Appendix I. Gulf of Maine winter flounder
by Paul Nitschke

SCALE Model Results

The use of a simple forward projecting model that tunes to length data for larger fish and indices of recruitment at age (SCALE) was investigated as an alternative model for Gulf of Maine winter flounder. For the biological reference point meeting recruitment indices at age in SCALE were estimated by length slicing due to questions of smearing across ages in the age-length keys. The assumed negligible error in the catch for the VPA was questioned with the poor sampling of the commercial landings data. For the final GARM III meeting length slicing indices were not used with the exception of the Seabrook index (Figures I19 through I22). Some SCALE runs modeled the population with the sexes separated. Females grow larger and appear to have a lower natural mortality rate than males (Figures I25 through I27). A natural mortality of 0.2 was assumed for females and 0.3 for males. Female based reference points were developed for the sex specific model. Similar results and status determinations are seen between the sex specific model and the single sex model. Both models had similar problems in the diagnostics.

The retrospective pattern in the SCALE model was very similar to the retrospective pattern seen in the VPA. The scale model can not fit the age 1 and 2 recruitment indices along with the trends in the catch, 30+ cm abundance indices, and 30+ cm survey length frequencies. Lower weights on the recruitment indices and a low penalty on recruitment variation were used to allow the model to produce a lack of fit to the recruitment indices so that a larger initial population in 1982 can be estimated by the model. The model needs to estimate a declining trend in recruitment to fit the trend in the catch and the adult abundance in the surveys. Splitting the surveys had the same effect as in the VPA (Figure I31). This allowed the model to estimate further declines in the recruitment indices to produce a closer fit to the catch. Comparisons between the split SCALE and VPA runs can be seen in Table I4 and Figure I32. The splitting of the survey results in about a tripling of the survey Qs (Table I3).

SCALE Model Biological Reference Points

For SCALE the length based selectivity was converted to an age based vector (Figure I56). Mean weights of the population and the catch was estimated by sex or for the sexes combined (Figure I35). Long term AGEPRO projections were run to determine the biological reference points. Separate runs were done for each sex in the sex specific model to estimate biological reference points.

$F_{40\%}$ was also estimated within the SCALE model so that the model will be consistent with the reference points. $F_{40\%}$ was estimated with the sexes combined using a female maturity vector. $F_{40\%}$ was also estimated for a female only SSB_{msy} reference point and a two sex MSY yield. The scale model estimated $F_{40\%}$ at 0.38 in the combined sex model (run 5) and 0.35 for females in the sex specific model (run 6) (Table I4). Little differences in the estimated selectivity exists between the age based VPA model and the SCALE model. Lower mean weights of the older fish from the estimated growth curve in the SCALE model likely contributed to the higher $F_{40\%}$ reference points from the SCALE model.

Table I1. Gulf of Maine winter flounder large and small mesh trawl and gillnet kept ratios (kept/sum all species kept), CVs, and estimated landings in metric tons.

	Kept Ratio			CV			Metric Tons		
	trawl			trawl			trawl		
year	lg mesh	sm mesh	gillnet	lg mesh	sm mesh	gillnet	lg mesh	sm mesh	gillnet
1989	0.006	0.015	0.007	0.38	0.45	0.58	131	27	107
1990	0.001	0.000	0.015	0.47	0.77	0.44	42	1	244
1991	0.019	0.001	0.003	0.44	0.54	0.22	572	2	43
1992	0.008	0.001	0.013	0.49	0.58	0.13	227	4	163
1993	0.004	0.027	0.014	0.76	0.53	0.14	93	68	236
1994	0.001		0.006	0.83		0.88	14	0	84
1995	0.032	0.000	0.005	1.03		0.28	575	0	83
1996	0.017	0.000	0.007	2.32		0.41	305	0	99
1997	0.001	0.040	0.021	2.01	0.33	0.51	12	76	262
1998	0.005		0.010	0.80		0.37	65	0	136
1999	0.110	0.000	0.007	0.66		0.45	1241	0	57
2000	0.012		0.023	0.40		0.39	179	0	183
2001	0.025	0.000	0.011	0.25		0.72	410	0	85
2002	0.028	0.005	0.045	0.29	0.51	0.40	446	7	295
2003	0.021	0.013	0.033	0.19	0.54	0.18	369	7	220
2004	0.031	0.034	0.025	0.21	0.72	0.13	841	13	176
2005	0.021	0.018	0.012	0.16	0.38	0.15	404	6	78
2006	0.017	0.003	0.002	0.27	0.39	0.41	189	1	12
2007	0.012	0.005	0.013	0.20	0.34	0.37	121	4	98

Table I2. Split SCALE area swept estimated Qs.

Scale run 5 (0.1 wt rec, 20wt catch)

survey	season	age	split	q
DMF	Spr	1	1	0.44
DMF	Spr	2	1	0.92
DMF	Spr	3	1	0.85
DMF	Fall	0	1	0.01
DMF	Fall	1	1	0.89
DMF	Fall	2	1	1.03
SEA	Spr	1	1	0.000001
SEA	Spr	2	1	0.000002
NEFSC	spr	1	1	0.01
NEFSC	spr	2	1	0.10
NEFSC	spr	3	1	0.20
NEFSC	Fa	1	1	0.05
NEFSC	Fa	2	1	0.22
DMF	Spr	1	2	1.46
DMF	Spr	2	2	3.16
DMF	Spr	3	2	2.09
DMF	Fall	0	2	0.05
DMF	Fall	1	2	3.05
DMF	Fall	2	2	3.07
NEFSC	spr	1	2	0.03
NEFSC	spr	2	2	0.21
NEFSC	spr	3	2	0.52
NEFSC	Fall	0	2	0.13
NEFSC	Fall	1	2	0.55
DMF	Spr	30+	1	0.62
DMF	Fall	30+	1	0.38
NEFSC	Spr	30+	1	0.20
NEFSC	Fall	30+	1	0.20
DMF	Spr	30+	2	1.44
DMF	Fall	30+	2	1.27
NEFSC	Spr	30+	2	0.46
NEFSC	Fall	30+	2	0.80

Table I3. Split SCALE area swept Q ratios (2^{nd}/1st).

Scale run 5 (0.1 wt rec, 20wt catch)

survey		age	q ratio (2nd/1st)
DMF	Spr	1	3.3
DMF	Spr	2	3.4
DMF	Spr	3	2.5
DMF	Fall	0	4.8
DMF	Fall	1	3.4
DMF	Fall	2	3.0
DMF	Spr	1	3.3
DMF	Spr	2	3.4
DMF	Spr	3	2.5
DMF	Fall	0	4.8
DMF	Fall	1	3.4
DMF	Fall	2	3.0
DMF	Spr	30+	2.3
DMF	Fall	30+	3.4
NEFSC	Spr	30+	2.3
NEFSC	Fall	30+	4.0

Table I4. Non-parametric empirical biological reference points from the VPA and SCALE models for Gulf of Maine winter flounder.

	1 VPA Base	2 VPA Split	3 SCALE Split	4 SCALE Split	5 SCALE Split	6 SCALE Split
	all indices	all indices	1.0 wt rec	0.1 wt rec	0.1 wt rec 20 wt catch	separate sex
F40%	0.30	0.28	0.38	0.39	0.38	0.35
YPR	0.237	0.235	0.214	0.215	0.214	0.162
SSBR	0.972	0.972	0.846	0.851	0.843	0.481
Mean Recruit million	4.585	4.072	4.286	4.251	4.289	2.582
MSY	1,050	917	902	873	873	lower
SSBMSY	4,305	3,792	3,162	3,069	3,040	2,146
SSB07	2,765	1,100	1,723	1,030	1,067	725
F07	0.11	0.42	0.27	0.53	0.47	0.48
SSB07/SSBMSY	64%	29%	54%	34%	35%	34%
F07/FMSY	39%	147%	71%	135%	125%	136%

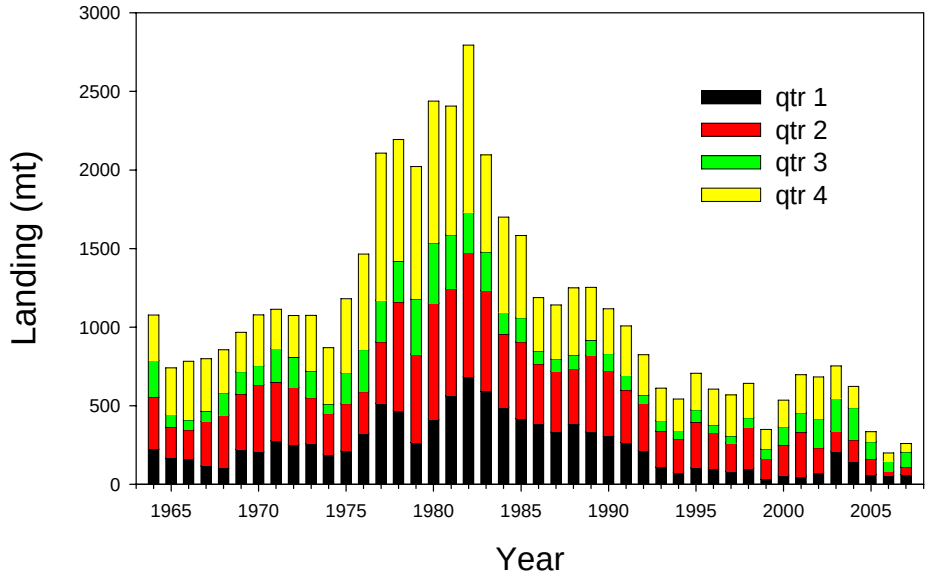


Figure I1. Gulf of Maine winter flounder commercial landings by quarter from 1964-2007.

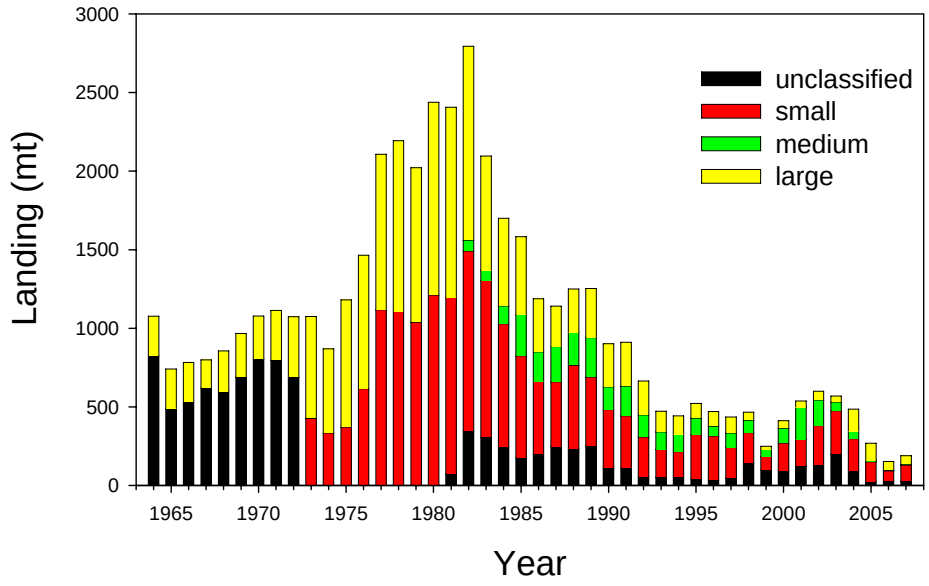


Figure I2. Gulf of Maine winter flounder commercial landings by market category from 1964-2007.

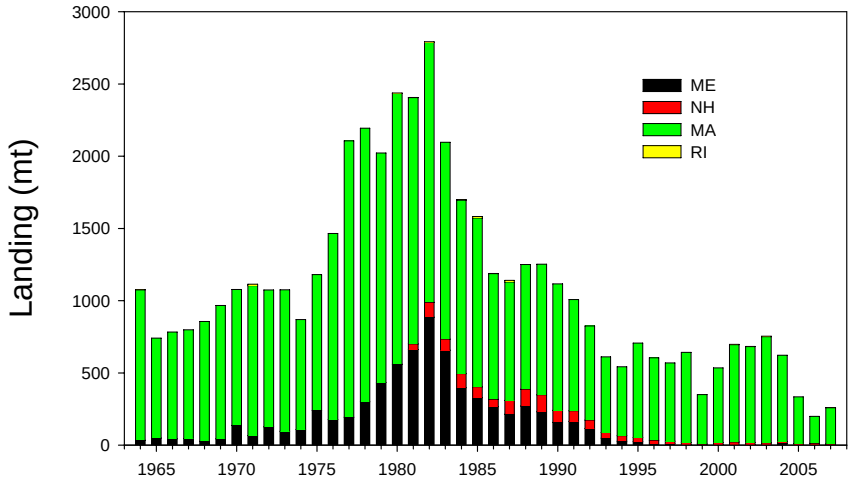


Figure I3. Commercial landings by state from 1964-2007.

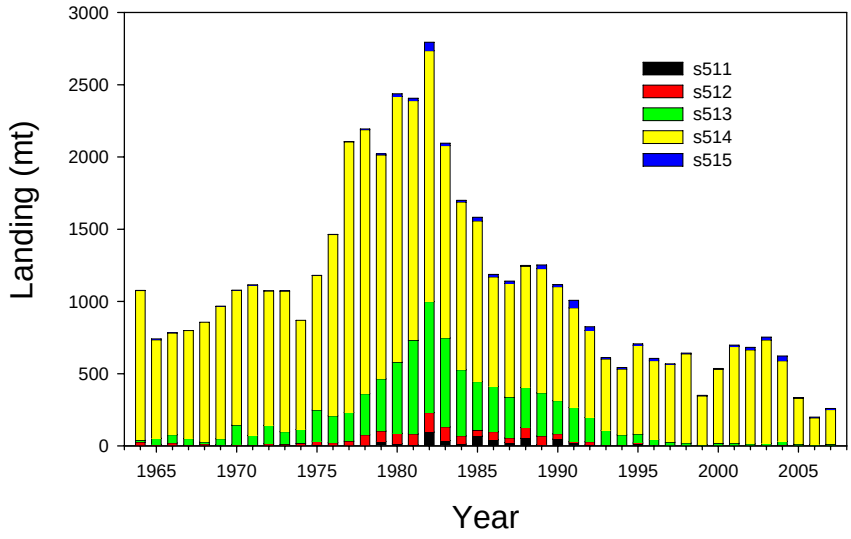


Figure I4. Commercial landings by statistical area from 1964-200

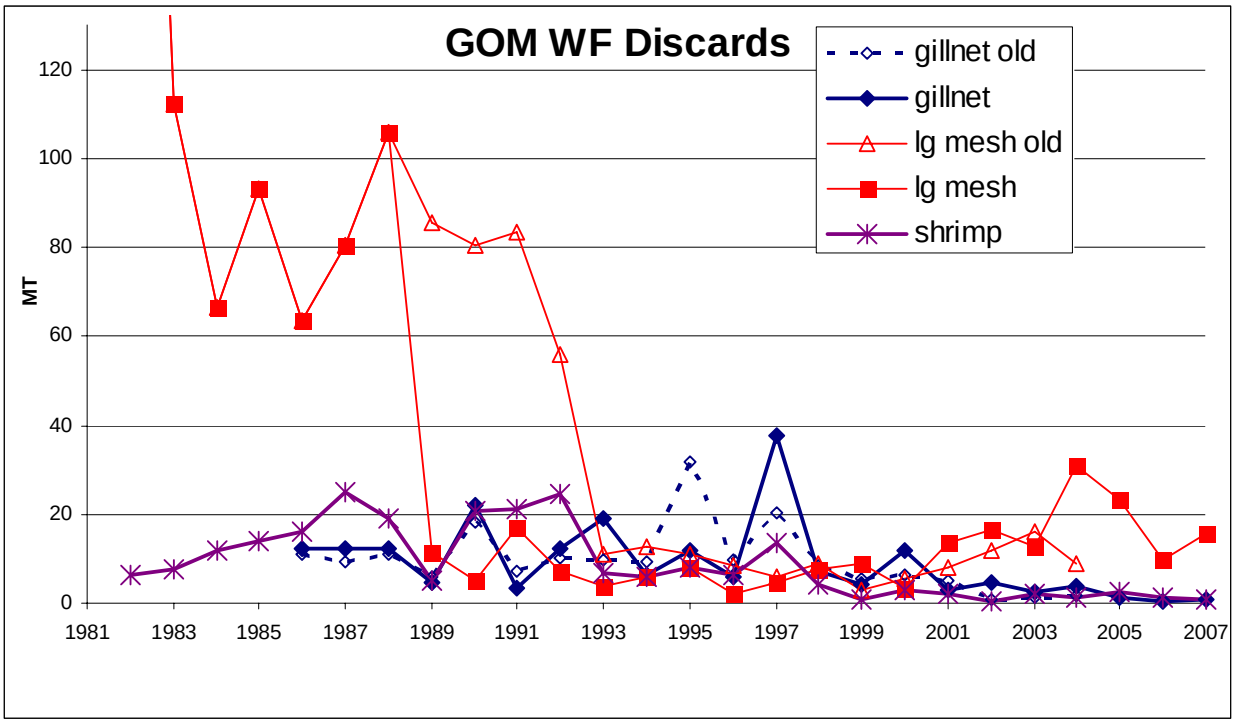


Figure I5. Estimated discards using the GARM II method and updated GARM III method.

