B. APPENDICES

Appendix B1. Southern Demersal Working Group meetings regarding the SARC 52 assessment of the three winter flounder stocks

The SDWG reviewed the data included in the stock assessments during April 19-21. The models were reviewed during April 26-28 and the reference points and remaining issues were reviewed during May 3-5, 2011 at the Northeast Fisheries Science Center in Woods Hole, MA. The following individuals attended one or more of the meetings:

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Appendix B2. Development of an environmentally explicit stock-recruitment model for three stocks of winter flounder (*Pseudopleuronectes americanus*) along the northeast coast of the United States

The objective of the analysis was to develop environmentally-explicit stock recruitment relationships for the three winter flounder stocks. For the Georges Bank stock, recruitment (lagged by 1 year) and spawning stock biomass pairs from the final VPA model were used in the analysis. Two general types of temperature data were used: air temperatures and coastal water temperatures (Appendix B2 Table 1). Air temperature data from the NCEP/NCAR Reanalysis (Kalnay et al. 1996) were used. This product combines observations and an atmospheric model to produce an even grid of atmospheric variables, in our case monthly mean surface air temperature. The spatial resolution is 2.5^o latitude by 2.5^o longitude. Air temperatures are closely related to estuarine water temperatures owing to efficient heat exchange in the shallow systems (Roelofs and Bumpus 1953, Hettler and Chester 1982, Hare and Able 2007). Data from representative grid points were averaged for each of three regions, and the monthly/regional averages were further averaged into annual estimates for three, two monthly periods (January-February, March-April, May-June).

Coastal water temperature data from Woods Hole, Massachusetts and Boothbay Harbor, Maine were used (see Nixon et al. 2004 and Lazzari 1997 respectively). Monthly means were calculated from mostly daily data. These monthly means were then averaged into annual estimates for the three, two monthly periods (January-February, March-April, May-June). The Woods Hole data were evaluated relative to the SNE/MA stock. Temperature data were analyzed as annual averages for three, two month periods (January-February, March-April, May-June). These two monthly periods capture temperature variability from the late winter, through spring and into early summer. The spring period was identified as important by Manderson (2008). The broader seasonal range was chosen because of potential differences in the timing of winter flounder spawning and development among the three stocks (Able and Fahay 2010) and the uncertainty as to the stage where recruitment is determined.

In addition to temperature, four large-scale forcing indices were included in the analyses. The North Atlantic Oscillation (NAO) is the dominant mode of winter climate variability in the North Atlantic region and has been related to numerous physical and biological variables across the North Atlantic (Ottersen et al. 2001, Visbeck et al. 2003). Brodziak and O'Brien (2005) identified a significant effect of NAO on recruit-spawner anomalies of winter flounder in the Gulf of Maine. The mechanism is unspecified, but NAO is related to estuarine water temperatures in the region (Hare and Able 2007). The winter NAO index is used here (Hurrell and Deser 2010). The Atlantic Multidecadal Oscillation (AMO) is a natural mode of climate variability and represents a detrended multi-decadal pattern of sea surface temperatures across the North Atlantic with a period of 60-80 years (Kerr 2005). Nye et al. (2009) found the AMO was strongly related to distribution shifts of fishes in the northeast U.S. shelf ecosystem. Finally, the Gulf Stream index is a measure of the northern extent of the Gulf Stream south of the northeast U.S. shelf ecosystem. The Gulf Stream position is related to the larger basin-wide circulation, which in turn is related to NAO and AMO. Work by Nye et al (in review) shows the Gulf Stream index has explanatory power for the distribution of silver hake in the system, possibly through the large-scale linkages between the Gulf Stream, Labrador Current and hydrographic conditions on the northeast U.S. shelf. Two Gulf Stream indices are used here (Joyce and Zhang 2010, Taylor and Stephens 1998).

The two indices differ in their calculation, with the Joyce and Zhang (2010) index more associated with the Gulf Stream south of the northeast U.S. shelf and the Taylor and Stephens (1998) index more associated with the Gulf Stream across the North Atlantic. For all four large-scale forcing indices, annual values were obtained. Numerous studies have found lagged effects of the NAO on the northeast U.S. shelf ecosystem (Greene and Pershing 2003, Hare and Kane in press). In particular, a two year lag has been related to the remote forcing of the NAO on the northeast U.S. shelf through the Labrador Current system. In addition, a zero year lag has been related to direct atmospheric forcing on the northeast U.S. shelf. Zero, one, and two year lags of were included for NAO and zero year lags were used for the other three large-scale forcing variables. To understand the relations between the host of 21 environmental variables, a simple correlation matrix was calculated. Significant correlations were considered in the context of previous research in the region. Significance was based on standard p-values; no corrections for multiple comparisons were made. The purpose was exploratory with an aim of understanding the relation between variables before incorporating them into stock recruitment functions.

