

## SUPPLEMENTARY METHODS

### Text S1. Quality control of wild morphology data

We started with the wild morphology data set available at <https://doi.org/10.5066/P14DVCSK> (USGS Alaska Science Center – Walrus Research Program, 2024). Per the process steps identified in that data release, we removed mass and length data that failed quality control processes described in the release. In addition, we plotted age relative to mass and length and length relative to mass and removed outliers (residuals  $>2.5x$  the standard deviation). Similarly, for individual data sets used in analyses, we removed values of the dependent variable with residuals  $>2.5x$  the standard deviation.

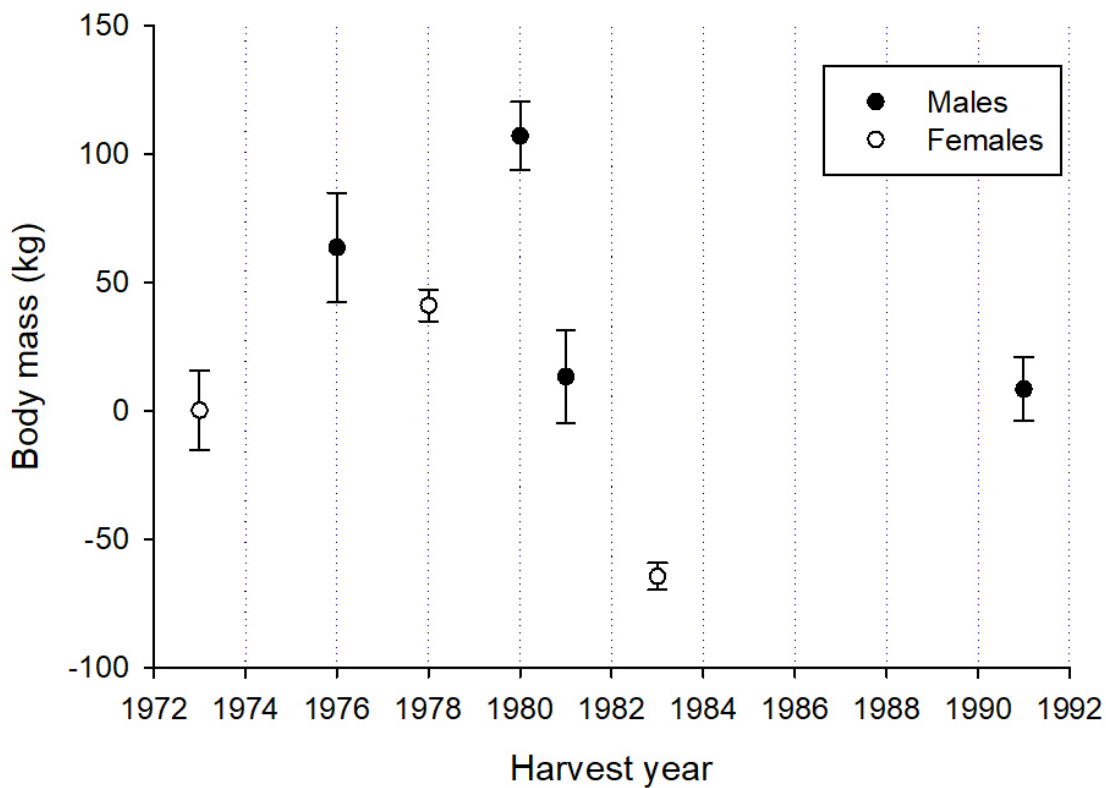


Fig. S1. Variation in mean ( $\pm$ SE) residual body mass (the difference between expected body mass based on growth curves between age and mass and observed mass) of male and female Pacific walrus between 1973 and 1991.

