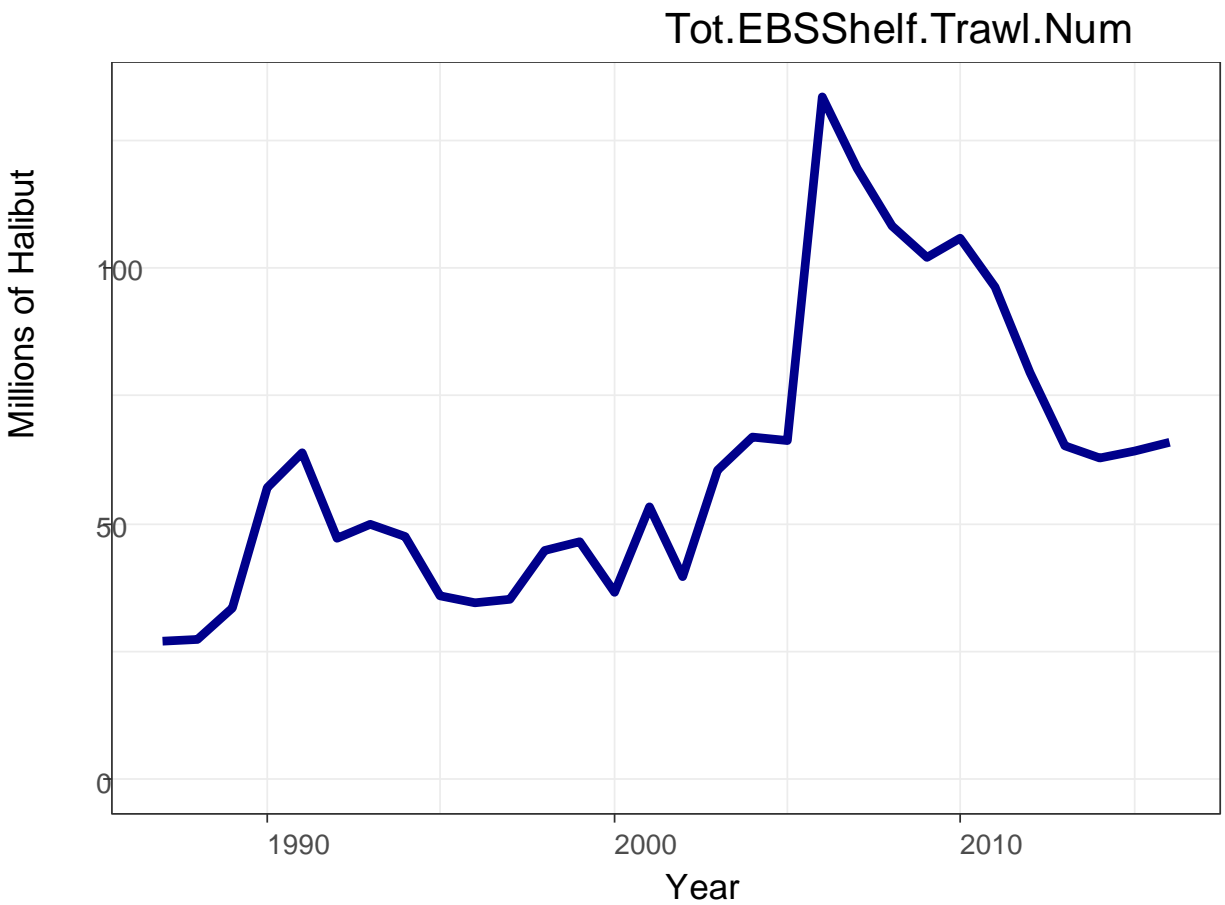


AN EXAMPLE ABUNDANCE BASED MANAGEMENT CALCULATION FOR ABM1

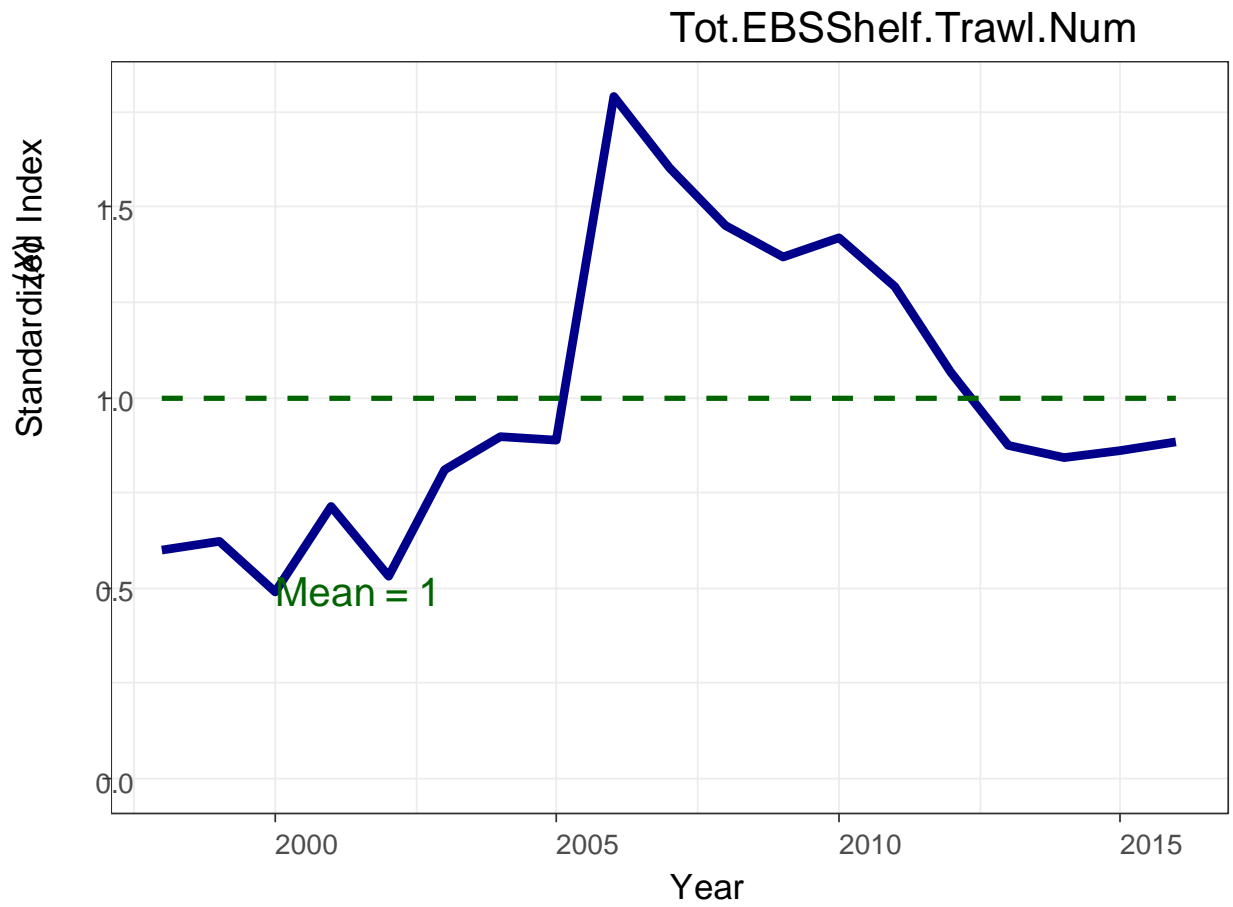
STEP 1 (INDEX PART 1)

Obtain an index of abundance that relates to the halibut PSC limit such as the total EBS Shelf Trawl Numbers index shown below.