Ricker, Beverton-Holt, and Cushing stock recruitment models were used with and without the different environmental terms. The model forms followed Levi et al. (2003), who built upon the ideas of Neill et al. (1994) and Iles and Beverton (1998). The fits of the three standard models were all very similar for the SNE/MA stock. Owing to the general acceptance of the Beverton-Holt model for use in stock-recruitment relationships and the overall similarity in the fits of the three models, here only the analyses using the Beverton-Holt model are presented. Environmental variables were assigned *a priori* for consideration with specific stocks. This was done to limit the number of environmentally-explicit stock recruitment relationships considered for each stock.

The standard stock-recruitment relationships were calculated first using the lsqcurvefit function in MatLab using the trust-region-reflective algorithm. A series of environmentally-explicit models also were fit using the same methods. The resulting models were compared using AICc and AICc weights, which represent the relative weight of evidence in favor of a model. The best environmentally-explicit model also was compared to the standard stock recruitment model using an evidence of weights procedure (Burnham and Anderson 2002). In this way the value of the environmentally-explicit stock recruitment functions relative to standard stock recruitment functions was judged. Model fitting included bounded parameters (or priors) to force realistic model forms.

Numerous relationships between environmental variables were evident based on the correlation analysis. The two Gulf Stream indices were related (r=0.54) but different enough to retain both in the analyses. Both Gulf Stream indices were related to the NAO with a 2 year lag (NAO leading). This relationship has been described before (Taylor and Stephens 1998). The Atlantic Multi-decadal Oscillation exhibited relatively little relationship with other variables. There was a negative relationship with the 2 year lagged NAO. The only strong positive correlation was found with Boothbay Harbor water temperatures. Both series exhibit a strong increasing trend over the time period considered. The North Atlantic Oscillation was related to the two Gulf Stream indices as already noted. NAO was not related to winter temperatures which may result from non-stationarity in the NAO-winter temperature relationship (Joyce 2002). Woods Hole temperature is closely related to regional air temperatures. This link is not surprising based on previous studies. Woods Hole temperature is also related to a lesser extent Boothbay Harbor temperatures. There is evidence of seasonal correlation in Woods Hole temperature, with values in January and February correlated to values in March and April, which in turn are correlated to values in May and June. However, the seasonal correlation is diminished after two months; temperatures in January and February are less related to temperatures in May and June. Boothbay Harbor temperature is strongly related to the AMO particularly in early summer. The lower magnitude of correlation with air temperatures compared to Woods Hole temperature is interesting and an explanation is lacking. It is possible that greater depths of coastal Maine increase the influence of oceanic factors and decreases the influence of atmospheric factors. The seasonal correlation described for Woods Hole temperatures in evident for Boothbay Harbor temperatures, but to a lesser degree.

The three air temperature series were all closely related indicating coherent air temperatures over the entire region. These analyses agree with the more comprehensive results of Joyce (2002). Correlations among regions over the same time (Jan-Feb) were higher than correlations within region between times (Gulf of Maine Jan-Feb compared to Gulf of Maine Mar-Apr). Seasonal correlation (Jan-Feb to Mar-Apr) were lower in the air temperature series compared to the water temperatures series as expected from the greater specific heat capacity of water.

The analyses suggest that the environmental forcing experienced by the three stocks differs in several important elements. The SNE/MA stock experiences coastal water temperatures that are strongly linked to local air temperatures. The GBK stock experiences water temperatures that are affected by both local air temperatures and more importantly, large-scale advective supply of relative cold, fresh water associated with the Labrador Current. Finally, the temperatures experienced by the GOM stock remain uncertain. If the Boothbay Harbor data is representative, then temperature is related to large-scale processes (AMO) and not local processes (air temperature). On the other hand, air temperature may be important, if early stage winter flounder are using shallower habitats.

Spawning stock biomass is comparable between the SNE/MA and GBK stock but recruitment is approximately four times greater for the SNE/MA stock at higher stock sizes (Appendix B2 Figure 1). The stock recruitment functions for the GBK and GOM stock are similar, with near constant recruitment over a relatively broad range of spawning stock biomasses. Recruitment on Georges Bank is estimated to be higher than in the Gulf of Maine at a given spawning stock biomass.

