Exploring System Behaviour Using Model Structure

Worksheets

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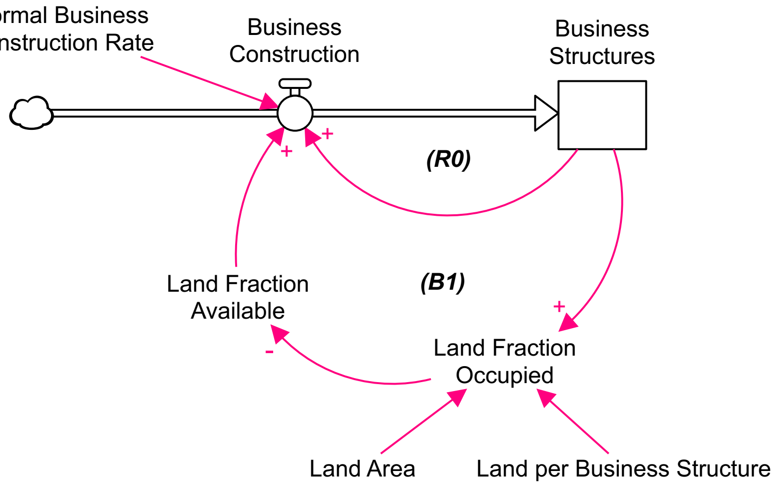
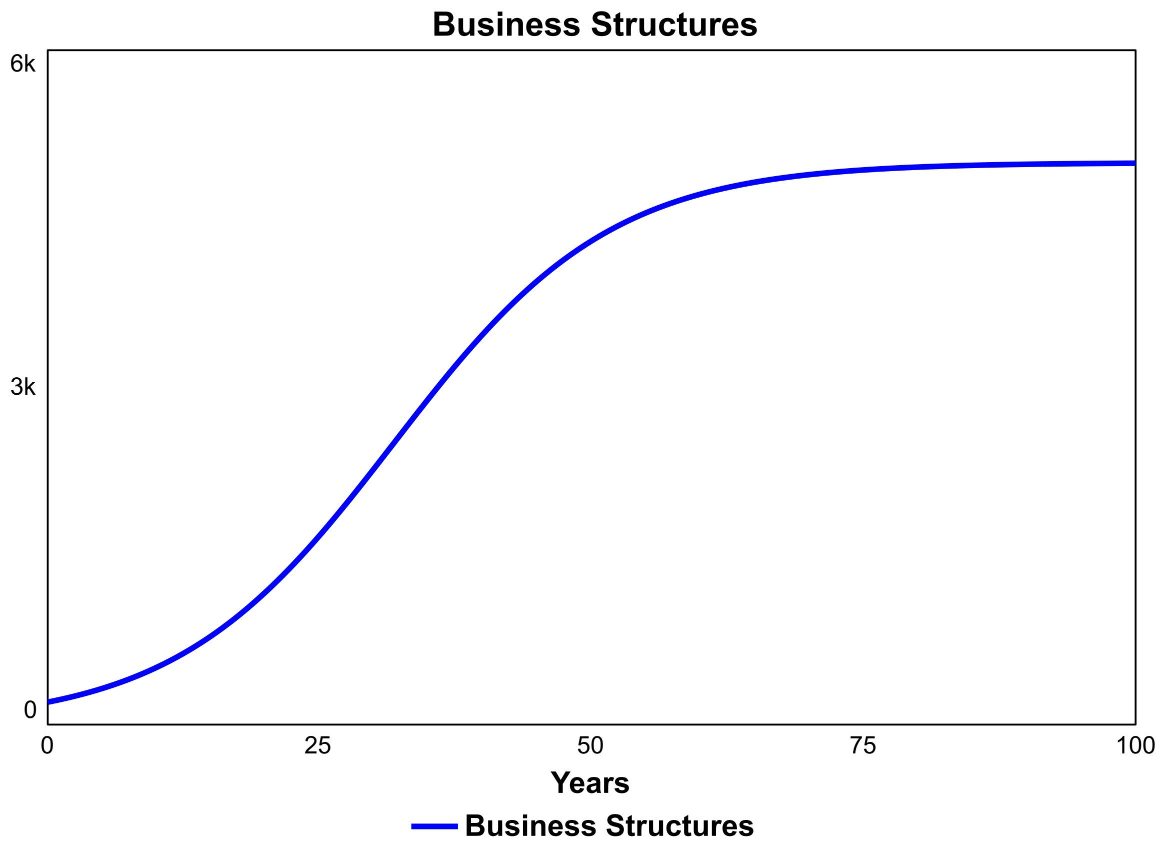
Limits to Growth

A fixed amount of land is designated for a new trading estate in order to encourage business development in a town. Initially, the trading estate grows rapidly as more businesses attract more business developments - the urban attractiveness hypothesis. However, as growth continues, land availability falls, and business development slows. The result is S-shaped growth



