Bias Estimation of Biological Reference Points Under Two-Parameter SRRs

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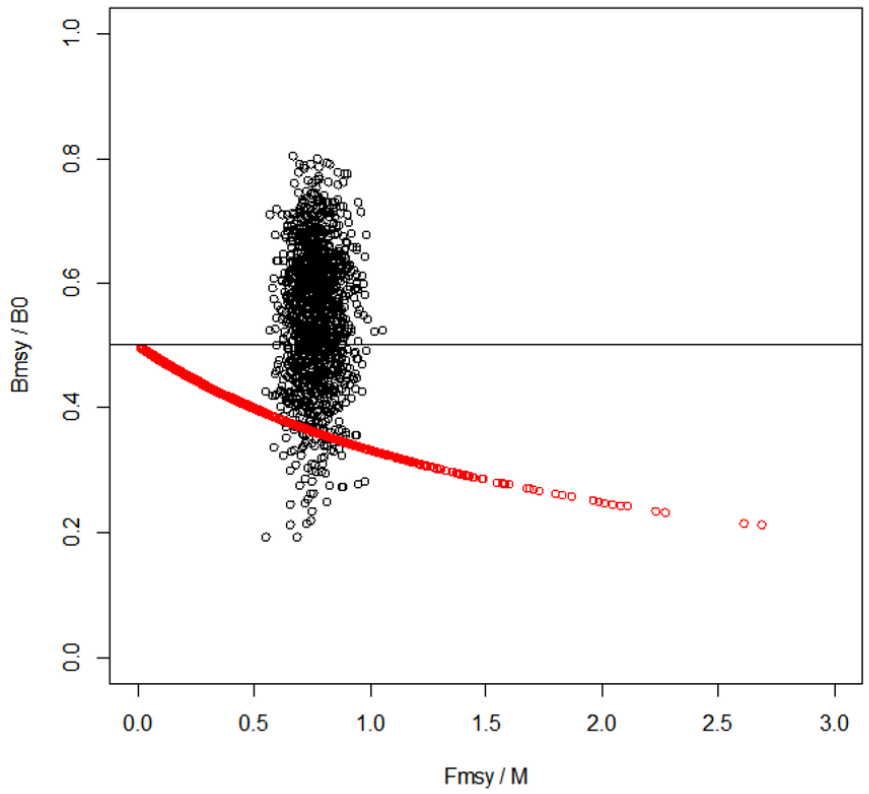
Mangel et al. 2013, CJFAS

$$\frac{dB(t)}{dt} = \frac{\alpha B(t)}{1 + \beta B(t)} - (M + F(t))B(t)$$

$$h = \frac{\frac{\alpha}{M}}{4 + \frac{\alpha}{M}}$$

$$\frac{F^*}{M} = \sqrt{\frac{4h}{1-h}} - 1$$

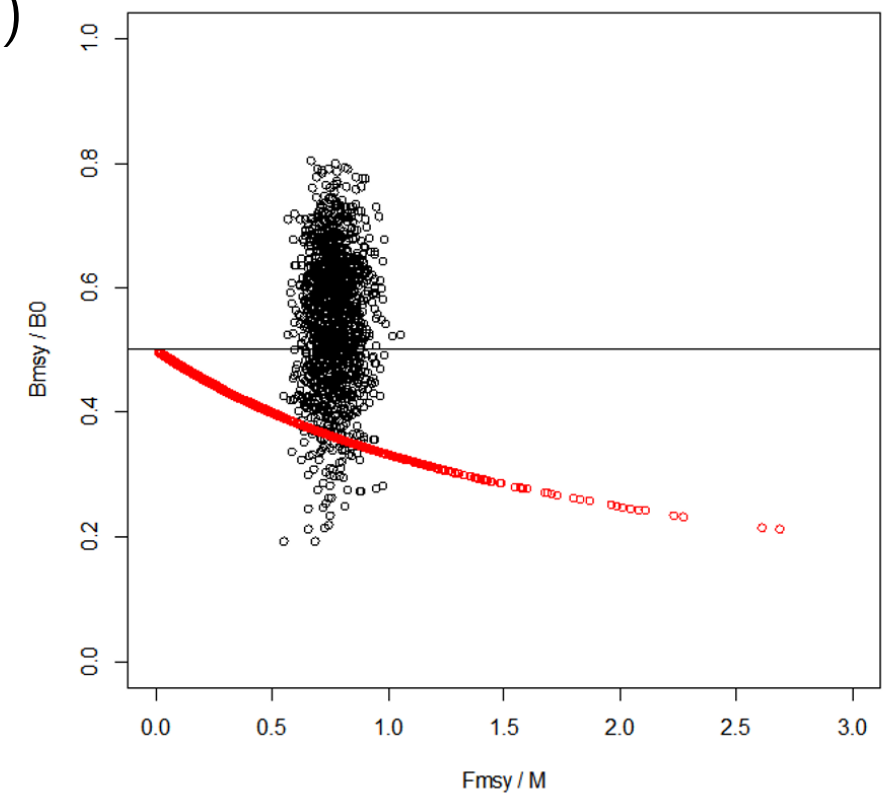
$$\frac{B^*}{B_0} = \frac{\sqrt{\frac{4h}{1-h}} - 1}{\frac{4h}{1-h} - 1}$$



Mangel et al. 2013, CJFAS

$$\frac{dB(t)}{dt} = \frac{\alpha B(t)}{1 + \beta B(t)^{\frac{1}{\gamma}}} - (M + F(t))B(t)$$

Mangel et al. (2013) suggest exploration of three parameter stock recruit relationships (SRRs) to avoid pre-determined reference points (RP) in assessments



A'Priori RP Prior Relationships

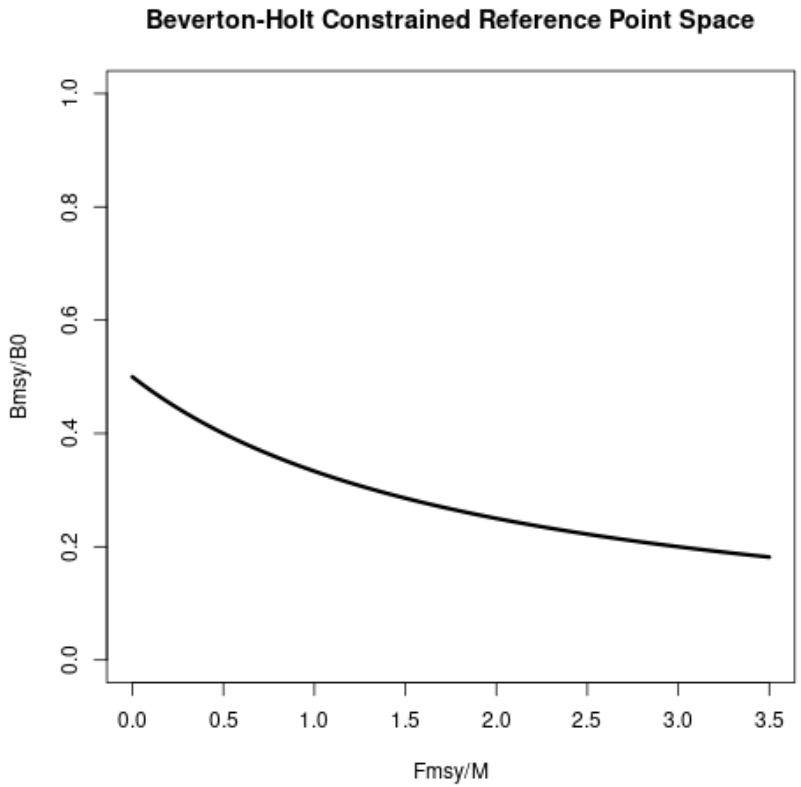
$$\frac{dB(t)}{dt} = \frac{\alpha B(t)}{1+\beta B(t)} - (M + F(t))B(t)$$

$$\frac{B^*}{B_0} = \frac{1}{\frac{F^*}{M} + 2}$$

$$log(F^*) \sim N(\mu, \sigma^2)$$

$$\Updownarrow$$

$$2\frac{B^*}{B_0} \sim \text{logit-N}\left(\log(2M) - \mu, \sigma^2\right)$$



Pella-Tomlinson Production Model

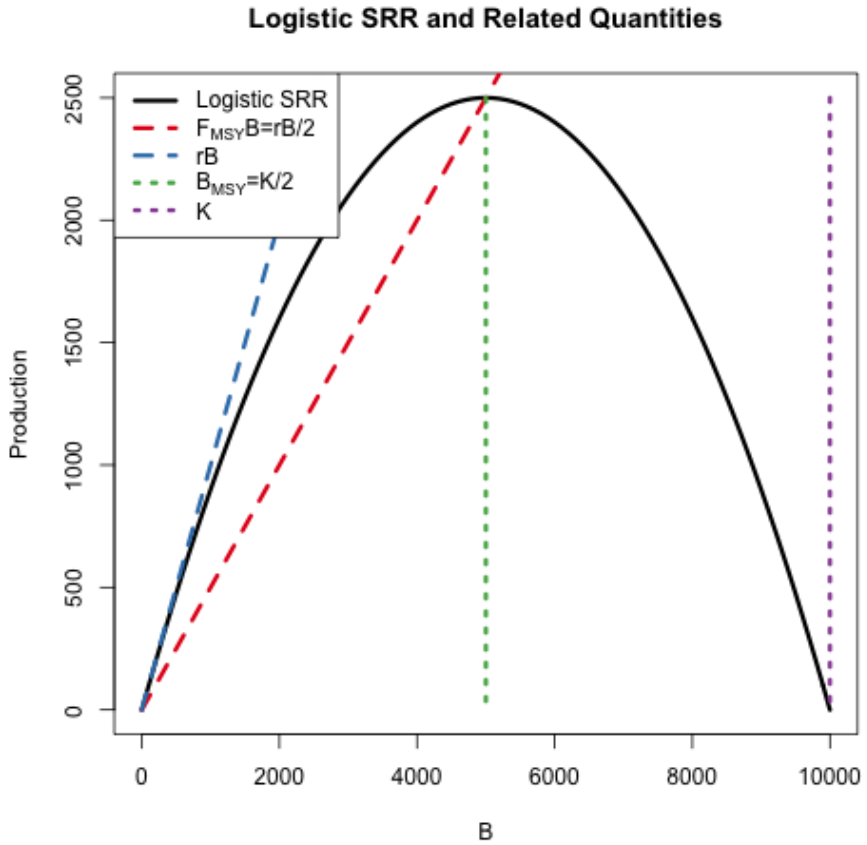
$$I(t) \sim LN(qB(t), \sigma^2)$$

$$\frac{dB(t)}{dt} = R_{\boldsymbol{\theta}}(B(t)) - F(t)B(t)$$

$$R_{\boldsymbol{\theta}}(B) = \frac{rB}{\gamma - 1}\left(1 - \frac{B}{K}\right)^{\gamma - 1}$$

$$\boldsymbol{\theta} = (r, K, \gamma)$$

$$\gamma = 2 \Rightarrow \text{Schaefer Model}$$



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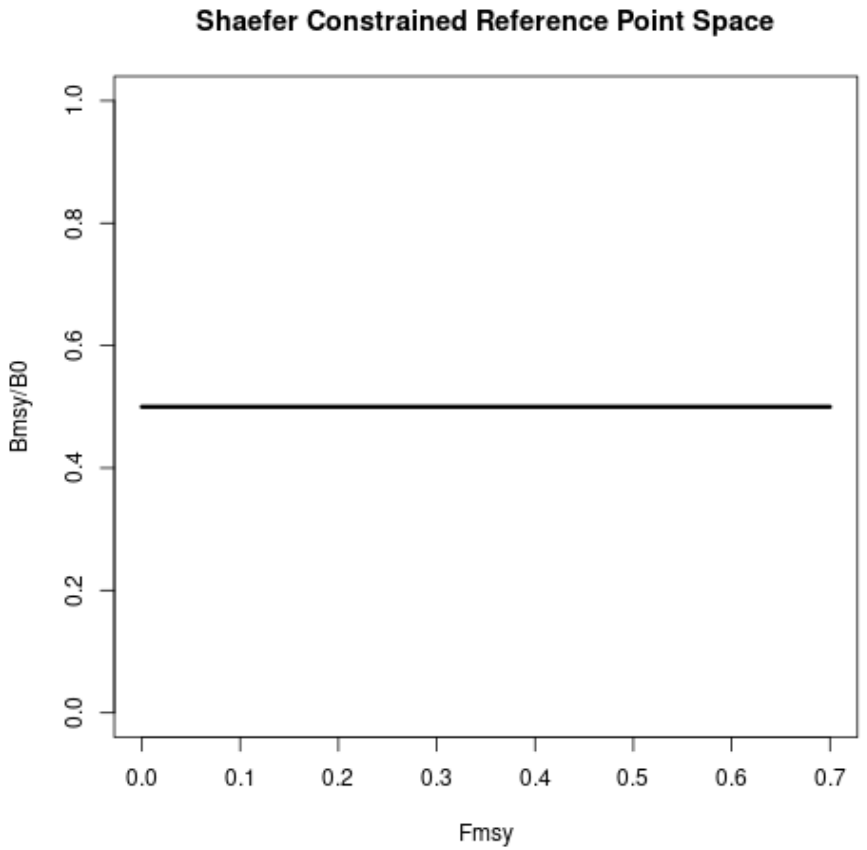
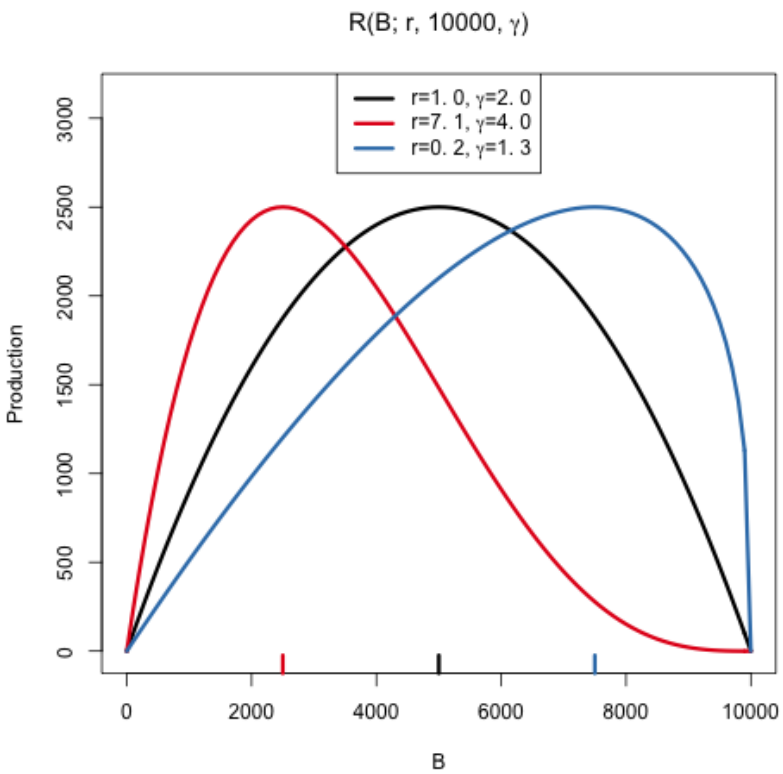
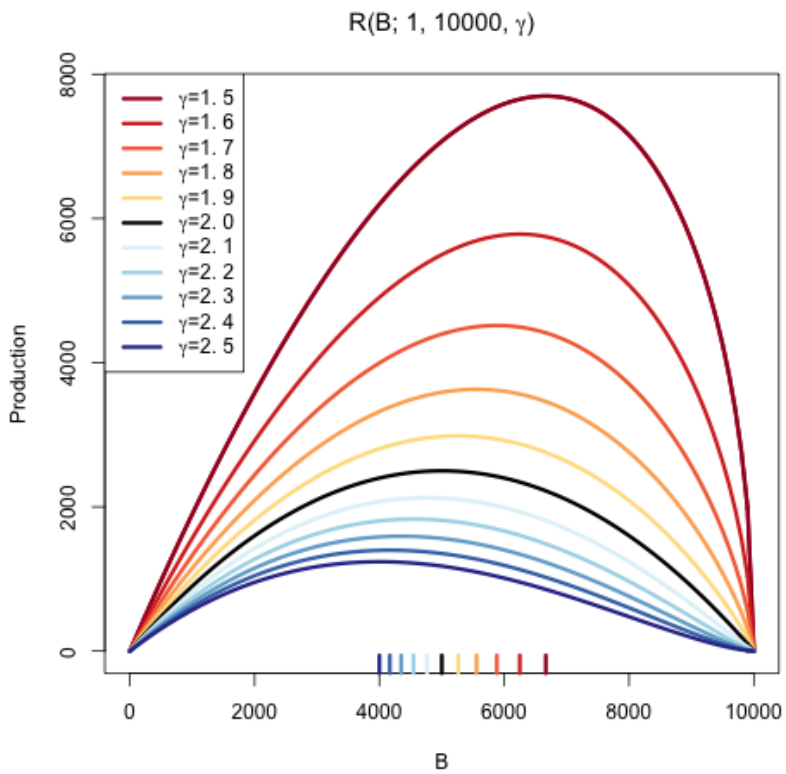
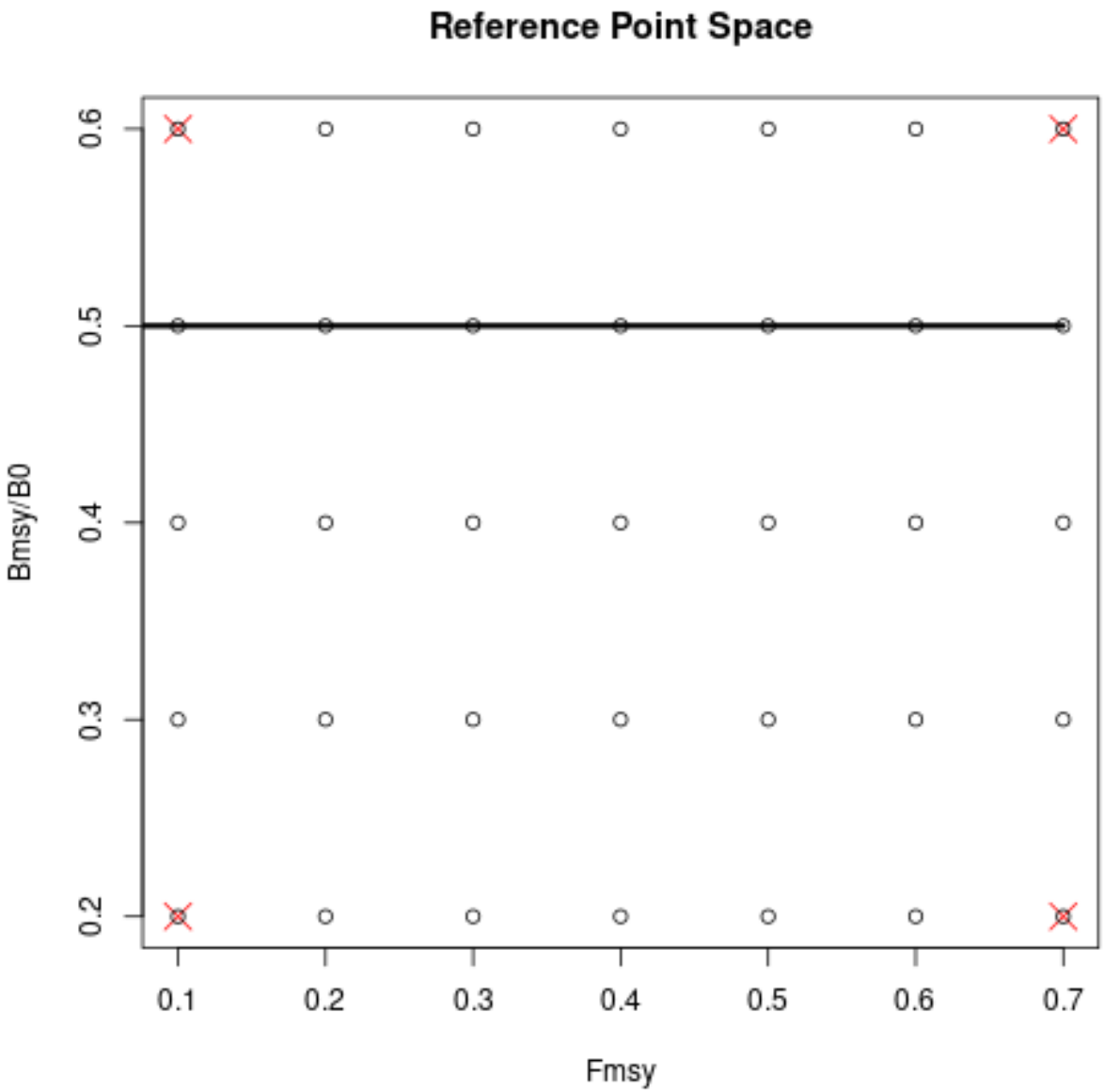