The residuals of the stock-recruitment relationships for the three stocks appear to exhibit synchrony through time (Appendix B2 Figure 2). Early in the time series, residuals between the stocks appear unrelated, but all residuals were positive in the mid 1990s and all were negative in the early 2000s. A formal analysis was conducted using serial correlation: calculating the correlation coefficient between two variables using a moving window. A similar analysis was used by Joyce (2002) to show that the relationship between NAO and east coast air temperatures has changed over the last 80 years and by Hare and Kane (in press) to show that the correlation between NAO and *Calanus finmarchicus* abundance has changed over the last twenty years. The serial correlation analysis demonstrated that early in the time series the residuals of the stock-recruitment functions were negatively or not correlated between the stocks (Appendix B2 Figure 3). Then, during the early 1990s, the residuals became positively correlated. The trend is most evident for the SNE/MA and GOM stocks and less so for these two stocks compared to the GBK stock.

The timing in the synchrony between the SNE/MA and GOM stocks is similar to the timing in synchrony among local populations within the SNE/MA stock (Manderson 2008). This synchrony suggests that some large-scale forcing is responsible for creating variance in the stock recruitment relationships of winter flounder across the northeast U.S. shelf ecosystem. The synchrony is greater between the SNE/MA and GOM stocks suggesting that the large-scale forcing has greater coherence along the coastal areas of the northeast compared to the offshore waters of Georges Bank.

Including an environmental term did not improve the stock recruitment relationship for the Georges Bank stock (Appendix B2 Table 2). The standard model was the best fit model and predicted near constant recruitment over the range of observations (Appendix B2 Figure 4). The evidence ratio of the best environmental model was 0.7 compared to the standard model (Appendix B2 Table 2). Environmental variables in the top 10 models included air temperatures, water temperatures and the Gulf Stream index, but these variables added no strength to the stock recruitment relationship (Appendix B2 Table 3). Importantly, the model fit, whether standard or environmental, was dependent on the priors imposed for the b term (Appendix B2 Table 4), which is related to but not identical to the steepness term (see Myers et al. 1999).

The environmentally-explicit models support the hypothesis that increased temperatures during spawning and the early life history result in decreased recruitment in the SNE/MA stock. Winter temperature is correlated with spring temperature providing a potential bridge between this study and that of Manderson (2007). Using the same serial correlation approach to examine trends in winter air temperature shows an increase in correlation among the three regions starting in the late-1980's early-1990's. The correlation coefficients of Southern New England and Gulf of Maine air temperatures are correlated with the similar coefficients for recruitment. This result suggests that as regional air temperatures have become more coherent, winter flounder recruitment in the coastal stocks also has become more coherent.

The results of the analyses support Manderson's (2008) earlier finding. Recruitment in coastal stocks of winter flounder is related to temperature during the spawning season. Importantly, recruitment is also dependent on spawning stock biomass and the environmentally-explicit stock-recruitment models capture the combined effect of environment and stock size. The temperature effect is strongest in the Southern New England stock, where the species is at the southern extent of its range. The signal is less pronounced in the Gulf of Maine, but recruitment is still linked to winter temperatures. The effect of environment on recruitment of Georges Bank winter flounder is less clear. There is a lot of variability in the stock-recruitment relationship and none of this variability is explained with the environmental terms considered here. Whether other environmental factors play a role in Georges Bank winter flounder recruitment is an important question requiring future research.

One use of the environmentally-explicit models is to develop short-term and long-term forecasting models. Based on the above analyses, there is no trend in winter temperature over the past 30 years and thus short-term forecasts can be developed using the environmentally-explicit models assuming winter temperatures to be at their mean state. It may also be useful to develop short-term forecasts under warm temperatures and short temperatures to provide managers with a tangible understanding of the effect of temperature on the stocks. The environmentally-explicit models could also be used to develop longer-term forecasts following the approach of Hare et al. (2010). These forecasts would provide an assessment of the sustainability of the winter flounder fishery on the 30-100 time scale.

Appendix B2 Table 1. Environmental variables used in the SDWG response to TOR 5 and their sources.

Variable	Abbreviation		Stocks	Source
Southern New England Air Temperature	aSNE	three 2 monthly periods	SNE	http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html
Georges Bank Air Temperature	aGB	three 2 monthly periods	GBK	http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html
Gulf of Maine Air Temperature	aGOM	three 2 monthly periods	GOM	http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html
Woods Hole Coastal Water Temperature	WH	three 2 monthly periods	GBK, SNE	http://www.nefsc.noaa.gov/epd/ocean/MainPage/ioos.html
Boothbay Harbor Coastal Water Temperature	BH	three 2 monthly periods	GOM	http://www.nefsc.noaa.gov/epd/ocean/MainPage/ioos.html
Atlantic Multidecadal Oscillation	AMO	0 year lag	GBK, GOM, SNE	http://www.cdc.noaa.gov/Correlation/amon.us.long.data
North Atlantic Oscillation (DJFM)	NAO	0, 1, and 2 year lags	GBK, GOM, SNE	http://www.cgd.ucar.edu/cas/jhurrell/Data/naodjfmindex.asc
Gulf Stream Index – Joyce and Zhang (2010)	GS-J	0 year lag	GBK GOM, SNE	Terry Joyce (pers. comm.)
Gulf Stream Index – Taylor and Stephens (1998)	GS-PLY	0 year lag	GBK, GOM, SNE	http://www.pml-gulfstream.org.uk/Web2009.pdf