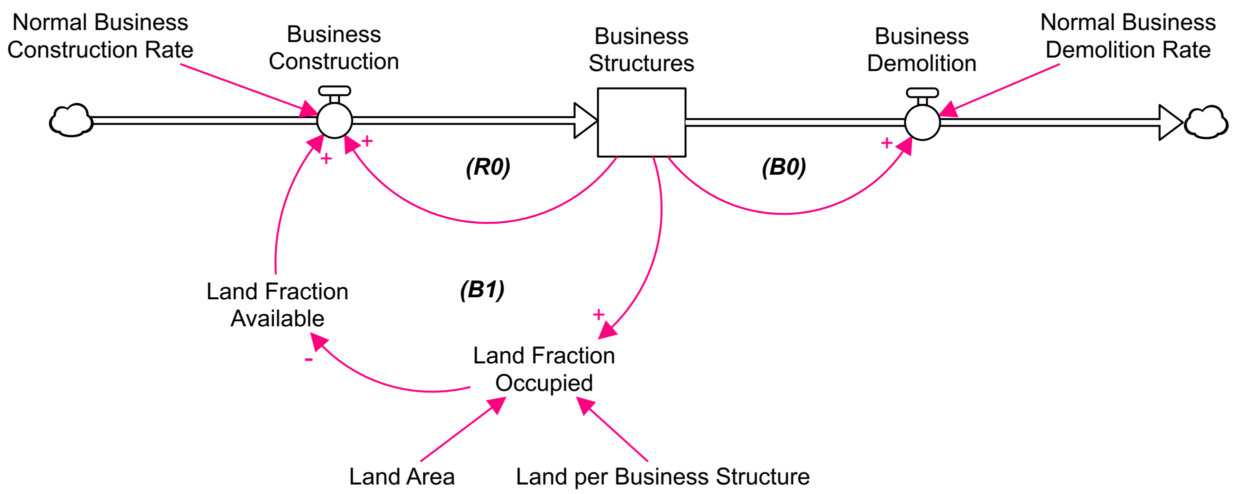
R0 – Reinforcing Loop
B1 – Balancing Loop
Stock achieves carrying capacity of 50,000 structures

- Mark on the diagram below the regions where each loop dominates behaviour



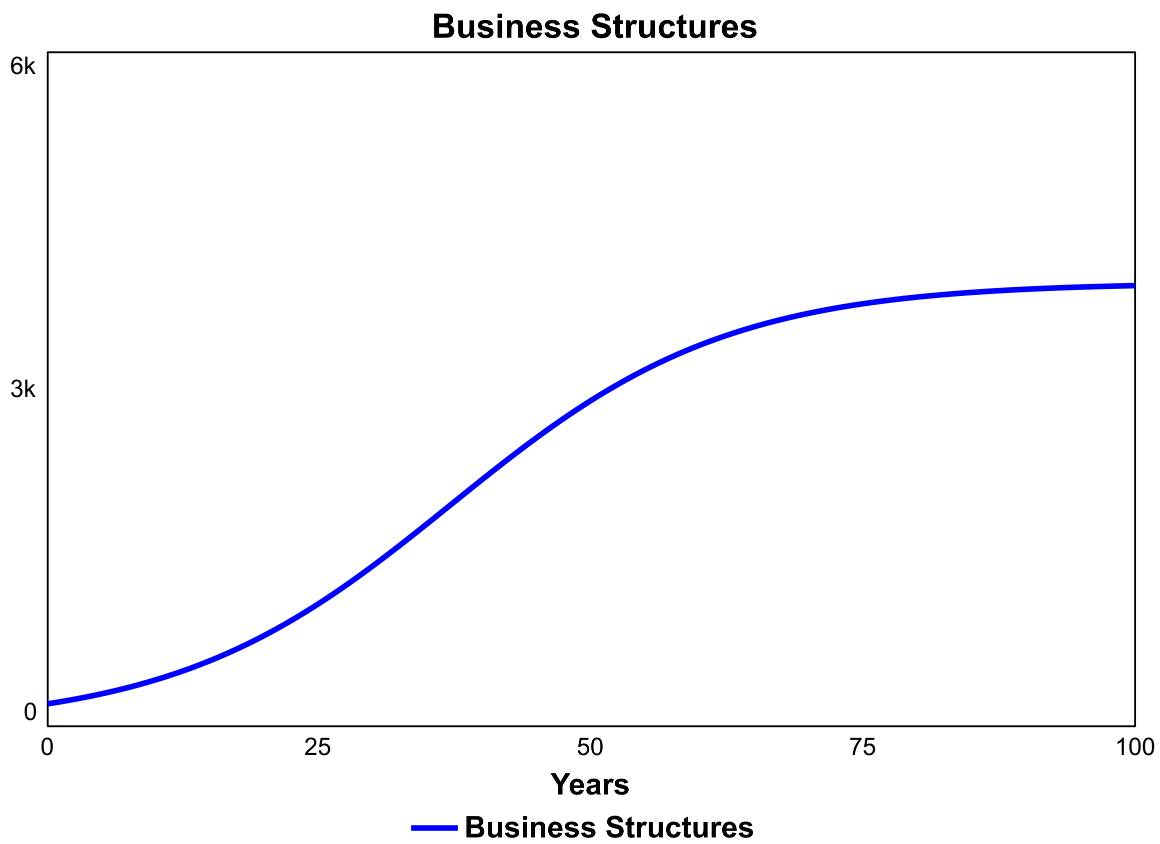
Limits to Growth Continued

Business may now be demolished, a third loop, B0, balancing.



