APPENDIX B7: Selectivity and efficiency of large camera video data from the SMAST video survey during 2003-2006[5]

Selectivity curves were estimated for sea scallops in the SMAST video ("large" camera) survey using the Millar's maximum likelihood SELECT model (Millar and Fryer, 1999) and "small" camera video data as a standard measure of sea scallop length composition and density at study sites. The small camera is believed to be fully efficient (100% detection probability) for sea scallops about 35+ mm SL. The data were ideal because large and small camera data were collected at each station so that stations can be analyzed as replicate "paired tow" experiments. Estimates for Georges Bank and Mid-Atlantic Bight combined during 2003-2006 indicate that the large camera system has an increasing logistic selectivity pattern for sea scallops with selectivity ≥ 50% at 48+ mm, ≥ 90% at 71+ mm SL, and ≥ 95% at 79+ mm (approximate SE 1.7 mm for all estimates). The selectivity range for the large camera (L_{75}-L_{25}) was 22 mm (SE 2.4 mm). The SELECT model was configured so that the estimated split parameter p measured the ratio of total catches of sea scallops large enough to be fully selected by both cameras. Estimates of the split parameter p averaged 0.84 (SE 0.003 mm), which is approximately the same as the ratio expected based on assumed sample areas (A) for the two cameras, i.e. expected $p = A_{large} / (A_{small} + A_{large}) = 3.235 / (3.235 + 0.788) = 0.80$. This suggests that the large camera also has 100% detection probability for large fully selected scallops in its sample area.

Introduction / Methods

The primary purpose of the SMAST video survey camera selectivity comparisons was to identify the shell height at which the large camera was fully selective, assuming that the small camera was 100% selective at 35+mm shell height. SMAST camera survey selectivity curves were estimated by comparing large camera to small camera data from Georges Bank and the Mid-Atlantic Bight area combined during 2003-2006. Only stations where data was available for both cameras were included; any stations that were missing data from more than 2 quadrats were excluded. The number of stations varied each year with survey coverage (Figure 1).

Because the large and small cameras simultaneously collect data from the same locations, they can be directly compared for selectivity estimates. The large camera effective field of view is 3.235 m^2 at each quadrat and the small camera effective field of view is 0.788 m^2 (Stokesbury et al., 2004). The large camera's view field allows for a larger number of scallops to be identified and measured, whereas the small camera with higher resolution allows for detection of smaller scallops (Figure 2).

Selectivity comparisons were based on shell height measurements from the large and small cameras by year and area (Table 1). Shell height measurements were binned in 10 mm increments to minimize potential effects of imprecise shell height measurements. Increment mid-points were used in all calculations (e.g. 5 mm for the 1-9.99 mm bin). Millar's SELECT model (EXCEL Solver Version[6]) was used to fit an increasing logistic shape curve of selectivity for the large camera using the small camera as a standard. The model is:

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[6] http://www.stat.auckland.ac.nz/~millar/selectware/code.html

$$s_L = \left[\frac{e^{a+bL}}{1+e^{a+bL}} \right]$$

where s_L is selectivity at length and a and b are parameters (Millar and Fryer, 1999). A third "split" parameter p represents relative sampling intensity between the two gears and was initially estimated by taking the average of the ratio of the sample in the large camera to the total sample (large / large + small) at each shell height bin. The model was used to estimate the shell heights with selectivity values of 50% (L_{50}), 90% (L_{90}) and 95% (L_{95}) as well as the selectivity range (SR = L_{75}–L_{25}).

Results / Discussion

The estimated selectivity curves for all years in both Georges Bank and the Mid-Atlantic showed a similar pattern of low selectivity at small sizes, increasing between approximately 35mm to 80 mm and reaching an asymptote of 1.0 around 85 mm (Figures 3-6). Parameter estimates (Table 2) were generally similar although L_{50} and related statistics were relatively high and imprecise for 2004. Simple averages were used to calculate "best" overall selectivity parameters for sea scallops in the large camera (Table 3). Similar results were obtained when means were computed using inverse variance weights.

Deviance residuals indicate generally good model fit (Figure 7). There were some runs of positive and negative residuals in 2003 and 2004. In 2005 and 2006 the model seemingly overestimated selectivity for the very large scallop size bins but this is most likely a result of low sample sizes for large scallops due to their low abundance.

Appendix B7 Table 1. Numbers of sea scallops measured and counted used in this analysis from video surveys during 2003-2006 in the Mid-Atlantic Bight and Georges Bank.

