

Investigation of limited resources using NetLogo

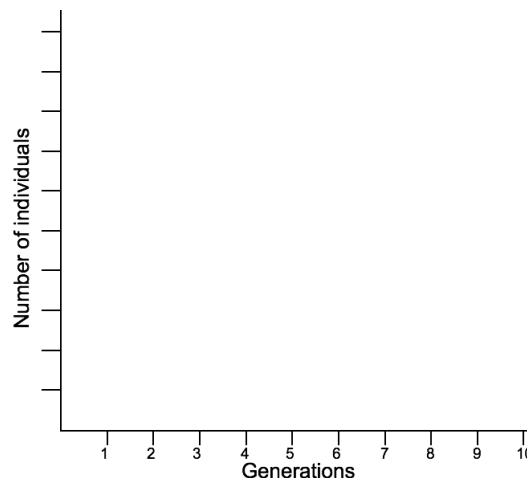
The goal of this activity is for students to investigate the effect of limited resources in a population and provide evidence for the idea of 'struggle for existence'. We will use NetLogo, a modeling environment, to simulate the growth of a population of finches.

NetLogo can be installed on regular computers (not on chromebooks) or can be played on the web browser if you want students to play independently. Alternatively, you can play as a demo for the whole class. It is still effective as long as you engage the class in making "decisions" about settings, and discussion afterward. We provide the file: **MBER NetLogo Limited Resources.nlogo**. This is a simulation of simple birth and death rate for finches.

Question: If populations have the potential of growing exponentially, why do the number of individuals in a population tend to be stable?

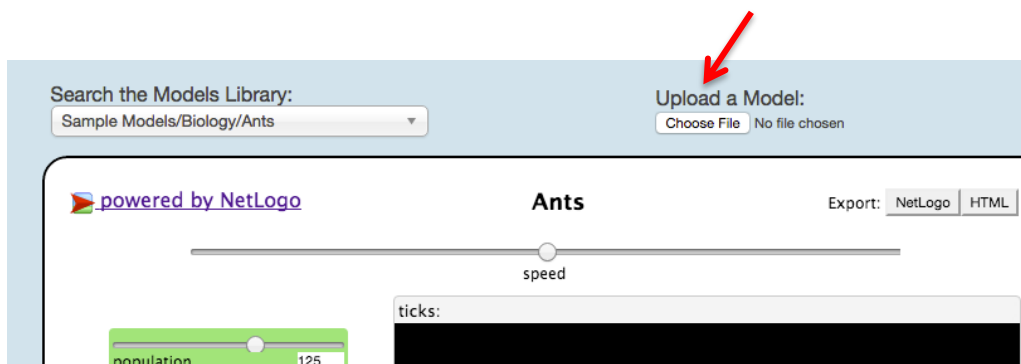
From the population dynamics model students might come with some ideas about population growth. You can start by reviewing some of the ideas of birth and death rate, and prime the idea of population growth by asking them to sketch a graph predicting what they think would happen to a population over time if **all** individuals survive and reproduce. You might need define a generation –a group that is born about the same time, grandparents- parents- children = three generations.

You will test their predictions using NetLogo.



Getting started with NetLogo (Web version)

1. Open the NetLogo page (<https://ccl.northwestern.edu/netlogo/>)
2. Go to: NetLogo Web
3. On the top right side of the page under Upload a Model: Choose File. You will choose the file **MBER NetLogo Limited Resources.nlogo**.

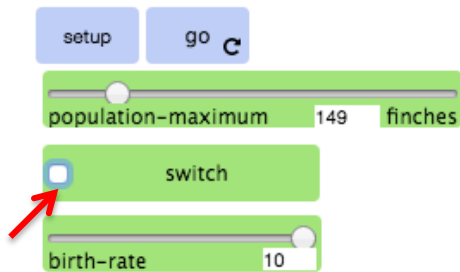


4. Now you are ready to start the simulation.

You will follow similar steps if you download the software. Except for step 3 you will go to >File > Open > find the MBER NetLogo file.

Starting the simulation

1. Before you start make sure that the “switch” green button is unclicked (web version) or in the OFF position (software version). This switch is for resources, but do not discuss this with your students yet.



2. Set birth rate, speed and population-maximum as the class decides.
3. Click “setup”
4. Click “Go” (start and pause)
5. When it has run as long as desired click “Go” again to pause it.
6. Click “setup” to reset.

Students can discuss and decide how they would like to set the speed, ticks vs. continuous, population maximum (has no effect with the switch off), and most importantly, the birth rate. If you do this as a demo, have the class discuss and decide these settings (again, switch must be OFF). Try as many different combinations as you have time for. As you try each different setting ask students to predict what they think will happen. Ask lots of questions: What will happen if we set the birth rate higher? What if the birth rate is 1 – will we still get the same pattern? How many babies do finches really have (*in average 3 per year*)? How long would these generations really be? etc. They will see that no matter the settings, as long as the birth rate is >0 , exponential growth will happen.

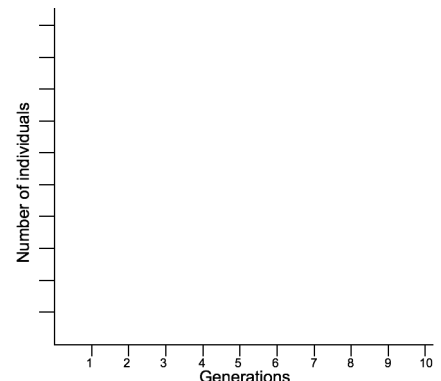
Each time you do a trial have students observe and discuss what is happening.

Limited resources

Now that students have experience with exponential growth ask them: “Is this what really happens?”

We ask them to sketch a graph that shows what they think really happens to population size over time and test their predictions with NetLogo. Now we run the simulation with the switch ON. Allow students to decide on the other parameters. Involve the whole class in a discussion about the results. Do not give away what the switch means.

The fruitful part is to have students reason about what the “switch” represents. Students can pair/share then share out with class to generate a list. Usually they will say “death” but some will also say “running out of food, etc.”. You can ask what the “leveling off” or “plateau” represents. “Why does it level off at a particular place each time?” Why is the plateau a zigzag line instead of a flat line? This should lead to the idea that population growth is limited by the resources available in the environment.



At the end you can connect back to the finches. During the drought in the Galapagos food became scarce causing a decline in the population. Specifically, the limited amount of food available for the finches with shorter beak depth resulted in higher death rates for these finches.