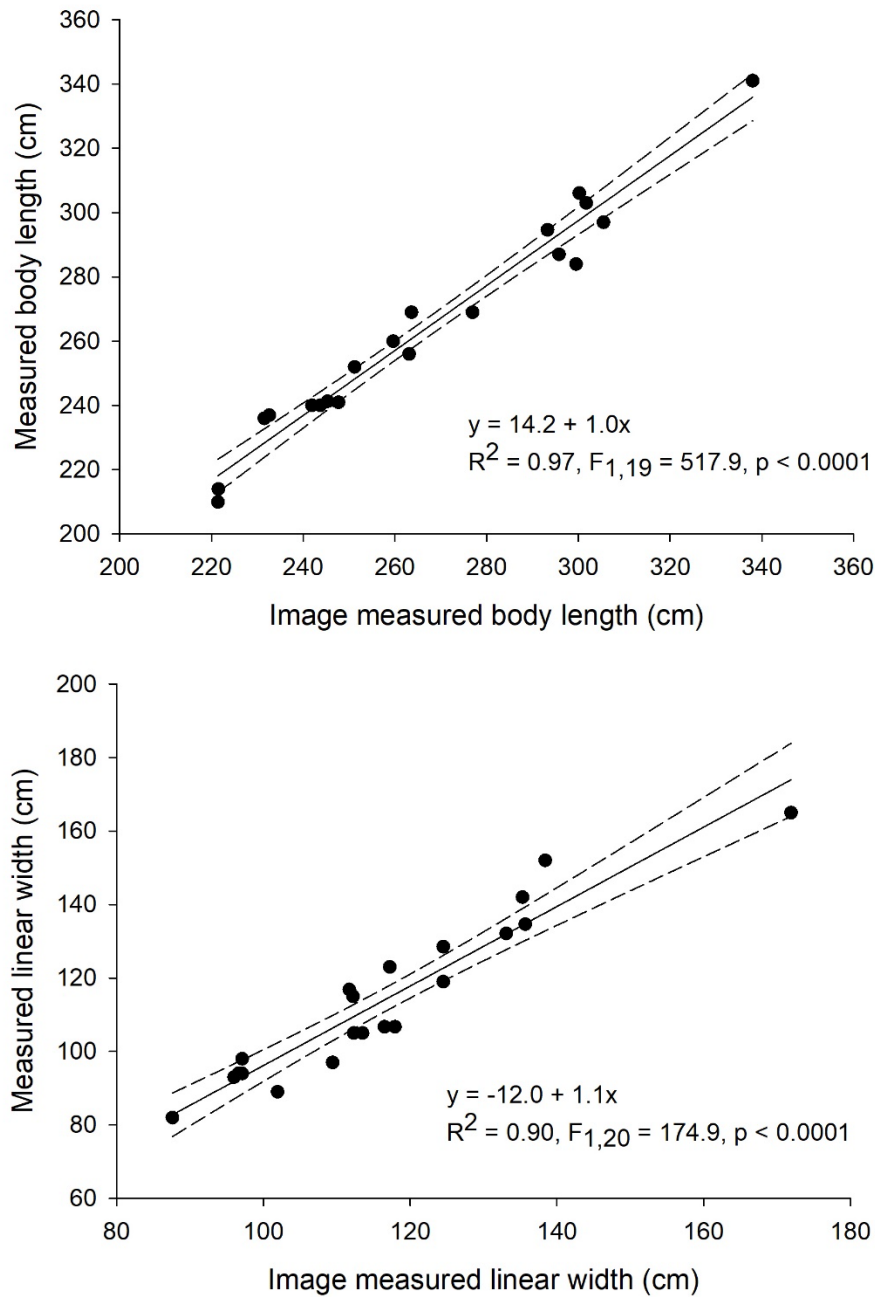


Fig. S2. The relationship between physical measures of length (top panel) and linear width behind the front flipper (bottom panel) and the same measures made from images taken by a camera suspended directly above the walrus at a resolution of  $\pm 1$ cm. Dashed lines are 95% confidence intervals.