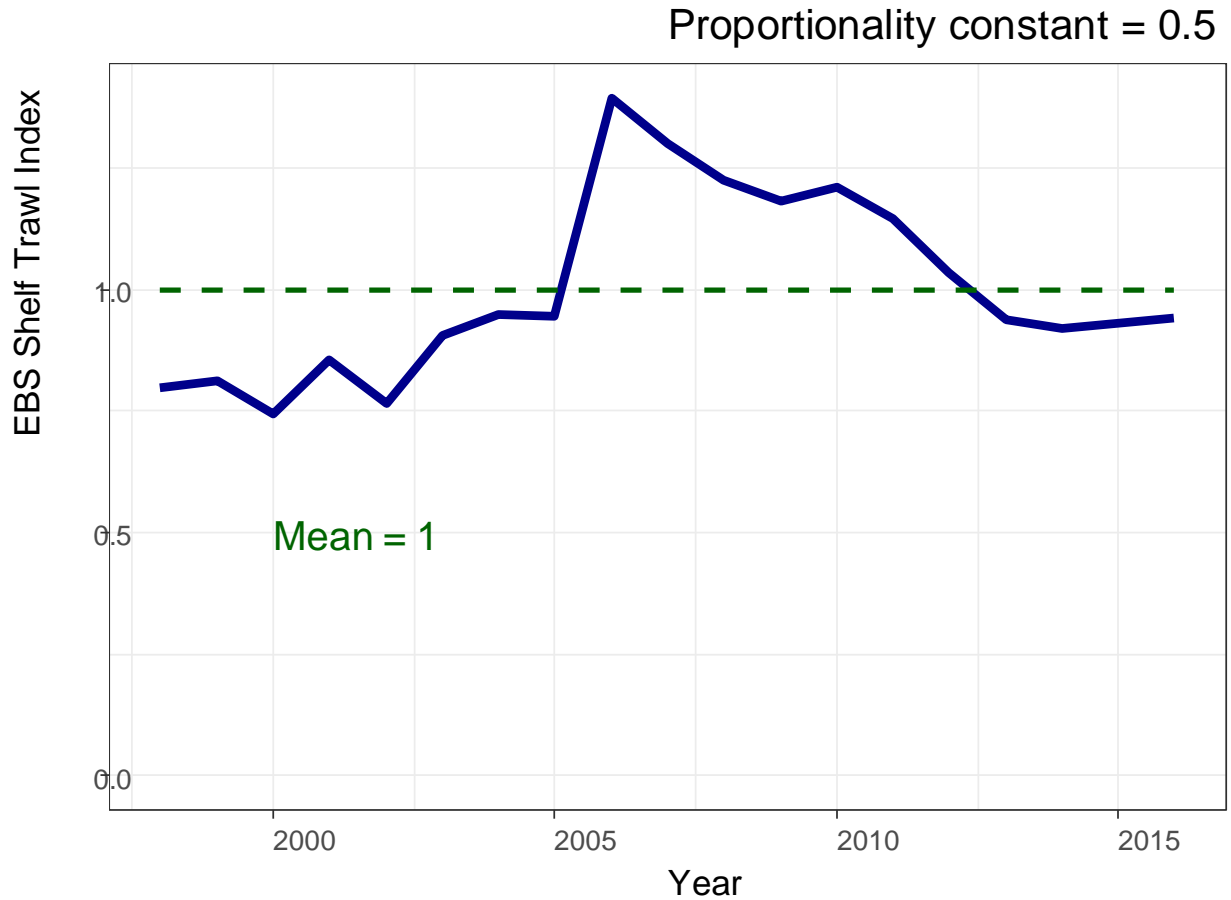
STEP 2 (INDEX PART 2)

Standardize it so the mean value of the time series from (1998-2016) is equal to one (divide by the average).



