Parameter	Definition	Range to be explored
N:	maximum group size	20-30
G, L:	rate (per group) of resource gain or loss	$0 < \frac{G}{G+L} < 1$
K:	rate parameter for intergroup encounters	$0 < K < 100$
H:	probability of philopatry	$0 < H \leq 1$

Assumption	Definition	Possible alternative forms
$v(nc_n^s, n'c_{n'}^{s'}) = \frac{nc_n^s}{nc_n^s + n'c_{n'}^{s'}}$	Victory function	$\frac{(nc_n^s)^k}{(nc_n^s)^k + (n'c_{n'}^{s'})^k}$, $\frac{1}{2}(1 + \mathrm{Tanh}(k(nc_n^s - n'c_{n'}^{s'})))$
$\hat{p}_n^s = \begin{cases} P, & s = 0 \\ P + b, & s = 1 \end{cases}$	Fecundity function	$\hat{p}_n^s = \begin{cases} P(1 - \frac{n}{N}), & s = 0 \\ (P+b)(1 - \frac{n}{N}), & s = 1 \end{cases}$
$\hat{m}_n^s = Me^{-\frac{\hat{x}_n^s + (n-1)\bar{x}_n^s}{n}} + g_x {\hat{x}_n^s}^2 + g_y {\hat{y}_n^s}^2$	Mortality function	$Me^{-\frac{\hat{x}_n^s + (n-1)\bar{x}_n^s}{n} + g_x {\hat{x}_n^s}^2 + g_y {\hat{y}_n^s}^2}$, $M(1 + g_x {\hat{x}_n^s}^2 + g_y {\hat{y}_n^s}^2)/(1 + \frac{\hat{x}_n^s + (n-1)\bar{x}_n^s}{n})$

Demographic variables:

- f_n^s: fraction of groups that are of size n and in resource state s
- m_n^s: mortality rate of an individual in such a group
- p_n^s: rate of offspring production by an individual in such a group
- c_n^s: contribution to group competitive performance by an individual in such a group
- f_n^s: mean relatedness of two distinct individuals sampled randomly from such a group
- v_n^s: reproductive value of an individual in such a group

Strategic variables:

- x_n^s: in-group cooperative effort of an individual in a group of size n in state s
- y_n^s: out-group conflict effort of an individual in such a group

Key functional relationships assumed:

$$c_n^s = y_n^s$$

$$v(nc_n^s, n'c_{n'}^{s'}) = \frac{nc_n^s}{nc_n^s + n'c_{n'}^{s'}}$$

$$\hat{p}_n^s = \begin{cases} P, & s = 0 \\ P + b, & s = 1 \end{cases}$$

$$\hat{m}_n^s = Me^{-\frac{\hat{x}_n^s + (n-1)\bar{x}_n^s}{n}} + g_x \hat{x}_n^{s\,2} + g_y \hat{y}_n^{s\,2}$$

$$\begin{aligned}
\dot{f}_n^0 = {} & f_n^1 L - f_n^0 G && \text{resource loss or gain} \\
& + f_{n+1}^0 (n+1) m_{n+1}^0 - f_n^0 n m_n^0 && \text{death} \\
& + f_{n-1}^0 (n-1) H p_{n-1}^0 - f_n^0 n H p_n^0 && \text{local birth} \\
& + f_{n-1}^0 (1-H)\bar{p} - f_n^0 (1-H)\bar{p} && \text{immigration} \\
& + K f_n^1 \sum_{j=1}^{N} f_j^0 v(jc_j^0, nc_n^1) - K f_n^0 \sum_{j=0}^{N} f_j^1 v(nc_n^0, jc_j^1) && \text{resource capture}
\end{aligned}$$

$$\begin{aligned}
\dot{f}_n^1 = {} & f_n^0 G - f_n^1 L && \text{resource gain or loss} \\
& + f_{n+1}^1 (n+1) m_{n+1}^1 - f_n^1 n m_n^1 && \text{death} \\
& + f_{n-1}^1 (n-1) H p_{n-1}^1 - f_n^1 n H p_n^1 && \text{local birth} \\
& + f_{n-1}^1 (1-H)\bar{p} - f_n^1 (1-H)\bar{p} && \text{immigration} \\
& + K f_n^0 \sum_{j=0}^{N} f_j^1 v(nc_n^0, jc_j^1) - K f_n^1 \sum_{j=1}^{N} f_j^0 v(jc_j^0, nc_n^1) && \text{resource capture}
\end{aligned}$$