Appendix B2 Table 2. Model weights, explained variance and evidence ratios for best environmentally-explicit models compared to best standard model.

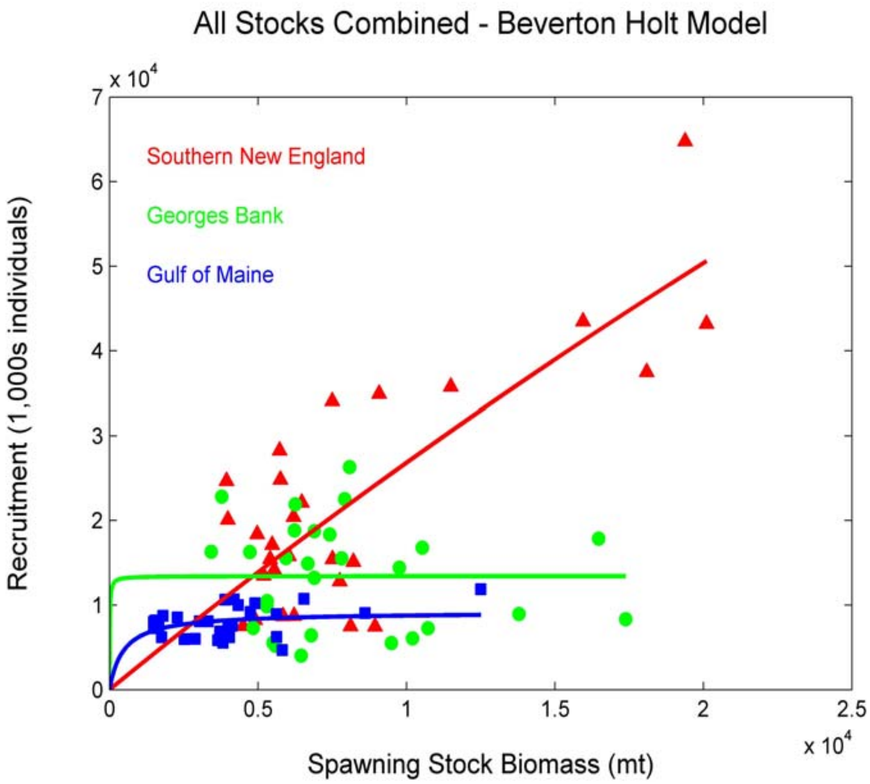
Stock	Model	Variable	W	r^2	Evidence Ratio
Southern New England	BH env M2	aSNE-JF	0.214	0.74	105.8
	BH std M	None	0.002	0.60	
Georges Bank	BH env M3	aGB-JF	0.057	0.07	0.7
	BH std M	None	0.082	0.00	
Gulf of Maine	BH env M2	aGOM-JF	0.108	0.21	2.2
	BH std M	None	0.003	0.07	

Appendix B2 Table 3. Akaike Information Criteria (AIC) statistics for the top ten ranked models for each stock.

