The following supplement accompanies the article

Chinook salmon exhibit long-term rearing and early marine growth in the Fraser River, B.C., a large urban estuary

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Extended Methods and Results

Otolith analyses

Width and estuarine entry measurements were taken at 10x magnification or higher, and daily growth measurements were taken at 20x or 40x magnification in the dorso-posterior (DP) quadrant of the sagittal otolith, where growth increments are consistently the widest (Zhang et al. 1995, Fig. 1 in the main text). Daily growth measurements were averaged over at least 7 increments, in order to minimize variation due to natural fluctuations in environmental factors (Zhang et al. 1995). For each growth value, measurements were taken 3 times within the DP quadrant and averaged to reduce within-otolith variability.

We measured daily growth in the estuary in all otoliths, as well as early estuarine growth, late estuarine growth, and late freshwater growth (just prior to estuarine entry) in otoliths where 7 or more of these increments were clearly visible in the DP quadrant.

The estuarine entry inflection was identified on LA-ICPMS scans, and while our Sr:Ca and Ba:Ca values at entry (0.49-1.8 mmol:mol and 0.19-4.5 µmol:mol) were more aligned toward "freshwater" values than "estuarine" values indicated in a detailed study (Miller 2011), the inflection patterns were consistent among fish that had recently entered the estuary (within 14 days). Based on the number of daily increments post-inflection and the capture of some of these fish in high salinity estuarine environments (i.e. eelgrass sites), we believe these values to be representative of the Fraser River estuary microchemistry signature (Fig. S1). This aligns with the low salinity range measured at high tide throughout the emigration period in the marsh habitat of the Fraser estuary (Table S1).

References

Miller, J.A. 2011. Effects of water temperature and barium concentration on otolith composition along a salinity gradient: Implications for migratory reconstructions. J. Exp. Mar. Bio. Ecol. **405**(1–2): 42–52. Elsevier B.V. doi:10.1016/j.jembe.2011.05.017.

Zhang, Z., Beamish, R.J., and Riddell, B.E. 1995. Differences in otolith microstructure between hatchery-reared and wild Chinook salmon (Oncorhynchus tshawytscha). Can. J. Fish. Aquat. Sci. **52**(2): 344–352. doi:10.1139/f95-035.