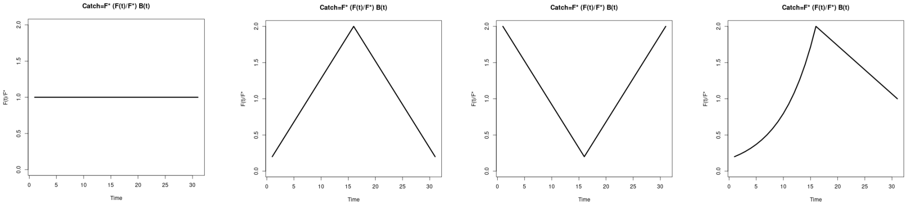
Pella-Tomlinson Family of Curves



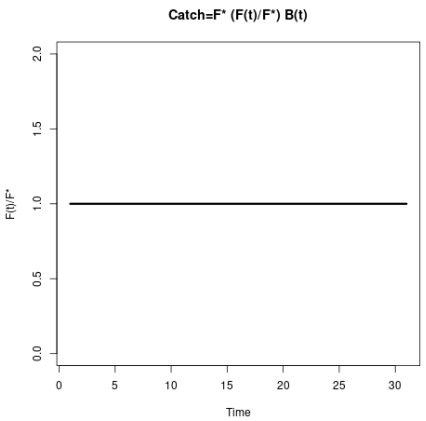


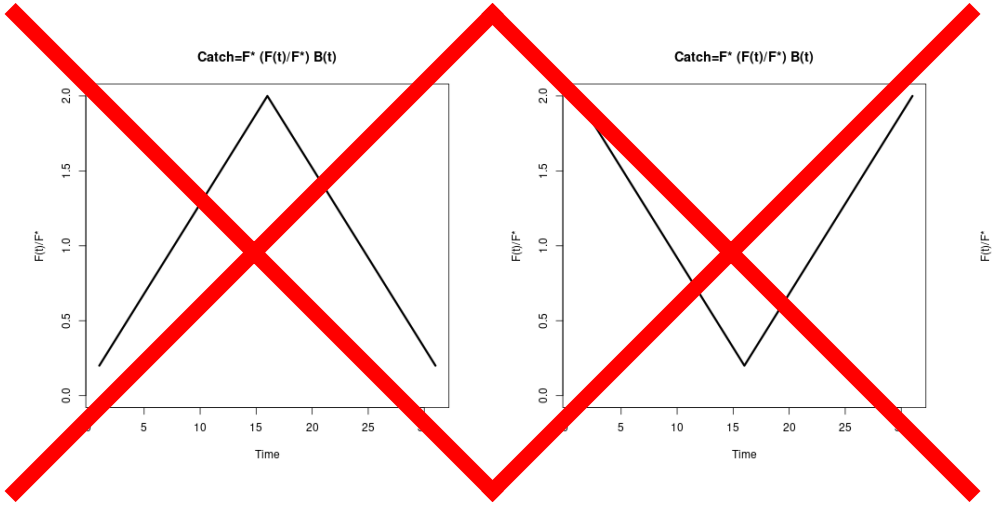

Reference Point Space
Bmsy/B0
0.2
0.3
0.4
0.5
0.6
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Fmsy

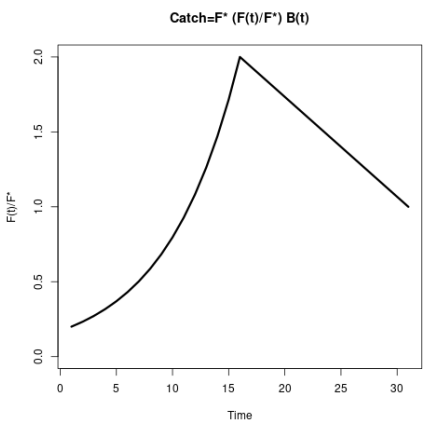
Catch


Catch=F* (F(t)/F*) B(t)
Catch=F* (F(t)/F*) B(t)
Catch=F* (F(t)/F*) B(t)
Catch=F* (F(t)/F*) B(t)
F(t)/F*
Time

