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# The Effect of Carrying Capacity and Reproduction Rate: A Summary

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We've focused on the effect of changes in $q$ to the behavior of the system, but of course, the reproduction rate $r$ could change as well. Generically, there are three behaviors the system can exhibit depending upon the choice of parameters $r$ and $q$.

1. A single non-zero equilibrium at a "low" value of $P$;

2. A single non-zero equilibrium at a high level of $P$;

3. Three equilibria: low-level, threshold, and high-level.

Examples of scenarios when you'd see these behaviors are:

1. High $r$ and a low $q$: in which case the combination of rapid budworm reproduction and poor environmental resources makes them survive at a low level. The graph of the line $r(1 - \frac{P}{q})$ versus $P$ has a large vertical intercept and a small horizontal intercept;

2. A low $r$ and a high $q$, in which case the good environment allows the worms to achieve their outbreak level. The graph of the line $r(1 - \frac{P}{q})$ versus $P$ has a small vertical intercept but a large
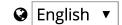
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horizontal intercept;

3. Intermediate combinations of $r$ and $q$ (such as $r = 1/2$ and $q = 8$) can create two stable equilibrium states, separated by a third (unstable) equilibrium. Unstable equilibria are not observed in nature —they merely act as thresholds to separate the regions of population which gravitate to one or the other stable ones. In this case, the initial conditions dictate the eventual fate of this system.

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