

Appendix II, SYM reference point models

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Introduction

This is an update of the SYM reference point model. SYM estimates F_{MSY} and B_{MSY} using per-recruit calculations combined with a stock-recruit relationship. The distinctive feature of SYM is that it treats the per-recruit and stock-recruit parameters as uncertain, and propagates this uncertainty to give probabilistic reference point estimates. For more details regarding this model, see Hart (2013) and NEFSC (2018). The methods and assumptions are the same as in the 2018 benchmark (NEFSC 2018), except that the variance of natural mortality was reduced by 33%.

Results

The reduced uncertainty in M in this assessment is probably more realistic than the higher uncertainty used in the benchmark (Figure 1). Both regions show evidence for higher recruitment at higher SSB (Figure 2). Estimated stock recruit curves were more stable on Georges Bank, where it appears that most of the uncertainty is in the asymptote of the Beverton-Holt relationship. In the Mid-Atlantic, the stock-recruit relationship in some iterations continues to increase well beyond the observed SSB. Although Y_{MAX} and B_{MAX} values were generally well defined, F_{MAX} was highly uncertain in both regions, and hit the $F = 2$ bound in a majority of the simulations in the Mid-Atlantic and in about 15% of the cases on Georges Bank (Figures 3, 4). MSY-based reference points are somewhat better defined, as the stock-recruit relationships tend to constrain F_{MSY} (Figures 5, 6). The F_{MSY} value for Georges Bank is less than that for the Mid-Atlantic, with the combined estimate in between (Table 1, Figures- 6, 7). The updated estimates of F_{MSY} , B_{MSY} , and MSY are somewhat less than those of the benchmark, likely due to the poor recruitment in the two additional years added in the update and the slower assumed growth. Reference points using the benchmark natural mortality uncertainty values were only slightly different than the proposed updated reference points: $F_{\text{MSY}} = 0.6$ and $B_{\text{MSY}} = 99443$ t.

References

- Hart, DR. 2013. Quantifying the tradeoff between precaution and yield in fishery reference points. ICES Journal of Marine Science, 70:591-603.
- Northeast Fisheries Science Center (NEFSC). 2018. 65th Northeast Regional Stock Assessment Workshop (65th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 18-11; 659 p.

Table

Table 1. Summary of reference points for Georges Bank, Mid-Atlantic and combined. Med. Yield_{0.61} and Med. SSB_{0.61} are the yield and SSB from the median curves at the combined $F_{\text{MSY}} = 0.61$.

Region	F_{MSY}	MSY	B_{MSY}	Med. Yield _{0.61}	Med. Bms _{0.61}
GB	0.46	13582	51839	13348	41403
MA	0.72	18847	54516	18731	61253
Combined	0.61	32079	102657	32079	102657