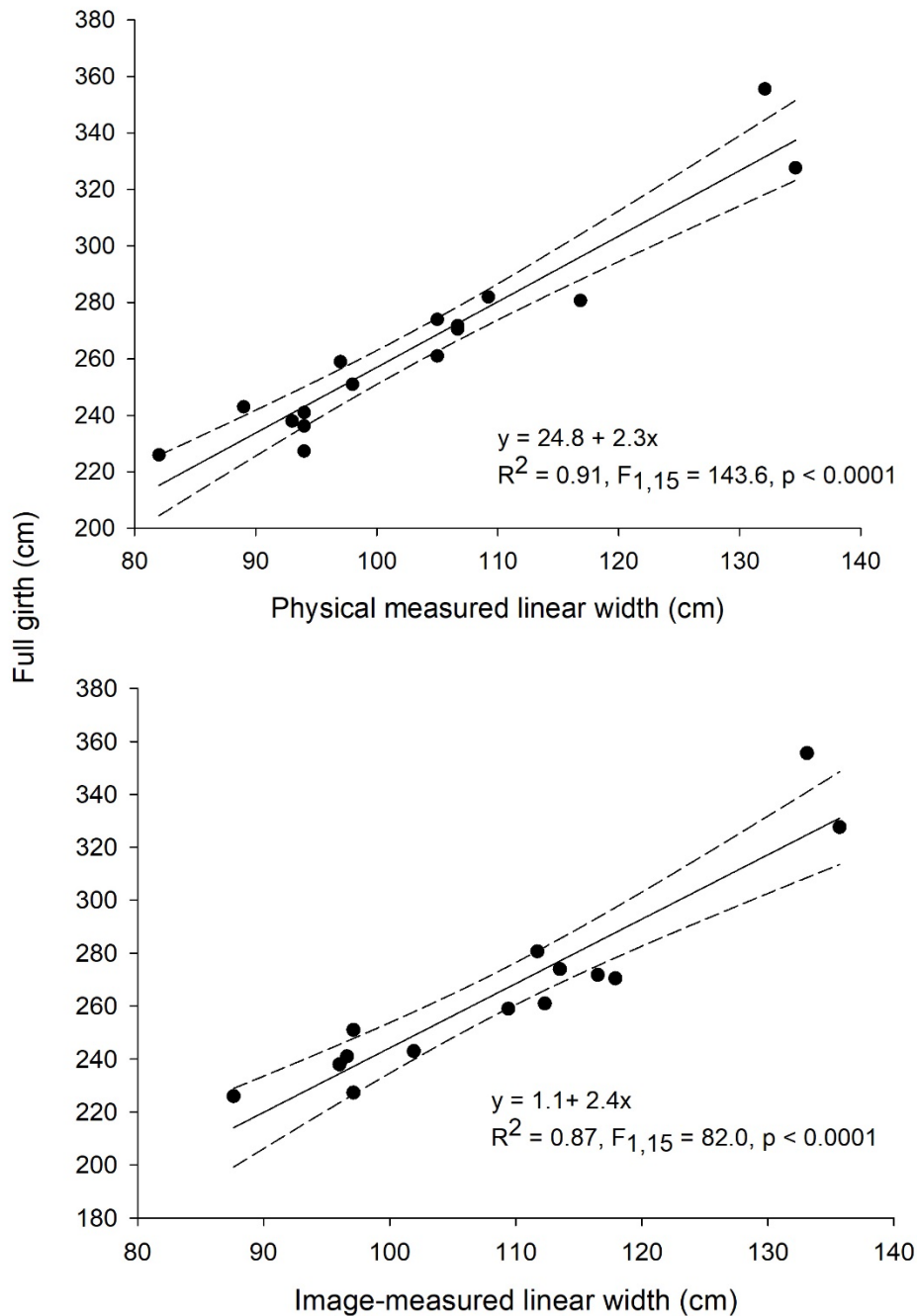


Fig. S3. The relationship between the full girth behind the front flippers of 9 female and 4 male Pacific walrus ranging in age from 2 to 45 years and a linear width measured behind the front flippers (FFwidth) via physical measurement (top panel) and measurements of aerial images (bottom panel). Dashed lines are 95% confidence intervals.