Catch

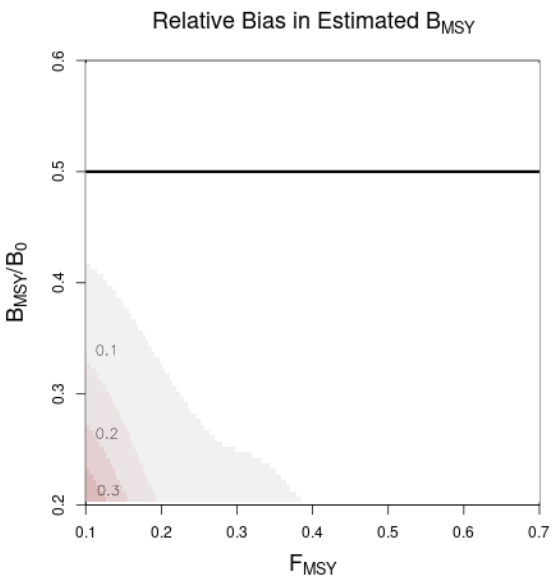


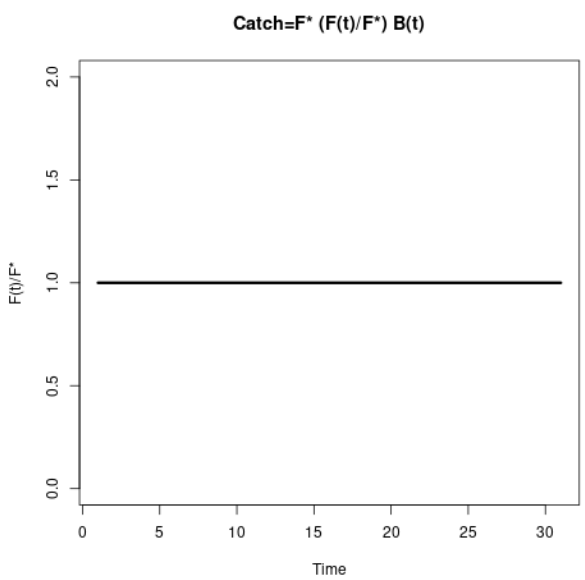


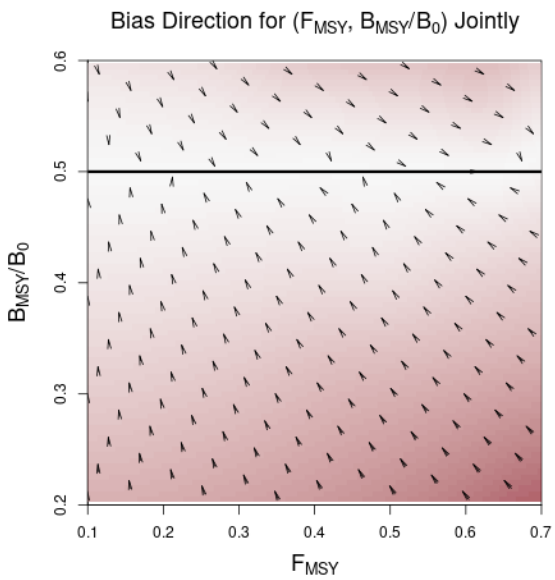


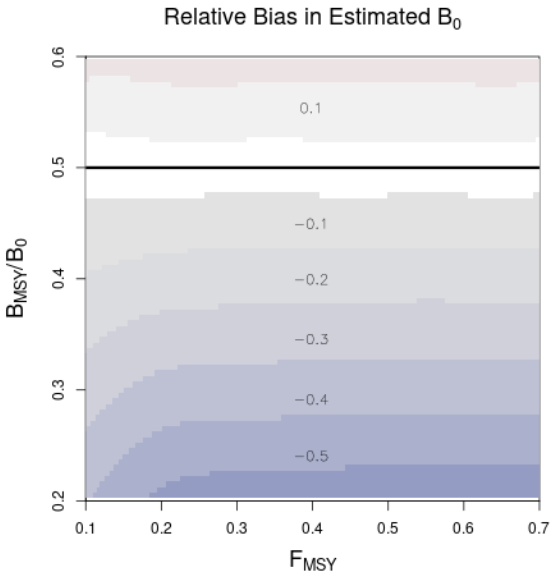
Flat

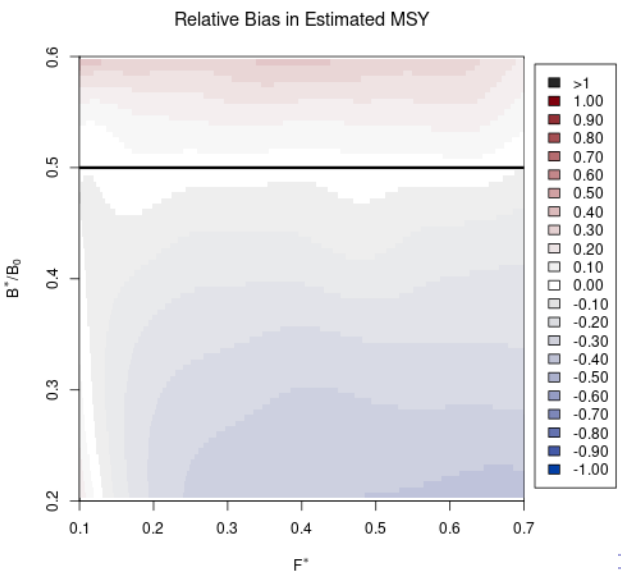
Contrast

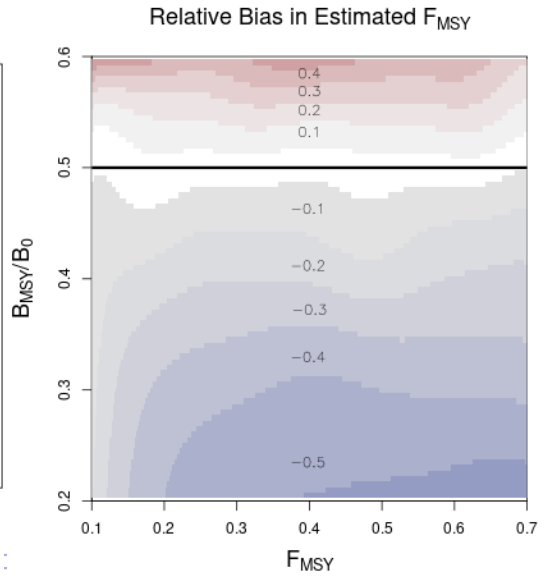

Relative Bias in Estimated B_{MSY}
B_{MSY}/B_0
F_{MSY}
0.1
0.2
0.3

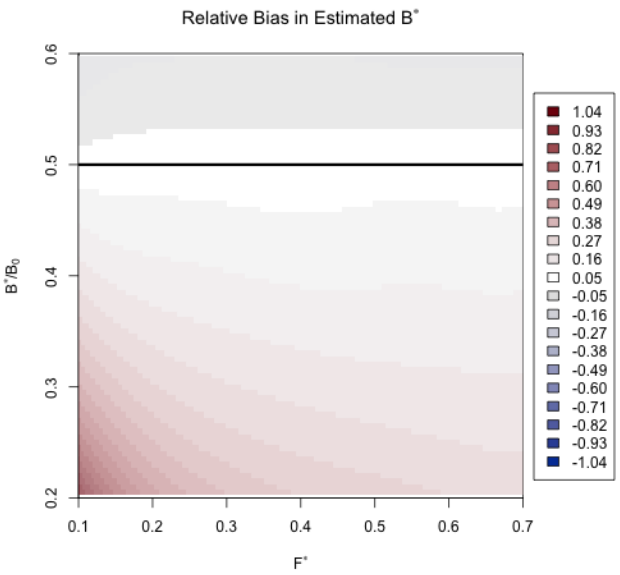

Catch=F* (F(t)/F*) B(t)
F(t)/F*
Time

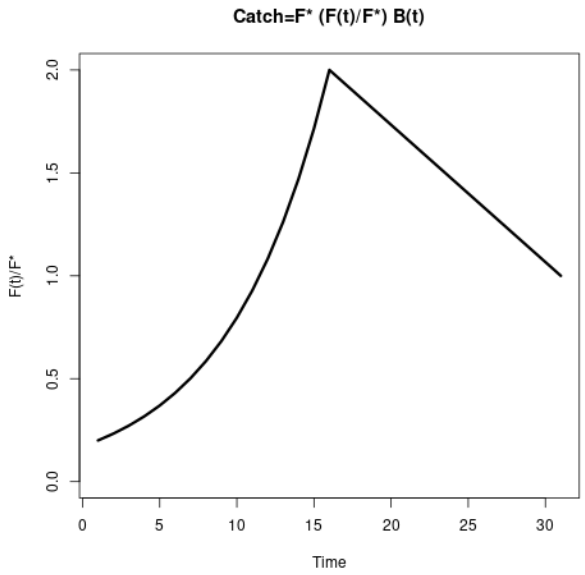

Bias Direction for (F_{MSY}, B_{MSY}/B_0) Jointly
B_{MSY}/B_0
F_{MSY}

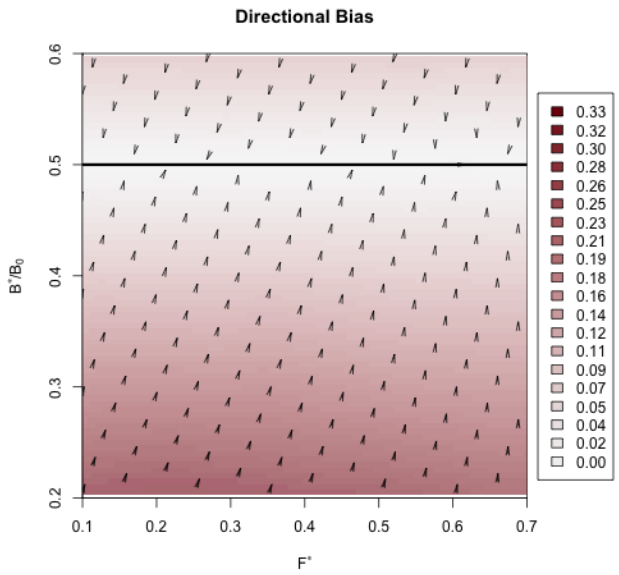

Relative Bias in Estimated B_0
B_{MSY}/B_0
F_{MSY}
0.1
−0.1
−0.2
−0.3
−0.4
−0.5

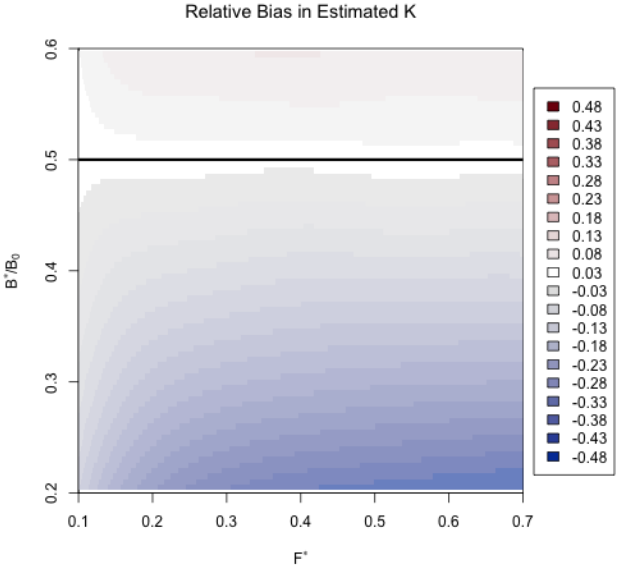

Relative Bias in Estimated MSY
B^*/B_0
F^*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

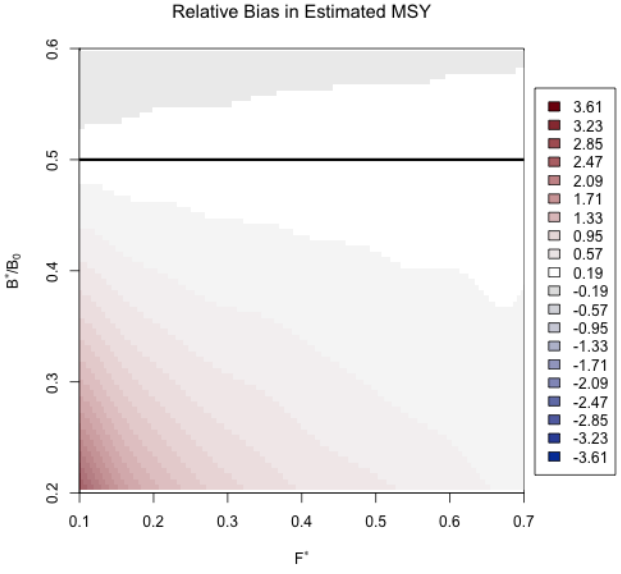

Relative Bias in Estimated F_{MSY}
B_{MSY}/B_0
F_{MSY}
0.4
0.3
0.2
0.1
−0.1
−0.2
−0.3
−0.4
−0.5

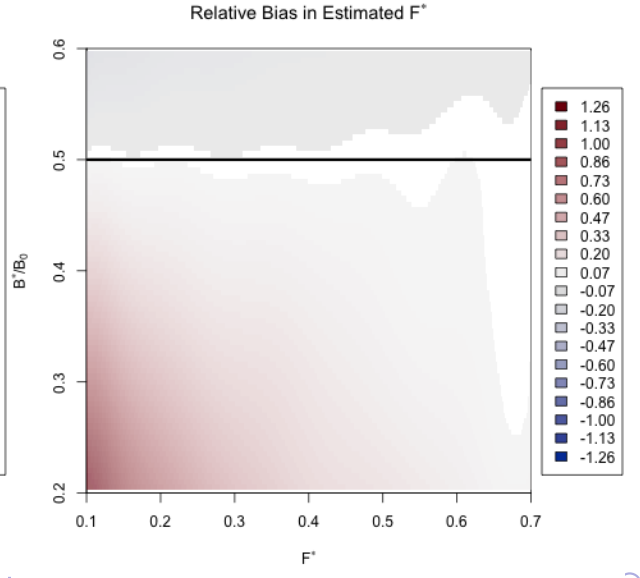

Relative Bias in Estimated B*
B*/B0
F*
1.04
0.93
0.82
0.71
0.60
0.49
0.38
0.27
0.16
0.05
-0.05
-0.16
-0.27
-0.38
-0.49
-0.60
-0.71
-0.82
-0.93
-1.04

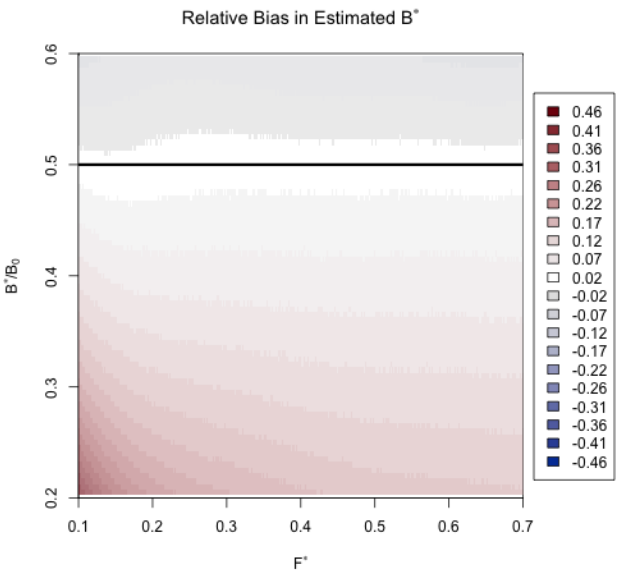

Catch=F* (F(t)/F*) B(t)
F(t)/F*
Time

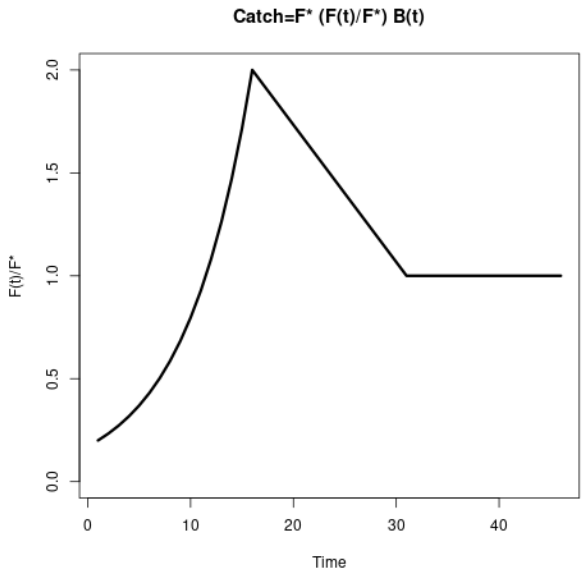

Directional Bias
B*/B0
F*
0.33
0.32
0.30
0.28
0.26
0.25
0.23
0.21
0.19
0.18
0.16
0.14
0.12
0.11
0.09
0.07
0.05
0.04
0.02
0.00

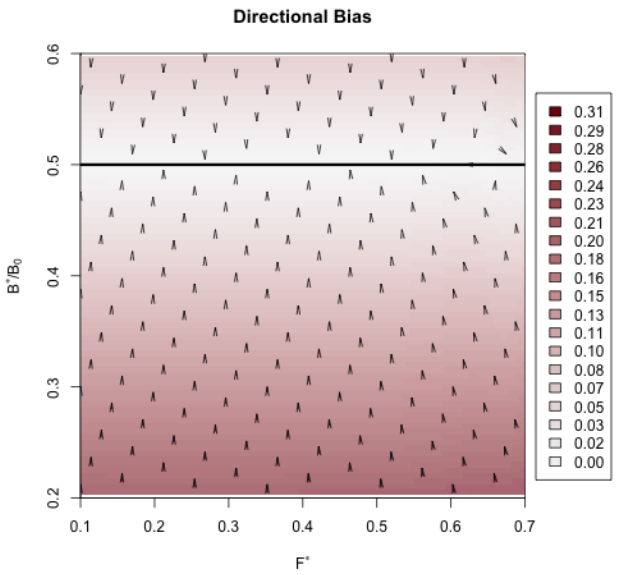

Relative Bias in Estimated K
B*/B0
F*
0.48
0.43
0.38
0.33
0.28
0.23
0.18
0.13
0.08
0.03
-0.03
-0.08
-0.13
-0.18
-0.23
-0.28
-0.33
-0.38
-0.43
-0.48

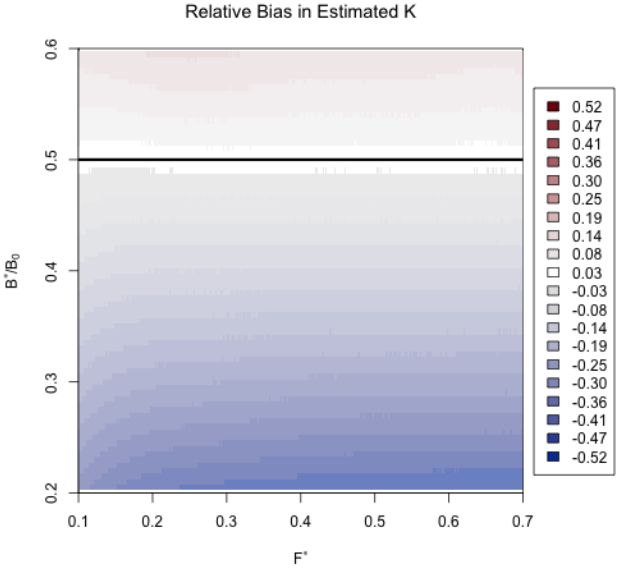

Relative Bias in Estimated MSY
B*/B0
F*
3.61
3.23
2.85
2.47
2.09
1.71
1.33
0.95
0.57
0.19
-0.19
-0.57
-0.95
-1.33
-1.71
-2.09
-2.47
-2.85
-3.23
-3.61

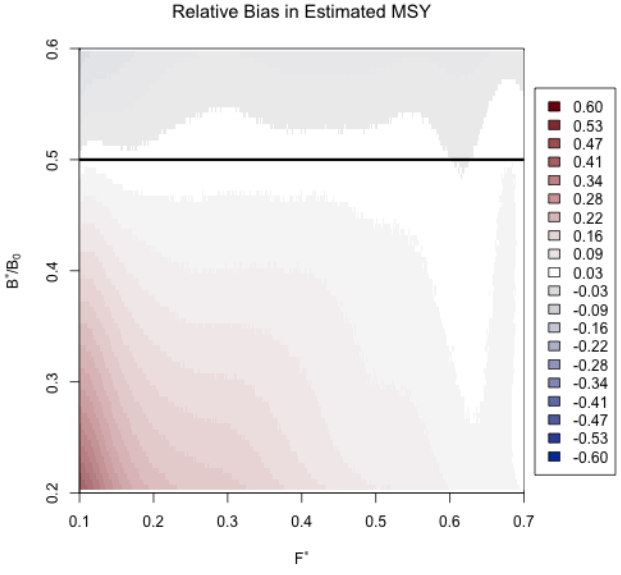

Relative Bias in Estimated F*
B*/B0
F*
1.26
1.13
1.00
0.86
0.73
0.60
0.47
0.33
0.20
0.07
-0.07
-0.20
-0.33
-0.47
-0.60
-0.73
-0.86
-1.00
-1.13
-1.26

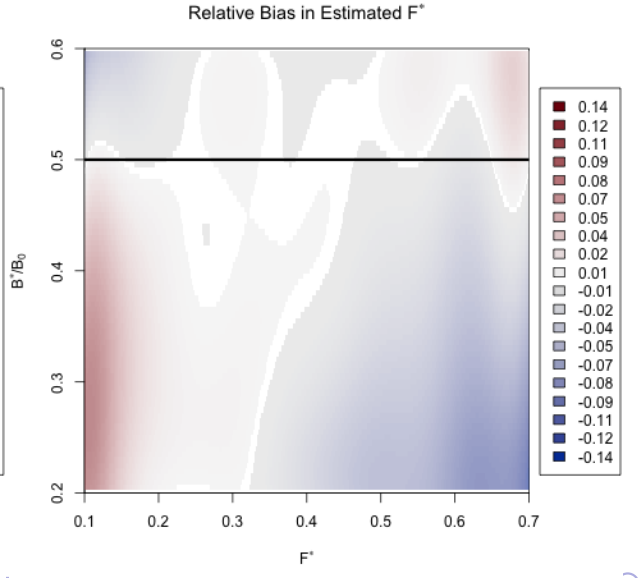

Relative Bias in Estimated B*
B*/B0
F*
0.46
0.41
0.36
0.31
0.26
0.22
0.17
0.12
0.07
0.02
-0.02
-0.07
-0.12
-0.17
-0.22
-0.26
-0.31
-0.36
-0.41
-0.46

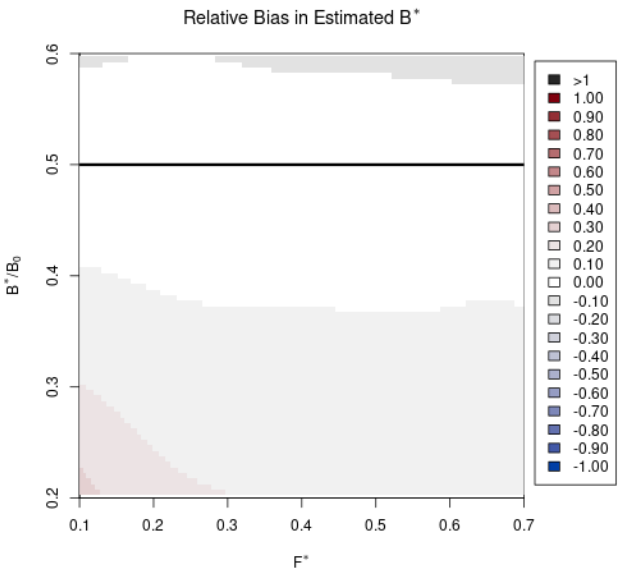

Catch=F* (F(t)/F*) B(t)
F(t)/F*
Time

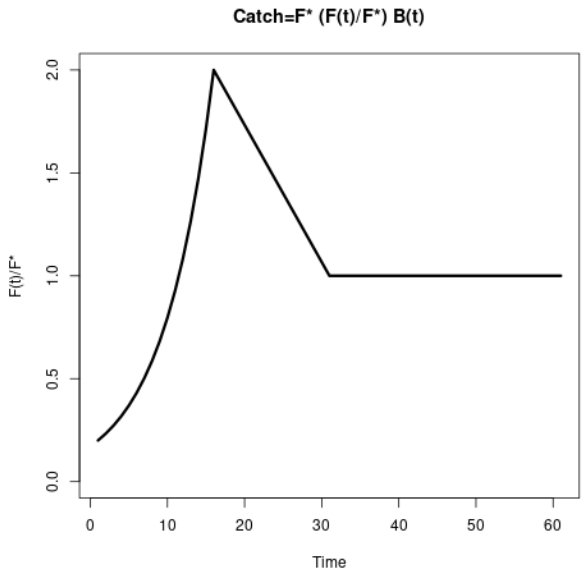

Directional Bias
B*/B0
F*
0.31
0.29
0.28
0.26
0.24
0.23
0.21
0.20
0.18
0.16
0.15
0.13
0.11
0.10
0.08
0.07
0.05
0.03
0.02
0.00

