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Marine and Freshwater Research

Supplementary Material

Age and growth of *Pomatomus saltatrix* in the south-western Pacific Ocean (eastern Australia), with a global comparison

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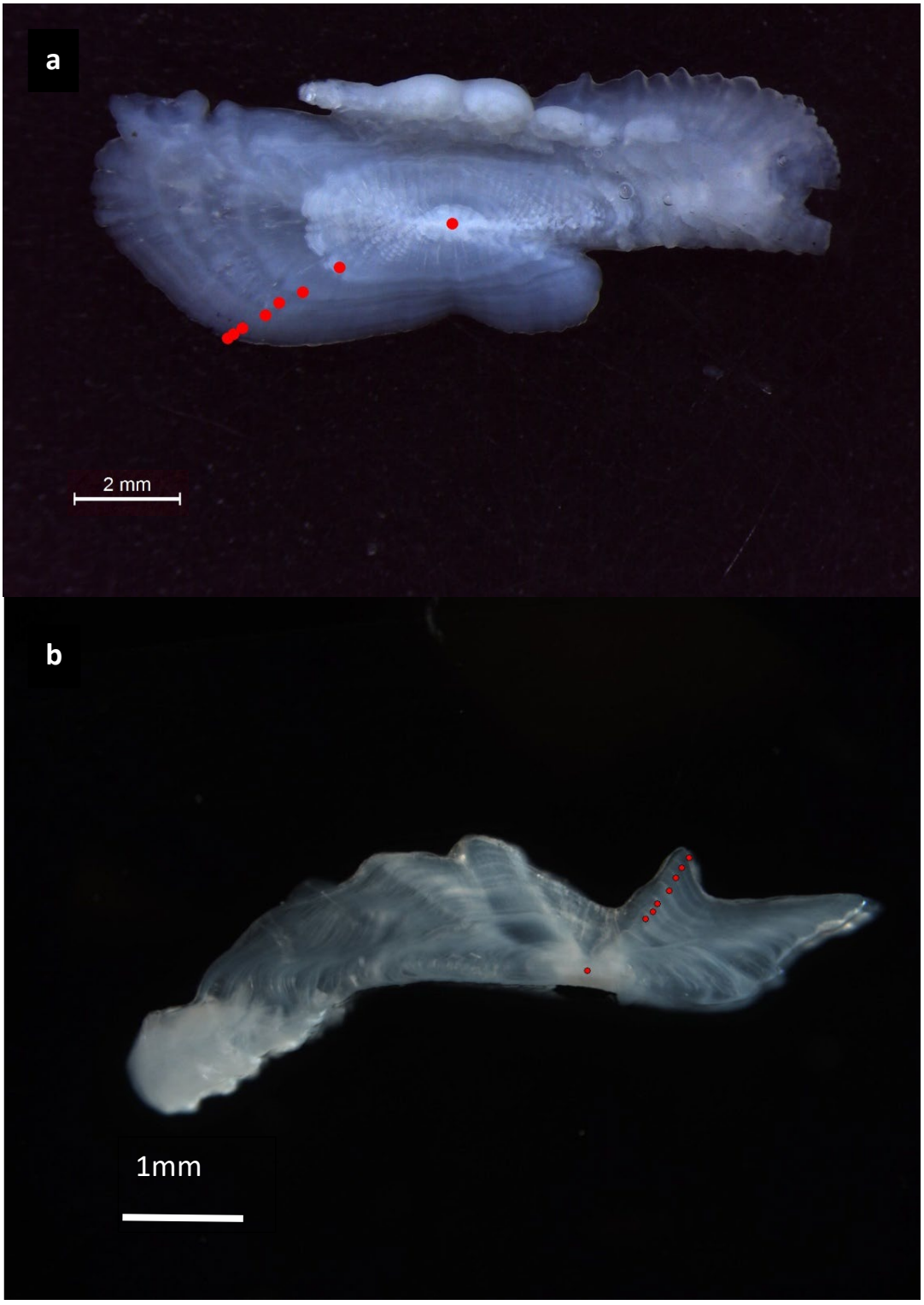

Figure S1. A comparison of a single otolith showing the a) whole and b) sectioned methods of reading *Pomatomus saltatrix* otoliths from eastern Australia. This is the same otolith in both images (6 increments). From the core to the edge, the red marks indicate the core, each increment and the edge of the otolith. Interpretation of the otolith increment macrostructure were done according to the fish ageing protocols for the Fisheries Queensland Fishery Monitoring program (Fisheries Queensland 2017, 2018).

