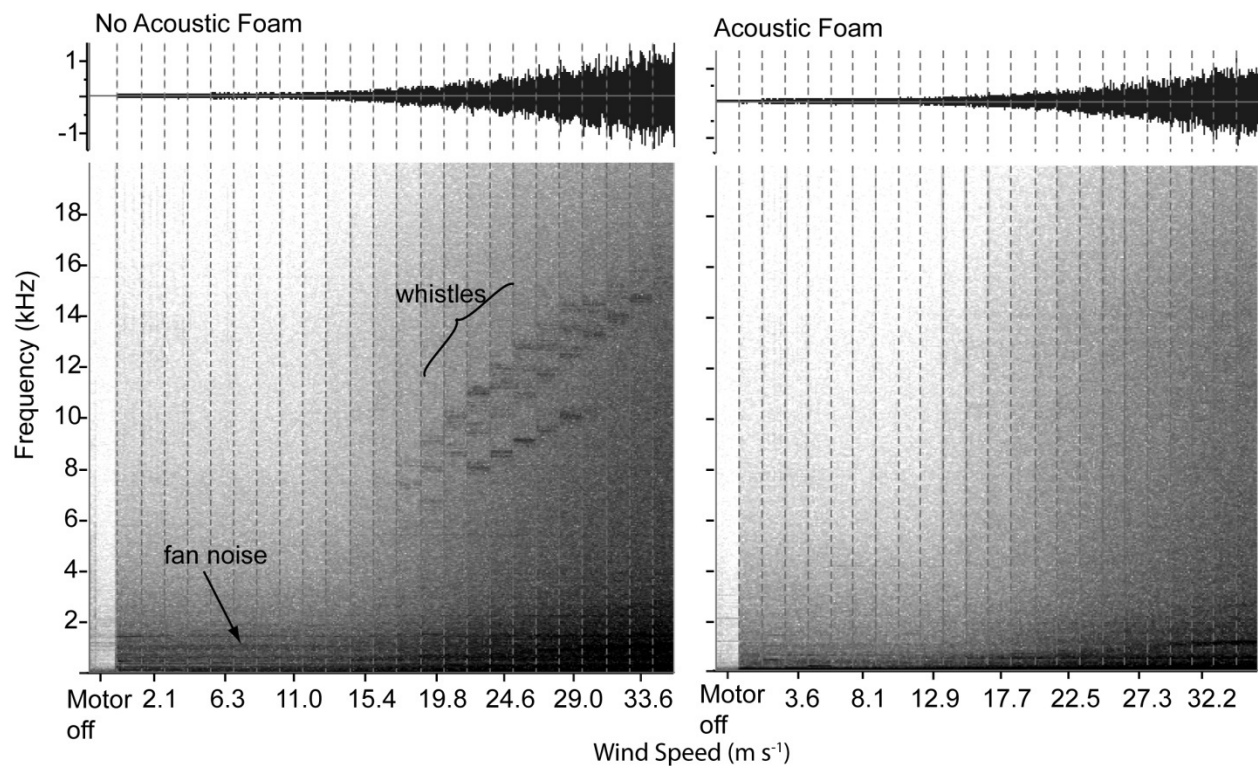
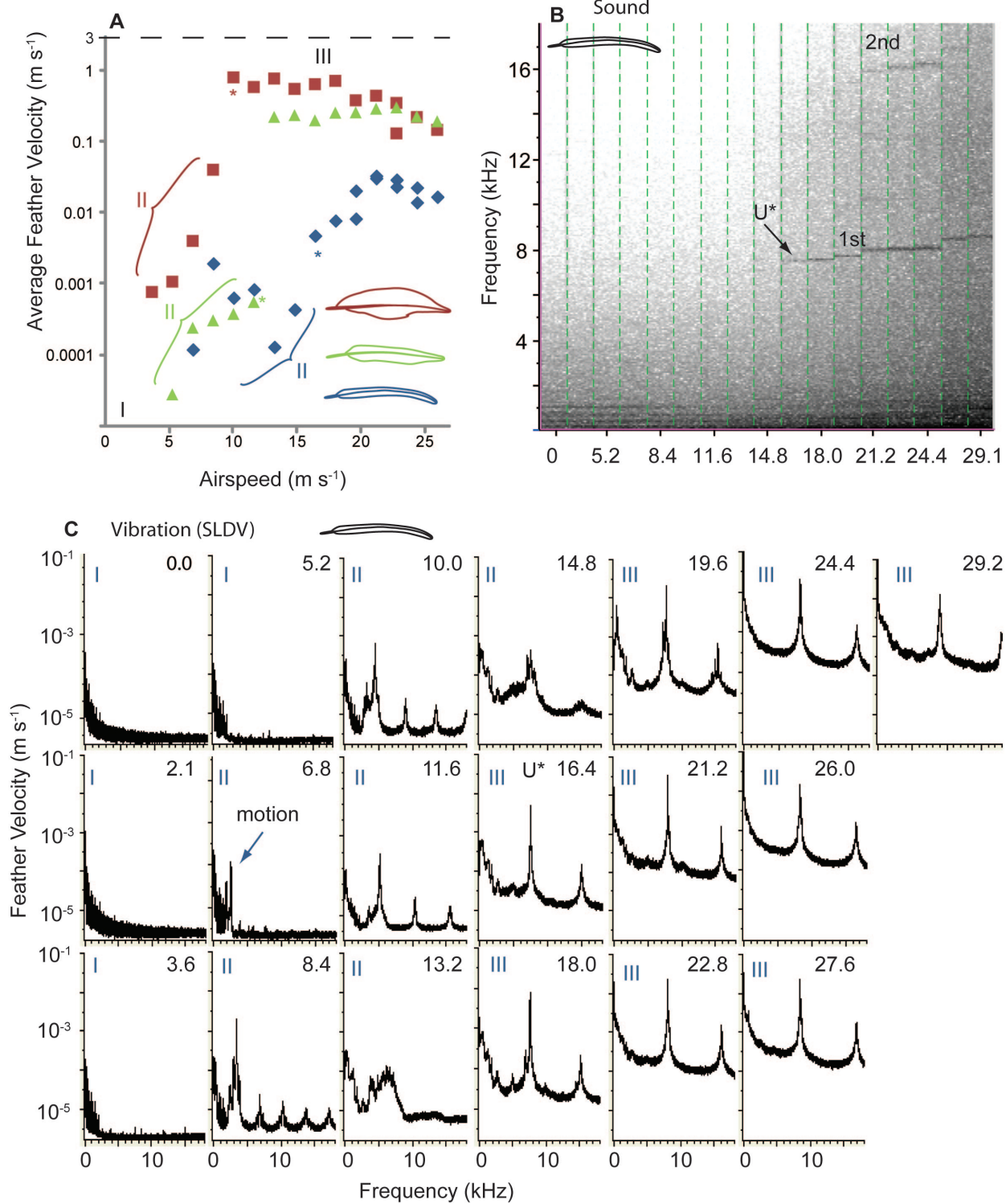


Figure S1. Waveform (above) and sound spectrograms (below) of the background sound of the wind tunnel as a function of airspeed ( $U_{air}$ ), without (left) and with (right) acoustic treatment of the wind tunnel. Sound samples separated by dashed lines. Each sample is of 5 seconds of sound, recorded at a fixed  $U_{air}$ . Without the acoustic foam, interval between samples is  $1.48 \text{ m s}^{-1}$ ; with the foam, interval is  $1.58 \text{ m s}^{-1}$ . The motor of the wind tunnel produced significant levels of sound, even with the fan off (compare ‘motor off’ sample to its neighbor); at higher  $U_{air}$ , fixtures within the tunnel created aerodynamic whistles that were individually eliminated.



