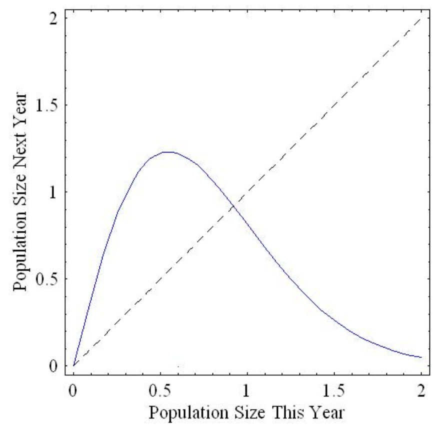
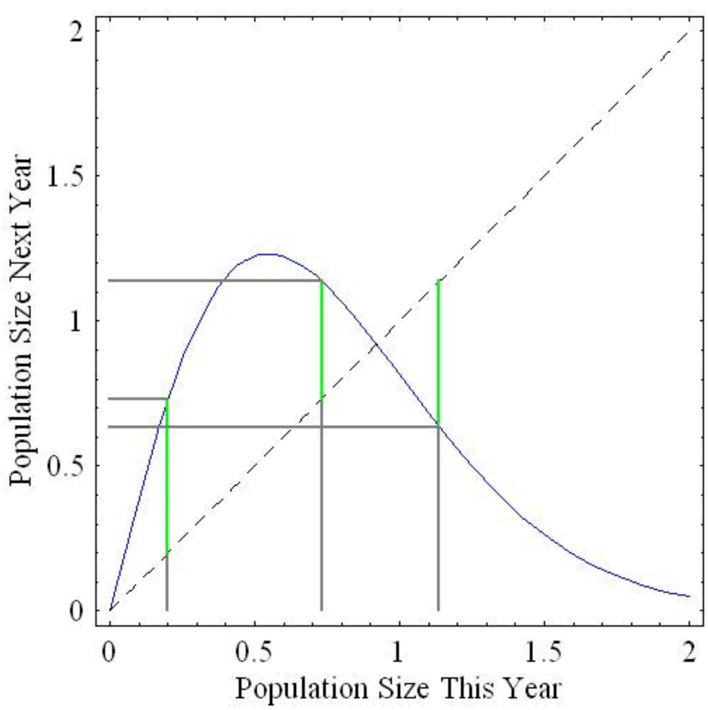
Reproduction Curves

A reproduction curve is a mathematical model that gives the population size in the next year if the population size this year is known:

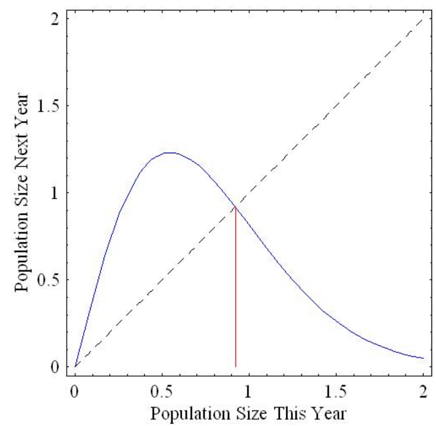


The basic shape of this curve is no accident. It rises on the left since there are enough resources for the population to increase, and falls on the right since the population is too large for the available resources and must decline. The details of the shape of the reproduction curve depend on the particular population being studied, but the basic shape is always the same.

The reproduction curve is usually used in the following manner. Vertical lines represent moving from one year to the next. The amount of the vertical line between the line $y = x$ and the reproduction curve represent the natural increase or natural decrease of the population from one year to the next.



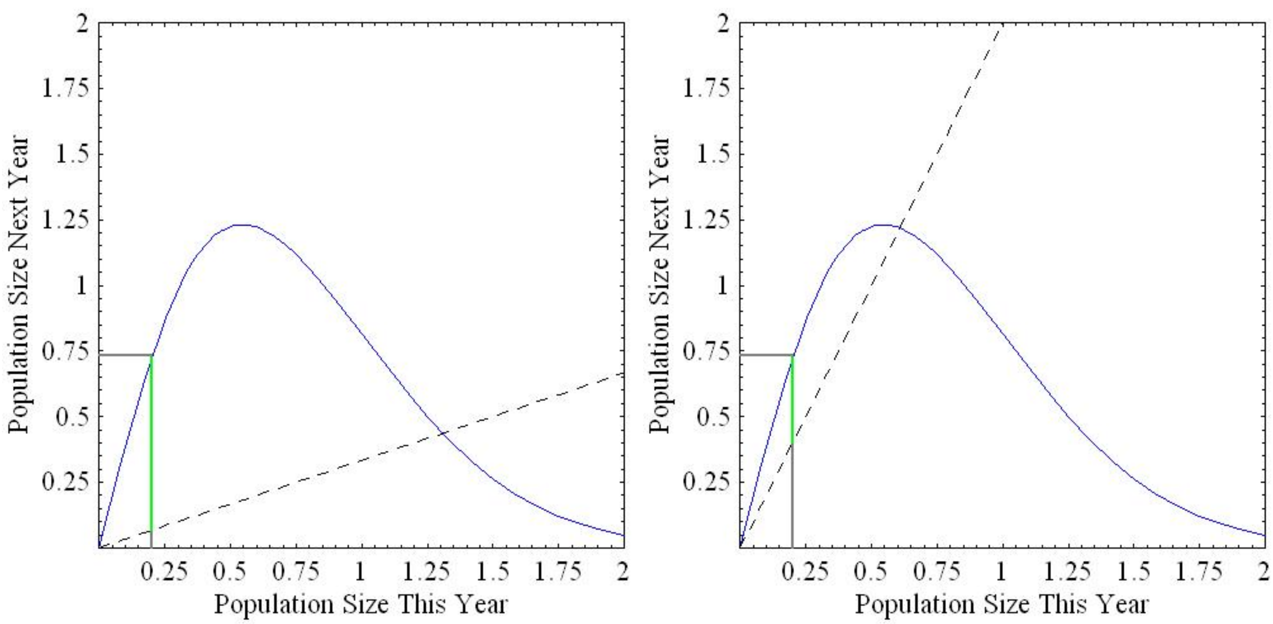
An equilibrium population is a population which does not change from year to year. An equilibrium population occurs where the reproduction curve intersects the line $y = x$.