	LARGE			SMALL		
	MA+GB	*MA all*	*GB all*	*MA+GB*	*MA all*	*GB all*
		2003			**2003**	
Measured	4001	3018	993	1322	1041	281
Total Counted	6860	5043	1817	2014	1554	460
		2004			**2004**	
Measured	2216	1363	853	528	330	198
Total Counted	3902	2430	1472	917	564	353
		2005			**2005**	
Measured	1866	1196	670	430	276	154
Total Counted	3696	2333	1363	839	555	284
		2006			**2006**	
Measured	2265	1528	737	535	344	191
Total Counted	3549	2218	1331	940	536	404

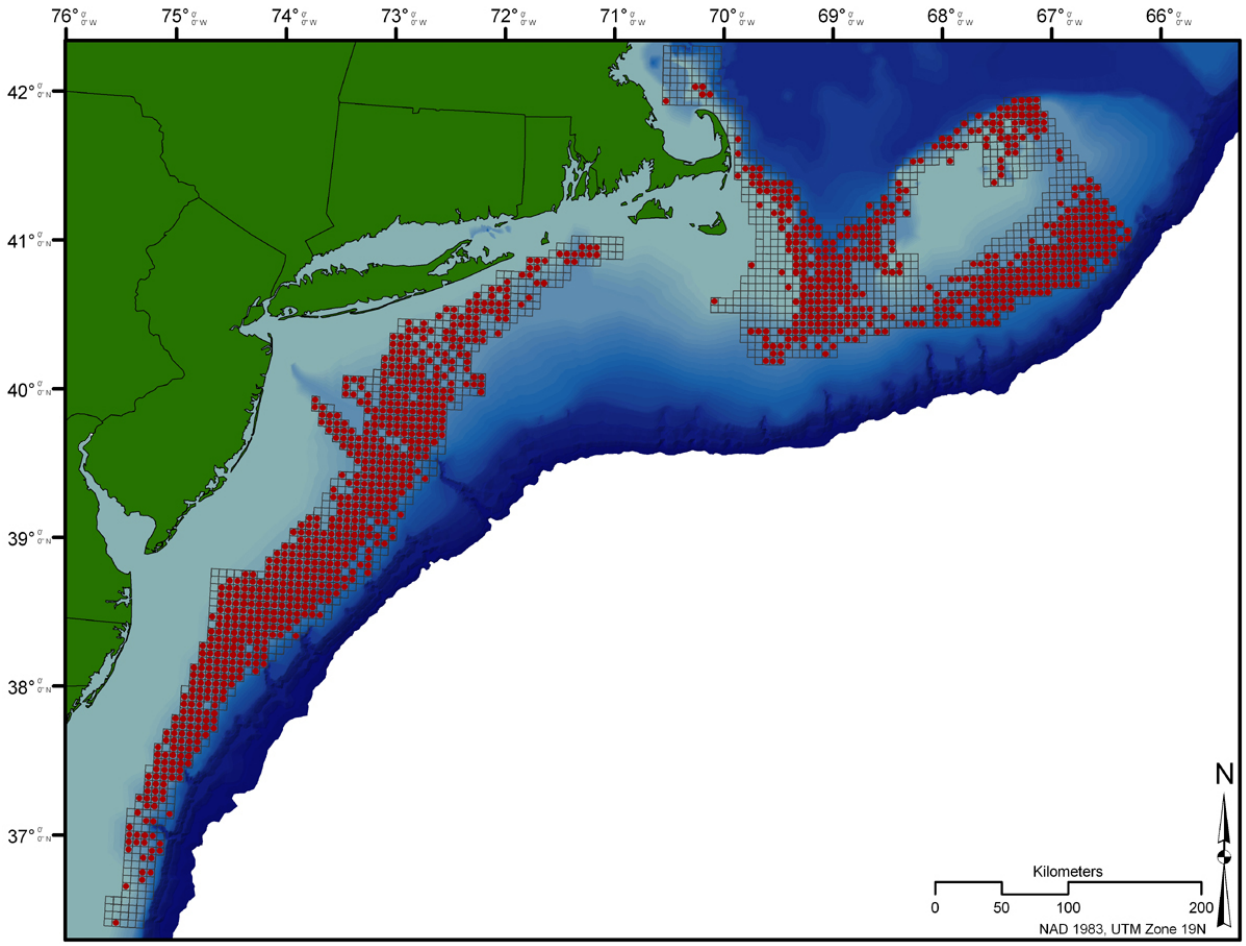
Appendix B7 Table 2. Estimated selectivity parameters p, a, b, L_{95}, L_{90}, L_{50} and SR with standard errors and variances from SELECT models fit to large and small camera video data collected during 2003-2006 on Georges Bank and in the Mid-Atlantic.