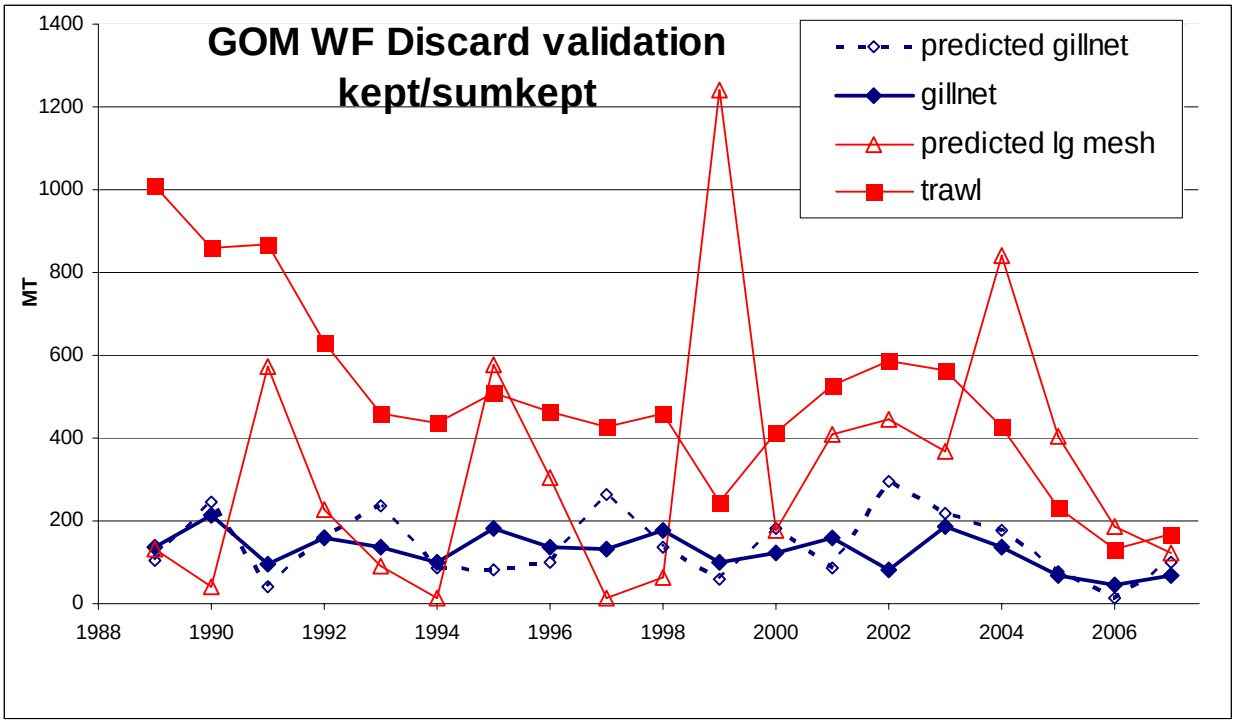


Figure I6. Estimated landings using the kept to sum all species ratios and the actual landings by fleet.

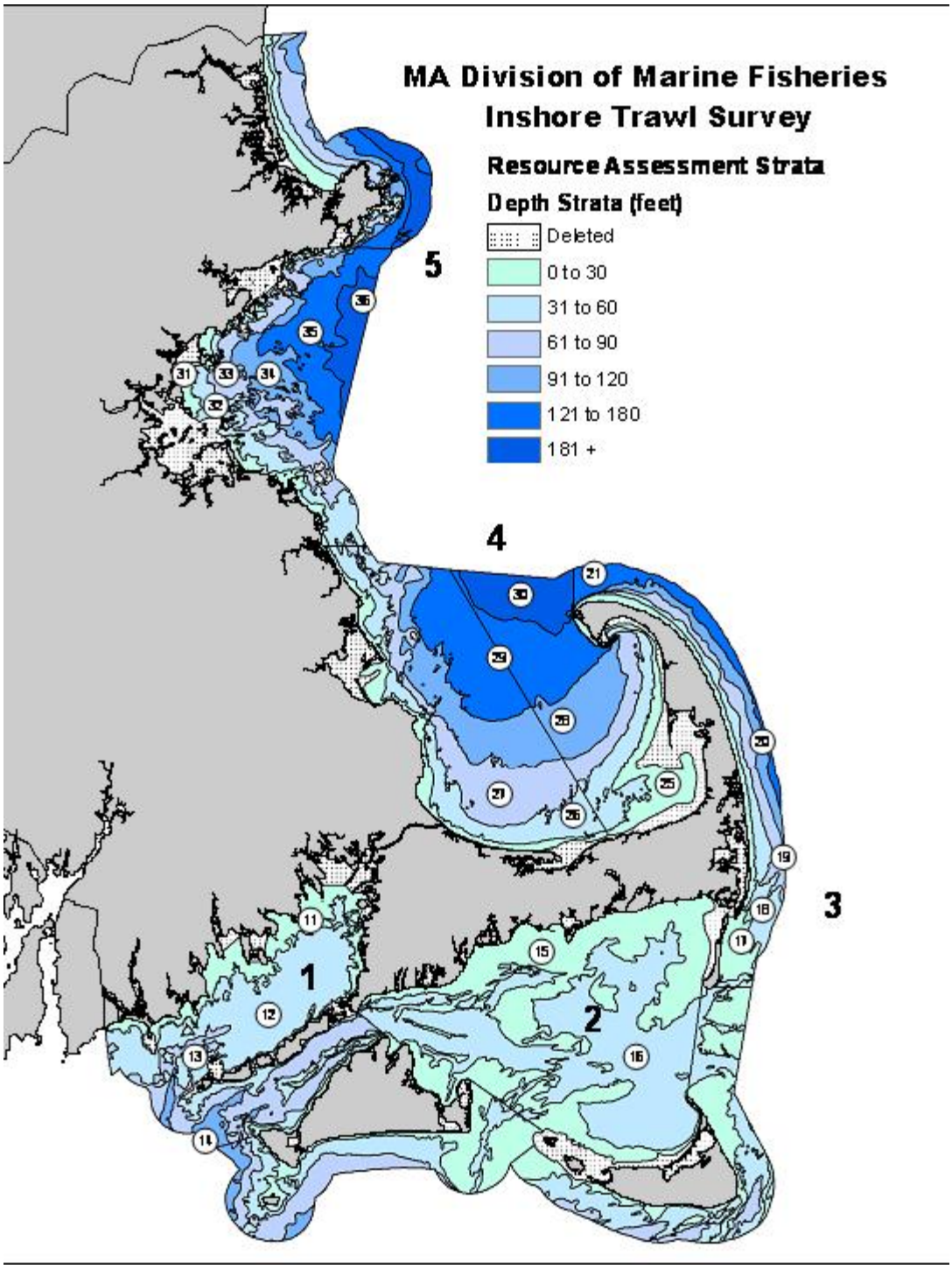


Figure I7. Survey strata for the MDMF bottom trawl survey.

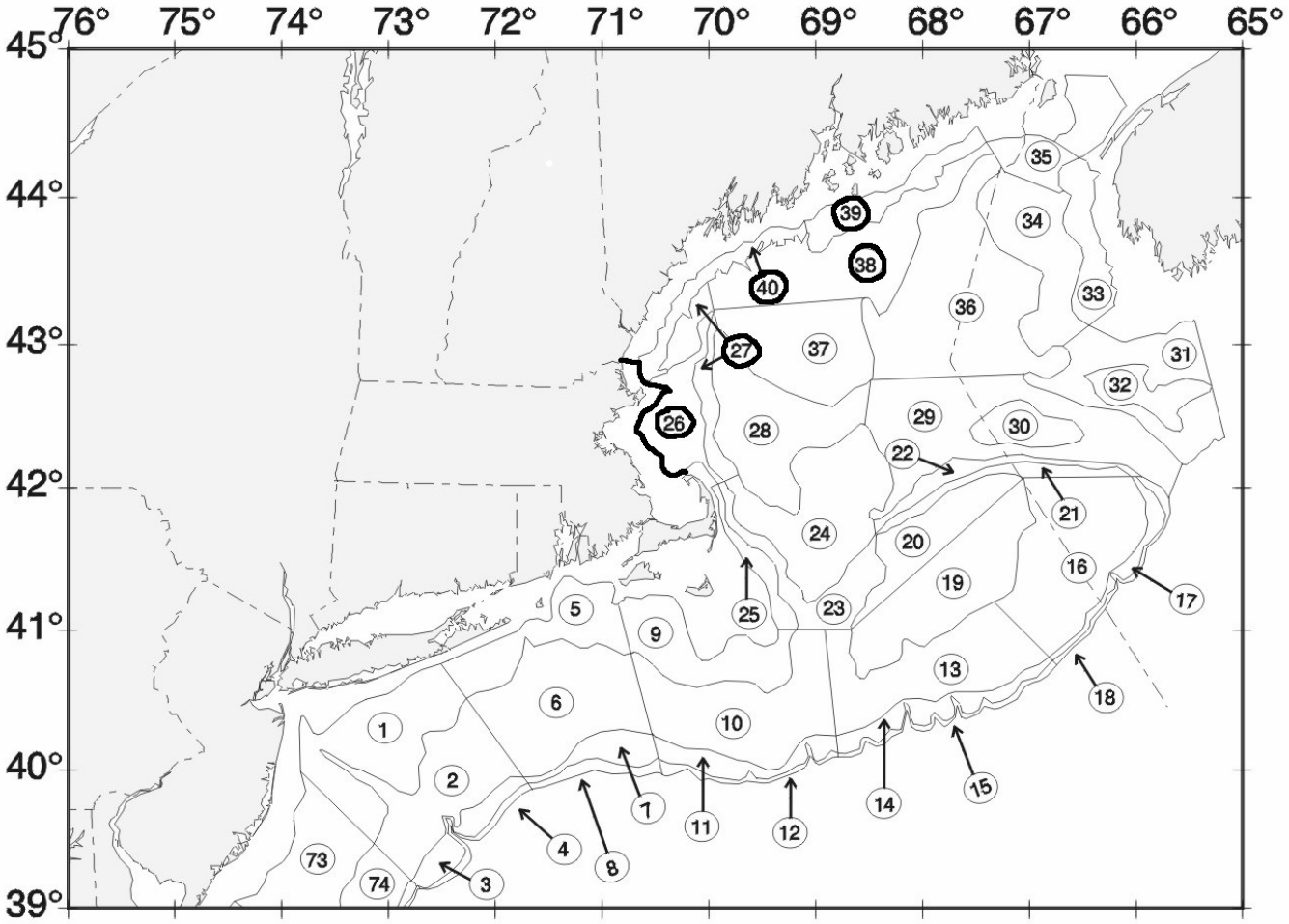


Figure I8. Offshore survey strata for the NEFSC bottom trawl survey for Gulf of Maine winter flounder.

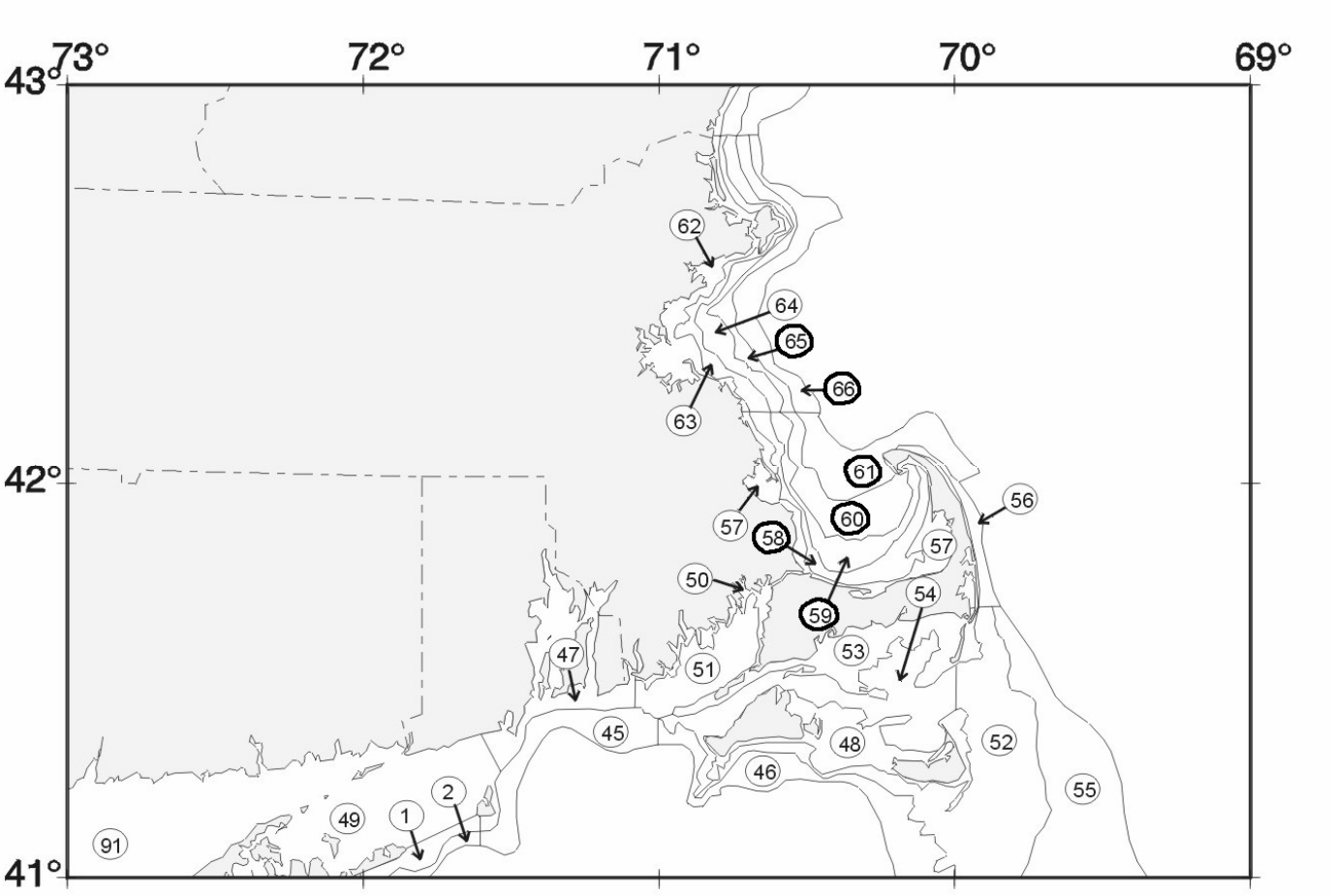


Figure I9. Inshore survey strata for the NEFSC bottom trawl survey for Gulf of Maine winter flounder.

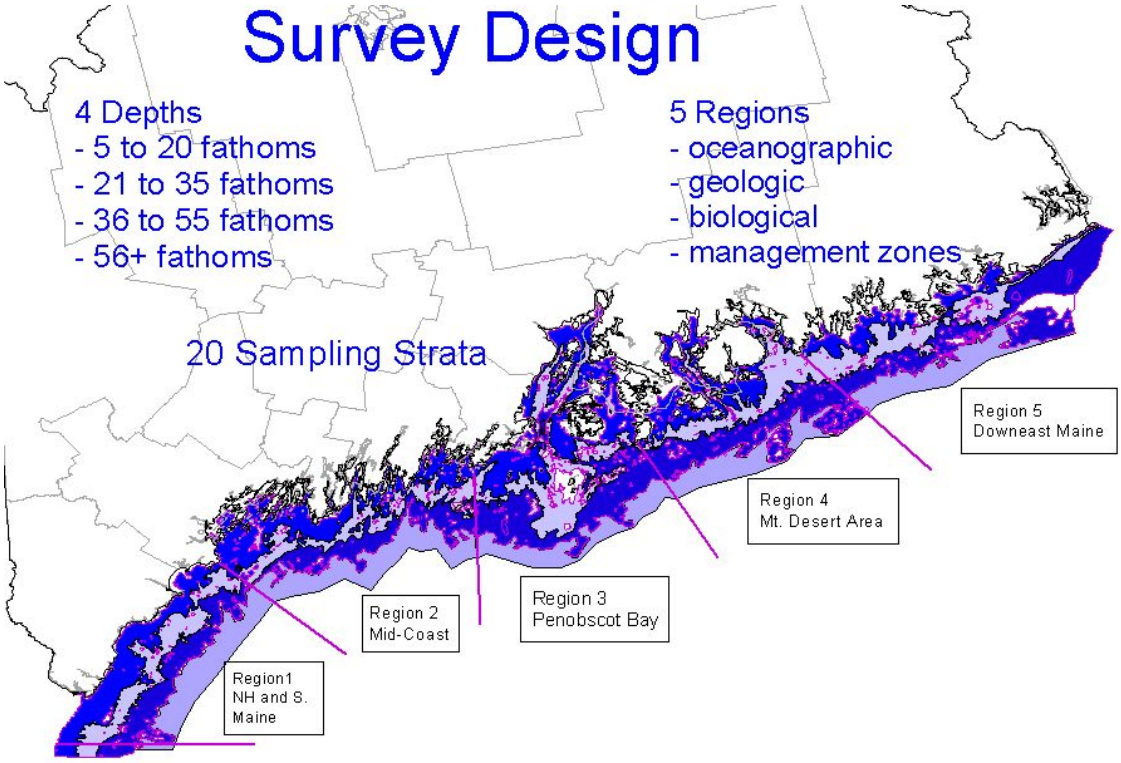


Figure I10. Survey strata for the NH/ME bottom trawl survey.

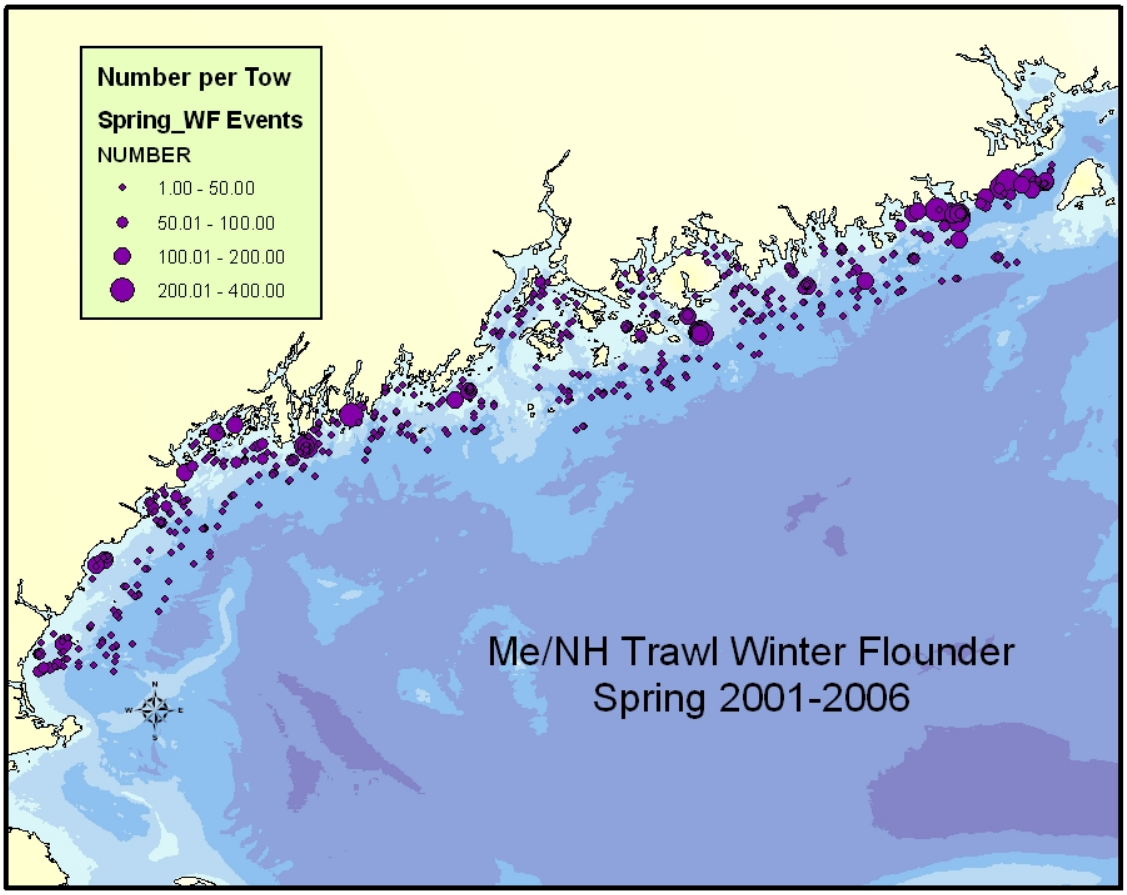


Figure I11. Spring ME/NH bottom trawl survey winter flounder distribution.