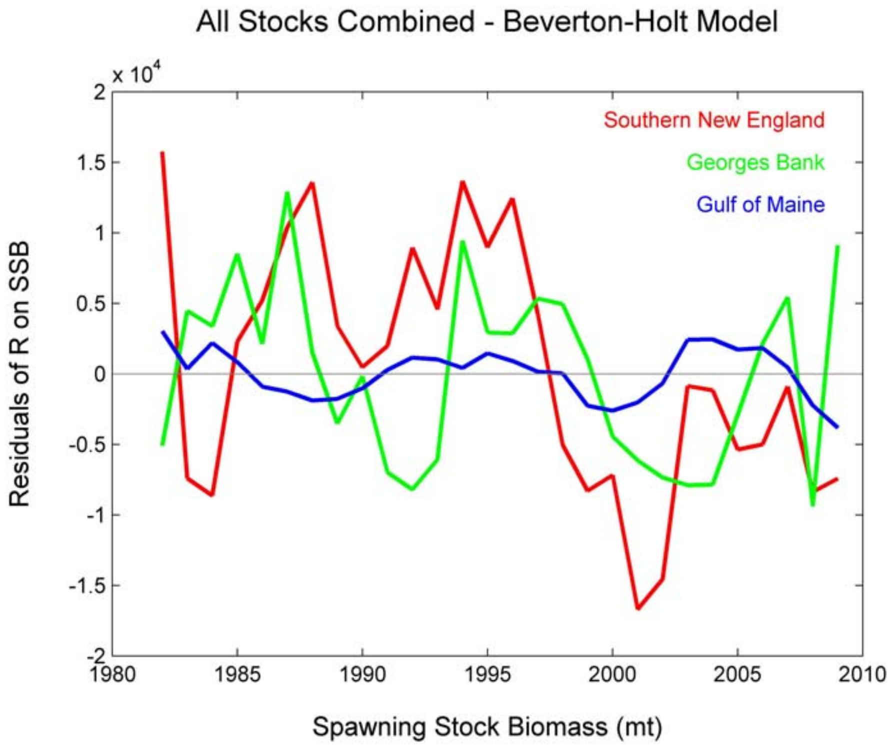
Stock	Model Rank	Model	Variable	AICc	delta	weight	cumulative weight
Southern New England	1	BH env M2	aSNE-JF	505.12	0.00	0.214	0.214
	2	BH env M2	GS-J-0	505.62	0.50	0.166	0.380
	3	BH env M1	aSNE-JF	505.79	0.66	0.153	0.533
	4	BH env M3	aSNE-JF	506.15	1.03	0.128	0.661
	5	BH env M2	AMO-0	507.47	2.35	0.066	0.727
	6	BH env M3	AMO-0	508.00	2.88	0.051	0.778
	7	BH env M1	AMO-0	508.05	2.93	0.049	0.827
	8	BH env M1	GS-J-0	509.17	4.05	0.028	0.855
	9	BH env M3	GS-J-0	509.21	4.09	0.028	0.883
	10	BH env M1	WH-JF	509.47	4.35	0.024	0.907
Georges Bank	1	BH std M	none	496.04	0.00	0.082	0.082
	2	BH env M3	aGB-JF	496.76	0.72	0.057	0.139
	3	BH env M1	aGB-MJ	496.95	0.91	0.052	0.191
	4	BH env M2	aGB-MJ	496.96	0.92	0.052	0.243
	5	BH env M3	GS-PML-0	497.29	1.25	0.044	0.287
	6	BH env M2	GS-J-0	497.55	1.51	0.039	0.326
	7	BH env M1	GS-J-0	497.56	1.51	0.039	0.365
	8	BH env M2	WH-MJ	498.04	2.00	0.030	0.395
	9	BH env M1	WH-MJ	498.06	2.02	0.030	0.425
	10	BH env M2	NAO-0	498.15	2.11	0.029	0.454
Gulf of Maine	1	BH env M2	aGOM-JF	423.39	0.00	0.108	0.108
	2	BH env M1	aGOM-JF	423.50	0.10	0.103	0.211
	3	BH env M2	aGOM-MJ	424.72	1.33	0.056	0.267
	4	BH env M2	BH-JF	424.83	1.44	0.053	0.320
	5	BH env M1	aGOM-MJ	424.84	1.45	0.052	0.372
	6	BH env M1	BH-JF	424.86	1.47	0.052	0.424
	7	BH std M	none	424.97	1.58	0.049	0.473
	8	BH env M2	aGOM-MA	425.04	1.64	0.048	0.521
	9	BH env M1	aGOM-MA	425.13	1.74	0.045	0.566
	10	BH env M3	BH-JF	425.63	2.24	0.035	0.601

Appendix B2 Table 4. List of standard and environmentally-explicit stock recruitment models used in the study. Formulation follows Levi et al. (2003).