Year	2003	2004	2005	2006
Split (%)	88.5	83.8	82.5	81.8
SE(Split)	0.005	0.012	0.008	0.008
Var(Split)	2.75E-05	1.44E-04	6.40E-05	6.40E-05
weights	0.364	0.159	0.238	0.238
L95(mm)	85.71	103.07	63.99	64.96
SE(L90)	1.720	5.070	3.080	2.780
Var(L90)	2.959	25.705	9.486	7.728
weights	0.397	0.135	0.222	0.246
L90(mm)	77.62	90.62	57.43	59.98
SE(L90)	1.720	5.070	3.080	2.780
Var(L90)	2.959	25.705	9.486	7.728
weights	0.397	0.135	0.222	0.246
L50(mm)	54	54	38	45
SE(L50)	1.720	5.070	3.080	2.780
Var(L50)	2.959	25.705	9.486	7.728
weights	0.397	0.135	0.222	0.246
SR(mm)	24	36	19	15
SE(SR)	2.709	9.430	7.980	4.400
Var(SR)	7.341	88.925	63.680	19.360
weights	0.446	0.128	0.151	0.275
a	-4.98	-3.24	-4.35	-6.8
SE(a)	0.470	0.730	1.740	1.880
Var(a)	0.221	0.533	3.028	3.534
weights	0.462	0.297	0.125	0.115
b	0.09	0.06	0.11	0.15
SE(b)	0.011	0.016	0.047	0.045
Var(b)	1.11E-04	2.56E-04	0.002	0.002
weights	0.473	0.311	0.106	0.111

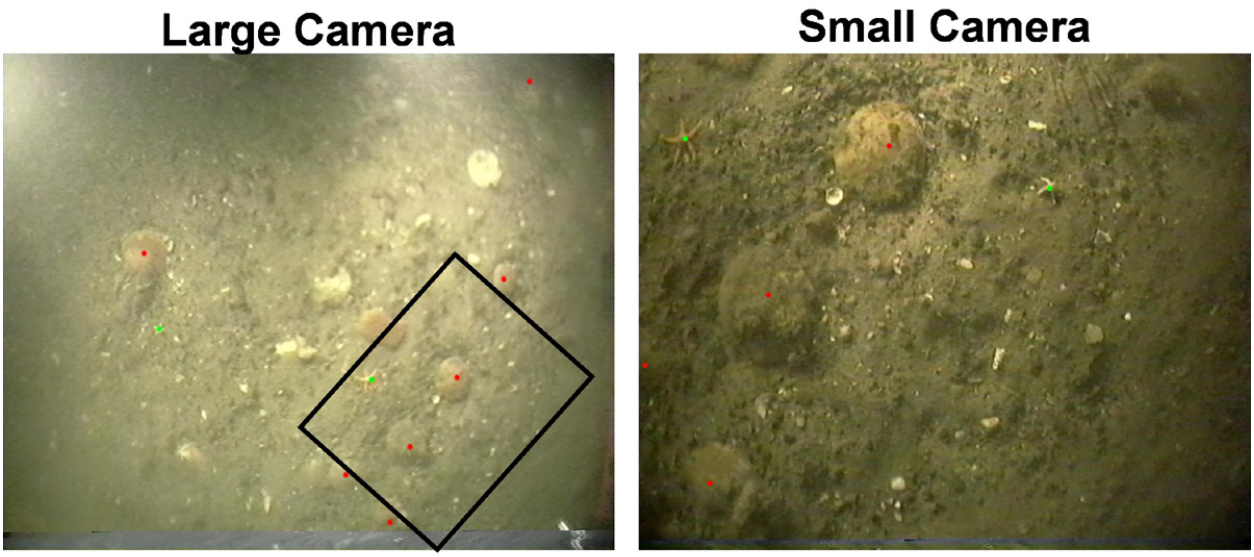
Appendix B7 Table 3. Average values for selectivity parameters p, a, b, L_{95}, L_{90}, L_{50} and SR with standard errors, variances, CVs and 90% confidence intervals from SELECT models fit to large and small camera video data collected during 2003-2006 on Georges Bank and in the Mid-Atlantic.