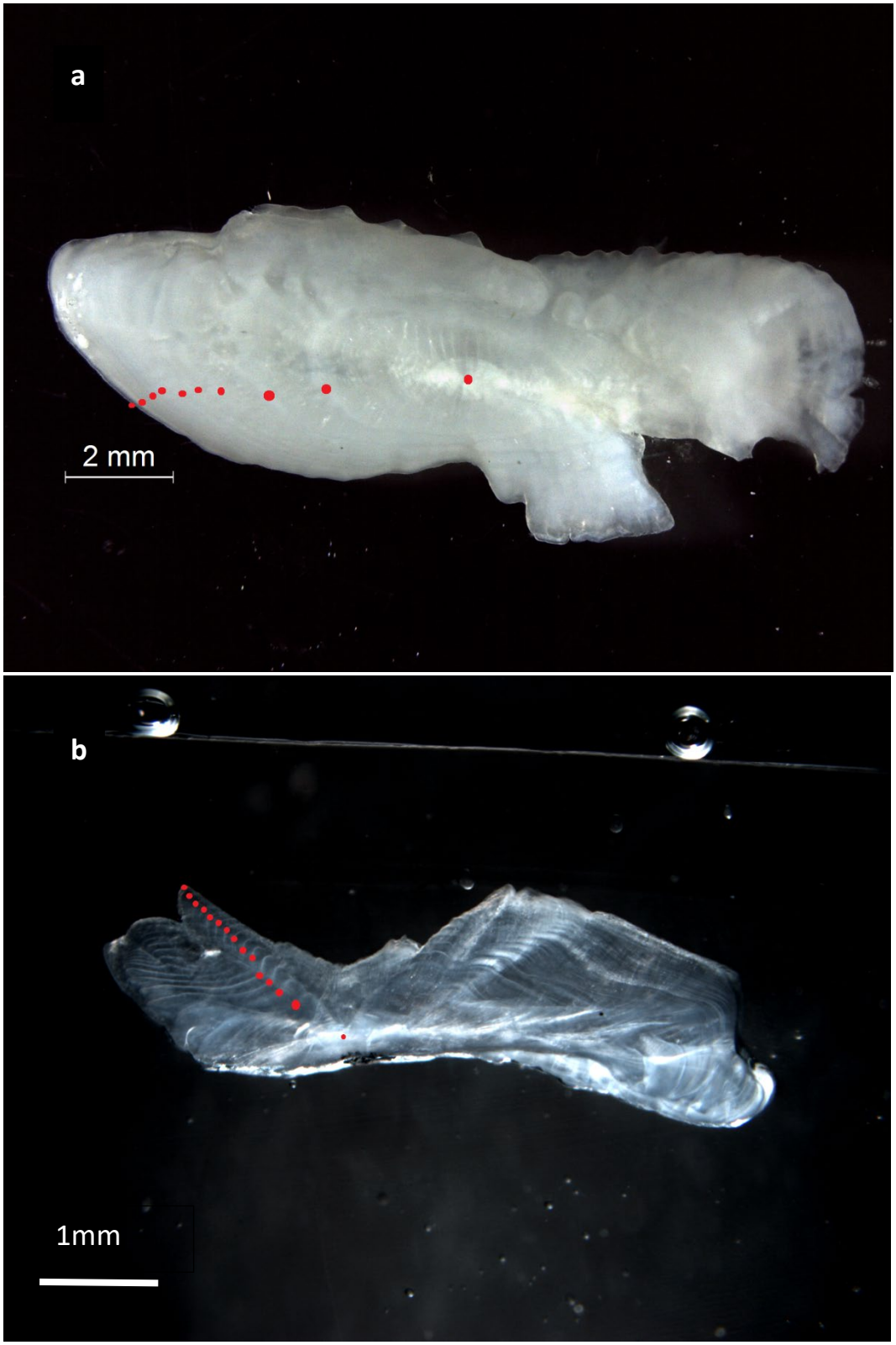

Figure S2. A comparison of the otolith from the exceptionally large *P. saltatrix* from St George's Basin showing the a) whole and b) sectioned methods of reading *Pomatomus saltatrix* otoliths. From the core to the edge, the red marks indicate the core, each increment and the edge of the otolith. Note the thickness of the whole otolith making the increments very hard to observe.

