BauchModel_DefaultParamsHighMovement

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11 April, 2023, 13:00

Table 1: Parameter values used in this analysis

Parameter	Population_1	Population_2	Def
r	0.4	0.35	Fish net growth
s	0.8	0.8	Supply and demand
h	0.25	0.5	Harvesting efficiency
k	1.014	1.014	Social learning rate
w	0.2	0.35	Conservation cost
c	1.5	1.5	Rarity valuation
d	0.5	0.5	Social norm strength (within pop)
i	0	0	Fish immigration (from opposite patch)
rho	0.5	0.5	Social norm strength (opposite pop)

Table 2: Starting values used in this analysis

Parameter	Population_1	Population_2
F	0.406	0.406
X	0.240	0.240

SCENARIO: DEFAULTS PARAMS HIGH MOVEMENT

Function:

$\frac{dP_1}{dt} = r_1 P_1(1 - P_1) - \frac{h_1 * P_1(1-X_1)}{P_1+s_1} - e_1 P_1 + i_1 P_2$

$\frac{dP_2}{dt} = r_2 P_2(1 - P_2) - \frac{h_2 * P_2(1-X_2)}{P_2+s_2} - e_2 P_2 + i_2 P_1$

$\frac{dX_1}{dt} = k_1 X_1(1 - X_1)[\frac{1}{P_1+c_1} - w_1 + d_1(2X_1 - 1) + prop_1(2X_2 - 1)]$

$\frac{dX_2}{dt} = k_2 X_2(1 - X_2)[\frac{1}{P_2+c_2} - w_2 + d_2(2X_2 - 1) + prop_2(2X_1 - 1)]$

