C. SAW METHODS GROUP ADVISORY REPORT

The SARC reviewed the working document and presentation describing a new tool for stock assessment, based on the use of survey indices of abundance. This new approach could be applied when assessing certain fish stocks for which limited data might preclude the application of more traditional stock assessment methods. The technique provides a graphical representation of trends in biomass that assists in determining whether management measures are successful in sustaining or rebuilding a fish stock.

Prior to applying new methods in formal stock assessments, it is essential that the technical aspects, utility, and limitations of these methods are subjected to external peer review by scientists with considerable expertise in the field of stock assessment. After a new approach has been endorsed by such an external peer-review process, it may be applied to appropriate data sets with confidence that the results are likely to be reliable. Accordingly, it was appropriate that the SARC review the new technique and provide advice on the adequacy and potential of the proposed new index-based method, prior to endorsing the use of the new method as an additional tool that might be applied in future stock assessments of certain fish stocks.

The standard Advisory Report format for reporting scientific stock status and stock specific management advice is not well suited to reviews of technical issues that are more methodological in nature. Therefore, we provide a brief description of the method and then report on the SARC's findings with respect to the following terms of reference.

Terms of Reference

1) Describe the underlying theoretical basis for the index-based assessment and projection methodologies;
2) Identify critical limitations for application of such methodologies;
3) Compare reference point estimates and projections with results from VPA and other modeling approaches; and
4) Investigate the applicability of these methods to summer flounder and scup assessments for SAW 35.

Brief description of the index-based method

A value termed the 'replacement ratio' is estimated by dividing the value of the annual survey index for a fish stock by a moving average of the previous five values of that index. If the resulting value is 1, the stock has been maintained at the same average level as recorded in the previous five years. However, if the ratio exceeds 1, the abundance of the stock is increasing, and the extent of that increase is reflected in the magnitude of the replacement ratio. Conversely, if the replacement ratio is less than 1, then the abundance of the stock has declined relative to the

average level recorded in the previous five years. A plot of the time series of values of the annual replacement ratio reveals the trends in abundance that have occurred through that period of the fishery's history for which survey indices are available (Figure C1b).

The relationship between the changes in stock abundance and changes in the relative levels of fishing mortality can also be determined using the survey indices if the time series of total annual catches (landings plus dead discarded fish) is available. For this, an estimate of the relative F is calculated, as described by Applegate *et al*. (1998), by dividing the value of the catch by the three-point average of the survey indices centered on the year in which that catch occurred. The resulting time series of the values of relative F may be plotted (Figure C1f) and the pattern of changes compared with those of the plots of the time series of replacement ratios (Figure C1b), survey indices (Figure C1d) or landings (Figure C1e). Alternatively, the replacement ratio or survey indices may be plotted against the values of relative F (Figure C1a or C1c, respectively). The resulting six-panel plot is a convenient graphical device to communicate the changes in the annual values of relative F and replacement ratios, thereby allowing examination of the relationships between these variables and the raw catch and survey data.

For many of the fisheries that are subject to assessment and consideration by the SARC, survey indices reveal a pattern of decline associated with increasing exploitation followed by an increase that is linked to the reductions in exploitation resulting from the various management controls that have been implemented. The resulting set of points in the plot of the replacement ratio versus relative F (Figure C1a) often suggests a linear trend, to which a robust regression line has been fitted and an ellipsoid has been drawn, which encompasses points that lie within approximately 1 standard deviation of the means of the two variables. Clusters of points around a replacement ratio of 1 may form if the relative F has been maintained at around the same level for a sufficient period such that the stock has settled around a stable equilibrium.

Techniques that provide estimates of the projected levels of the survey index and associated catches have been described. The method has also been used to hindcast estimates of the survey indices in earlier years of a fishery's history, for which catch data are available but for which no survey data exist.

Theoretical bases for the method

The SARC viewed the method as a useful empirical approach, but a number of issues were raised regarding its theoretical basis. Further work in a number of areas was recommended.

Limitations for application of the methods

- The use of the relative F statistic requires reliable catch data and would thus not be applicable to stocks for which catch records are inadequate, or substantial portions of the catch are poorly estimated (e.g. discards, recreational catch, etc.).

- The method assumes that the survey indices adequately represent the fishable biomass.

- The method will not adequately estimate relative F at replacement when stock trends are mainly driven by environmental effects. Strong year classes or, worse, persistent changes in productivity, such as connected with regime shifts, would lead to spurious results.

- The method would be unsuitable for developing fisheries, or situations when fishing mortality is increasing from a low value.

- The estimate of replacement fishing mortality will be sensitive to transition effects due to variations in recruitment, fishery selectivity, average weights, age structure and other factors.

Comparison of projections with results from VPA and other modeling approaches

- Projections based on this method should not be used to forecast population trends beyond a few years.

- Projections are sensitive to transient effects even in the absence of density dependence. For example, initial stock increases obtained in response to reductions in F may be large initially but the rate of increase would slow as the age structure broadens. The selection of the relative F needed to achieve a given rate of increase in the projections would be sensitive to transient conditions. When required relative F differs markedly from the current F, catch projections will be off scale compared to projections made using conventional age-structured models (e.g., Georges Bank yellowtail flounder).

- Further evaluation of the degree to which the method produces results that are comparable with those produced by a VPA is required, noting that the new method has the potential to be applied when data limit the applicability of other methods.

Applicability to summer flounder and scup assessments for SAW 35

- Due to inadequate catch records, the SARC concluded that the method was not applicable to the scup assessment.