Figures

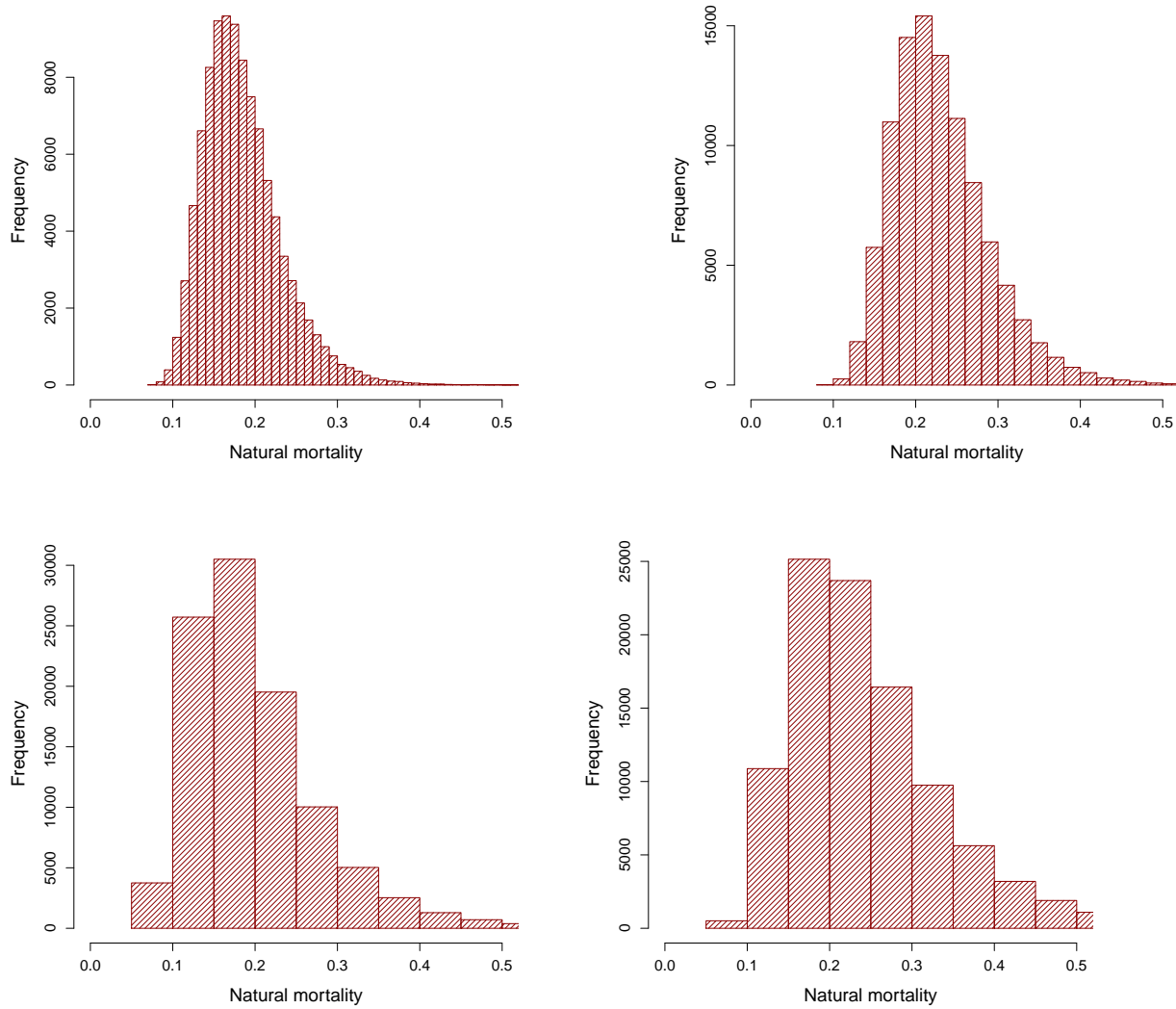


Figure 1. *Above:* Distribution of the natural mortality parameters used in the SYM model for Georges Bank (left) and Mid-Atlantic (right). *Below:* Distribution of the natural mortality parameters used in the SYM model for Georges Bank (left) and Mid-Atlantic (right) based on the 2018 benchmark assumptions.