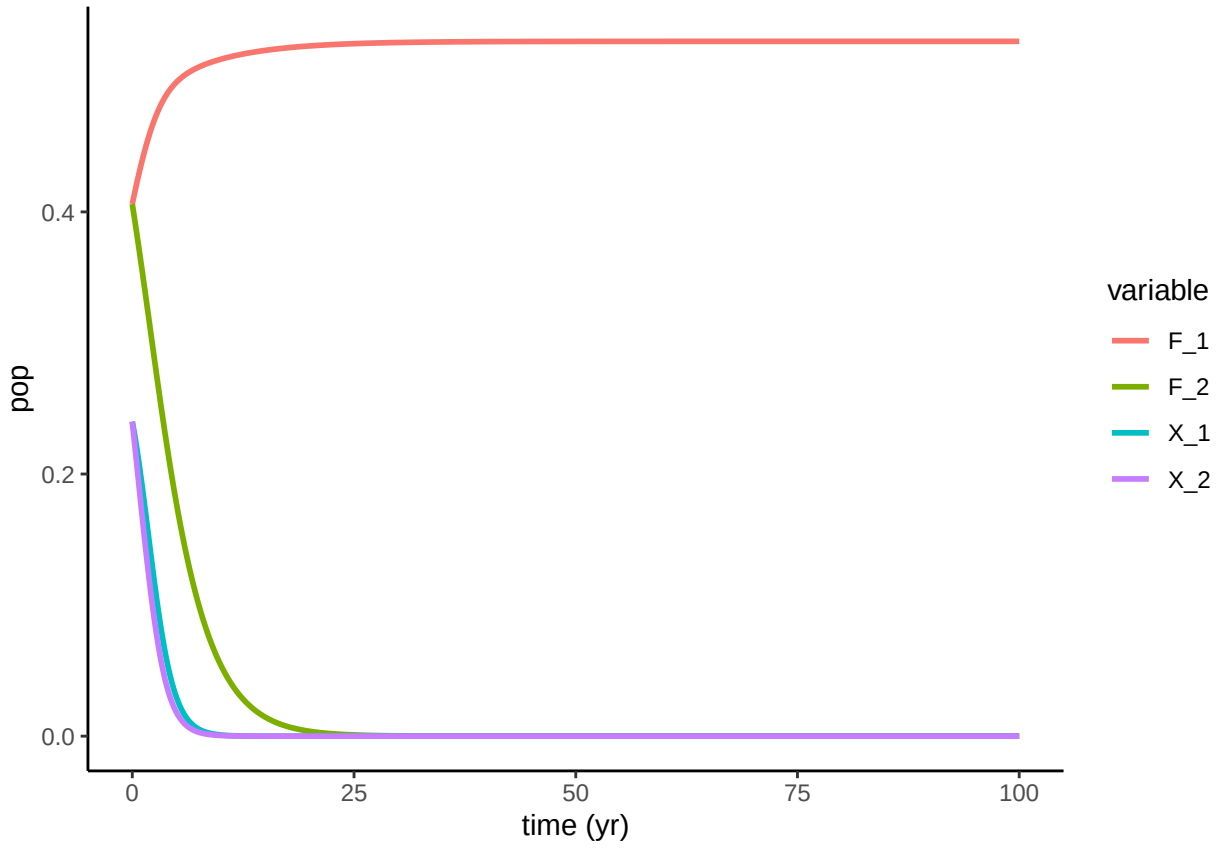


Figure 1: New Model with default paramters

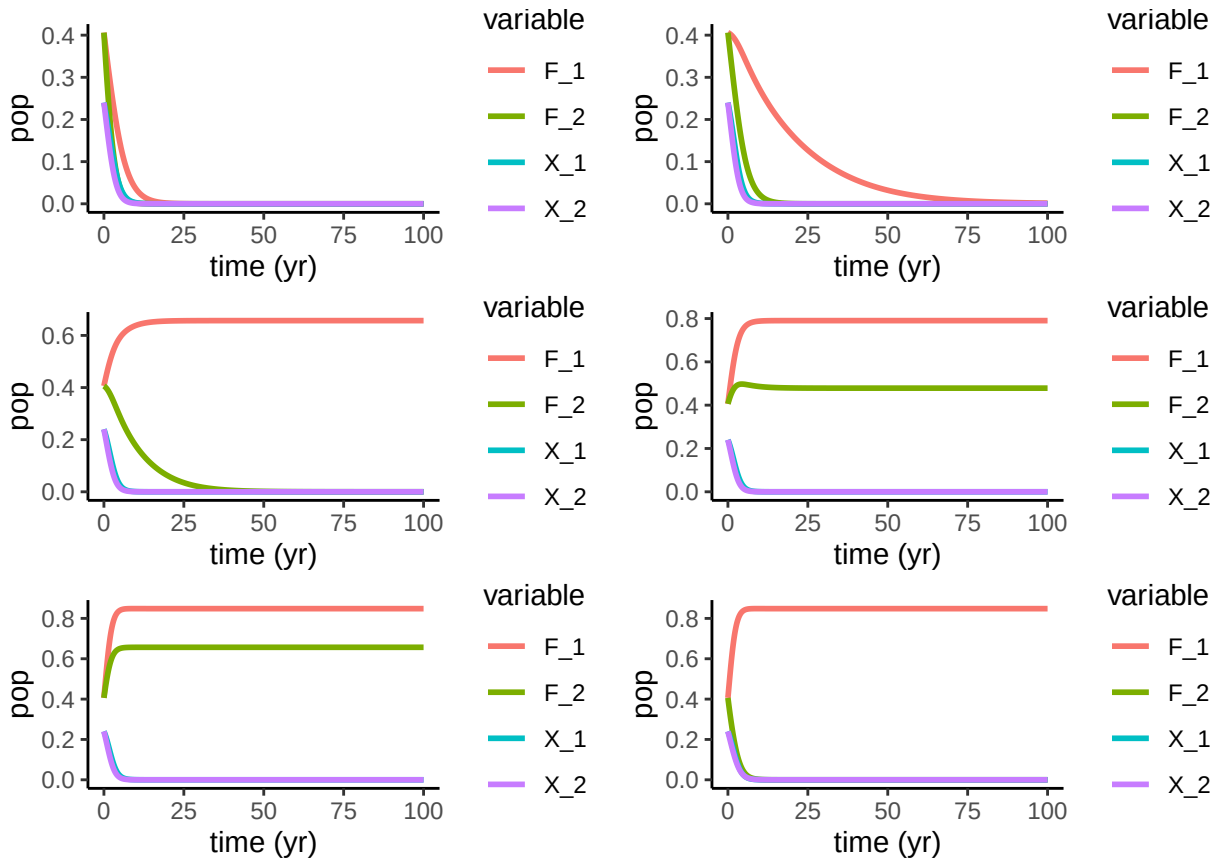


Figure 2: r - Net growth/fecundity, range 0 to 1

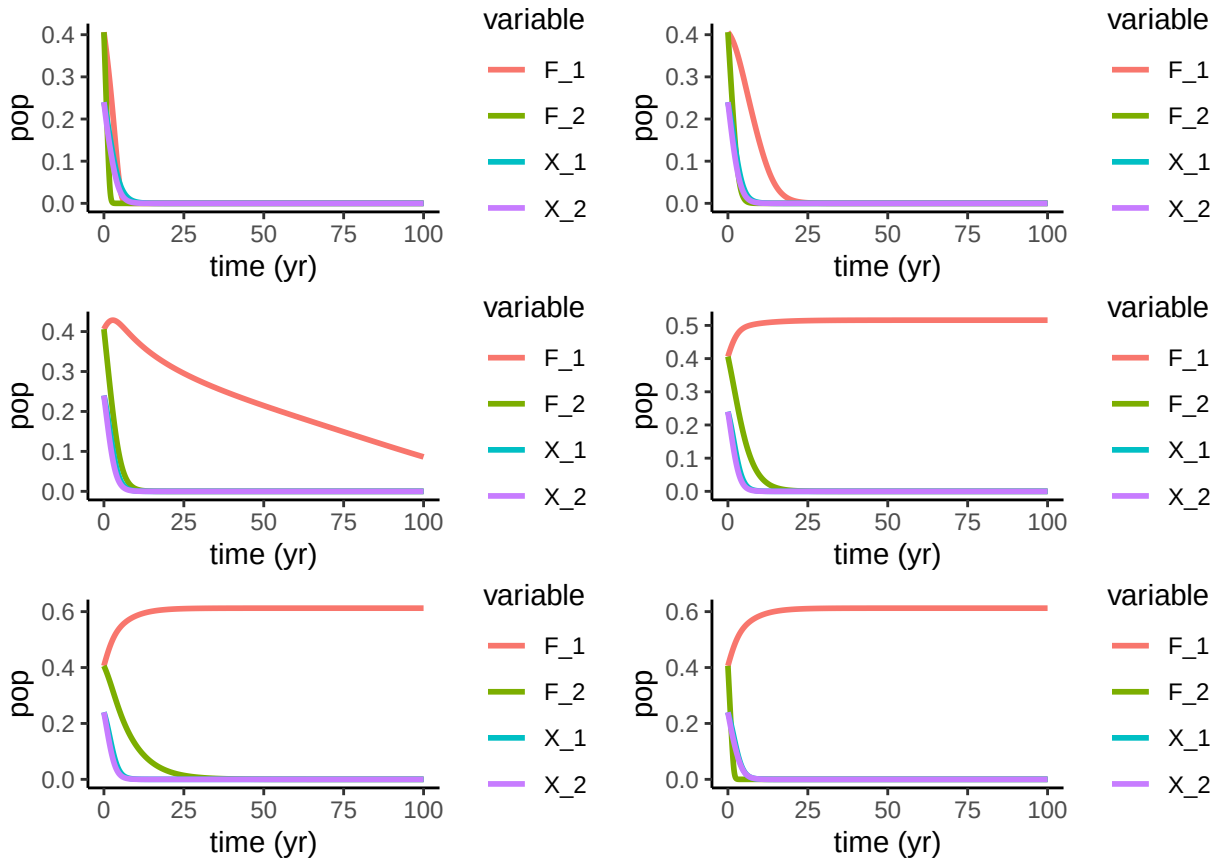


Figure 3: s - supply and demand, range 0.1 to 1

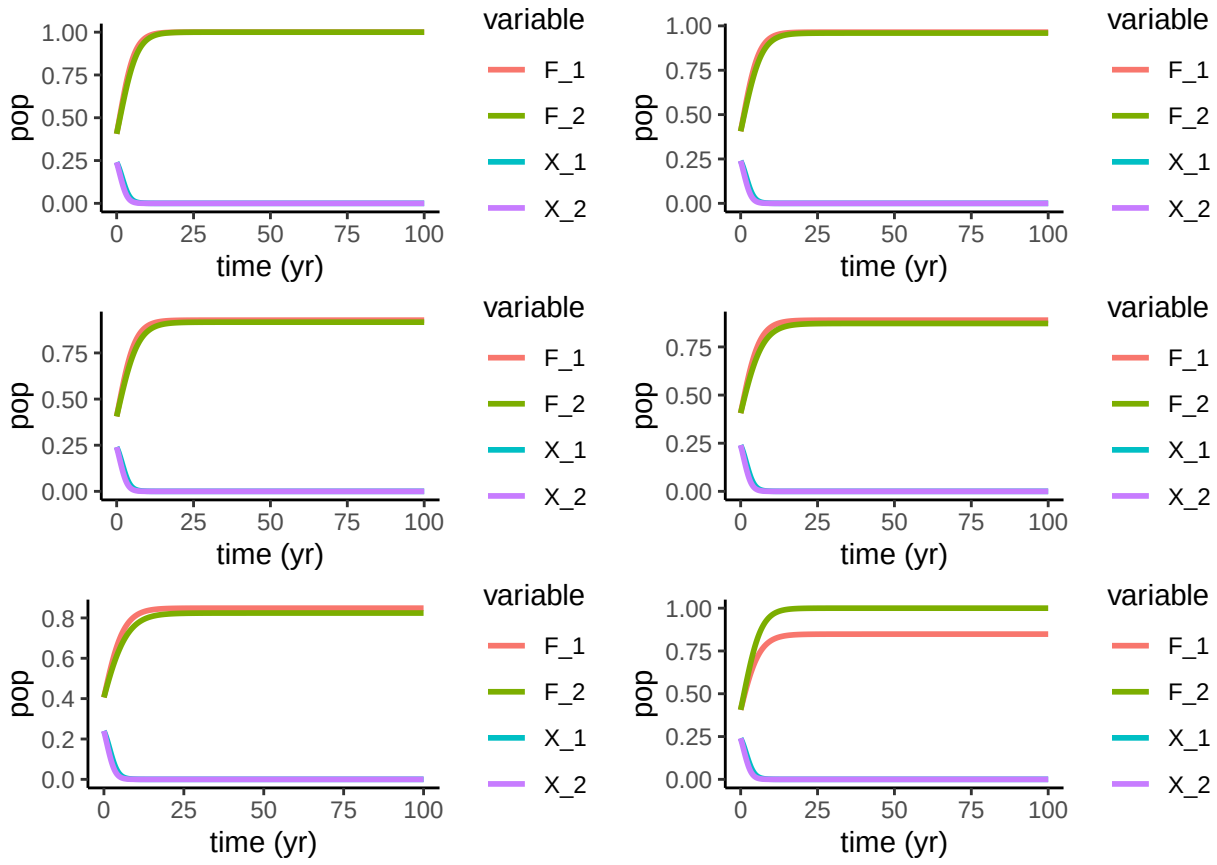


Figure 4: h - Harvesting efficiency, range 0 to 0.1. Note, default is .075

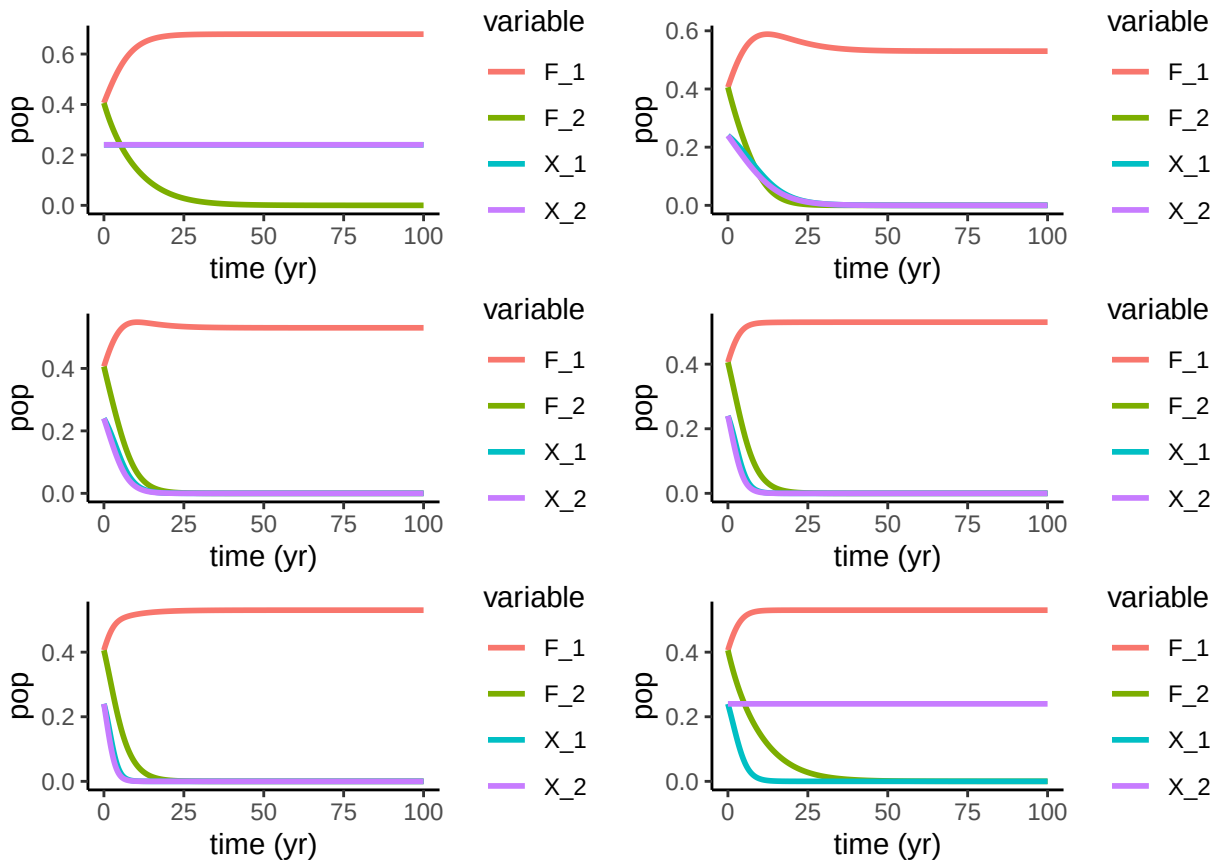


Figure 5: K - Social learning rate 0 to 1

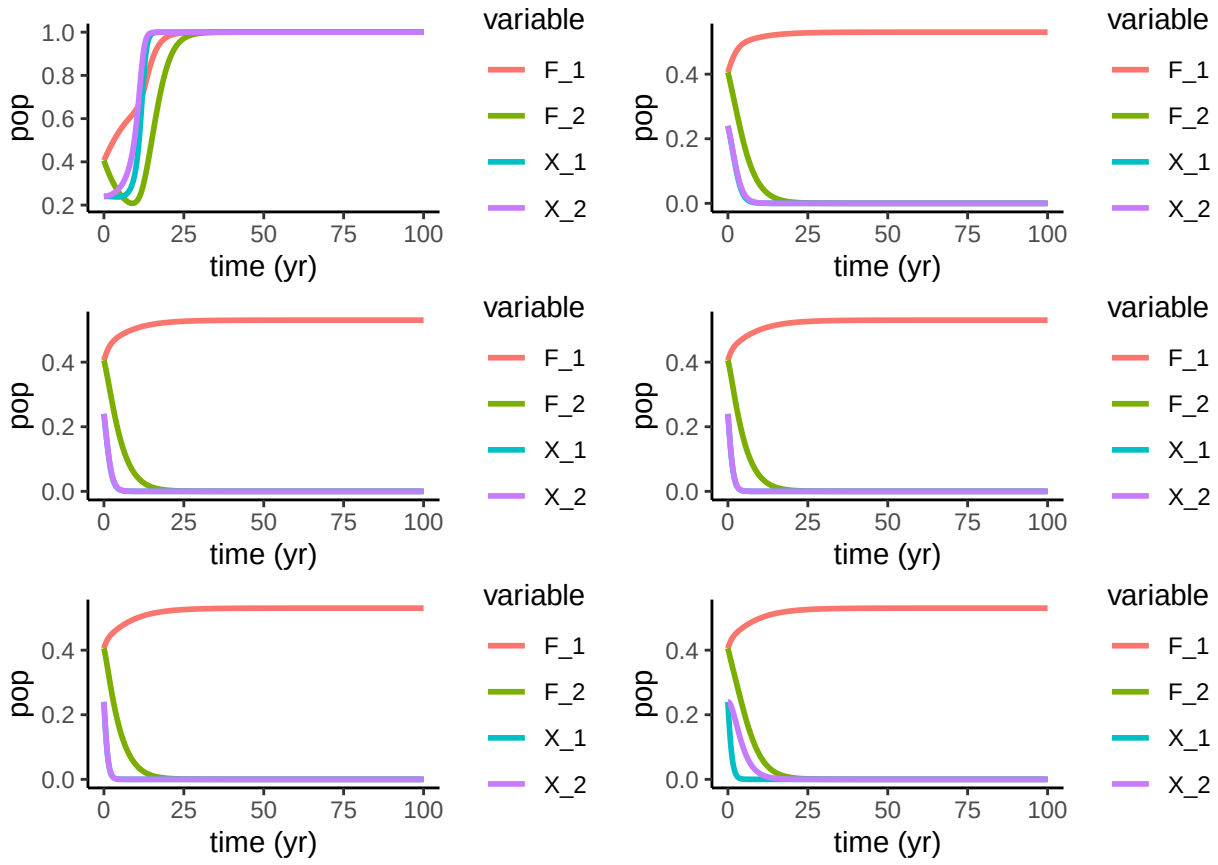


