

# Pareto Frontiers - Multiple Objective Trade-offs

Pollack

L Kell

14 November, 2019

## Summary of simulations and analyses

- The random MSE has been run to derive the calibration regressions and pareto frontiers, based on these the “final” MSEs have been run.
- The OM is the same as for the ROC paper, however, only one stock was run, pollack, as a single example is interesting enough
- There are factors for CPUE CV with three levels (0.1, 0.2, 0.3) and number of years in the HCR regression (3, 5, 7).
- The MP is an empirical HCR, where K1 is how much you decrease TAC for a -ve trend in CPUE and K2 how much you increase TAC for a +ve trend

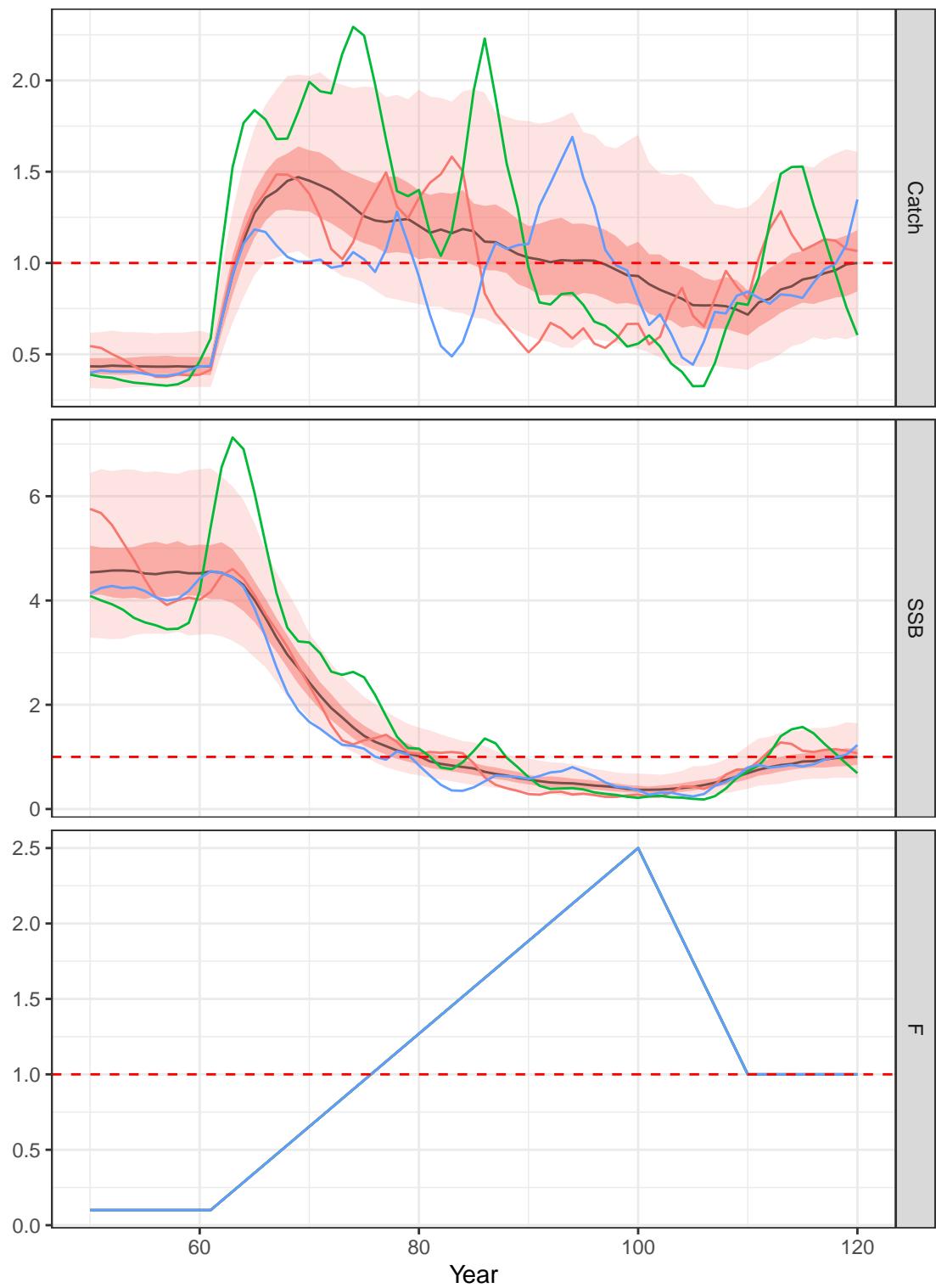
Catches are increased when the trend in an index is positive, and decreased if the trend is negative

$$TAC_{y+1}^1 = TAC_y \times \begin{cases} 1 - k_1|\lambda| & \text{for } \lambda < 0 \\ 1 + k_2\lambda & \text{for } \lambda \geq 0 \end{cases}$$