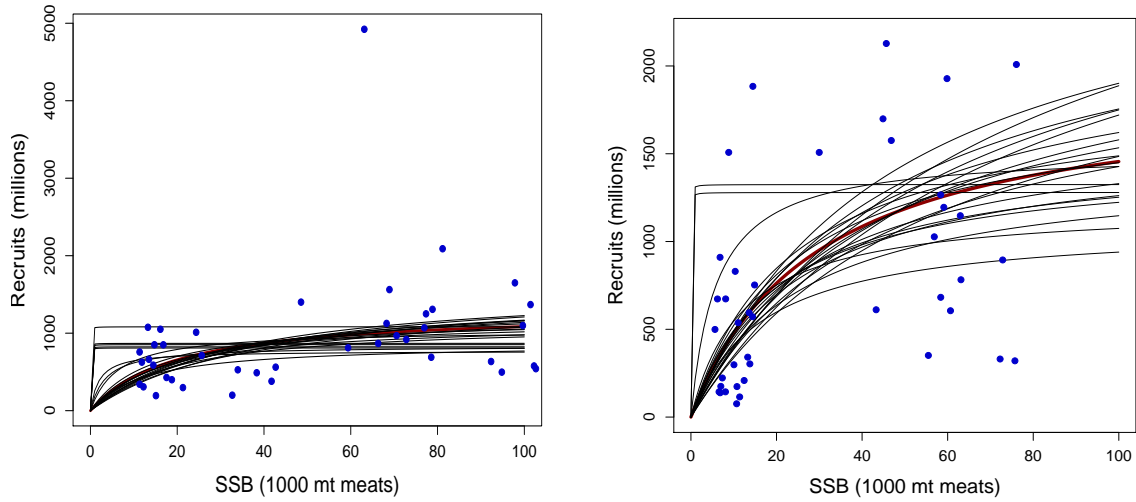


Figure 2. Stock-recruit plots for Georges Bank (left), and Mid-Atlantic (right) (blue dots), with best fits to the data (think red line), and 25 example fits (thin black lines) from the SYM model.

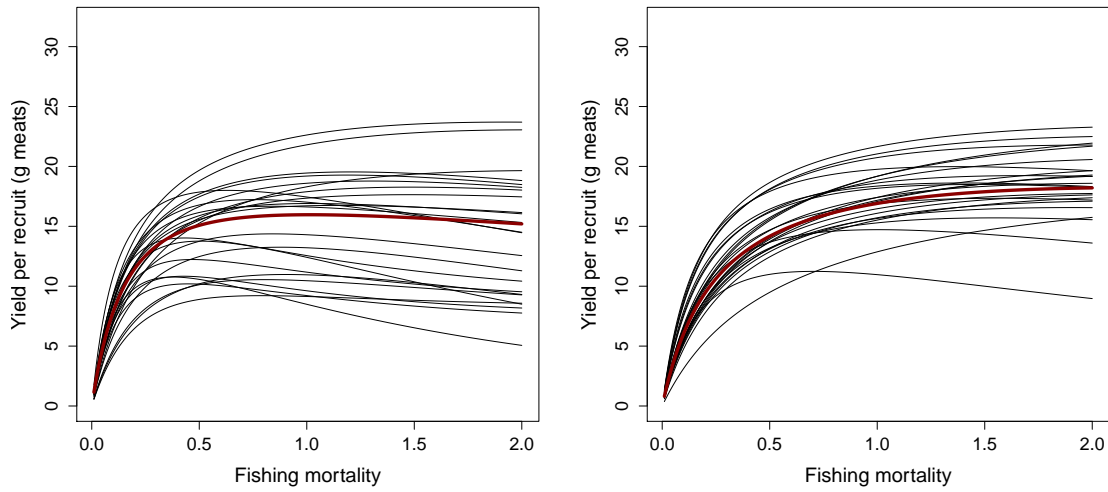


Figure 3. Mean yield per recruit plot (dark red line) together with 25 example yield per recruit plots (thin black lines) from the SYM model for Georges Bank (left) and the Mid-Atlantic (right).

