Supplementary material to:

The phantom chorus: birdsong boosts human well-being in protected areas

Authors

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Contents:

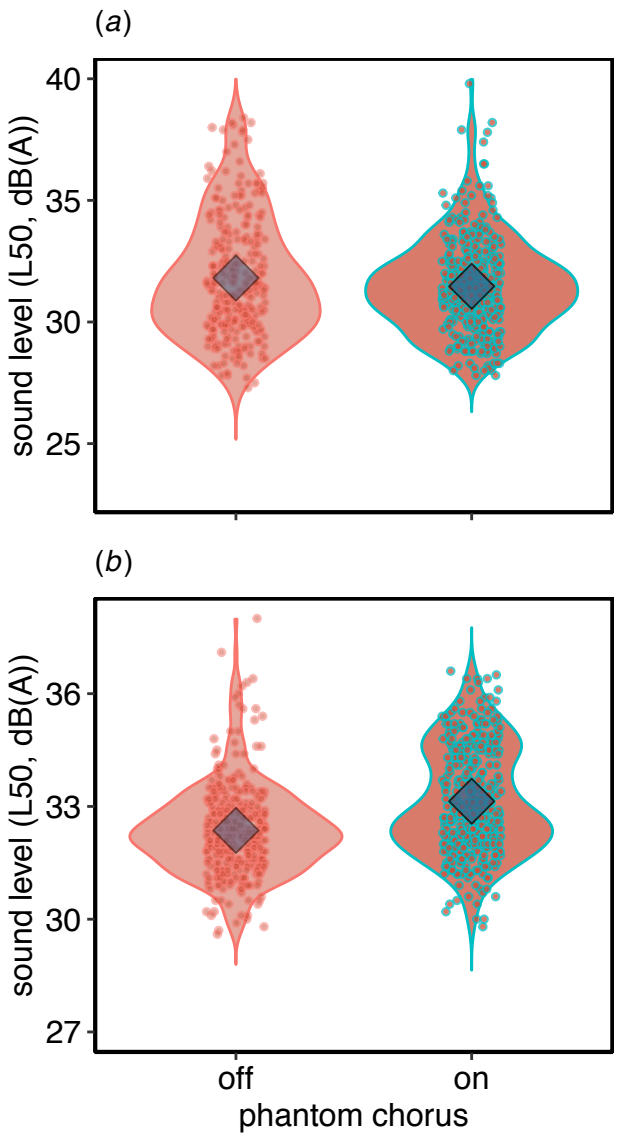

Figure S1. Hourly median sound levels as measured by L50 were significantly lower Gregory Canyon (*a*) and higher on McClintock (*b*) when the phantom chorus playback was "on" versus "off". Additionally, sound levels were higher on McClintock (*b*) than on Gregory Canyon (*a*). Violin outlines illustrate kernel probability density and diamonds denote mean sound levels. Project dates ranged from 15 July 2017 to 4 September 2017.