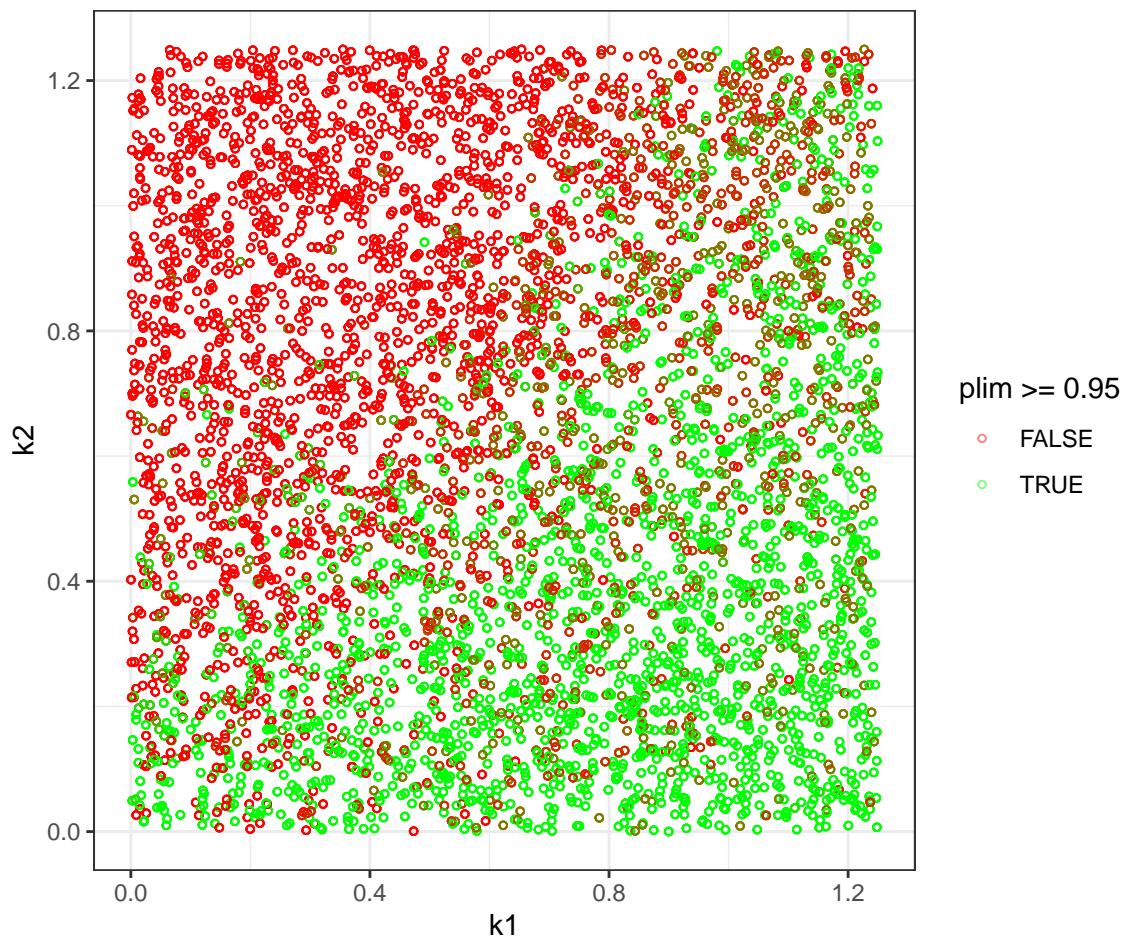
where  $\lambda$  is the slope in the regression of  $\ln I_y$  for the most recent  $n$  years,  $k_1$  and  $k_2$  are *gain* parameters and  $\gamma$  actions asymmetry so that decreases in the index do not result in the same relative change as an increase.