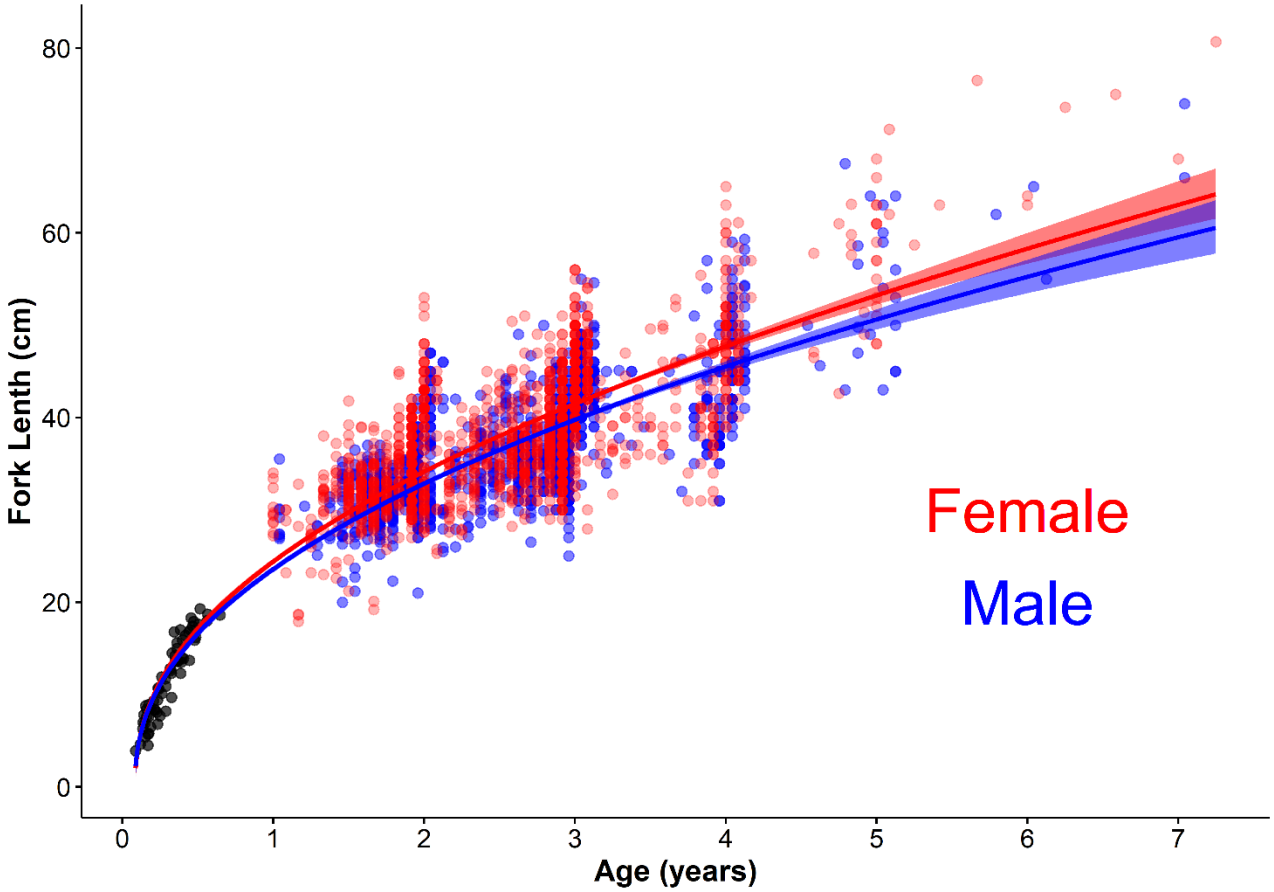

Figure S3. Fitted Schnute growth curves (variation 1) for *Pomatomus saltatrix* in eastern Australia by sex. The red line shows the fitted growth curve for only female fish (a = -0.04 (95% CI: -0.10–0.03), b = 2.25 (95% CI: 2.11–2.41), size at age 1 = 24.41 (95%CI: 24.09–24.75), size at age 4 = 47.71 (95% CI: 47.21 – 48.20)), and the blue line shows the fitted line for only the male fish (a = -0.02 (95% CI: -0.09–0.05), b = 2.26 (95% CI: 2.11–2.41), size at age 1 = 23.58 (95% CI: 23.24–23.92), size at age 4 = 45.54 (95% CI: 44.98–46.09)). Note the male points have been offset by 0.5 months to the right to reduce overlapping points. The ribbons show the 95% credible intervals for the median size at each age.