Figure 6: w - conservation costs

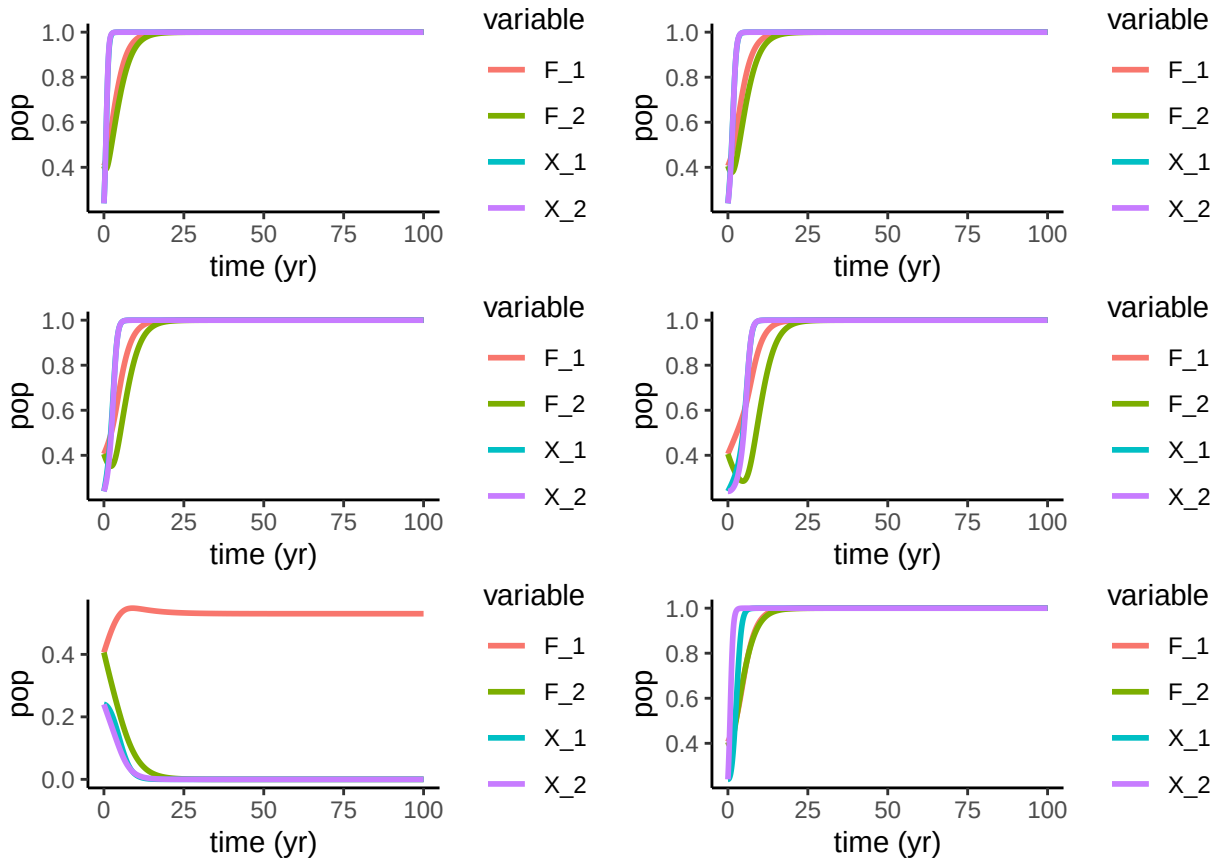


Figure 7: c - rarity valuation param

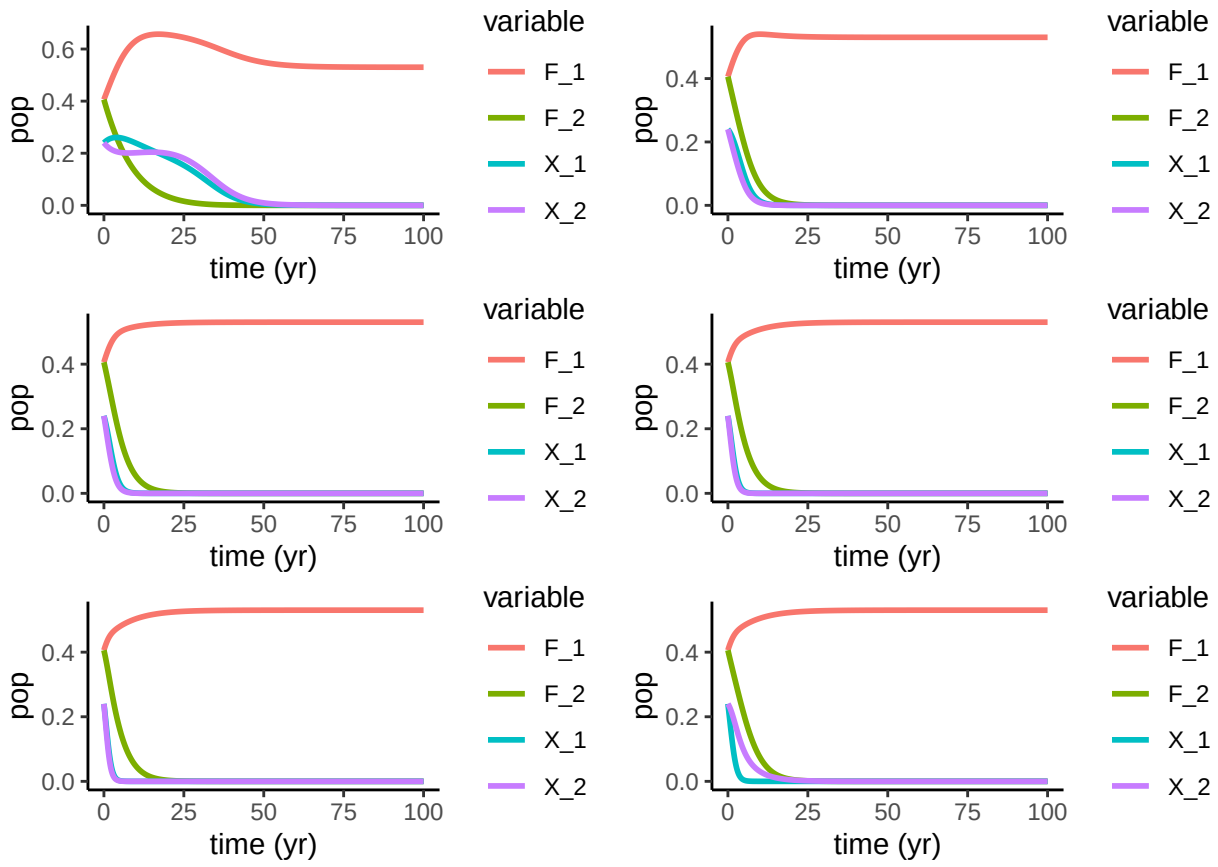


Figure 8: d - social norm strength

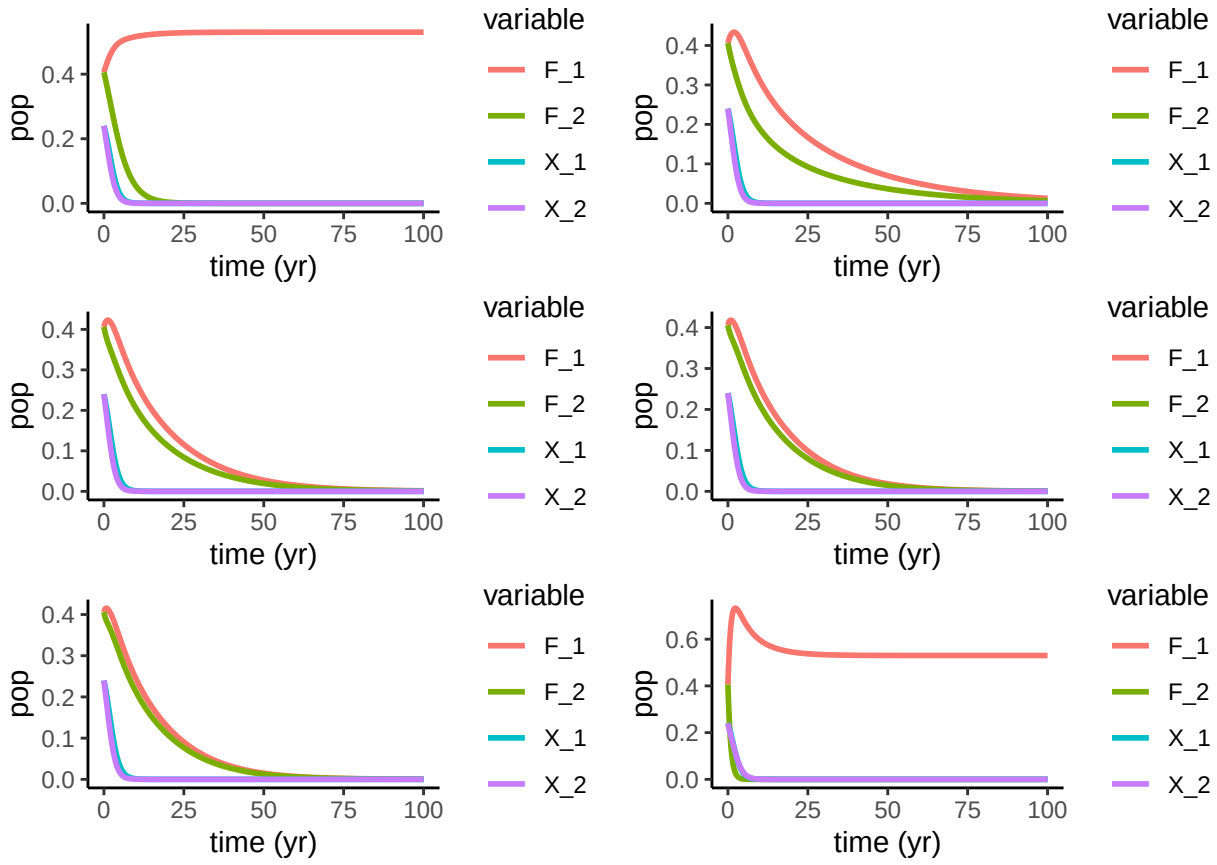


Figure 9: i - fish immigration

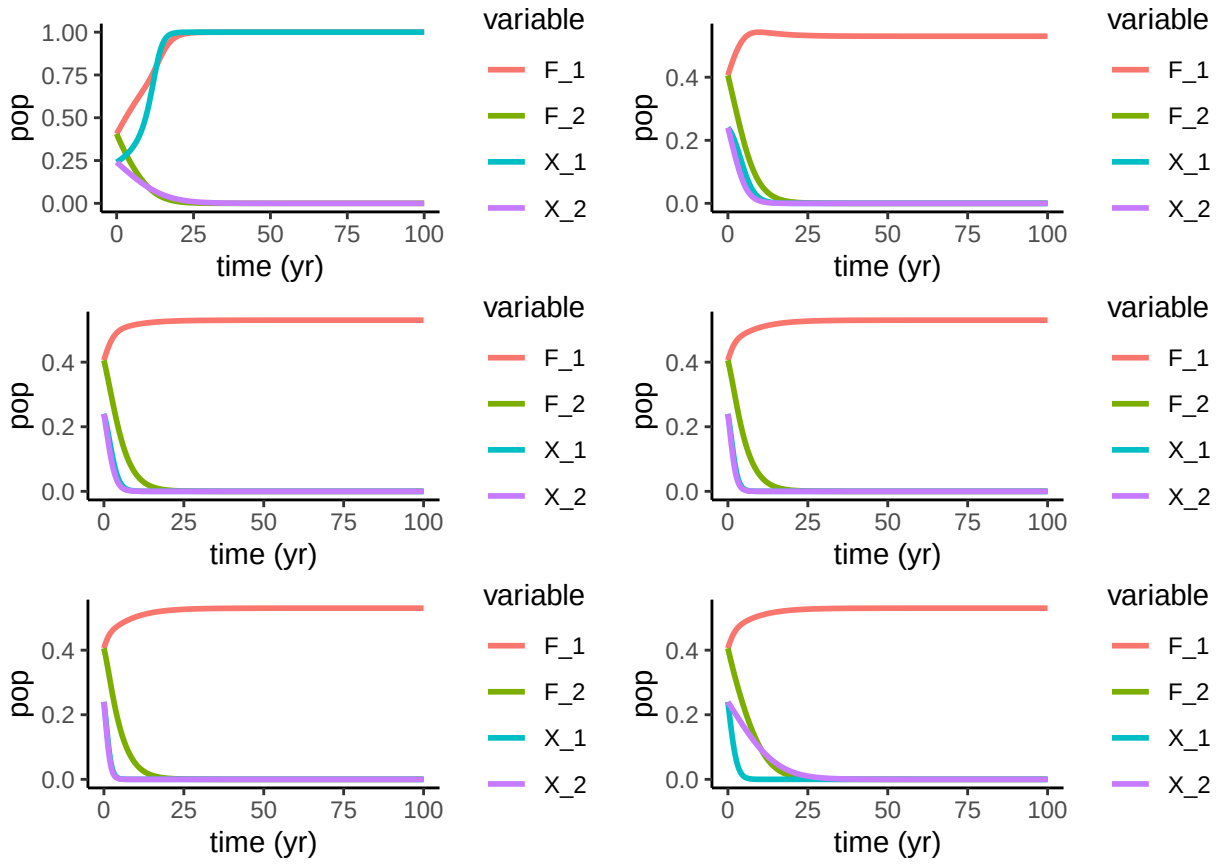
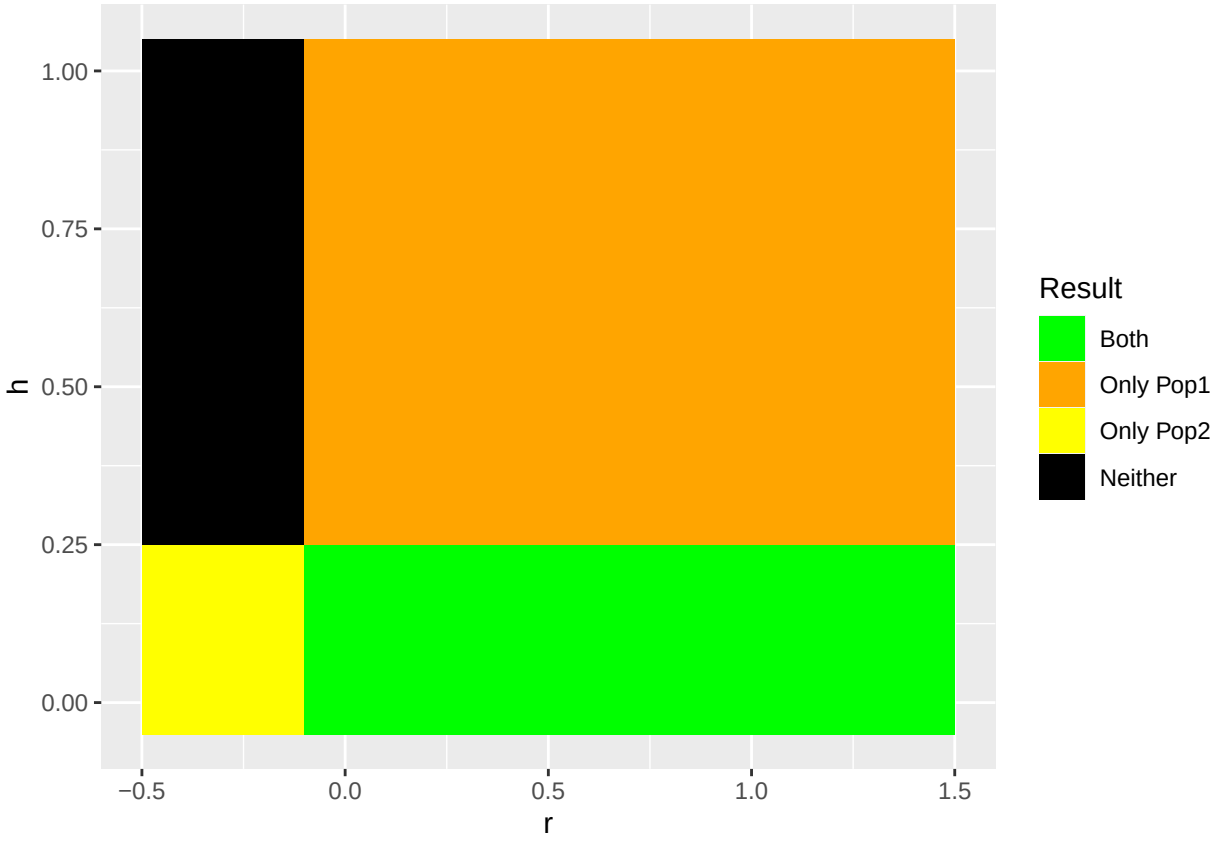


Figure 10: rho - Population influence on the other


1.00
0.75
0.50
0.25
0.00
h
−0.5
0.0
0.5
1.0
1.5
r
Result
Both
Only Pop1
Only Pop2
Neither