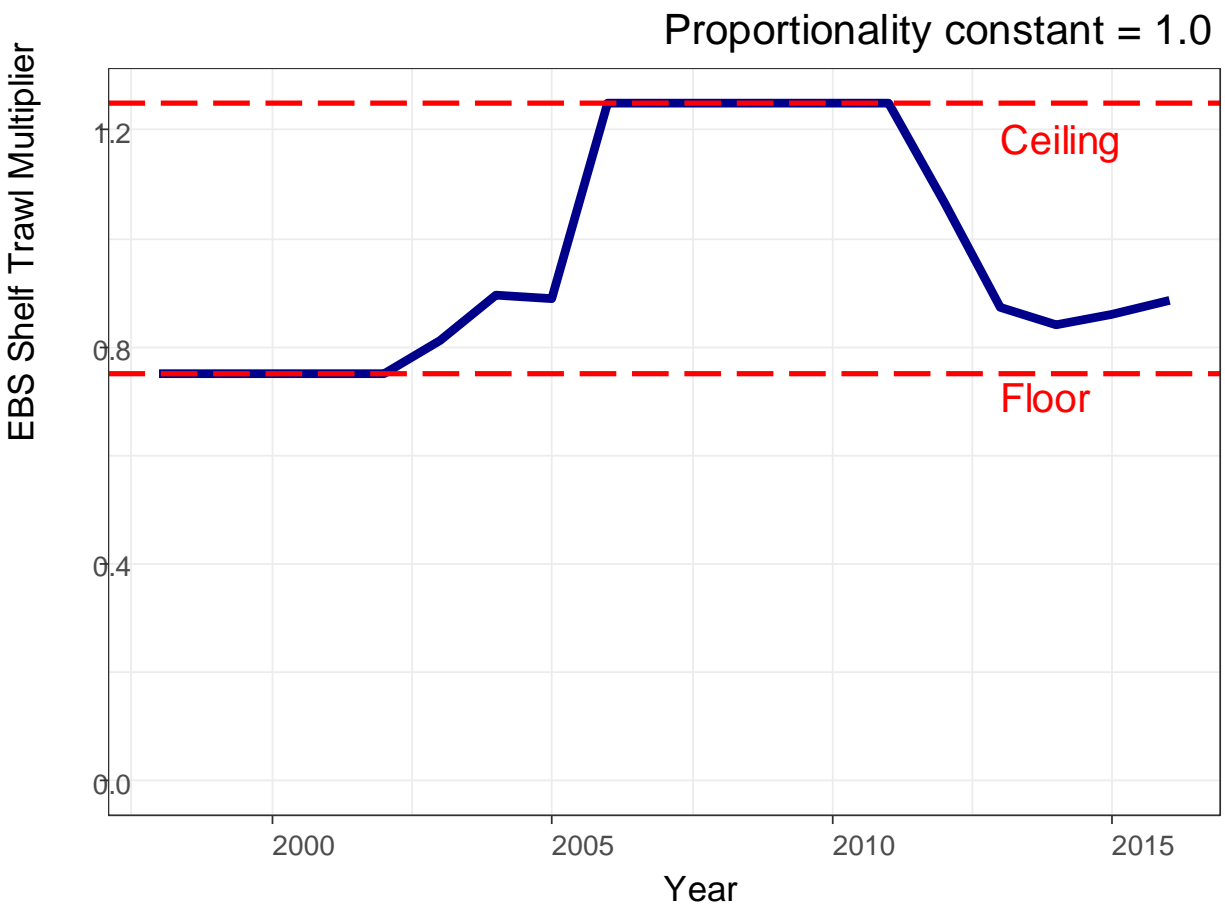
STEP 3 (CONTROL RULE PART 1)

Set a proportionality constant (b) so that a 10% change in the index equals a $b \times 10\%$ change in the adjustment. The discussion paper assumes $b = 1$, or a 10% change in the underlying index would result in a 10% change in the multiplier. For illustration, the example below shows $b = 0.5$, or a 10% change in the underlying index would result in a 5% change in the multiplier (a dampening of the variability).



STEP 4 (CONTROL RULE PART 2)

Set a floor and ceiling so that the index cannot be allowed to go beyond a specified amount above or below the mean. In the example below the b is set back to one as described in the discussion paper, and ceilings and floors of 25% above and below the mean are implemented.