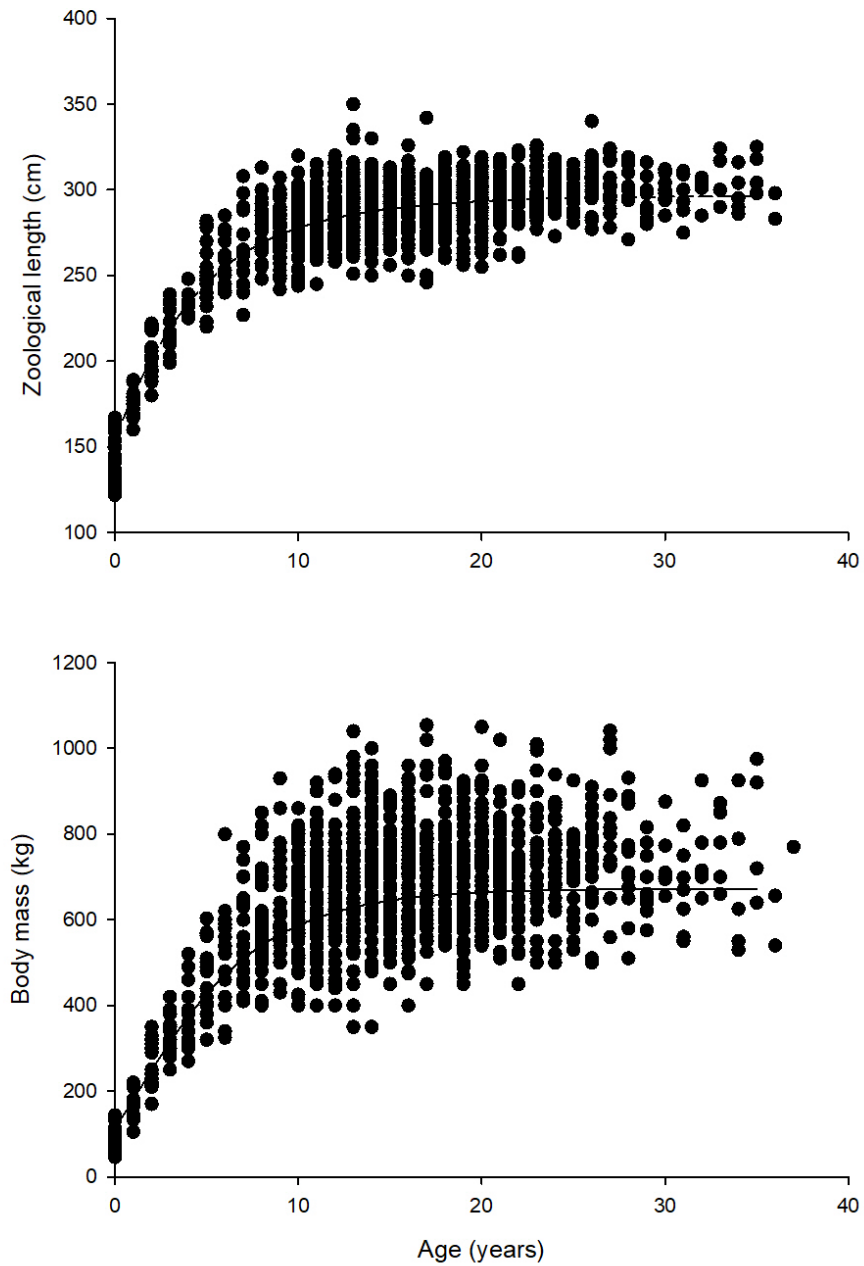


Fig. S4. Relationship between age, zoological length (top panel), and body mass (bottom panel) of female walrus harvested in the Chukchi Sea between 1973 and 1987.