- The method could have potential for summer flounder assessment as an interim technique (between the application of analytical assessments) to evaluate new catch and survey data relative to management targets, especially in combination with medium-term projections from assessments.

Conclusions

The method is a useful addition to the approaches that are used in stock assessment and has value in identifying appropriate stock assessment model structure. Some aspects of the approach, including calculation of the replacement ratios, relative Fs and graphical presentation of the resulting data, were endorsed by the SARC for use in the stock assessment of fisheries with appropriate data. However, performance of the method should be evaluated through simulation studies and the results subjected to peer review prior to use in estimating TACs or TALs, or before the approach is used in formal stock assessments. Such studies are also required to determine whether it is possible to identify alternative reference points, based on the replacement ratio, and how these reference points may relate to existing target and threshold reference points for a stock.

References

Applegate, A., S. Cadrin, J. Hoenig, C. Moore, S. Murawski and E. Pikitch. 1998. Evaluation of existing overfishing definitions and recommendations for new overfishing definitions to comply with the Sustainable Fisheries Act. Final Report, Overfishing Definition Review Panel. New England Fishery management Council, Newburyport, Massachusetts. 179 pp.

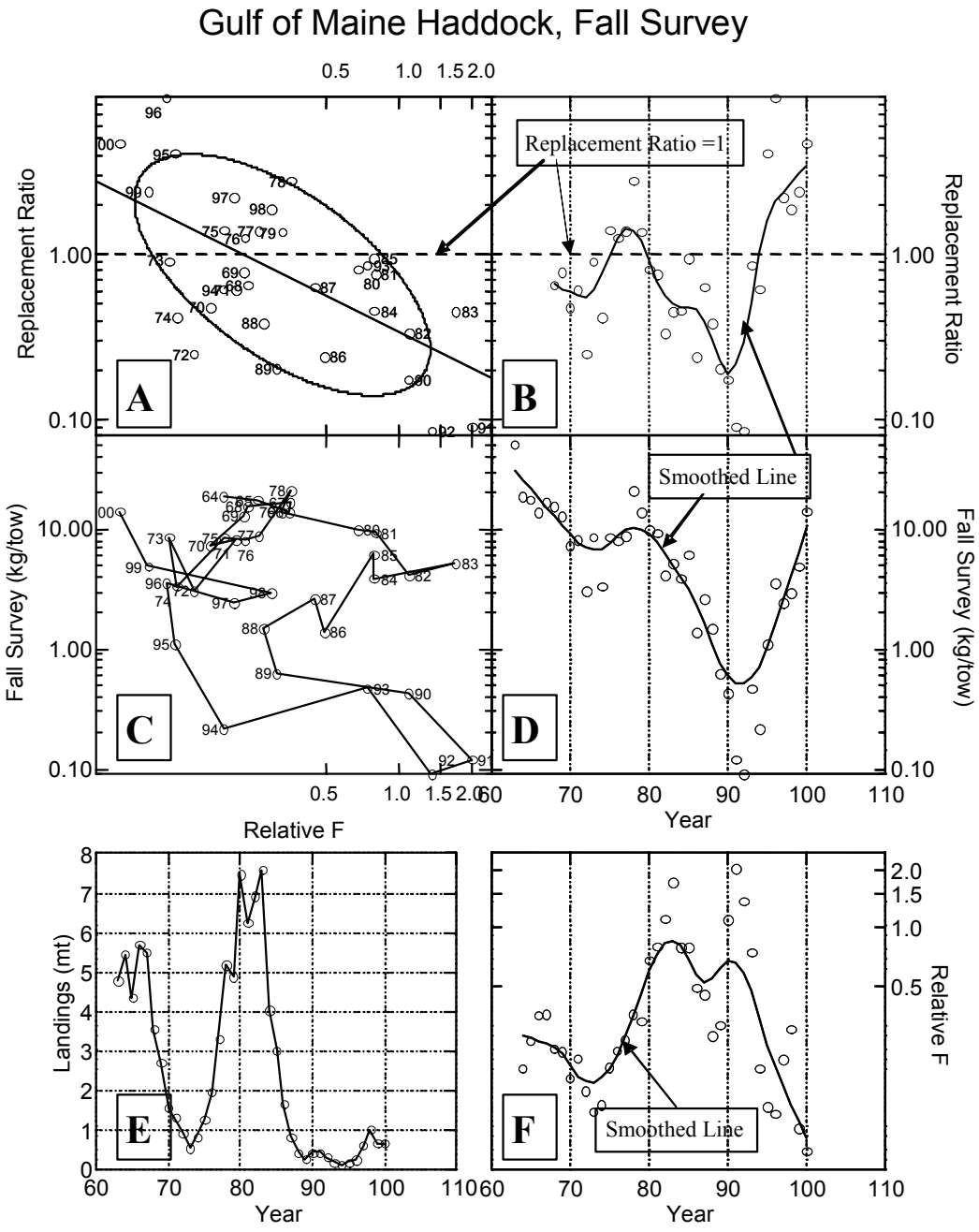

Figure C1. Annotated six-panel plot depicting trends in relative biomass, landings, relative fishing mortality rate (landings/index) and replacement ratios for Gulf of Maine haddock, using NMFS fall survey and commercial landings. Horizontal dashed (---) lines represent replacement ratios = 1 in (A) and (B). The confidence ellipse in (A) has a nominal probability level of 0.68. The diagonal line in (A) uses a robust regression estimator.