This is now the PSC multiplier (or adjustment, see Figure 9 in the discussion paper) for the EBS Shelf Trawl Survey numbers index (c)

STEP 5

Repeat steps 1-5 for additional indices of abundance. In addition to the EBS Trawl Survey, ABM1 uses the GOA Trawl Survey and the O32 IPHC Setline Survey as indices of abundance.

STEP 6 (CONTROL RULE PART 3)

Multiply adjustments for the three indices together to make an overall index multiplier.

We present examples of PSC limit calculations for two arbitrary cases, one where the indices are all above average and one where the indices are all below average (which could be any future year).

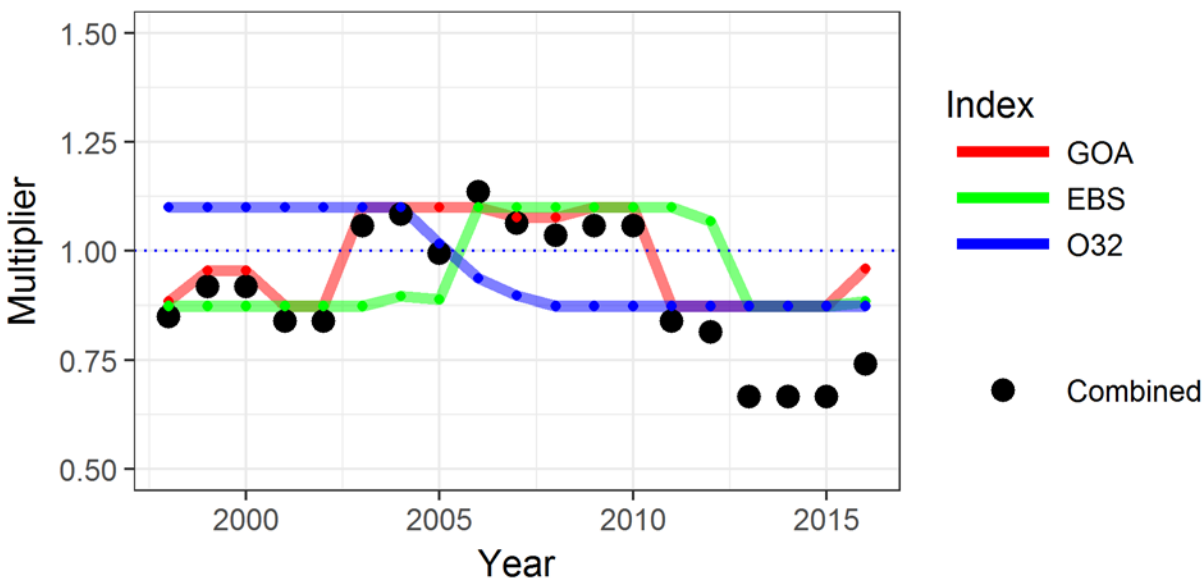
Index	Source		Case 1	Case 2
1	EBS Trawl Survey	$x_1 =$	1.03	0.90
2	GOA Trawl Survey	$x_2 =$	1.05	0.93
3	O32 IPHC Setline Survey	$x_3 =$	1.10	0.97

The overall index multipliers are calculated as follows for Case 1 and Case 2:

Case 1: $1.03 \times 1.05 \times 1.1 = 1.19$

Case 2: $0.9 \times 0.93 \times 0.97 = 0.81$

The figure below shows this multiplication as black dots over the time series of the indices used in ABM1.



STEP 7 (CONTROL RULE PART 4)

Choose a starting value for the PSC limit (PSC_0) to pin the multiplier to. PSC_0 is the estimated PSC limit when the overall multiplier is equal to 1. This step is critical for determining the scale of the PSC limits. In this example, we calculate PSC_0 so that the overall index in 2016 produces the 2016 PSC limit (3,515 t) by dividing the 2016 PSC limit by the overall index multiplier produced in Step 6. The calculation below shows that the PSC limit for ABM1 when the overall multiplier is at a value of 1 is 4,783 t.