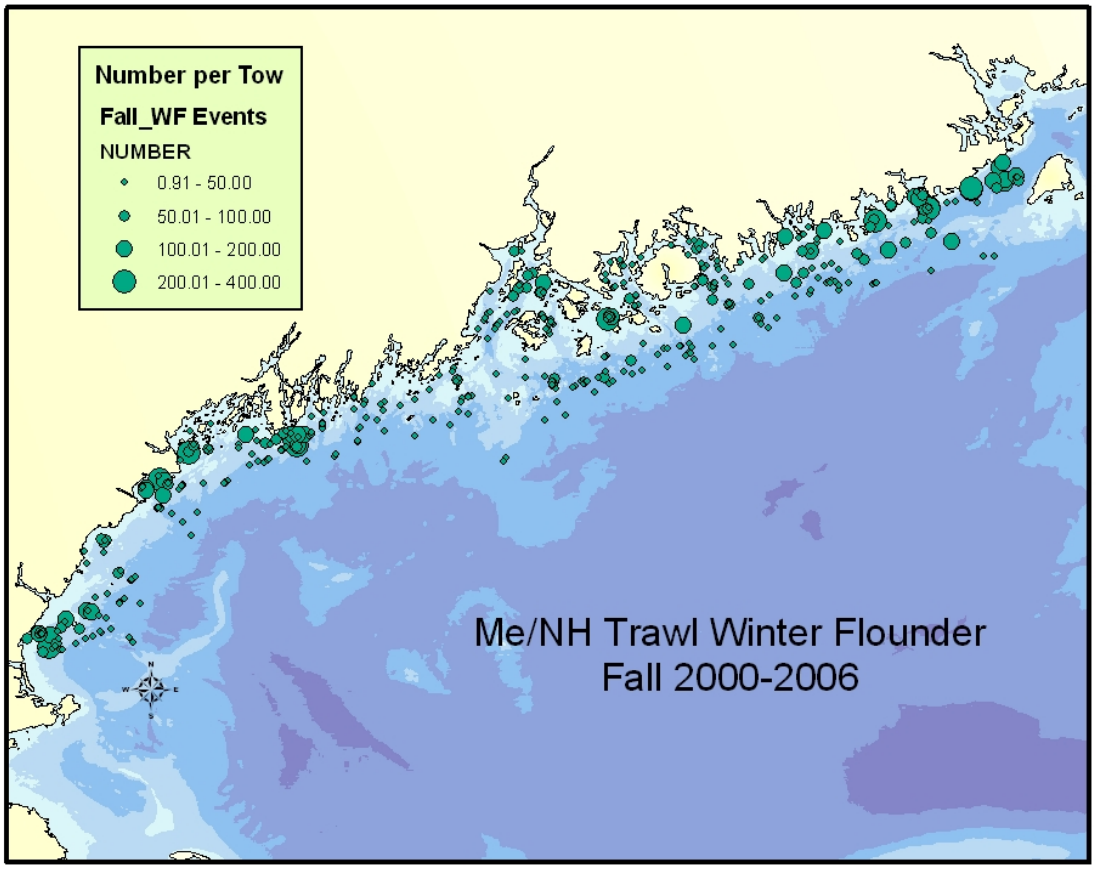


Figure I12. Fall ME/NH bottom trawl survey winter flounder distribution.

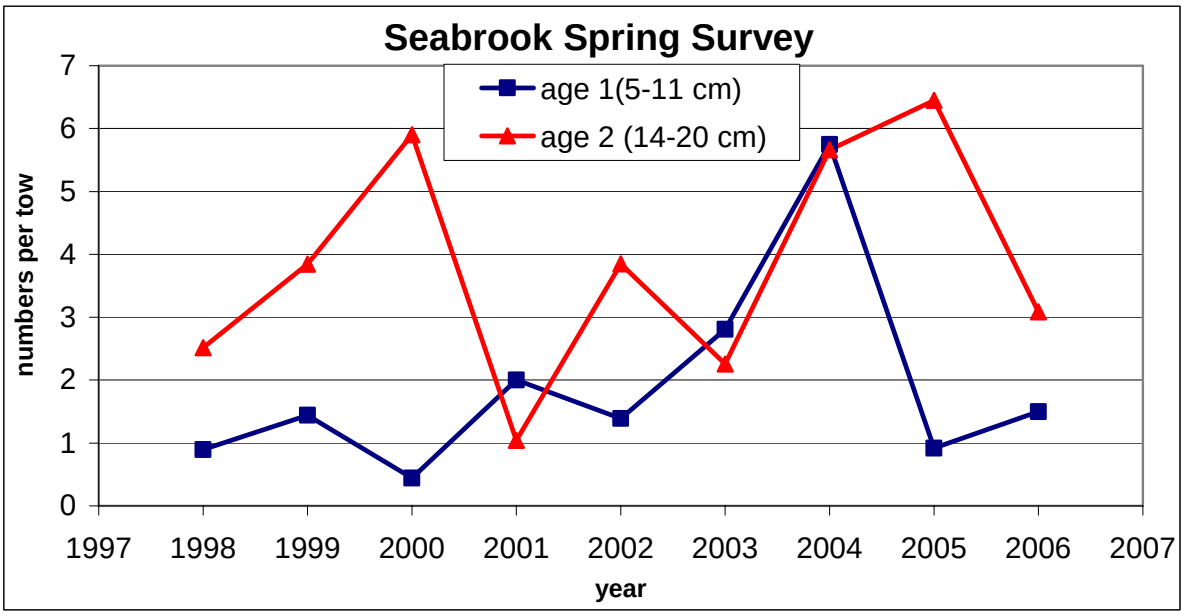


Figure I13. Estimated Seabrook age 1 and 2 index using length slicing.

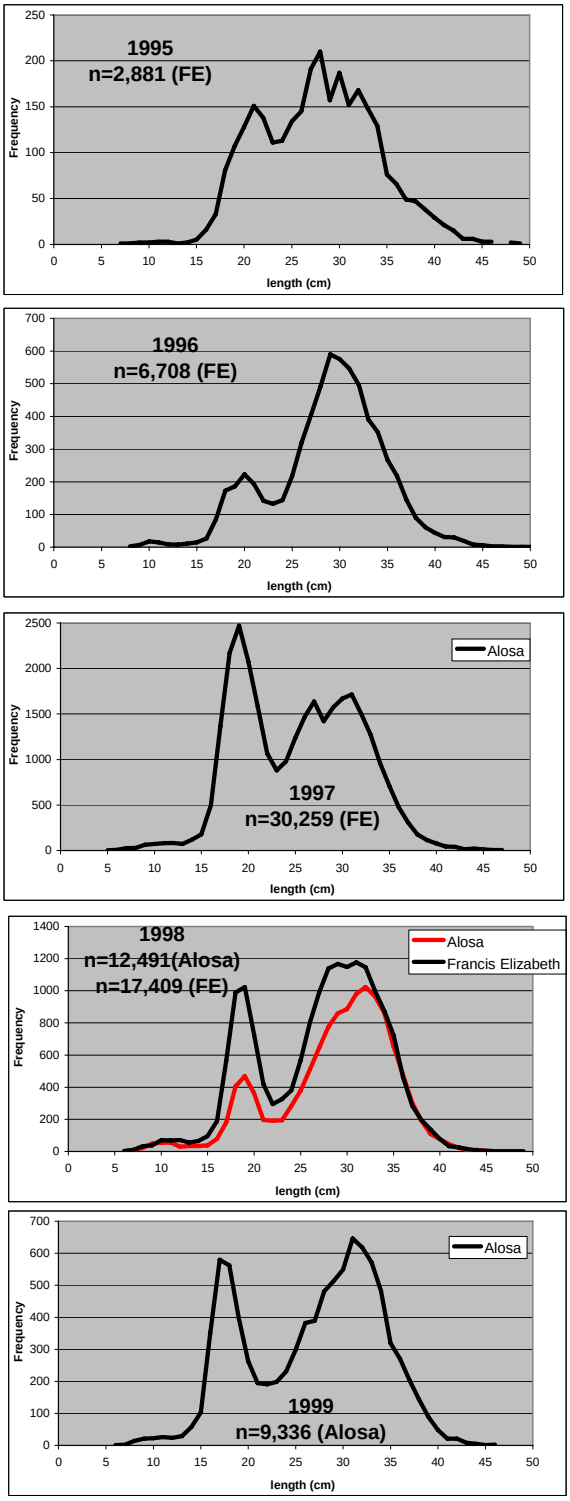


Figure I14. Length frequency distributions from the Pilgrim Nuclear power plant winter flounder area swept study in Western Cape Cod Bay. 1998 and 1999 had an additional vessel (FV Alosa) was contracted for the survey.

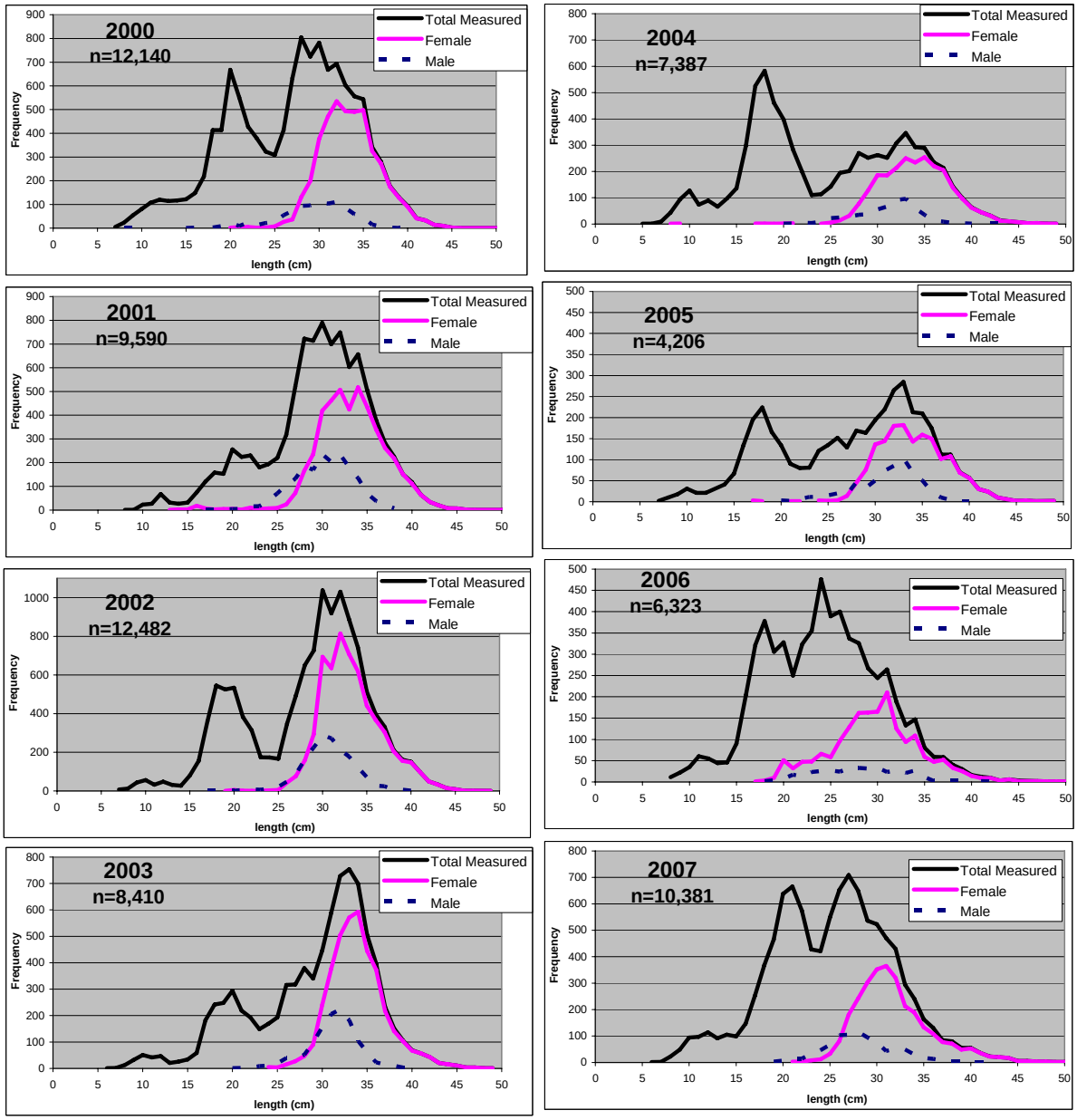


Figure I4. Cont.

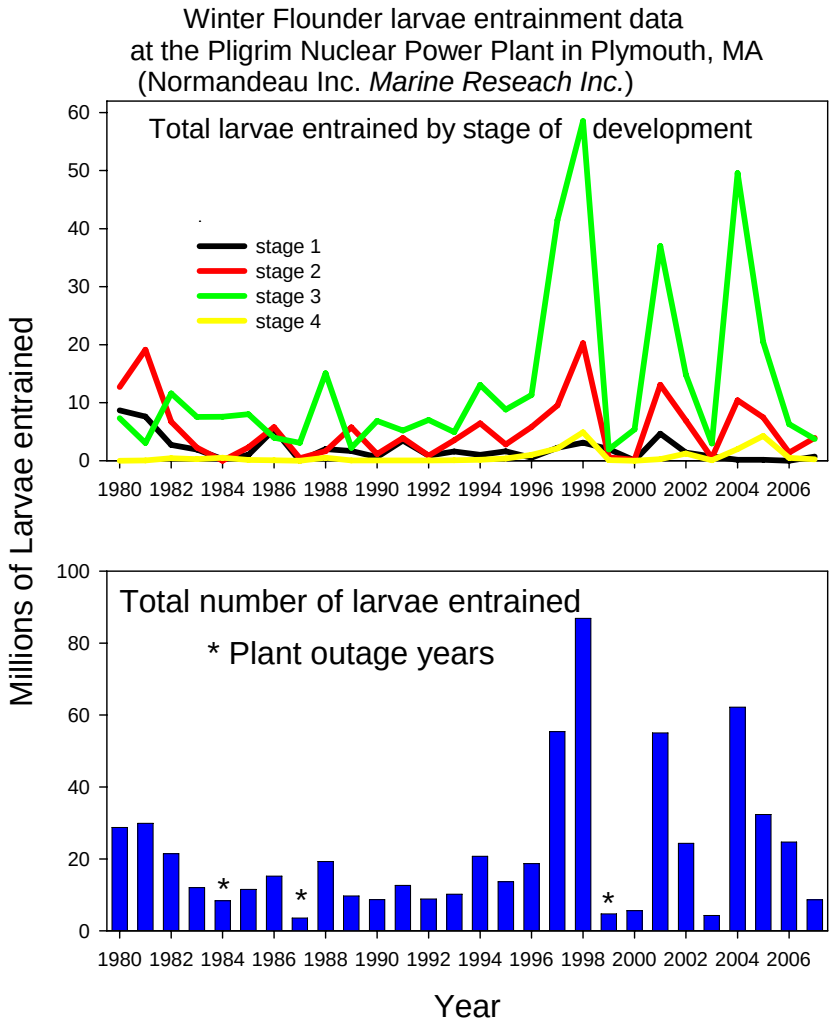


Figure I15. Entrainment of winter flounder larvae at the Pilgrim Nuclear power plant in Plymouth MA from Normandeau Inc.

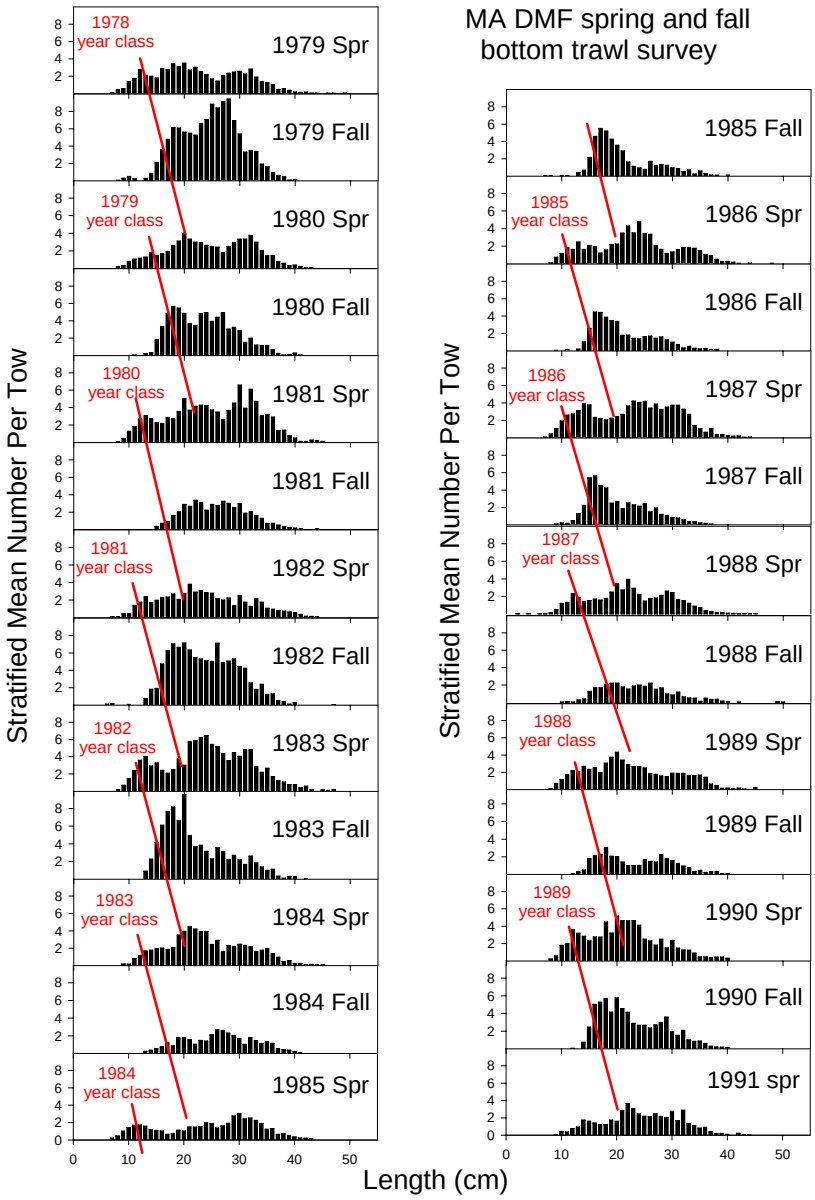


Figure I16. Spring and fall MDMF bottom trawl survey Gulf of Maine winter flounder catch per tow at length.

