

Report of the SUN Subcommittee on evaluating multi-year ABC advice  
September 2013 meeting of the MAFMC SSC

**Rumble Strips for Assessing the Performance of Multi-year Acceptable Biological  
Catch Limits**

Report of the Scientific Uncertainty Subcommittee  
Scientific and Statistical Committee  
Mid-Atlantic Fishery Management Council

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## **Introduction**

The scientific uncertainty (SUN) subcommittee was tasked with the continued development of approaches for setting and reviewing multi-year Acceptable Biological Catch (ABC) recommendations. The two primary questions are 1) how should the SSC determine if multi-year ABCs are performing as intended, and 2) if the performance is not acceptable, how should an ABC be changed? Performance of an ABC can be monitored using a variety of metrics that indicate status of the stock and performance of the fishery, such as indices of abundance or biomass, catch, or relative exploitation. However, each of the metrics contains uncertainty (noise), which causes the observed value to not necessarily reflect the true status of the stock or fishery. Therefore, it is critically important to determine which metrics to use for monitoring ABC performance and how they will be used in the determination of ABCs if a decision is made to change the ABC.

One of the primary reasons for multi-year ABCs is that the Northeast Science Center does not have the resources to assess all stocks annually. Therefore, methods for checking ABC performance should use sources of information that require less effort to compile than a full stock assessment. Additionally, approaches for changing multi-year ABCs should be transparent to avoid the potential appearance of capriciousness. With these considerations in mind, the SUN subcommittee developed a three step approach to evaluating ABC performance and potentially changing multi-year ABCs. This report describes a general approach reviewing performance of multi-year ABCs.

### **“Rumble Strip” Approach**

The basic idea behind the rumble strip approach is that multiple indicators will be evaluated to determine if they are within a range that was expected when the multi-year ABCs were originally set. The analogy is that rumble strips alert drivers when they are going off the road. If indices are outside the bounds that were expected when ABCs were initially set, corrective action may be necessary.

The rumble strip approach uses multiple indices to determine if sufficient information exists such that reevaluation is necessary. Each index is scored as zero if it is within expected bounds or one if it is outside expected bounds. The overall score for a given year is calculated as the sum of the indicators across the indices for that year. An aggregate score greater than or equal to a prespecified threshold would trigger a reevaluation of the available data for that stock. If the reevaluation suggests the need, corrective actions would be taken by the SSC to modify the ABC or make recommendations to the Council.

The SUN subcommittee recommends a three step approach to reviewing and potentially deviating from multi-year ABC levels: 1) evaluate multiple indices to determine if they are within pre-specified bounds, 2) if a number are outside the pre-specified bounds, take a closer look at all available data for the stock, 3) if concerns persist that the stock is outside the range originally anticipated, make a corrective action (e.g., change the ABC, request a new stock assessment).

#### *How to set determine indices*

Many sources of data are available to use as indicators, but the subcommittee thought that several sources of information should be used together, and several types of data are particularly appropriate for use in rumble strip analysis. Desirable indices are ones that will be available on an annual basis, are relatively easy to calculate, and indicate changes in exploitation rate, biomass, or other important metrics of stock status. For many of the MAFMC stocks, the NMFS trawl survey (spring, fall, or both) is used as an index of biomass in their respective stock assessments. To provide an index of fishing mortality, the relative fishing mortality (total removals / index of biomass) should be monitored. Additionally, changes in mean length of the population can indicate poor recruitment or loss of older age classes, so mean length from surveys may provide an important indicator for assessing stock condition. Indices of biomass that are included in the stock assessment of a given species should also be used in the rumble strips if they are going to be available. For example, the summer flounder stock assessment uses a variety of federal and state surveys as indices, but we suggest only using the NMFS trawl surveys in rumble strip analyses because they cover the largest area and the data are processed by the NEFSC. Thus, the timing of other agency's data availability need not be relied upon.

The subcommittee thought that a variety of data sources were not particularly useful for inclusion in the rumble strip analyses. These include catch (other than used to calculate the relative fishing mortality), fishery dependent catch-per-unit-effort (CPUE; if other indices are available), mean length in the catch, and metrics that rely on age data. Catch was not thought to be useful because it is also affected by regulations and can change because of changes in effort or changes in stock size. Fishery CPUE may not be available because of time lags in reporting and data processing, and it is generally considered to be of lower quality for providing an index of biomass than survey CPUE. Mean length in the catch can have substantial effects of gear regulations or size limits, which reduce its usefulness for providing information about the stock. Aging data are not likely to be available within the time frame needed and, therefore, cannot be relied upon for inclusion in rumble strip analyses.

We first describe the general approach to developing rumble strips and then provide a worked example with summer flounder.

