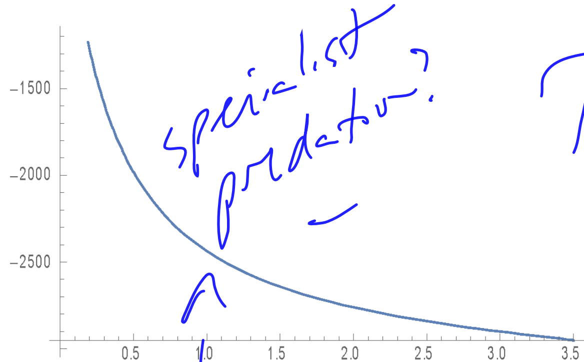
Samuel Kaelin 9.5/10 Hare and Lynx :Lab III

Nice work Samuel. Edit for language

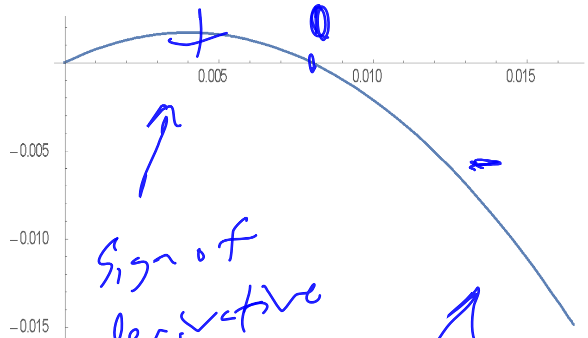
A)

There are four graphs



steadily!

This graph is about the hare population which falls off eventually as the time goes by. In the second graph we can see that the lynx population spikes sand then falls off dramatically as the hare population dies. This is the case for when the hare population is set at a constant P and when graphing P when the N is a constant. If we were to see this data follow a sin graph with a oscillation we would see the graphs that appear later in this picture.