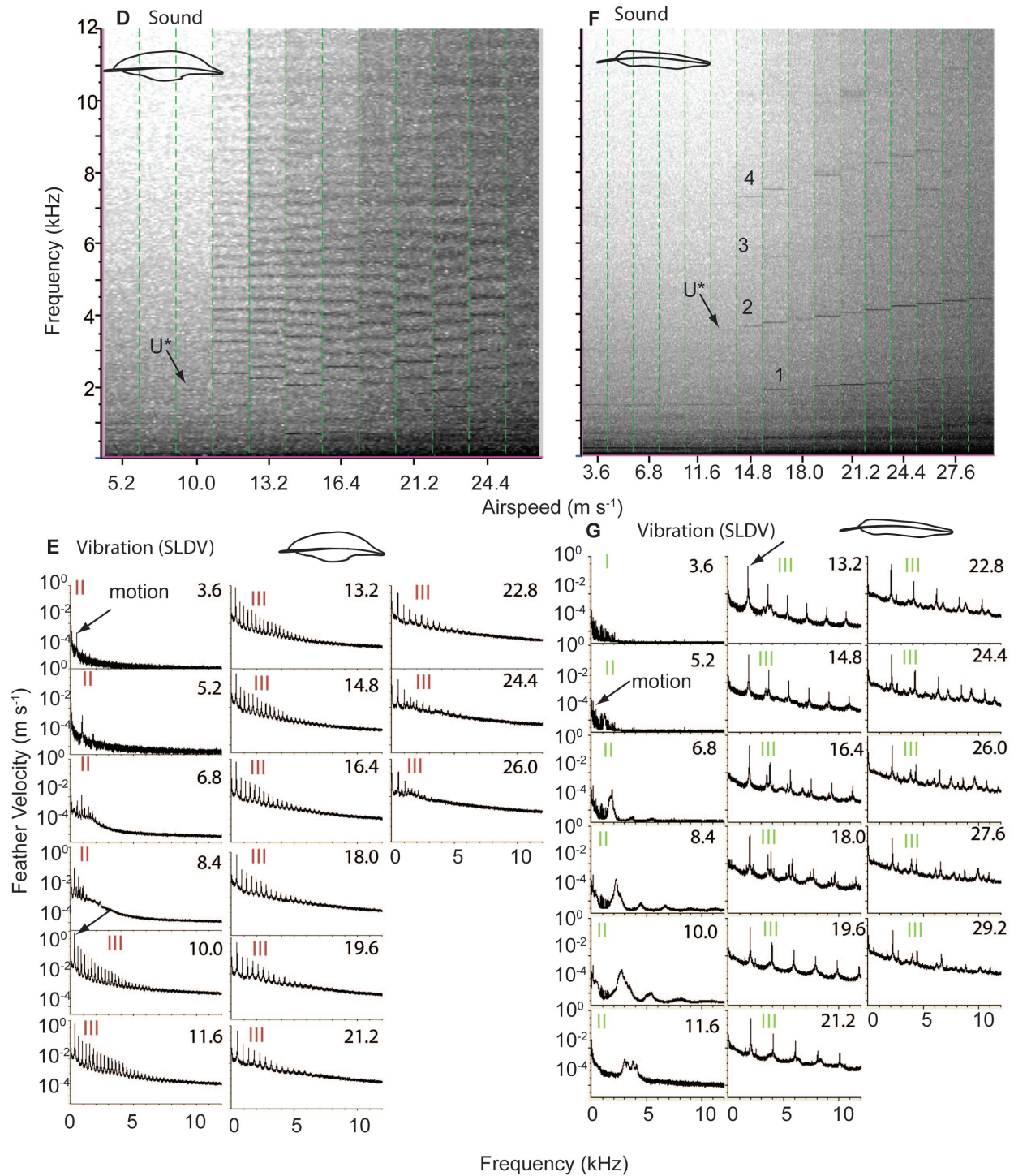


Figure S2. Sound production and flutter amplitude as a function of airspeed ( $U_{\text{air}}$ ), for the hummingbird tail-feathers Costa's R5 (blue), Broad-tailed R2 (red), and Black-chinned R5 (green). **A.** Velocity of the peak frequency of vibration as a function of airspeed. All feathers exhibited varying magnitudes of flutter that fit into three ranges. Range I: at low  $U_{\text{air}}$ , no motion

was detected (no data present). Range II: at intermediate  $U_{\text{air}}$ , small amplitude vibrations recorded, but no sound detected (brackets). \* = sound was first detected. The transition from range II to range III occurs at a critical velocity ( $U^*$ ) characterized by an abrupt increase in vibration velocity. The SLDV had a maximum velocity of  $3 \text{ m s}^{-1}$  (dashed line) that biases downward the points in range III. **B-G**. sound spectrograms from Costa's R5 (**B**), Broad-tailed R2 (**D**), and Black-chinned R5 (**F**) over a range of  $U_{\text{air}}$ , accompanied by the corresponding velocity spectra for the fluttering feather (**C**, **E**, **G**). In **B**, **D**, and **F**, spectrograms from a 5-second sample of sound are each separated by a green dashed line. The speed at which sound was first detected is indicated with an asterisk;  $f$ , fundamental frequency; numbers are harmonics. In **F**, the fundamental frequency is difficult to see against the background sound of the tunnel. Feather velocity measured by SLDV is the average value of up to  $\sim 100$  points across the feather.