### *Set bounds for rumble strips*

Indices are inherently variable, and this variability needs to be considered in determining the bounds for rumble strips. Development of rumble strips needs to include consideration of the amount of variability in each index that differs from its true signal (i.e., noise). For most indices, noise is introduced by sampling variability, environmental variability, and other sources of error. Rumble strips ideally have a high probability of detecting true positives (e.g., determining that stock size is low when it actually is low), while minimizing false positives (e.g., indicating stock size is low when it is not of concern). The same idea is important for negative results (e.g., an indicator that stock size is within the acceptable range should have a low probability of producing that result if stock size is outside that range). Contributing to the difficulty, each type of index has different amounts of variability, and indices from the same source should be expected to have different levels of variability for each stock. For example, biomass indices from the NMFS fall trawl survey have substantially lower variability for summer flounder than they do for black sea bass. Thus, a single, simple approach (e.g., using 95% confidence intervals) will not produce the desired properties in rumble strips.

The approach developed by the SUN subcommittee uses the variability of each time series, along with a determination of the appropriate confidence bounds to set rumble strips. Ideally, previous values of the overall scores are considered, and the confidence level is chosen so there is a high probability of detecting periods when the stock or fishery was in an undesirable state. The percentage to use in the confidence interval and the score to trigger reevaluation should be selected so the score (of indicator variables summed over indices) identifies periods of concern. Some stocks have not had a historical period during which they were thought to be overfished or undergoing overfishing. In these cases the most recent 10 years should be used to calculate the mean and variability. Alternatively, a period with stable catch could be used. We expect that the critical score for reevaluation will differ among stocks because they will have different numbers of indices in the analysis. However, a fixed proportion (e.g., 1/3 of the total) might be a useful default rule for the critical score. Also, indices that are very highly, or perfectly, correlated should not be included (only one of the pair should be included).

### *Initial evaluation and reevaluation*

During each annual review of ABC performance, the number of indices outside the rumble strips will be tallied and compared to the score needed to trigger

reevaluation. If reevaluation is not deemed to be necessary, then the multi-year ABC advice should continue in place. However, if a reevaluation is triggered, then a more in-depth look at the available information is required to determine possible causes of the rumble strip triggering and if corrective measures are required.

Reevaluation should involve first looking at the indices used to conduct the rumble strip analyses to determine which ones are outside the bounds and to determine whether they indicate a better than anticipated or worse than anticipated situation. For some indices this will be easy. For example, an index of biomass below a lower bound would be worse than expected, while relative fishing mortality lower than a bound would be better than expected. Other indices, such as mean size in the survey, require a more detailed evaluation to interpret their meaning. For example, a mean size larger the upper bound could indicate an increase in the number of large fish, but it could also indicate a reduction in the proportion of small fish or a recruitment failure. Thus, each index that is out of bounds will need to be inspected carefully to determine what the appropriate response might be. It is possible that multiple indices conflict with one another (e.g., one indicating worse than expected status and another better). In these cases it is likely that reevaluation will conclude that corrective measures are not warranted. Additionally, data not used in the rumble strips can also be considered during reevaluation.

### *Corrective measures*

If after reevaluation of the indices corrective measures are deemed necessary, the type of corrective measure to take must be determined. Corrective measures could be necessary in two directions. The reevaluation could indicate that either the situation is better than expected or that the situation is worse than expected. The consequences of these determinations are asymmetric relative to the probability of overfishing. In the case that the situation is worse than expected (e.g., lower stock size, higher fishing mortality rate), the probability of overfishing will be higher than desired. Conversely, if the situation is better than expected, the probability of overfishing will be lower than desired. For the Magnuson-Stevens Act, avoiding overfishing is given a higher priority than avoiding underfishing. Thus, different corrective measures can be justified if the stock appears to be worse or better than expected when the multi-year ABC advice was originally provided.

Because of the inherent uncertainty in making management decisions in the absence of a full stock assessment, default responses should be available. Deviation from the default response will be possible, but will require specific justification.

The SUN subcommittee recommends that the following default rules be used if a reevaluation determines that corrective measures are necessary:

- If the state of the stock appears to be worse than expected, the ABC for all remaining years should be reduced by 25% and a new stock assessment requested.
- If the state of the stock appears to be better than expected, a new stock assessment should be requested.

Alternative rules could also be justified, such as different percentages for a default decrease or increase. However, in all cases requesting a new assessment seems like a prudent action.

### *Important considerations*

The SUN subcommittee identified a number of important considerations for implementing the rumble strip approach. These include:

1. Rumble strips should be defined in advance (metrics and values, and how many metrics must be out of bounds to trigger reevaluation).
2. Default rules for corrective action should be developed to facilitate changes or recommendations if they are deemed necessary.
3. The rumble strip method does not consider a desired trend in the population. This could be built in, but the expected amount of change in most stocks is small given that most multi-year ABCs are for three years or less. Therefore, this additional level of detail is likely not necessary for most situations. However, in cases where a large change in population size, and thus ABC, is expected, a trend can be incorporated into the rumble strips.