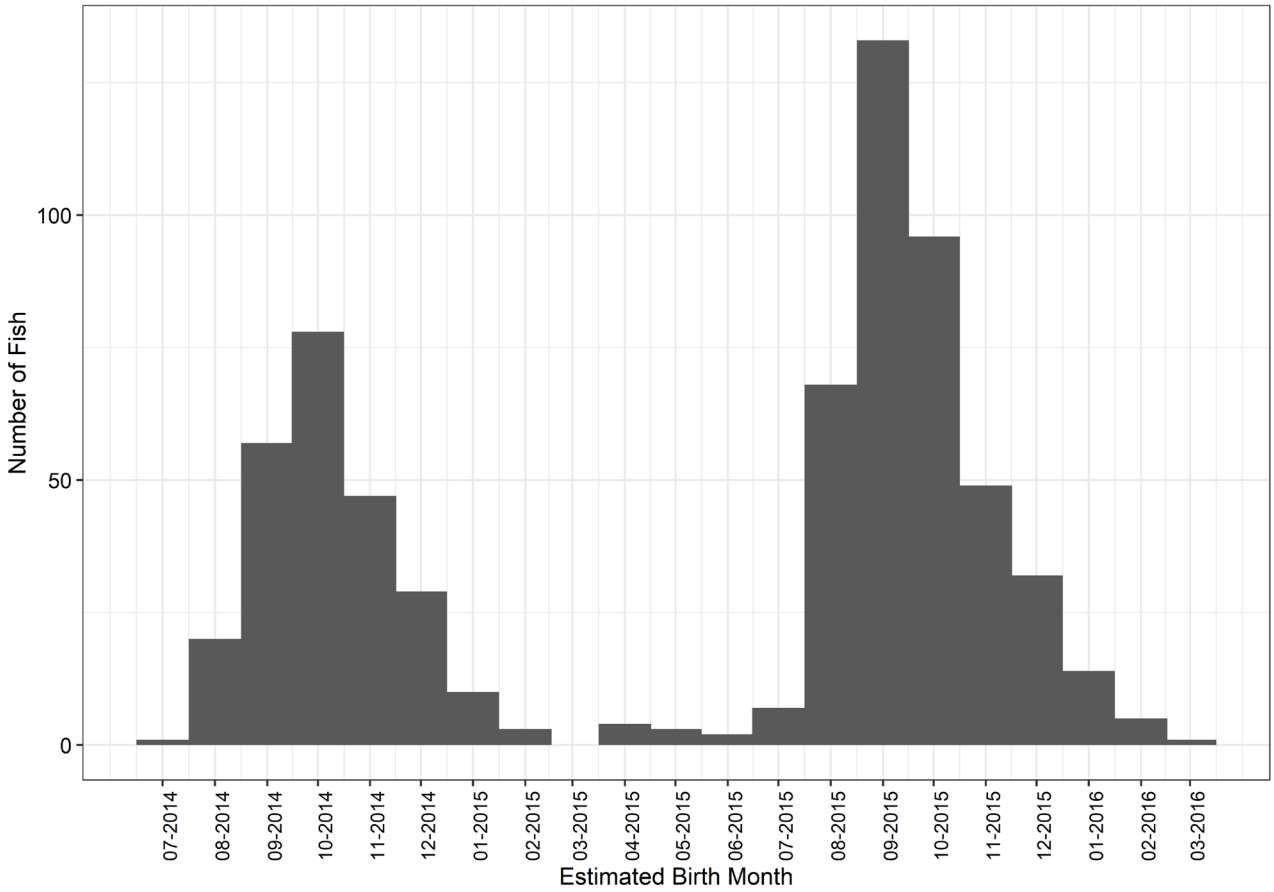

Figure S4. Estimated birth months for all *P. saltatrix* that were captured with fork lengths 5–20 cm. Birth dates were estimated from the logistic growth equation based upon daily increment counts of a subset of fish. Note this distribution is strongly biased by sampling effort for juveniles, which was primarily conducted in February–April.

Table S1. Growth models used in the model selection process to find the best fitting model for *Pomatomus saltatrix* growth in eastern Australia.

