

The following supplement accompanies the article

# Linking at-sea mortality of a pelagic shearwater to breeding colonies of origin using biogeochemical markers

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## Supplement

Table S1. Summary of secondary isotopic reference materials (SIRMs) used to calibrate unknowns and measure instrument precision. Accepted values and overall values among all runs are presented as mean  $\pm$  SD (n = number of duplicates). Within runs, data are presented as the range of SDs (n = number of runs where the SIRM was run more than once)

SIRM	Accepted value (‰) (mean $\pm$ SD)		Within runs (‰) (range of SDs)			Overall among runs (‰) (mean $\pm$ SD)		
	$\delta^{13}\text{C}$	$\delta^{15}\text{N}$	$\delta^{13}\text{C}$	$\delta^{15}\text{N}$	n	$\delta^{13}\text{C}$	$\delta^{15}\text{N}$	n
IAEA-CH6	-10.45 $\pm$ 0.13	–	0.07–0.23	–	8	-10.45 $\pm$ 0.18	–	30
IAEA-N1	–	+0.43 $\pm$ 0.07	0.03–0.26	–	9	–	+0.45 $\pm$ 0.11	34
IAEA-N2	–	+20.32 $\pm$ 0.09	0.02–0.19	–	9	–	+20.32 $\pm$ 0.10	34
MUN CO <sub>2</sub> (calcium carbonate)	-40.11 $\pm$ 0.15	–	0.08–0.27	–	8	-40.11 $\pm$ 0.14	–	33
USGS 24	-16.05 $\pm$ 0.11	–	0.03–0.37	–	8	-15.95 $\pm$ 0.19	–	26
USGS 25	–	-30.25 $\pm$ 0.38	0.01–0.22	–	9	–	-30.25 $\pm$ 0.11	41

Table S2. *Puffinus carneipes*. Because metal concentrations in feathers can be variable within individuals, we analysed 2 feathers per individual, and ran 12% of individuals in duplicate. Values: relative SD of duplicate analyses

<b>Element</b>	<b>Relative SD</b>
Al	8.871
V	0.346
Mn	0.158
Co	0.120
Ni	1.124
Cu	0.865
Zn	2.638
Mo	0.188
Ag	0.048
Cd	0.127
Sb	0.025
Ba	1.853
Tl	0.002
Pb	0.400
U	0.010

Table S3. *Puffinus carneipes*. High recovery of 2 keratin-based reference materials was achieved using inductively coupled plasma mass spectrometry (ICP-MS) to measure trace element concentrations in Flesh-footed Shearwater feathers. Data are presented as the mean  $\pm$  SD % recovery relative to the mean certified concentration in  $\mu\text{g g}^{-1}$  (ppm). CV = (SD  $\div$  mean)  $\times$  100

Reference material (n)	Element	Certified concentration	Measured concentration $\pm$ SD	CV	Mean % recovery	
6H-09 (8)	Al	33	33 $\pm$ 5	13.92	100	
	V	2.61	2.35 $\pm$ 0.29	12.26	90	
	Cr	1.24	1.54 $\pm$ 0.30	19.38	124	
	Mn	0.93	1.13 $\pm$ 0.14	12.10	121	
	Co	0.476	0.410 $\pm$ 0.139	33.85	86	
	Ni	2.67	3.44 $\pm$ 0.57	16.65	129	
	Cu	107	112 $\pm$ 3	2.26	106	
	Zn	101	116 $\pm$ 5	4.39	114	
	As	0.19	0.224 $\pm$ 0.04	16.86	118	
	Mo	26	28 $\pm$ 1	3.50	109	
	Ag	0.77	0.87 $\pm$ 0.05	5.67	113	
	Cd	0.24	0.24 $\pm$ 0.05	21.29	100	
	Sb	0.205	0.243 $\pm$ 0.030	12.21	119	
	Ba	1.48	1.77 $\pm$ 0.25	14.19	119	
	Hg	4.49	4.58 $\pm$ 1.81	39.48	102	
	Tl	0.45	0.46 $\pm$ 0.02	4.43	102	
	Pb	14.8	14.9 $\pm$ 0.7	4.84	100	
	U	0.022	0.024 $\pm$ 0.003	10.45	109	
	7H-09 (8)	Al	159	158 $\pm$ 7	4.35	100
		V	0.346	0.294 $\pm$ 0.112	38.22	85
Cr		8.6	8.4 $\pm$ 0.6	6.77	97	
Mn		5.64	6.26 $\pm$ 0.25	4.06	111	
Co		6.12	6.60 $\pm$ 0.27	4.08	108	
Ni		6.6	7.4 $\pm$ 0.6	7.90	112	
Cu		132	139 $\pm$ 4	2.61	105	
Zn		179	189 $\pm$ 5	2.74	106	
As		2.64	2.66 $\pm$ 0.13	4.70	101	
Mo		0.473	0.599 $\pm$ 0.063	10.47	127	
Ag		1.67	1.90 $\pm$ 0.10	5.33	114	
Cd		1.7	1.9 $\pm$ 0.1	6.62	109	
Sb		1.54	1.70 $\pm$ 0.13	7.49	110	
Ba		13.7	14.4 $\pm$ 0.6	4.00	105	
Hg		3.78	3.38 $\pm$ 1.28	37.84	89	
Tl		0.175	0.182 $\pm$ 0.016	8.53	104	
Pb		5.28	5.92 $\pm$ 0.75	12.72	112	
U		1.73	1.86 $\pm$ 0.11	5.63	108	