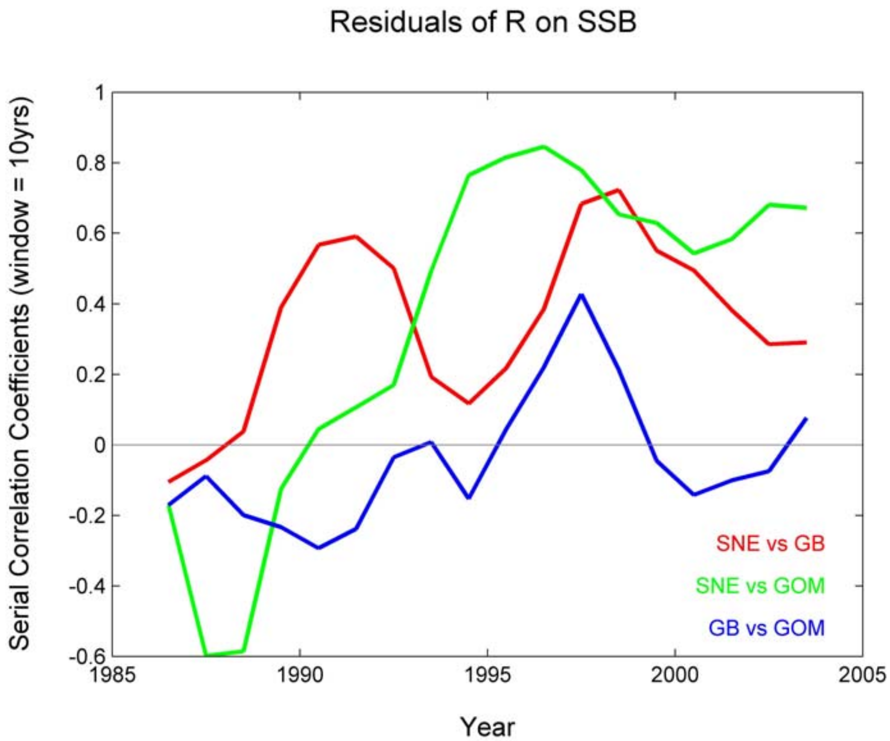
Model Name	Model Formulation	Model
Beverton-Holt	$R = S/(b + aS)$	Standard / No Environment
Beverton-Holt	$R = Se^{cE}/(b + aS)$	Environmental Model 1 Controlling Effects (alters the rate of change of numbers of young fish in time)
Beverton Holt	$R = S/(b + ae^{cE}S)$	Environmental Model 2 Limiting Effects (alters the carrying capacity of the habitat for recruits)
Beverton Holt	$R = S/(be^{cE} + aS)$	Environmental Model 3 Masking Effects (determines the metabolic work needed for the maintenance of the individual.)



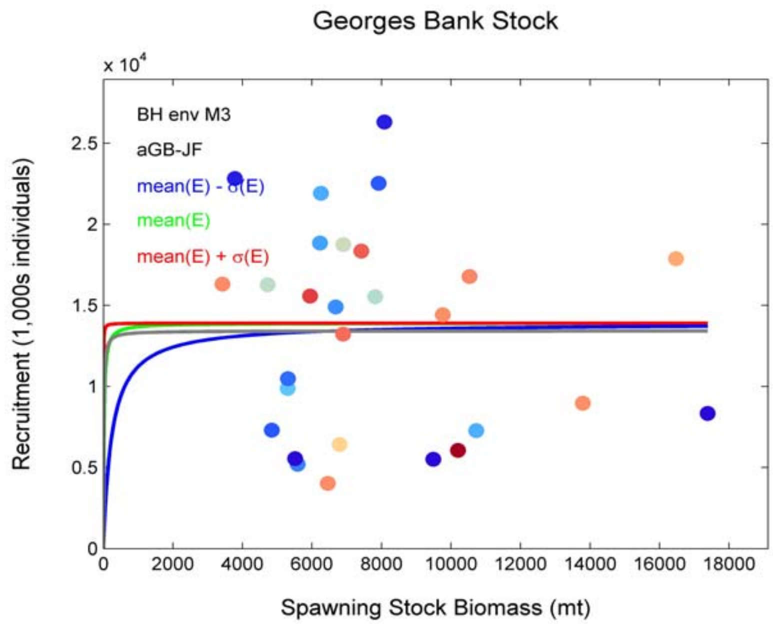
Appendix B2 Figure 1. Comparison of stock-recruitment data and standard Beverton-Holt stock-recruitment models for the three U.S. winter flounder stocks.



Appendix B2 Figure 2. Comparison of the residuals of the stock-recruitment relationships for the three U.S. winter flounder stocks based on the standard Beverton-Holt stock-recruitment model.



Appendix B2 Figure 3. Serial correlation of the residuals of the stock recruitment relationship making the three pairwise comparisons: SNE vs. GB, SNE vs. GOM, and GB vs. GOM. Window for serial correlations set at 10 years.



Appendix B2 Figure 4. Environmentally-explicit stock recruitment relationships for Georges Bank winter flounder. The best overall environmental model is shown as is the standard model (gray). Symbols are color coded to the value of the environmental variable and model predictions for mean environment and ± 1 standard deviation of the environmental variable are shown. The specific models and environmental variables are noted in the upper left hand corner (see Appendix B2 Tables 1 and 2).

