Executive Summary: Problem C

Chemical Espionage

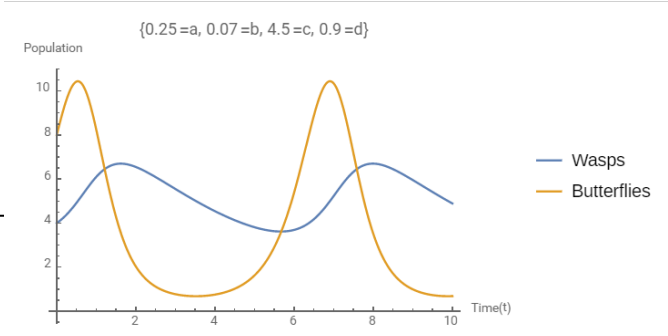
CDT Luke Masisak , CDT Daniel Macune, CDT Huram-Abi Nzia Yotchoum
United States Military Academy at West Point
09 November 2019

Situation/Introductrion

Wasps act as a parasite to the butterfly population, intercepting egg-producing female butterflies to grow their larvae. The wasps are preventing the growth of the butterfly population. The wasp's survival is dependent on the increasing population of butterflies. Also, the wasps act as an agent that prevents the population of butterflies from overpopulating. We will use a system of differential that makes up a predator/prey model to accurate illustrated how the wasp population would adjust as the butterfly population changes and vice versa. On the other hand, we will also evaluate the logistics growth model as a representation of the butterfly's (Male and Female) population grow without interference from the wasps.

We predict that, given our Predator-Prey model, when more butterflies are in the ecosystem, there will be more encounters and more opportunities to spread the wasps' larvae; therefore, the wasp's population will grow and vice -versa. On the contrary, if the butterfly population is modeled as a logistic growth differential equation, the model will reach the maximum population of the butterflies in an ecosystem, which is unrealistic in a real-world scenario where there are preys. Males and females' butterflies may depend on each other, but the population as a whole could be modeled together because they both are a contributing factor to the increase of their overall population

$$\frac{dx}{dt} = -ax + bxy \ , \frac{dy}{dt} = cy - dyx$$

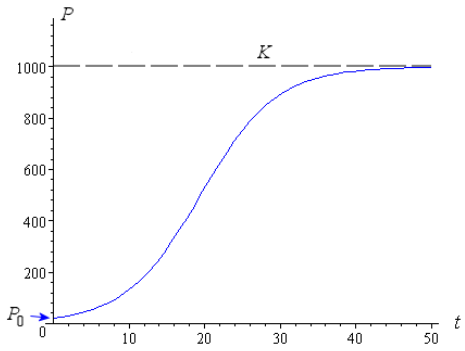


(1) Predator Pray Model
- x. Population of butterflies
  - a) Butterfly Population rate
  - b) The effect of wasps on butterfiles
- y. Population of Wasps
  - c) Wasps population Rate
  - d) The effect that butterflies have on wasps

$$\frac{dP}{dt} = rP(1 - \frac{P}{K})$$

1) Logistics Growth Model

a. r is the population growth rate
b. P is the population
c. K is the carrying capacity



Anlysis and Conlusion

Overall , According to the Predator Pray Model ,the wasp population—is affected by the population size of the butterflies, where the wasps act as predator to the butterfly population. As the butterfly population shrinks, the wasps can only increase so far until there is a point when there are not enough butterfly eggs to intercept with larvae. In addition, we could also say that the butterfly population—depends on the negative correlation to the wasp population, where butterflies will grow, when the wasps population decreases.On the other hand, Logistics growth model show shows that the butterflies will reach their carrying capacity, which is unsustainable and unrealistic in an ecosystem.

Although we only use a predicted set of parameters to illustrate how each model will behave, the system of differential equations used in the predator pray model are a more realistic representation of the relationship between butterflies and the wasps.Without wasps, butterflies will grow out until its reaches its carrying capacity, the point at which the population is too large to sustain itself. The wasp population acts as limiting variable that keeps the butterfly population from overtaking the ecosystem. In that fact, the butterfly population also limits wasps from going to its carrying capacity. The limit as the time approaches infinity for either population would be the carrying capacity.