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Supplementary Material

Age and growth of the endangered Maugean skate (*Zearaja maugeana*) by using microchemical analysis

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Table S1. Element list included in laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) ablation analysis and mean detection limits calculated in parts per million (ppm) based on Longerich *et al.* (1996).

Element	Detection limit (ppm)
^{7}Li	0.293
^{23}Na	6.41
^{24}Mg	0.157
^{27}Al	0.112
^{29}Si	37.5
^{39}K	1.81
^{43}Ca	10.9
^{44}Ca	8.02
^{55}Mn	0.137
^{56}Fe	1.42
^{66}Zn	0.117
^{75}As	0.239
^{85}Rb	0.019
^{88}Sr	0.005
^{111}Cd	0.024
^{115}In	0.000307
^{137}Ba	0.000743
^{202}Hg	0.047383
^{208}Pb	0.004989
^{232}Th	0.000189
^{238}U	0.000121

Table S2. Growth parameters of female Maugean skate (*Zearaja maugeana*) aged using vertebrae.

Model		Rank	Model fit				L_∞ (mm)	s.e.(±)	L_0 (mm)	s.e.(±)	k (y^{-1})	s.e.(±)	φ4	s.e.(±)	Longevity	
			RSE	AICc	Δ_i	w_i									t_{max}	t_{maxth}
M2	VBGM, L_0 = 103.50	1	45.28	308.33	0.00	58.16	843.53	35.76	103.50		0.27	0.04			10	12.84
M5	TPVB hyper-*k*	2	44.33	310.51	2.19	19.48	809.45	28.38	102.26	27.57	0.36	0.07	0.26	0.13		9.63
M1	VBGM	3	46.11	310.99	2.67	15.32	845.06	36.05	109.49	31.52	0.26	0.04				13.33
M6	TPVB log-L_∞	4	46.96	313.86	5.53	3.66	837.22	67.08	109.68	29.24	0.27	0.05	845.21	45.17		12.84
M3	Gompertz	5	48.79	314.27	5.94	2.98	804.21	23.86	131.60	23.45	0.43	0.05				8.06
M4	Logistic	6	52.25	318.25	9.92	0.41	788.36	20.16	156.48	29.28	0.58	0.07				5.98
Model- averaged							835.58	35.10	110.41	15.32	0.29	0.05			10	12.12

Models fitted to observed data (n = 44). Models 1–6 (Table 3) ranked based on performance using the corrected Akaike information criteria (AIC_c) and Akaike weights (w_i). Parameter estimates and standard error for 2, 3 and 4 parameter models are provided. Model averaged results were calculated as a weighted mean based on w_i. RSE, residual standard error; s.e., standard error for the parameter estimates; $\varphi 4$, additional parameter for bi-phasic models. $M5 = h$, $M6 = L_{\infty 2}$. In model 3, $t_0 = 1.38 \pm 0.22$. In model 5, the growth coefficient (k) is modified by h at a scale derived by A. A is a derivative of time around the inflection point at time of maturity. Therefore at L_{50}, At = 1 and growth = $k*h$. In model 6 the phase specific values of L_∞ were used to estimate the growth rate at t_0, L_{50} and t_{95}. Longevity: t_{max}, observed oldest individual (based on visual banding estimates); t_{maxth}, theoretical longevity (Fabens 1965) ($5\ln(2)/k$)

Table S3. Growth parameters of male Maugean skate (*Zearaja maugeana*) aged using vertebrae.