Fig S1. *Puffinus carneipes*. Log-transformed trace element and stable isotope values for known provenance Flesh-footed Shearwaters showing the degree of overlap of group assignments at the colony scale resolution. Bar: median; box: 25th to 75th percentiles; whiskers: 5th to 95th percentiles; circles: outliers

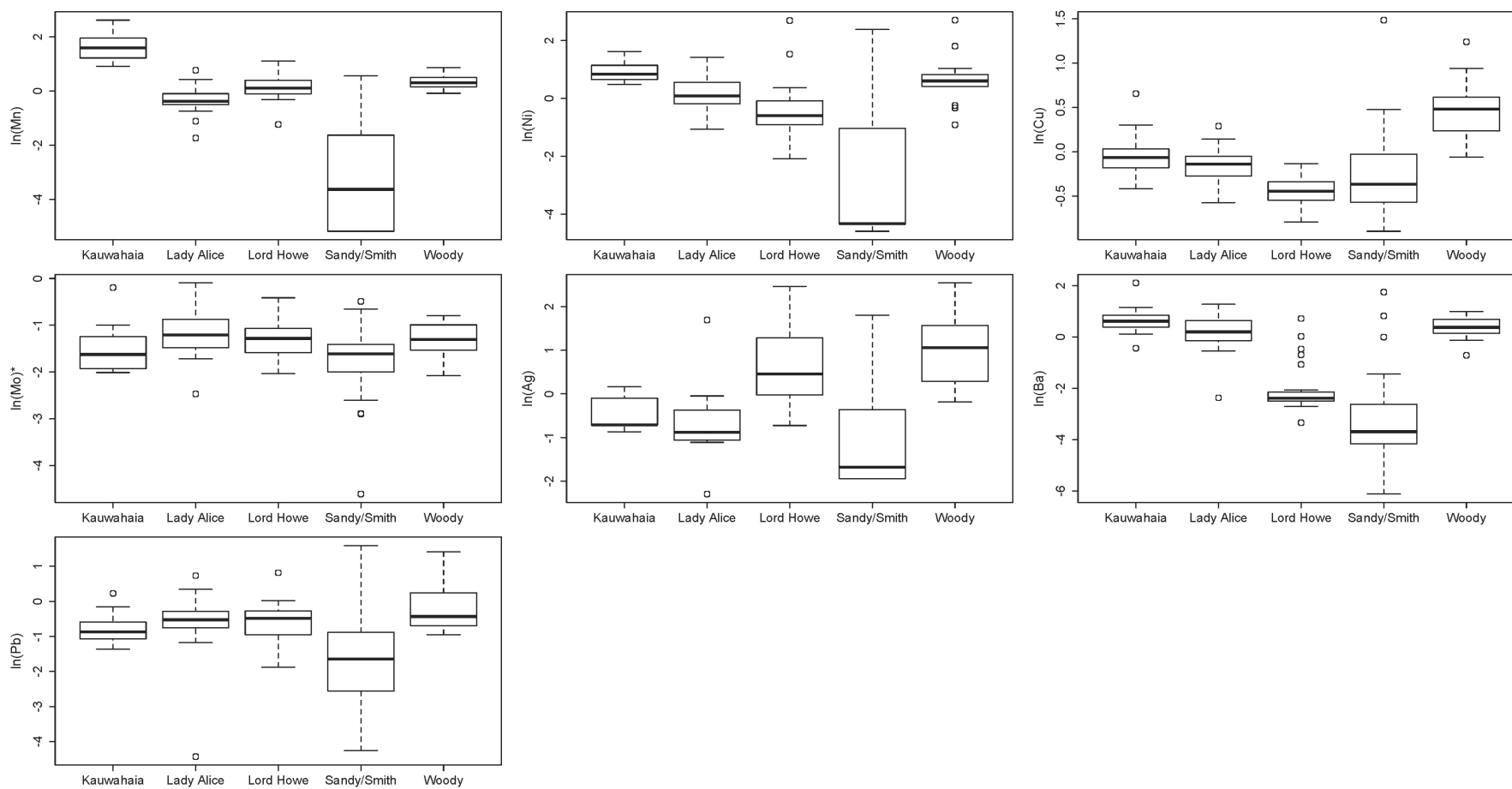


Table S4. *Puffinus carneipes*. We used the residuals from linear regressions for each log-transformed trace element and stable isotope value against year of collection (1936–2011) to account for temporal variability in trace element concentrations and stable isotope values in Flesh-footed Shearwater feathers. Results = slope ( $\beta$ )  $\pm$  SE, with  $r^2$  and p-values

<b>Element/isotope</b>	<b><math>\beta \pm SE</math></b>	<b><math>r^2</math></b>	<b>p</b>
Al	$-0.013 \pm 0.006$	0.015	0.042
Mn	$-0.008 \pm 0.003$	0.016	0.039
Ni	$-0.008 \pm 0.003$	0.020	0.021
Cu	$-0.004 \pm 0.001$	0.0539	<0.001
Zn	$-0.001 \pm 0.001$	0.003	0.358
Mo	$0.001 \pm 0.001$	0.002	0.415
Ag	$-0.012 \pm 0.002$	0.055	<0.001
Ba	$-0.025 \pm 0.004$	0.117	<0.001
Pb	$-0.029 \pm 0.003$	0.206	<0.001
U	$0.002 \pm 0.001$	0.004	0.297
$\delta^{13}\text{C}$	$-0.001 \pm 0.001$	0.071	<0.001
$\delta^{15}\text{N}$	$-0.002 \pm 0.001$	0.048	<0.001