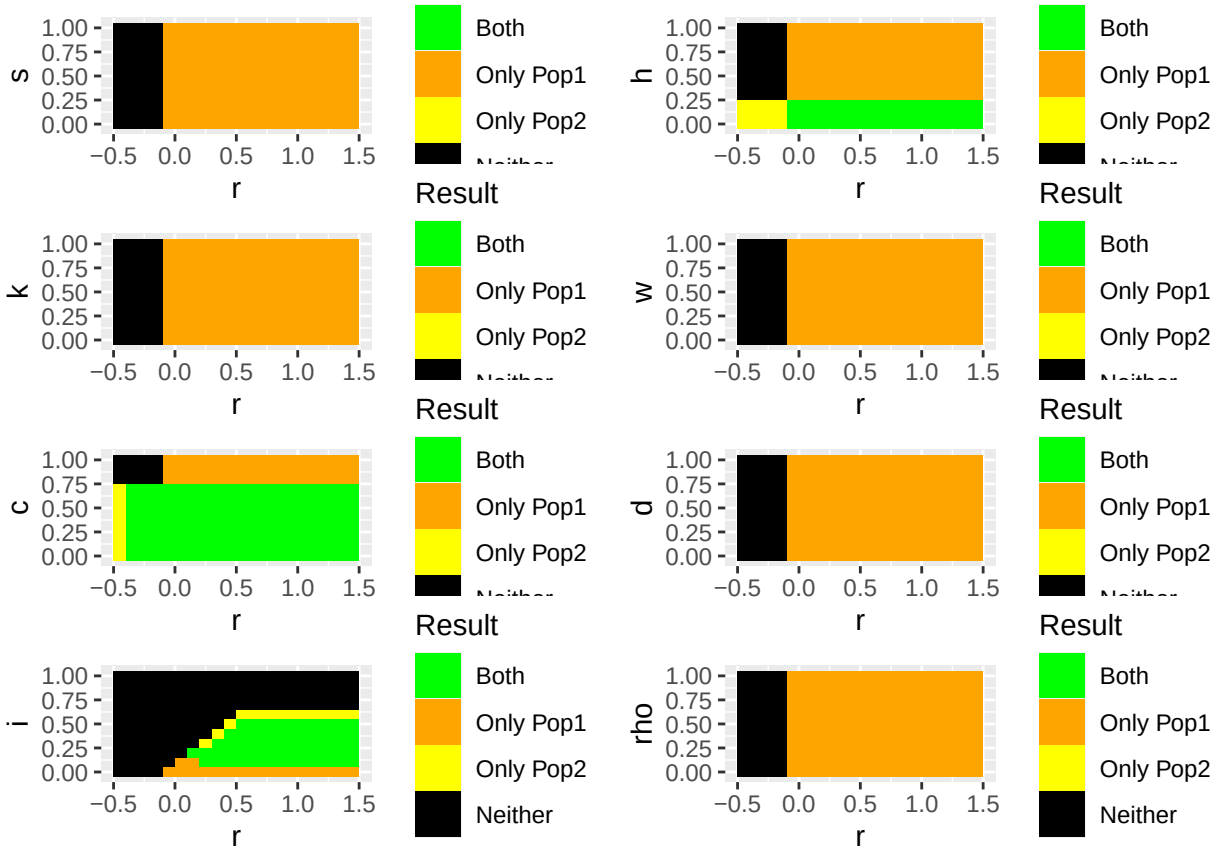


Figure 11: R parameter planes

```
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 3.52605e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 3.52605e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 3.52605e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 2.81872e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 2.81872e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 2.33485e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 2.33485e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 2.33485e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 1.86648e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 53.0575, R2 = 1.86648e-15
##
## DLSODA-  Above warning has been issued I1 times.
##      It will not be issued again for this problem.
## In above message, I1 = 10
##
```

```
## DLSODA-  At current T (=R1), MXSTEP (=I1) steps
##       taken on this call before reaching TOUT
## In above message, I1 = 5000
##
## In above message, R1 = 53.0575
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 48.9325, R2 = 3.35799e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 48.9325, R2 = 3.35799e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 48.9325, R2 = 3.35799e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 48.9325, R2 = 2.68438e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 48.9325, R2 = 2.68438e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 48.9325, R2 = 2.22357e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 48.9325, R2 = 2.22357e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 48.9325, R2 = 2.22357e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 48.9325, R2 = 1.77752e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
```

```
## In above message, R1 = 48.9325, R2 = 1.77752e-15
##
## DLSODA-  Above warning has been issued I1 times.
##      It will not be issued again for this problem.
## In above message, I1 = 10
##
## DLSODA-  At current T (=R1), MXSTEP (=I1) steps
##       taken on this call before reaching TOUT
## In above message, I1 = 5000
##
## In above message, R1 = 48.9325
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 6.58325e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 6.58325e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 5.45316e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 5.45316e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 5.45316e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 4.35925e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 4.35925e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 3.61093e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
```

```
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 3.61093e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.2152, R2 = 3.61093e-15
##
## DLSODA-  Above warning has been issued I1 times.
##      It will not be issued again for this problem.
## In above message, I1 = 10
##
## DLSODA-  At current T (=R1), MXSTEP (=I1) steps
##       taken on this call before reaching TOUT
## In above message, I1 = 5000
##
## In above message, R1 = 64.2152
##
```