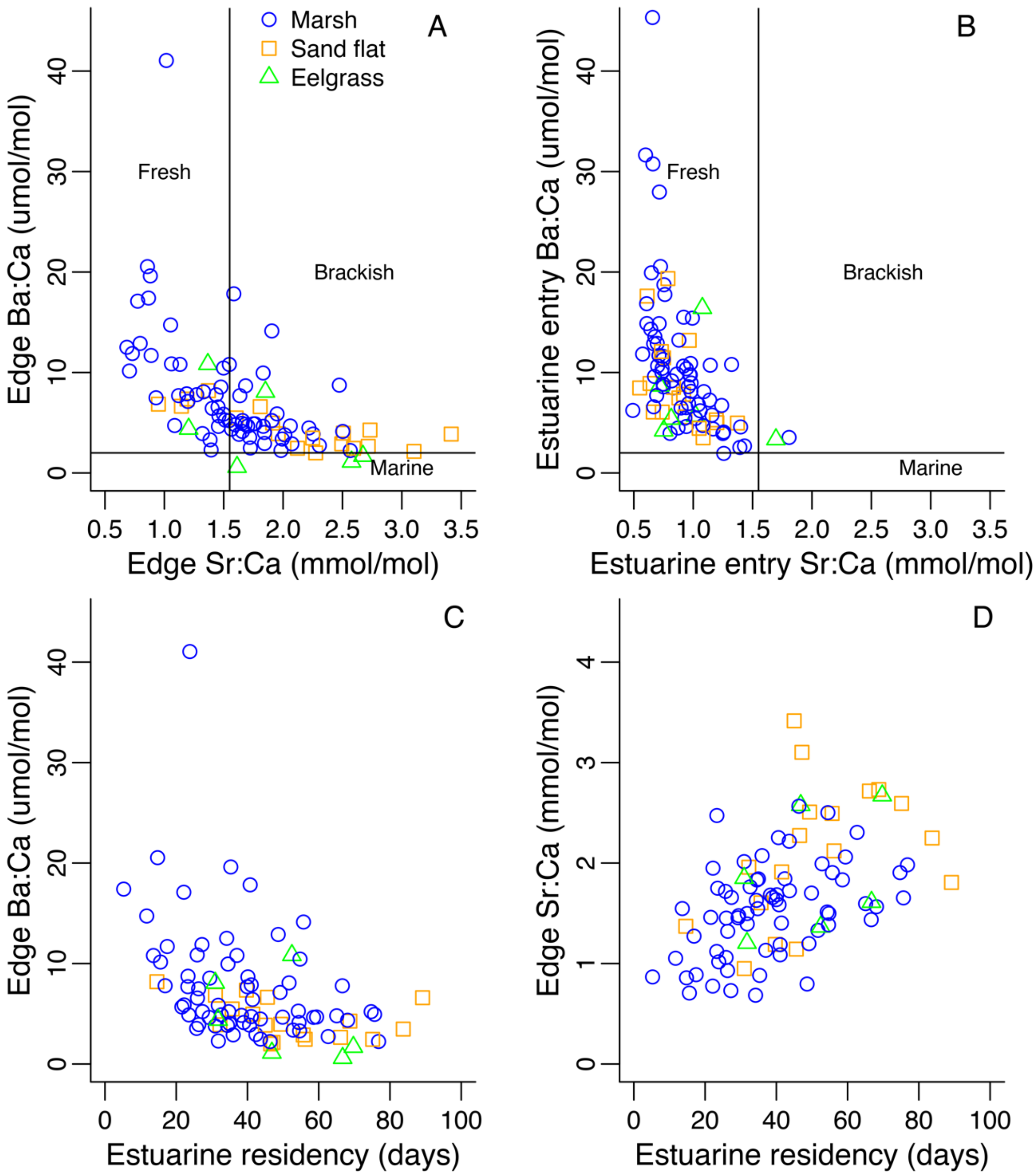

Fig. S1. Evaluation of otolith microchemistry in relation to estuarine residency and habitat. Lines demarking "Fresh" (>2 µmol/mol Ba:Ca and <1.55 mmol/mol Sr:Ca), "Brackish" (>2 µmol/mol Ba:Ca and >1.55 mmol/mol Sr:Ca), and "Marine" (<2 µmol/mol Ba:Ca and >1.55 mmol/mol Sr:Ca) elemental ratios are derived from Miller (2011). Shapes and colours indicate habitat at capture (Marsh = blue circles, Sand flat = orange squares, Eelgrass = green triangles).