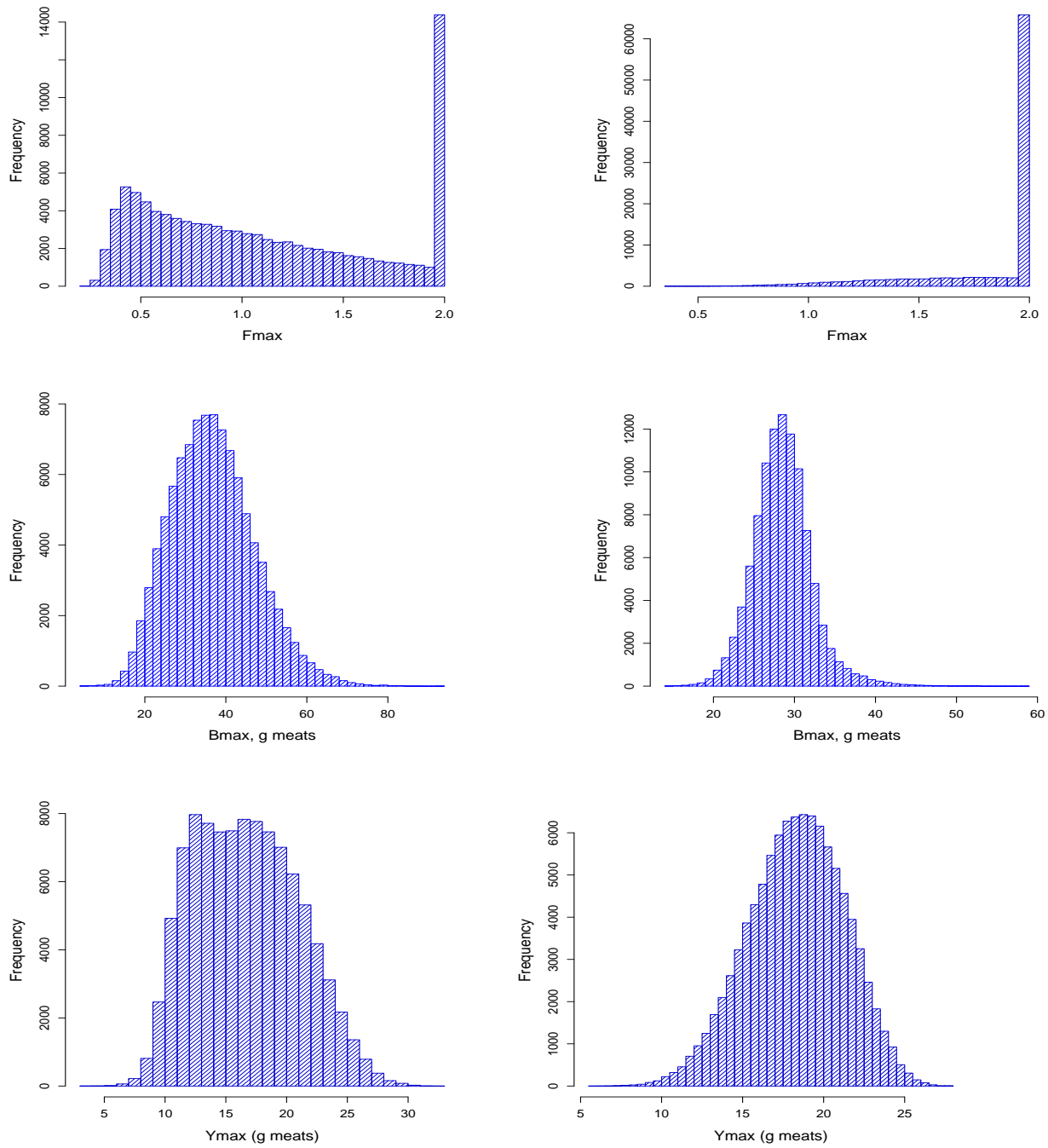


Figure 4. Distribution of the yield per recruit reference point F_{MAX} , B_{MAX} and Y_{MAX} for Georges Bank (left), and the Mid-Atlantic (right).