The normal business demolition rate is set to non-zero.
Business Structures falls short of the 50,000 carrying capacity.

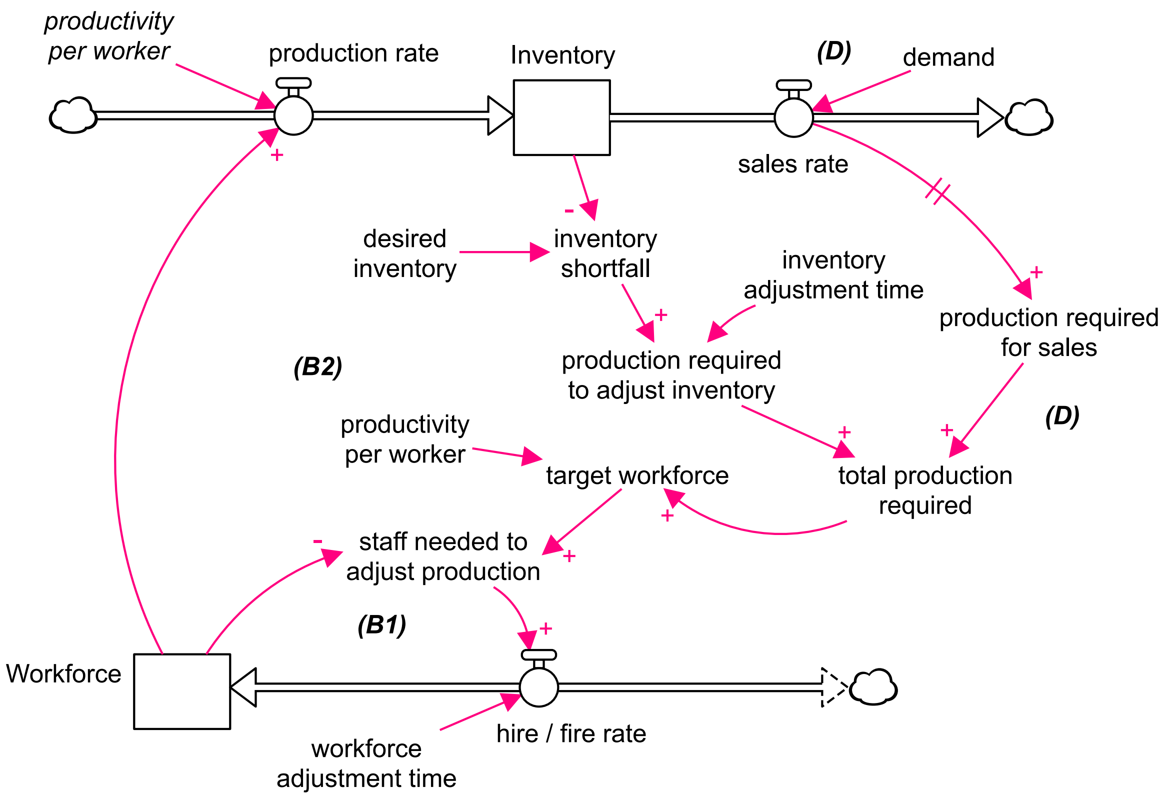
- Mark on the diagram below the regions where each loop dominates behaviour



https://exchange.iseesystems.com/public/john-hayward/limits-to-growth-archetype

Inventory Workforce Model

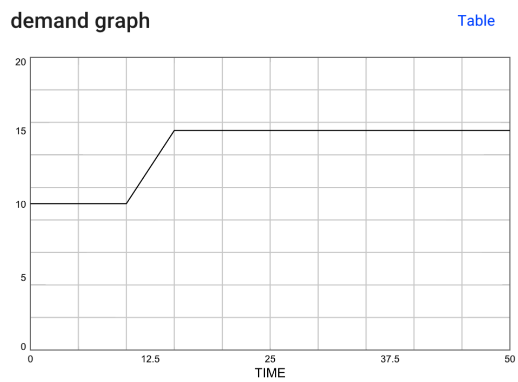
A manufacturing company maintains an inventory of goods ready for sale to customers. The inventory is maintained at a fixed level. If demand increases, then the company will need to increase production so that sales can be met, and the inventory size maintained. Thus workers are hired, or fired, accordingly.