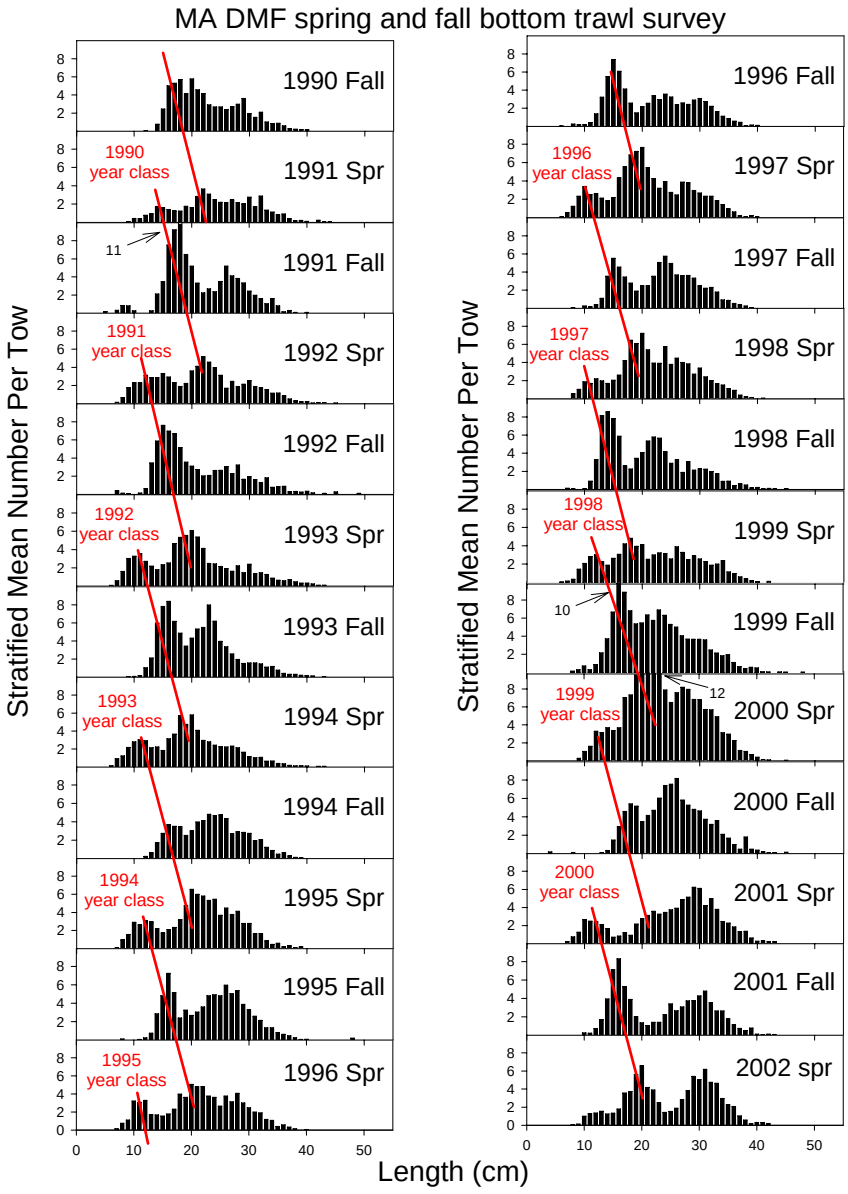
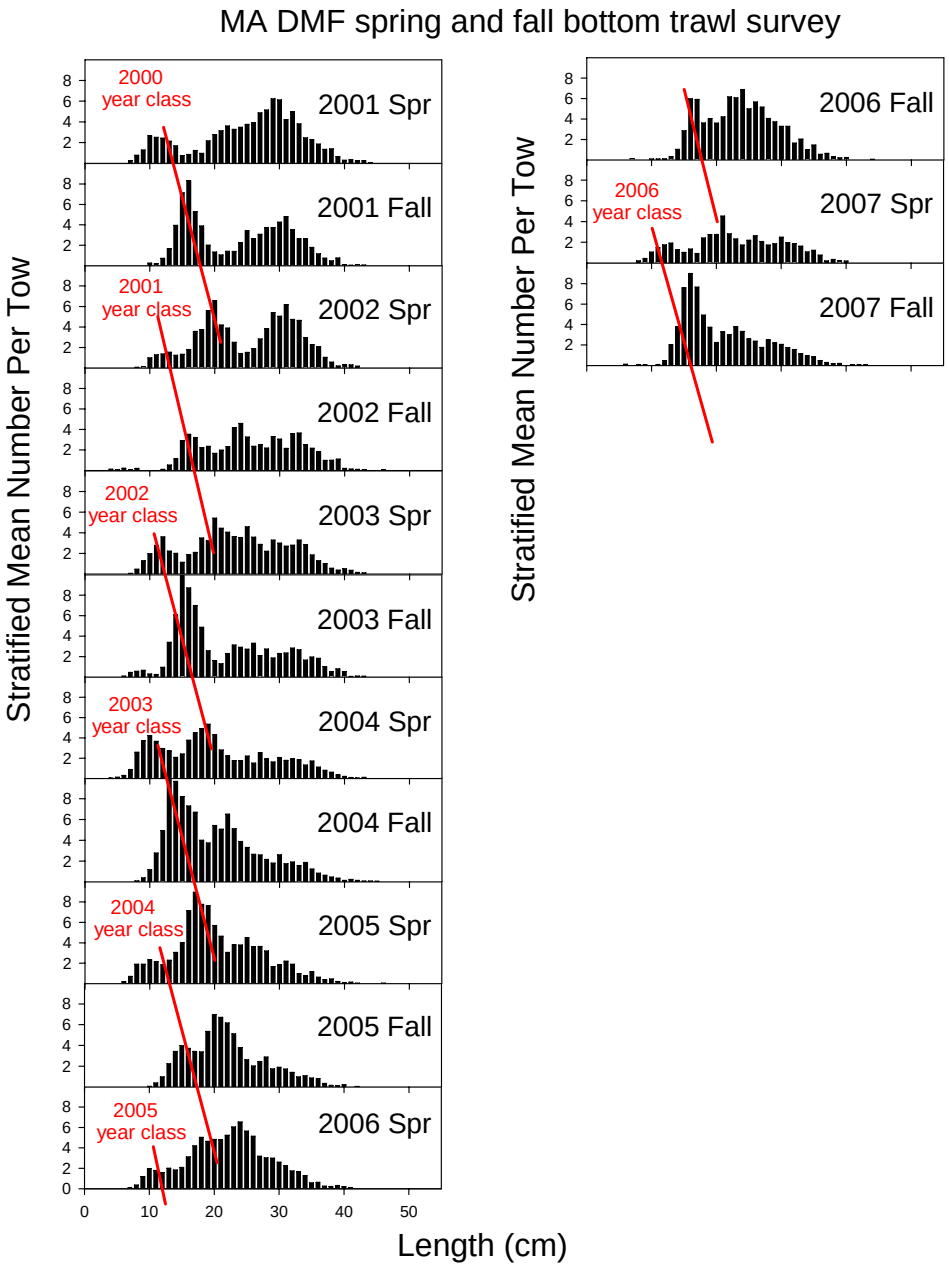


Figure I16. Cont.



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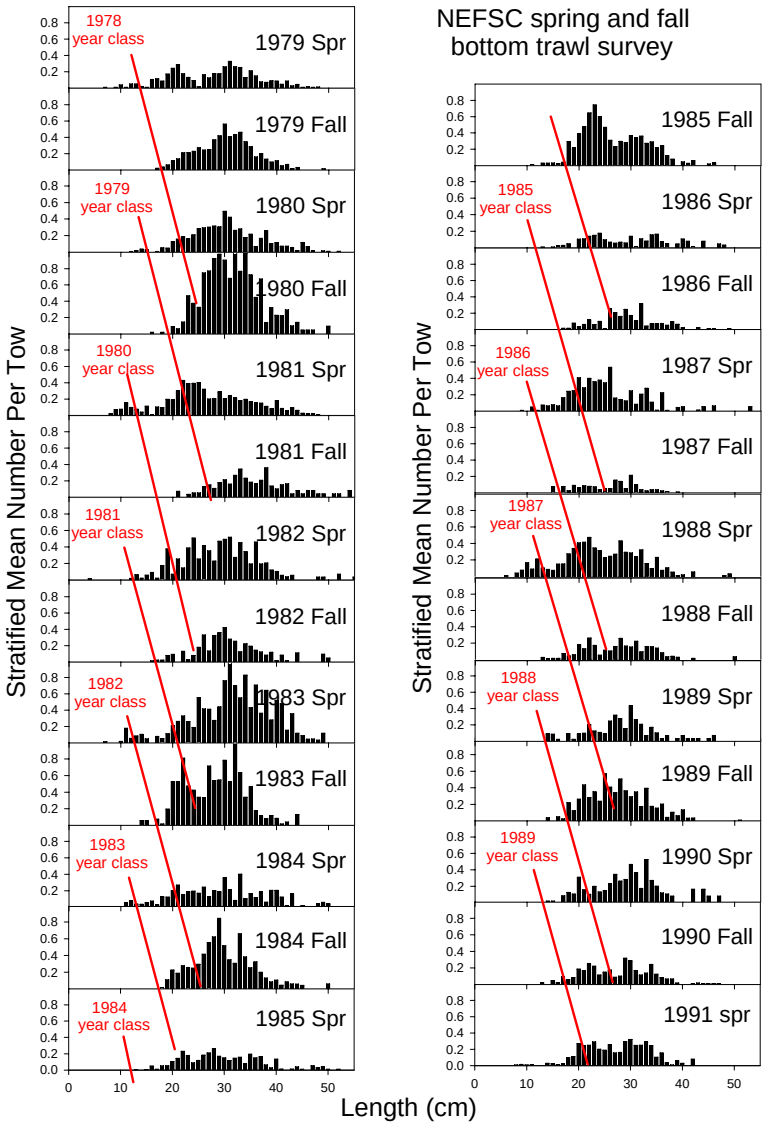
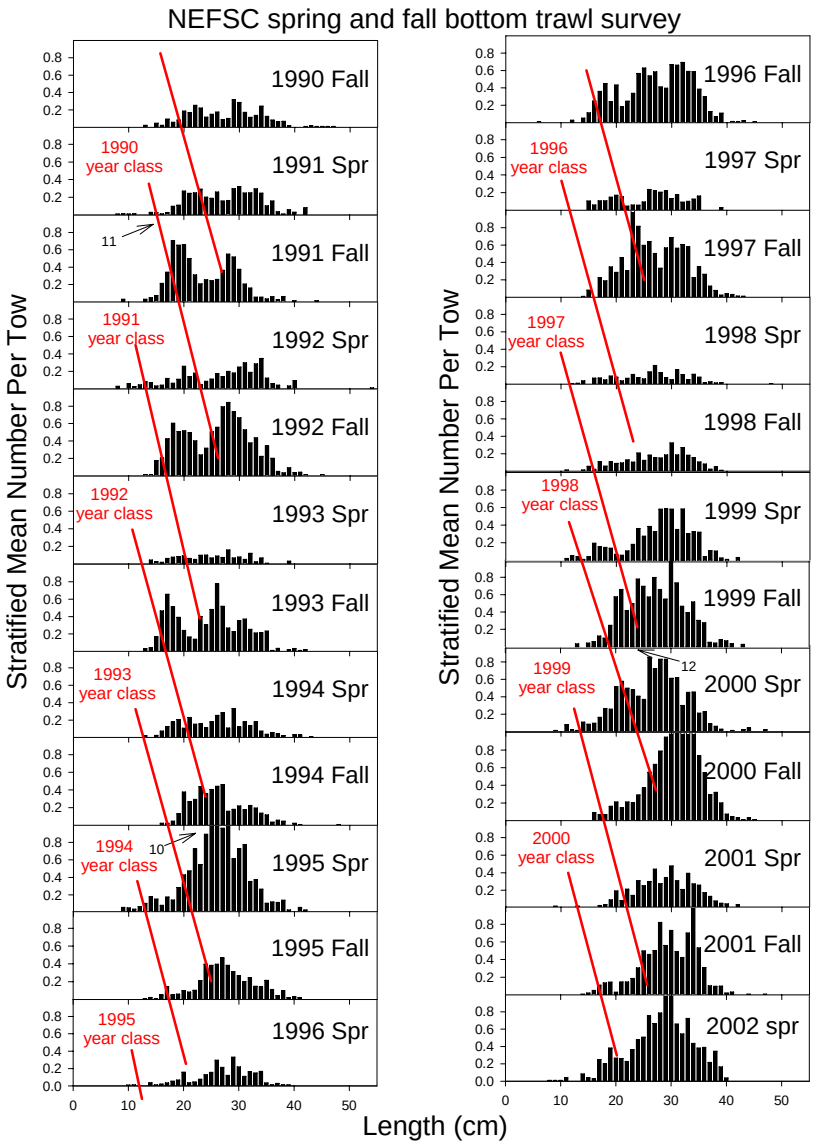


Figure I17. Spring and fall NEFSC bottom trawl survey Gulf of Maine winter flounder catch per tow at length.



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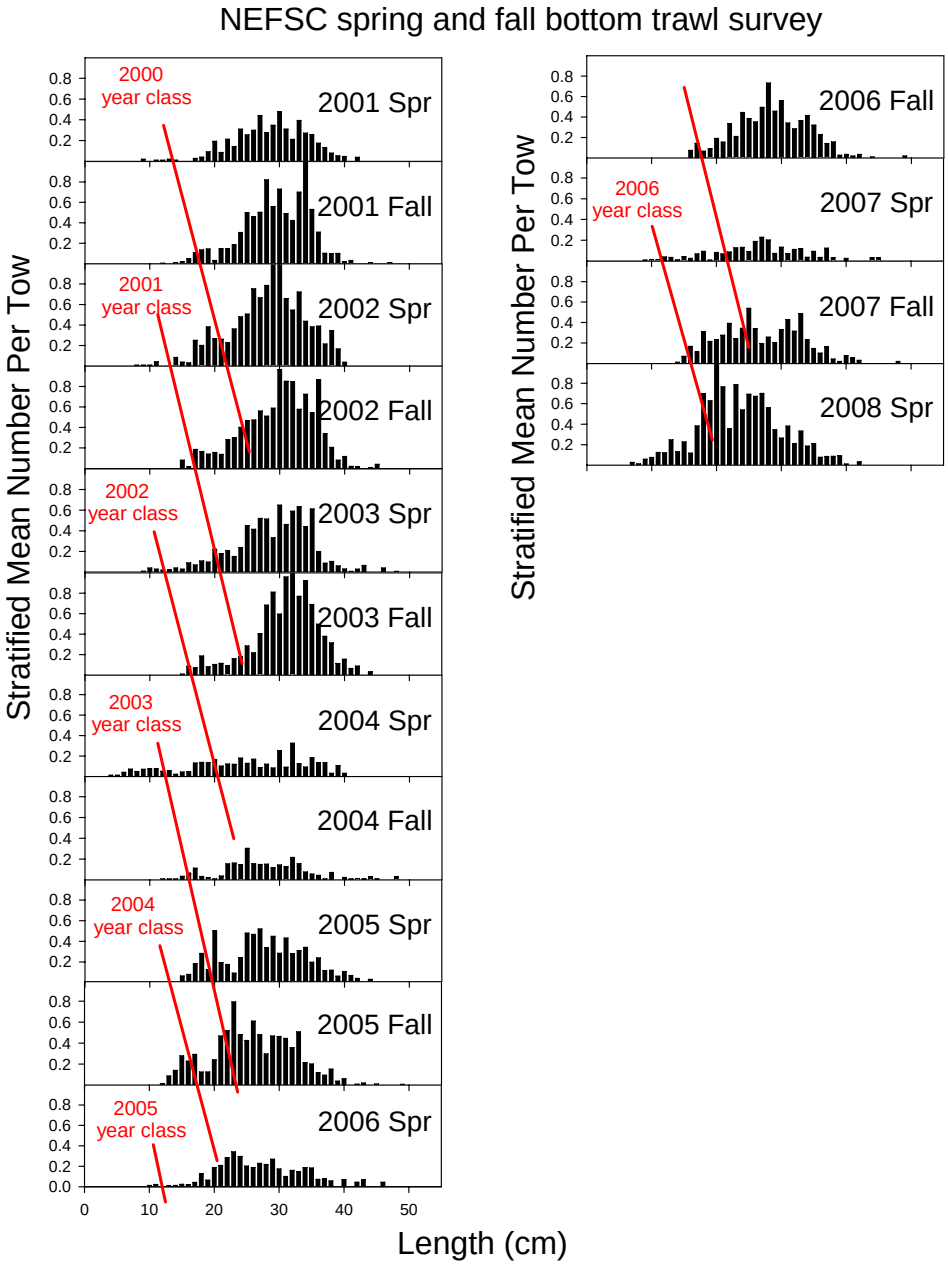

