Honeybee Colony Loss

Introduction:

Nearly 90% of flowering plant species and 75% of our global agricultural crops use pollinators to set seed and produce fruit (Klein et al., 2016; Ollerton et al., 2011). However, in 2006 beekeepers and farmers started to notice significant losses in bees. These losses have continued over time.

In this simulation you will first explore a healthy population of flowers and bees, and then you will explore 4 factors associated with colony loss: 1) pesticides, 2) varroa mites, 3) honeybee diet, and 4) landscape.

Simulation:

In this simulation, the landscape is home to a population of bees and flowers.

<u>Bees:</u>

Bees in the simulation move around randomly to collect pollen for energy to stay alive and for the hive.

<u>Flowers:</u>

Flowers in the simulation are concerned with producing pollen and planting seeds for new flowers to grow.

<u>The Hive:</u>

The hive is a yellow rectangle which acts as the spawn point of every bee. Its purpose is to store nectar created from every five pollen that is returned by the bees.

Investigation 1

In this first experiment, you will observe a population of bees and flowers that do not have any pesticides, mites, deforestation, or alternative diets (corn syrup).

Question: How does a healthy population of bees and flowers change over time?

- Go to http://modelingcommons.org/browse/one_model/4399#
- In the blue tabs on the bottom, click on Run in NetLogo Web
- Click to run the model
- Click setup
- Slide the model speed bar (at the top of the model) all the way to the right.
- Click go to run the model. Run the model for 4,000 ticks (an unspecified measure of time) or until your population of bees and flowers reaches zero, whichever occurs first.
- Once the simulation has run for 4,000 ticks, click go to stop the simulation.
    1. Take a screenshot of your population and include below. In addition provide a description of what you see/observed.

- For the population plot, click the three lines in the top right corner.
- Click download csv.
- Open the shared google sheet titled RET Investigation1 2020.
- Click file, then click import, then click upload to find file in downloads folder. Click the most recent download in your folder. You may have to save the file to a known location if you don't see it in your downloads.
- It may take a few minutes for the import file option to appear. Under import location, click insert new sheet. Then, click import data.
- Once your data is imported, name the tab Experiment 1- Name.
- Once everyone has imported their data on a new tab, we will create a spreadsheet that includes all data as a class. Make sure to include only 4,000 ticks for each trial or until the population of bees and flowers reaches zero, whichever occurs first.
- Once you have merged all of the data, create a graph or data display that illuminates differences and trends among the multiple runs of the simulation.
    2. Were your results the same as everyone else's? If not, why do you think this might be?

Simulation Rules for Bees, Flowers, and Hives

The movements and traits of the bees, flowers, and hives have already been programmed for you, but the model builder has explained the behaviors of each agent in plain language.

Bees:

- Below the simulation click the purple tab model info.
- Scroll down to find the rules that the bees operate by:
    1. How does a bee collect pollen?

    2. How does a bee lose energy? What is the consequence if it does not have enough energy?

Flowers:

- On the model info tab, scroll down to find the rules that the flowers operate by:
    1. How does a flower reproduce?

    2. How does a flower die?

Hive:

- On the model info tab, scroll down to find the rules of the hive:
    1. How does a hive store nectar?

    2. How does a hive increase in size?

Investigation 2

In this second investigation, you will explore how one of the following factors – pesticides, landscape, nutrition, and disease (mites) - affects the bee population and the flower population.

Question: How do(es) _____ effect the honeybee population and in turn the flower population?

Predict: In the space below write what you think will happen.

Procedure: In the space below, design an investigation using the simulation to answer your question. Once you have written out your design, you may carry out your investigation. Make sure for each trial that you export your result to a csv file and import them into google sheets.

Results: Using your exported results, make a graph or data display to show your findings. Paste your graph/data display below.

Investigation 2

1. Describe the trend that you observed.

Discussion: How were the bee population and flower population affected by your particular factor? Write your claim and then provide evidence and reasoning to support your claim.

Your claim is....

Your evidence for this is...

Your reasoning is....

Investigation 3

In the third investigation you will explore how multiple factors combine and interact to cause colony collapse disorder. In each group you will have one expert on each factor (landscape, nutrition, pesticides, and disease). You can choose any combination of factors to explore.

Question: How do _____ interact to cause colony loss?

Procedure: In the space below, design an investigation using the simulation to answer your question. Once you have written out your design, you may carry out your investigation. Make sure for each trial that you export your result to a .csv file and import them into google sheets.

Results: Using your exported results, make a graph or data display to show your findings. Paste your graph/data display below.

Investigation 3

1. Describe the trend that you observed.

2. All models are wrong, but some are useful. When conducting your investigation did your group find any limitations?
   a) If yes, what were they?

   b) If no, what do you think are some limitations of the simulation? Why?

Discussion: How were the bee population and flower population affected by your combination of factors? Write your claim and then provide evidence and reasoning to support your claim.

Your claim is....

Your evidence for this is...

Your reasoning is....