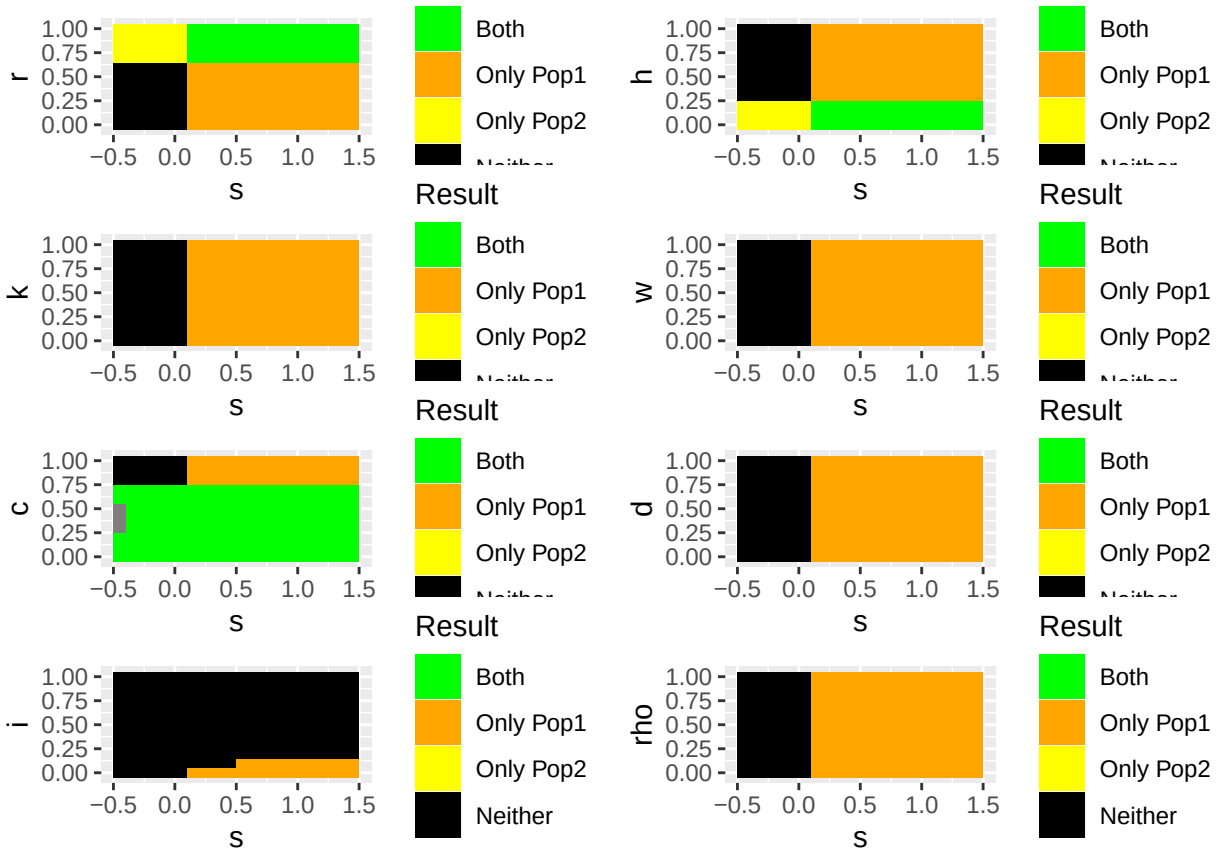


Figure 12: S parameter planes

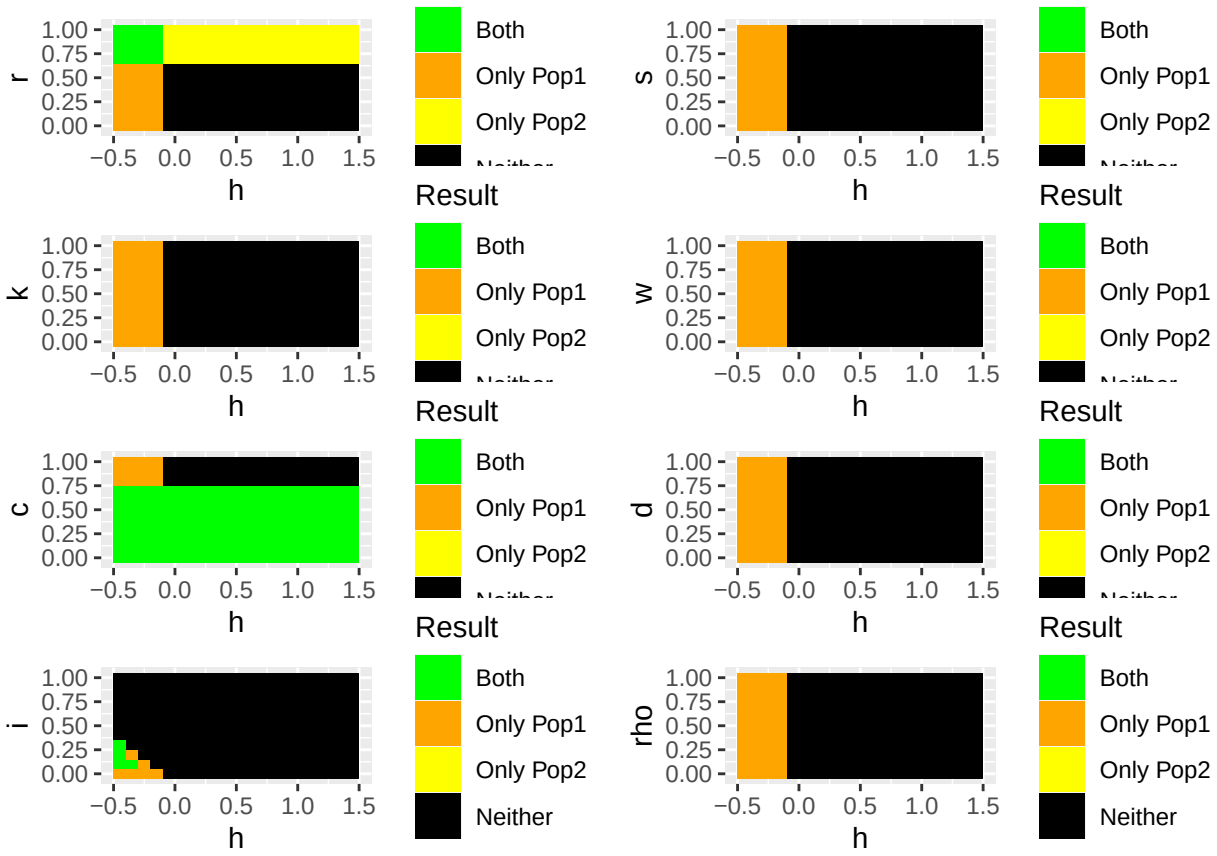


Figure 13: h parameter planes

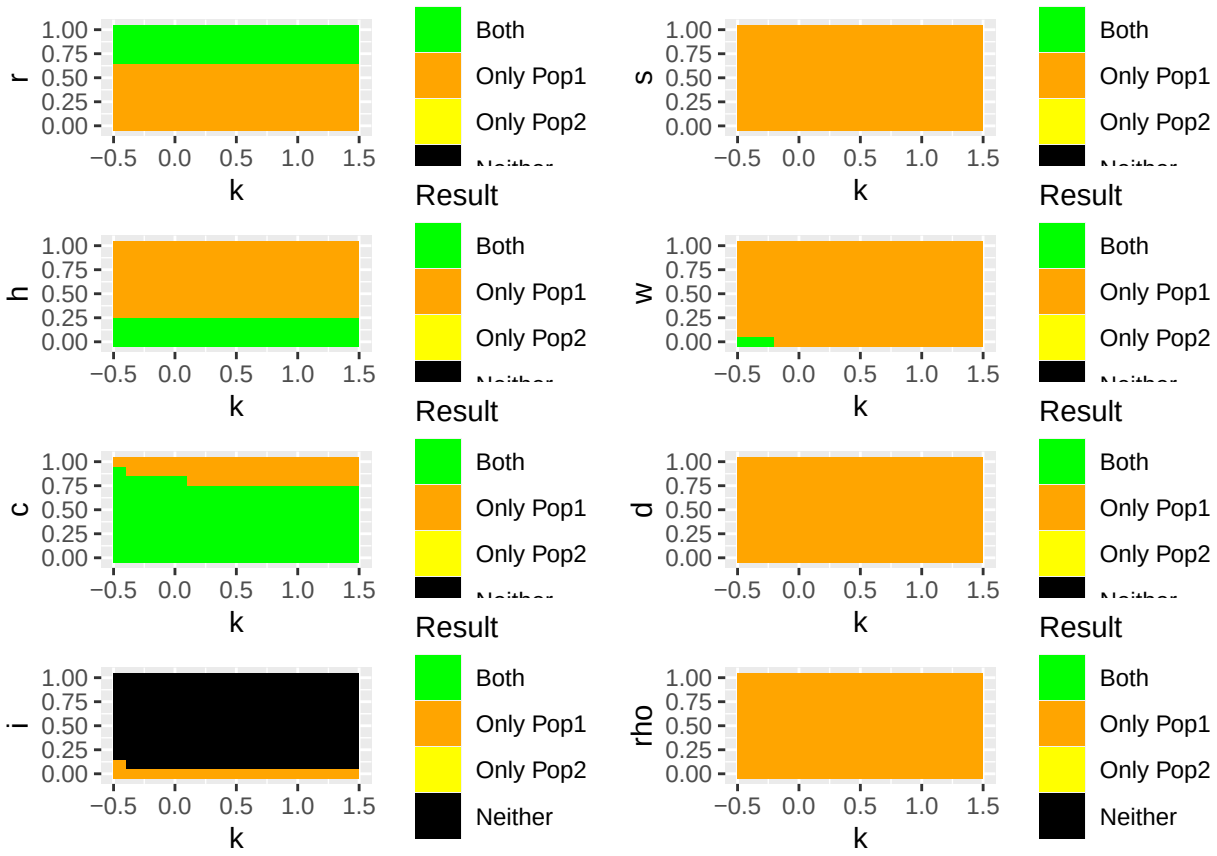


Figure 14: K parameter planes ranging from 0-1

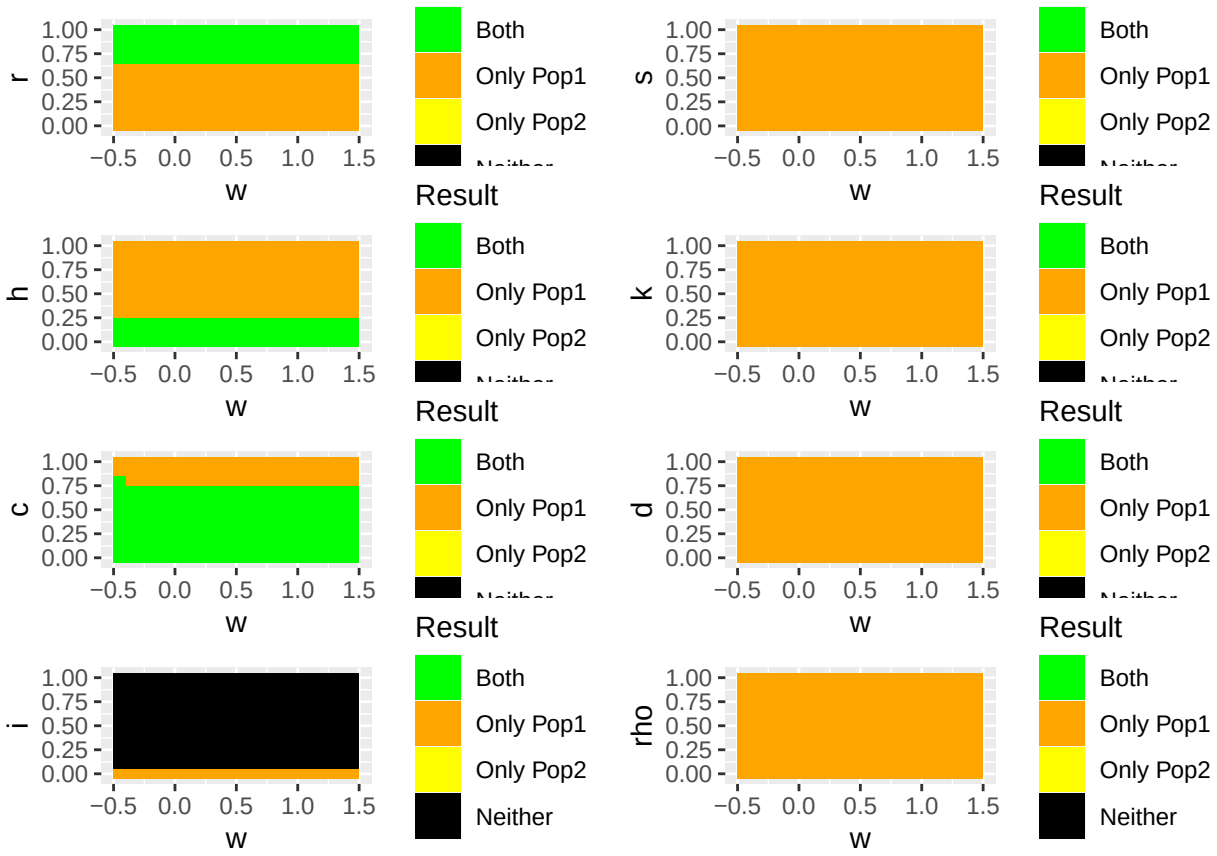


Figure 15: w parameter planes

```
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 6.11806e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 6.11806e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 5.06782e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 5.06782e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 5.06782e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 4.05121e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 4.05121e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 3.35577e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 3.35577e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 71.7292, R2 = 3.35577e-15
##
## DLSODA-  Above warning has been issued I1 times.
##      It will not be issued again for this problem.
## In above message, I1 = 10
##
```

```
## DLSODA-  At current T (=R1), MXSTEP (=I1) steps
##       taken on this call before reaching TOUT
## In above message, I1 = 5000
##
## In above message, R1 = 71.7292
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 78.6283, R2 = 6.4677e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 78.6283, R2 = 6.4677e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 78.6283, R2 = 5.35745e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 78.6283, R2 = 5.35745e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 78.6283, R2 = 5.35745e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 78.6283, R2 = 4.28274e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 78.6283, R2 = 4.28274e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 78.6283, R2 = 3.54755e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 78.6283, R2 = 3.54755e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
```

```
## In above message, R1 = 78.6283, R2 = 3.54755e-15
##
## DLSODA-  Above warning has been issued I1 times.
##      It will not be issued again for this problem.
## In above message, I1 = 10
##
## DLSODA-  At current T (=R1), MXSTEP (=I1) steps
##       taken on this call before reaching TOUT
## In above message, I1 = 5000
##
## In above message, R1 = 78.6283
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 6.61603e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 6.61603e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 5.48031e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 5.48031e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 5.48031e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 4.38096e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 4.38096e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 3.62891e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
```

```
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 3.62891e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 80.9687, R2 = 3.62891e-15
##
## DLSODA-  Above warning has been issued I1 times.
##      It will not be issued again for this problem.
## In above message, I1 = 10
##
## DLSODA-  At current T (=R1), MXSTEP (=I1) steps
##       taken on this call before reaching TOUT
## In above message, I1 = 5000
##
## In above message, R1 = 80.9687
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 6.21742e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 6.21742e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 5.15012e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 5.15012e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 5.15012e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 4.117e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 4.117e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
```

```
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 3.41027e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 3.41027e-15
##
## DLSODA-  Warning..Internal T (=R1) and H (=R2) are
##       such that in the machine, T + H = T on the next step
##      (H = step size). Solver will continue anyway.
## In above message, R1 = 64.1559, R2 = 3.41027e-15
##
## DLSODA-  Above warning has been issued I1 times.
##      It will not be issued again for this problem.
## In above message, I1 = 10
##
## DLSODA-  At current T (=R1), MXSTEP (=I1) steps
##       taken on this call before reaching TOUT
## In above message, I1 = 5000
##
## In above message, R1 = 64.1559
##
## DLSODA-  At T (=R1) and step size H (=R2), the
##       corrector convergence failed repeatedly
##       or with ABS(H) = HMIN
## In above message, R1 = 95.2146, R2 = 3.84827e-11
##
## DLSODA-  At T (=R1) and step size H (=R2), the
##       corrector convergence failed repeatedly
##       or with ABS(H) = HMIN
## In above message, R1 = 71.9943, R2 = 4.57494e-22
##
```