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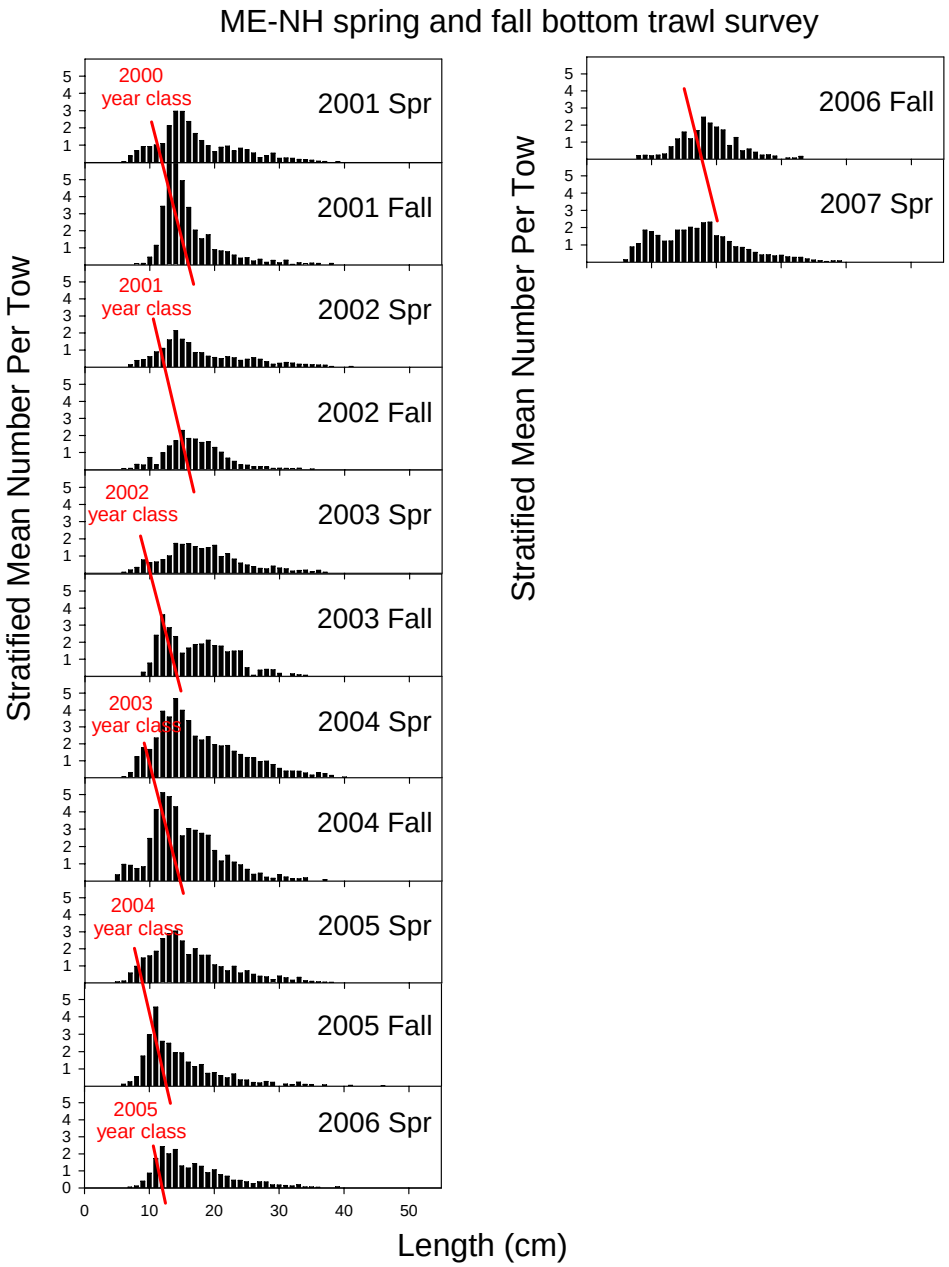


Figure I18. Spring and fall ME/NH bottom trawl survey Gulf of Maine winter flounder catch per tow at length.

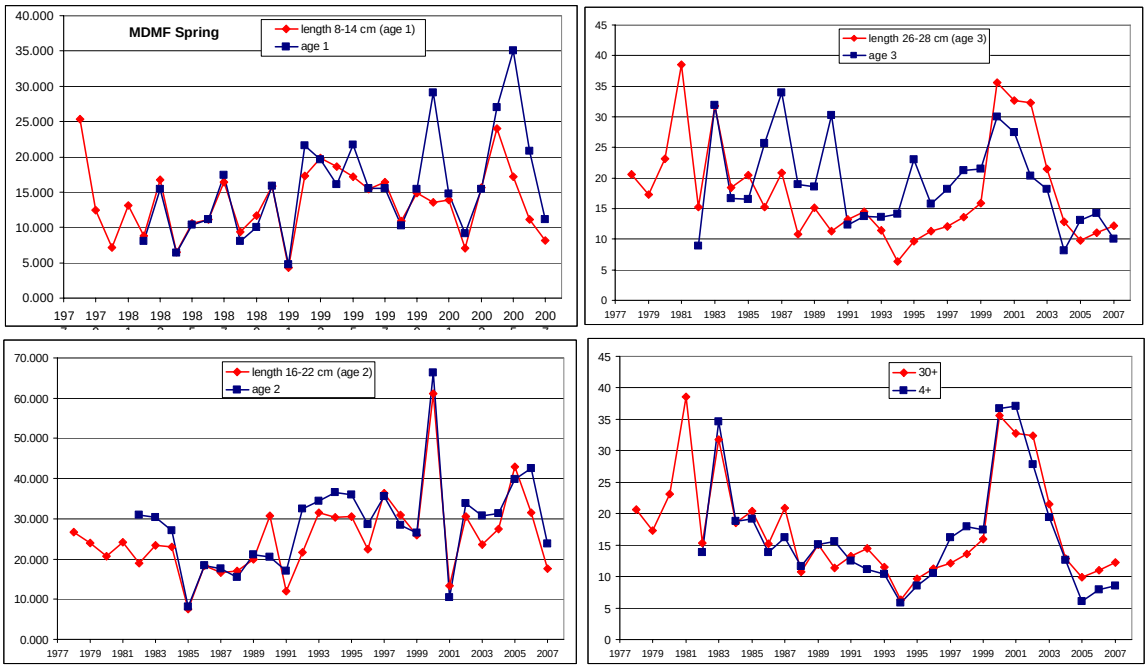


Figure I19. MDMF spring comparison of indices at age with the estimated index at age from slicing of length modes from the catch per tow at length distributions.

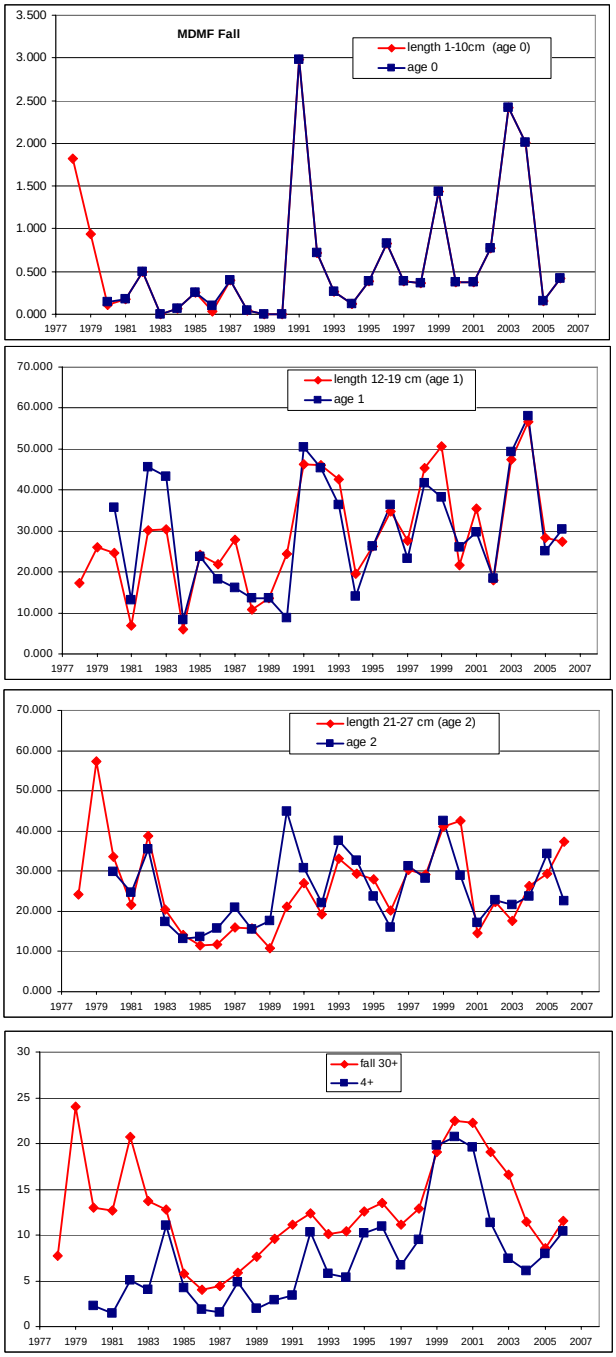


Figure I20. MDMF fall comparison of indices at age with the estimated index at age from slicing of length modes from the catch per tow at length distribution.

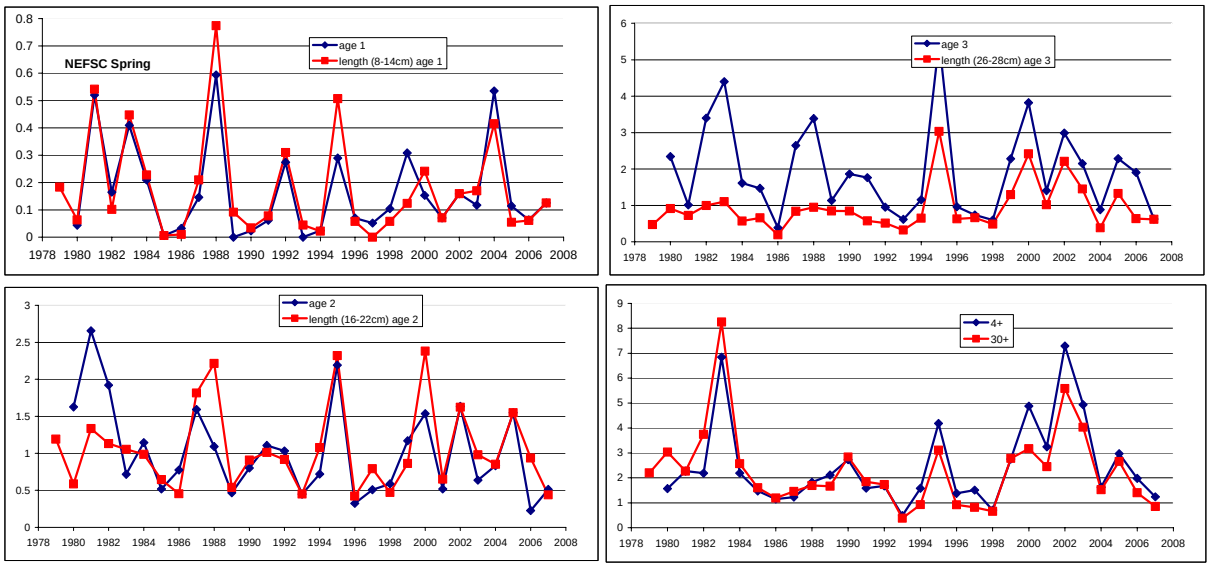


Figure I21. NEFSC spring comparison of indices at age with the estimated index at age from slicing of length modes from the catch per tow at length distribution.

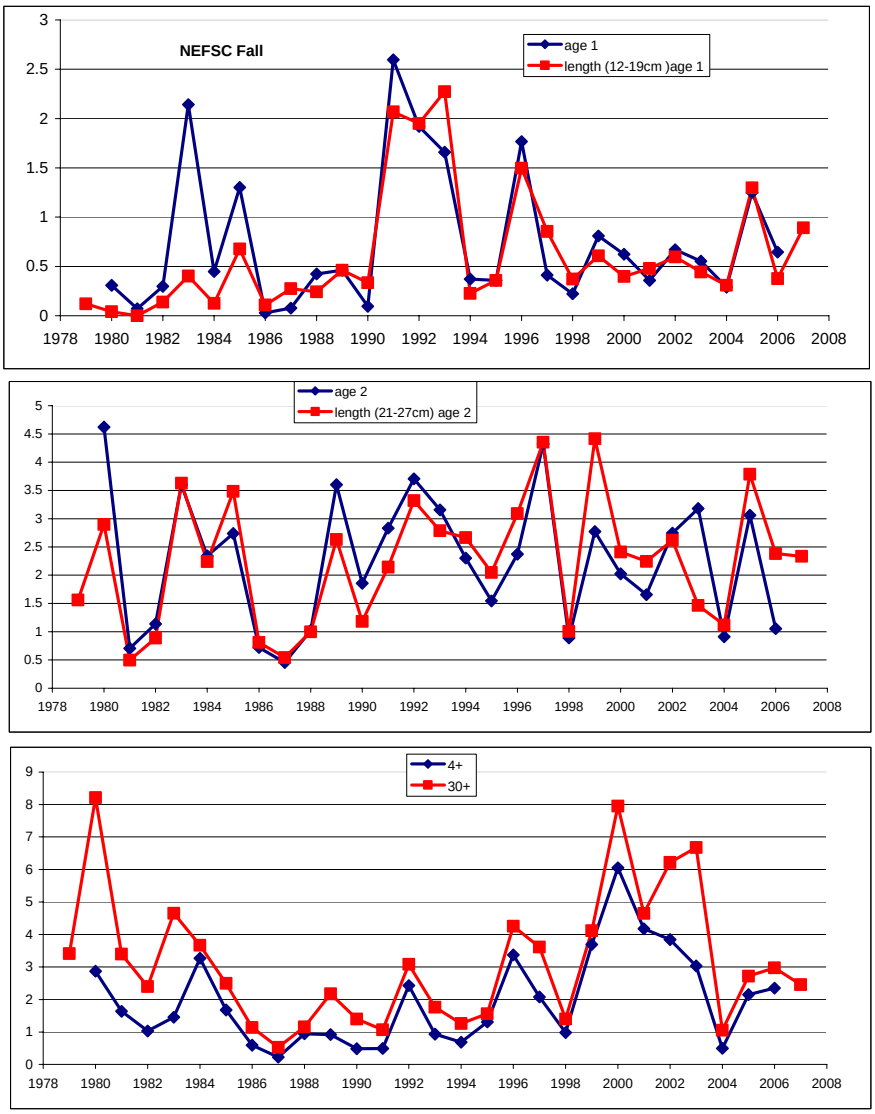


Figure I22. NEFSC fall Spring comparison of indices at age with the estimated index at age from slicing of length modes from the catch per tow at length distribution.

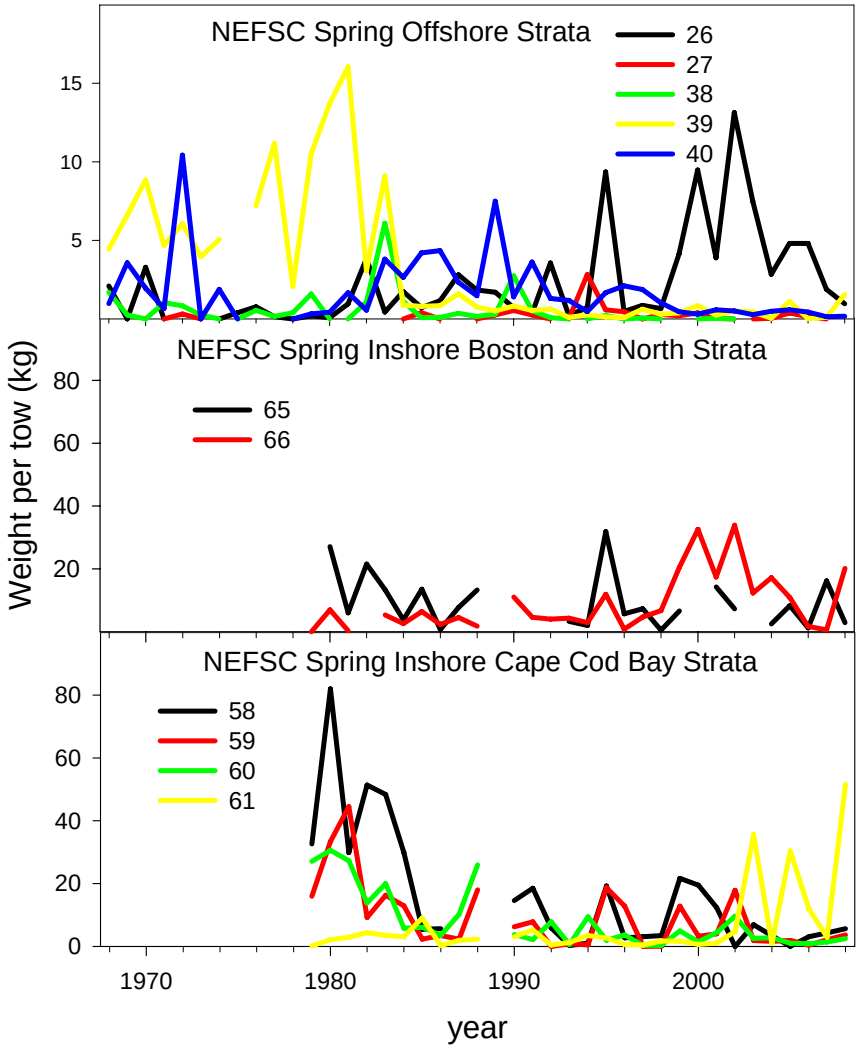


Figure I23. NEFSC spring weight per tow by strata.

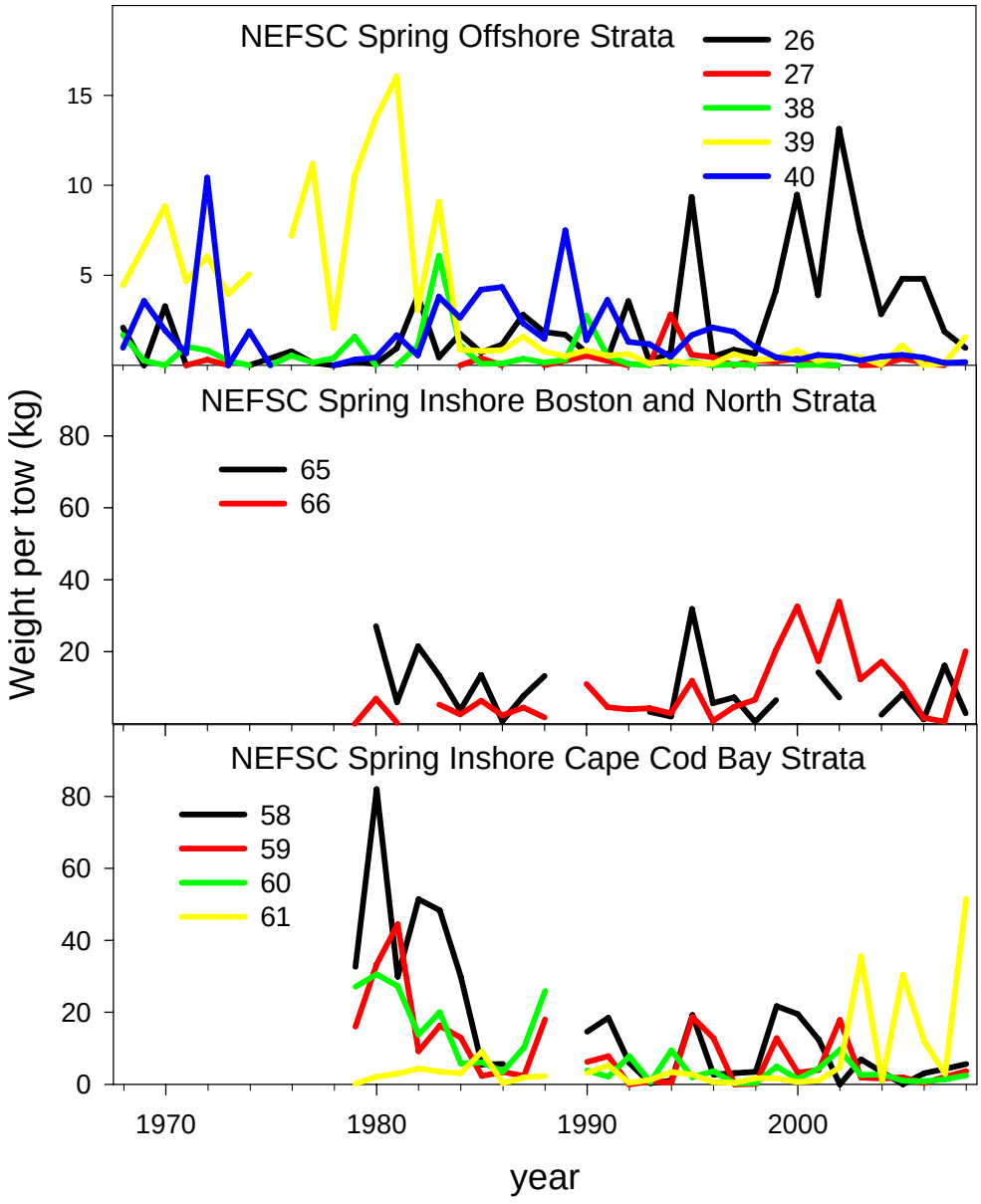


Figure I24. NEFSC fall weight per tow by strata.