Index	Source		2016 standardized index values
1	EBS Trawl Survey	$x_1 =$	0.88
2	GOA Trawl Survey	$x_2 =$	0.96
3	O32 IPHC Setline Survey	$x_3 =$	0.69*

$$PSC_0 = \frac{2016 \text{ PSC limit}}{2016 \text{ Index1} \times 2016 \text{ Index2} \times \text{Index3}}$$

$$PSC_0 = \frac{3,515}{0.88 \times 0.96 \times 0.87^*} = 4,783$$

*Note: The 3rd Index (O32 IPHC Setline Survey) is at the index floor in the ABM1 example in the discussion paper, so instead of 0.69, a value of 0.87 is used. See discussion paper for the reasoning for 0.87.

STEP 8 (CONTROL RULE PART 5)

Calculate PSC limits for two example cases shown above where the overall multiplier is above 1 and below 1 and when PSC_0 is 4,783 tons:

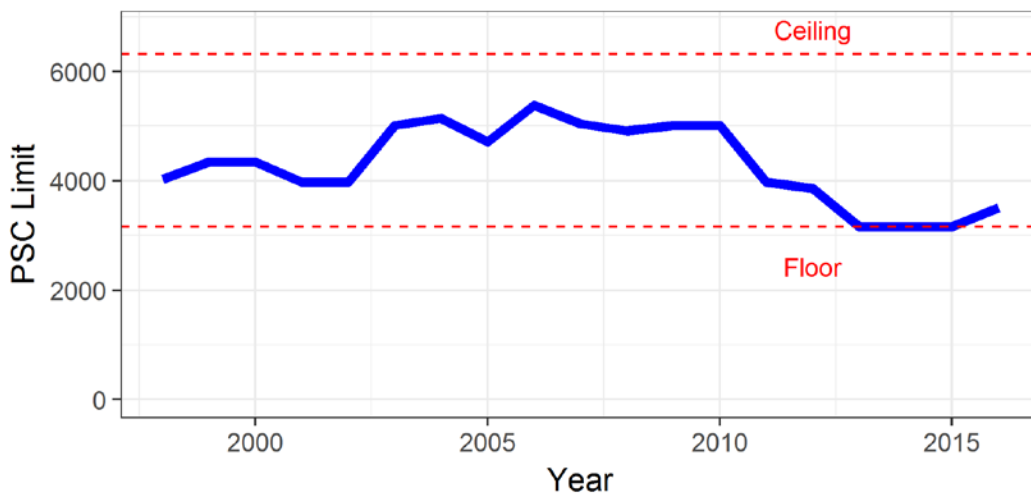
$$PSC = Overall\ Multiplier \times PSC_0$$

Case 1: $PSC = 1.19 \times 4,783 = 5,690$

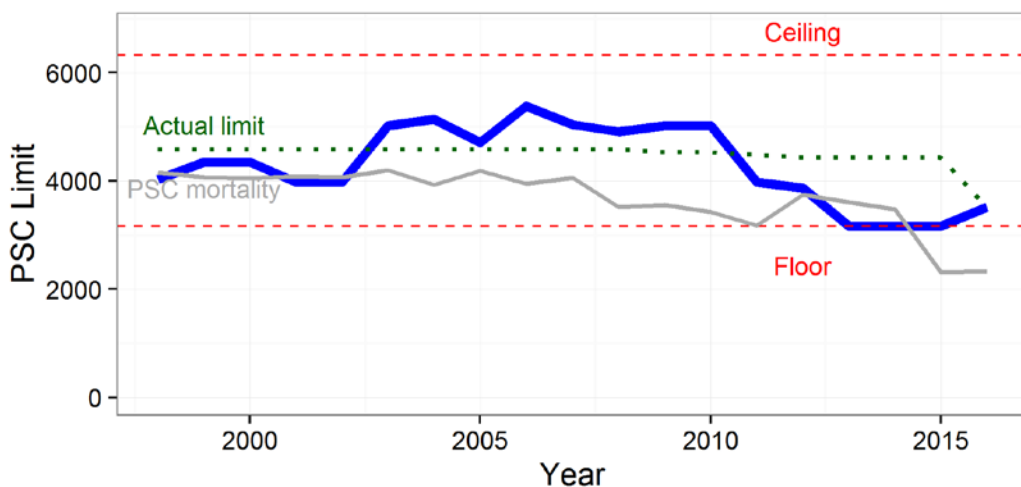
Case 2: $PSC = 0.81 \times 4,783 = 3,883$

