The Basic DEs of Bees

How do you model populations? Using *differential equations* is a natural approach, especially in the form

rate of change of population = population added - population subtracted (per unit time).

Let's do this with bees.

We'll model the life-cycle of a hive by looking at the populations of *hive bees* and *forager bees* each day. Make sure you've done the reading to answer the following questions.

1. Using what you learned from the reading, draw a flowchart for the lifecycle of a female non-queen bee.

2. Which of H, F, L, α, and m have units "bees per day" and which are percentages or ratios?

3. Write a basic differential equation for the hive population H using the laying rate L for the queen and the maximum recruitment rate α for conversion from hive bee to forager bee.

4. Write a basic differential equation for the forager population F using the maximum recruitment rate α for conversion from hive bee to forager bee and the death rate m.

5. Check that your units are right – both sides of the equation should have units "bees per day"!

The Basic DEs of Bees

6. When is the population of hive bees constant? (What does "constant" mean for the left-hand side of your differential equation?)

7. When is the population of forager bees constant?

8. Use your answers above to find an *equilibrium solution* to the system of two differential equations you wrote.

9. If the laying rate is 2000 bees per day, the recruitment rate is 0.25, and the death rate is 30%, how many bees are in the hive and how many are foraging on any particular day if the hive is perfectly in equilibrium?