B1 – Balancing Loop, First Order

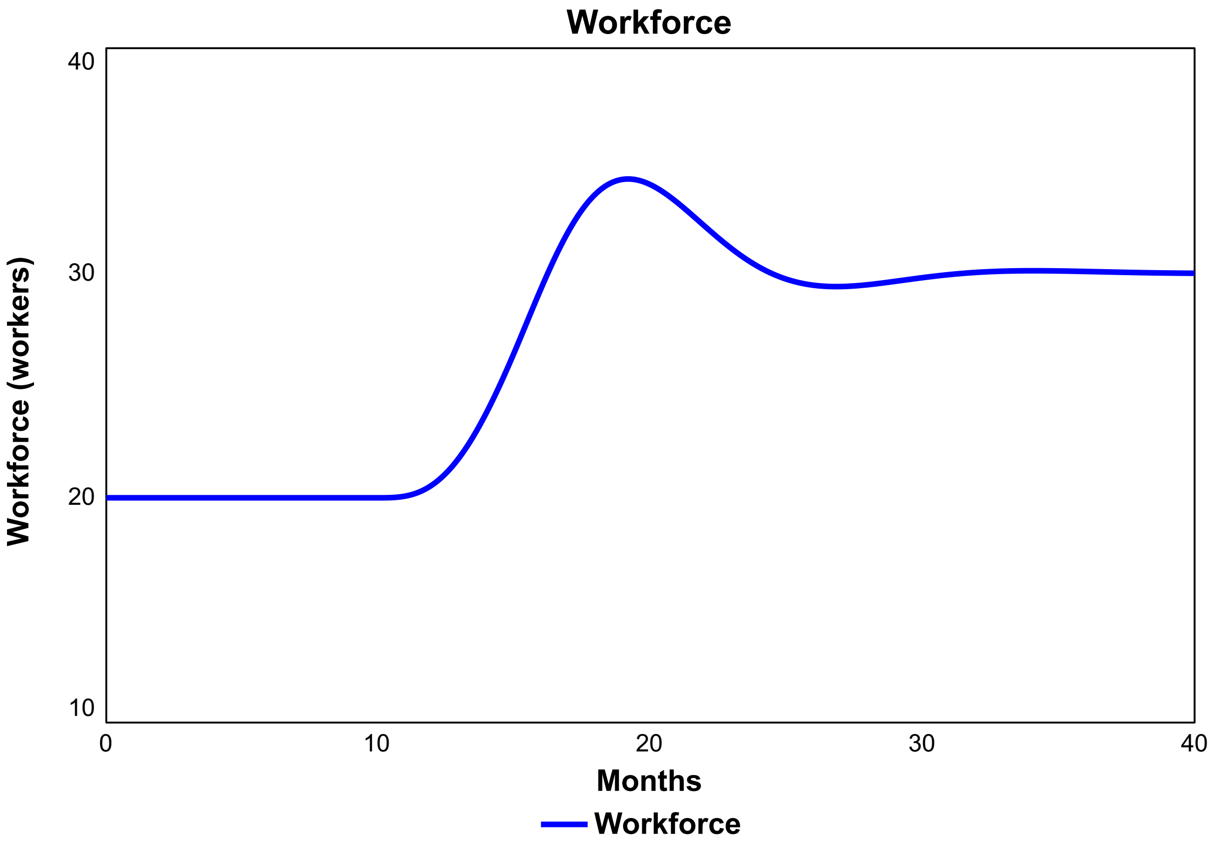
B2 – Balancing Loop, Second Order

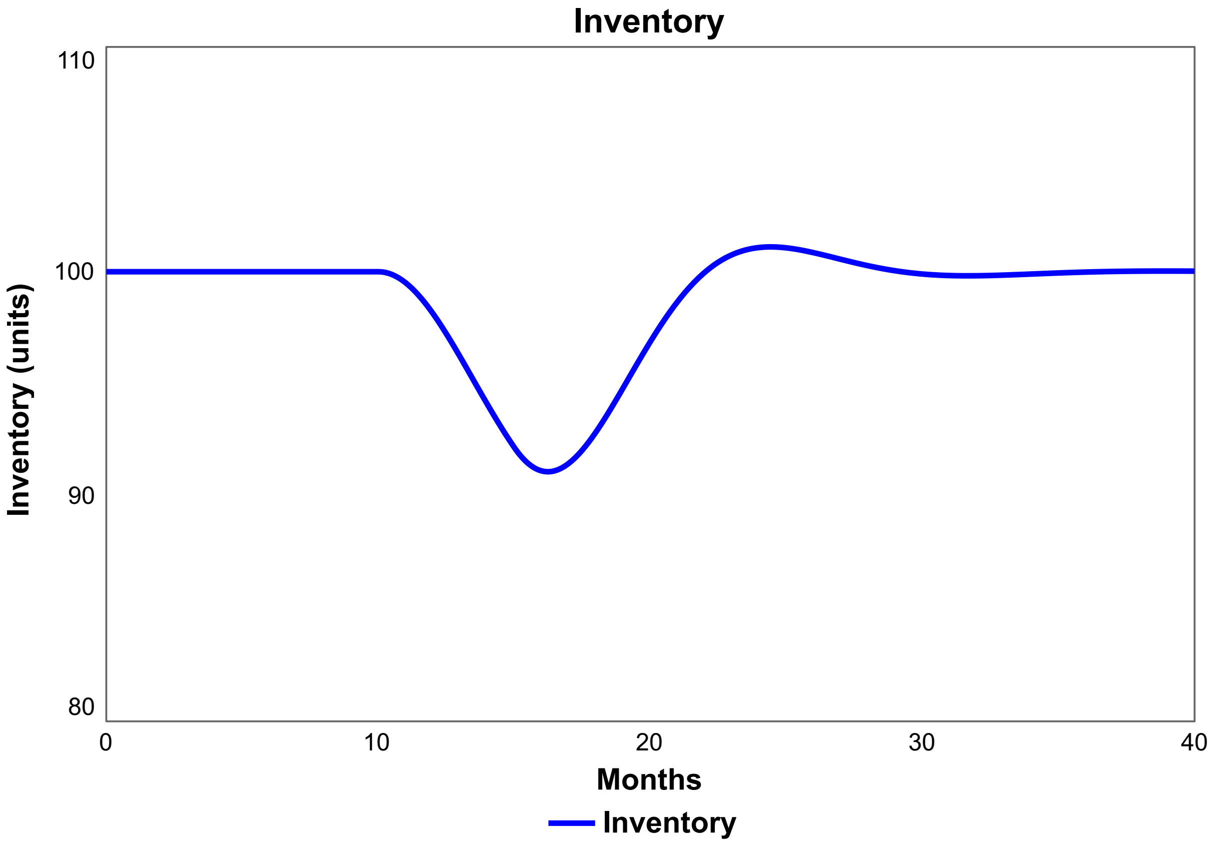
D – Demand, Exogenous, rising from 10 to 15 units/month