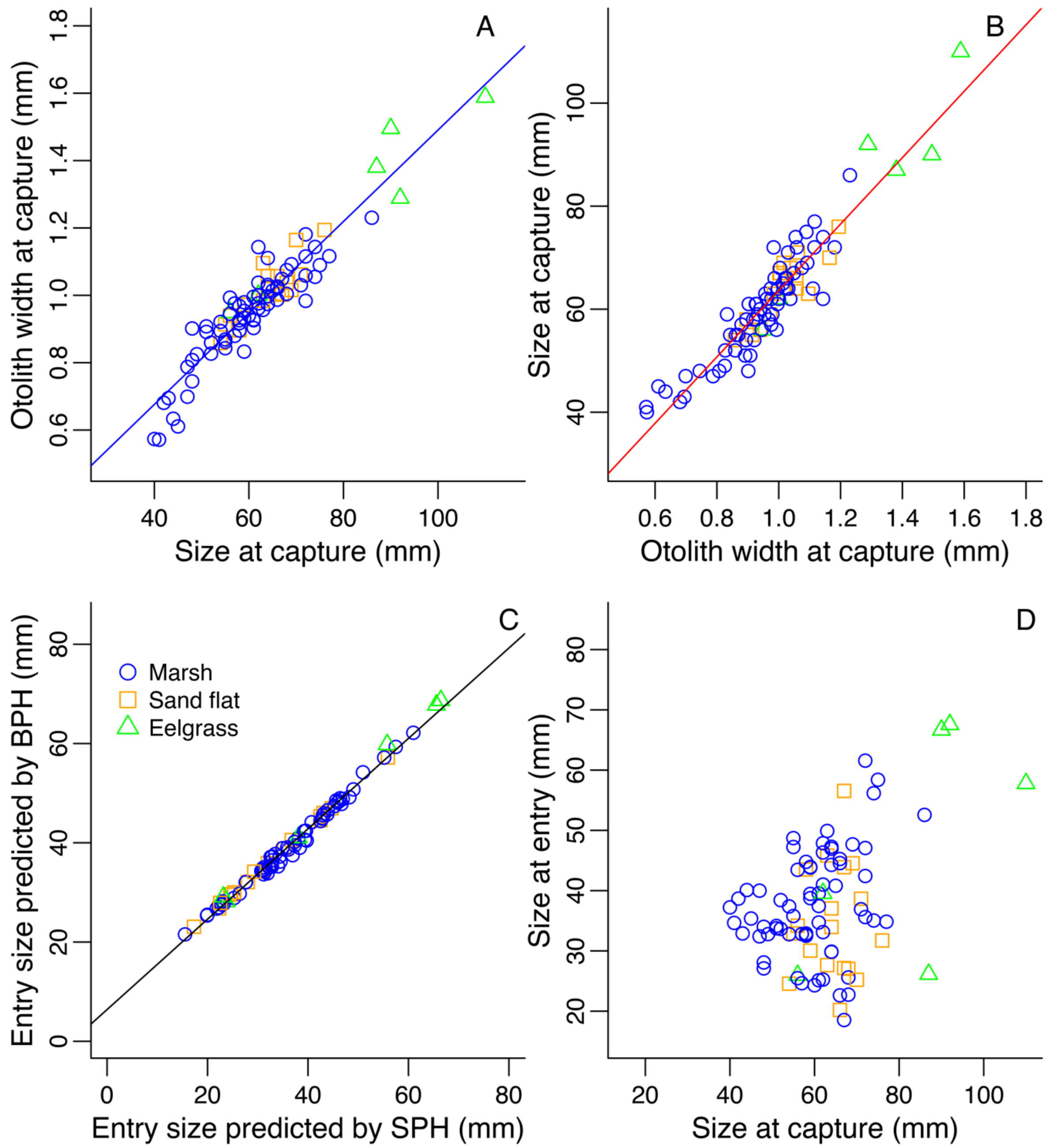

Fig. S2. Exploration of results of otolith back-calculation methods, following Francis (1990). Linear regressions of otolith width and fork length at capture were used to estimate A: otolith width at entry (from which fork length at entry was derived) following the Scale Proportional Hypothesis (blue line; R^2: 0.88, P: <2.2 x10^{-16}) and B: fork length at entry following the Body Proportional Hypothesis (red line; R^2: 0.88, P: <2.2 x10^{-16}). C: comparison of estimated fork length at entry calculated by each method (R^2: 0.99, P: <2.2 x10^{-16}). D: the mean of both methods was used to estimate the final fork length at entry, shown here in relation to fork length at capture. Habitat of capture shown for interest (marsh = blue circles (n=67), sand flat = orange squares (n=18), eelgrass = green triangles (n=6)).

Table S1. Environmental conditions measured at 17 sites representing three habitat types in the Fraser River estuary in 2016 and 2017.