Growth Model	Equation	Parameters	Full Model looic	Full Model ΔELPD	Juvenile Model looic	Juvenile Model ΔELPD
Von Bertalanffy (Beverton and Holt 1957)	$Y(t) = L_\infty\left(1 - e^{-k(t-t_0)}\right)$	$Y(t)$ =length at age t k = Brody growth coefficient t =age t_0 = age at size 0 L_∞ = average maximum length	20481.2	-71.8	230.9	-2.7
Linear	$Y(t) = mt + b$	$Y(t)$ =length at age t t =age b = intercept m = gradient of slope	23536.8	-1599.6	231.9	-6.3
Logistic	$Y(t) = {L_\infty}/{(1 + e^{-k(t-t_0)})}$	$Y(t)$ =length at age t t =age L_∞ = average maximum length t_0 = age at size 0	20448.7	-55.5	225.6	0
Power	$Y(t) = d_0 + dx^c$	$Y(t)$ =length at age t t =age c = curvilinear parameter d = growth parameter d_0 = intercept	20375.8	-19.1	232.3	-3.4
Schnute variation 1 (a≠0, b≠0) (Schnute 1981)	$Y(t) = \left[y_1^b + \left(y_2^b - y_1^b\right)\frac{1 - e^{-a(t-T_1)}}{1 - e^{-a(T_2-T_1)}}\right]^{1/b}$	$Y(t)$ =length at age t t =age a = growth parameter b = growth parameter T_1 = Arbitrary age 1 T_2 = Arbitrary age 2 y_1 = size at T_1 y_2 = size at T_2	20337.6	0	230.7	-2.3
Schnute variation 2 (a≠0, b=0) (Schnute 1981 equivalent to Gompertz 1825)	$Y(t) = y_1\, e^{\left[\log\left(\frac{y_2}{y_2}\right)\frac{1-e^{-a(t-T_1)}}{1-e^{-a(T_2-T_1)}}\right]}$		20437.3	-49.9	230.2	-2.3
Schnute variation 3 (a=0, b≠0) (Schnute 1981)	$Y(t) = \left[y_1^b + (y_2^b - y_1^b)\frac{t - T_1}{T_2 - T_1}\right]^{1/b}$		20360.4	-11.4	234.2	-4.5
Schnute variation 4 (a=0, b=0) (Schnute 1981)	$Y(t) = y_1\, e^{\left[\log\left(\frac{y_2}{y_1}\right)\frac{t-T_1}{T_2-T_1}\right]}$		20441.8	-52.1	267.7	-21.1

ΔELPD is the difference in expected log pointwise predictive density from the best model.

Table S2. Summary of priors used to fit the Bayesian growth models.

Growth Model	Parameter	Prior (full model)	Prior (juvenile model)
Von Bertalanffy (Beverton and Holt 1957)	K	Normal(0.1,0.1)	Normal(0.5,1)
	t_o	Normal(0,0.5)	Normal(0,5)
	L_∞	Normal(100,20)	Normal(25,5)
Linear	m	Normal(10,10)	Normal(0.8,1)
	b	Normal(0,10)	Normal(0.8,1)
Logistic	L_∞	Normal(80,10)	Normal(20.5,0.1)
	k	Normal(0.5,0.2)	Normal(0.02,0.001)
	T_0	Normal(3,5)	Normal(95,5)
Power	c	Normal(0.5,1)	Normal(0.5,1)
	d	Normal(25,10)	Normal(1.2,1)
	d_0	Normal(0,5)	Normal(-5,1)
Schnute variation 1 (a≠0, b≠0) (Schnute 1981)	a	Normal(0,1)	Normal(0.5,1)
	b	Normal(2.3,0.5)	Normal(0.5,1)
	Y_1	Normal(25,5)	Normal(5,3) (age 1 =50)
	Y_2	Normal(48,5)	Normal(20,5) (age 2 = 180)
Schnute variation 2 (a≠0, b=0) (Schnute 1981, equivalent to Gompertz 1825)	a	Normal(0.2,0.05)	Normal(0.5,1)
	Y_1	Normal(25,2)	Normal(5,3) (age 1 =50)
	Y_2	Normal(48,3)	Normal(20,5) (age 2 = 180)
Schnute variation 3 (a=0, b≠0) (Schnute 1981)	b	Normal(2.2,0.1)	Normal(0.5,1)
	Y_1	Normal(24,1)	Normal(5,3) (age 1 =50)
	Y_2	Normal(47,1)	Normal(20,5) (age 2 = 180)
Schnute variation 4 (a=0, b=0) (Schnute 1981)	Y_1	Normal(5,3)	Normal(5,3) (age 1 =50)
	Y_2	Normal(20,5)	Normal(20,5) (age 2 = 180)

Table S3 Age−length key used to convert the length frequency data to age composition data.

