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Bias Estimation of Biological Reference Points Under Two-Parameter SRRs

Nick Grunloh

In collaboration with:
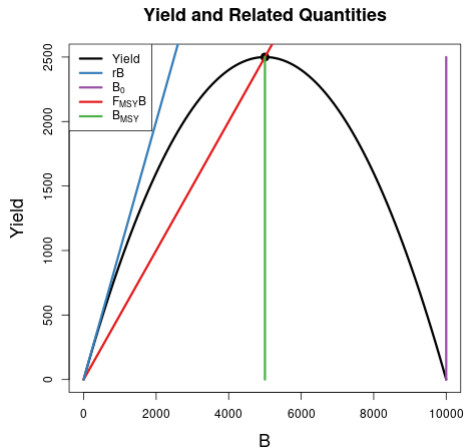Dr. E.J. Dick
Dr. H. K.H. Lee

15 Aug 2022

$$I_t = qB_t e^\epsilon \quad \epsilon \sim N(0, \sigma^2)$$

$$\frac{dB(t)}{dt} = P(B(t); \boldsymbol{\theta}) - Z(t)B(t)$$

$$RP : MSY, \ \frac{F_{MSY}}{M}, \ \frac{B_{MSY}}{B_0}$$
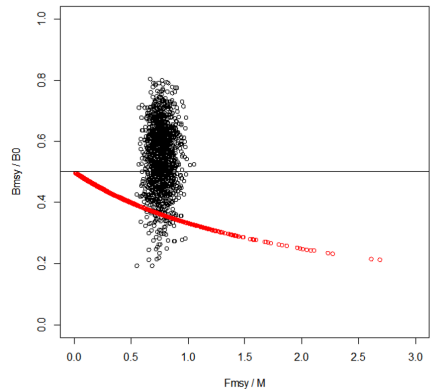
Yield and Related Quantities

Conceptually:

$$\frac{F_{MSY}}{M} \in \mathbb{R}^+ \quad \frac{B_{MSY}}{B_0} \in (0,1)$$

Mangel et al. 2013, CJFAS:

- BH Model:
  $F_{MSY} \in \mathbb{R}^+ \quad \frac{B_{MSY}}{B(0)} = \frac{1}{F_{MSY}/M+2}$
- Similar Constraints for other Two-Parameter Curves

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- BH Model:
  $F_{MSY} \in \mathbb{R}^+ \quad \frac{B_{MSY}}{B(0)} = \frac{1}{F_{MSY}/M + 2}$
- Similar Constraints for other Two-Parameter Curves
- Three-Parameter Relationships Allow Independent RP Estimation

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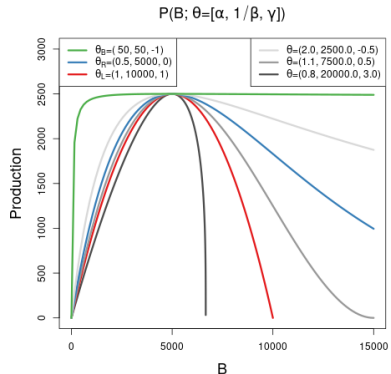Simulation
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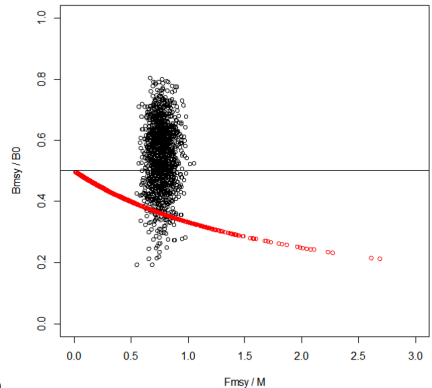
Schnute 1985, CJFAS

$$\frac{dB}{dt} = P(B; \boldsymbol{\theta}) - (M + F)B$$

$$P(B; [\alpha, \beta, \gamma]) = \alpha B(1 - \beta\gamma B)^{\frac{1}{\gamma}}$$

$\gamma = -1 \Rightarrow$ Beverton-Holt

$\gamma \to 0 \Rightarrow$ Ricker

$\gamma = 1 \Rightarrow$ Logistic

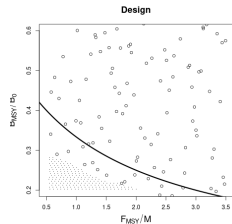$P(B; \theta=[\alpha, 1/\beta, \gamma])$

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Introish Ideas list

- PT/Schaffer work (link)
- Computational Difficulties
- Schnute Space Filling
- Catch/Contrast

$$\frac{B_{MSY}}{B_0} = \frac{1 - \left(\frac{M+F_{MSY}}{\alpha}\right)^{\gamma}}{1 - \left(\frac{M}{\alpha}\right)^{\gamma}}$$
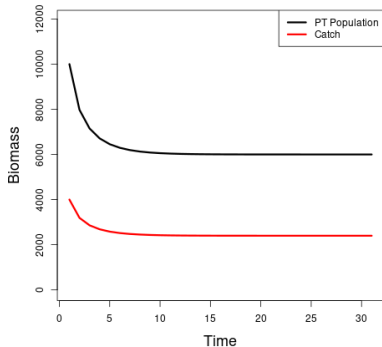
$$\alpha = (M + F_{MSY}) \left(1 + \frac{\gamma F_{MSY}}{M + F_{MSY}}\right)^{1/\gamma}$$