Appendix B3. Estimation of length-based vessel calibration factors

The Survey Research Vessel (SRV) *Albatross IV* (Albatross) was replaced in 2009 by the SRV *Henry B. Bigelow* (Bigelow) as the main platform for NEFSC research surveys, including the spring and fall bottom trawl surveys. The size, towing power, and fishing gear characteristics of the Bigelow are significantly different from the Albatross, resulting in different fishing power and therefore different survey catchability. Calibration experiments to estimate these differences were conducted during 2008 (Brown 2009), and the results of those experiments were peer-reviewed by a Panel of independent (non-NMFS) scientists during the summer of 2009 (Anonymous 2009, Miller et al. 2010). The terms of reference for the Panel were to review and evaluate the suite of statistical methods used to derive calibration factors by species before they were applied in a stock assessment context. Following the advice of the August 2009 Peer Review (Anonymous 2009), the combined-seasons ratio estimator calibration factors were initially adopted to convert Bigelow survey catch number and weight indices to Albatross equivalents. The aggregate catch number calibration factor for winter flounder, for combined seasons, is 2.490 and the aggregate catch weight factor, for combined seasons, is 2.086.

Since the 2009 Peer Review, it has become evident that accounting for size of individuals can be important for many species. If there are different selection patterns for the two vessels for a given species, the ratio of the fractions of the fish caught by the two vessels can vary with size. Since 2009, length-based calibration factors have been estimated for several stocks (cod, haddock, and yellowtail flounder through the Trans-boundary Resource Assessment Committee [TRAC] assessment process; silver, offshore, and red hakes during the 2010 SARC 51 and *Loligo* squid during the 2010 SARC 51 (Brooks et al. 2010, NEFSC 2011). For those length-based calibrations, the same basic beta-binomial model from Miller et al. (2010) was assumed, but various functional forms were assumed for the relationship of length to the calibration factor. Since then, Miller (submitted) has explored two types of smoothers for the relationship of relative catch efficiency to length and the beta-binomial dispersion parameter. The smoothers (orthogonal polynomials and thin-plate regression splines) allow much more flexibility than the functional forms previously considered for other stocks by Brooks et al. (2010) and NEFSC (2011).

The SDWG reviewed work by Miller (MS 2011) on winter flounder in greater detail, and compared the model results for all winter flounder to those from a model that accounted for effects of stock area (GOM, GBK, and SNE/MA). The SDWG also explored seasonal effects, but did not fully pursue those models due to a lack of samples in the Gulf of Maine stock region during the spring. The lead assessment scientists for each of the winter flounder stocks compared predicted indices in Albatross units based on the different fitted models to explore the degree of consistency between calibrated indices using the different models.

When fitting the fourth order polynomial with smoother models to data from each stock region, there were convergence issues for the GOM stock data, likely due to over-parameterization of the length effects. When the order of the polynomial was reduced to two for this region, these issues were resolved. The resulting model performed better than the best models that Miller (submitted) fit that did not account for effects of stock area. Inspection of residuals revealed no strong trend with predicted number captured by the Bigelow or total number captured by station and no strong departure from normality. The predicted relative catch efficiency was lowest at intermediate size classes for all three stock areas, but the location of the minimum was at larger size for the Georges Bank stock than for the two other stock areas.