Length (FL cm)	Age								
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**14**
2	1	0	0	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0
6	1	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	0
10	0.988	0.012	0	0	0	0	0	0	0
12	0.971	0.029	0	0	0	0	0	0	0
14	0.992	0.008	0	0	0	0	0	0	0
16	0.981	0.019	0	0	0	0	0	0	0
18	0.882	0.118	0	0	0	0	0	0	0
20	0.794	0.206	0	0	0	0	0	0	0
22	0.214	0.786	0	0	0	0	0	0	0
24	0.214	0.429	0.357	0	0	0	0	0	0
26	0.029	0.779	0.176	0.015	0	0	0	0	0
28	0.007	0.707	0.287	0	0	0	0	0	0
30	0.003	0.685	0.291	0.022	0	0	0	0	0
32	0.002	0.604	0.376	0.018	0	0	0	0	0
34	0	0.390	0.561	0.049	0	0	0	0	0
36	0	0.199	0.710	0.091	0	0	0	0	0
38	0	0.138	0.683	0.167	0.013	0	0	0	0
40	0	0.080	0.577	0.310	0.033	0	0	0	0
42	0	0.012	0.418	0.510	0.056	0.004	0	0	0
44	0	0.009	0.336	0.514	0.131	0.009	0	0	0
46	0	0	0.258	0.555	0.188	0	0	0	0
48	0	0	0.108	0.591	0.280	0.022	0	0	0
50	0	0	0.145	0.364	0.455	0.036	0	0	0
52	0	0	0.056	0.333	0.528	0.083	0	0	0
54	0	0	0	0.429	0.381	0.143	0.048	0	0
56	0	0	0	0.273	0.591	0.136	0	0	0
58	0	0	0.071	0	0.643	0.286	0	0	0
60	0	0	0	0	0.538	0.462	0	0	0
62	0	0	0	0	0.200	0.700	0.100	0	0
64	0	0	0	0	0.400	0.200	0.400	0	0
66	0	0	0	0	0.250	0.250	0.250	0.250	0
68	0	0	0	0	0	0.500	0	0.500	0
70	0	0	0	0	0	1	0	0	0
72	0	0	0	0	0	0	1	0	0
74	0	0	0	0	0	0.500	0.250	0.250	0
76	0	0	0	0	0	1	0	0	0
80	0	0	0	0	0	0	0	1	0
90	0	0	0	0	0	0	0	0	1

Lengths are in 2-cm bins.

Table S4. Length composition of the Southwest Pacific *Pomatomus saltatrix* harvest as estimated by this study (Figure 6).

Length (FL cm)	Percentage
22	0.013
24	0.04
26	1.26
28	6.11
30	11.93
32	20.55
34	19.57
36	14.41
38	9.56
40	6.71
42	3.36
44	2.78
46	1.04
48	0.83
50	0.58
52	0.30
54	0.14
56	0.19
58	0.23
60	0.10
62	0.09
64	0.00
66	0.00
68	0.06
70	0.02
74	0.04
76	0.04
80	0.04

Table S5. Age composition of the southwest Pacific *Pomatomus saltatrix* harvest as estimated by this study (Figure 6).

Age	Percentage
0	0.16
1	38.36
2	47.58
3	11.22
4	2.15
5	0.43
6	0.25
7	0.08

Table S6. Summary of published von Bertalanffy growth curve estimates for the populations of *P. saltatrix*.

Region	k (year^{-1})	L_∞ (cm)	t_0 (years)	References
Northwest Atlantic	0.311	81.5	-0.30	Robillard *et al.* (2009)
Mediterranean	0.150	88.3	-1.43	(Cengiz *et al.* 2013)
Eastern Atlantic	0.214	104.3	-0.05	Recalculated from Champagnat (1983)
West Indian	0.094	124.7	-2.09	Govender (1999)
East Indian	0.464	59.2	-0.10	Smith *et al.* (2013)
Southwest Atlantic	0.387	66.2	0.32	Haimovici and Krug (1996)
Southwest Pacific	NA	NA	NA	This study

Von Bertalanffy growth curve parameter estimates are not given here for the south-west Pacific population due to this study finding that the growth model is not appropriate for this population. Some populations show large t_0 estimates ($|t_0| > 1$), which suggests that the model may also not be appropriate for the juvenile (< 1 year old) portion of the populations. k, $L\infty$ and t_0 are parameters in the von Bertalanffy growth equation.

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