## Figures

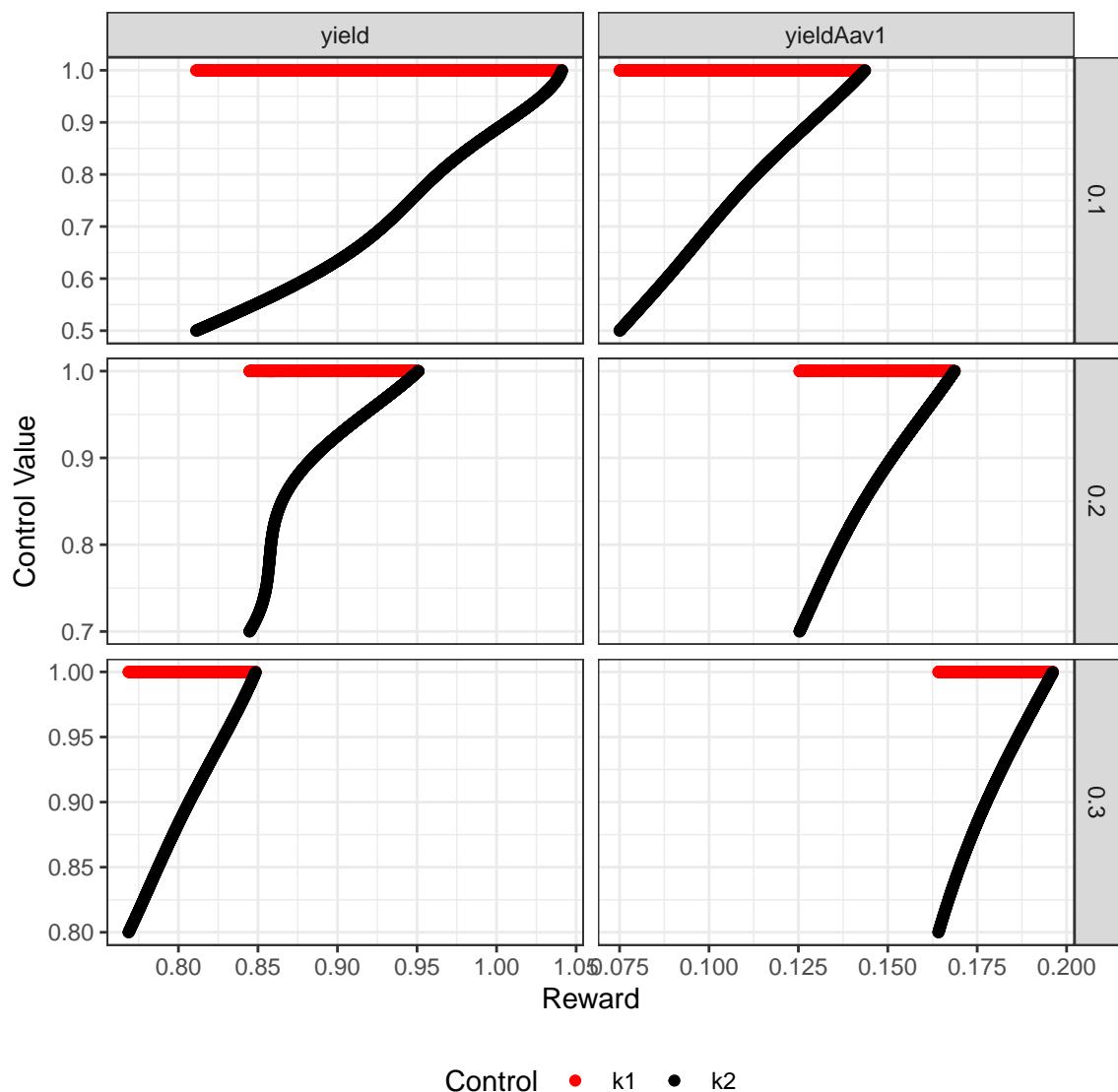
- Fig 1, Example OM
- Fig 2, shows that the stock collapses if  $K1 < K2$
- Fig 3,4,5 Calibration regressions, showing K1 and K2 as a function of yield and AAV. These shows that there is a trade-off between yield and AAV, i.e. fix K1 at 1 and keep K2 ~1 if you want high yield, if you want to reduce AAV at the expense of yield then decrease K2.
- Fig 5 for the 7 year regression may look a bit wonky, but I think I can explain it. If the stock varies as a sin wave with a wavelength < 14 year, when you start at the minimum you have <7 years with an upward trend. As you move forward they will be a tipping point and the regression slope will suddenly change sign. If you allow big changes in catch increases (k2) you will get high yield but at the expense of high variability. If you only allow small changes in k2 then you will lose yield.
- Fig 6 are the Pareto frontiers, which shows the trade-offs between yield and AAV
- Fig 7 are the MSE summaries that confirm the calibrations