n=4 for experiment from 2003- 2006

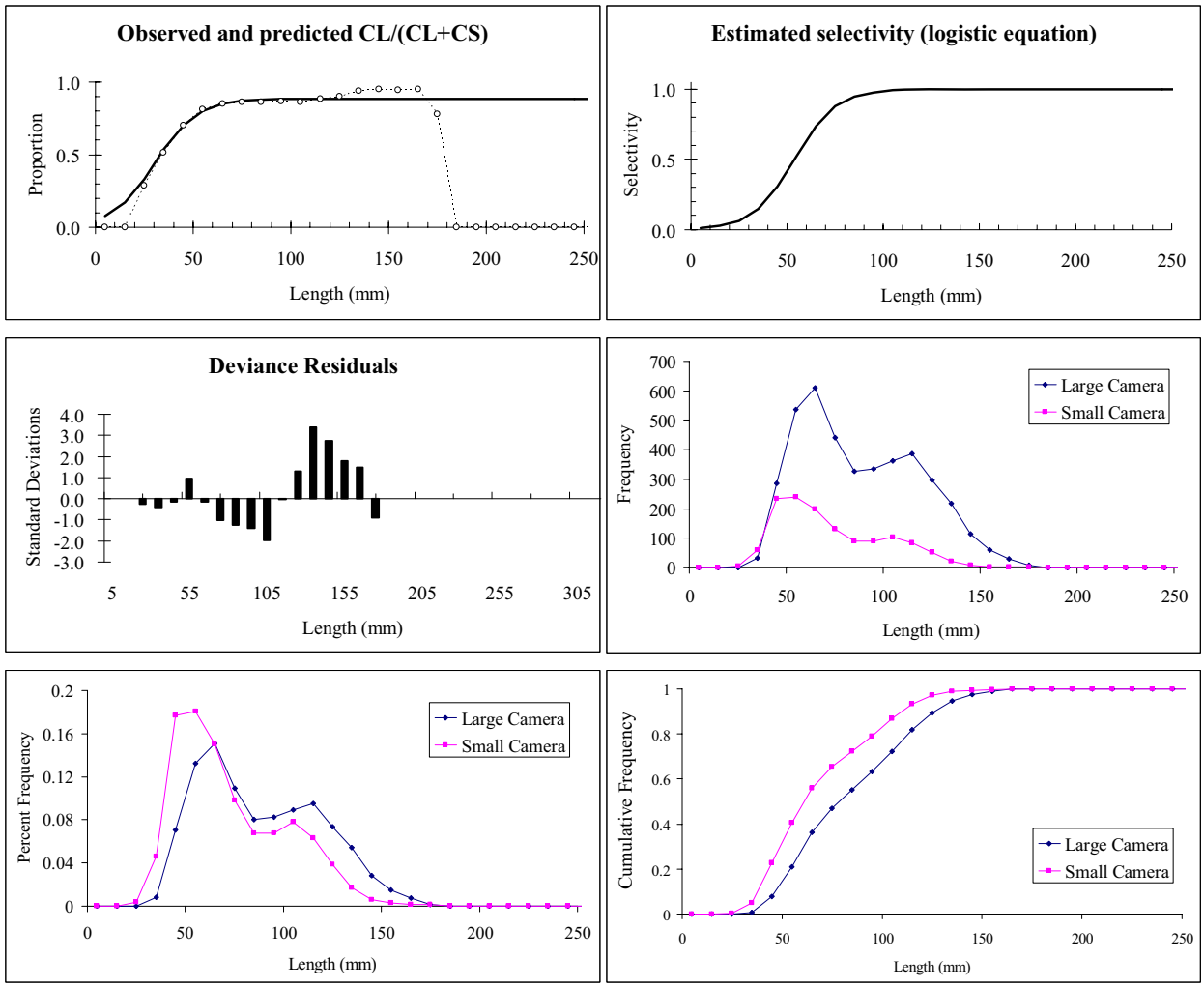
	Split (%)	L95(mm)	L90(mm)	L50(mm)	SR(mm)	a	b
Average	84.15	79.43	71.41	47.71	23.44	-4.84	0.10
Var	1.87E-05	2.867	2.867	2.867	11.207	0.457	0.000
SE	0.004	1.693	1.693	1.693	3.348	0.676	0.017
CV	5.14E-05	0.021	0.024	0.035	0.143	-0.140	0.163
CI90	0.008	3.319	3.319	3.319	6.561	1.325	0.033
Upper	84.16	82.75	74.73	51.03	30.01	-3.52	0.14
Lower	84.14	76.11	68.09	44.39	16.88	-6.17	0.07