Desired Inventory = 100 units
Productivity per worker = 0.5 units/month/worker

- Mark on the diagrams (next page) the regions where each loop dominates behaviour.
- How does the second order loop, B2, affect each stock?
- How does demand affect dominance?





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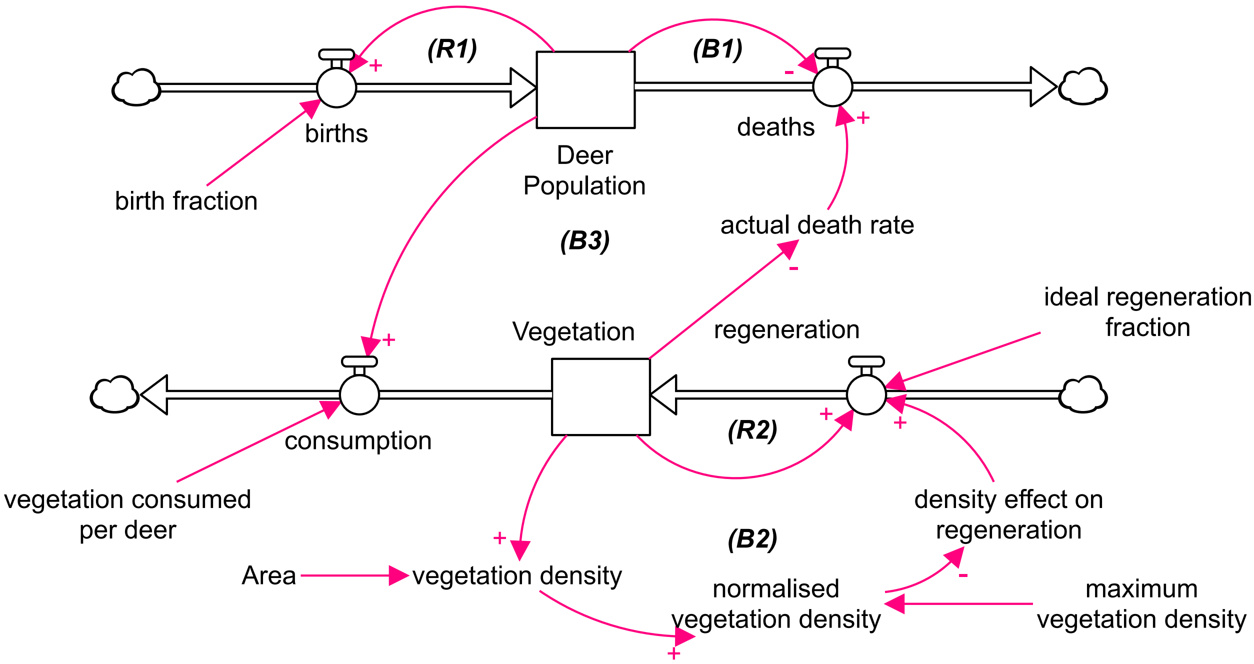
Overshoot and Collapse