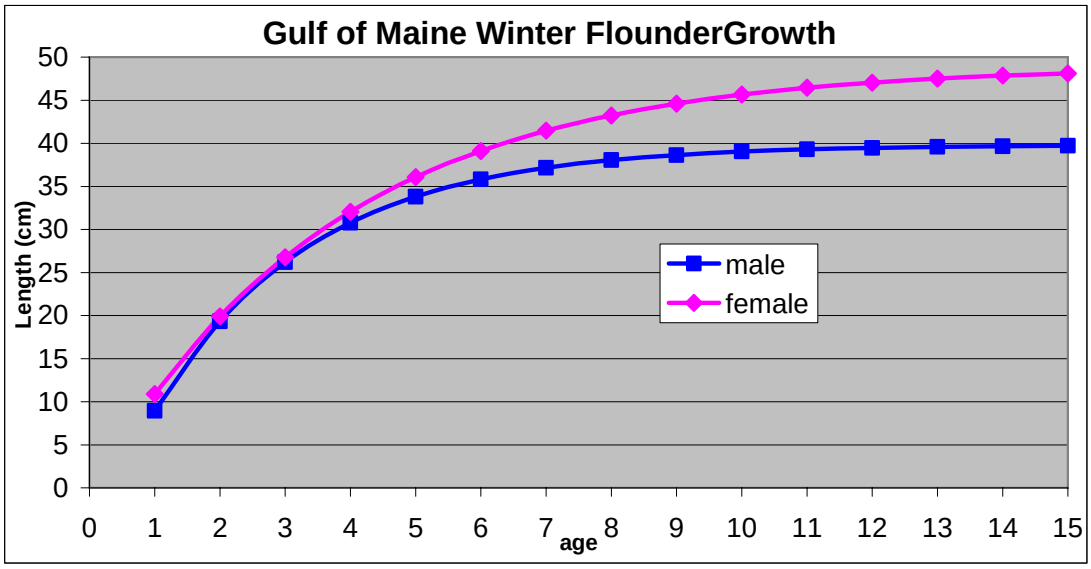
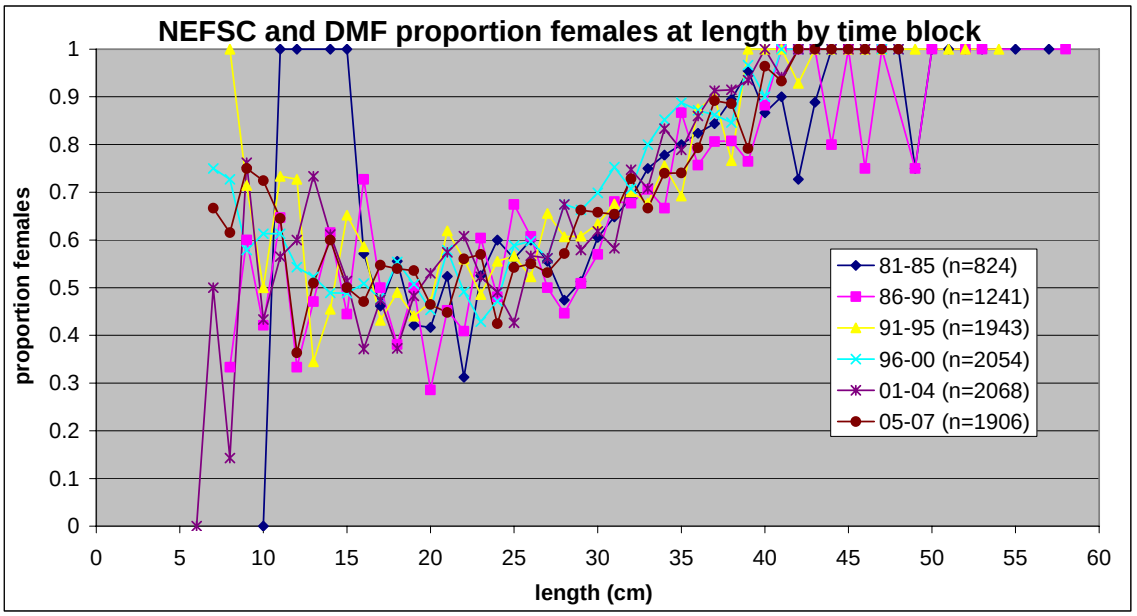


Figure I25. Von Bertalanffy growth curves by sex from Witherell and Burnett (1993).



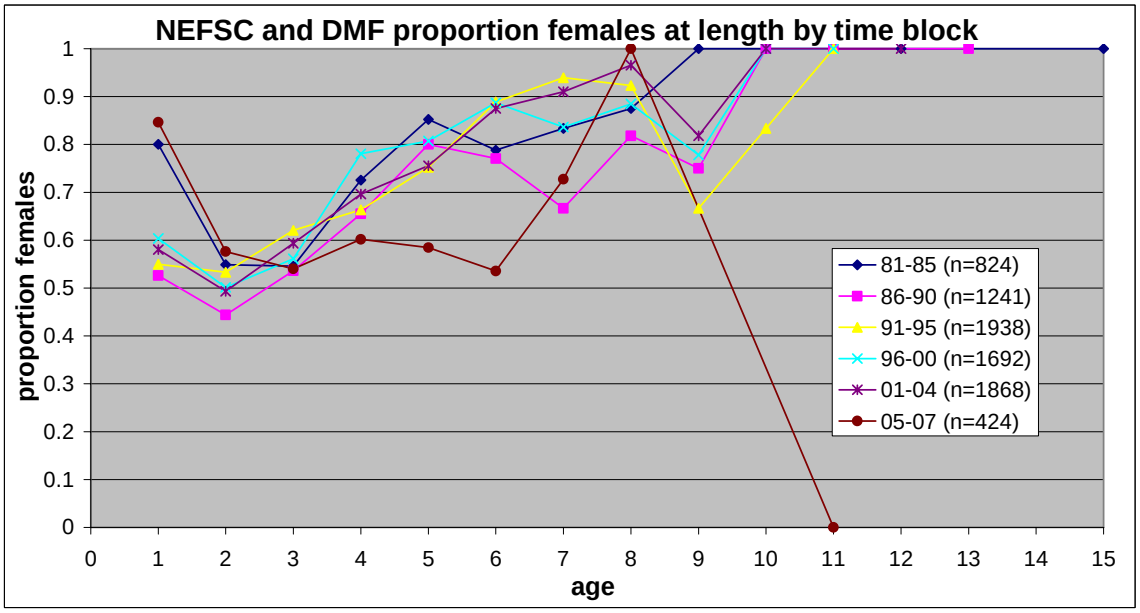


Figure I26. Proportion female by time block in the NEFSC and MDMF survey sample data.

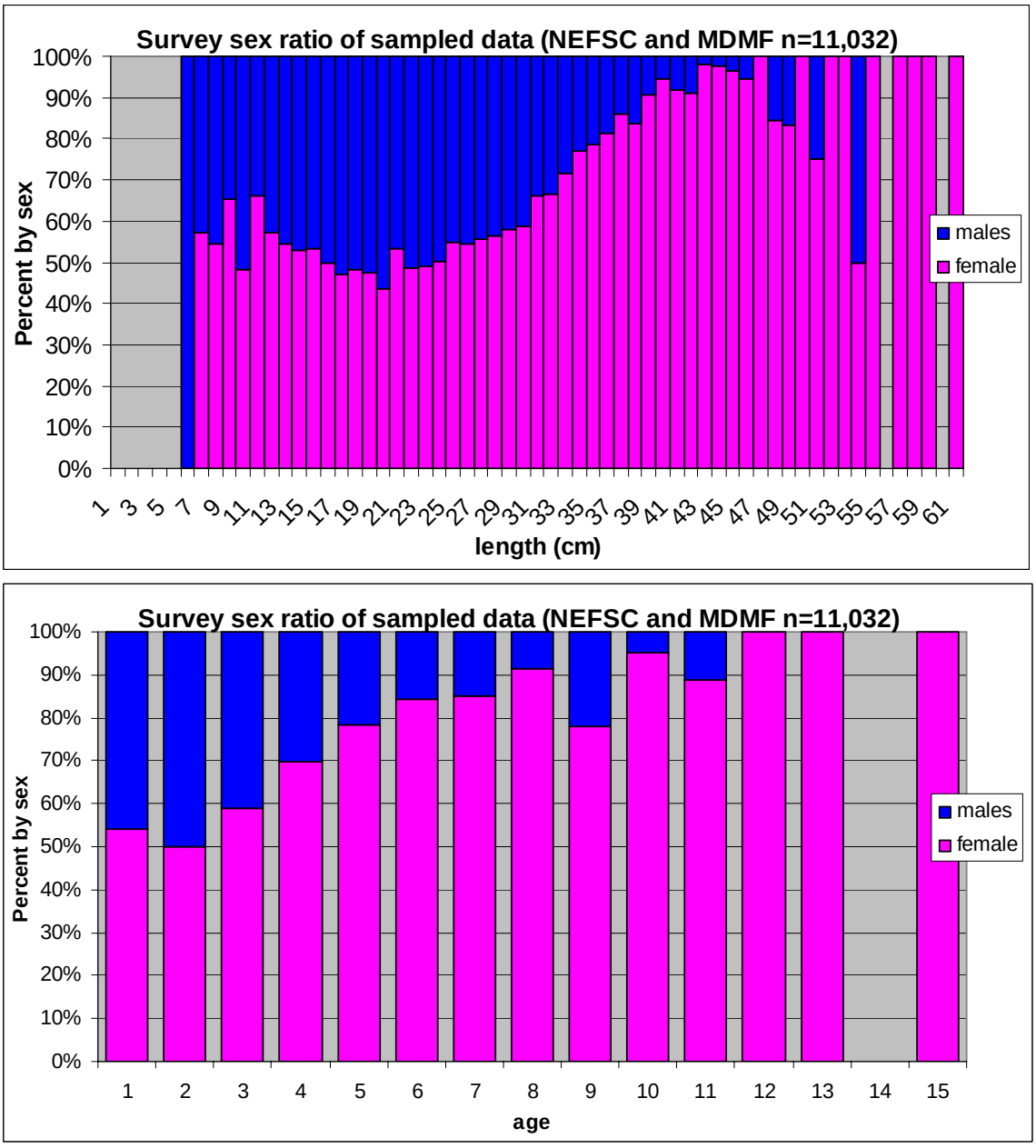


Figure I27. Sex ratio at length and age in the NEFSC and MDMF survey sample data with all year combined (1982-2007).

Figure I28. Gulf of Maine winter flounder female and male three year moving average of the A50 and L50 from the spring MDMF survey.

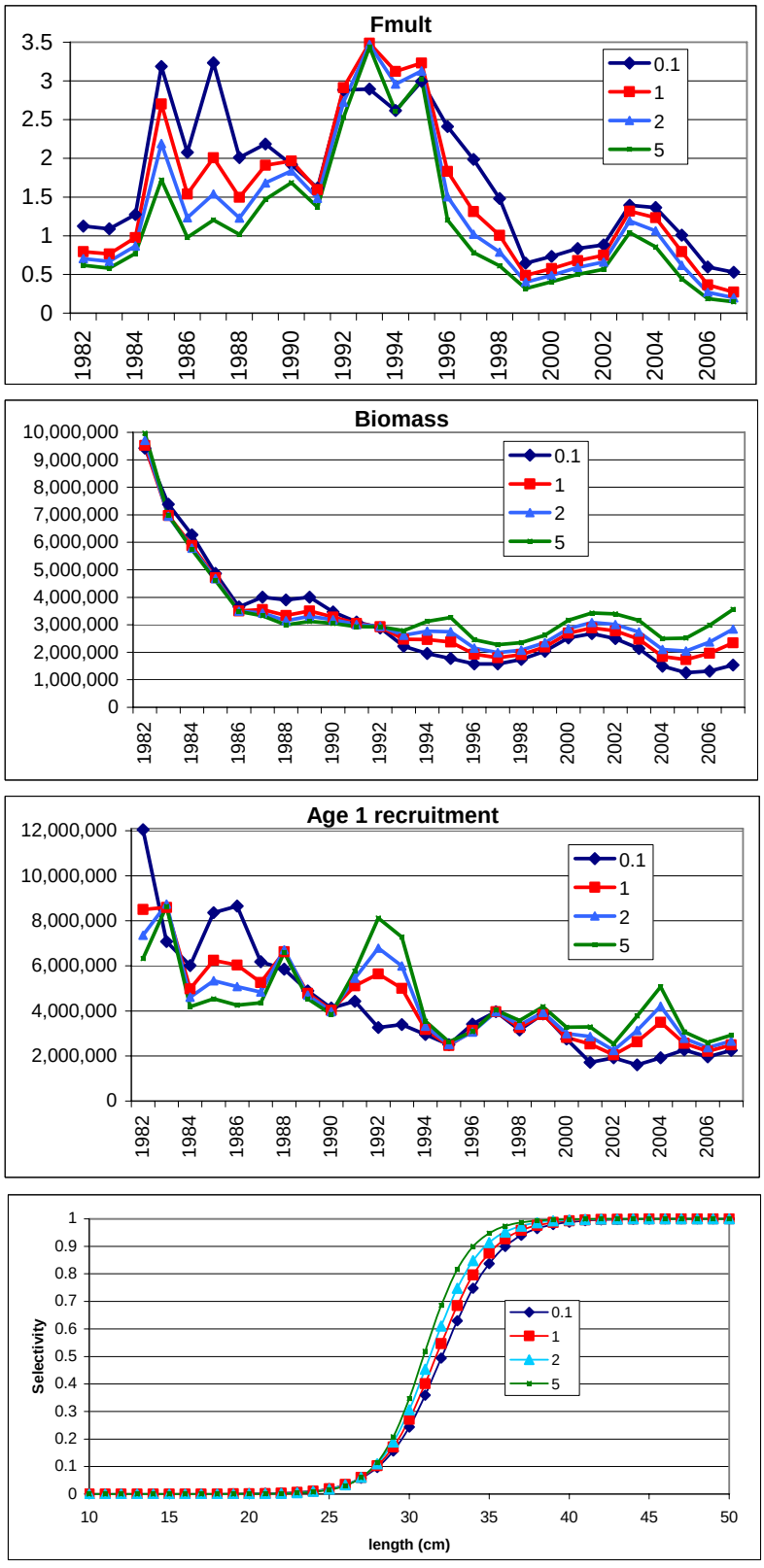


Figure I29. SCALE sensitivity to input weight on the recruitment indices.

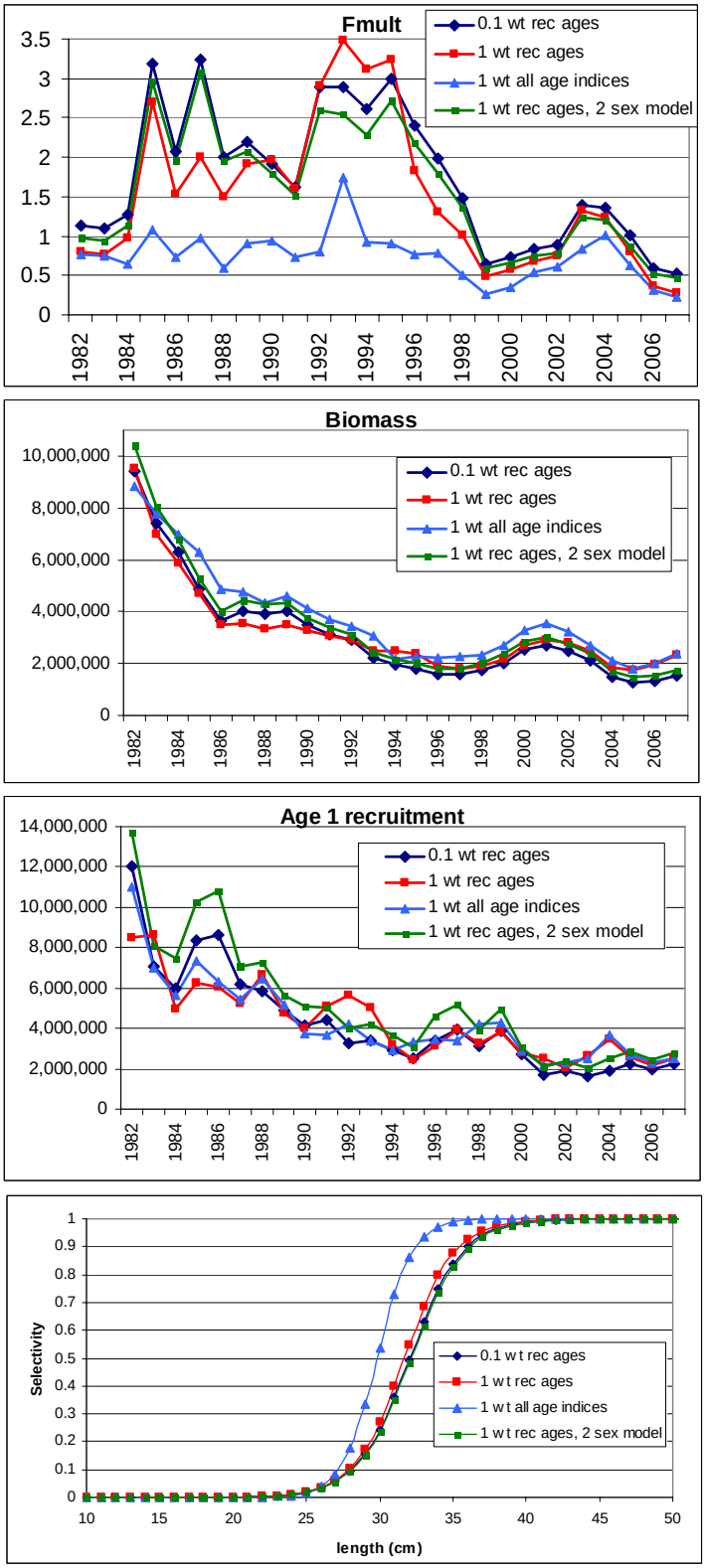


Figure I30. SCALE sensitivity to different model configurations.