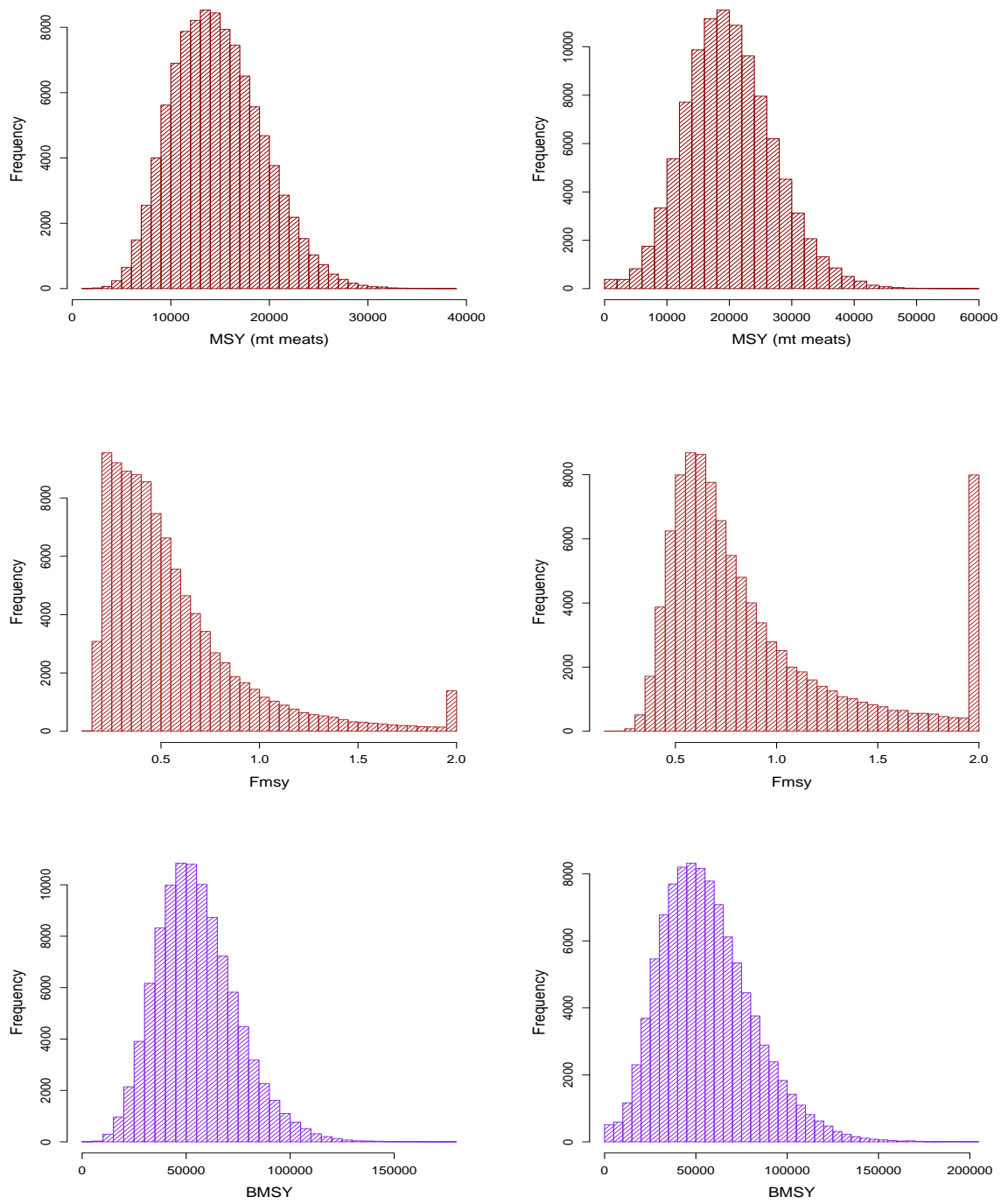


Figure 5. Distributions of MSY, F_{MSY} and B_{MSY} for Georges Bank (left) and Mid-Atlantic (right).