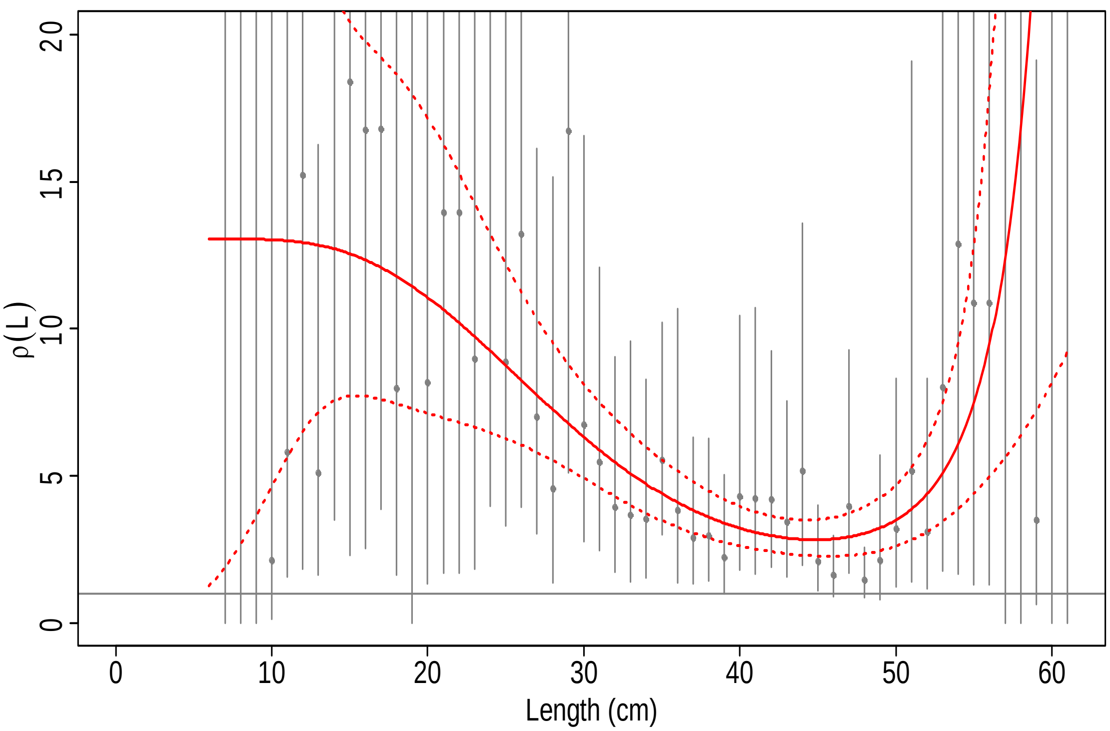
When applying the relative catch efficiencies to surveys conducted in 2009 and 2010 with the Bigelow, there is an important caution to note. Lengths may be observed in these surveys that are outside of the range of lengths observed during the calibration study. This problem is exacerbated when the data are subset by stock area for the estimation of relative catch efficiency, because the limits of the range of sizes available in the subsets can be narrower than the range of the entire data set, and so caution must be taken in predicting catches in Albatross units at these sizes. The SDWG also had some concerns with the asymptotically increasing estimates of relative catch efficiencies at the smallest and largest sizes for the winter flounder stocks, particularly when converting historic Albatross indices to Bigelow equivalents. Sizes of fish outside of the ranges observed during the calibration study (7-61 cm for the Georges Bank stock) would potentially lead to extremely high Bigelow abundance indices at the extremes of the length composition for the historic data In order to address this concern, an adaptation of the model was explored that constrained lengths beyond a minimum and maximum length to have constant relative catch efficiencies. The minima and maxima were determined by specifying a maximum coefficient of variation (CV) of predicted relative catch efficiencies at these lengths. These CV criteria resulted in models that provided aggregate abundance indices that were very similar to the corresponding models without the CV criteria. Because no ad-hoc CV criteria were necessary in the initial regional length models, the SDWG found those to be preferable.

Lastly, the swept areas for each tow during the 2009 and 2010 surveys would ideally be used to predict Albatross catches at each station, but if there is little variability in the swept areas, a mean can be used and the mean number per tow at length in Bigelow units can be converted to Albatross units. The fourth order polynomial model fit to data for the Georges Bank stock region, incorporating a mean ratio of the vessel swept areas of 0.5505 (Bigelow to Albatross), was used to calculate the calibration factors-at-length (Appendix B3 Figure 1) that were used to convert the 2009-2010 Bigelow survey indices to Albatross units for use in population model calibration (Appendix B3 Table 1).

Appendix B3 Table 1. NEFSC spring and fall survey indices from the SRV *Henry B. Bigelow* (HBB) and length-calibrated, equivalent indices for the SRV *Albatross IV* (ALB) time series. Indices are the sum of the stratified mean numbers (n) at length. Spring and fall strata sets include offshore strata 13-23. The length calibration factors are for the Georges Bank stock region for the lengths observed in the calibration experiment (7-61 cm) and include a constant, swept area factor of 0.5505. The effective total catch number calibration factors vary by year and season, depending on the characteristics of the Bigelow length frequency distributions.

Year	Spring (n) HBB	CV	Spring (n) ALB	Effective Factor
2009	8.600	51.9	2.683	3.204
2010	5.063	28.0	2.085	2.428

Year	Autumn (n) HBB	CV	Autumn (n) ALB	Effective Factor
2009	14.220	26.8	6.578	2.162
2010	5.298	36.3	2.380	2.226



Appendix B3 Figure B1. Relative catch efficiency of Georges Bank winter flounder from a beta-binomial model where relative catch efficiency was modeled as an orthogonal polynomial smoother of length (solid red line) and from separate models fit to catch data in each length class (gray points). The dashed red lines and vertical gray lines represent approximate 95% confidence intervals. The horizontal gray line represents equal efficiency of the SRVs *Henry B. Bigelow* and *Albatross IV*.