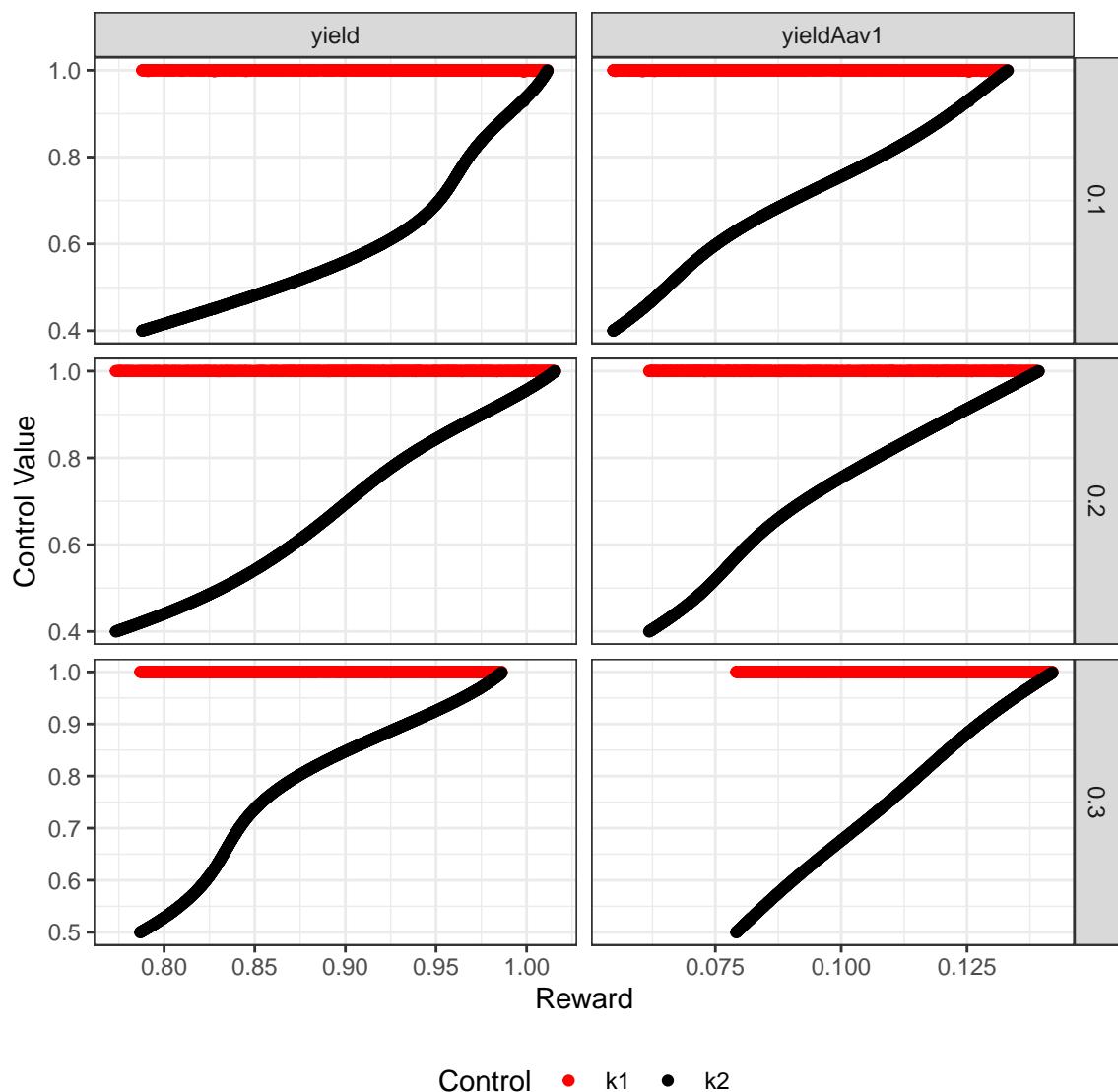
**Figure 1.** Operating Model.