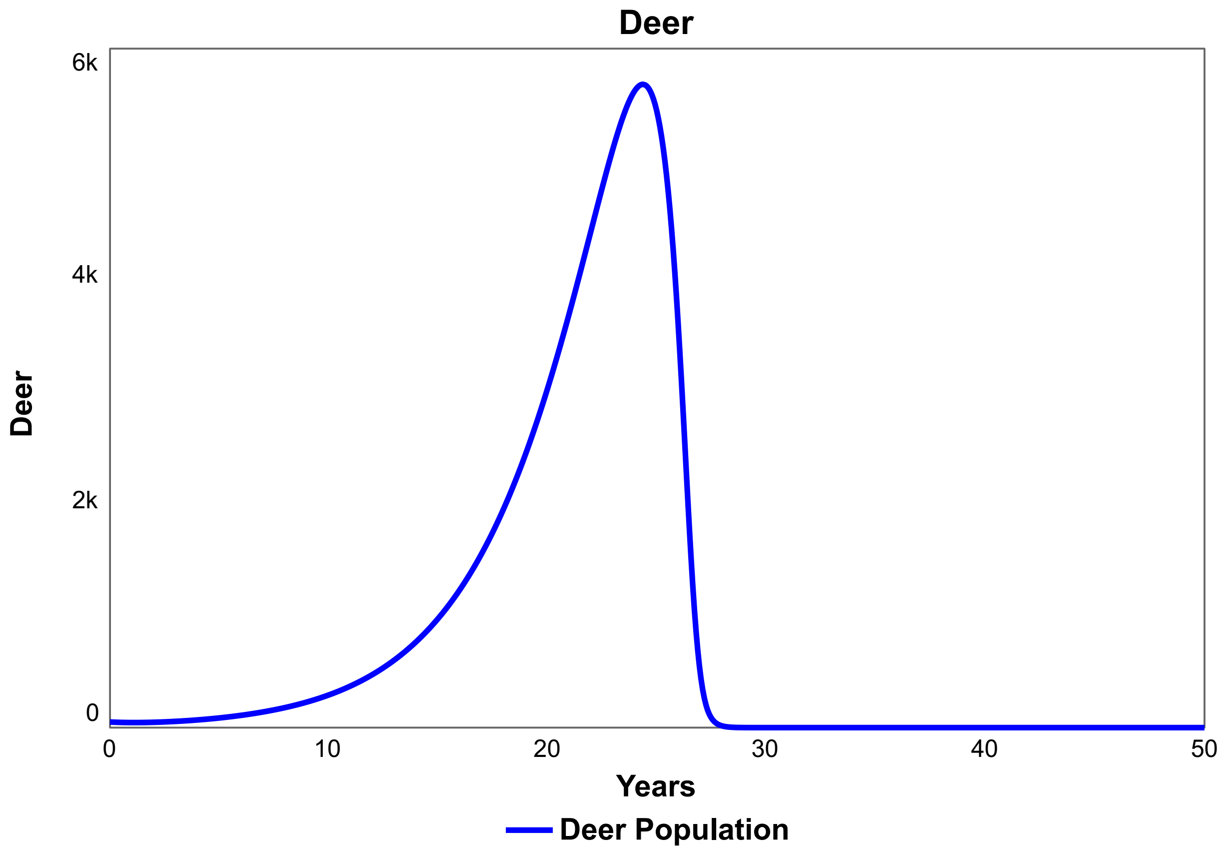
A population of deer live on a plateau, consuming its vegetation. When the vegetation is plentiful, the birth rate of the deer is much higher than its death rate. However, the plateau limits the growth of the vegetation; thus there comes a point where there is insufficient food supply for the expanding deer population. The food supply is depleted and the deer population falls. Under some circumstances recovery is not possible and both populations collapse to zero.