Two graphs look like this logistic

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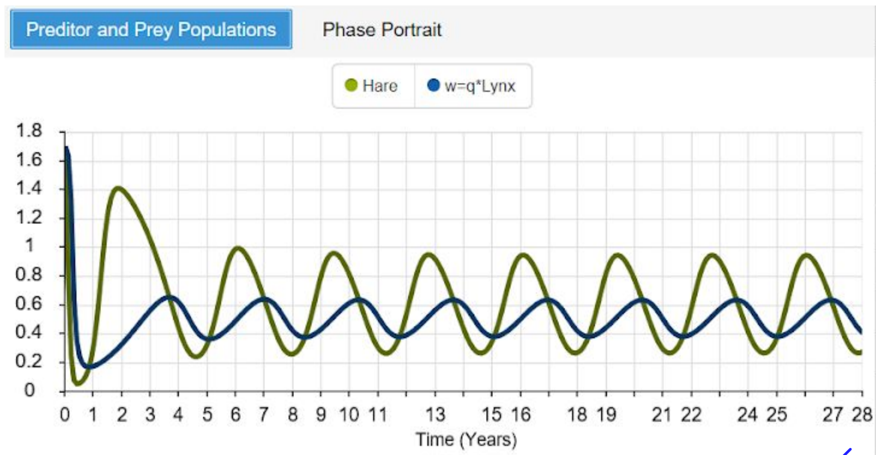
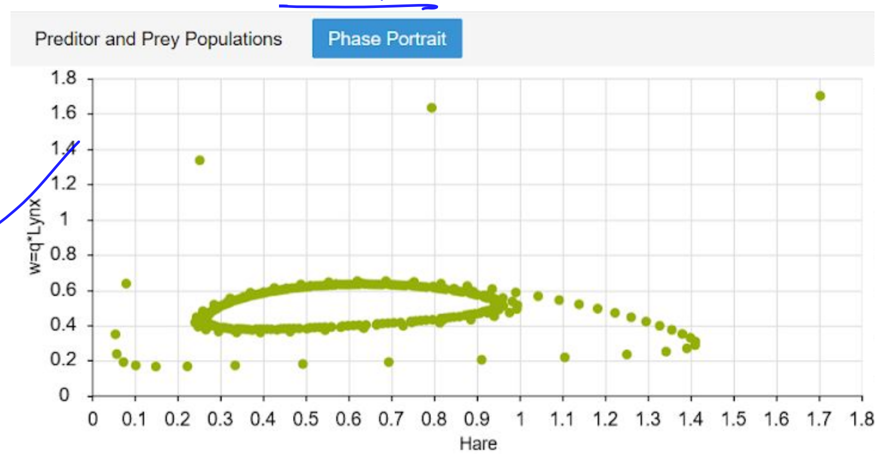
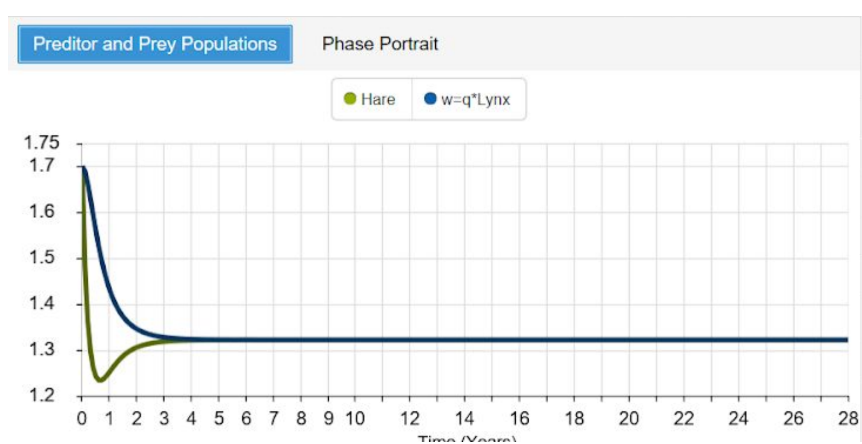
1) When we view the simulation of our model, we notice a lot of things are present. First looking at the population vs. time graph we can see that the graphs are oscillating and not 'flattening' out to equilibrium. This is a constant cycle. The population of both the Hare and lynx never hit 'perfect population' or equilibrium value. This is more realistic because a population will never truly be constant all the time. Instead it fluctuates either due to generational gaps dying off or deaths due to natural causes. This is the same for both species. So in the end the graph oscillates around the equilibrium values Hare being about 0.6 and Lynx being about 0.5.



When looking at the phase portrait we can see that the populations will spiral down towards the equilibrium values but never reach that point. Instead they will circle the value and never reach it. Again we can see the center that this graph is rotating around is the point approximately equal to (0.6,0.5).

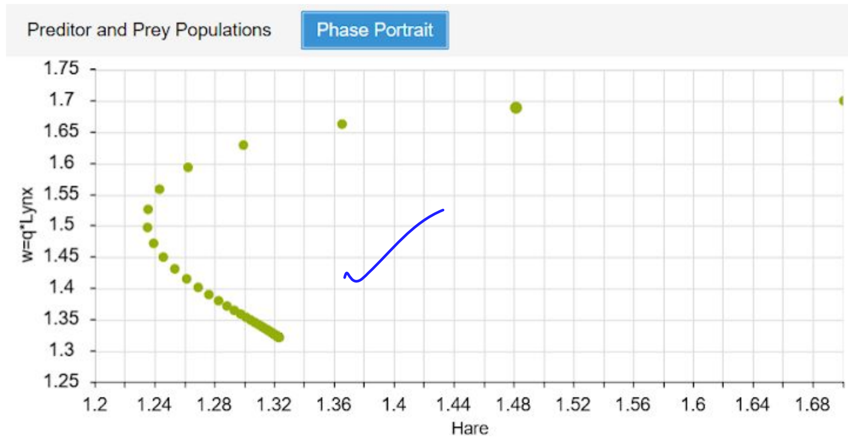


2) Once we change α to equal 505.0 we notice that the populations start from a value and then almost immediately hit equilibrium value. The values of both seem to have the same