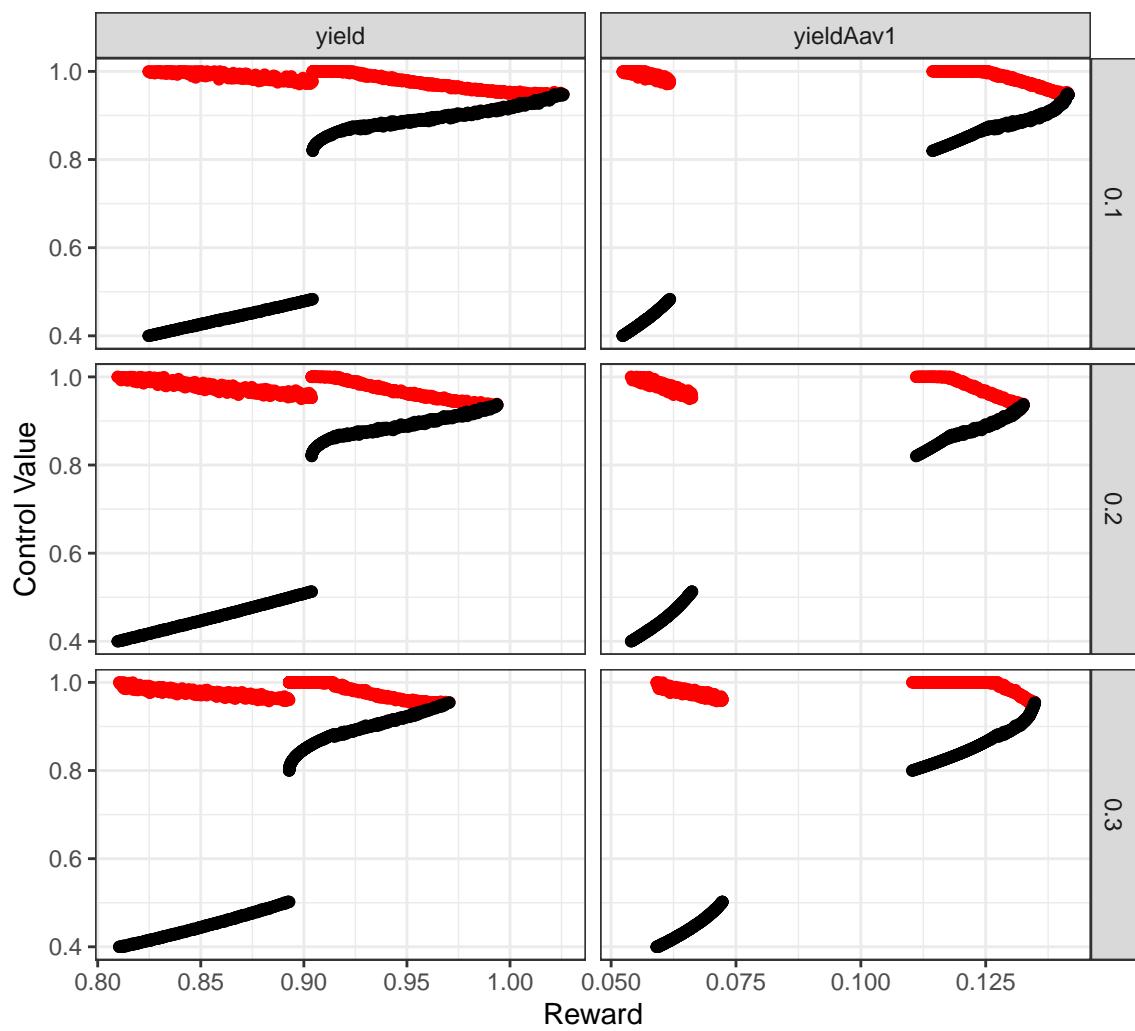
**Figure 2.** Summary of control parameters where  $P(SSB > B_{lim}) > 0.95$ .