where $\bar{p}$, which denotes the mean rate of offspring production per patch, is given by

$$\bar{p} = \sum_{s=0}^{1} \sum_{n=1}^{N} f_n^s n p_n^s$$

(terms colored blue are omitted for the case $n = 0$, terms colored red for the case $n = N$)

$$
\begin{aligned}
\dot{r}_n^0 &= f_n^1 L(r_n^1 - r_n^0) && \text{resource loss} \\
&+ f_{n+1}^0 (n+1) m_{n+1}^0 (r_{n+1}^0 - r_n^0) && \text{death} \\
&+ f_{n-1}^0 (n-1) H p_{n-1}^0 \left(\left(\frac{2}{n(n-1)} + (1 - \frac{2}{n(n-1)}) r_{n-1}^0\right) - r_n^0\right) && \text{local birth} \\
&+ f_{n-1}^0 (1-H) \bar{p} \left(\left(\frac{n-2}{n} r_{n-1}^0\right) - r_n^0\right) && \text{immigration} \\
&+ K f_n^1 \sum_{j=1}^{N} f_j^0 v(jc_j^0, nc_n^1)(r_n^1 - r_n^0) && \text{resource capture}
\end{aligned}
$$

$$
\begin{aligned}
\dot{r}_n^1 &= f_n^0 G(r_n^0 - r_n^1) && \text{resource gain} \\
&+ f_{n+1}^1 (n+1) m_{n+1}^1 (r_{n+1}^1 - r_n^1) && \text{death} \\
&+ f_{n-1}^1 (n-1) H p_{n-1}^1 \left(\left(\frac{2}{n(n-1)} + (1 - \frac{2}{n(n-1)}) r_{n-1}^1\right) - r_n^1\right) && \text{local birth} \\
&+ f_{n-1}^1 (1-H) \bar{p} \left(\left(\frac{n-2}{n} r_{n-1}^1\right) - r_n^1\right) && \text{immigration} \\
&+ K f_n^0 \sum_{j=0}^{N} f_j^1 v(nc_n^0, jc_j^1)(r_n^0 - r_n^1) && \text{resource capture}
\end{aligned}
$$

$$
\begin{aligned}
0 &= G(v_n^1 - v_n^0) && \text{resource gain} \\
&+ m_n^0 (0 - v_n^0) && \text{death of focal} \\
&+ (n-1) m_n^0 (v_{n-1}^0 - v_n^0) && \text{death of neighbour} \\
&+ H p_n^0 (2 v_{n+1}^0 - v_n^0) && \text{local birth to focal} \\
&+ H (n-1) p_n^0 (v_{n+1}^0 - v_n^0) && \text{local birth to neighbour} \\
&+ (1-H) \bar{p} (v_{n+1}^0 - v_n^0) && \text{immigration} \\
&+ H p_n^0 \left(v_n^0 + \sum_{s=0}^{1} \sum_{j=0}^{N-1} f_j^s v_{j+1}^s - v_n^0\right) && \text{distant birth to focal} \\
&+ K \sum_{j=0}^{N} f_j^1 v(nc_n^0, jc_j^1)(v_n^1 - v_n^0) && \text{resource capture}
\end{aligned}
$$

$$
\begin{aligned}
0 &= L(v_n^0 - v_n^1) && \text{resource loss} \\
&+ m_n^1(0 - v_n^1) && \text{death of focal} \\
&+ (n-1)m_n^1(v_{n-1}^1 - v_n^1) && \text{death of neighbour} \\
&+ Hp_n^1(2v_{n+1}^1 - v_n^1) && \text{local birth to focal} \\
&+ H(n-1)p_n^1(v_{n+1}^1 - v_n^1) && \text{local birth to neighbour} \\
&+ (1-H)\bar{p}(v_{n+1}^1 - v_n^1) && \text{immigration} \\
&+ Hp_n^1(v_n^1 + \sum_{s=0}^{1}\sum_{j=0}^{N-1} f_j^s v_{j+1}^s - v_n^1) && \text{distant birth to focal} \\
&+ K\sum_{j=1}^{N} f_j^0 v(jc_j^0, nc_n^1)(v_n^0 - v_n^1) && \text{resource capture}
\end{aligned}
$$