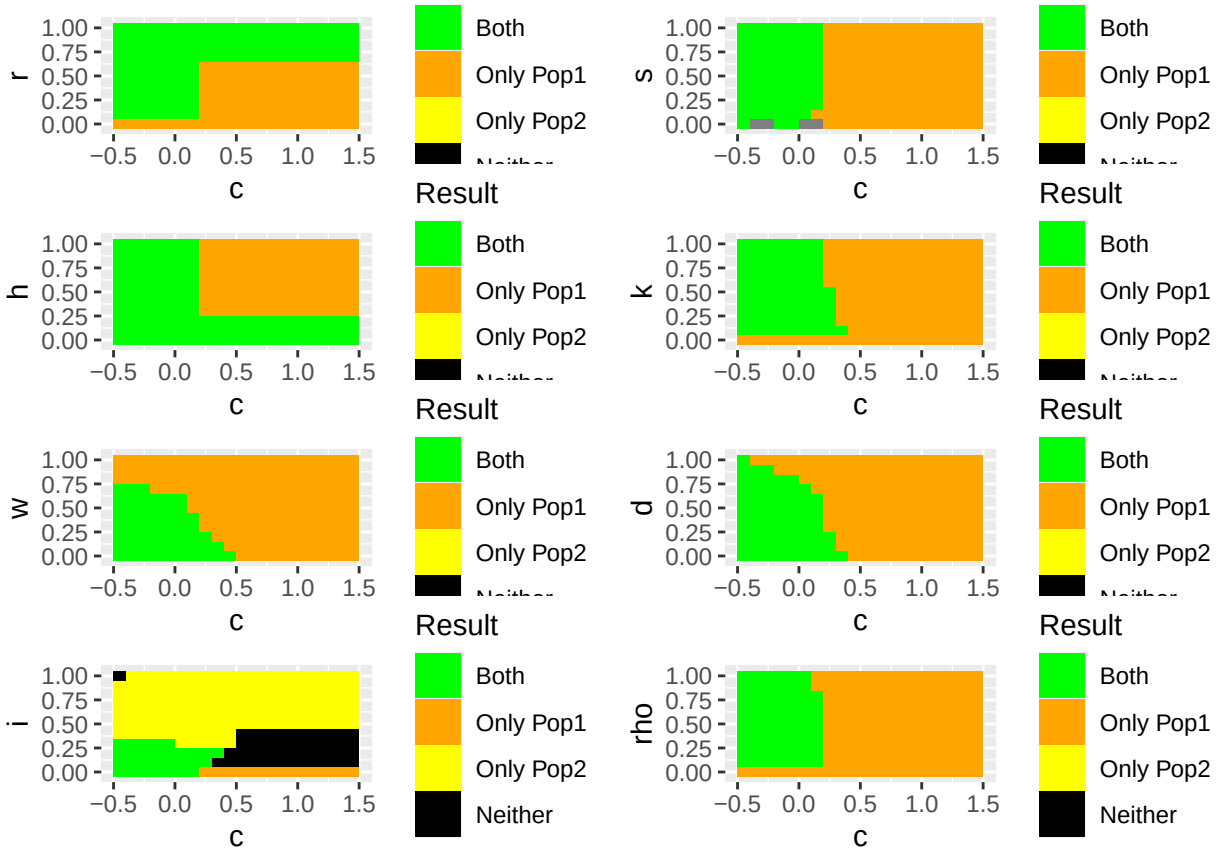


Figure 16: c parameter planes

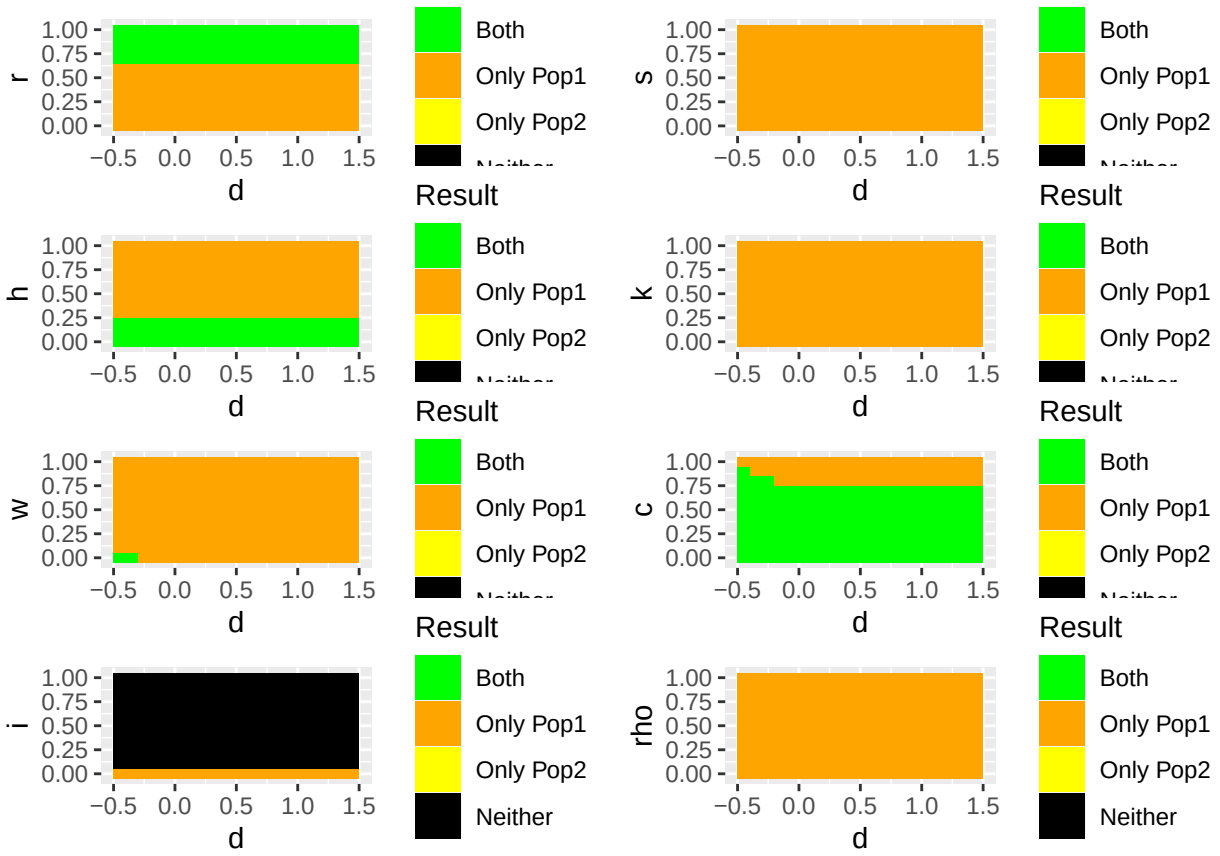


Figure 17: d parameter planes

```
## DLSODA-  At T (=R1) and step size H (=R2), the
##       corrector convergence failed repeatedly
##       or with ABS(H) = HMIN
## In above message, R1 = 74.026, R2 = 7.62939e-12
##
## DLSODA-  At T (=R1) and step size H (=R2), the
##       corrector convergence failed repeatedly
##       or with ABS(H) = HMIN
## In above message, R1 = 79.8868, R2 = 6.14385e-10
##
```

