The following supplement accompanies the article

Contrasting whisker growth dynamics within the phocid lineage

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Text S1. Additional description of methodology

Photogrammetric measurements of each whisker were determined using Image J software (https://imagej.nih.gov/ij/). We analyzed two photographs per whisker bed, which resulted in between 0 and 2 measurements per whisker for each session depending on the visibility of the whisker base and tip. Sadou et al. (2014) reported that photogrammetric measurements of post-mortem seals were within 1 mm of the actual length assuming standardized geometric relationships between the camera and whisker bed. Our data generally supported the reliability of this method, but measurement accuracy appeared dependent on the positioning of the whisker with respect to the camera (Fig. 1), and absolute differences between the two methods were smallest when the whisker was shorter. Photogrammetry was an ineffective method for the bearded seals because the large number of whiskers and their length and proximity on the whisker bed made it difficult to discern the base and tip of all but a few whiskers in photographs. We were able to obtain direct measurements easily from the bearded and monk seal because they displayed no aversion to having their whiskers handled. The ringed seal tolerated direct measurement but was more sensitive to whisker handling; her whiskers were also shorter, slender, and transparent, making it difficult to obtain accurate measurements for all but the longest whiskers. As a result, we opted to use the photogrammetric measurements in all further analyses for the ringed seal, and the direct measurements of whisker length for the bearded and monk seals.

We used exploratory plots of whisker length vs. time to determine the most appropriate analysis of whisker growth rates for each species. A von Bertalanffy growth function was used to describe growth of the ringed seal whiskers

$$L_t = L_\infty \cdot (1 - e^{-K(t-t_0)})$$

where the length of a single whisker at time *t* can be predicted from the asymptotic length (L_∞), a curvature constant (*K*) that describes how quickly a whisker reaches L_∞, and the time of initial growth (t_0). We used the growth model described in Beltran et al. (2015), which accepts multiple measurements per follicle (per timestep) and accounts for sequential shedding events from a single follicle to estimate these parameters and the retention time (lifespan) of each whisker. As described in McHuron et al. (2016), this model underestimated *K* when whisker lengths decreased due to breakage or measurement error that resulted in consistent underestimation of whisker lengths. For the ten whiskers where this occurred, we identified this transition point using length vs. time plots and excluded the measurements from each whisker that occurred after the transition, which always occurred after the whisker entered the non-linear phase of growth. We did calculate a linear growth rate for each whisker using all whisker measurements that occurred following loss that were less than 75% of the estimated asymptotic length. Growth rates were calculated from consecutive measurements; these were averaged to provide one measurement per whisker shedding cycle and then further averaged across multiple shedding cycles (when applicable). The growth of both the bearded and monk seal whiskers was non-linear but did not appear to include a resting phase of limited or no growth. For these species, we calculated growth rates of consecutive measurements as the length difference divided by the time difference, differentiating growth rates that occurred within the first 100 days of regrowth following loss from those that occurred prior to loss (or were never lost) or after the first 100 days. We excluded negative growth rates from these calculations, as they reflect wear, breakage, or measurement error and not actual growth. For all seals, a whisker length of zero was only assigned once at the first observation of loss (when applicable) to avoid artificially inflated growth rates if the whisker took more than one week to remerge.

A loss date was assigned to each shedding event using data from visual observations; whiskers that were present in one week and missing the following week were assumed to be lost on the day of observation of the empty follicle. The ringed seal frequently lost whiskers between two sampling events, where the old whisker was present at the first sampling event and a newly emerged whisker was present at the next sampling event. For these cases, we assigned a loss data that was one day after the first sampling event.