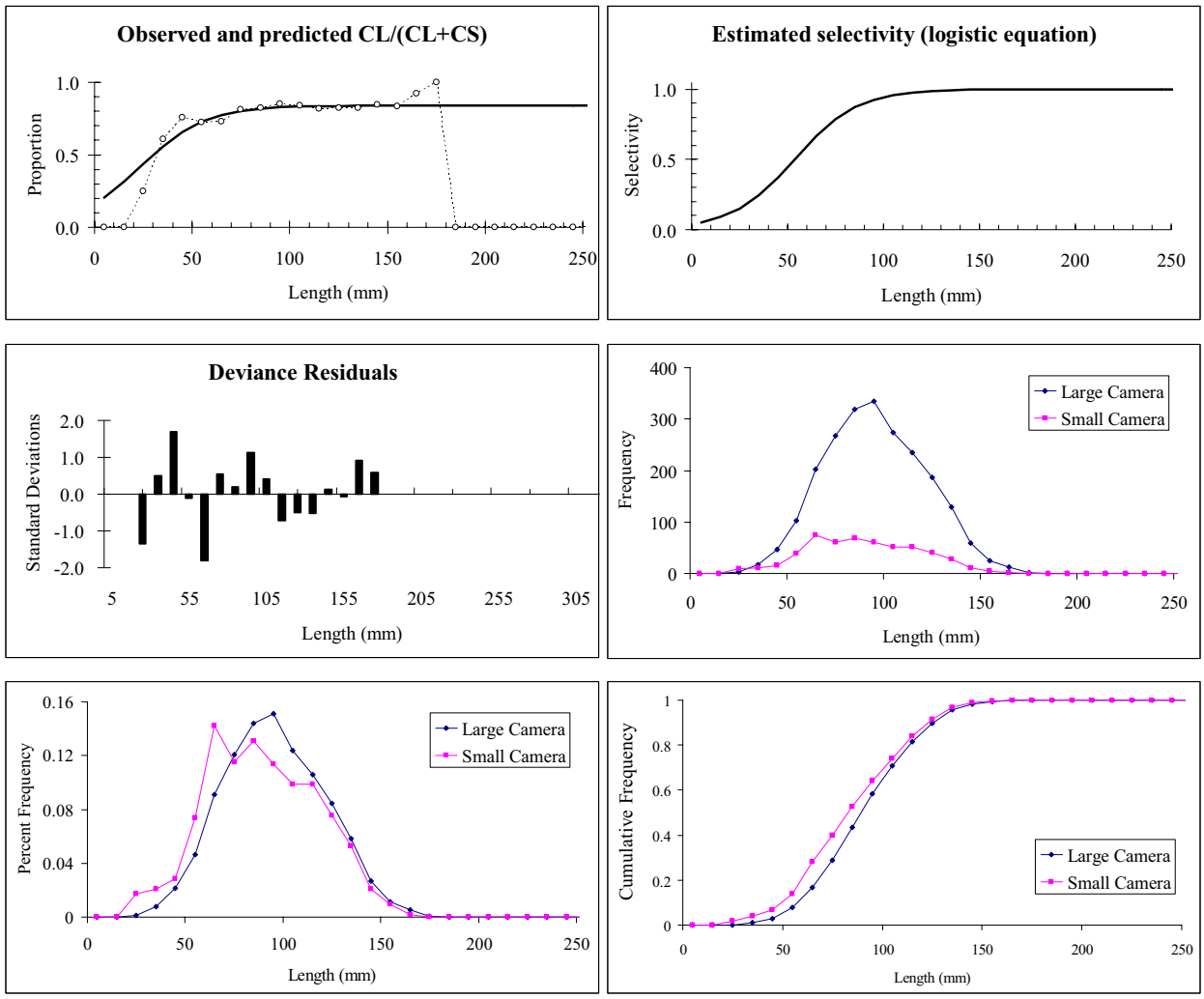
Appendix B7 Figure 1. SMAST video stations during 2003-2006. Stations where scallops were detected by both cameras in at least two quadrats were used to estimate selectivity curves and are highlighted in red.