### *Summer flounder example*

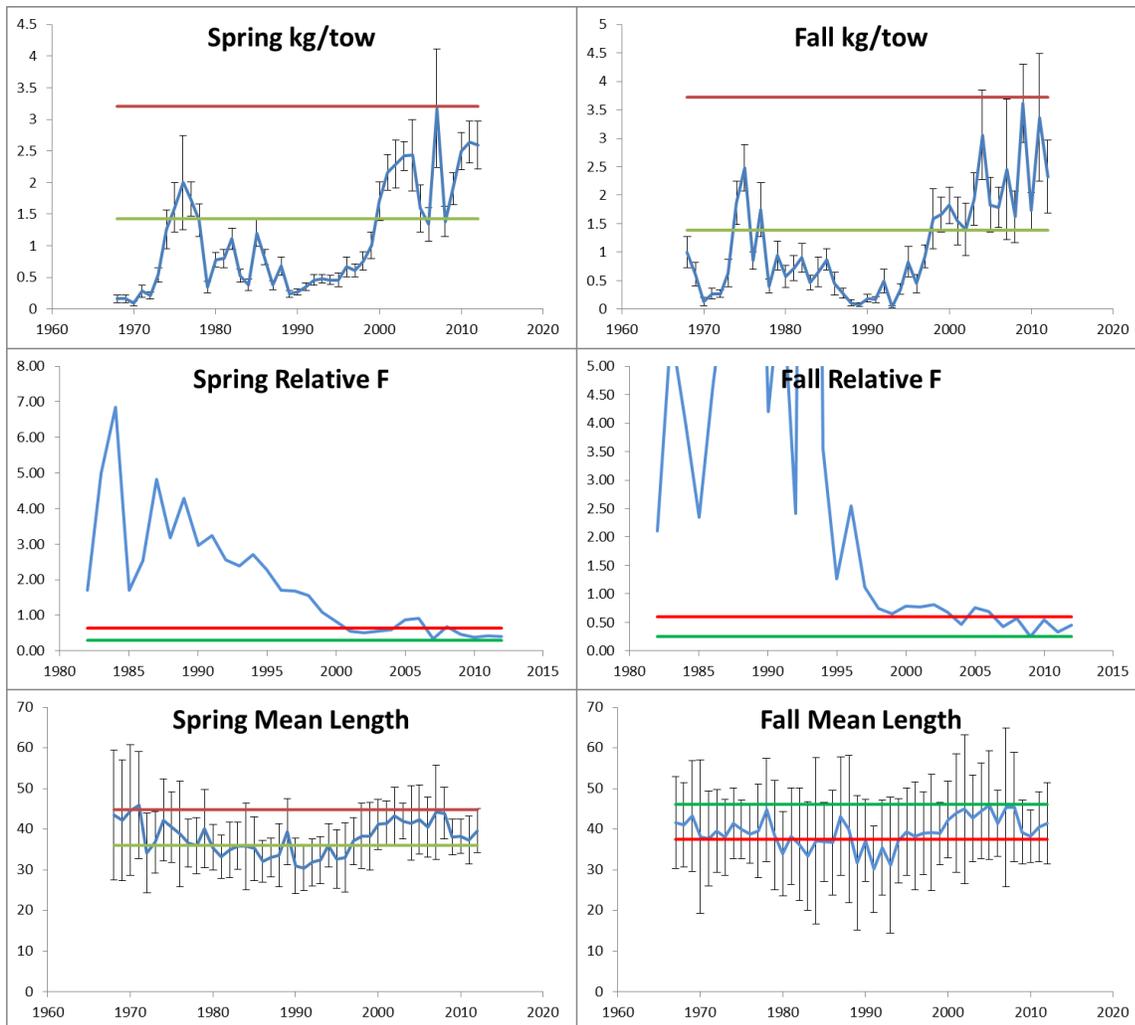
The SUN subcommittee reviewed the data that would likely be available on an annual basis through the NEFSC and included six indices in the summer flounder rumble strip analysis. The six indices were the index of biomass from the fall and spring survey, relative fishing mortality (removals / survey index) calculated using the fall and spring survey, and mean length in the fall and spring surveys. These indices were selected to represent biomass of the stock, fishing mortality, and average size in the population. Indices from the years 2007-2011 were selected to estimate the standard deviation from the index, because this represents the period where the stock was not overfished and not undergoing overfishing. Rumble strips for each index were developed by calculating 80% confidence intervals about the 2007-2011 mean using a

normal distribution. Each year of an index was scored as a zero if it was within the bounds and as a one if it was outside the bounds. The overall score for a year was the sum of the indicators. For this example, two was chosen as the critical score because total scores greater than two did not occur when overfishing was occurring or when the stock was overfished.