Model		Rank	Model fit				L_∞ (mm)	s.e.(±)	L_0 (mm)	s.e.(±)	k (y^{-1})	s.e.(±)	φ4	s.e.(±)	Longevity	
			RSE	AICc	Δ_i	w_i									t_{max}	t_{maxth}
M2	VBGM, L_0 = 103.50	1	33.18	192.48	0.00	62.16	747.47	33.25	103.50	0.00	0.32	0.05			10	10.83
M1	VBGM	2	34.06	195.58	3.10	13.18	746.36	31.83	103.28	22.08	0.33	0.05				10.50
M3	Gompertz	3	34.19	195.72	3.25	12.27	716.67	20.04	105.54	20.38	0.52	0.06				6.66
M4	Logistic	4	35.03	196.65	4.18	7.71	697.88	15.61	107.50	22.22	0.78	0.08				4.44
M6	TPVB log-L_∞	5	34.85	198.99	6.51	2.40	724.88	56.96	103.56	21.32	0.36	0.12	738.33	37.06		9.63
M5	TPVB hyper-*S*	6	34.95	199.10	6.61	2.28	751.33	35.29	103.73	20.56	0.30	0.06	-0.09	0.19		11.55
Model-averaged							739.27	30.70	109.32	10.43	0.38	0.06			10	9.78

Models fitted to observed data (n = 44). Models 1 - 6 (Table 3) ranked based on performance using the corrected Akaike information criteria (AIC_c) and Akaike weights (w_i). Parameter estimates and standard error for 2, 3 and 4 parameter models are provided. Model averaged results were calculated as a weighted mean based on w_i.RSE, residual standard error; s.e., standard error for the parameter estimates; φ4, additional parameter for bi-phasic models. M5 = h, M6 = $L_{\infty 2}$. In model 3, t_0 = 1.25 ± 0.19. In model 5, the growth coefficient (k) is modified by h at a scale derived by A. A is a derivative of time around the inflection point at time of maturity. Therefore at L_{50}, At = 1 and growth = $k*h$. In model 6 the phase specific values of L_∞ were used to estimate the growth rate at t_0, L_{50} and t_{95}. Longevity: t_{max}, observed oldest individual (based on visual banding estimates); t_{maxth}, theoretical longevity (Fabens, 1965) (5ln(2)/k)

Table S4. Growth parameters of pooled female and male Maugean skate (*Zearaja maugeana*) aged using vertebrae.

Model		Rank	Model fit				L_∞ (mm)	s.e.(±)	L_0 (mm)	s.e.(±)	k (y^{-1})	s.e.(±)	φ4	s.e.(±)	Longevity	
			RSE	AICc	Δ_i	w_i									t_{max}	t_{maxth}
M2	VBGM, L_0 = 103.50	1	44.65	505.42	0.00	62.58	836.34	31.83	103.50	0.00	0.25	0.03			10	13.86
M1	VBGM	2	45.13	507.76	2.35	19.36	835.17	30.70	107.75	21.07	0.26	0 .03				13.33
M5	TPVB hyper-*k*	3	45.03	508.98	3.56	10.53	819.83	28.32	105.11	20.56	0.29	0.04	0.12	0.10		11.95
M6	TPVB log-L_∞	4	45.63	510.25	4.83	5.59	834.53	56.24	107.81	22.68	0.26	0.04	837.39	39.60		13.33
M3	Gompertz	5	47.39	512.45	7.03	1.86	788.32	20.21	123.03	17.21	0.43	0.04				8.06
M4	Logistic	6	50.61	518.77	13.35	0.08	767.73	16.65	141.93	19.79	0.61	0.05				5.68
Model- averaged							833.33	32.38	110.45	13.92	0.26	0.03			10	13.41

Models fitted to observed data (n = 44). Models 1 - 6 (Table 3) ranked based on performance using the corrected Akaike information criteria (AIC_c) and Akaike weights (w_i). Parameter estimates and standard error for 2, 3 and 4 parameter models are provided. Model averaged results were calculated as a weighted mean based on w_i. RSE, residual standard error; s.e., standard error for the parameter estimates; *φ4*= additional parameter for bi-phasic models. *M5 = h*, *M6* = $L_{\infty 2}$. In model 3, t_0 = 1.44 ± 0.17. In model 5, the growth coefficient (k) is modified by h at a scale derived by A. A is a derivative of time around the inflection point at time of maturity. Therefore, at L_{50}, At = 1 and growth = k*h. In model 6 the phase specific values of L_∞ were used to estimate the growth rate at t_0, L_{50} and t_{95}. Longevity: t_{max}, observed oldest individual (based on visual banding estimates); t_{maxth}, theoretical longevity (Fabens 1965) (5ln(2)/k)

References

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