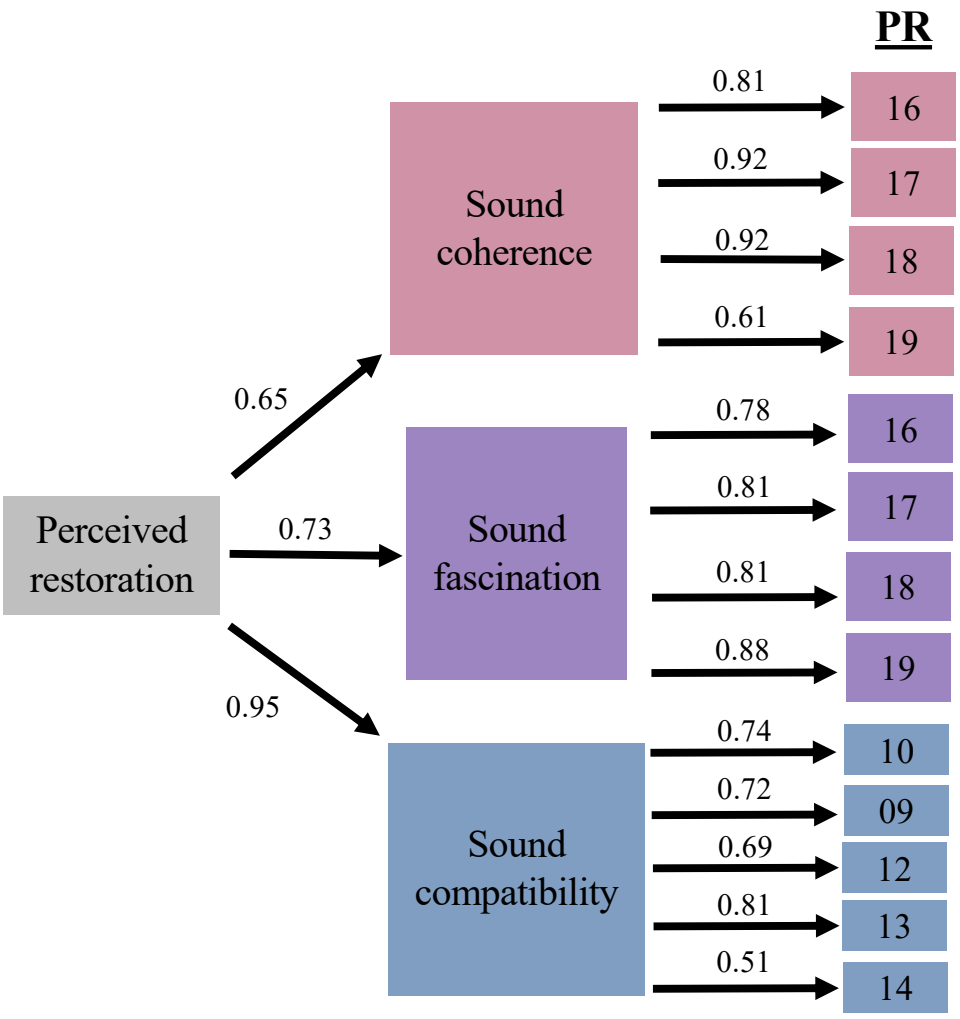

Figure S2. Second order CFA of perceived psychological restoration scale. Model fit: $\chi^2 =$ 279.419, $df = 62$, $p < 0.001$; BS_{boot}, $p = 0.002$; RMSEA = 0.073; SRMR = 0.0491; CFI = 0.958; TLI=0.947. Numbers below "PR" reflect variable codes (see table S1).

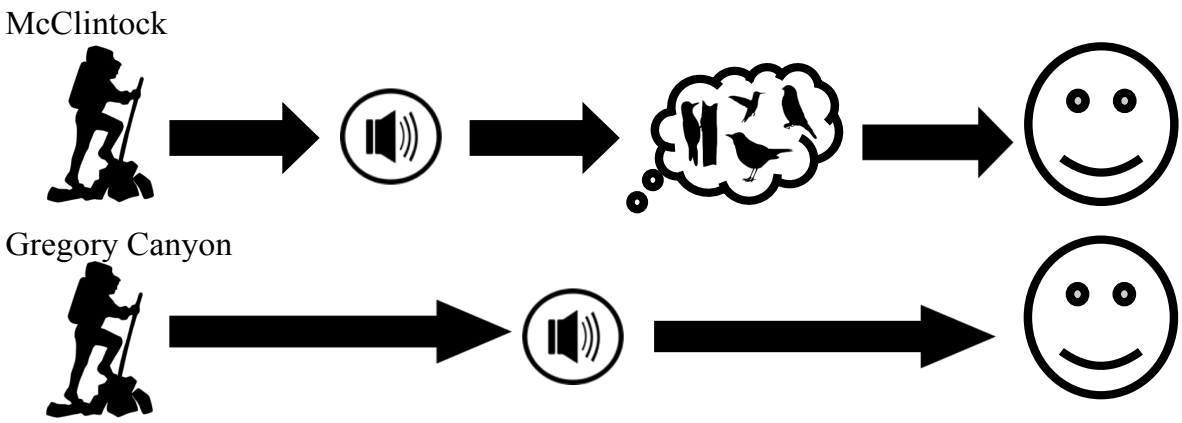

Figure S3. Conceptual figure showing the effect of the phantom chorus treatment. (*Bottom*) At the Gregory Canyon trail, hikers experienced perceived psychological benefits from the phantom chorus regardless of their perceived levels of bird species diversity. (*Top*) At the McClintock trail, hikers who perceived higher levels of bird species diversity experienced perceived psychological benefits from the phantom chorus.

Table S1. Principal components analysis for perceived soundscape restorativeness scale measures (KMO=916 , Bartlett's test of sphericity $p < 0.001$).