	Marsh		Eelgrass		Sand flat	
Variable	Mean	Median (Range)	Mean	Median (Range)	Mean	Median (Range)
Salinity (‰)	2.33	0.89 (0.00:19.4)	25.56	27.36 (10.38:33.92)	11.70	10.97(0.55:30.84)
Temperature (°C)	13.36	13.30 (3.43:18.32)	13.64	13.85 (7.49:18.85)	14.38	14.21 (7.55:20.41)
Dissolved oxygen (mg·L^{-1})	10.46	10.74 (4.68:15.50)	9.97	10.16 (5.53:14.19	10.28	10.36 (4.04:14.56)
pH	8.06	7.91 (6.44:10.46)	8.31	8.30 (7.78:9.00)	8.19	8.14 (7.81:8.70)

Estuarine Growth

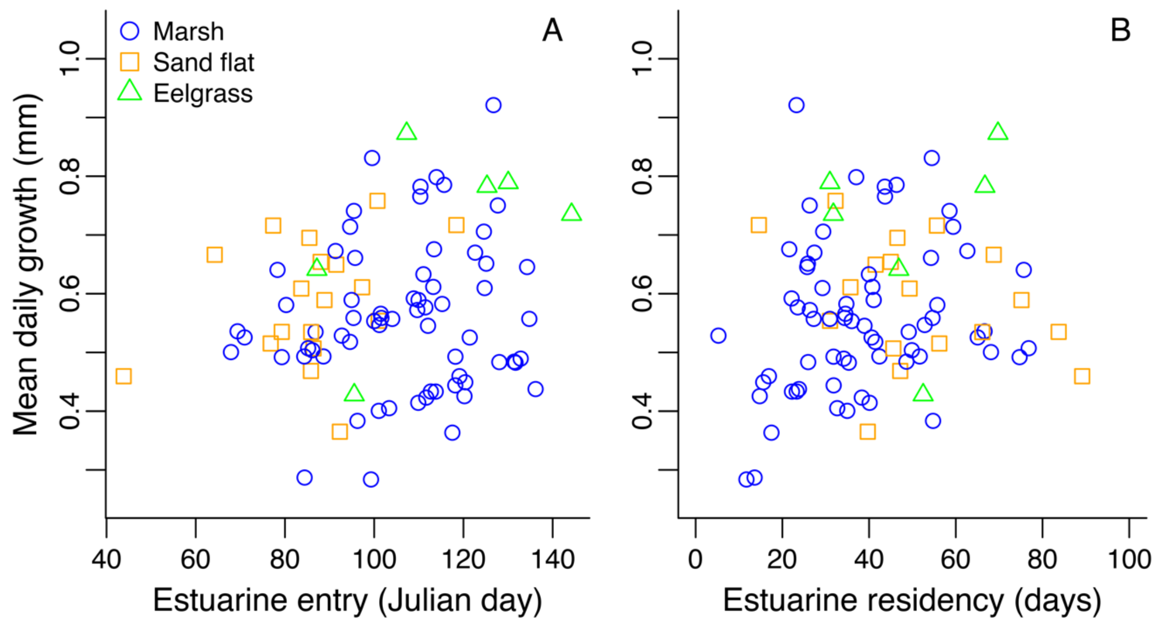

Fig. S3. Relationship between mean daily growth and estuarine entry timing (A) and estuarine residency (B). Neither of these patterns were significant ($p > 0.05$). Shapes and colours indicate habitat at capture (Marsh = blue circles, Sand flat = orange squares, Eelgrass = green triangles).