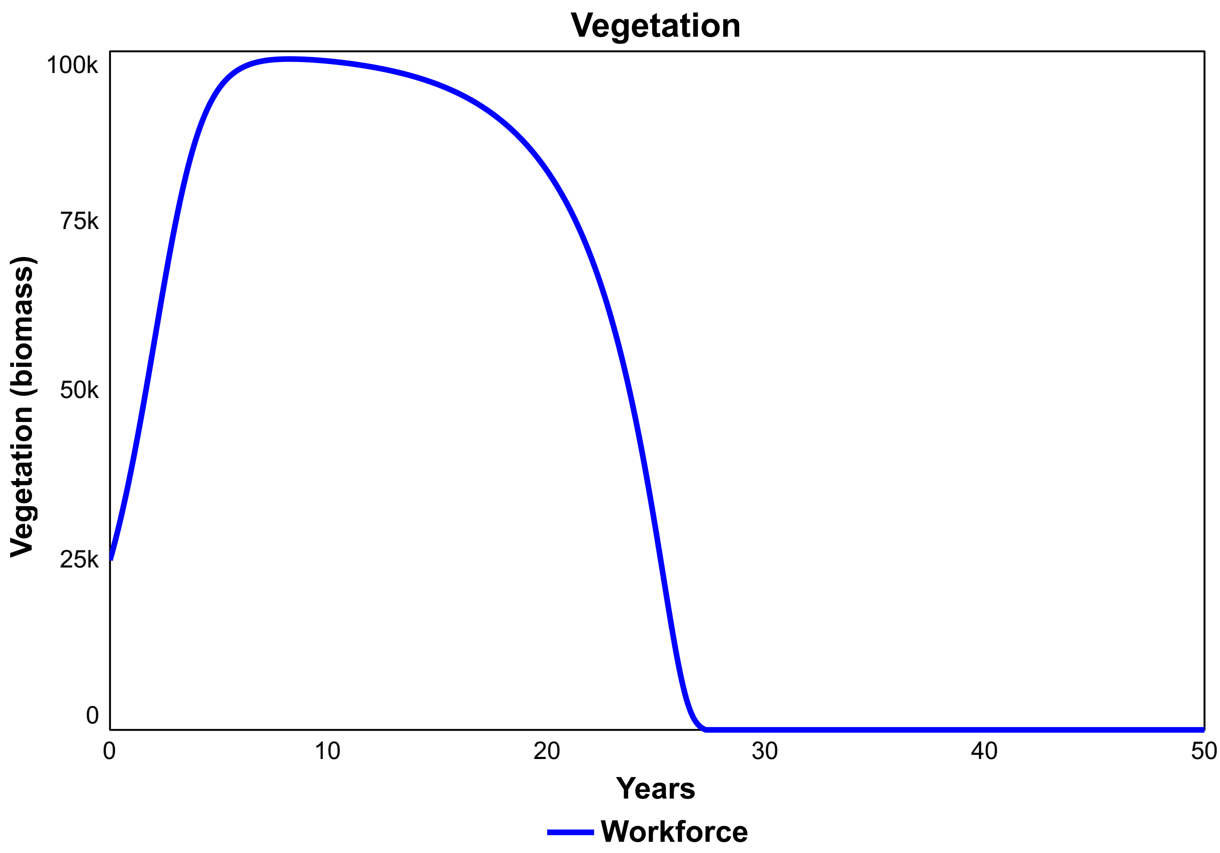


R1 – Reinforcing Loop, First Order
R2 – Reinforcing Loop, First Order
B3 – Balancing Loop, Second Order

B1 – Balancing Loop, First Order
B2 – Balancing Loop, First Order

- Mark on the diagrams (next page) the regions where each loop dominates behaviour.
- How does the second order loop, B2, affect each stock?





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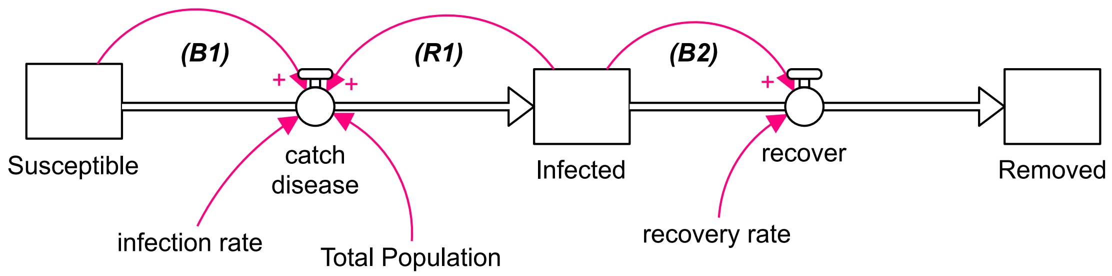
SIR Model

A disease spreads in a population of fixed size. Initially most people are susceptible (S) to the disease. An infected (I) person passes the disease on to a susceptible person, perhaps through contact, or through an airborne mechanism. People who are infected become infectious immediately, and remain so until the disease ends after a fixed period of time. Once cured, people are no longer susceptible to re-infection, the removed (R) category.

