Assignment 2

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Intraguild Predation

Assumptions of Intraguild Predation (IGP) between two species and one resource:

1. Species N_1 and N_2 engage in explicit exploitative competition for resource R
2. N_2 consumes N_1
3. N_1 consumes resource R according to the function $f_1(R)$
4. N_2 consumes resource R according to the function $f_2(R)$
5. N_1 is consumed by N_2 according to the function $y(N_1)$
6. N_2 consumes N_1 according to the function $g(y(N_1))$

Implicit System of Equations

$$\frac{dN_1}{dt} = N_1 f_1(R) - N_1 N_2 y(N_1)$$

$$\frac{dN_2}{dt} = N_2 f_2(R) - N_2 g(y(N_1))$$

At Equilibrium

$$\frac{dN_1}{dt} = 0 = N_1 f_1(R_1^*) - N_1 N_2 y(N_1)$$

$$R_1^* = f_1^{-1}(N_2 y(N_1))$$

$$\frac{dN_2}{dt} = 0 = N_2 f_2(R_2^*) - N_2 g(y(N_1))$$

$$R_2^* = f_2^{-1}(g(y(N_1)))$$

$$\hat{N}_1 > 0 \text{ and } \hat{N}_2 > 0 \text{ and } \hat{R} > 0$$

At Coexistence with IGP

$$R_2^* - R_1^* = f_2^{-1}(g(y(N_1))) - f_1^{-1}(N_2 y(N_1))$$

At Coexistence without IGP

$$R_1^* = R_2^*$$

$$f_1^{-1}(0) = f_2^{-1}(0)$$

$$f_1() = f_2()$$

IGP is likely to reduce coexistence unless the difference between the predatory effect is exactly equal to that of the minimum resource levels (R_i^*) that each species needs to maintain a greater than or equal to zero growth. In this scenario, species N_2 could have a theoretically higher R^* value than the N_1 species which would promote a decline in N_2 population until N_1 dominates. This system could be balanced to N_1 and N_2 coexistence if N_2 preyed on N_1 at a functional level equal to that of the R^* difference. This hypothesis is theoretical as we have not simulated these scenarios.

Due to the precarious relationship between two species consuming a single resource and experiencing IGP it is unlikely that the two species will coexist unless, numerically, the delta of the R^* values is exactly equal the delta of the predatory impact. One interesting note in this model that supports our hypothesis is that if the R^* values are equal, then the delta between them is zero. If this is true then the species can coexist with IGP if the predatory influence delta is also zero. This is reflected in the coexistence equations without IGP.

Explicit System of Equations

$$\frac{dN_1}{dt} = a_1 N_1 R - m_1 N_1 - b N_1$$

$$\frac{dN_2}{dt} = a_2 N_2 R - m_2 N_2 + c b N_1$$

$$\frac{dR}{dt} = R(r - \delta) - \frac{a_1}{Y_1} N_1 R - \frac{a_2}{Y_2} N_2 R$$

At Equilibrium

$$\frac{dN_1}{dt} = 0 = a_1 N_1 R_1^* - m_1 N_1 - bN_1 N_2$$

$$R_1^* = \frac{m_1 + bN_2}{a_1}$$

$$\frac{dN_2}{dt} = 0 = a_2 N_2 R_2^* - m_2 N_2 + cbN_1 N_2$$

$$R_2^* = \frac{m_2 - cbN_1}{a_2}$$

$$\hat{N}_1 > 0 \text{ and } \hat{N}_2 > 0 \text{ and } \hat{R} > 0$$

At Coexistence with IGP

$$R_2^* - R_1^* = \frac{m_2 - cbN_1}{a_2} - \frac{m_1 + bN_2}{a_1}$$

At Coexistence without IGP

$$R_1^* = R_2^*$$

$$\frac{m_1}{a_1} = \frac{m_2}{a_2}$$

The hypothesis as stated above is still supported even with explicit equations. Coexistence with IGP can only be supported if the difference in the R^* values is made up for by the predatory impact of IGP. Without IGP, coexistence can only occur when the R^* values are exactly equal.

Note: The remainder of the derviations were harder for me to follow and I do not think I have shown my work effectively.