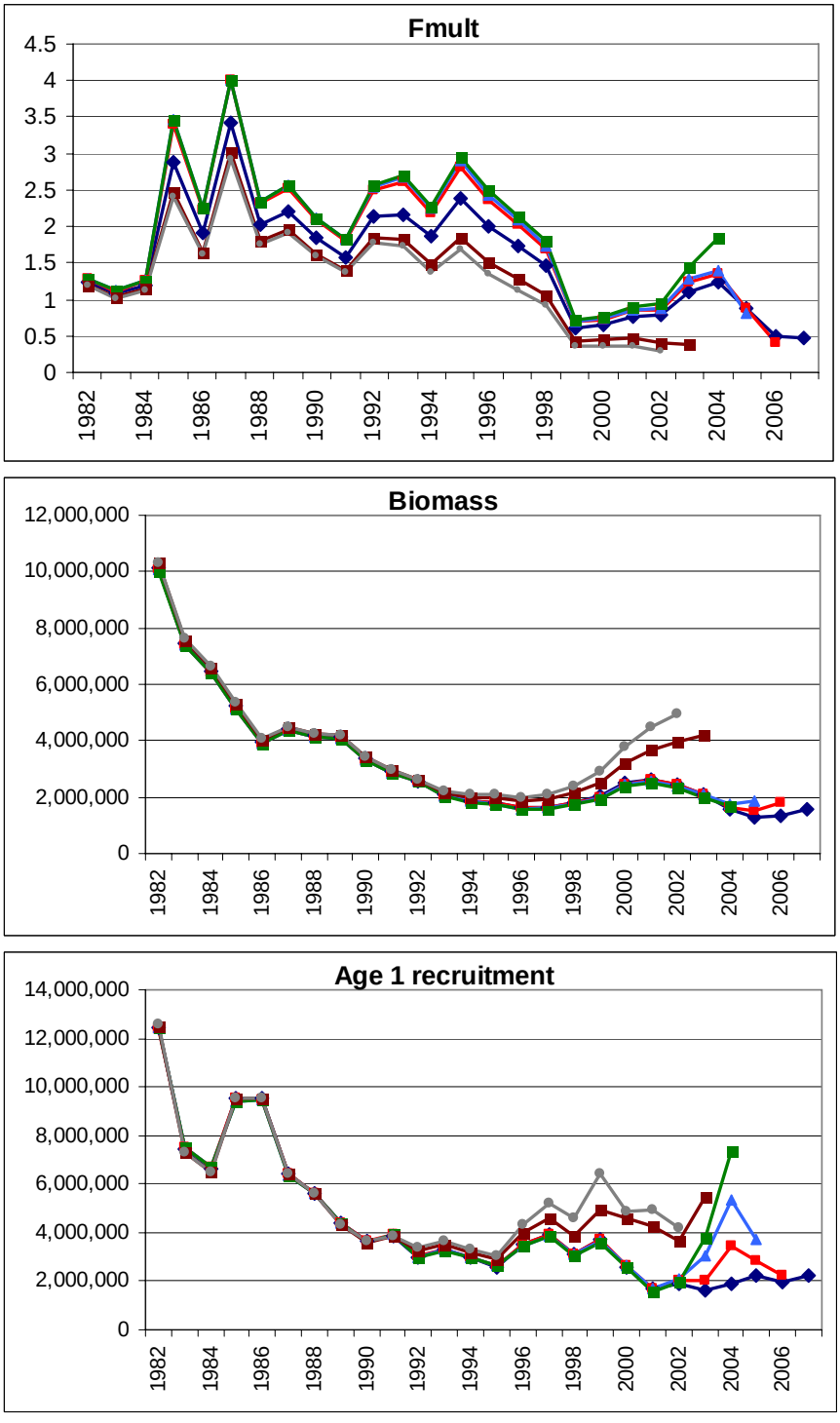


Figure I31. Gulf of Maine winter flounder split SCALE run 5 retrospective.

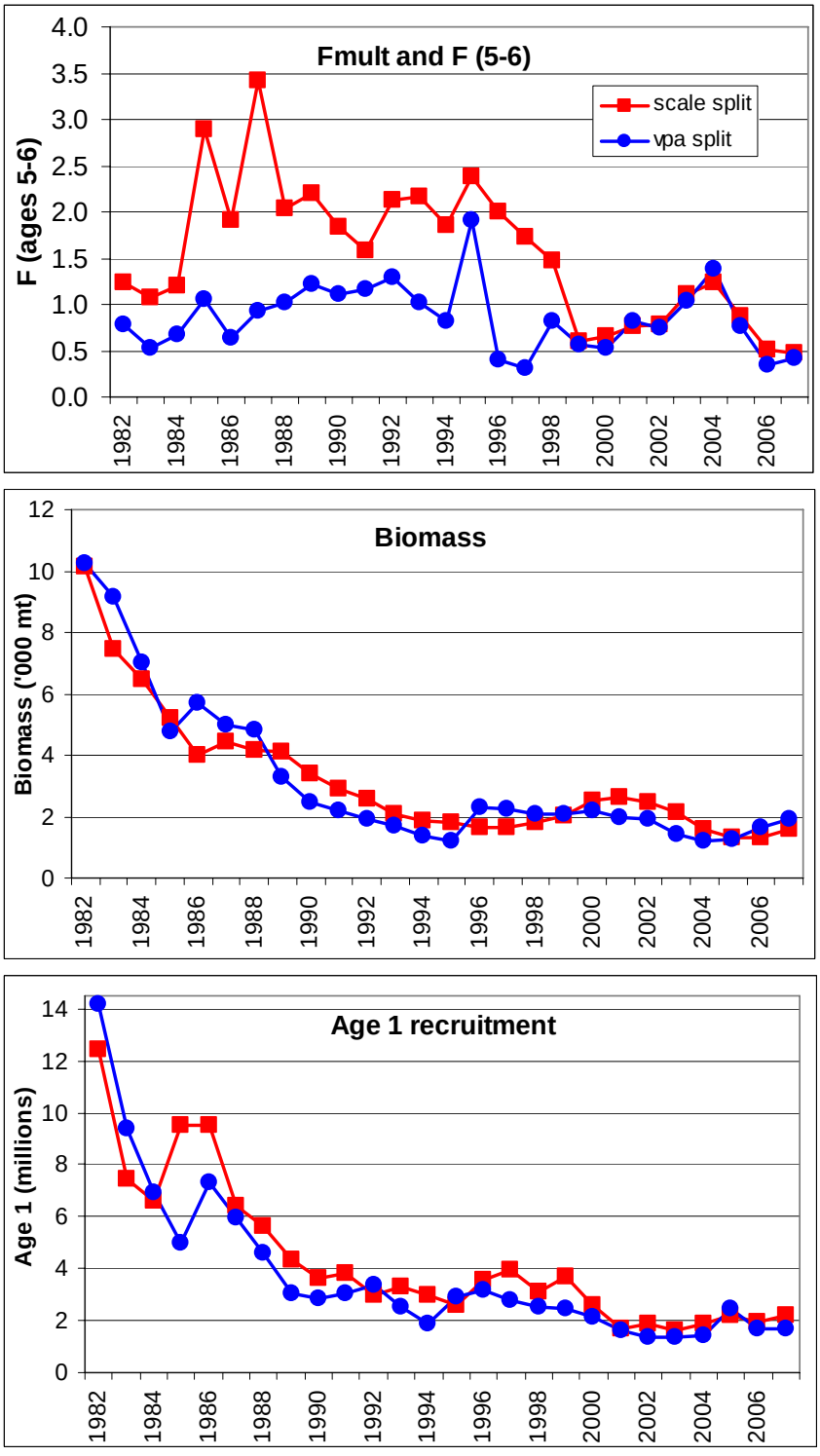


Figure I32. Comparison between the Split VPA run 2b and the split SCALE run 5.

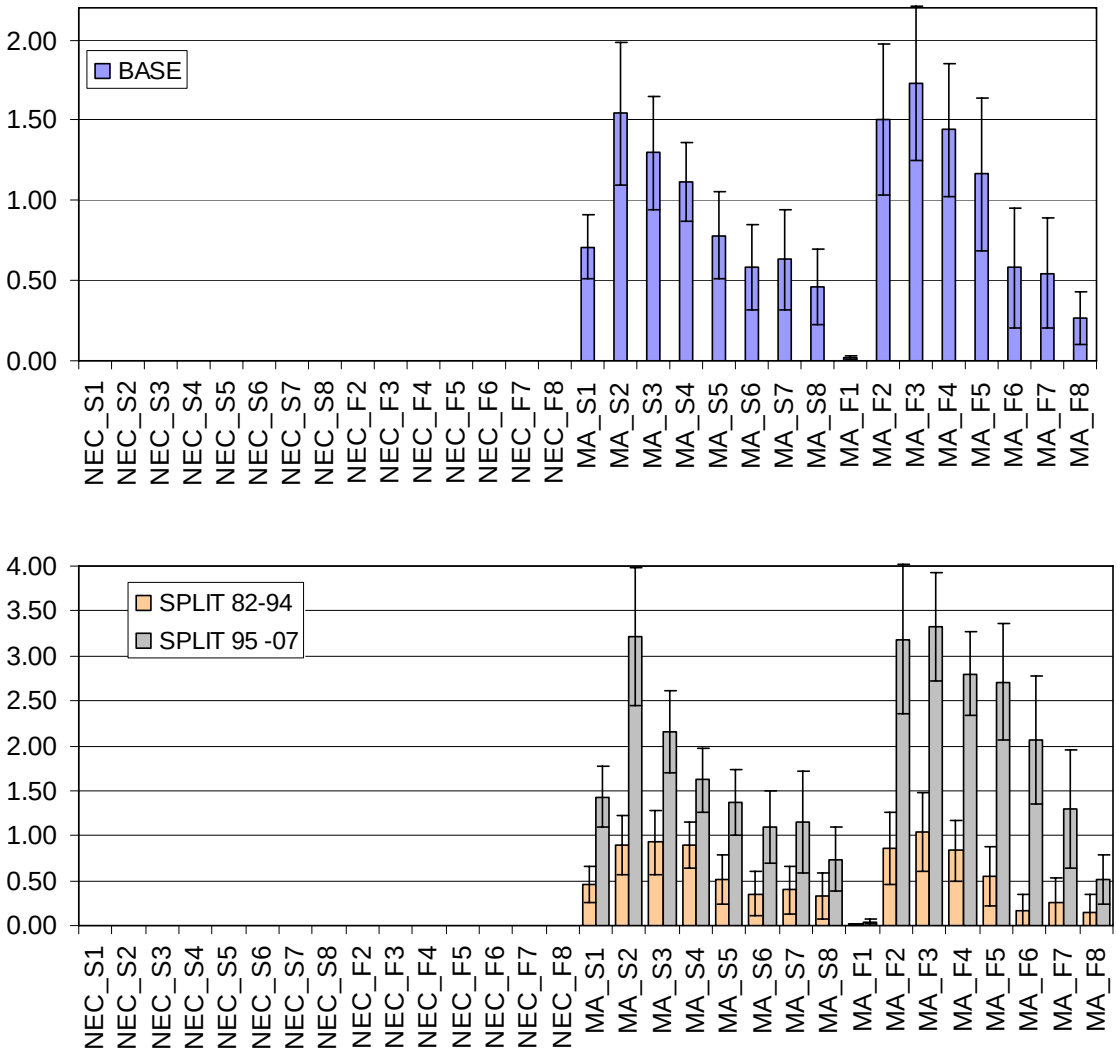


Figure I33. Gulf of Maine winter flounder Base and split VPA area swept Q estimates with standard deviations for run 5 and 6 which excludes the NEFSC surveys.

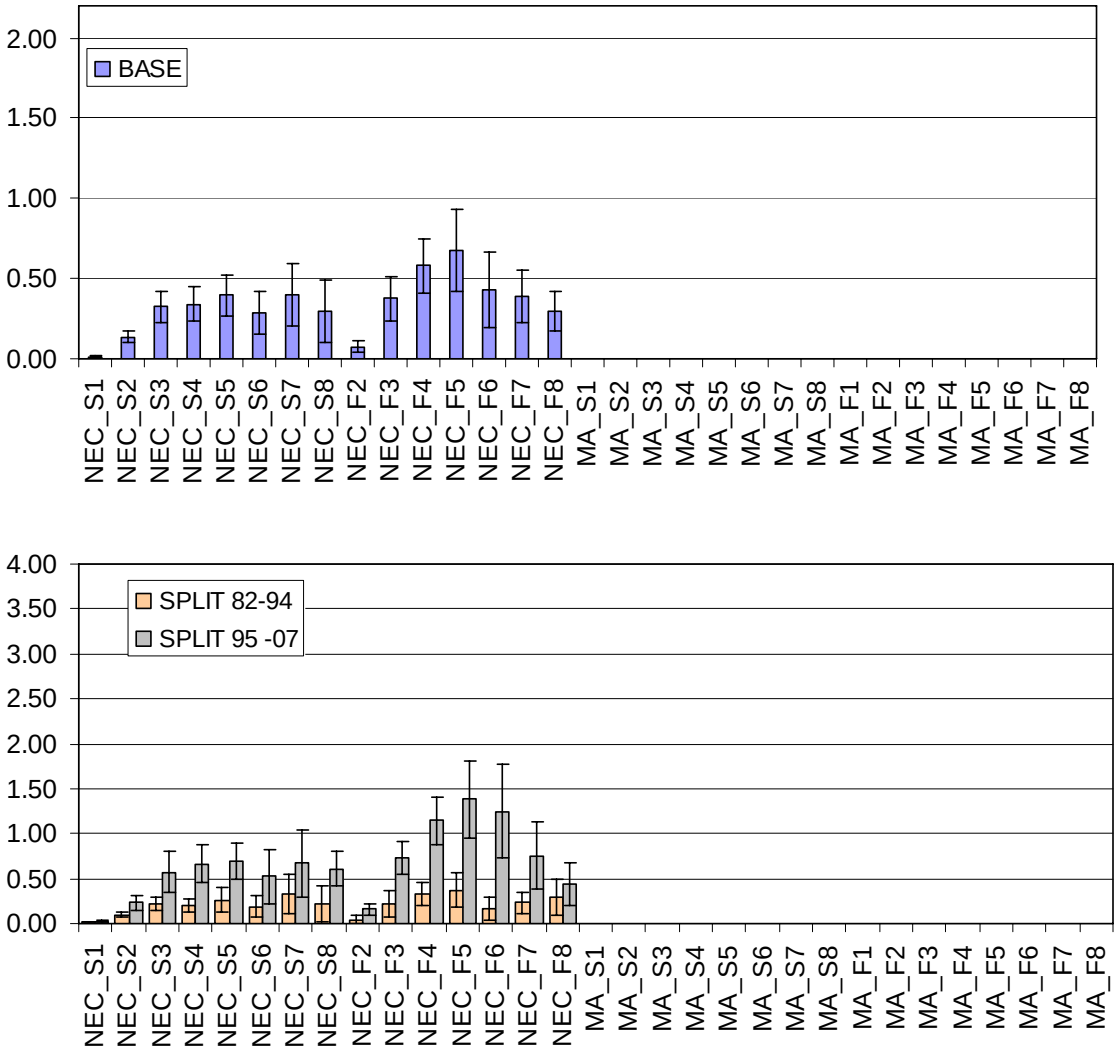


Figure I34. Gulf of Maine winter flounder Base and split VPA area swept Q estimates with standard deviations for run 7 and 8 which excludes the MDMF surveys.

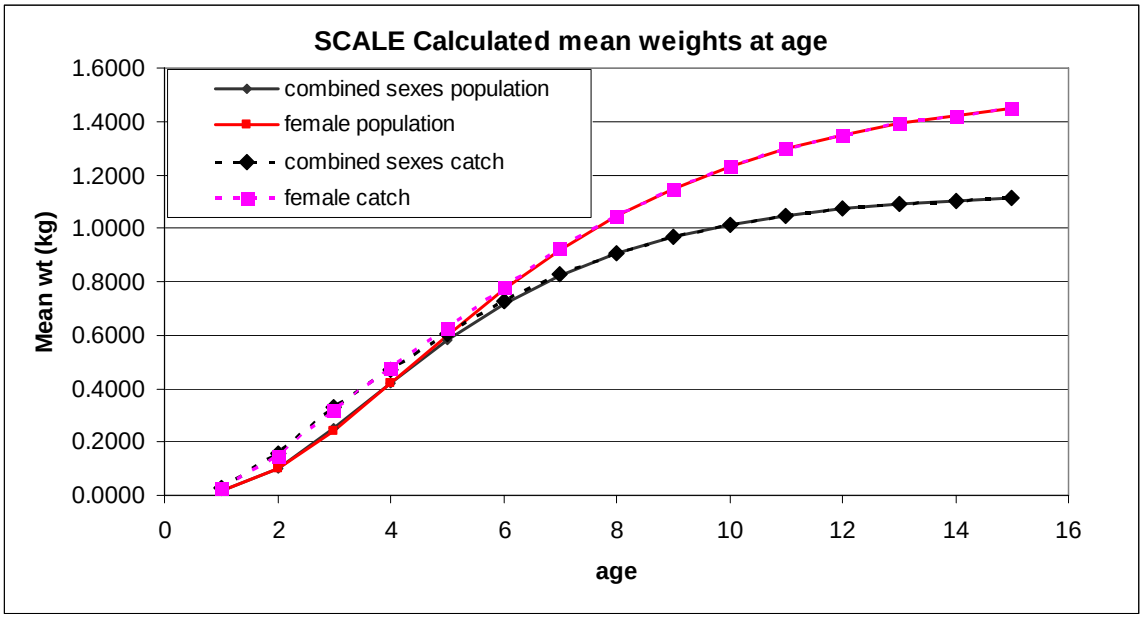


Figure I35. SCALE population and catch mean weight at age for females and for combined sexes.