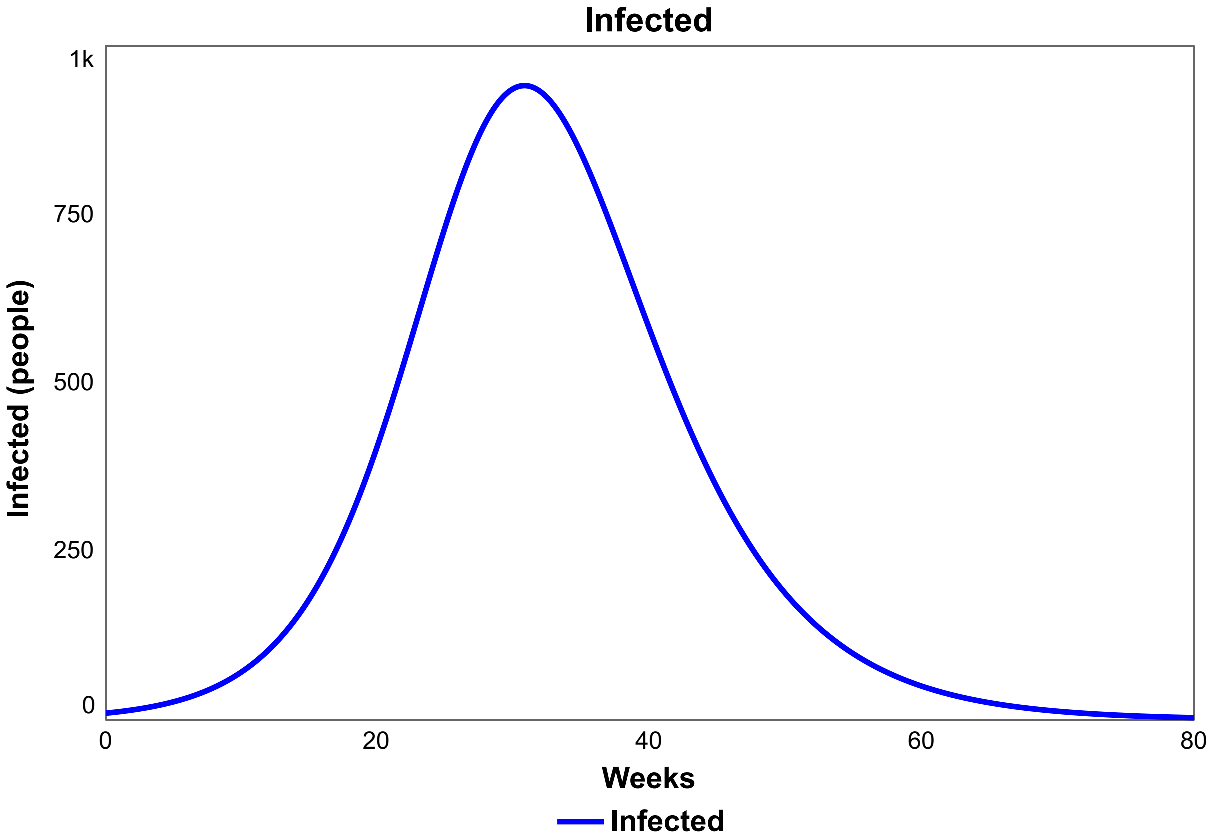


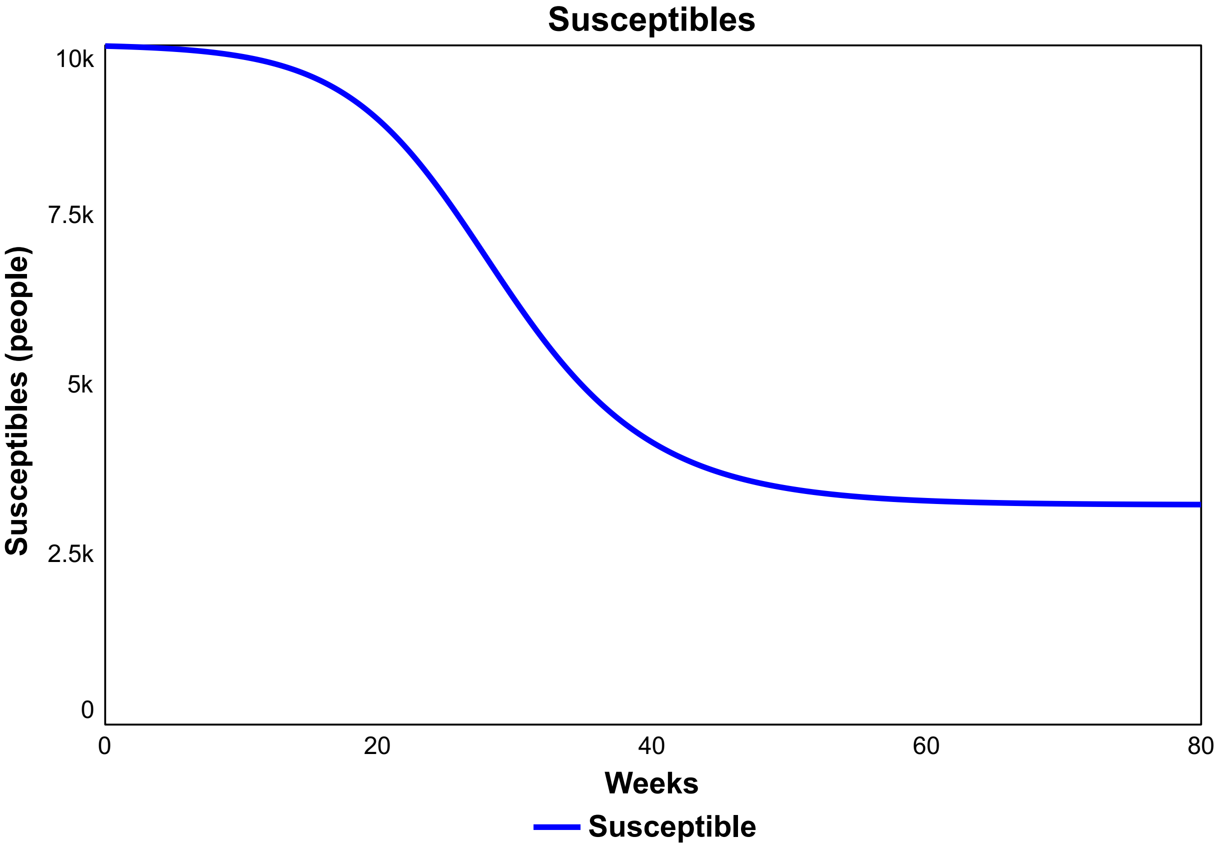
R1 – Reinforcing Loop, First Order

B1 – Balancing Loop, First Order

B2 – Balancing Loop, First Order

- Three feedback loops are <u>displayed</u> in the diagram. However, how many loops are really active in this model?
- Mark on the diagrams (next page) the regions where each loop dominates behaviour.
- How can the turning point in *Infected* be explained using feedback loops?





https://exchange.iseesystems.com/public/john-hayward/spread-of-disease