

SCUDEM 2019

Problem C



George Fox - Group 1

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Assumptions

- Chemical interaction is built into the equations
- Increase in male and female butterfly population due to interaction with each other
- Decrease in butterfly population due to interaction with wasps
 - Egg infiltration can be modeled as death of butterflies
- Population caps
- Wasp population has some sustainability without butterflies

Our Model

$$M' = FM(C_M - M) + MF - MW$$

$$F' = FM(C_F - F) + MF - FW$$

$$W' = W(C_W - W) + MW + FW$$

Based on lotka-volterra equations

Our Model - The Constants

$$M' = FM(C_M - M) + MF - aMW$$

$$F' = FM(C_F - F) + MF - aFW$$

$$W' = W(C_W - W) + aMW + aFW$$

Behavior

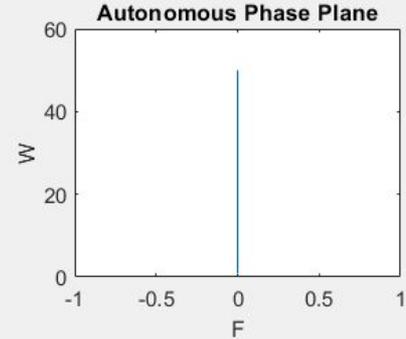
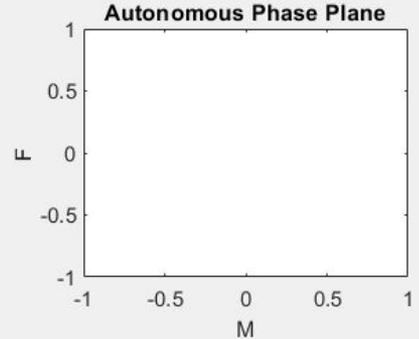
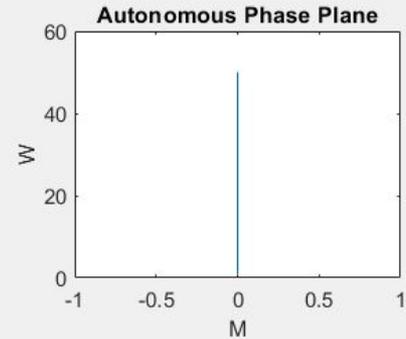
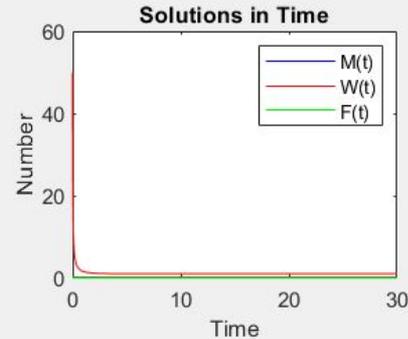
Initial condition: $(0, 0, 50)$

