Chemical Espionage

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White Cabbage butterfly (Pieris brassicae) VS Parasitic Wasps

Problem

Two competing pressures

- Butterfly side
- Wasps side

Our Solution

Building a model that shows the relationship between both these interactions.

Variables for our Model

N_B ~ Butterfly population at time t
N_W ~ Wasps population at time t
t ~ Time
r_B ~ Growth rate of butterfly population
r_W ~ Growth rate of wasp population
b_B ~ Birthrate of the butterfly (number of eggs that the butterfly can lay per period)
d_B ~ Mortality rate of the butterfly (percentage of the old population will die, range)
b_W ~ Birthrate of the wasp (number of eggs that the wasp can lay per period)
d_W ~ Mortality rate of the wasp (percentage of the old population will die, range)
p ~ The probability that the wasps can successfully find the butterfly's eggs, $(0 \leq p \leq 1)$

Our Assumptions

Our Model

$$N_B(t) = N_{B0} \cdot e^{r_B t} \text{ with } r_B = b_B(1 - p) - d_B$$

$$N_W(t) = N_{W0} \cdot e^{r_W t} \text{ with } r_W = p b_W - d_W$$

Notice that $p = f(N_B, N_W)$

Analysis

Model for the growth rate of Butterfly Population and Wasps Population

$$r_B = b_B(1 - p) - d_B$$

$$r_W = pb_W - d_W$$

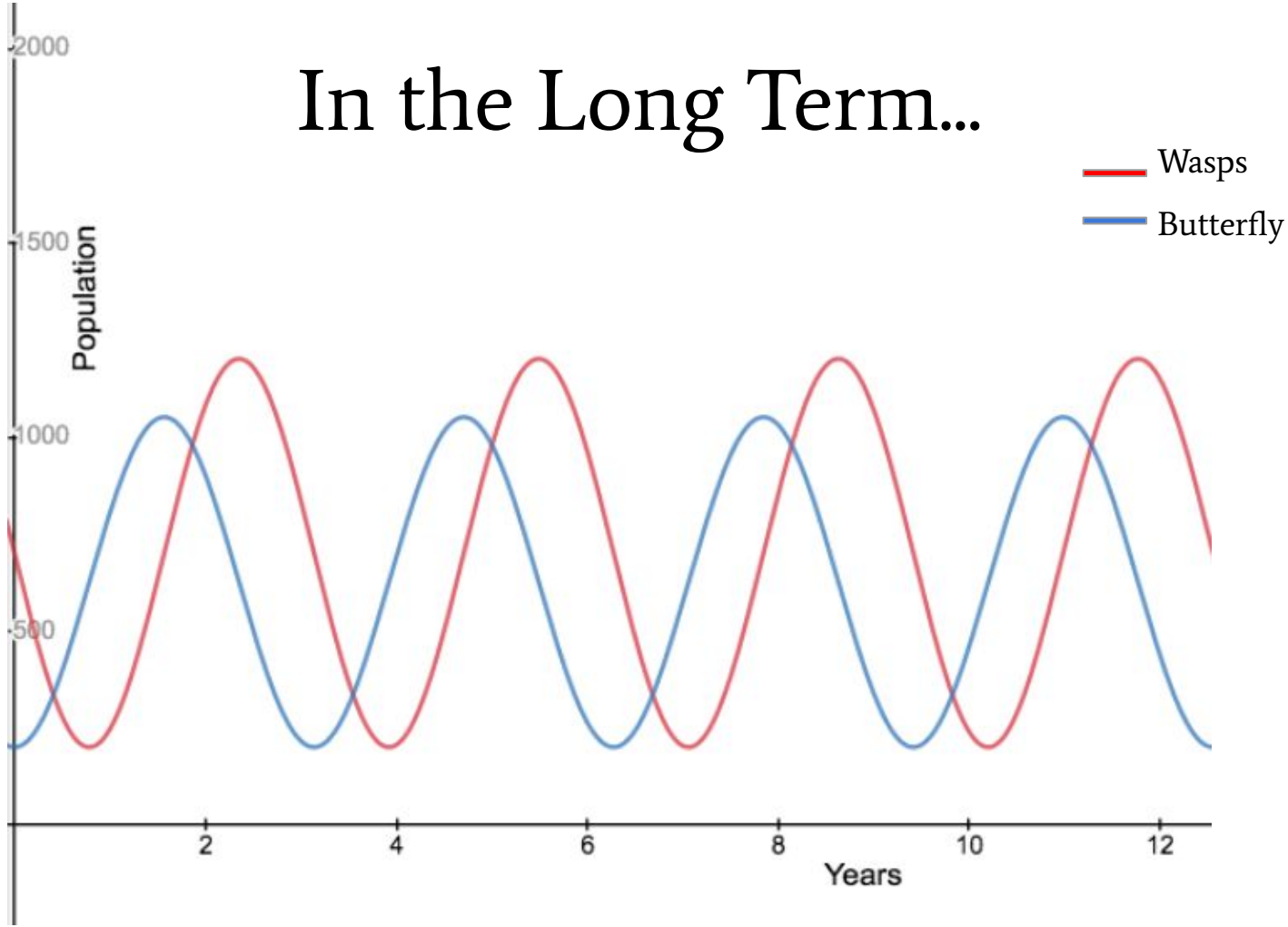
Relationship between P and the growth rate and the population

$$\frac{\partial r_w}{\partial p} > 0 \text{ and } \frac{\partial r_b}{\partial p} < 0$$

$$p = f(N_B, N_W)$$

$$\frac{\partial p}{\partial N_b} > 0 \text{ and } \frac{\partial p}{\partial N_w} > 0$$

In the Long Term...



Bird, the Predator of Both the Butterflies and the Wasps