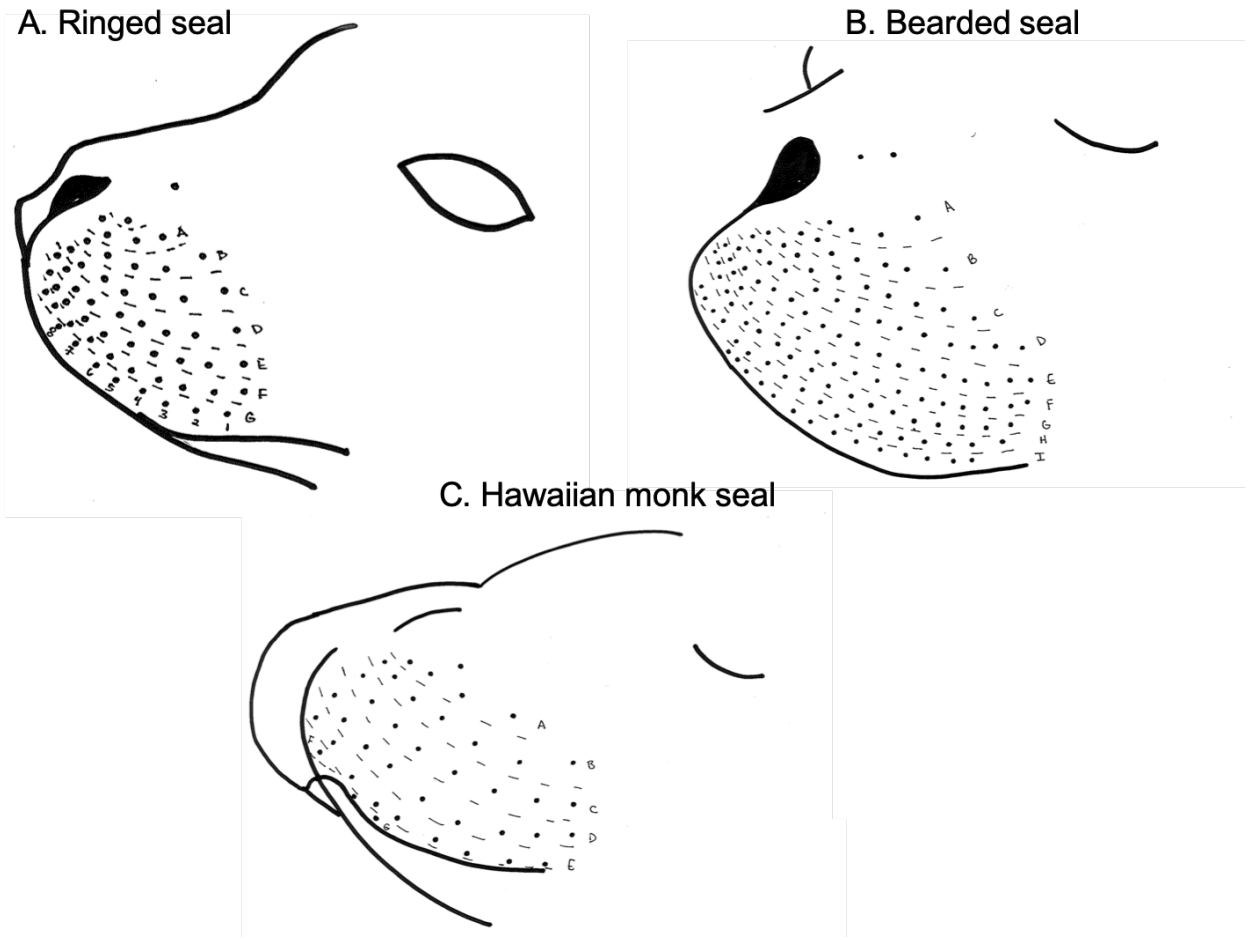

Figure S1. Example of whisker bed maps for each species used to measure whiskers and identify the position of lost or newly emerged whiskers. Rows are designated by letters, whereas columns are designated by numbers.

Table S1. Whisker growth dynamics and estimated asymptotic length for individual ringed seal whiskers. Note that the number of whiskers with output from the growth model differs slightly from the number of measured whiskers in Table 1 because not all whiskers had sufficient measurements to run the growth model.