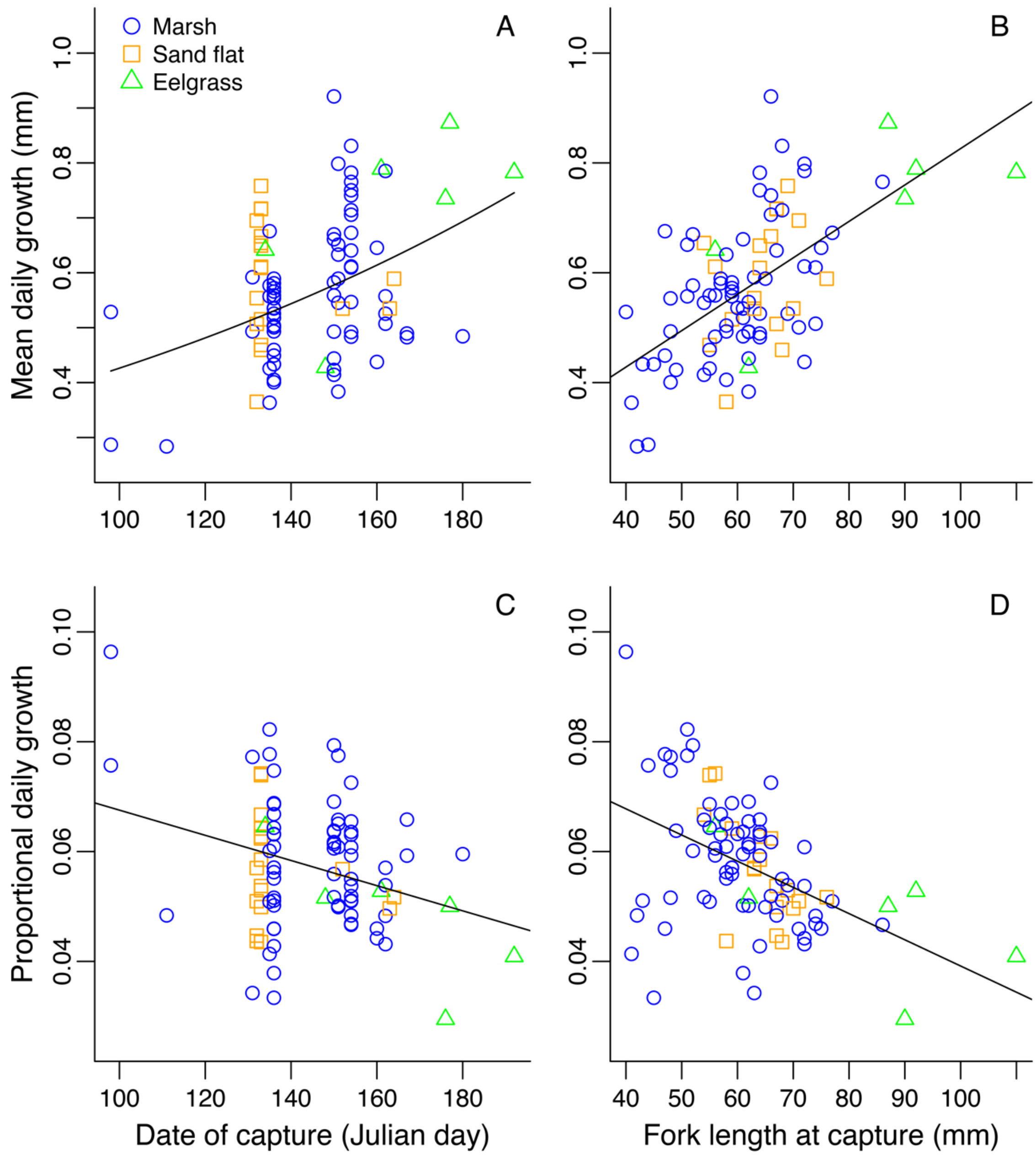

Fig. S4. Allometric patterns of growth by estuarine entry. A) Average daily growth in fork length over time (R^2: 0.15, *P*: 1.5 x10^{-04}), B) Average daily growth in fork length as a function of body size at capture (R^2: 0.34, *P*: 1.1 x10^{-09}), C) Average proportional daily growth (daily growth divided by fork length at capture) over time (R^2: 0.09, *P*: 3.8 x10^{-03}), and D) Average proportional daily growth in fork length as a function of body size at capture (R^2: 0.22, *P*: 2.8 x10^{-06}). Shapes and colours indicate habitat at capture (Marsh = blue circles, Sand flat = orange squares, Eelgrass = green triangles).