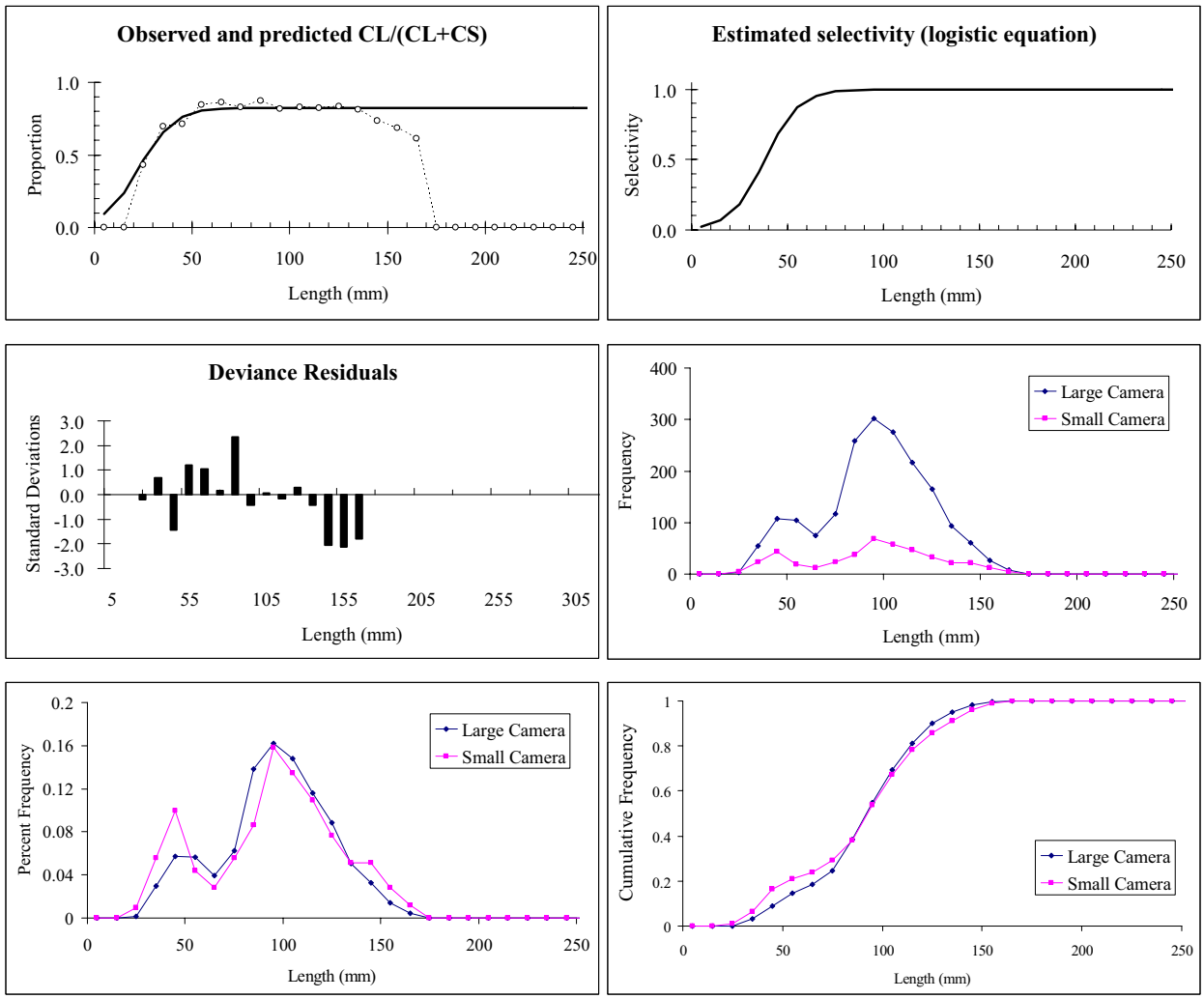
Appendix B7 Figure 2. *Left:* Large camera image with small camera inset. *Right:* Small camera inset enlarged