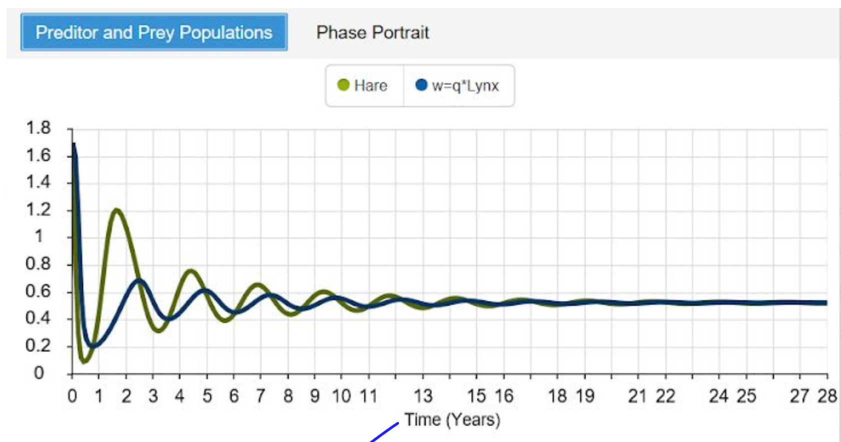


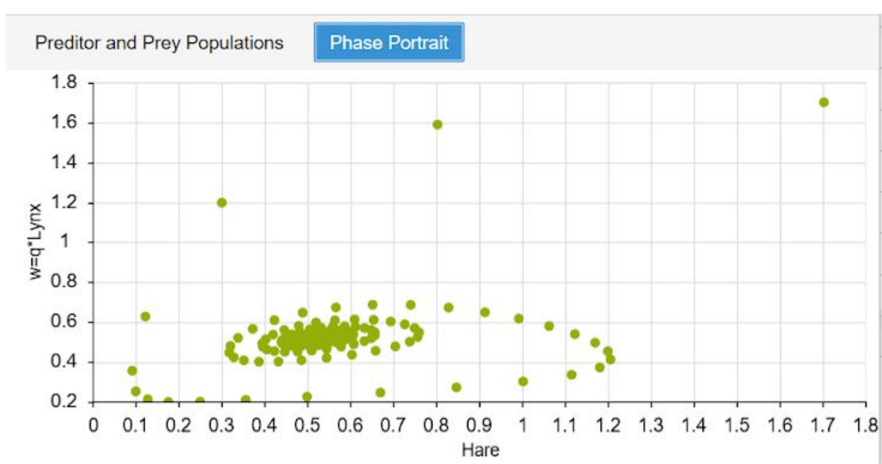
equilibrium value of about 1.322. Given this fact since it did reach equilibrium value and stayed constant with no oscillations the population will remain fixed until something disrupts them dramatically. For example, a natural disaster or another species comes in and disrupts the food chain. Anything could disrupt the enviroment and send this cycle back into oscillation.

Looking at the phase portrait we can see that there were no rotations except for a slight bend with will head directly to the equilibrium value. We can confirm the equilibrium value is (1.322,1.322) and that as t goes to infinity that they will remain centered **at** the equilibrium point.



3) When changing the α back to 1867.0 and moving s to 1.5 (increasing the Lynx birthrate) this will cause the equilibrium value to increase to help cope with the hire population of lynx. It will take longer, as we can see in the graph to the right, to ‘hit’ the equilibrium value. Eventually however, the equilibrium value will be reached and the ‘perfect population’ will remain constant for what looks like forever. So as time goes to infinity the equilibrium value will be reached and stay fixed forever.