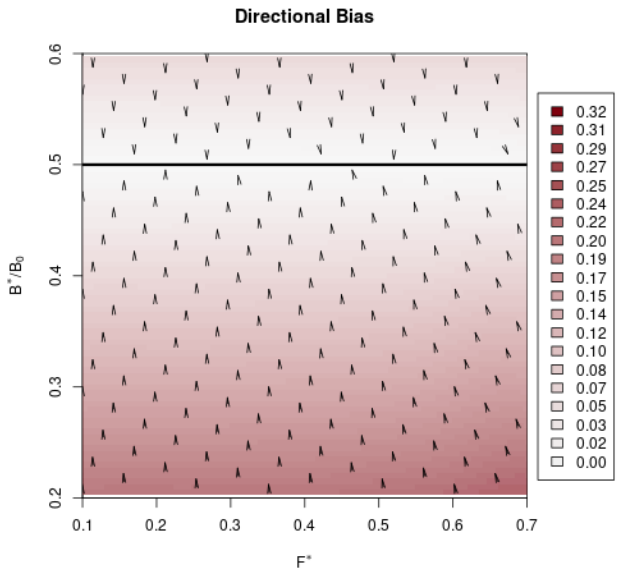

Relative Bias in Estimated K
B*/B0
F*
0.52
0.47
0.41
0.36
0.30
0.25
0.19
0.14
0.08
0.03
-0.03
-0.08
-0.14
-0.19
-0.25
-0.30
-0.36
-0.41
-0.47
-0.52

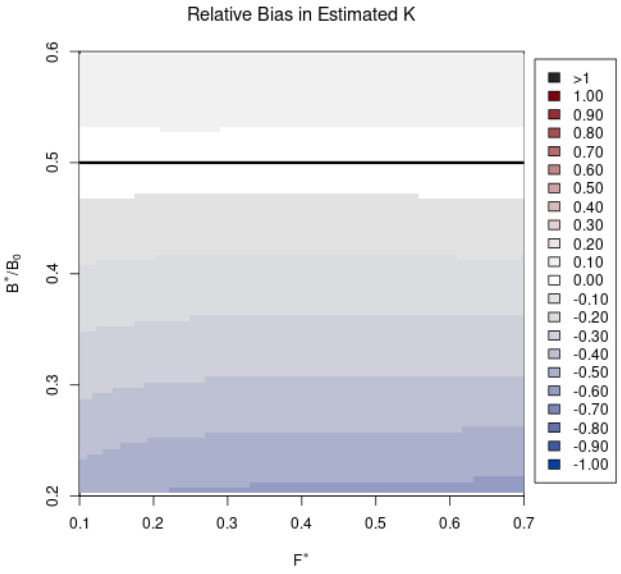

Relative Bias in Estimated MSY
B*/B0
F*
0.60
0.53
0.47
0.41
0.34
0.28
0.22
0.16
0.09
0.03
-0.03
-0.09
-0.16
-0.22
-0.28
-0.34
-0.41
-0.47
-0.53
-0.60

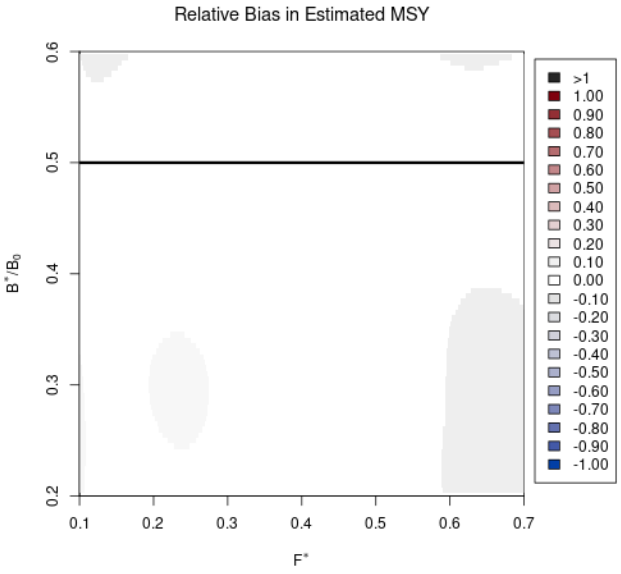

Relative Bias in Estimated F*
B*/B0
F*
0.14
0.12
0.11
0.09
0.08
0.07
0.05
0.04
0.02
0.01
-0.01
-0.02
-0.04
-0.05
-0.07
-0.08
-0.09
-0.11
-0.12
-0.14

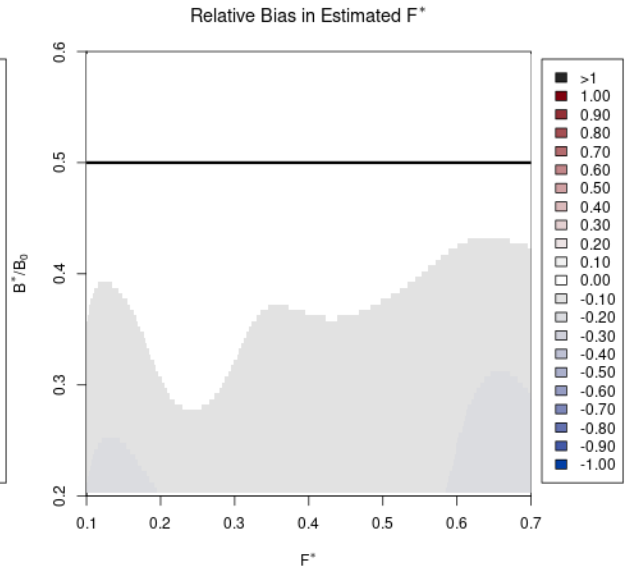

Relative Bias in Estimated B*
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

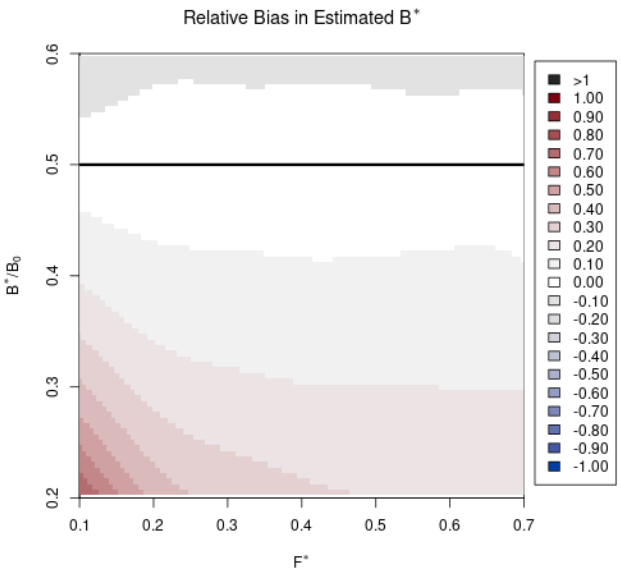

Catch=F* (F(t)/F*) B(t)
F(t)/F*
Time

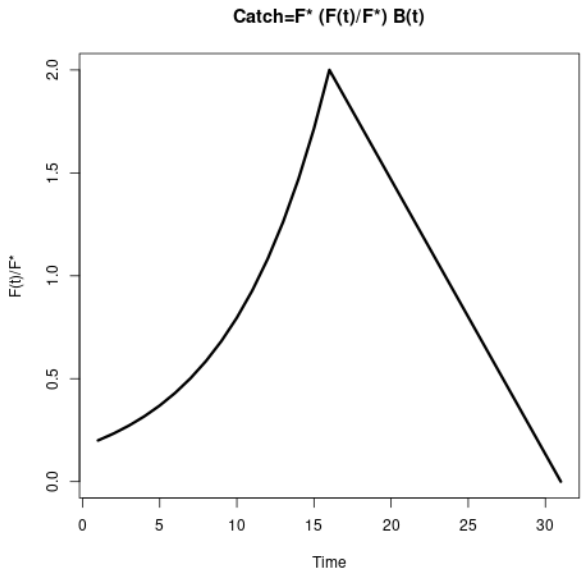

Directional Bias
B*/B0
F*
0.32
0.31
0.29
0.27
0.25
0.24
0.22
0.20
0.19
0.17
0.15
0.14
0.12
0.10
0.08
0.07
0.05
0.03
0.02
0.00

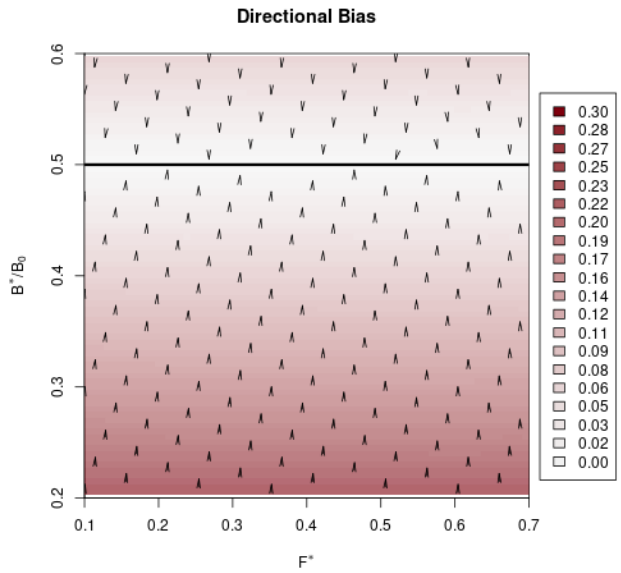

Relative Bias in Estimated K
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

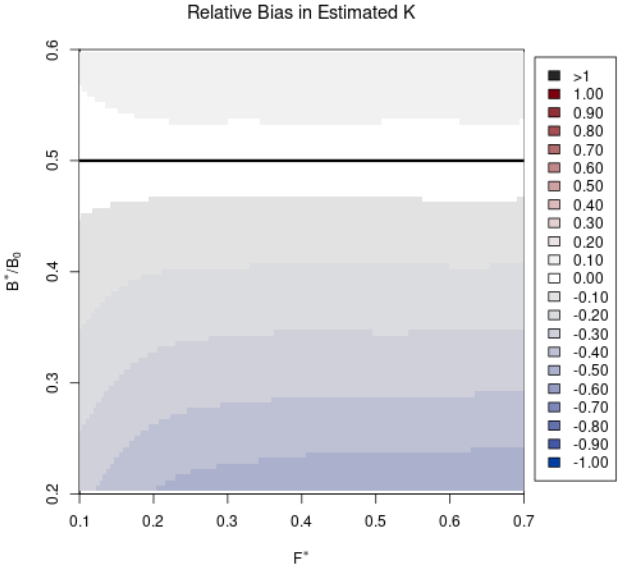

Relative Bias in Estimated MSY
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

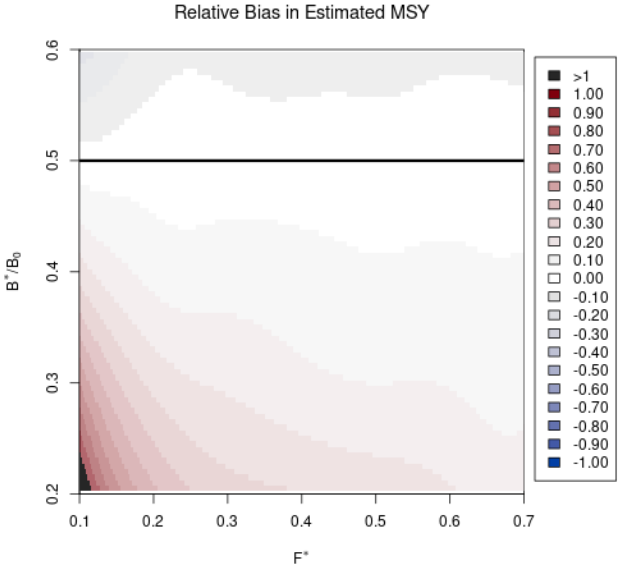

Relative Bias in Estimated F*
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

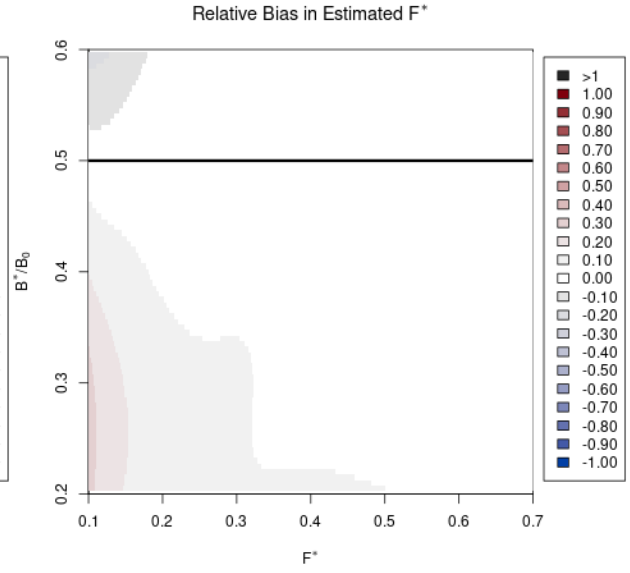

Relative Bias in Estimated B*
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

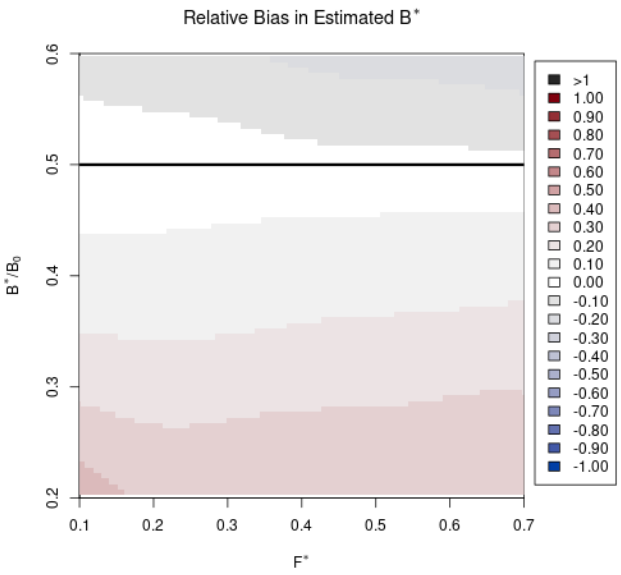

Catch=F* (F(t)/F*) B(t)
F(t)/F*
Time

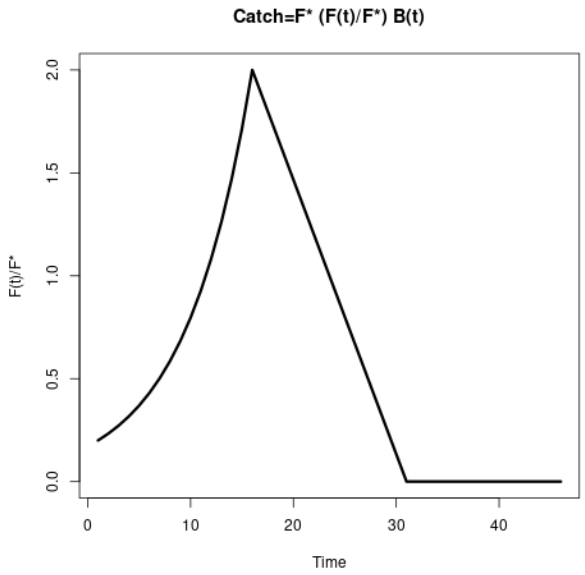

Directional Bias
B*/B0
F*
0.30
0.28
0.27
0.25
0.23
0.22
0.20
0.19
0.17
0.16
0.14
0.12
0.11
0.09
0.08
0.06
0.05
0.03
0.02
0.00