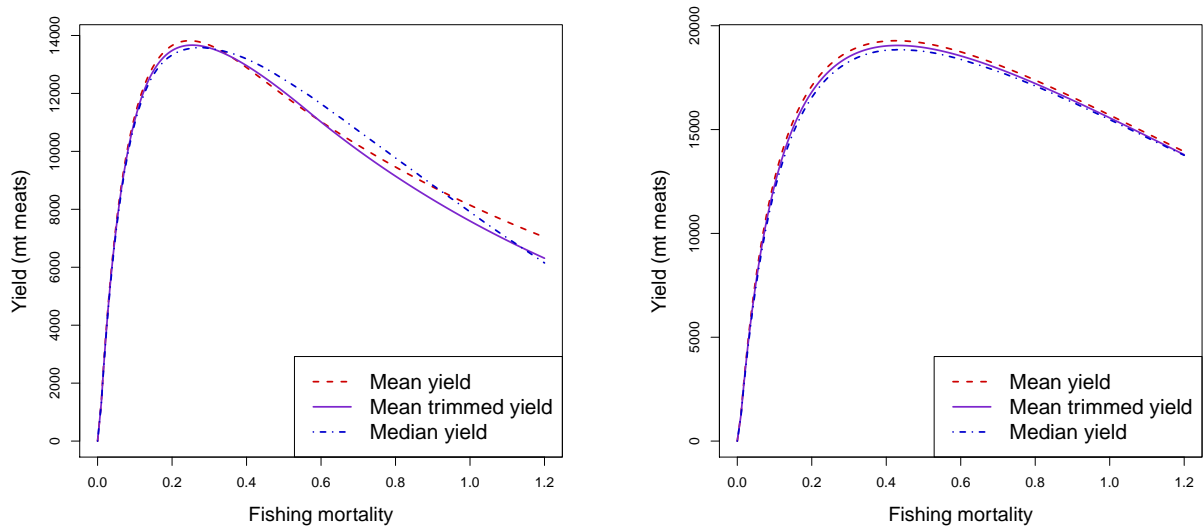


Figure 6. Estimated mean, trimmed mean, and median yield curves Georges Bank (left) and Mid-Atlantic (right).

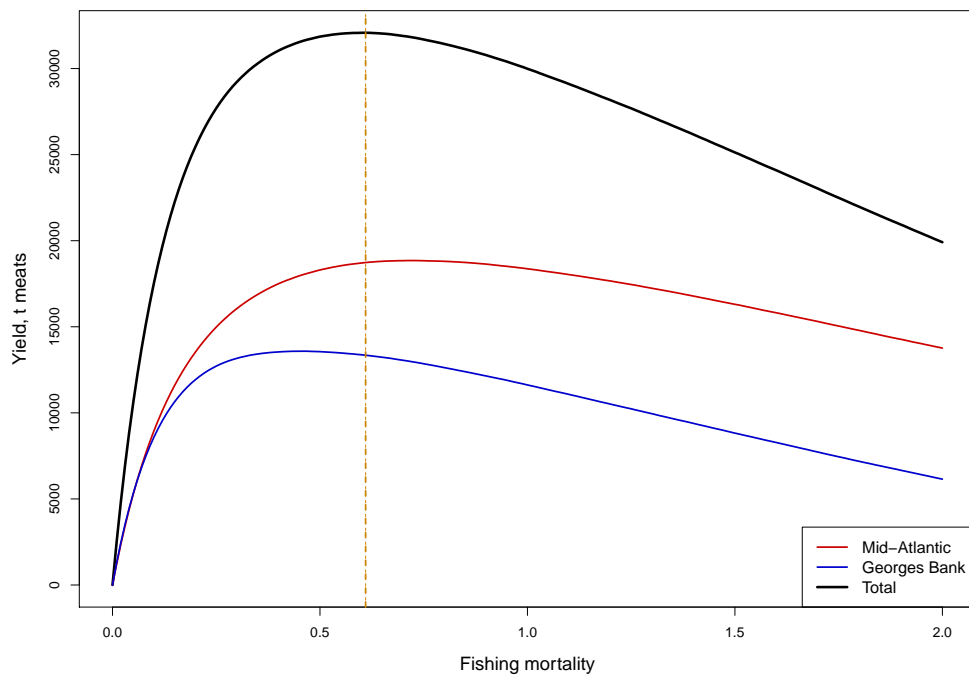


Figure 7. Median yield curves for Georges Bank (blue), the Mid-Atlantic (red) and combined (black). The vertical line is at $F_{MSY} = 0.61$