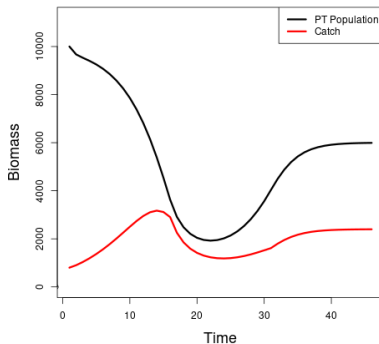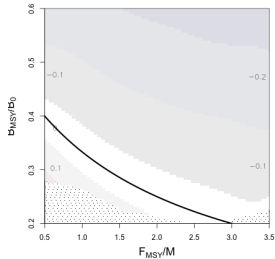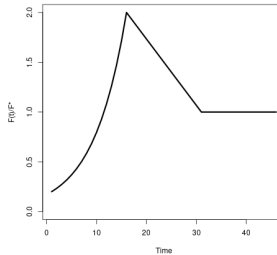$$\beta = \frac{1}{\gamma B_0} \left(1 - \left(\frac{M}{\alpha}\right)^{\gamma}\right)$$

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Results Idea List

- contrast
    - components
    - animated arrows and yeild curves
- flat
    - animated arrows and yeild curves
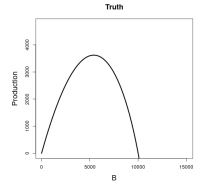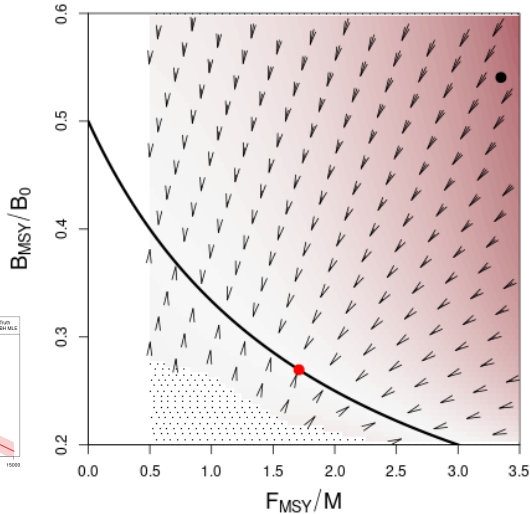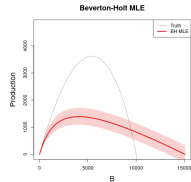
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Relative Bias in Estimated B_{MSY}

Catch=F^* ($F(t)/F^*$) $B(t)$

Relative Bias in Estimated F_{MSY}
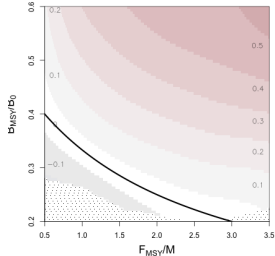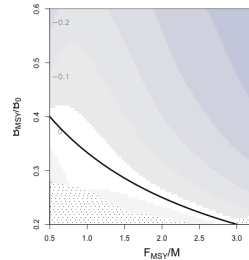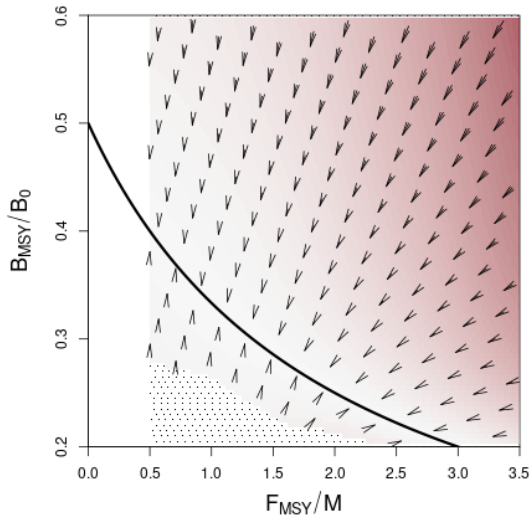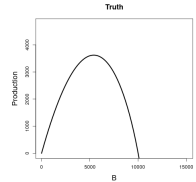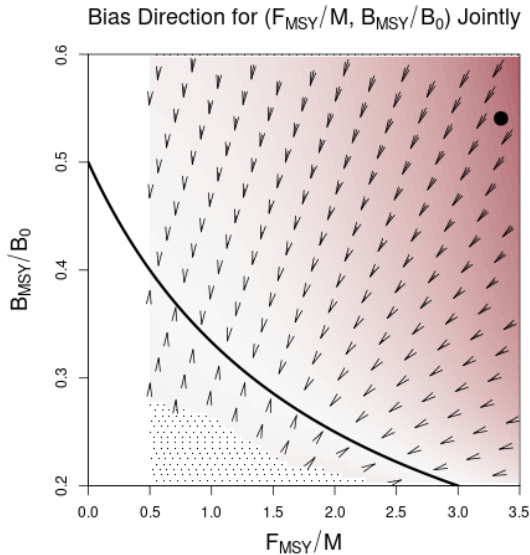
Relative Bias in Estimated B_0