Whisker	K (d^{-1})	Growth rate (cm day^{-1})	Asymptotic length (cm)	
			1st	2nd
LB1	0.059	0.09	3.3	2.8
LC1	0.022	0.06	5.4	4.7
LC2	0.046	0.07	3.0	3.2
LC3	0.093	0.11	2.3	2.2
LD1	0.024	0.09	7.0	7.5
LD2	0.032	0.08	4.9	5.4
LD3	0.039	0.08	3.7	3.5
LD4	0.097	0.15	2.7	2.8
LE1	0.018	0.08	8.7	8.8
LE2	0.026	0.09	6.4	6.7
LE3	0.033	0.10	5.0	5.2
LE4	0.047	0.10	4.0	4.3
LE5	0.073	0.13	3.1	3.2
LE6	0.054	0.07	2.5	2.9
LF1	0.021	0.09	8.7	8.7
LF2	0.024	0.10	7.5	7.7
LF3	0.028	0.09	6.1	6.0
LF4	0.041	0.11	4.8	5.1
LF6	0.042	0.08	3.5	3.6
LF7	0.045	0.07	2.7	2.6
LG1	0.021	0.09	7.9	8.2
LG2	0.024	0.09	6.8	6.9
LG3	0.025	0.08	5.7	5.8
LG4	0.030	0.08	4.5	4.8
LG5	0.041	0.08	3.3	3.5
RB1	0.034	0.06	3.4	3.1
RB3	0.072	0.04	1.1	1.0
RC1	0.025	0.06	5.2	4.7
RC2	0.032	0.06	3.2	3.1
RC3	0.099	0.10	2.0	2.0
RC4	0.088	0.07	1.6	1.7

RD1	0.020	0.07	7.1	7.0
RD2	0.032	0.08	4.8	4.7
RD3	0.033	0.06	3.9	3.7
RE1	0.019	0.09	8.6	8.4
RE2	0.032	0.11	6.2	6.3
RE3	0.056	0.13	4.6	4.6
RE4	0.049	0.11	3.9	4.1
RE5	0.063	0.12	3.1	3.4
RE6	0.091	0.13	2.5	2.6
RF1	0.019	0.09	8.8	8.9
RF2	0.023	0.09	7.7	7.6
RF3	0.029	0.10	6.2	6.3
RF4	0.032	0.09	5.0	4.9
RF5	0.046	0.10	3.9	4.1
RF6	0.049	0.08	3.5	3.1
RG1	0.021	0.09	7.9	8.0
RG2	0.021	0.08	7.1	7.2
RG3	0.026	0.08	5.5	5.5
RG4	0.036	0.09	4.6	4.8
RG5	0.041	0.08	3.4	3.5

Table S2. Mean whisker growth rates of the bearded and Hawaiian monk seals during the initial 100 days of regrowth following natural loss and all other time periods. Bolded whiskers are those where measurements were collected throughout the entire study interval; data collection for all other whiskers began at initiation of regrowth following loss. Maximum measured whisker lengths are also shown. Note that the number of whiskers with growth rates may be less than the number of whiskers measured as shown in Table 1 because not all whiskers had sufficient measurements to calculate robust growth rates.