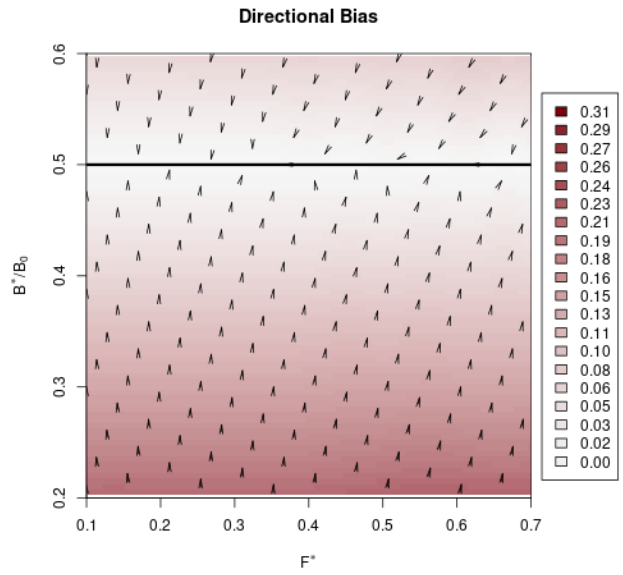

Relative Bias in Estimated K
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

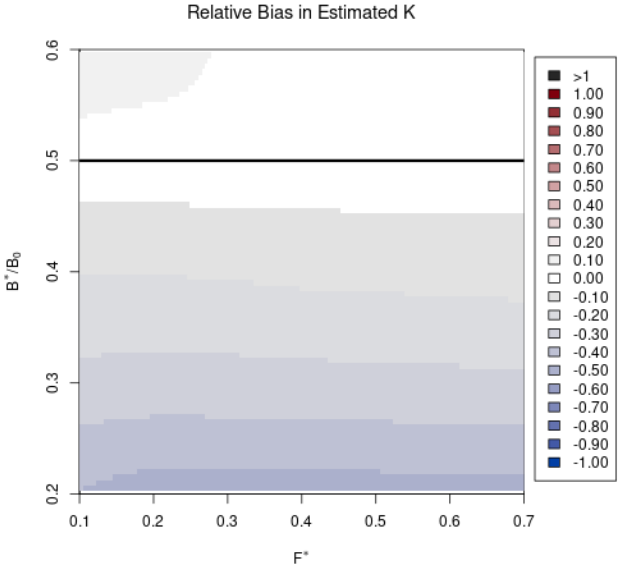

Relative Bias in Estimated MSY
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

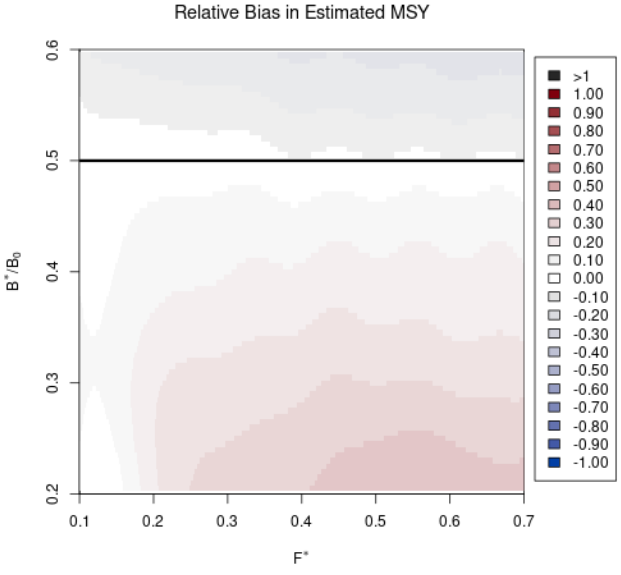

Relative Bias in Estimated F*
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

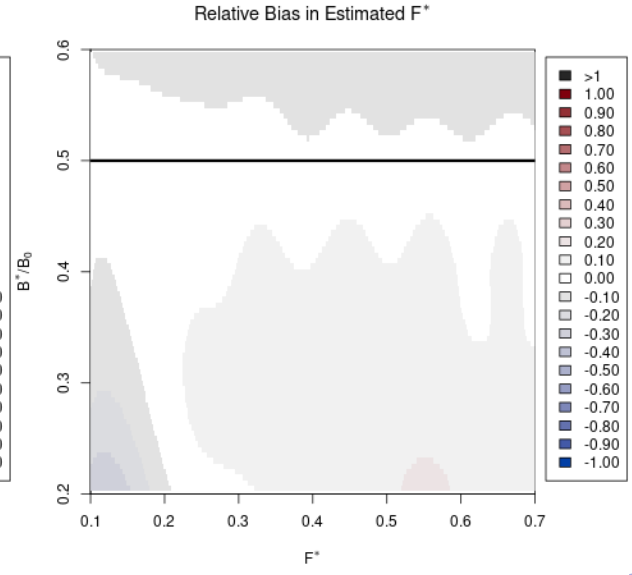

Relative Bias in Estimated B*
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

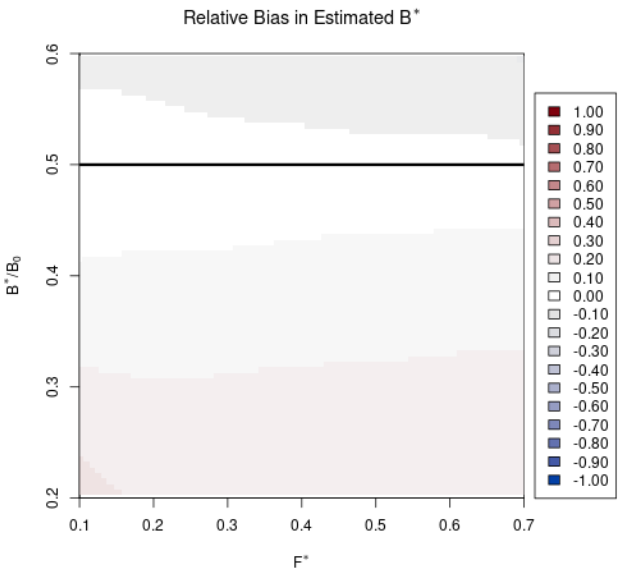

Catch=F* (F(t)/F*) B(t)
F(t)/F*
Time

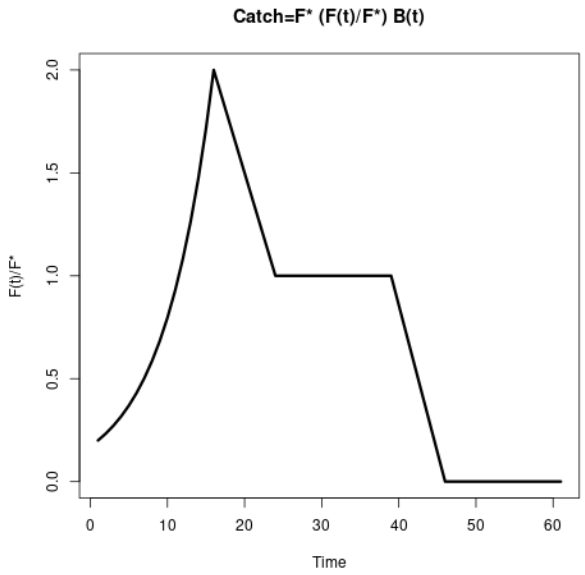

Directional Bias
B*/B0
F*
0.31
0.29
0.27
0.26
0.24
0.23
0.21
0.19
0.18
0.16
0.15
0.13
0.11
0.10
0.08
0.06
0.05
0.03
0.02
0.00

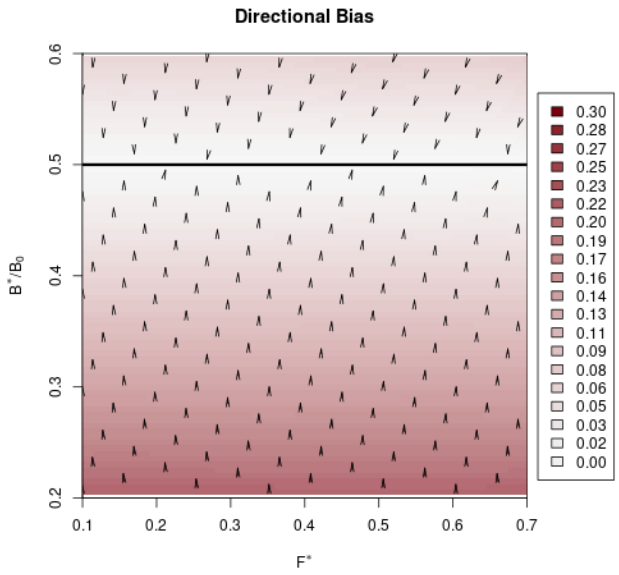

Relative Bias in Estimated K
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

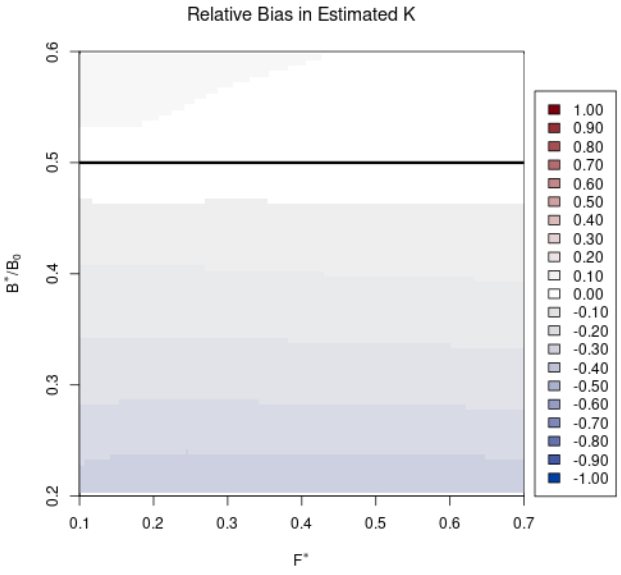

Relative Bias in Estimated MSY
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

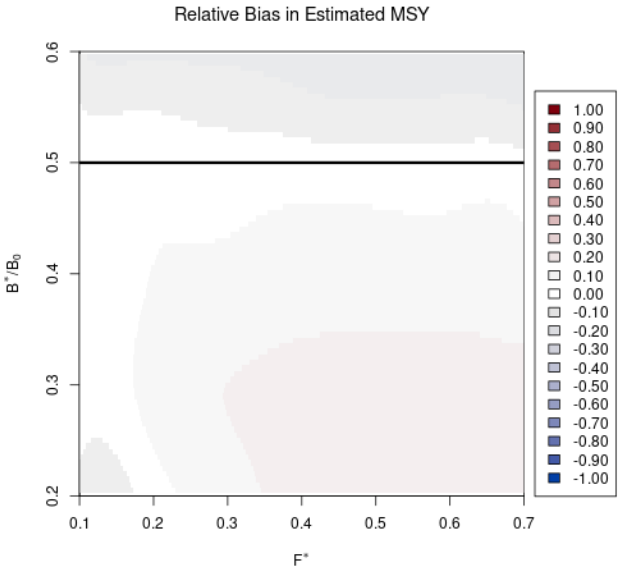

Relative Bias in Estimated F*
B*/B0
F*
>1
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

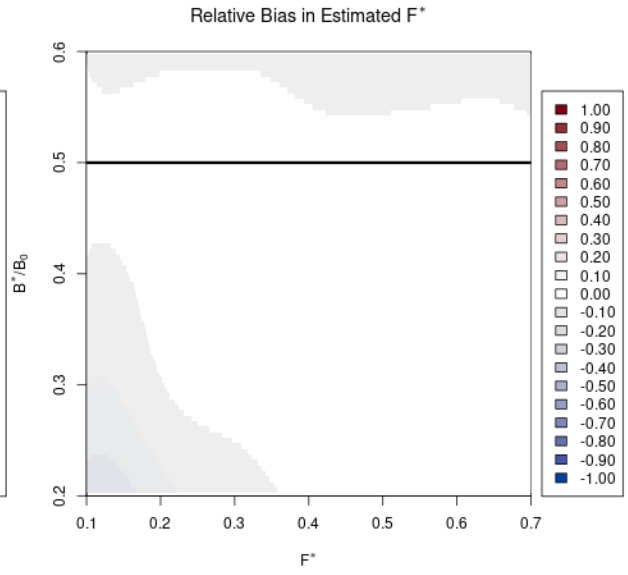

Relative Bias in Estimated B*
B*/B0
F*
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

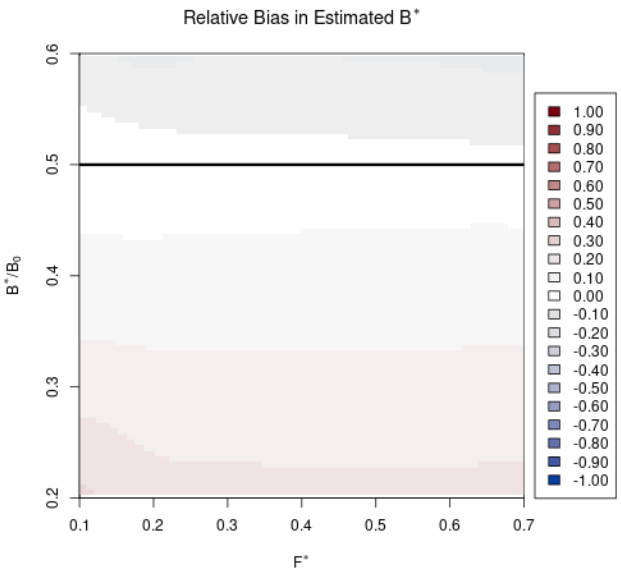

Catch=F* (F(t)/F*) B(t)
F(t)/F*
Time

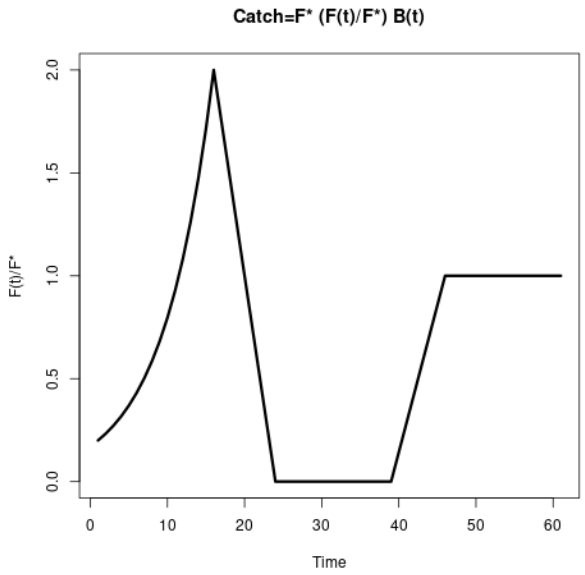

Directional Bias
B*/B0
F*
0.30
0.28
0.27
0.25
0.23
0.22
0.20
0.19
0.17
0.16
0.14
0.13
0.11
0.09
0.08
0.06
0.05
0.03
0.02
0.00

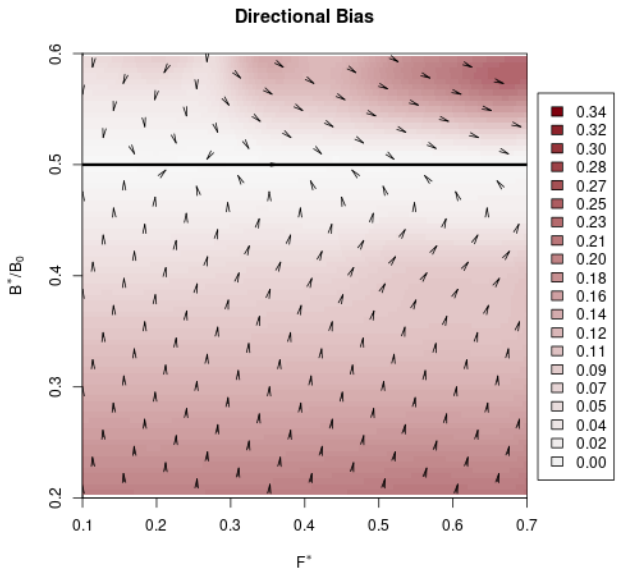

Relative Bias in Estimated K
B*/B0
F*
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

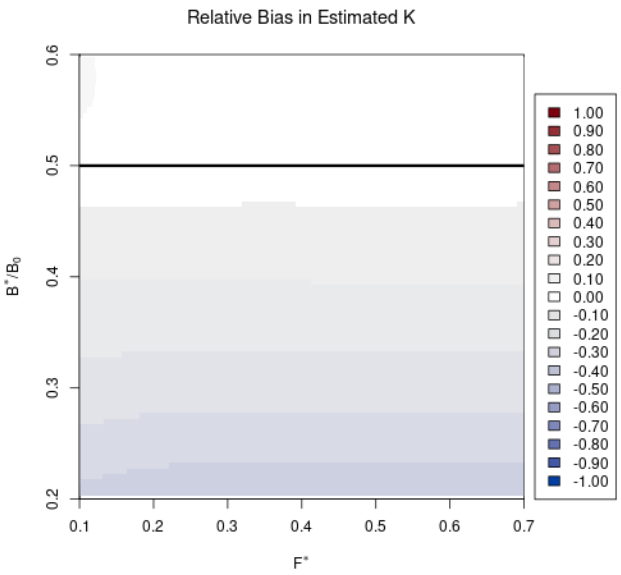

Relative Bias in Estimated MSY
B*/B0
F*
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