Component	Variable	Loading	Mean (*SD*)[†]
Sound fascination		--	--
α=0.89	PR_2: My attention is drawn to interesting sounds on the trail	0.781	5.1 *(1.42)*
	PR_3: Sounds on the trail make me want to linger	0.806	4.4 *(1.63)*
	PR_4: Sounds on the trail make me wonder about things	0.824	4.5 *(1.66)*
	PR_5: I am engrossed by the sounds I heard today	0.854	4.0 *(1.68)*
Sound compatibility		--	--
α=0.82	PR_9: The trail's acoustic environment is a refuge from unwanted distractions	0.657	5.4 *(1.41)*
	PR_10: Hearing sounds from the trail today made me feel free from work, routine, and responsibilities	0.632	5.6 *(1.38)*
	PR_12: Sounds on the trail today relate to activities I like to do	0.698	5.4 *(1.38)*
	PR_13: The trail's acoustic environment fits with my personal preferences	0.723	5.6 *(1.18)*
	PR_14: I rapidly get used to hearing the trail's acoustic environment	0.651	5.3 *(1.31)*
Sound coherence		--	--
α=0.88	PR_16: All the sounds I heard on the trail today belong here	0.780	5.0 *(1.56)*
	PR_17: All the sounds merge to form a coherent acoustic environment	0.791	5.1 *(1.48)*
	PR_18: The sounds I heard seem to fit together quite naturally with this area	0.795	5.3 *(1.44)*
	PR_19: The acoustic environment suggests the size of this area is limitless	0.453	4.8 *(1.65)*
Items removed from further analyses			
	The sounds I heard on the trail today are appealing	--	5.4 *(1.27)*
	I hear sounds I heard on the trail when I am doing something different than what I usually do	--	4.7 *(1.67)*
	Listening to sounds on the trail today gave me a break from my day-to-day listening experiences	--	5.4 *(1.41)*
	Hearings sounds heard on the trail today hinders what I would want to do in this place[‡]	--	4.2 *(1.60)*
	The trail's acoustic environment is different from what I usually hear in my daily life	--	5.7 *(1.46)*

[†]Items were measured on a 7-point scale, where 1=not at all and 7=completely; [‡]Item was reverse coded

Table S2. Linear model output for species richness added by phantom chorus.

Fixed effects	**Estimate**	**SE**	***t***	***p***
Intercept	12.550	0.752	16.694	< 0.001
Count method†	5.900	0.868	6.797	< 0.001
Trail (McClintock)	-2.300	0.868	-2.650	0.017

† Detected species vs. detected species plus additional unique species from playback

Table S3. Linear mixed model output for hourly ambient sound levels (L50, A-weighted decibels). Reference state is McClintock Trail when the phantom chorus was "off".

Fixed effects	**Estimate**	**SE**	***t***	***p***
Intercept	32.900	0.358	89.892	< 0.001
Treatment (On)	0.699	0.118	5.932	< 0.001
Trail (Gregory)	-0.750	0.501	-1.498	0.164
Date	0.008	0.003	2.639	0.008
Treatment:Trail	-0.965	0.177	-5.449	< 0.001

Table S4. Sample characteristics.

Variable	Categories	Gregory Canyon[†]	McClintock[‡]	Both sites combined[§]	OSMP summer[|]
Age (in years of age)	16-19[¶]	3%	2%	2%	3%
	20-29	37%	20%	29%	15%
	30-39	24%	26%	20%	15%
	40-49	15%	22%	18%	20%
	50-59	14%	21%	17%	21%
	60-69	6%	13%	9%	16%
	70+	2%	7%	4%	6%
	Median age	32	46	39	47
Gender identity	Female	49%	61%	55%	49%
	Male	51%	38%	45%	50%
	Other	1%	1%	1%	1%
Education[#]	Some high school	<1%	1%	<1%	3%
	High school diploma	2%	2%	2%	4%
	Some college	11%	10%	11%	9%
	Associate	5%	4%	5%	4%
	Bachelors	36%	30%	36%	33%
	Graduate/professional	39%	45%	39%	36%
	Ph.D.	8%	8%	8%	11%
Primary residence	Boulder city limits	31%	27%	29%	50%
	Other Boulder County city	14%	11%	12%	29%
	Metro Denver	21%	14%	18%	9%
	Other Colorado	5%	4%	5%	4%
	Other US State	25%	41%	32%	7%
	Other country	3%	5%	4%	2%
Group size	1	28%	18%	23%	49%
	2	53%	52%	53%	39%
	3 to 4	18%	21%	19%	8%
	5+	2%	9%	5%	5%

[†]n=354; [‡]n=311; [§]Represents all respondents intercepted in this study, n=665; [|]Data from VanderWoude and Kellogg (2018), n=624; [¶]Only people 18 years of age and older were included in Gregory and McClintock samples; [#]High level of education achieved.