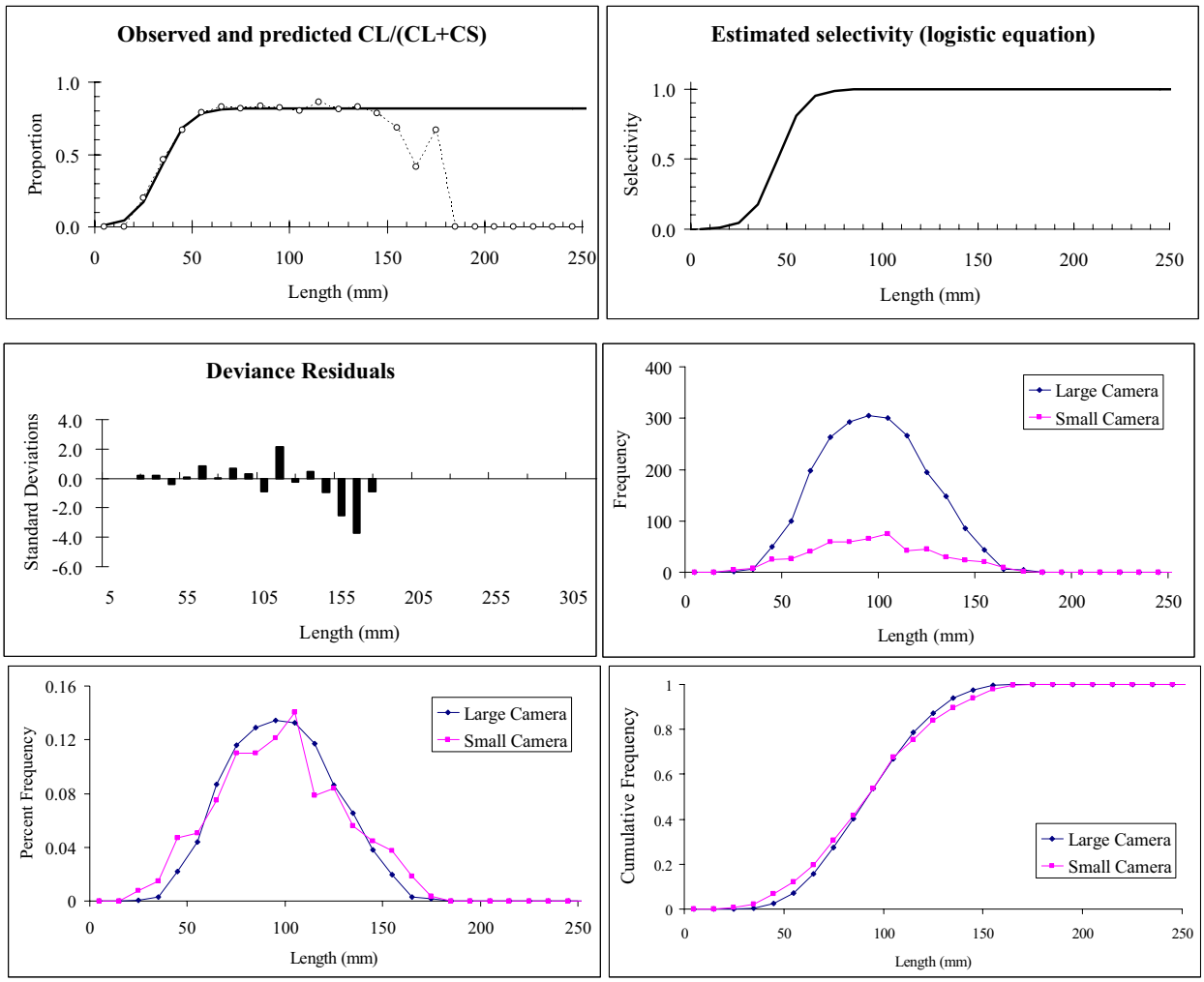
Appendix B7 Figure 3. Observed and predicted shell height measurements, Millar SELECT estimated selectivity logistic curve, deviance residuals for SELECT model, original shell height composition data (frequencies, percent, and cumulative frequencies) for video survey data from the Mid-Atlantic Bight and Georges Bank during 2003.



