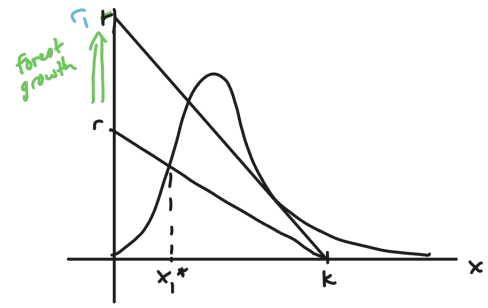
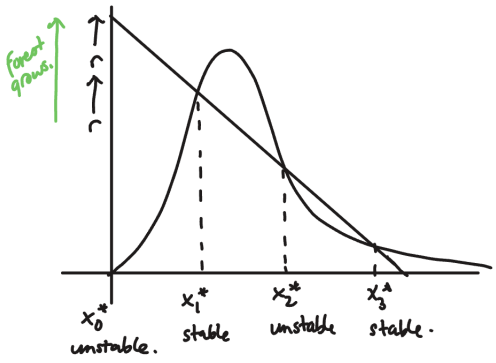
Spruce Budworm Continued

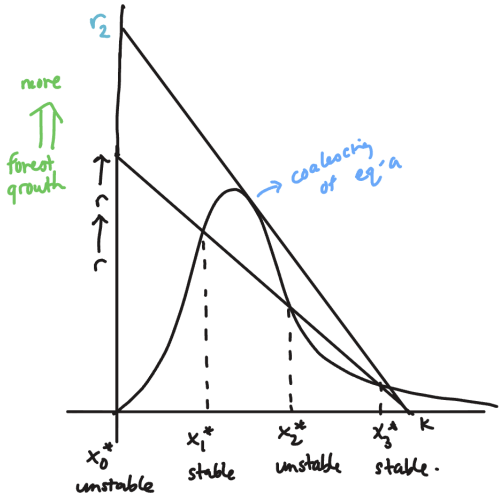
From last time, we know that our other equilibria are given by

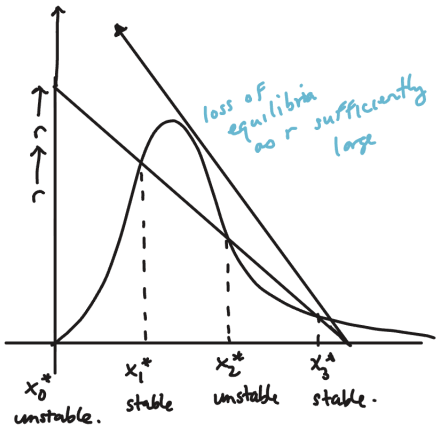
$$r\left(1-\frac{x}{k}\right)=\frac{x}{1+x^2}$$

So what happens are the forest grows (r increases)?

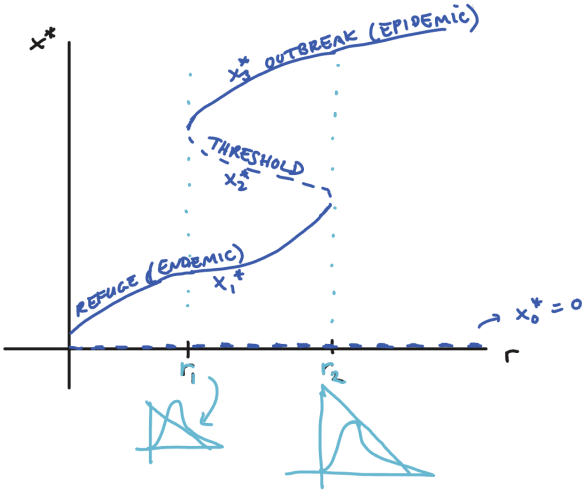




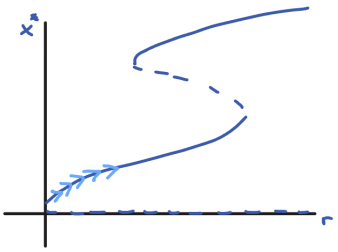




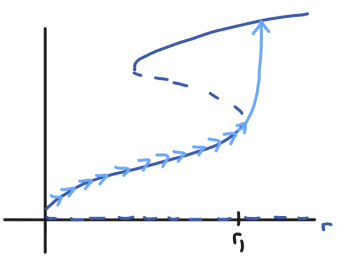
Let's try to summarize in a bifurcation plot



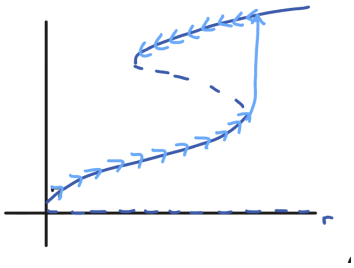
Now, the whole story:



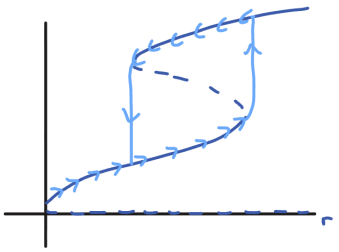
We start with an initially small / barren forest. The forest grows.



When the population is a certain size (r_1), the population jumps to the stable epidemic equilibrium.



Once we have a huge budworm population, they eat all the foliage and reduce r in the model.



Eventually r decreases to loss of foliage and we jump back to the stable endemic population.

This cycle is about 30 - 40 years, and is governed by the growth of softwood forests.

This exhibits hysteresis: cyclical behaviour where the system changes irreversibly to a new state (forward state $\neq$ backward state). Also called a hysteresis loop.