Applied historically, the ABM1 example tuned to 2016 yields the following PSC limits.

PSC limits for ABM1



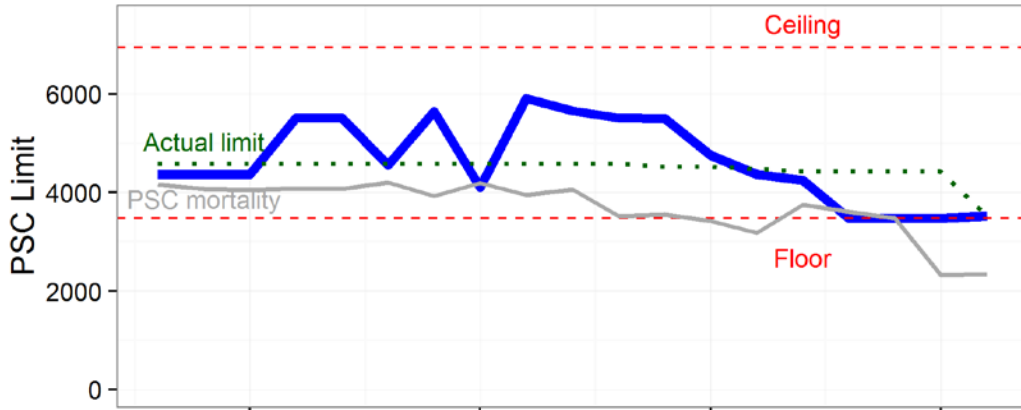
We then can compare the index-based PSC limits with the historical limits (green dotted line) and the estimated Pacific halibut PSC mortality (grey solid line). Note in most years, the realized halibut mortality was substantially below the limits.



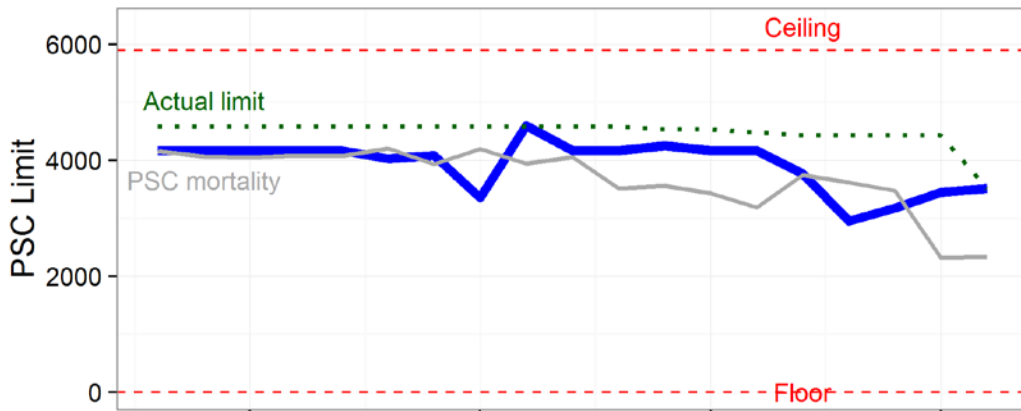
Abundance based Pacific halibut PSC setting

Finally, for comparison, the other three ABM alternatives with the actual PSC limits and realized PSC mortality are shown below:

PSC limits for ABM2



PSC limits for ABM3



PSC limits for ABM4