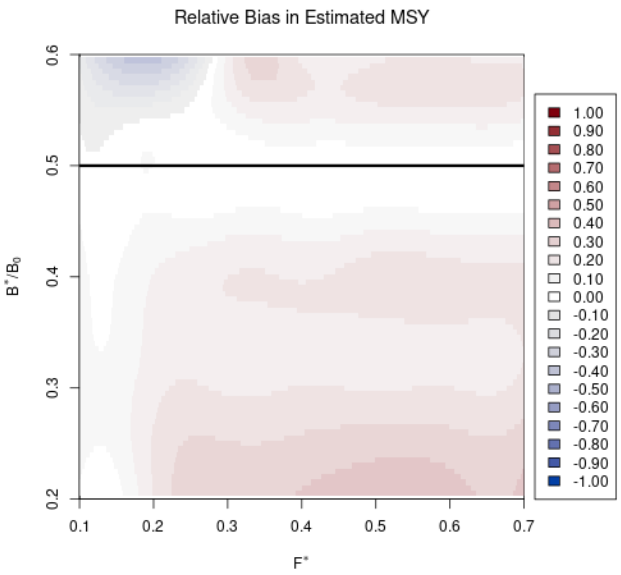

Relative Bias in Estimated F*
B*/B0
F*
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

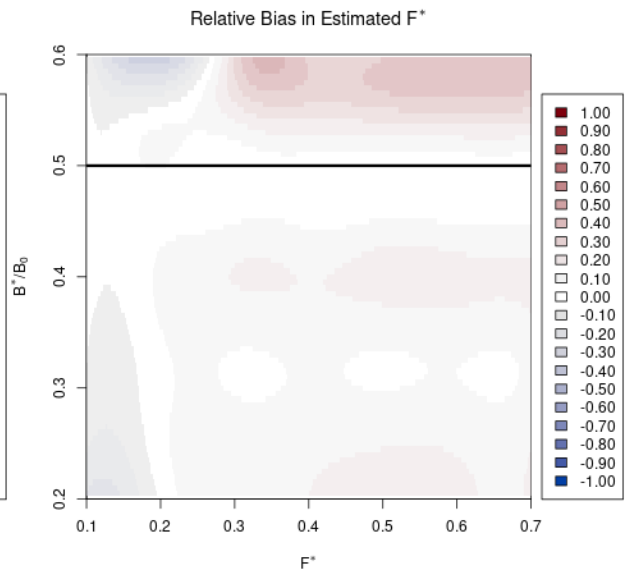

Relative Bias in Estimated B*
B*/B0
F*
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00


Catch=F* (F(t)/F*) B(t)
F(t)/F*
Time

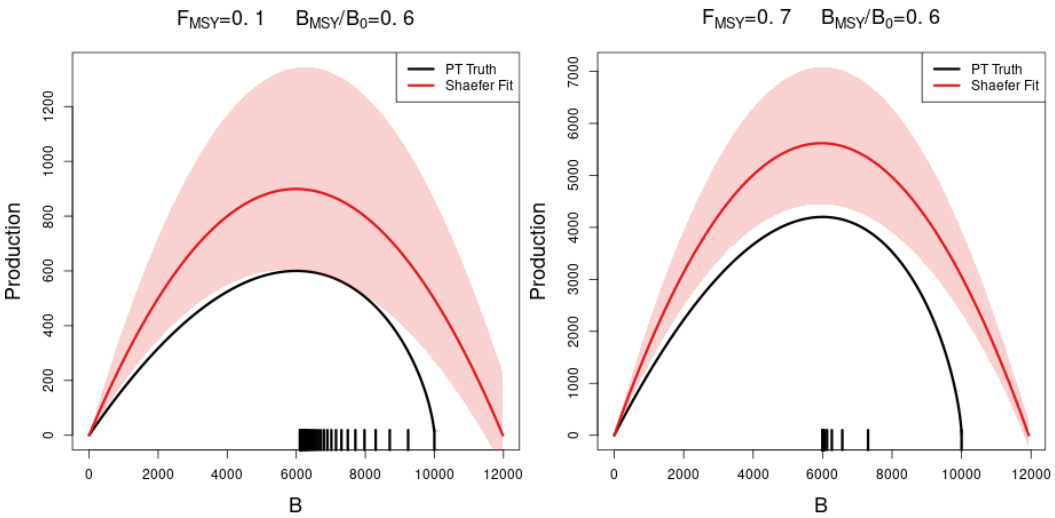

Directional Bias
B*/B0
F*
0.34
0.32
0.30
0.28
0.27
0.25
0.23
0.21
0.20
0.18
0.16
0.14
0.12
0.11
0.09
0.07
0.05
0.04
0.02
0.00

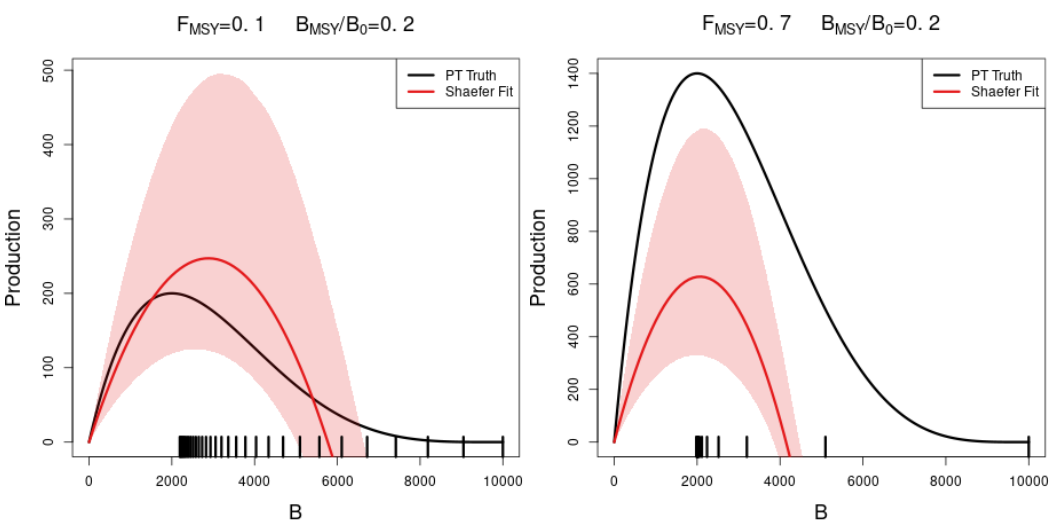

Relative Bias in Estimated K
B*/B0
F*
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

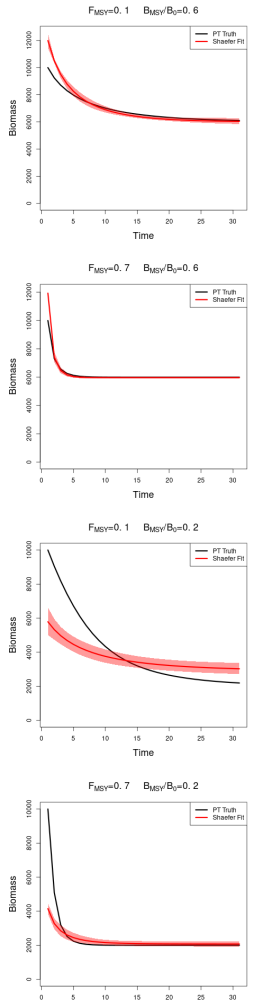

Relative Bias in Estimated MSY
B*/B0
F*
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

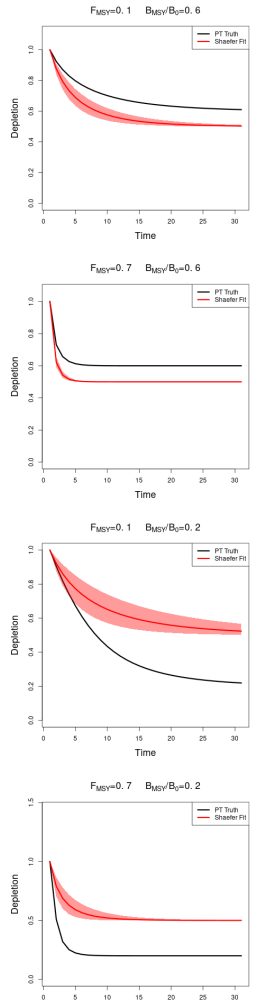

Relative Bias in Estimated F*
B*/B0
F*
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00