$C_m = 200$

$C_f = 200$

$C_w = 1$

MW/FW constant = 0.01



Behavior

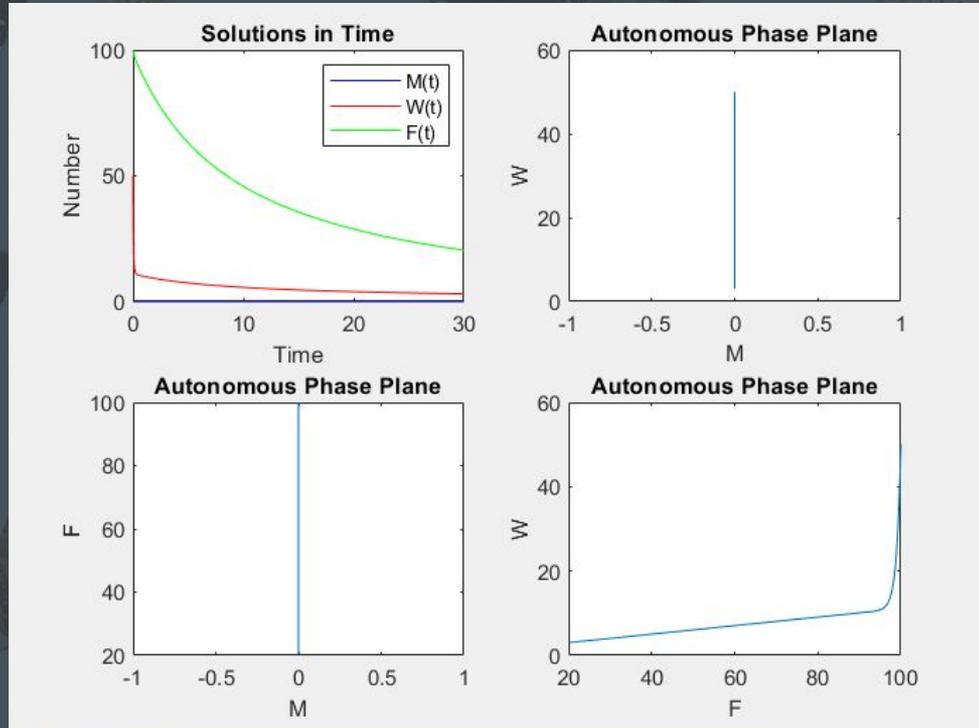
Initial condition: $(0, 100, 50)$

$C_m = 200$

$C_f = 200$

$C_w = 1$

MW/FW constant = 0.01



Behavior

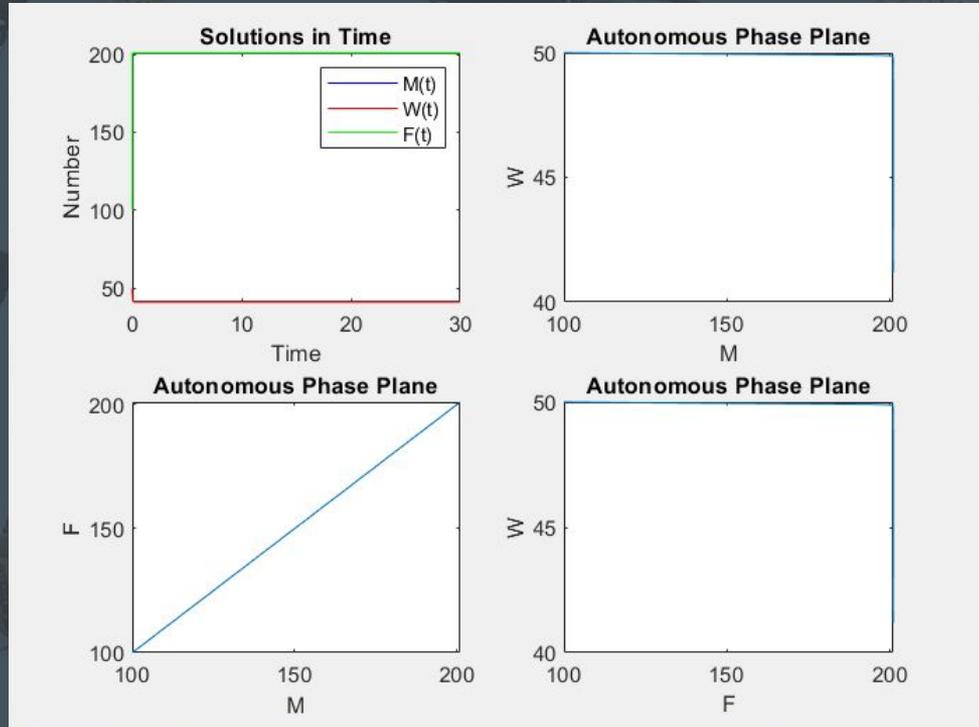
Initial condition: (100, 100, 50)

$$C_m = 200$$

$$C_f = 200$$

$$C_w = 1$$

$$MW/FW \text{ constant} = 0.01$$



Additional Issue #1

Suppose you are asked to add an animal that is a predator of both the butterflies and the wasps, a bird for example. How would you change your model to accommodate this new situation?

Possible Solutions using our Model

- Add an additional term to the three equations in our model
- Add another equation for the bird species
- Our model was constructed based on predator-prey system, so adding a predator requires only minor changes

$$M' = FM(C_M - M) + MF - MW$$

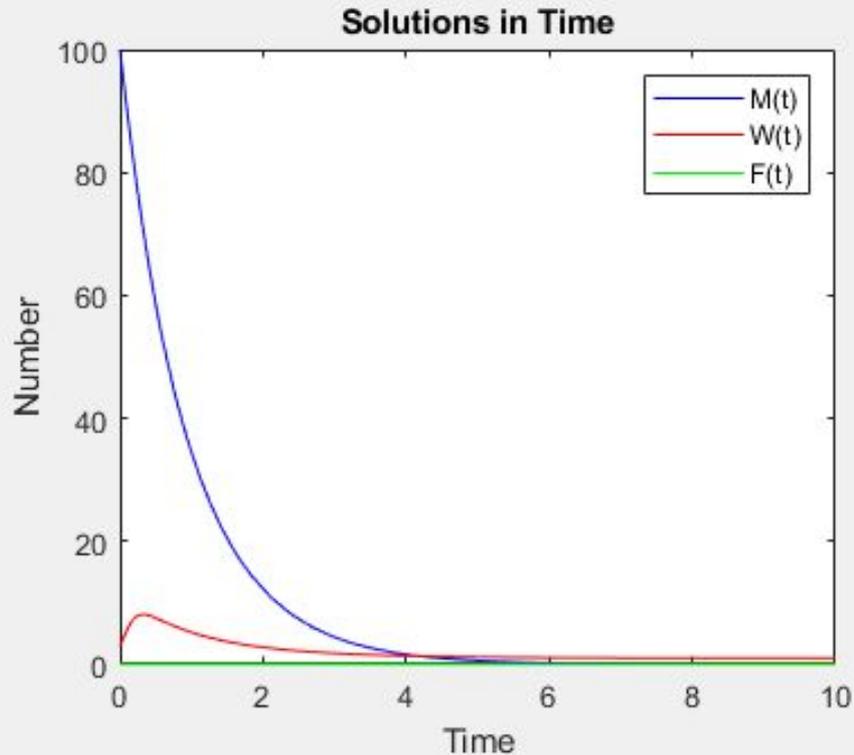
$$F' = FM(C_F - F) + MF - FW$$

$$W' = W(C_W - W) + MW + FW$$

Ways to improve our Model

- Our model does not show gradual change toward either a stable or unstable solution, our model shows nearly immediate change to either the carrying capacity of the species
- We made the assumption that the death rate can be factored into the carrying capacity of the butterflies, this leads to self-sustainability of the male and female butterfly even when one of the two has 0 population

Ways to improve our Model



Death rate added: represented by a neg M term in the male equation and a neg F term in the female equation

Initial Conditions

Male: 100

Female: 0

Wasps: 3

Constant in front of MW/FW : 0.01

The background is a dark blue-grey color, densely populated with various illustrations of butterflies and insects in lighter, muted tones. The insects are scattered across the frame, with some larger butterflies like a blue and black one in the center, and many smaller ones in various colors including yellow, green, and brown. The overall effect is a textured, nature-themed pattern.

Questions?