Bias in Estimated B_{MSY}/B_0

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Bias Direction for $(F_{MSY}/M, B_{MSY}/B_0)$ Jointly

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Bias Direction for (F_{MSY}/M, B_{MSY}/B_0) Jointly

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Bias Direction for (F_{MSY}/M, B_{MSY}/B_0) Jointly

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Bias Direction for $(F_{MSY}/M, B_{MSY}/B_0)$ Jointly

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Bias Direction for (F_{MSY}/M, B_{MSY}/B_0) Jointly

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Bias Direction for (F_{MSY}/M, B_{MSY}/B_0) Jointly

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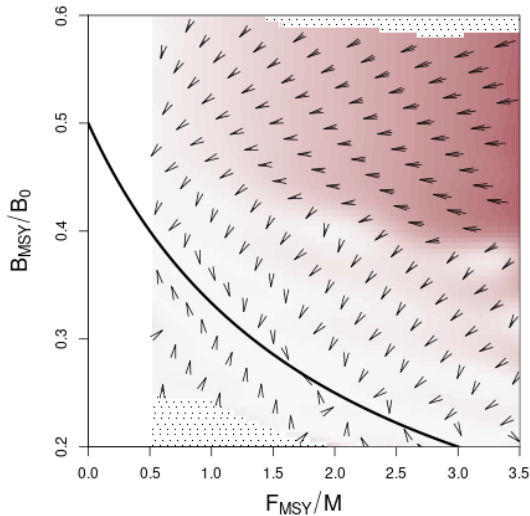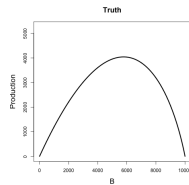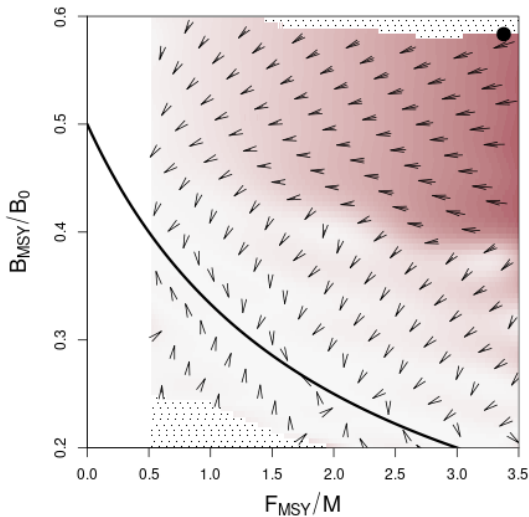
Bias
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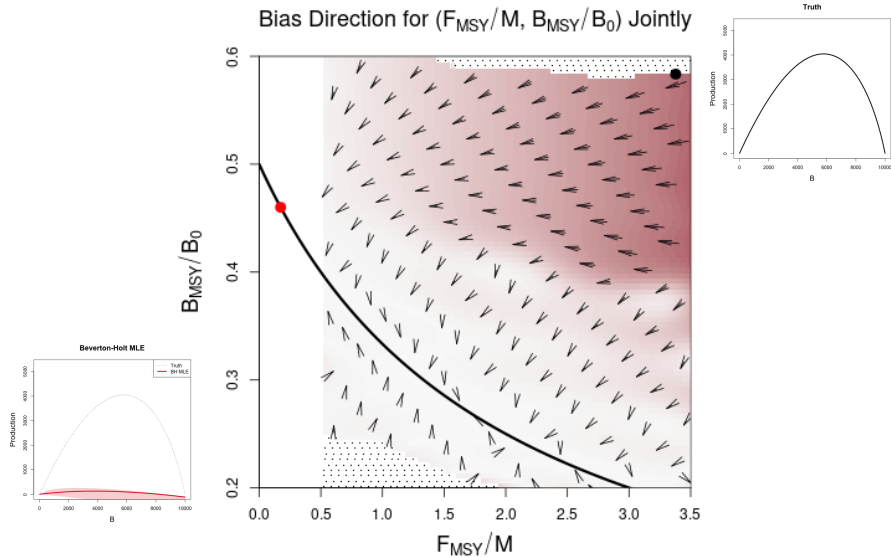
Conclusion
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Conclusions

- Contrast story
- Importance of getting the computaional details correct for moving to analysis of Delay Difference and age structure