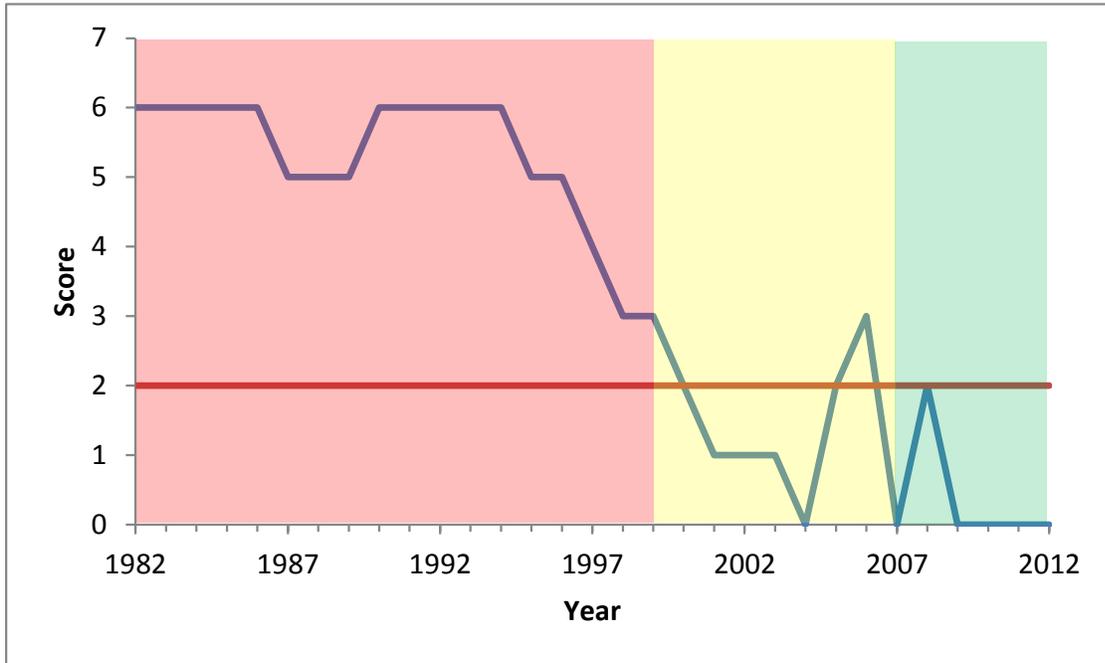
The method appears to work well for summer flounder. The trawl survey indices of biomass increased substantially in the 1990s and leveled out in the early to mid-2000s (Fig. 1). The indices of relative fishing mortality decreased substantially over the time series to their lowest levels in recent years. Mean length from the trawl surveys was somewhat less responsive than the biomass index, but showed a dip in the middle of the times series with a recovery at the end. The correlations among some of the indicators were high ( $r=0.88$  for fall mean length and fall kg/tow), but were considered acceptable (Table 1). The overall score began the time series at six and did not dip below the critical value for reevaluation (2) until 2001 (Fig. 2). Since then, the score increased to three once (2006) and to two twice (2005 and 2008). In the most recent year, the rumble strip analysis indicates that conditions are not different than anticipated (score=0) and that reevaluation is not necessary.

Table 1. Correlations of the indicator scores for each index.

	<b>Spring kg/tow</b>	<b>Fall kg/tow</b>	<b>Spring Rel F</b>	<b>Fall Rel F</b>	<b>spring mean L</b>	<b>fall mean L</b>
<b>Spring kg/tow</b>	1					
<b>Fall kg/tow</b>	0.766	1				
<b>Spring Rel F</b>	0.862	0.661	1			
<b>Fall rel F</b>	0.567	0.558	0.674	1		
<b>spring mean L</b>	0.673	0.879	0.580	0.490	1	
<b>fall mean L</b>	0.550	0.718	0.474	0.401	0.682	1



**Fig. 1. Indices for inclusion in summer flounder rumble strip analyses. The blue lines indicate the mean value for each index over time. The whiskers indicate one standard deviation. The red and green lines indicate the rumble strips (upper and lower bounds of 80% confidence intervals assuming normal distributions). The variance for the confidence interval calculation was from years 2007-2011.**



**Fig. 2. Overall score for summer flounder (blue line) compared to the rumble strip critical score (red line). Red background indicates overfishing and overfished status, yellow indicates overfishing (but not overfished), and green indicates not overfishing and not overfished.**