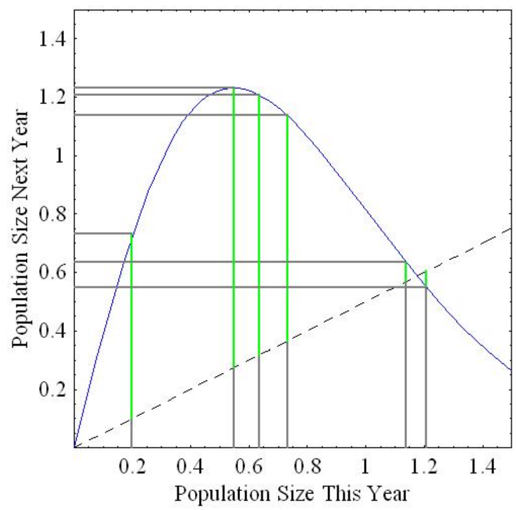
Sustained Yield Harvesting of a Population

A simple model of harvesting a population would include the idea that greater effort would result in greater harvest. The harvest line could therefore be a straight line with steeper slope indicating greater harvest. It looks like the $y = x$ line we used, but it has a different slope to indicate different levels of harvesting.

Where the curve and the harvesting line intersect, we have an equilibrium population, and the population will return to the current level next year. That's obviously important! A sustained yield harvesting policy is a policy that if continued indefinitely will maintain the same yield.



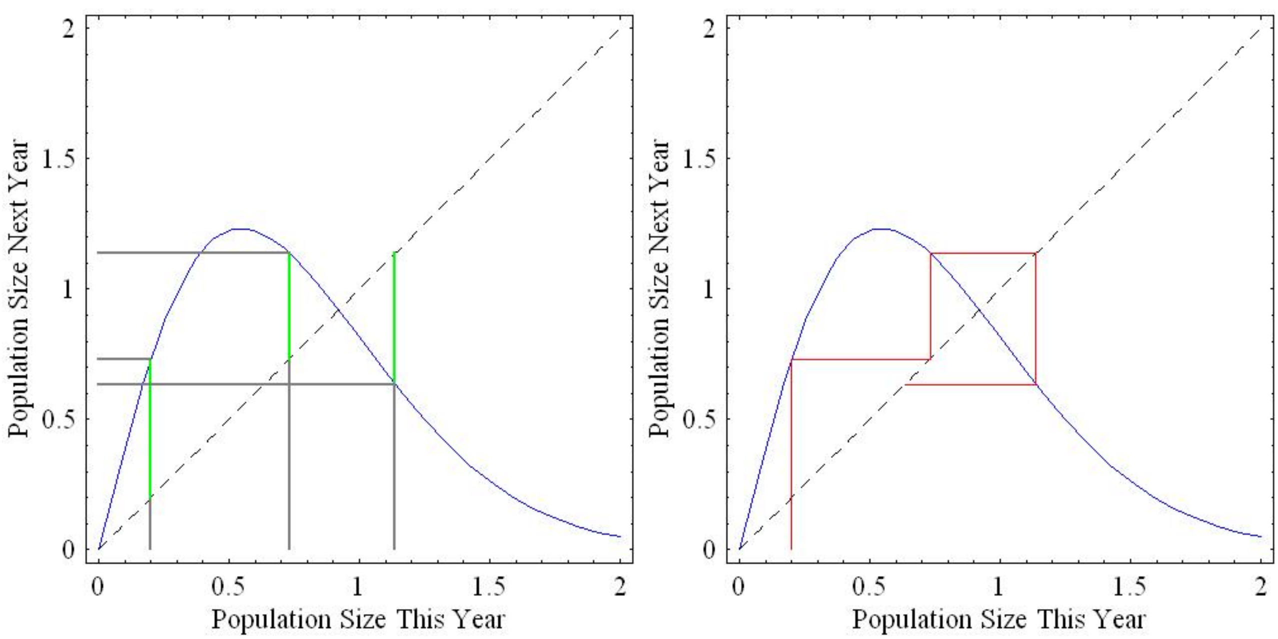
Look at the yields for the following harvesting scenario that begins at 0.2.



There is one year when the “harvest” is negative!

An Alternate Way of Showing The Population Dynamics: Cobweb Diagrams

Another way of presenting this information is shown on the right. The horizontal lines that move towards the straight line $y = x$ are used to “reset” to the next year (and therefore represent the <u>natural increase</u> or <u>natural decrease</u> of the population, since they are the same length as the green lines on the left).



Chaos in Biological Populations

One definition of chaos is that knowing the current population does not allow you to predict the future population. Of course, mathematically we can predict future populations, so a better definition of chaos would be a system for which small changes in initial conditions lead to large differences later. This is really what predictability is all about–the predictions for a system without chaos would be roughly the same if we changed our starting position by a small amount. This isn't true for chaotic systems, and much of nature is chaotic.

Show the Logistic map animations, chaos1.gif–chaos4.gif. Static images are in the Excel file as well.