**Figure 3.** Calibration regressions, 3 years.

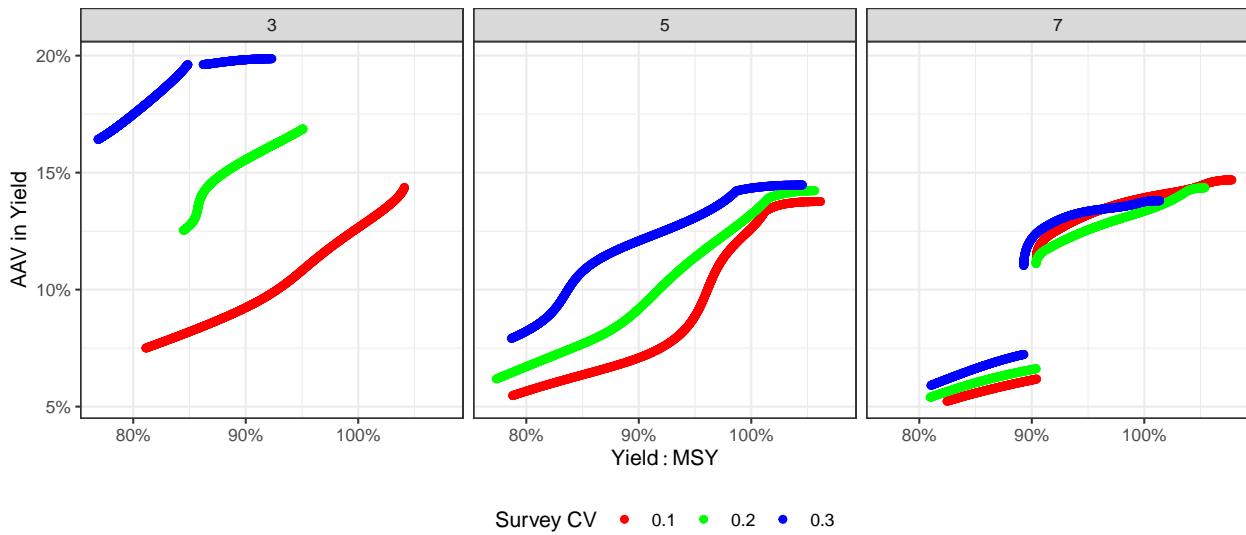


**Figure 4.** Calibration regressions, 5 years.



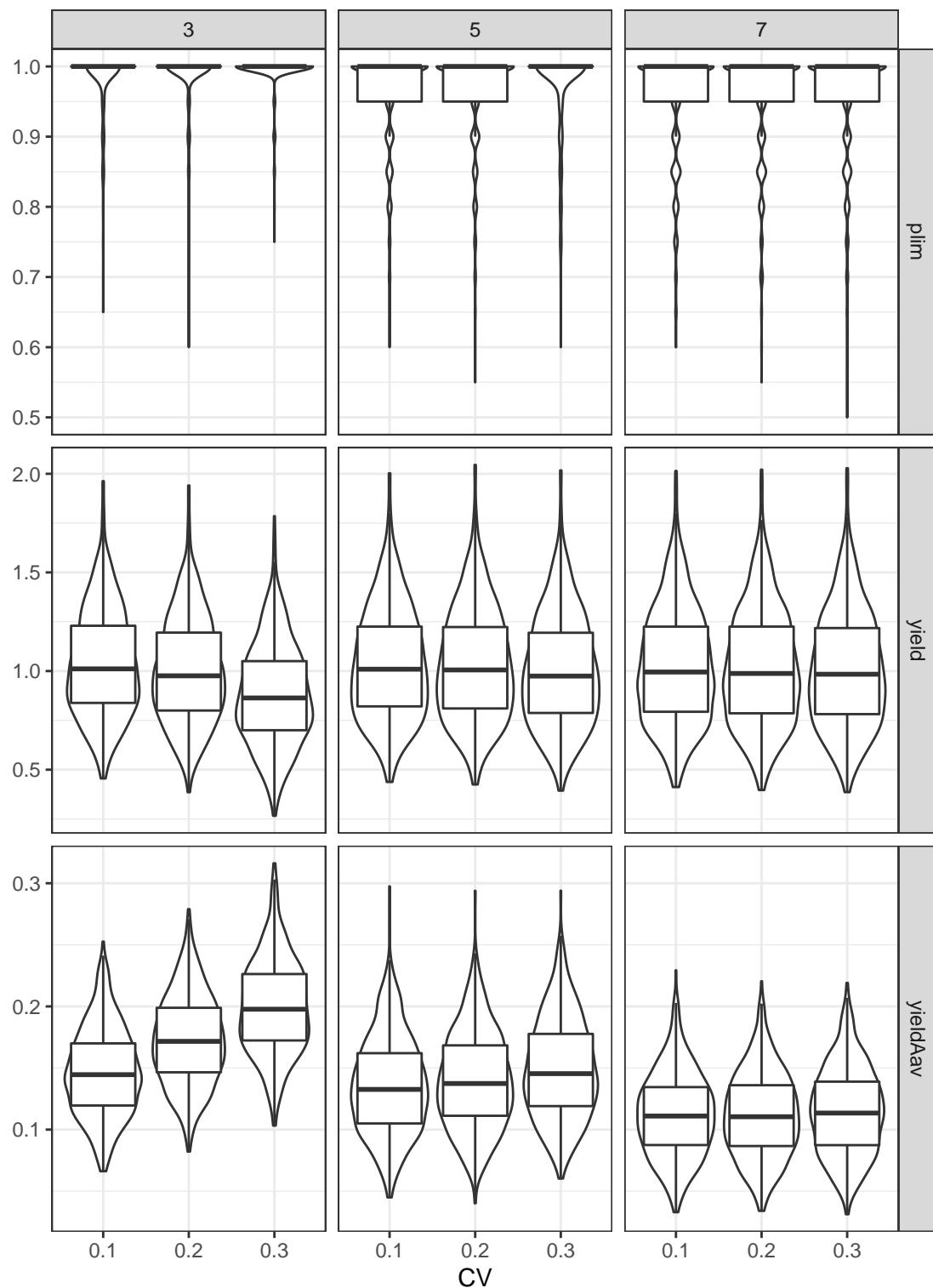
Control • k1 • k2

**Figure 5.** Calibration regressions, 7 years.



Survey CV • 0.1 • 0.2 • 0.3

**Figure 6.** Pareto Frontiers



**Figure 7.** Summary statistics.

## ## Software Versions

- R version 3.6.1 (2019-07-05)
- FLaCore: 2.6.13
- FLBRP: 2.5.3
- FLasher: 0.5.3.9001
- FLife: 3.3.1
- ggplotFL: 2.6.6
- **Compiled:** Thu Nov 14 11:11:46 2019

## Author information

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## Acknowledgements

This vignette and many of the methods documented in it were developed under the MyDas project funded by the Irish exchequer and EMFF 2014-2020. The overall aim of MyDas is to develop and test a range of assessment models and methods to establish Maximum Sustainable Yield (MSY) reference points (or proxy MSY reference points) across the spectrum of data-limited stocks.

## References

## Session Info

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R version 3.6.1 (2019-07-05)
Platform: x86_64-pc-linux-gnu (64-bit)
Running under: Ubuntu 16.04.5 LTS
```

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Matrix products: default
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LAPACK:  /usr/lib/lapack/liblapack.so.3.6.0
```

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[5] LC_MONETARY=en_GB.UTF-8   LC_MESSAGES=en_US.UTF-8
[7] LC_PAPER=en_GB.UTF-8     LC_NAME=C
[9] LC_ADDRESS=C              LC_TELEPHONE=C
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attached base packages:
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[8] base
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other attached packages:
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[7] mydas_1.1.6      GGally_1.4.0     mvtnorm_1.0-11
[10] randtests_1.0     FLife_3.3.1     ggplotFL_2.6.6
[13] FLasher_0.5.3.9001 FLFishery_0.1.5  FLBRP_2.5.3
[16] FLCore_2.6.13    iterators_1.0.12 lattice_0.20-38
[19] reshape_0.8.8     dplyr_0.8.3     plyr_1.8.4
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loaded via a namespace (and not attached):
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