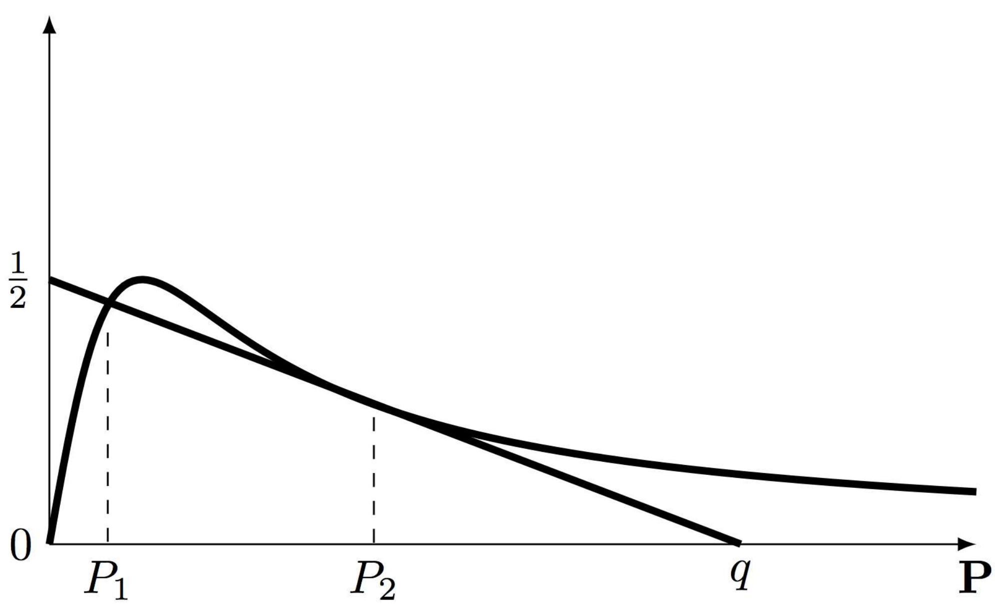
1.3.2 Exploratory Quiz: Increasing the Carrying Capacity q

Bookmark this page

We saw that by increasing q, the line becomes tangent to the curve. At this value of q, Wes said "a new equilibrium is born". We will call this value q_* and the new equilibrium P_2.

We now have three equilibria: $P = 0$, and P_1 and P_2 which correspond to where the curve and line intersect.

> **Note:** P_1 is our notation for the smaller equilibrium point, but we are not saying that P_1 is the same exact value as it was for the small q case shown earlier.



View Larger Image

Image Description

Question 1

1/1 point (graded)

Assume we start with some quantity of budworms ($P \neq 0$). **According to the mathematics of the model**, which of the following are possible long-term behaviors of the budworm population? If there is more than one, choose all such.

- You may find it useful to sketch arrows along the horizontal axis to indicate intervals where P is increasing or decreasing.
- Some of the options may not seem biologically realistic - this is discussed in the next question.

- [ ] Decrease toward zero $P = 0$
- [x] Increase toward the smaller non-zero equilibrium solution, P_1 ✔
- [x] Decrease toward the smaller non-zero equilibrium solution, P_1 ✔
- [ ] Increase toward the larger non-zero equilibrium solution, P_2
- [x] Decrease toward the larger non-zero equilibrium solution, P_2 ✔
- [ ] None of the above.

✔

Explanation

Choices B, C and E.

As $P = 0$ is an unstable equilibrium, the population will never tend toward it; that is, the population will never go extinct.

The smaller non-zero equilibrium P_1 is stable, so for P-values below it or between the two non-zero equilibria, the population will tend toward it.

For P-values above the larger equilibrium P_2, the population will decrease toward that P_2.

In theory, there are two main possible outcomes for the system, to tend toward the smaller or larger non-zero equilibrium. Which of these happens depends on the starting population. However, as we explore in the next question, the equilibrium at P_2 would never be observed in nature.

Submit You have used 1 of 3 attempts

Answers are displayed within the problem

As you probably noted, the equilibrium at P_2 is not stable. You might wonder: is it ever possible to observe this type of equilibrium $P = P_2$ in nature?

The answer is no. The differential equation is intended to model the mean value of the budworm population (the expected value), not an actual population value.

In reality, population is a discrete not continuous quantity, and random events can have small impacts on population. These random fluctuations in population would push a population to slightly below the equilibrium P_2 at some point in time. Since $\frac{dP}{dt} < 0$ for values just below P_2, this would then mean that the population would then decrease to P_1, the smaller stable equilibrium.

Question 2: Think About It...

1/1 point (graded)

What happens if we increase the carrying capacity q beyond the point of tangency? How many equilibria are there? Analyze their stability using this Desmos graph and record your observations. (If you already did this in the previous quiz, take this moment to try and identify the bifurcation in this system.)

```
there are 2 equilibria other than P=0, 1st ne unstable, 2nd
one stable.
```

✔

Thank you for your response.

The situation of large carrying capacity is discussed in the next video.

Submit You have used 2 of 2 attempts

Answers are displayed within the problem

Learn About Verified Certificates

English ▼