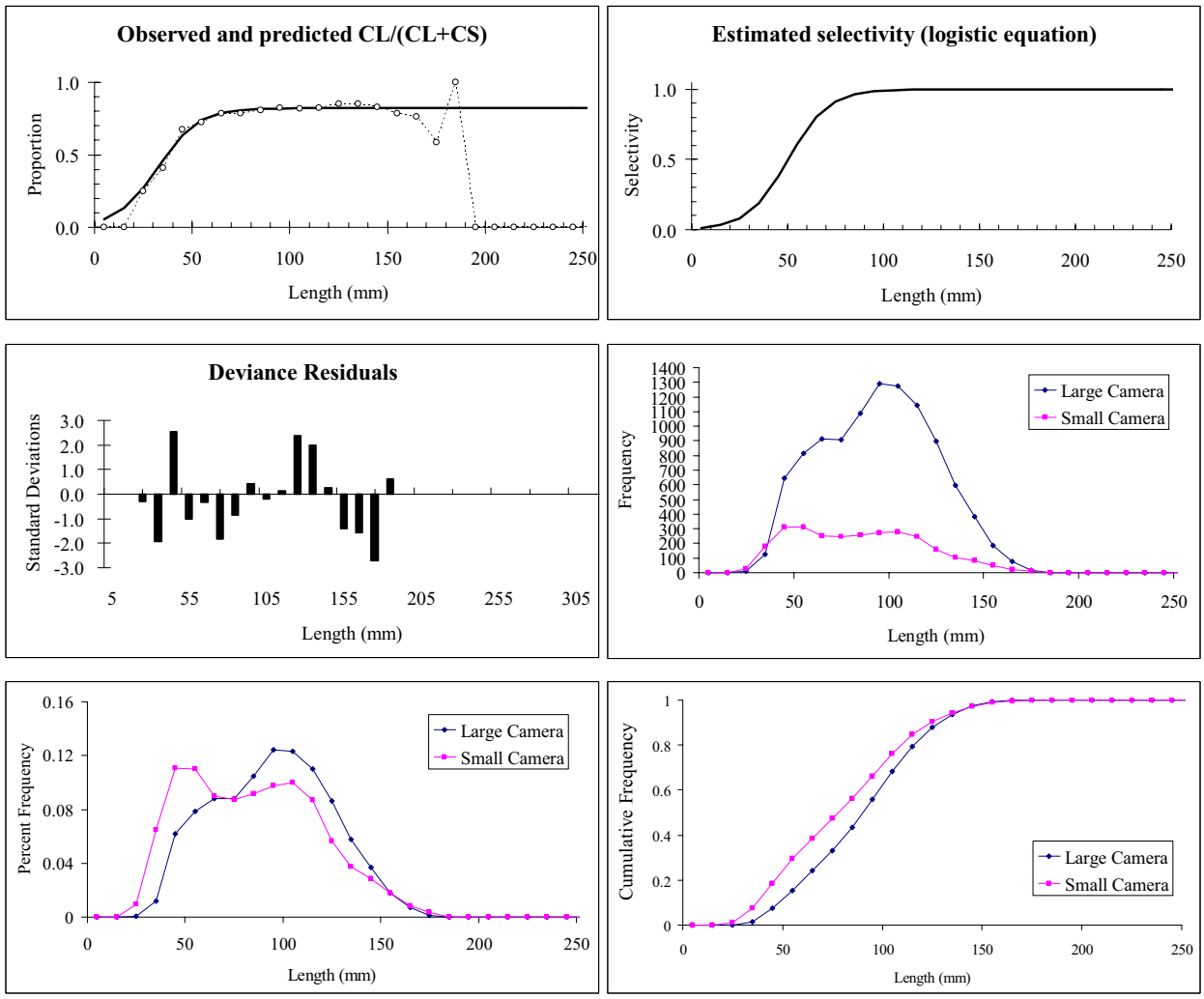
Appendix B7 Figure 4. Observed and predicted shell height measurements, Millar SELECT estimated selectivity logistic curve, deviance residuals for SELECT model, original shell height composition data (frequencies, percent, and cumulative frequencies) for video survey data from the Mid-Atlantic Bight and Georges Bank during 2004.



Appendix B7 Figure 5. Observed and predicted shell height measurements, Millar SELECT estimated selectivity logistic curve, deviance residuals for SELECT model, original shell height composition data (frequencies, percent, and cumulative frequencies) for video survey data from the Mid-Atlantic Bight and Georges Bank during 2005.



Appendix B7 Figure 6. Observed and predicted shell height measurements, Millar SELECT estimated selectivity logistic curve, deviance residuals for SELECT model, original shell height composition data (frequencies, percent, and cumulative frequencies) for video survey data from the Mid-Atlantic Bight and Georges Bank during 2006.



Appendix B7 Figure 7. Observed and predicted shell height measurements, Millar SELECT estimated selectivity logistic curve, deviance residuals for SELECT model, original shell height composition data (frequencies, percent, and cumulative frequencies) for video survey data from the Mid-Atlantic Bight and Georges Bank during 2003-2006 (combined).