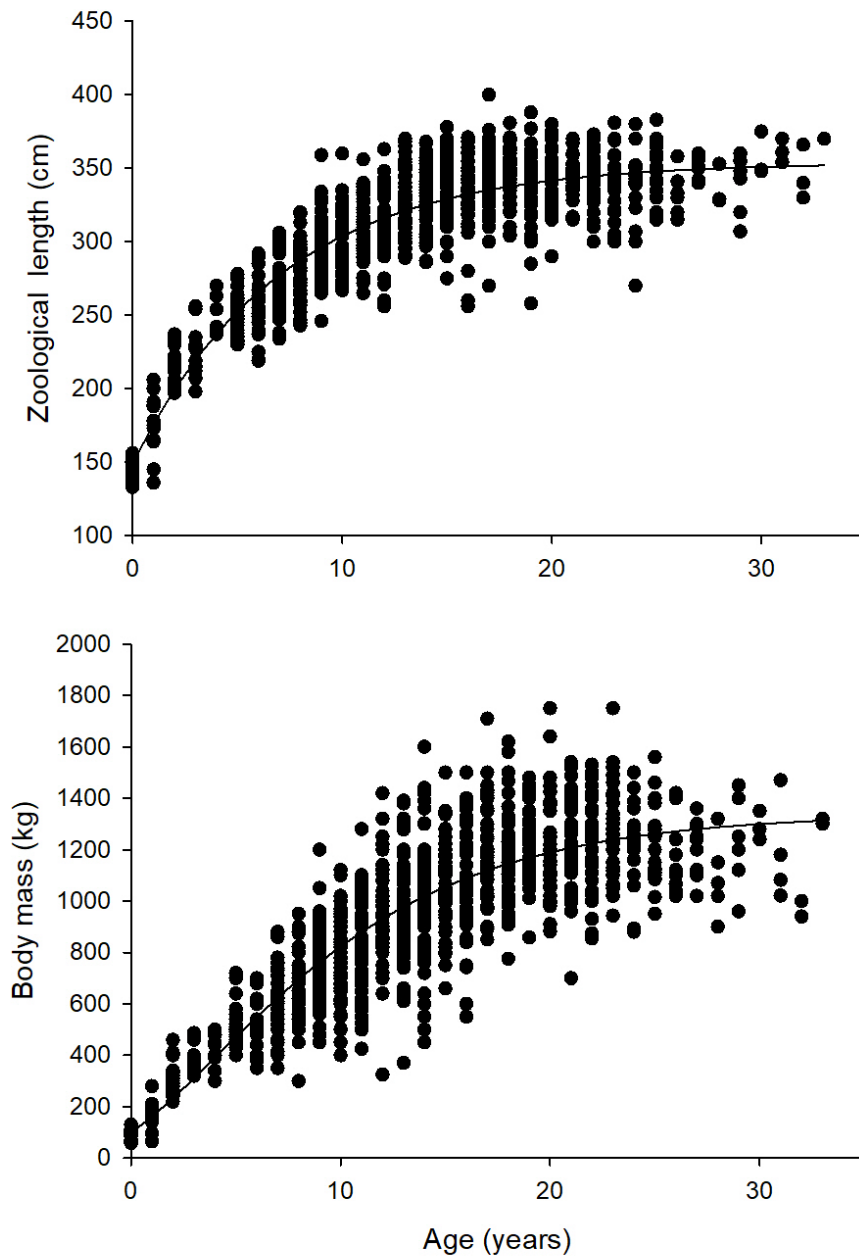


Fig. S5. Relationship between age and zoological length (top panel), and body mass (bottom panel) of male walrus harvested in the Chukchi Sea between 1972 and 1991.

Table S1. Akaike Information Criteria (AIC<sub>c</sub>) comparison of candidate models examining relationships between body mass of 8 male and 20 female Pacific walrus and the following predictor variables: image-measured body length (length), linear width behind the front flippers (FFwidth), hip width (HWidth) and body area (Area). Three females and one male were measured twice at different body masses 8 months apart resulting in a total of 21 observations. Random effects associated with repeated measures of the four walruses were not significant and were excluded from the models. Area units were m<sup>2</sup> while all other measures were in cm. Candidate models are ranked based on the AIC<sub>c</sub> fit metric corrected for small sample sizes. Mean residuals are provided with standard deviation (StDev).