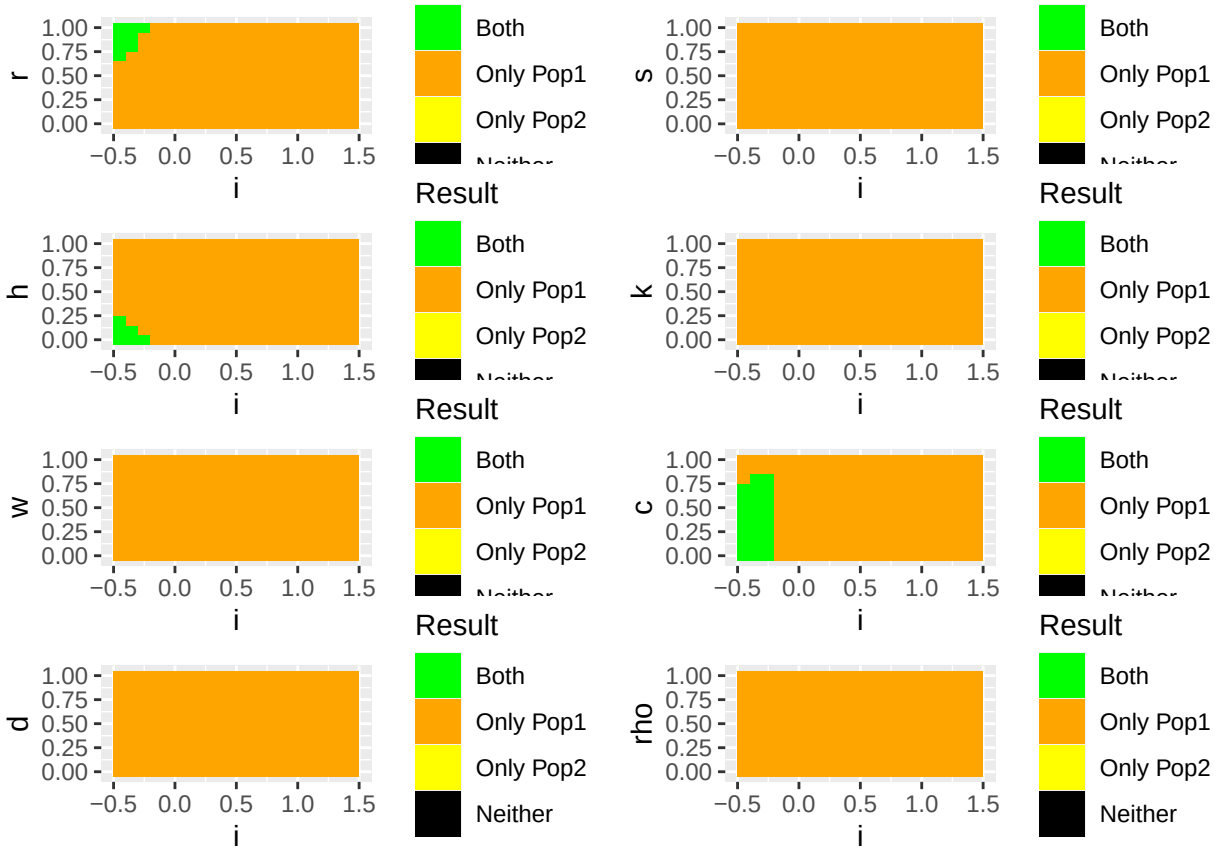


Figure 18: i parameter planes

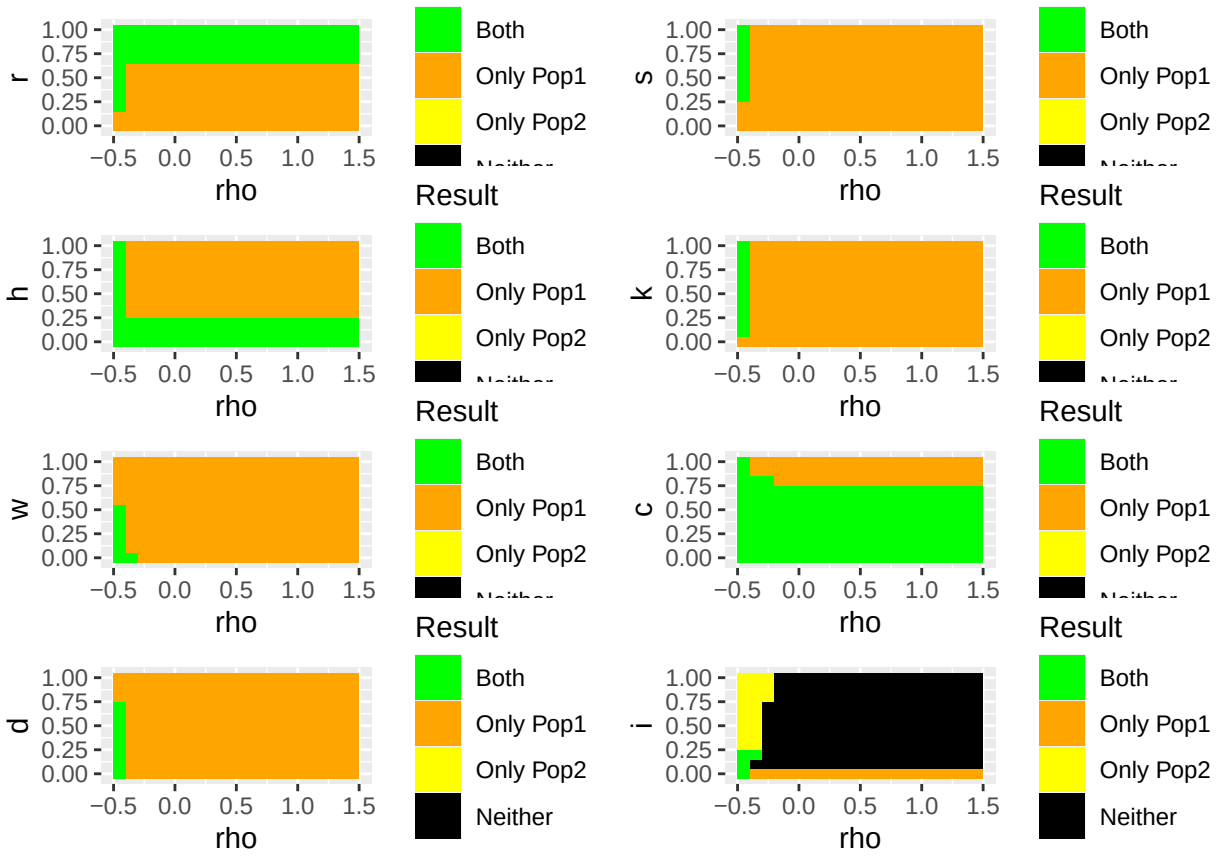


Figure 19: rho parameter planes

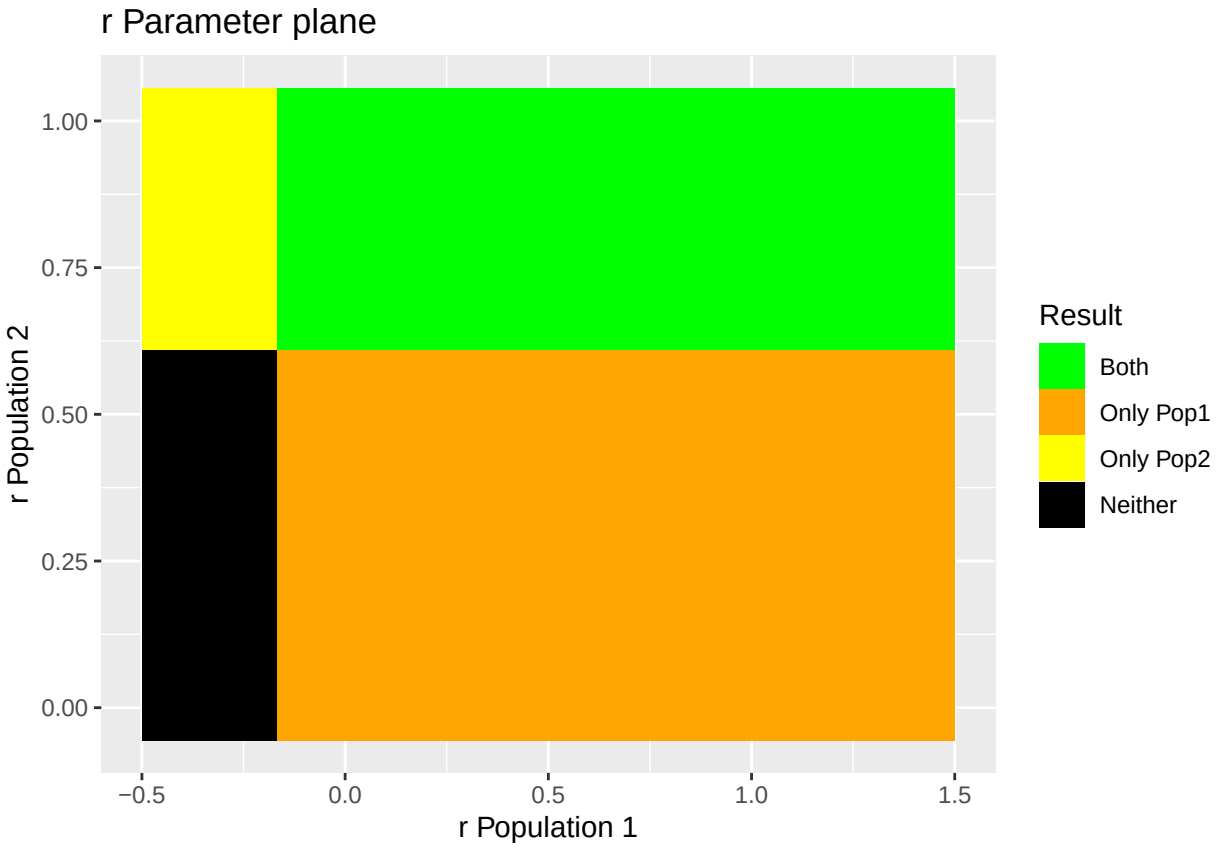


Figure 20: r population planes

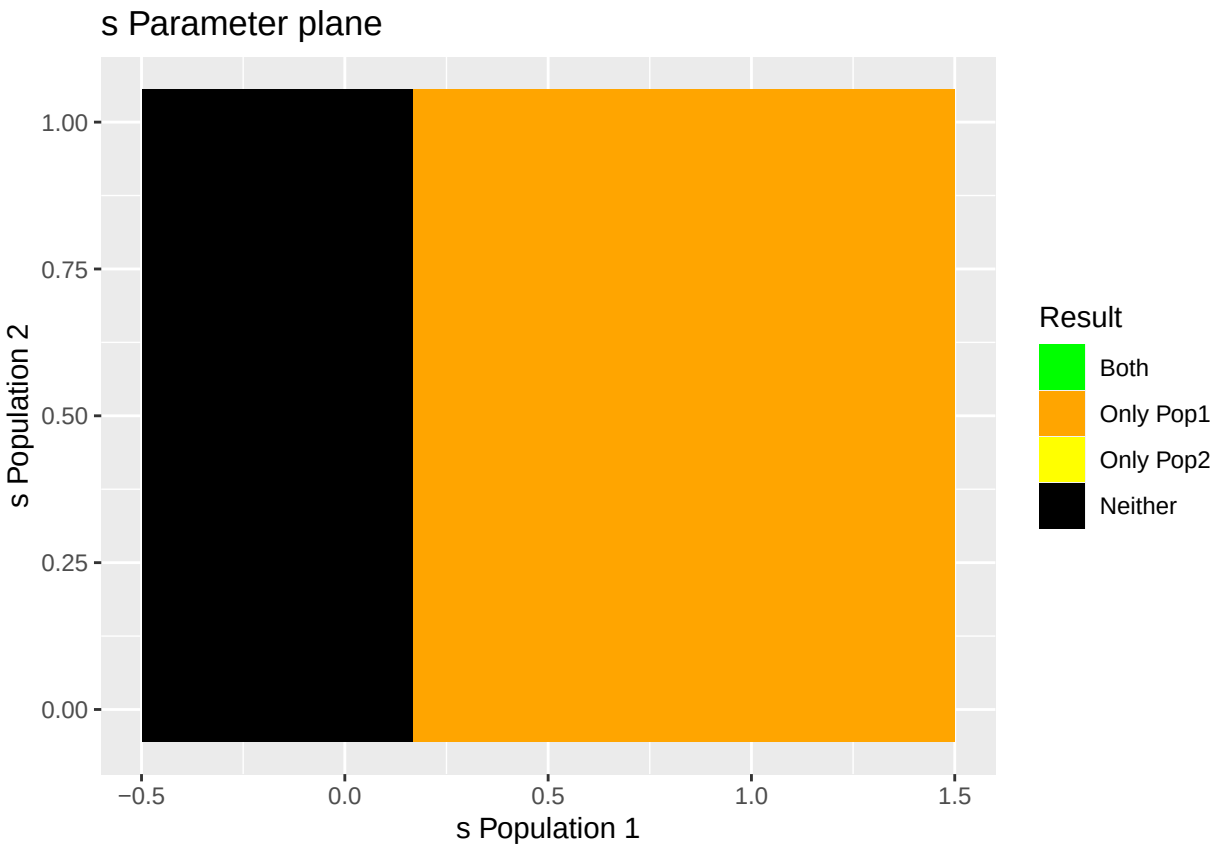


Figure 21: s population planes

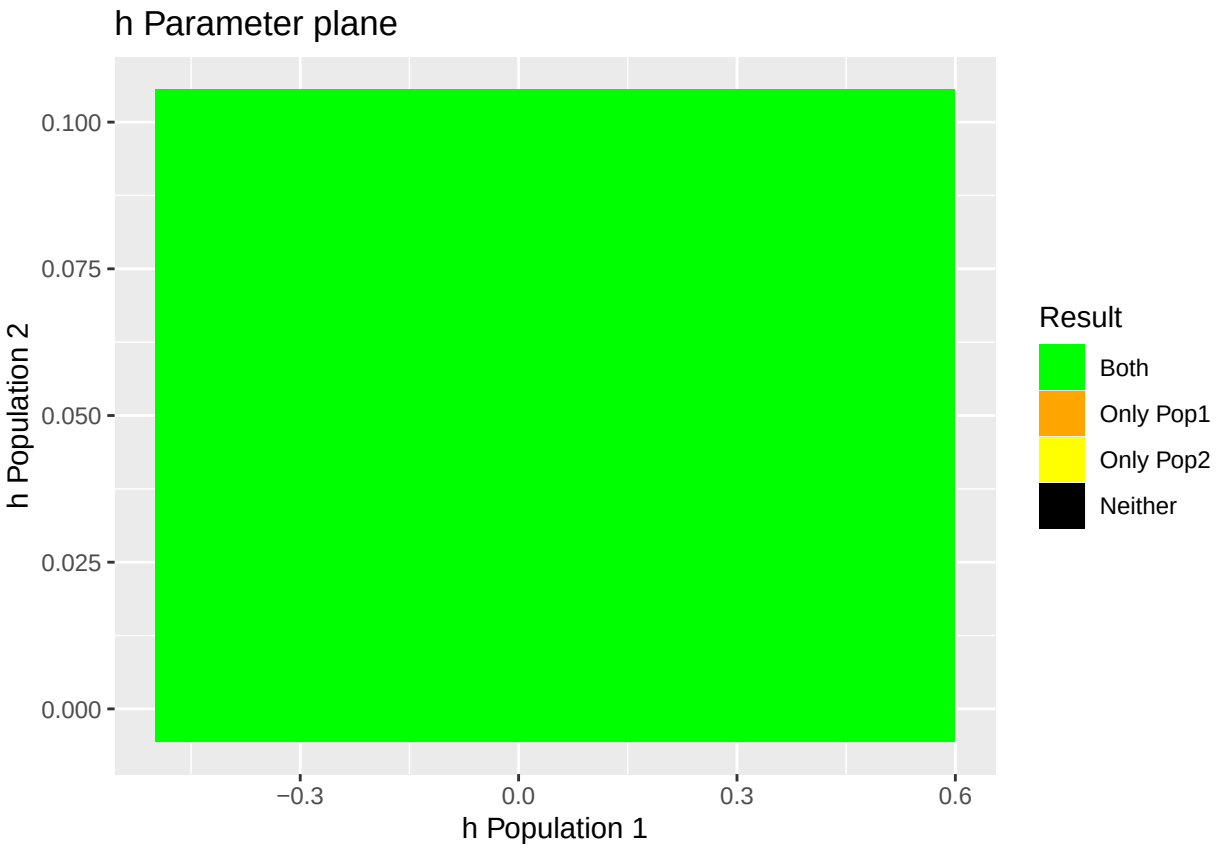


Figure 22: h population planes

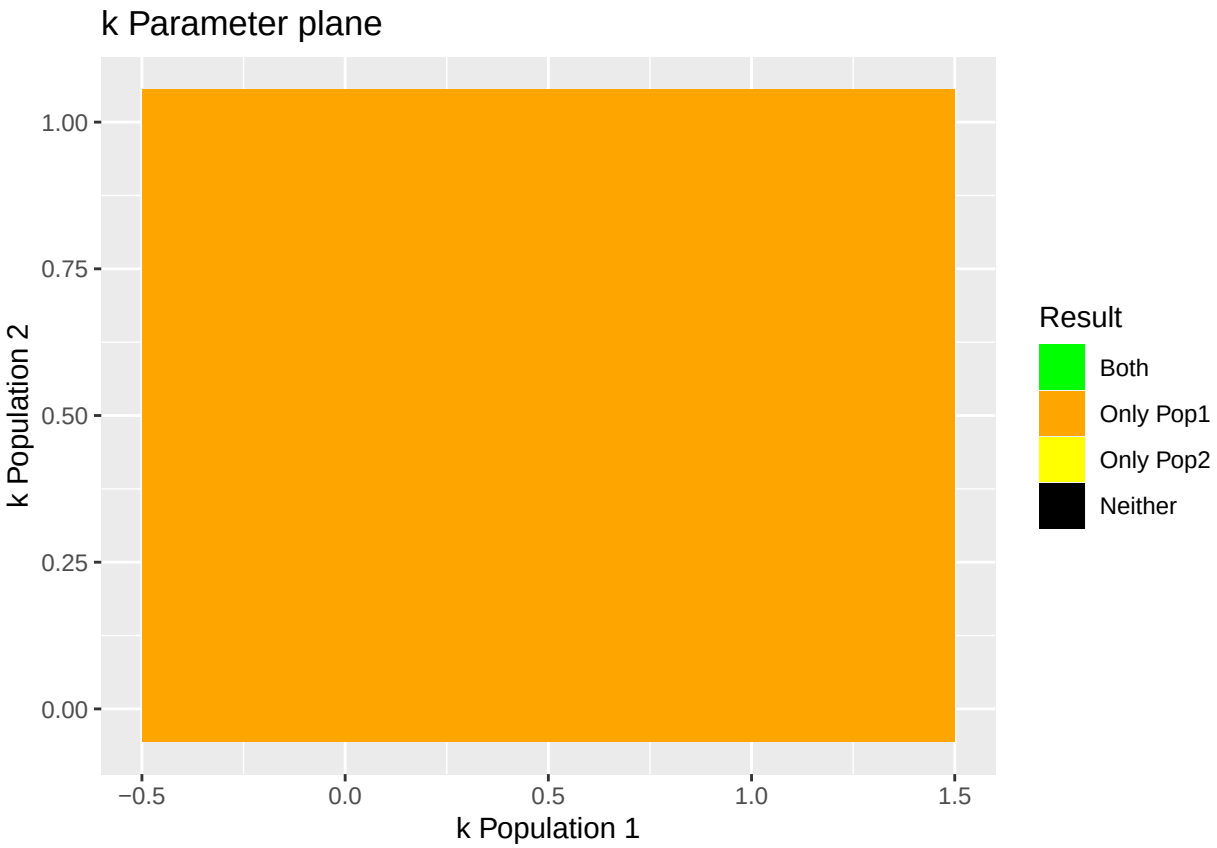