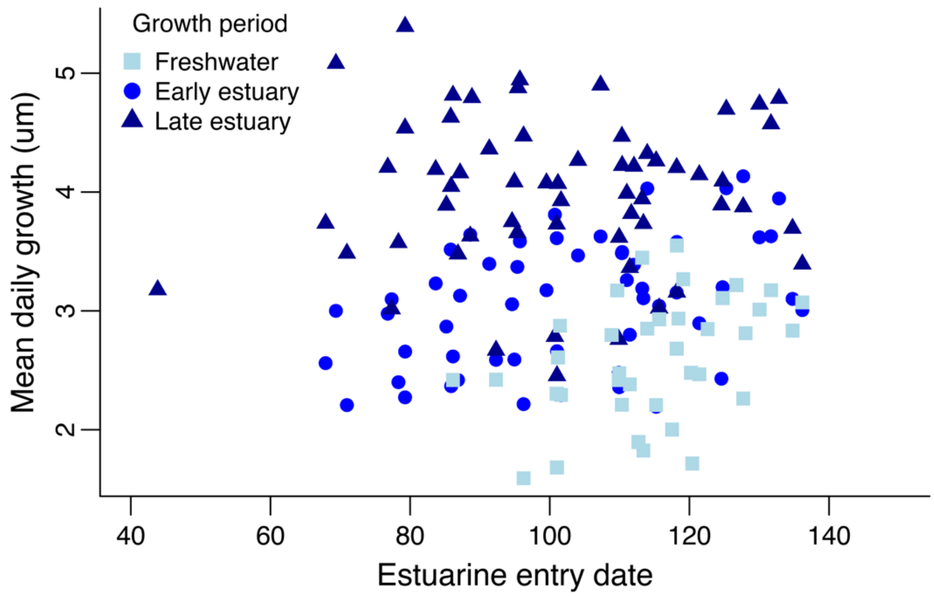

Fig. S5. Average daily width of otolith increments during the freshwater period prior to estuarine entry (light blue squares), just after estuarine entry (medium blue circles), and just prior to capture (dark blue triangles), shown by estuarine entry date. All measurements represent the mean width over 7-14 increments for each time period. Mean daily increment growth rates for each growth period are significantly different from one another (ANOVA, $F_{2,\,148} = 76.93$, $P < 2.2 \times 10^{-16}$). However, following conversion to fork length these relationships are no longer significant.

Table S2. Individual juvenile Harrison Chinook that experienced a decline of >5% in mean daily growth over time (Early:Fresh or Late:Early). Note that three of the five fish were caught at the same marsh site (M2), possibly indicating site-specific influences on growth conditions. Despite a measured decline in otolith growth rate, all except for a single individual had mean daily somatic growth rates near or above the population mean of 0.57 +/- 0.13 mm (mean +/- SD).

Site	Sr:Ca Entry (mmol·mol^{-1})	Sr:Ca Edge (mmol·mol^{-1})	Entry Day	Catch Day	Est. Res. (days)	Entry FL (mm)	Catch FL (mm)	Mean Daily GR FL (mm·day^{-1})	Mean Daily GR Oto. (µm·day^{-1})	Fresh GR (µm·day^{-1})	Early Est. GR (µm·day^{-1})	Late Est. GR (µm·day^{-1})	Early: Fresh	Late: Early
SF3	0.74	1.96	100.7	133	32.3	44.5	69	0.76	3.65	NA	3.81	2.79	NA	0.73
M4	1.25	1.50	118.2	150	31.8	46.3	62	0.49	4.28	3.55	3.58	3.16	1.01	0.88
M2	0.99	1.84	101.0	136	35.0	34.0	48	0.40	2.48	1.68	2.66	2.45	1.58	0.92
M2	0.69	0.93	127.7	154	26.3	44.3	64	0.75	4.07	2.26	4.13	3.88	1.83	0.94
M2	0.61	1.58	113.2	154	40.8	47.1	72	0.61	3.87	3.45	3.19	3.94	0.92	1.24