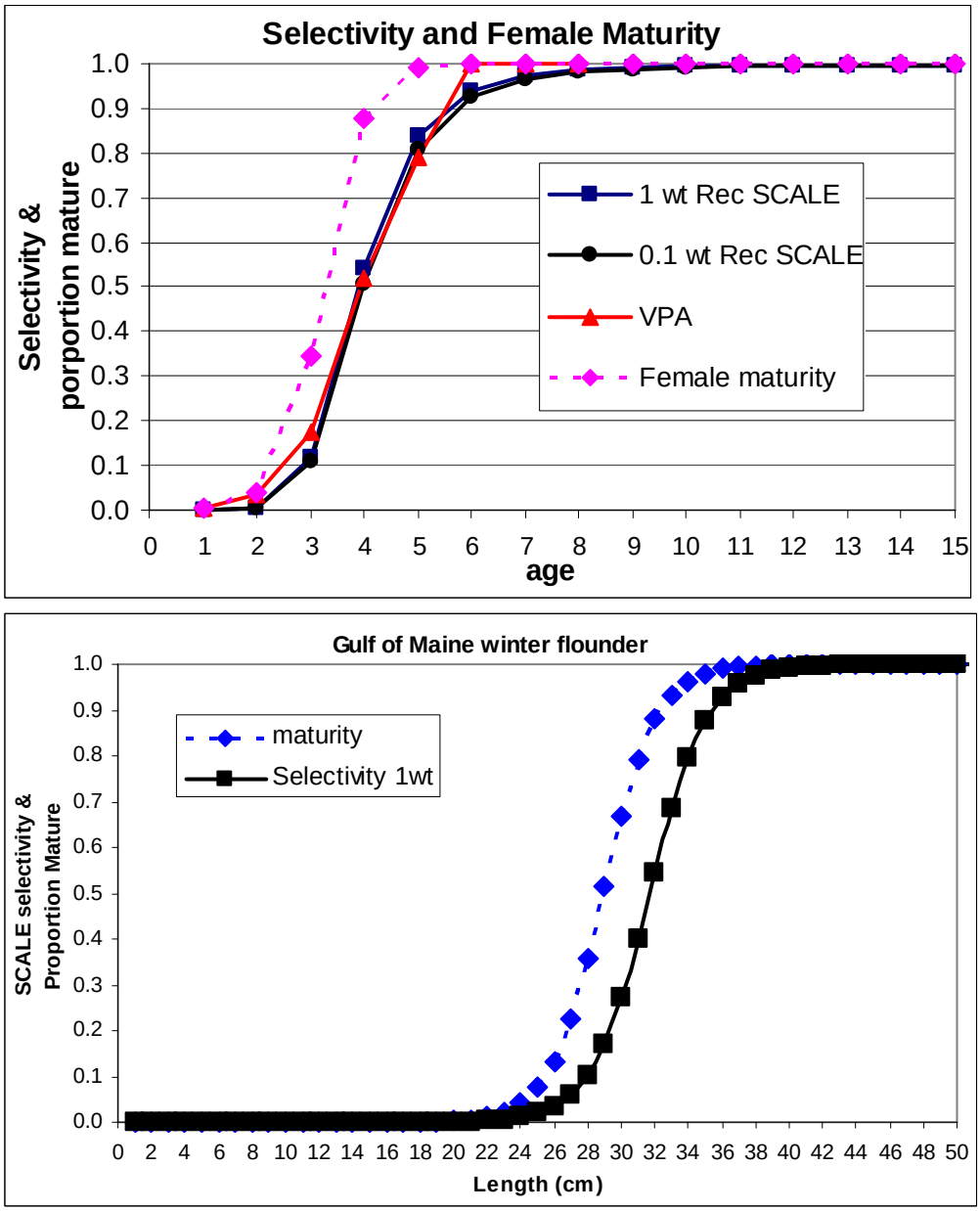


Figure I36. Comparison between estimated selectivity from the SCALE and VPA model. Maturity schedule is also shown.

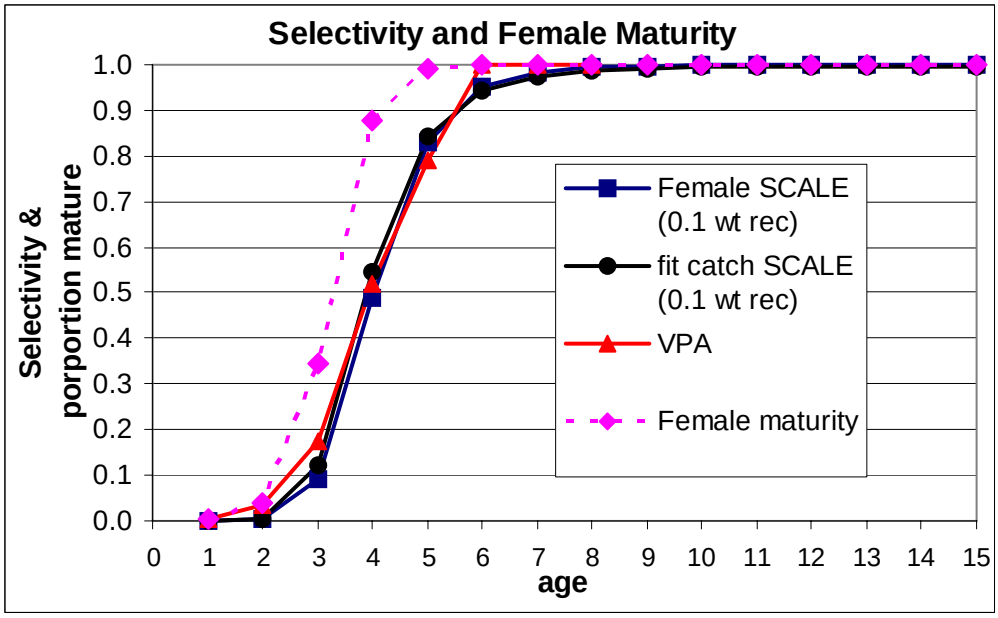


Figure I37. Comparison between estimated selectivity from the split SCALE sex specific run, sexes combined run and the split VPA model run. Maturity schedule is also shown.

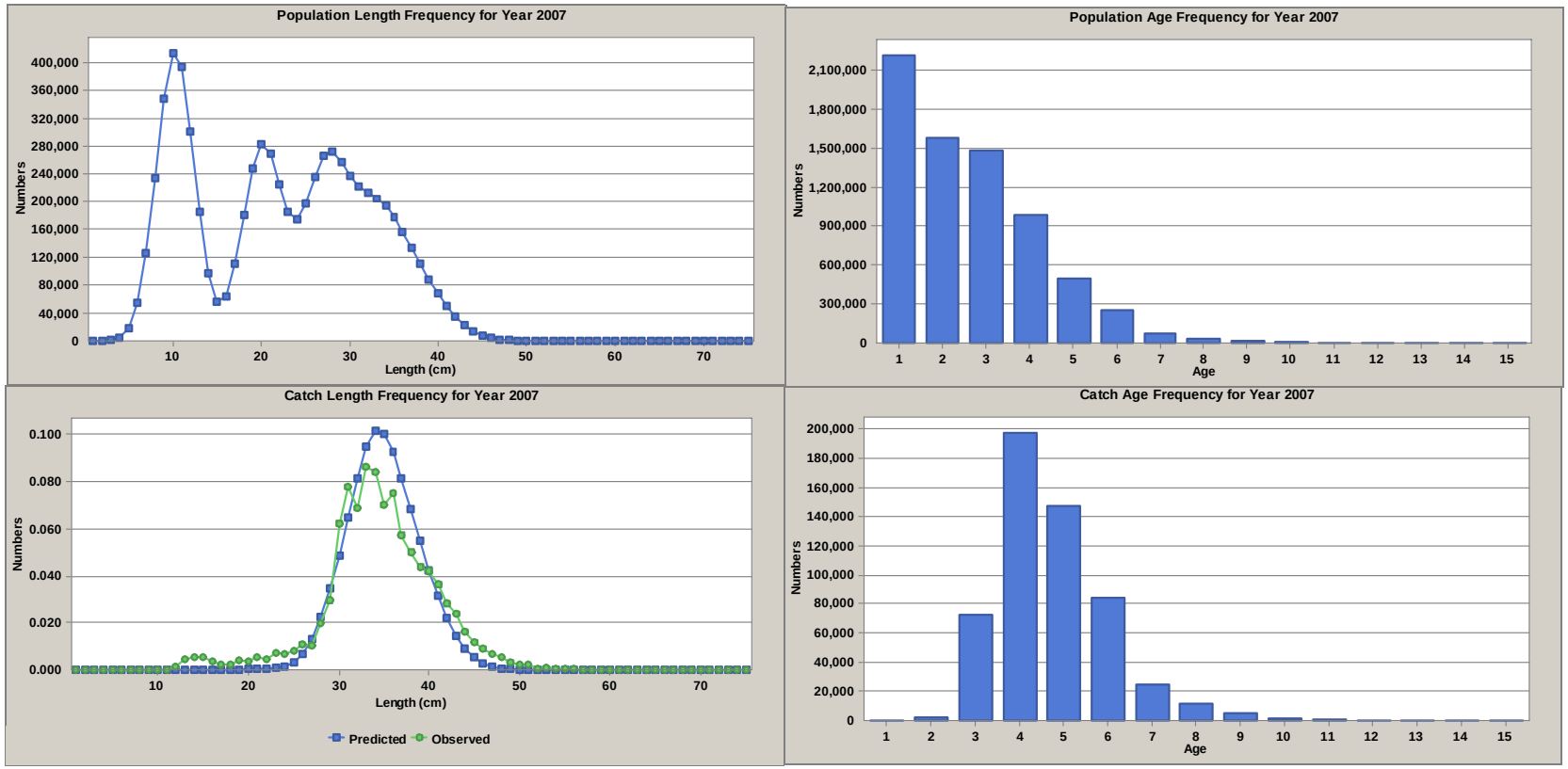


Figure I38. Split SCALE model (1982-1994, 1995-2006) population length and age frequency, predicted and observed catch length frequency and the predict age frequency in 2007 for run 5 (0.1 wt on recruitment indices and 20 wt on fitting the catch).

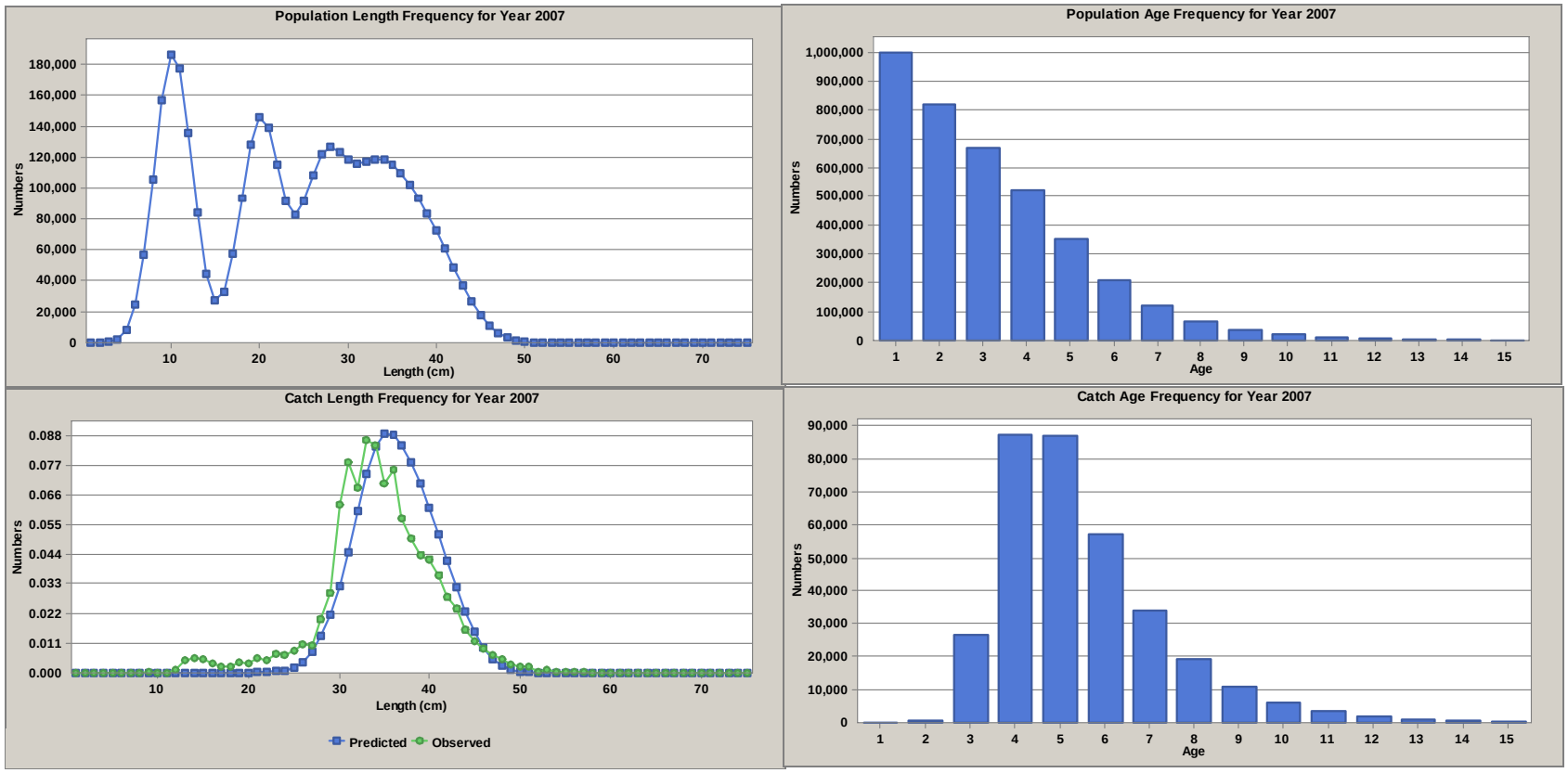


Figure I39. Split SCALE model (1982-1994, 1995-2006) predicted $F_{40} = 0.38$ population length and age frequency, predicted run 5 length frequency and observed catch length frequency at F_{40} and the predict age frequency at F_{40}.

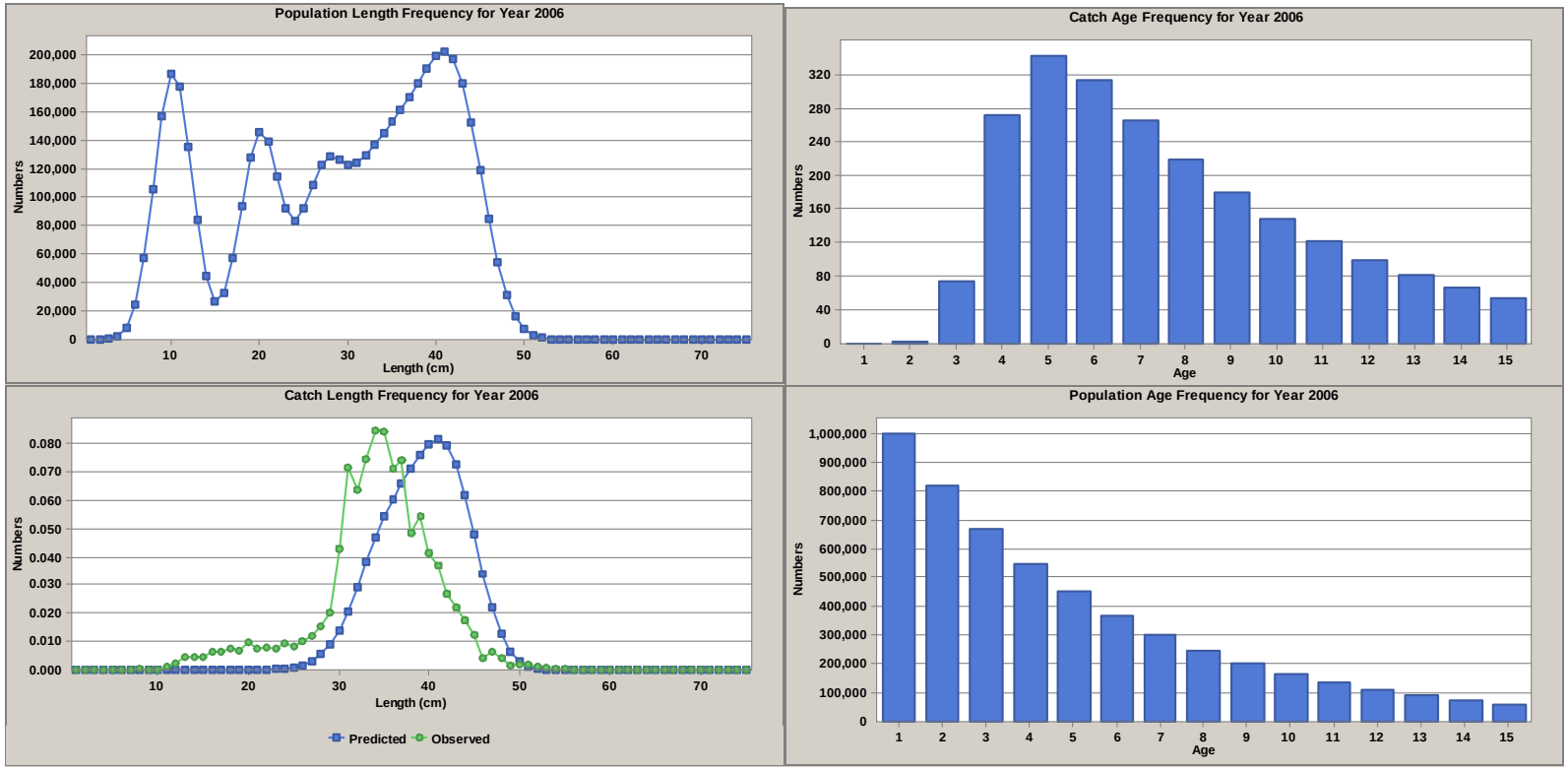


Figure I40. Split SCALE model (1982-1994, 1995-2006) predicted F=0 population length and age frequency, predicted run 5 length frequency and observed catch length frequency at F=0 and the predict age frequency at F=0