Figure 23: k population planes 0 to 1

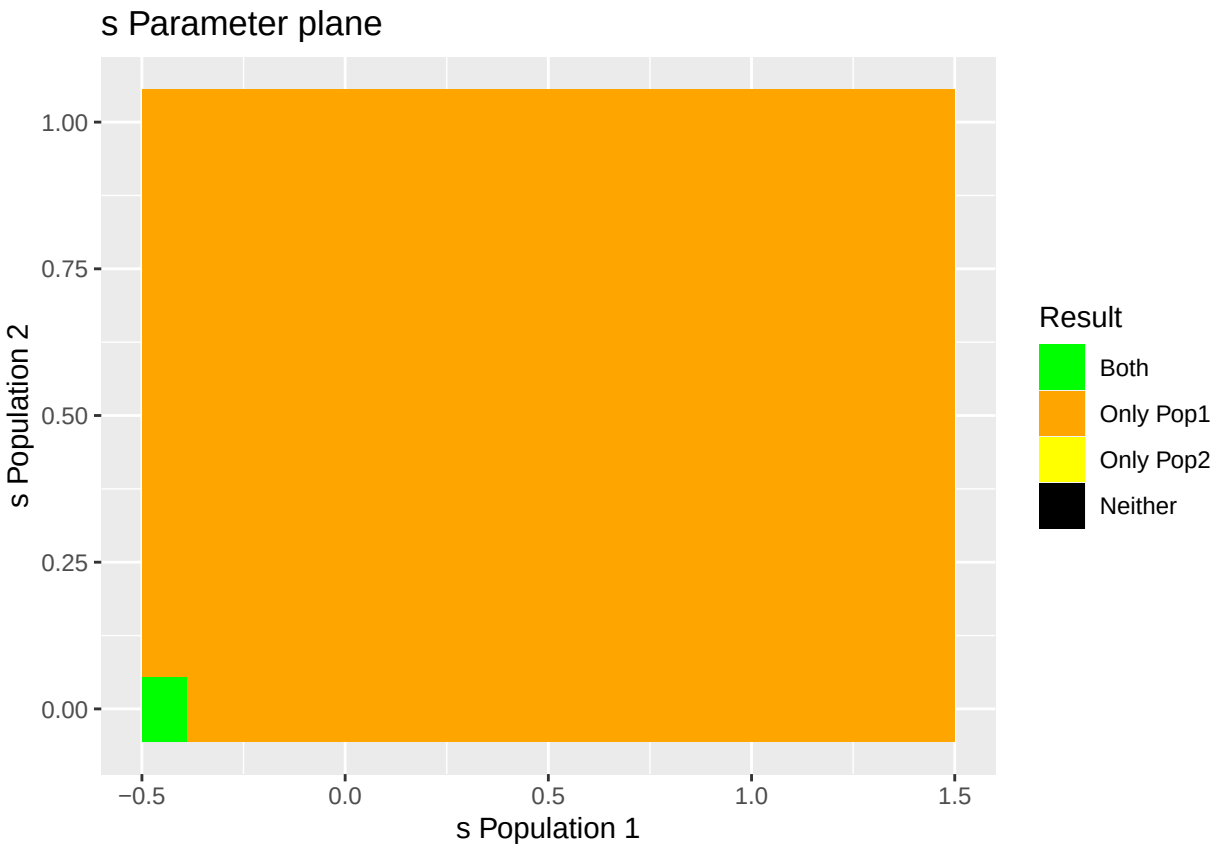


Figure 24: w population planes

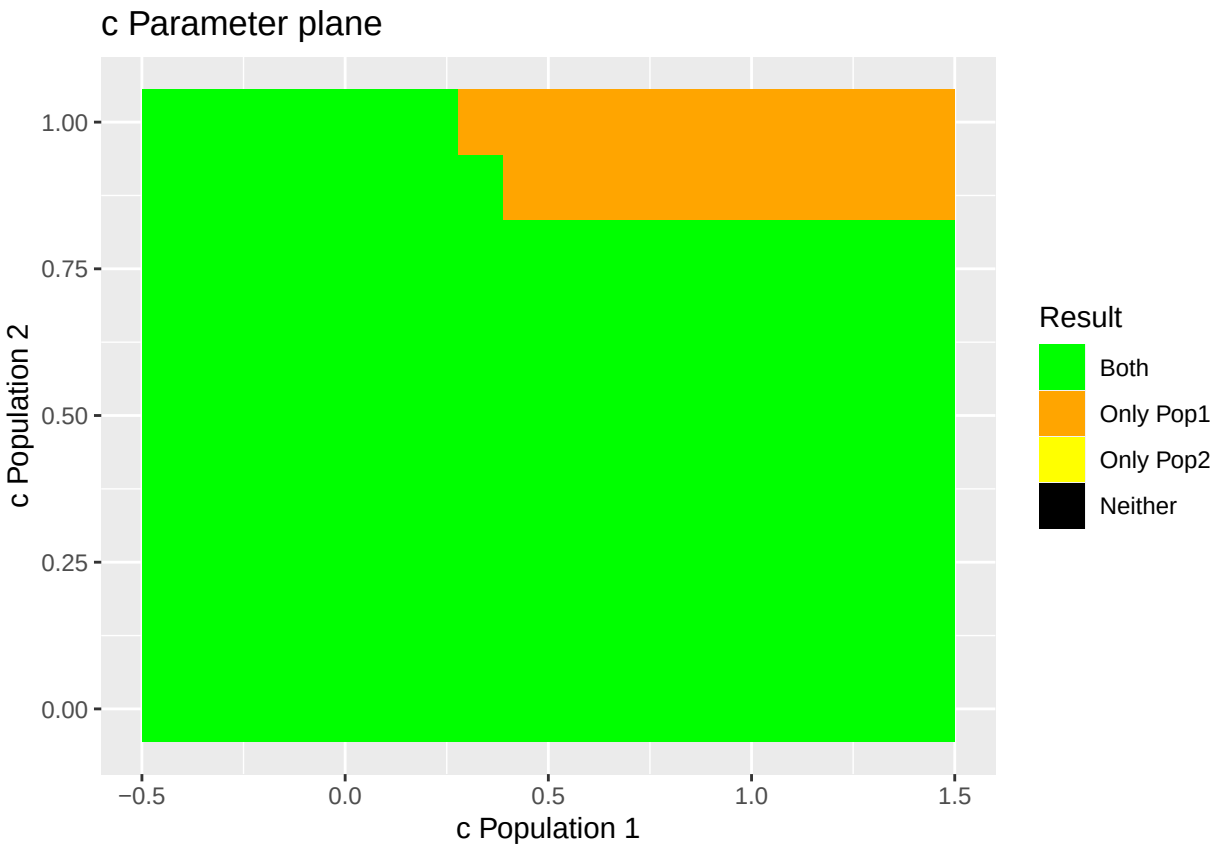


Figure 25: c population planes

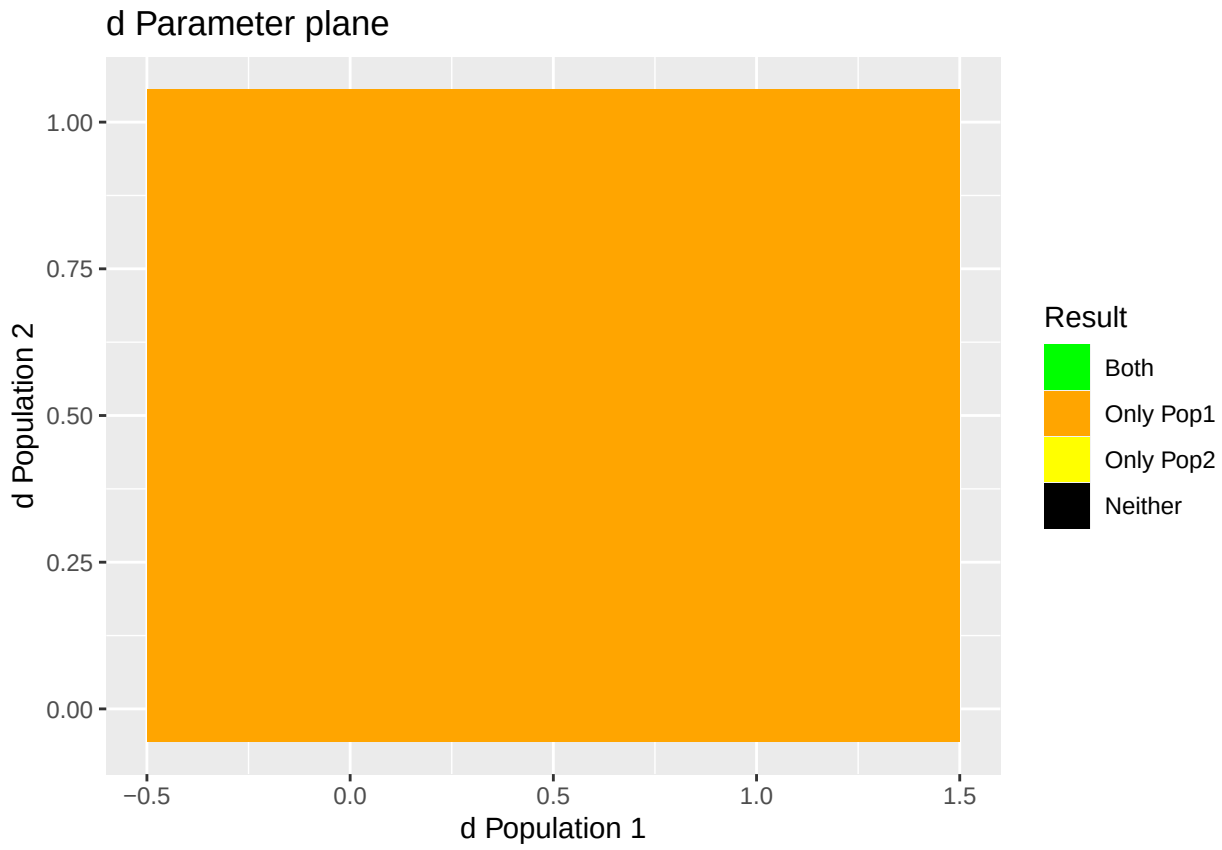


Figure 26: d population planes

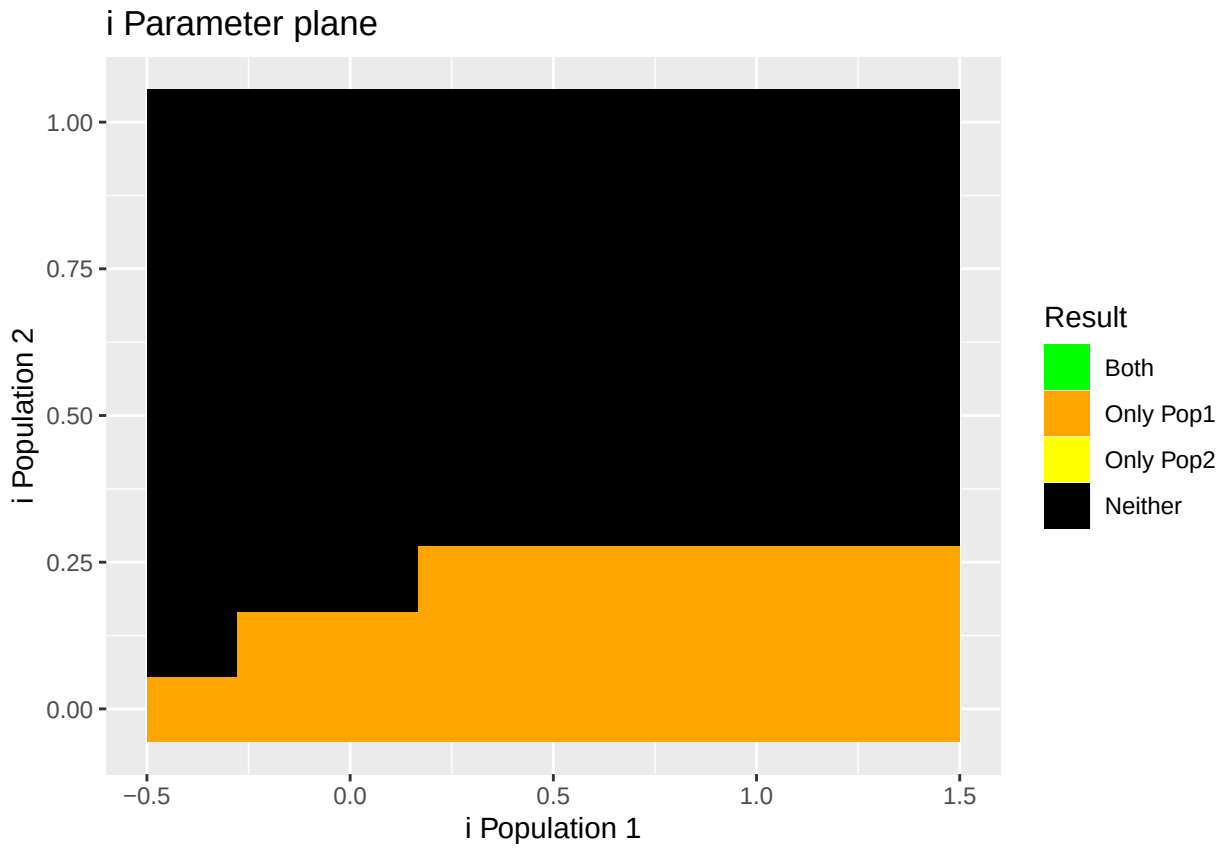


Figure 27: i population planes

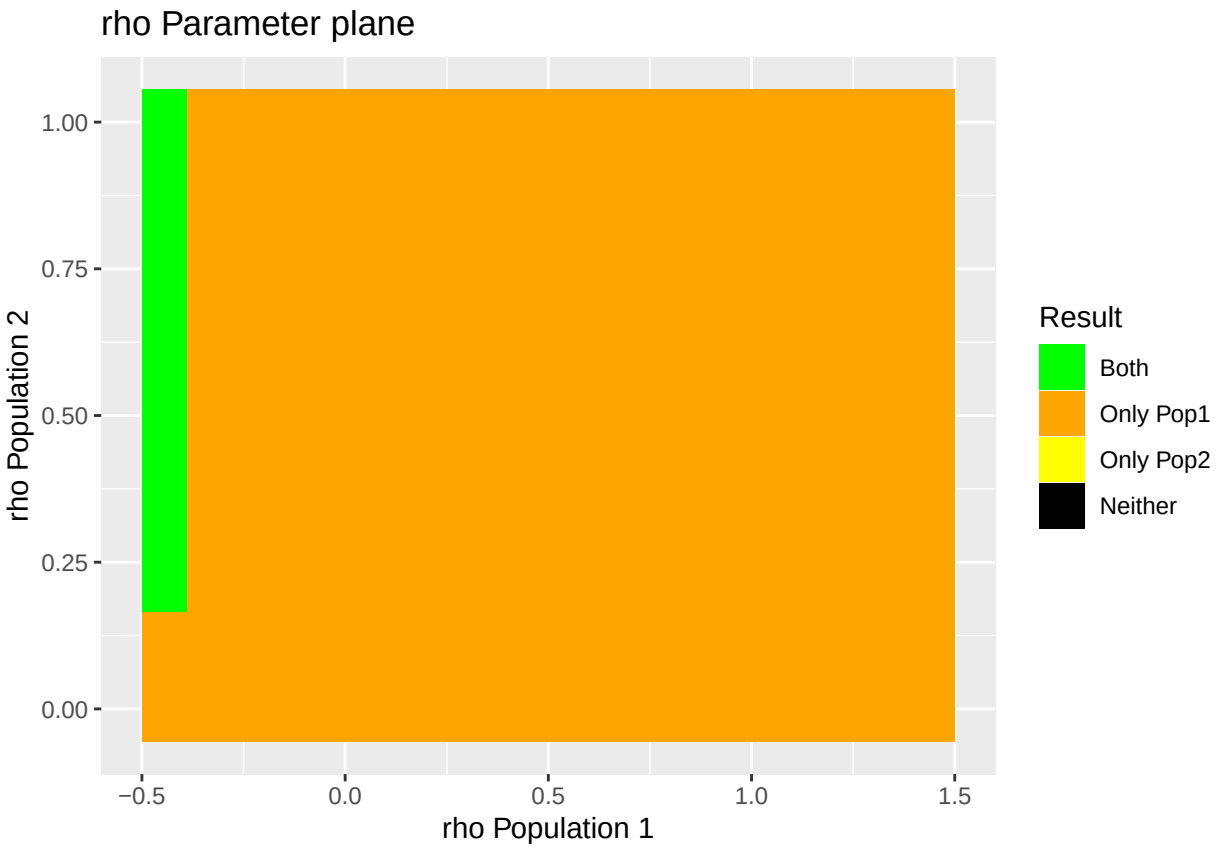


Figure 28: rho population planes