Candidate Model	AIC <sub>c</sub>	ΔAIC <sub>c</sub>	R <sup>2</sup>	Mean Residual (kg) ± StDev
438.0Area – 233.3	251.9	0	0.91	66.9 (8.3%) ± 59.0
8.8FFwidth + 4.7Length – 1472.9	253.1	1.2	0.93	55.2 (6.8%) ± 51.9
5.0Length + 6.0FFwidth + 6.2Hwidth – 1630.2	254.8	2.9	0.94	54.2 (6.7%) ± 52.8
6.7Length + 12.9Hwidth – 1872.1	255.6	3.7	0.93	61.1 (7.6%) ± 57.1
15.4FFwidth – 964.0	260.9	9.0	0.88	79.0 (9.8%) ± 64.8
9.5Length – 1708.4	262.7	10.8	0.88	84.4 (10.5%) ± 64.8
12.2FFwidth + 7.2Hwidth – 1092.5	262.7	10.8	0.88	74.6 (9.3%) ± 65.5
30.9Hwidth – 1322.1	273.4	21.5	0.76	110.1 (13.7%) ± 82.3

Table S2. Akaike Information Criteria (AIC<sub>c</sub>) comparison of candidate models examining relationships between body mass of 9 adult female Pacific walrus (≥8 years) and the following predictor variable: image-measured body length (length), linear width behind the front flippers (FFwidth), hip width (HWidth) and body area (Area). Three females were measured twice at different body masses 8 months apart for a total of 12 observations. Random effects were not significant, so multiple linear regression models were used. Area units were m<sup>2</sup> while all other measures were in cm. Candidate models are ranked based on the AIC<sub>c</sub> fit metric corrected for small sample sizes. Mean residuals are provided with standard deviation (StDev).

	AIC <sub>c</sub>	ΔAIC <sub>c</sub>	R <sup>2</sup>	Mean Residual (kg) ± StDev
409.4Area – 176.0	132.6	0	0.89	52.4 (6.8%) ± 34.7
9.1FFwidth + 3.6Length – 1222.7	135.6	3.0	0.90	49.8 (6.4%) ± 33.7
14.2FFwidth – 838.1	135.7	3.1	0.85	59.4 (7.7%) ± 48.4
8.1Length – 1381.9	138.8	6.2	0.75	71.5 (9.3%) ± 51.6
12.0FFwidth + 5.5Hwidth – 956.8	140.0	7.4	0.85	55.6 (7.2%) ± 48.3
4.1Length + 8.4FFwidth + 1.6Hwidth – 1366.2	142.8	10.2	0.90	49.5 (6.4%) ± 33.0
7.5Length + 7.0Hwidth – 1693.9	143.0	10.4	0.80	67.9 (8.8%) ± 49.3
25.0Hwidth – 922.5	147.3	14.7	0.53	112.1 (14.5%) ± 64.0

Table S3. Candidate model equations for models fit to imagery-derived morphometric measures of walrus of both sexes and all ages (“ALL WALRUSES”) and females  $\geq 8$  years old (“ADULT FEMALES”) when walrus were positioned with head up while moving and raised on the front flippers (Fig. 3) as opposed to a flat, resting position (Figs. 2 & 3) presented in Tables S1 & S2. Area units were  $m^2$  while all other measures were in cm. Mean residuals are provided with standard deviation (StDev).

Candidate Model	R <sup>2</sup>	Mean Residual (kg) $\pm$ StDev
ALL WALRUSES		
456.5Area – 140.0	0.93	69.7 (8.0%) $\pm$ 52.4
5.4FFwidth + 6.6Length – 1418.2	0.89	94.3 (10.9%) $\pm$ 59.2
ADULT FEMALES		
432.8Area – 93.5	0.93	49.4 (6.2%) $\pm$ 27.0
12.5FFwidth + 0.2Length – 431.4	0.91	$\pm$ 53.0 (6.7%) $\pm$ 28.0

Table S4. Number of Pacific walrus positioned appropriately for measurements from aerial survey images collected in 2018 and 2019. Means are provided with standard deviation.

	Females with calves	First year calves	Older calves	Lone, Independent	Total
2018-09-06	35	27	14	199	275
2018-09-13	18	16	17	164	215
2018-09-15	9	17	3	169	198
2019-08-28	11	20	14	202	247
2019-08-30	34	35	26	189	284
2019-09-02	11	19	2	43	75
Mean per image (stdev)	19 (13)	25 (9)	14 (12)	145 (88)	216 (77)