Seal	Whisker	Growth rates (cm day^{-1})		Max. length (cm)
		Initial regrowth	All other	
Bearded seal 1	LB1	0.06	0.07	4.3
Bearded seal 1	**LC1**	NA	0.03	12.0
Bearded seal 1	**LD1**	0.08	0.04	16.8
Bearded seal 1	**LE1**	0.11	0.03	22.0
Bearded seal 1	**LF1**	0.11	0.05	21.9
Bearded seal 1	LG1	0.10	0.05	13.2
Bearded seal 1	LG11	0.03	0.03	3.0
Bearded seal 1	RB1	0.06	NA	3.2
Bearded seal 1	**RC1**	0.07	0.02	13.5
Bearded seal 1	**RD1**	0.09	0.04	17.8
Bearded seal 1	RD2	0.10	NA	6.1
Bearded seal 1	**RE1**	0.09	0.04	21.0
Bearded seal 1	RE2	0.10	NA	4.5
Bearded seal 1	RE3	0.03	0.05	9.0
Bearded seal 1	**RF1**	0.11	0.04	22.2
Bearded seal 1	RG1	0.09	0.04	12.5
Bearded seal 1	RI1	0.12	NA	3.5
Bearded seal 2	LB1	0.07	NA	3.7
Bearded seal 2	LE1	NA	0.06	13.5
Bearded seal 2	RB1	0.05	NA	1.0
Bearded seal 2	RC1	NA	0.02	11.0
Bearded seal 2	RC2	0.14	NA	2.8
Bearded seal 2	RH2	0.15	NA	6.5
Hawaiian monk seal	**LB1**	0.08	0.05	15.0
Hawaiian monk seal	**LC1**	0.09	0.05	20.0
Hawaiian monk seal	**LD1**	0.09	0.05	22.1
Hawaiian monk seal	LE2	0.08	0.04	7.5
Hawaiian monk seal	LE3	0.08	0.05	17.6

Hawaiian monk seal	RA3	0.03	0.02	2.6
Hawaiian monk seal	**RB1**	0.07	0.04	17.0
Hawaiian monk seal	RB2	0.07	0.05	7.8
Hawaiian monk seal	RB3	0.05	0.04	10.2
Hawaiian monk seal	RB4	0.05	0.04	8.9
Hawaiian monk seal	RB5	0.03	0.03	4.0
Hawaiian monk seal	**RC1**	0.08	0.06	16.5
Hawaiian monk seal	**RD1**	0.05	0.07	17.1
Hawaiian monk seal	RD2	0.10	0.07	14.5
Hawaiian monk seal	RD3	0.09	0.05	19.0
Hawaiian monk seal	RD6	0.07	NA	4.1
Hawaiian monk seal	RD7	0.05	NA	4.0
Hawaiian monk seal	RE1	0.07	0.07	16.5
Hawaiian monk seal	RE3	0.08	0.06	16.0
Hawaiian monk seal	RE4	0.08	0.05	13.3
Hawaiian monk seal	RE7	0.05	NA	1.9

Table S3. Sources for phocid whisker morphology and growth dynamics data presented in Fig. 3 in the main text. Dashes represent data gaps.

Species	Morphology	Growth dynamics
Monachinae		
Leopard seal[a]	King 1983	Rogers et al. 2016
Weddell seal	Ginter Summarell et al. 2015	-
Ross seal	King 1969, N. Lübcker pers. comm.	-
Crabeater seal	King 1983, L. Hückstädt pers. comm.	-
S. elephant seal	Ling 1966	Lübcker et al. 2016
N elephant seal	Murphy et al. 2013	Beltran et al. 2015, McHuron et al. 2019
M. monk seal[b]	King 1956	-
H. monk seal[b]	King & Harrison 1961	This study
Phocinae		
Spotted seal	Ginter et al. 2012	McHuron et al. 2016
Harbor seal	Ginter et al. 2012, Murphy et al. 2013	Zhao & Schell 2004, Smith et al. 2018, C. Reichmuth unpubl. data
Baikal seal[a]	King 1983	-
Ringed seal	Ginter et al. 2012	This study
Caspian seal	Ognev 1935	-
Gray seal	Ognev 1935, Ginter et al. 2010	Greaves et al. 2004
Ribbon seal[a]	King 1983	-
Harp seal	Ognev 1935, Ginter et al. 2010	-
Hooded seal	Ginter et al. 2010	-
Bearded seal	Ognev 1935, Ginter et al. 2010	This study

[a] Whisker morphology assumed based on statements in King (1993) due to lack of species-specific description
[b] Allen (1890) noted that the now extinct Caribbean monk seal also had smooth whiskers

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