Flat: Misspecified SRR Biomass Depletion

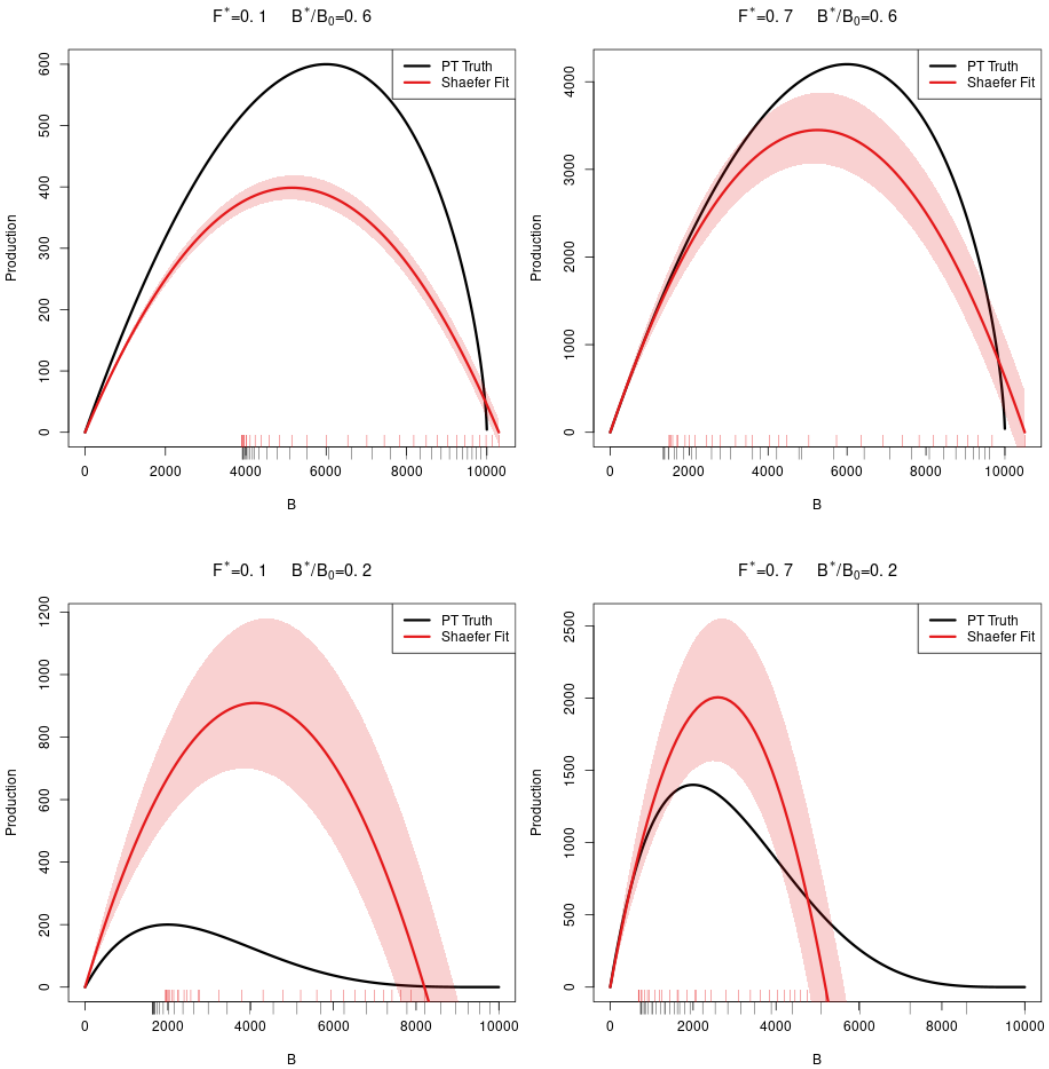


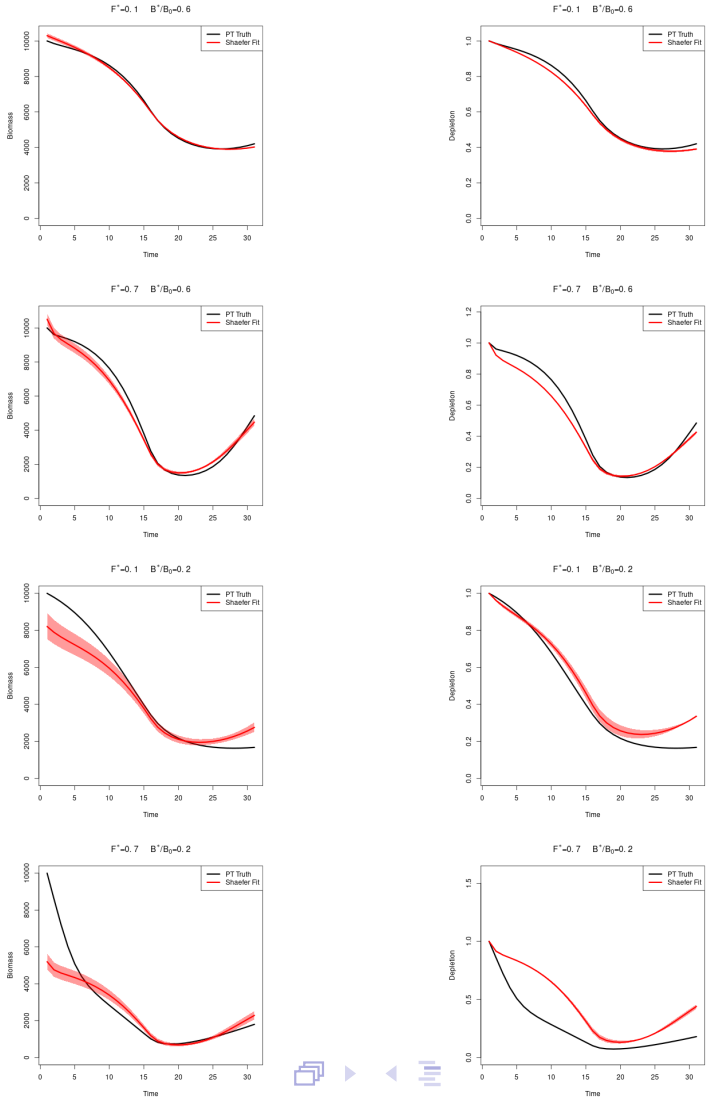




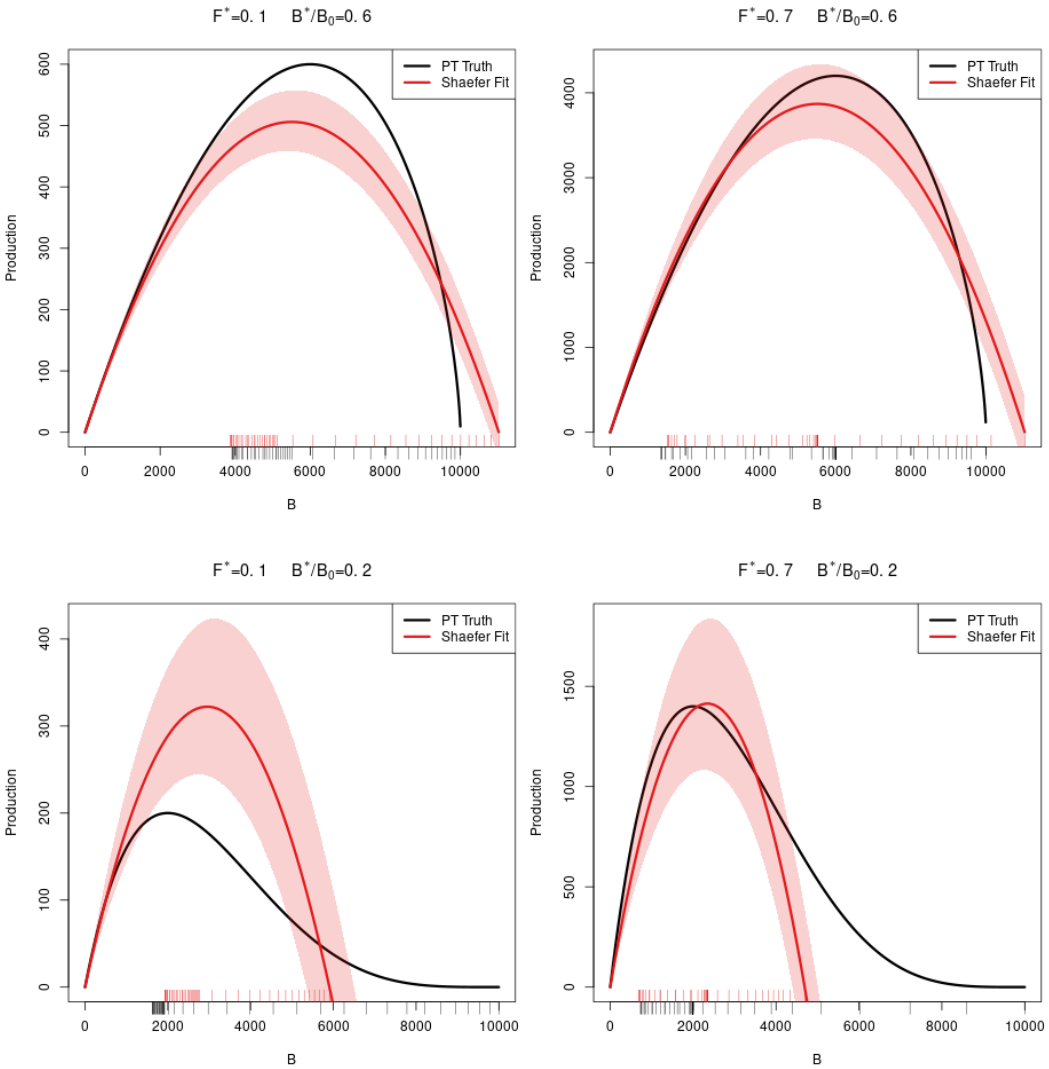


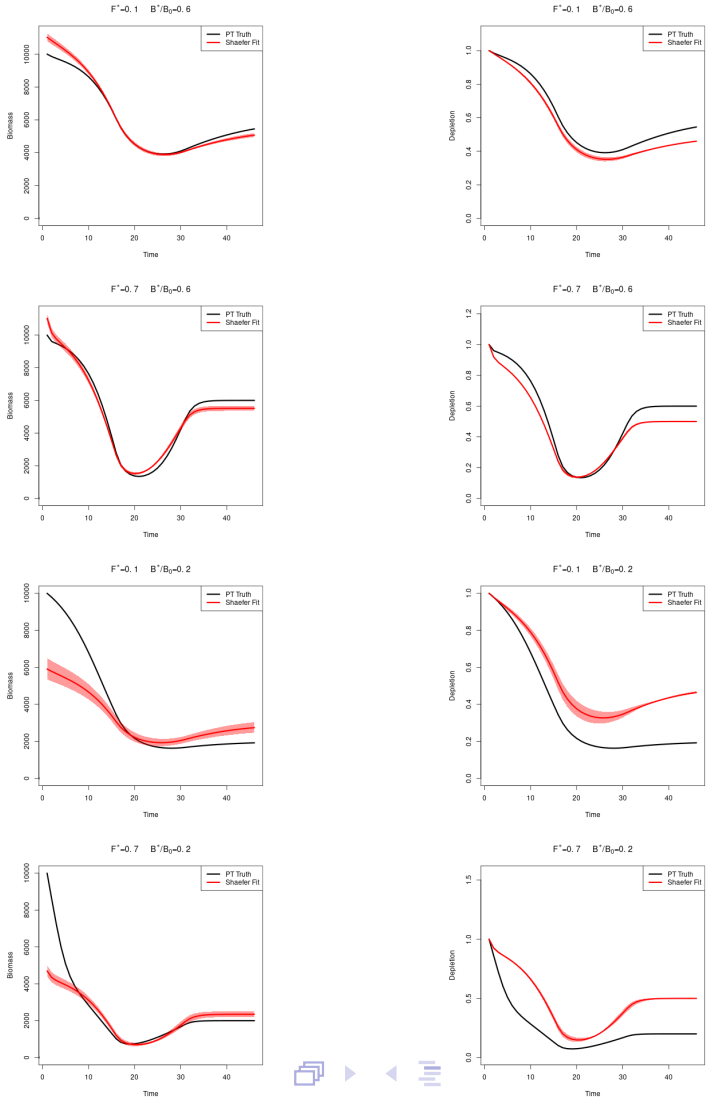
Contrast: Misspecified SRR Biomass Depletion



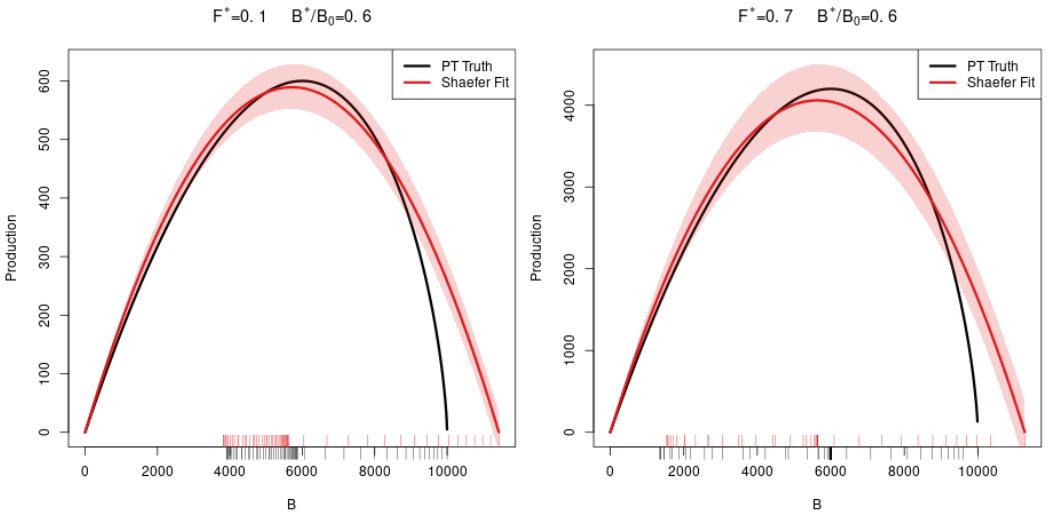


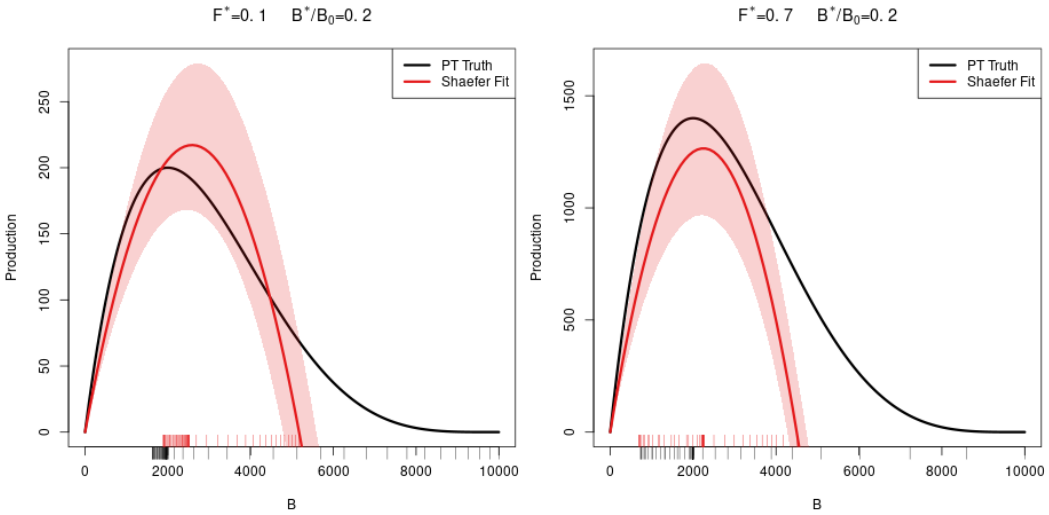
ContrastT45: Misspecified SRR Biomass Depletion

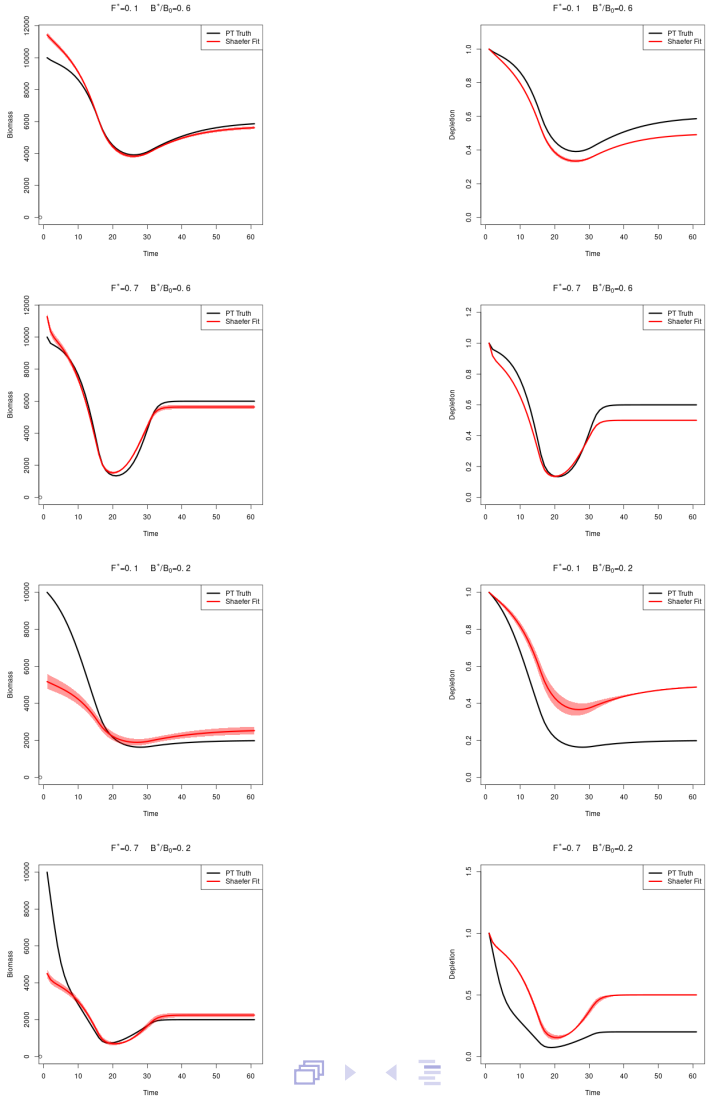




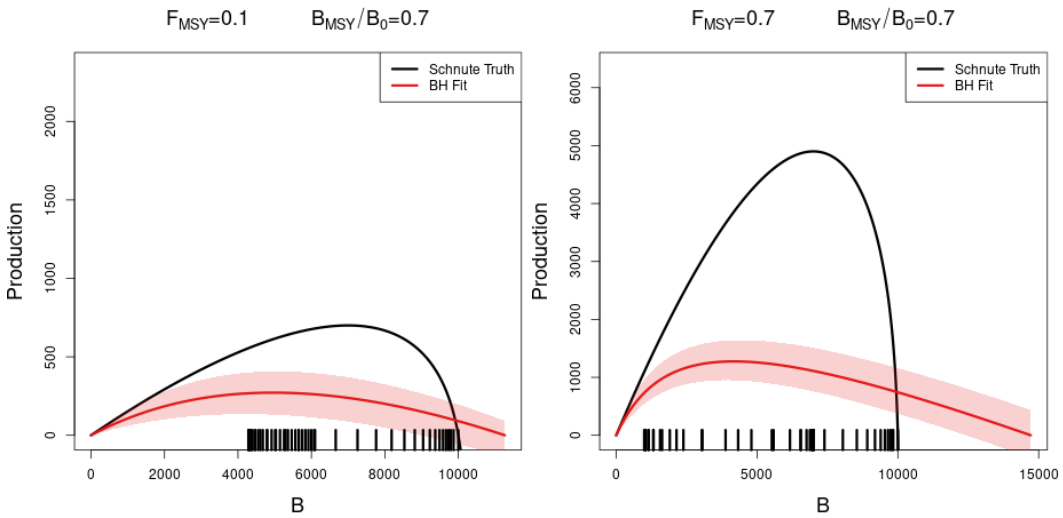
ContrastT60: Misspecified SRR Biomass Depletion

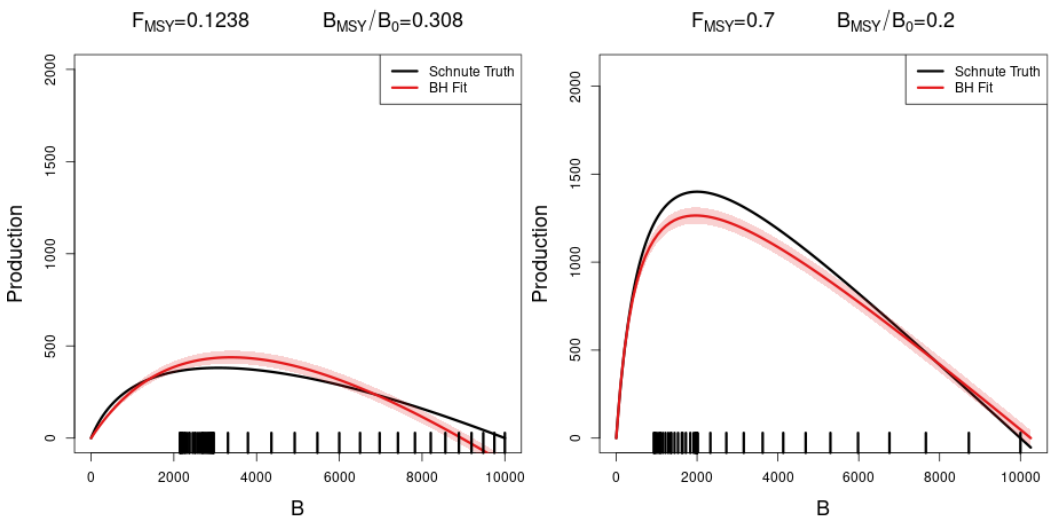


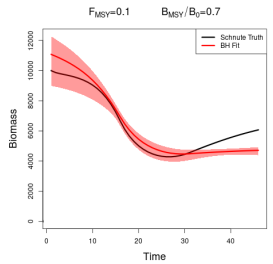


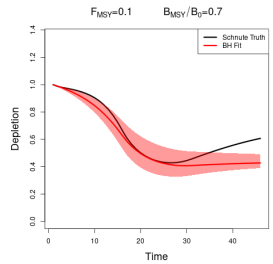


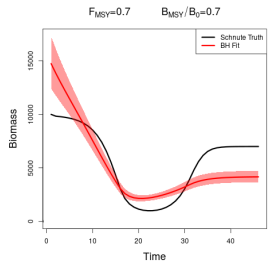
SchnuteExpT45: Misspecified SRR Biomass Depletion