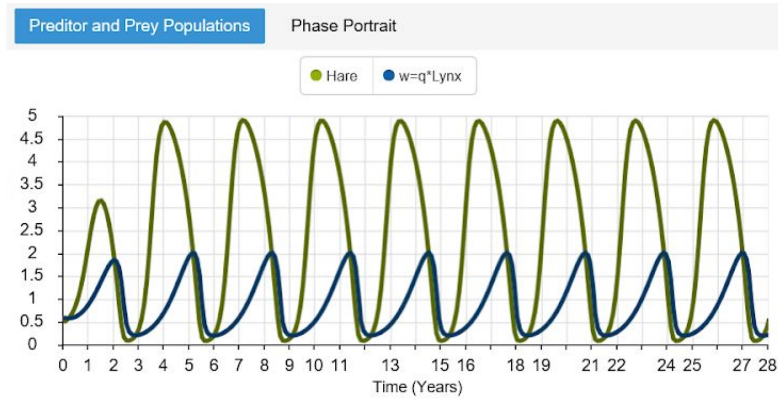




When we look at the phase portrait, we can see essentially the same thing occurring. The populations are rotating around the equilibrium value and slowly going to that point. I personally enjoy reading that population vs. time graph because I think it shows that equilibrium value better and shows the time with those population values. But all in all they are depicting the same information just in a different format.

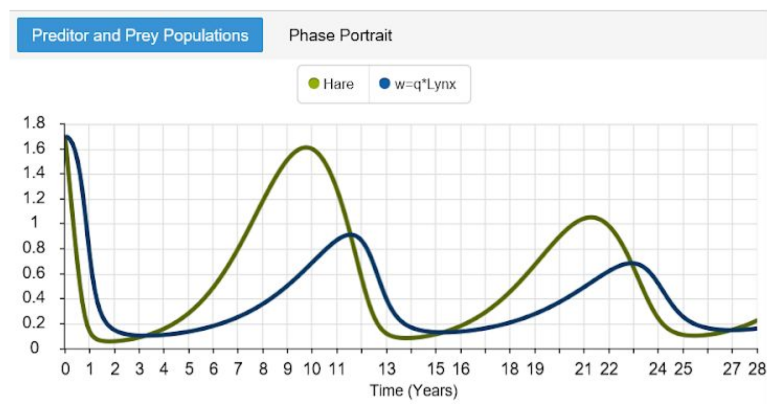
4) It took some though and trial and error but I eventually found a set of parameters that would cause the increase as time progresses. I through that if I increase the Hare predation rate, ϒ, from 0.035 to 1.2. Increasing this would make the rate at which Lynx kill much higher causing hare to need to produce more. Increasing Lynx birth rate, s, as well causes this trend to happen. You can see that the hare still leads but the lynx will get larger also. We can see a biological limit has been found where the Hare and Lynx will continue to rotate around those values. All in all, I also decreased the initial value of the species so that it starts at a small value.

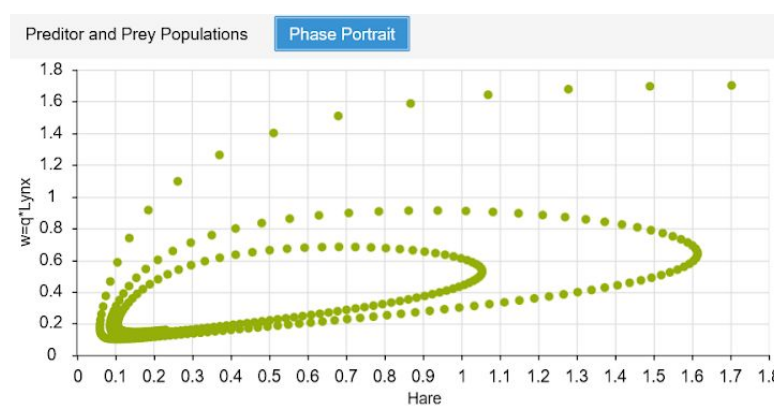
Good ✓



5) As we saw in the previous simulations the graph did have more of a "forward lean". Now the graph has more of a wave like structure of a "backwards lean" This was cause by adjusting a few values. I decrease the Lynx birth rate from .85 to .5 which will slow the rate at which Lynx reproduce. This would help the hares populate longer hence the shallow positive slopes of the blue line. In turn decreasing the Hare birth rate from 8 to 1.2 will give the shallow positive slope of the green line. This makes sense because when the rate of birth, positive slope of the line is made smaller the slope is decreased and lengthened. I also increased the carrying capacity from 1.2 to 5 which

I can't reproduce this, but it's a little hard to follow parameter values...





allowed for more species to be in the same enviroment.