Chemical Espionage (Problem C)

Team: Josh Marrs

Reagan McClellan

Jesus Hernandez

Coach: Kambiz Shahroudi

Chemical Espionage on species-specific butterfly anti-aphrodisiacs by hitchhiking Trichogramma wasps

Objective

- Determine the trade-offs and balance between the two competing interests
- Find a balance of pheromones that keeps the butterfly population in equilibrium
- Find a differential equation that measures the change in population of the butterflies over time
- Find the best balance for this system and what is likely to happen in the long run

Parameters and Variables

- $\frac{dE}{dt}$ $Change\ of\ butterfly\ eggs\ over\ time$
- E $Number\ of\ butterfly\ eggs$
- F $Number\ of\ female\ butterflies$
- S_1, S_2 Success rate of wasp parasitism
- W_{i1}, W_{i2} Wasp interest rates
- $\frac{dW_1}{dt}, \frac{dW_2}{dt}$ Change of wasp eggs over time
- B Number of adult wasps
- P Number of wasp eggs laid per interaction
- r Ratio of butterfly eggs over total eggs
- W_1 Total wasp population of type 1 wasp
- W_2 Total wasp population of type 2 wasp
- $\frac{dR}{dt}$ Rate of pheromone decay

Equations

Butterfly Eggs:

$$\frac{dE}{dt} = F(ME_{ave}) - DE - AE - W_{i1}W_1W_{r1}S_1 - W_{i2}W_2W_rS_2$$

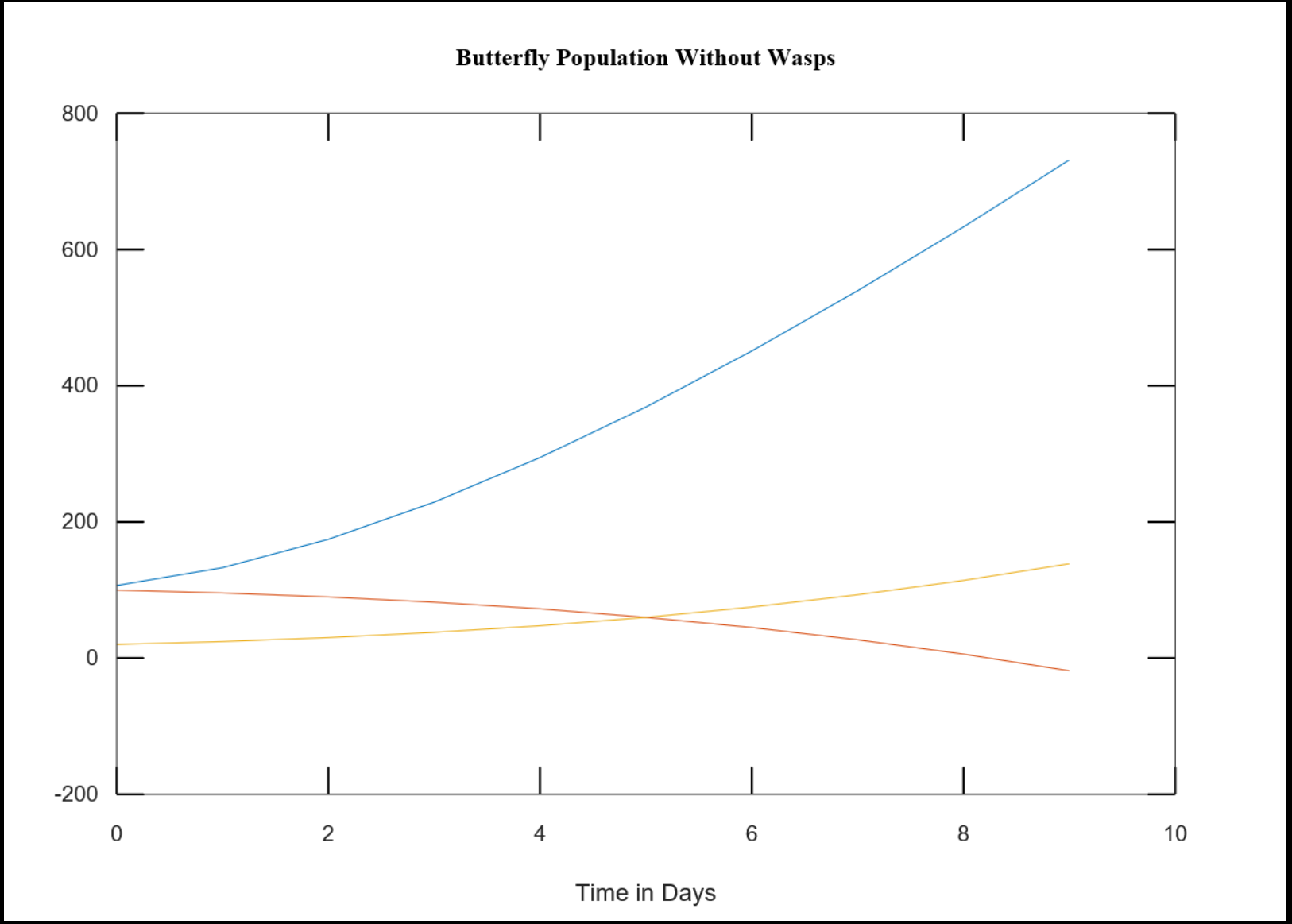
Wasp Eggs:

$$\frac{dW_1}{dt} = SBE_wrPW_{i1}W_{r1} - \frac{1}{2}W_1, \qquad \frac{dW_2}{dt} = SBE_wrPW_{i2}W_{r2} - \frac{1}{2}W_2$$

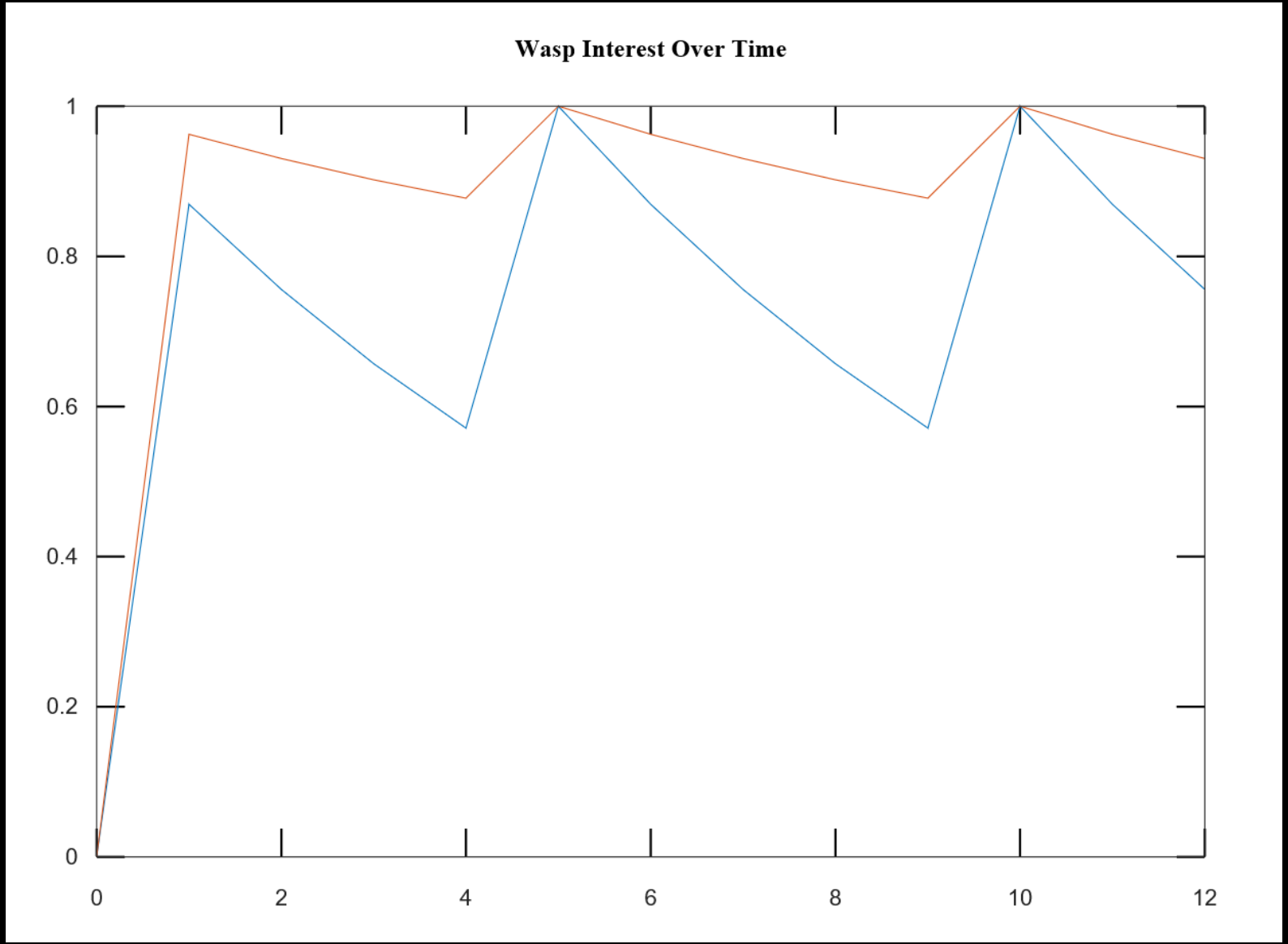
Pheromone Rate:

$$\frac{dR}{dt} = kR$$

Butterfly Population without Wasps



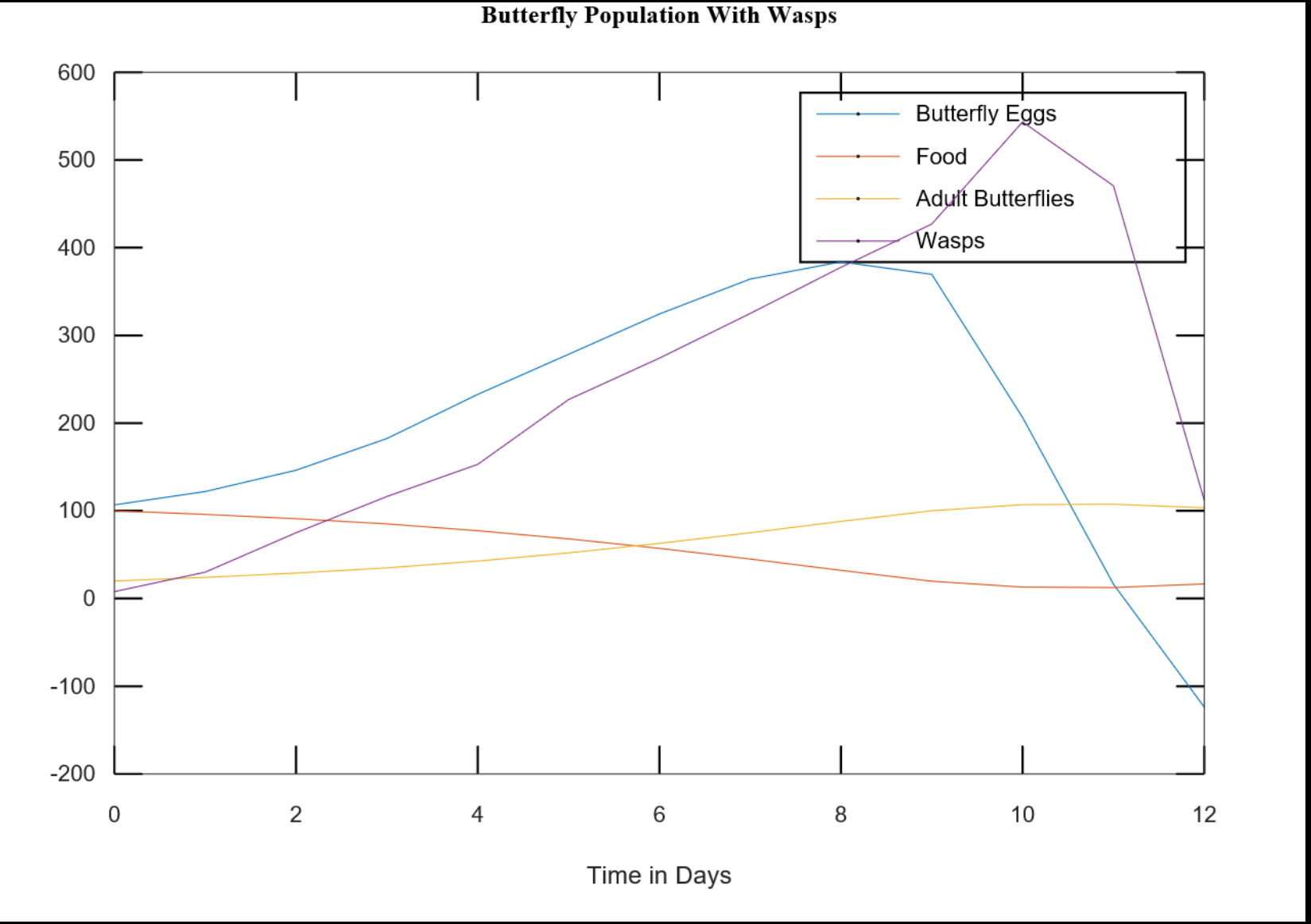
Wasp Interest over Time



Conclusion I

- Wasps overtook the butterflies
- Both populations fell to zero

Butterfly Population with Wasps



Problem C: Challenge Problem 3

- How would your model change if the effectiveness of the anti-aphrodisiac depends on the time of the day?

Conclusion II

- $\frac{dA}{dt} = mint(\frac{tmod(a,n)(max-min)}{24}$
- n$(\frac{a}{n} - q) = mod$
- q=trunc(a,n)=$(\frac{a}{n} - (\frac{|(a-n)|}{n})$