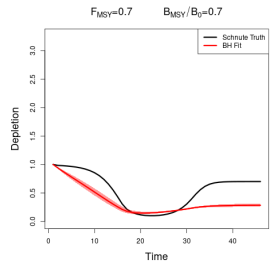


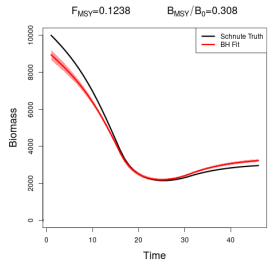


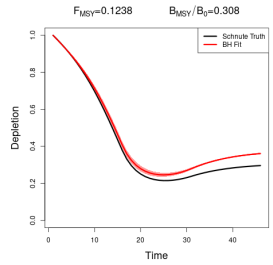


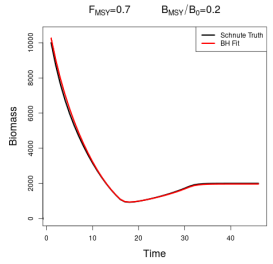


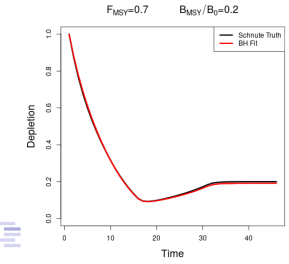




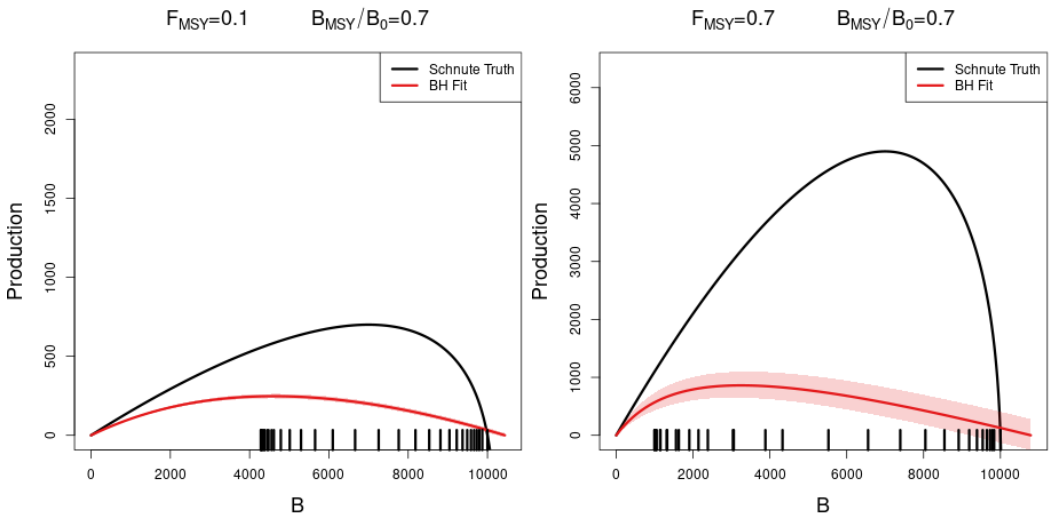


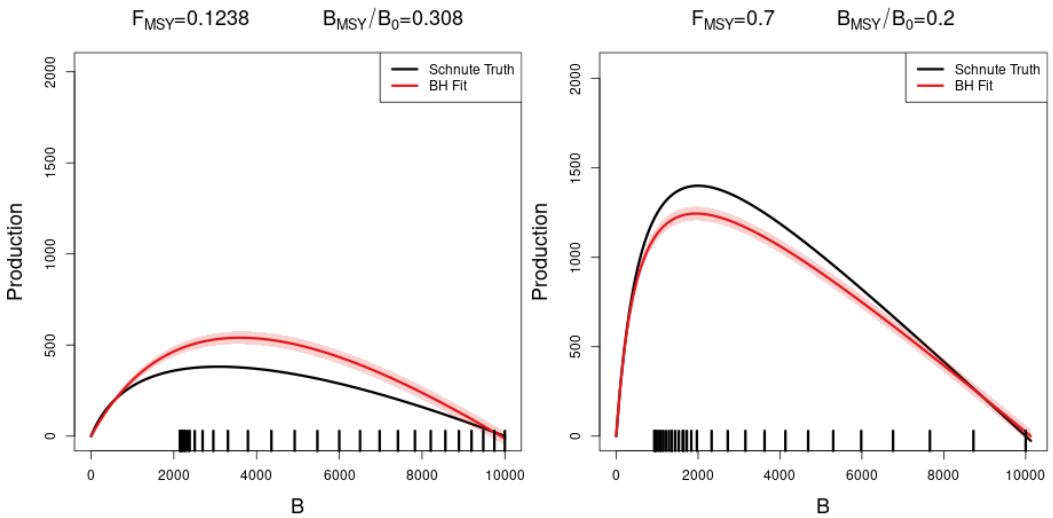


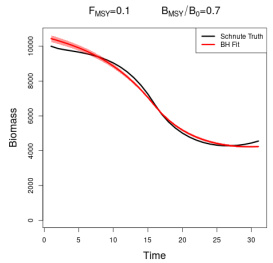


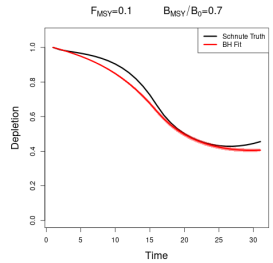


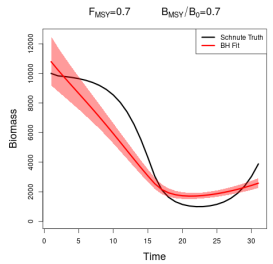
SchnuteExpT30: Misspecified SRR Biomass Depletion

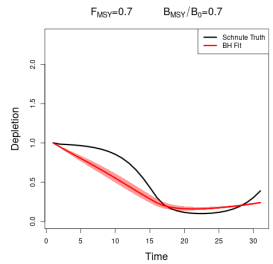


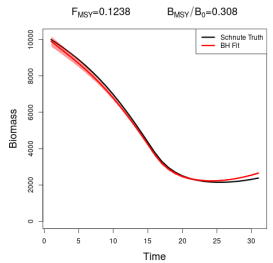


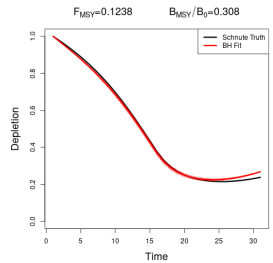


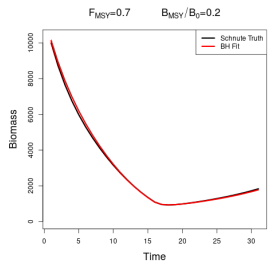


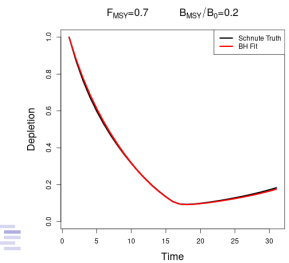




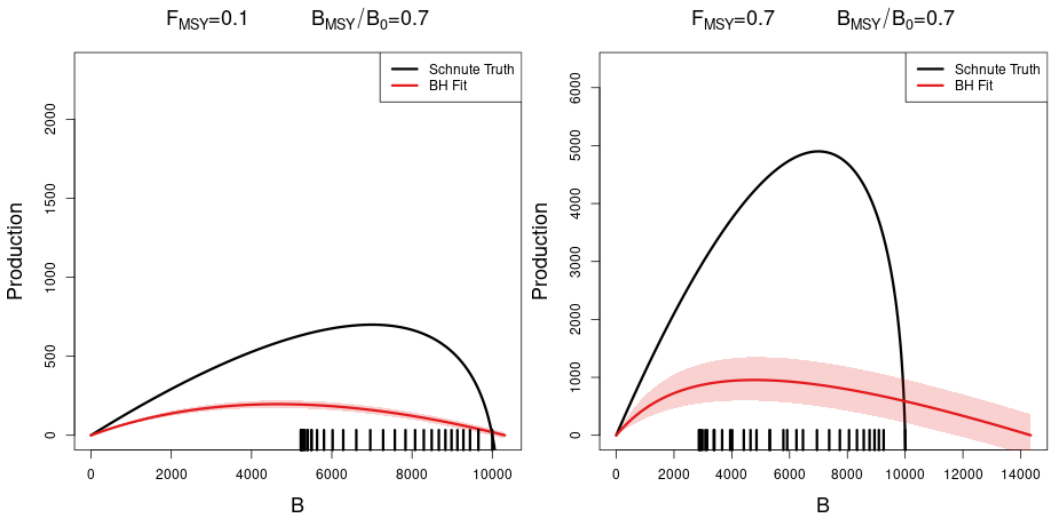


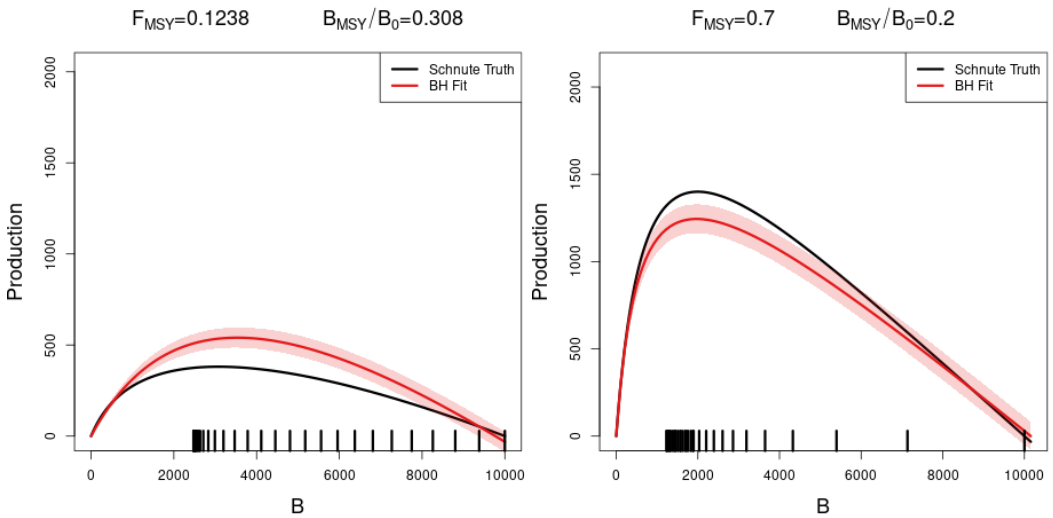


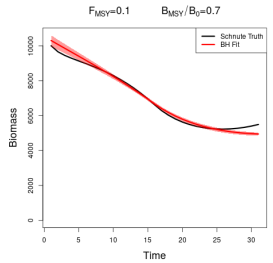


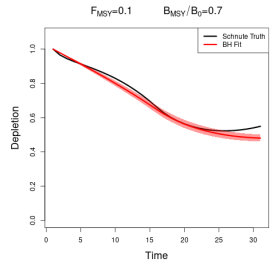


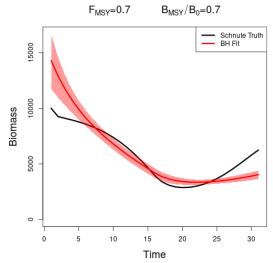
SchnuteExpT30L2: SRR Biomass Depletion

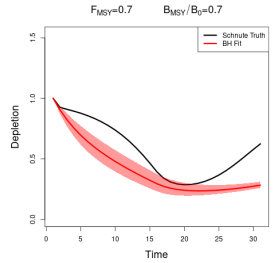


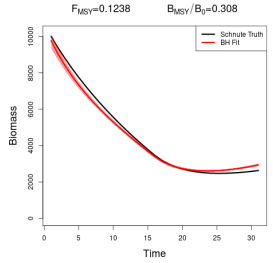


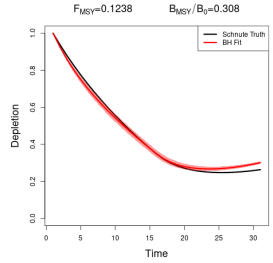


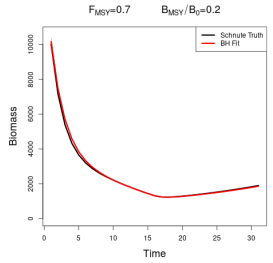


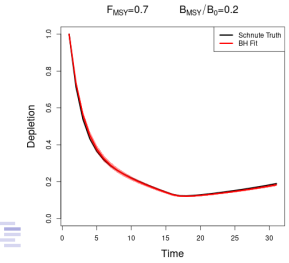




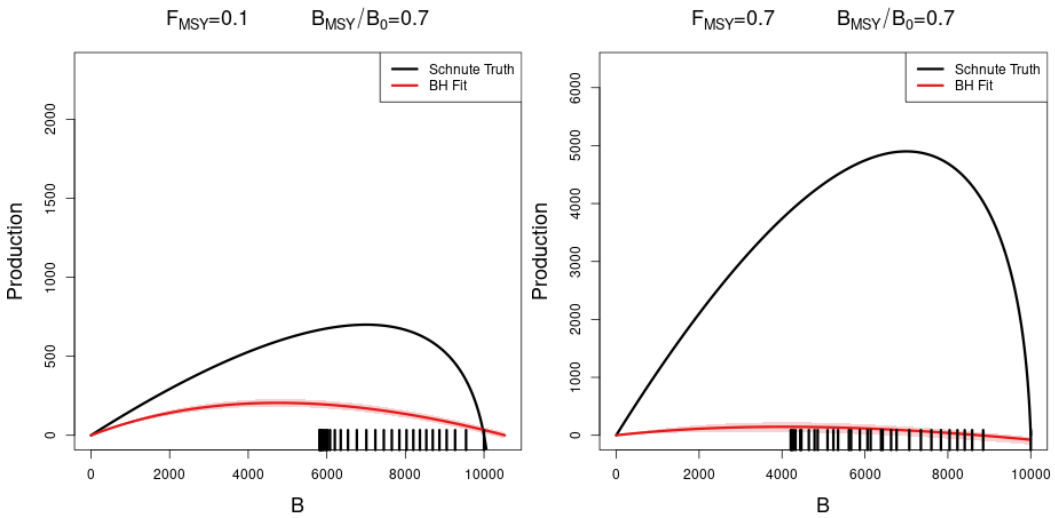


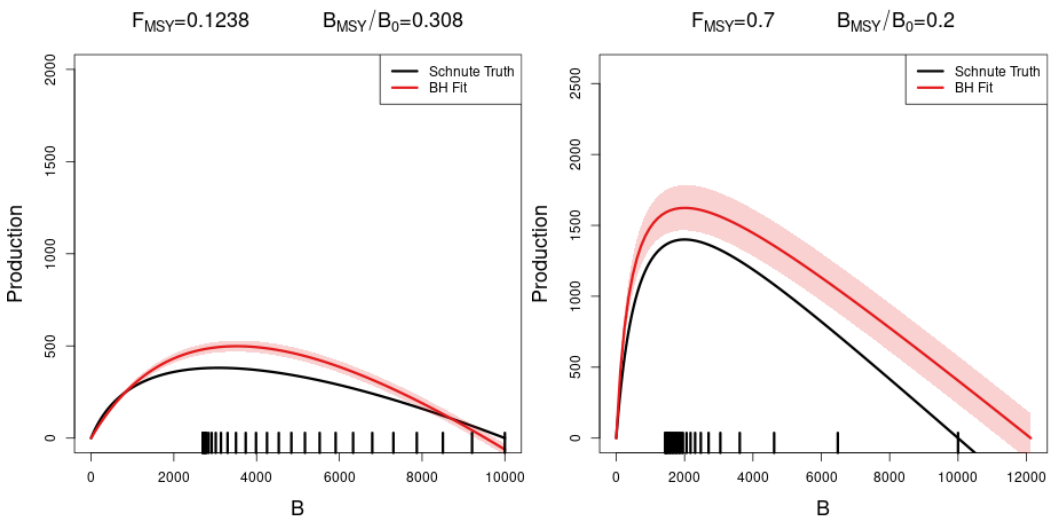


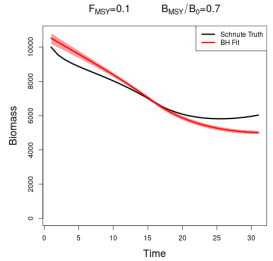


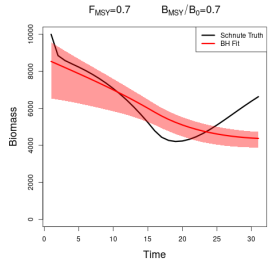


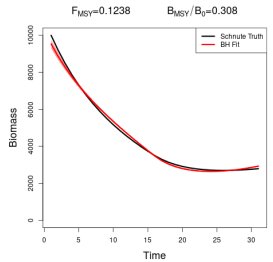
SchnuteExpT30L3: SRR Biomass Depletion

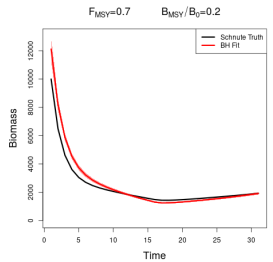


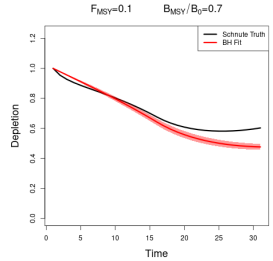


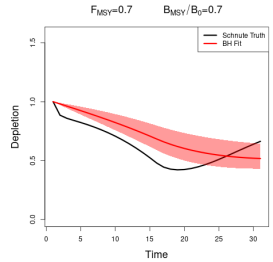


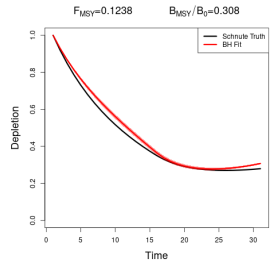


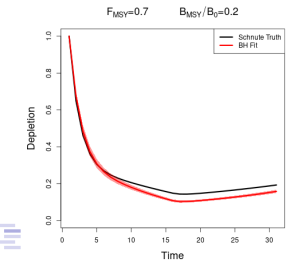












SchnuteFlatT30: SRR Biomass Depletion