26. You and your friends have monitored two populations of wild lupine for one entire reproductive cycle (June – Year 1 to June – Year 2). By carefully mapping, tagging and taking a census of the plants throughout this period, you obtain the data listed in the table below.

Parameter	Population A	Population B
Initial # of plants	500	300
# of new seedlings established	100	30
# of initial plants that die	20	100

(a) Calculate the following parameters for each population. *Round your answer to the nearest hundredth.*

Parameter	Population A	Population B
Birth Rate **(B)**	$\frac{100}{500}$ = 0.20	$\frac{30}{300}$ = 0.10
Death Rate **(D)**	$\frac{20}{500}$ = 0.04	$\frac{100}{300}$ = 0.33
Population Growth Rate **(B - D)**	0.2 - 0.04 = 0.16	0.1 - 0.33 = -0.23

(b) Given the intitial population size of population A and assuming that the population is experiencing growth at the growth rate [*calculated above*], what will the number of plants be in each of the next 3 years. (Use the intial population size as time 0.) *Round your answer to the nearest whole number.*

Time (year)	Population	Work Space
0	500	500 x 0.16 = 80
1	580	580 x 0.16 = 92.8 = 93
2	673	673 x 0.16 = 107.7 = 108
3	781	781 x 0.16 = 124.9 = 125

(c) Given the intitial population size of population B and assuming that the population is experiencing growth at the growth rate [*calculated above*], what will the number of plants be in each of the next 3 years. (Use the intial population size as time 0.) *Round your answer to the nearest whole number.*

Time (year)	Population	Work Space
0	300	300 x -0.23 = -69
1	231	231 x -0.23 = -53.1 = -53
2	178	178 x -0.23 = -40.9 = -41
3	137	137 x -0.23 = -31.5 = -32

27. In a population of **600** squirrels, the *birth rate* **(B)** in a particular period is **.06** and the *death rate* **(D)** is **0.12**.

a) What is the *growth rate* of the population (B – D)? *Round your answer to the nearest hundredth.*

b) What is the actual number of squirrels that were born during this particular period? *Round your answer to the nearest whole number.*

c) What is the actual number of squirrels that died during this period? *Round your answer to the nearest whole number.*

28. In a population of **750** fish, **25** die on a particular day while **12** were born.

a) What is the *death rate* **(D)** for the day? *Round your answer to the nearest hundredth.*

b) What is the *birth rate* **(B)** for the day? *Round your answer to the nearest hundredth.*

c) What is the *growth rate* of the population (B – D)? *Round your answer to the nearest hundredth.*

29. In a population of **125** foxes, **10** die on a particular day and **22** were born on that day.

a) What is the *death rate* **(D)** for the day? *Round your answer to the nearest hundredth.*

b) What is the *birth rate* **(B)** for the day? *Round your answer to the nearest hundredth.*

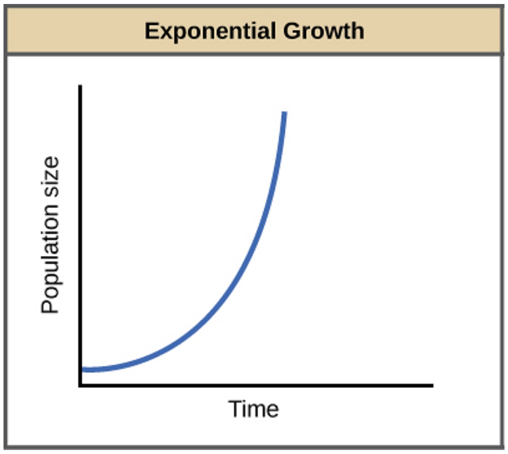
c) What is the *growth rate* of the population (B – D)? *Round your answer to the nearest hundredth.*

Kahn Academy: Exponential Growth

Exponential growth is continuous population growth in an environment where resources are unlimited; it is **density-independent growth**.

Most density-independent factors are **abiotic**, or nonliving, and include:

temperature	DO - dissolved O_2
natural disasters	pollution



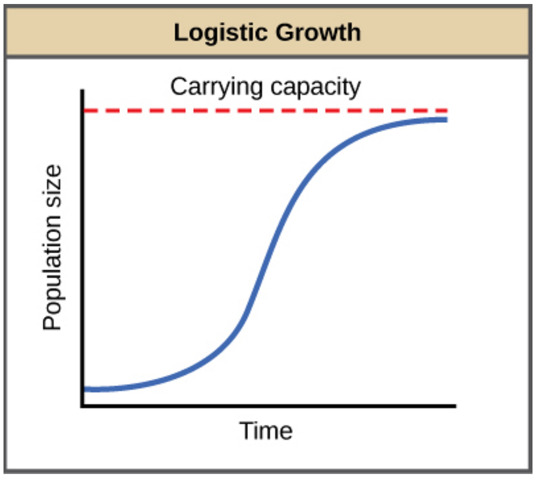
Formula: $$\frac{dN}{dt} = r_{max} N$$

Kahn Academy: Logistic Growth

Logistic growth is continuous population growth in an environment where resources are limited; it is **density-dependent growth.**

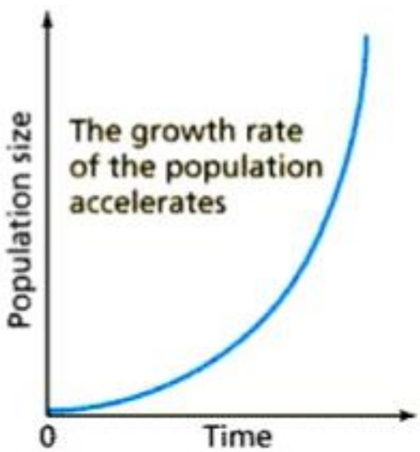
Most density-dependent factors (*a limiting factor that depends on population size*) are mainly **biotic**, or living, and include:

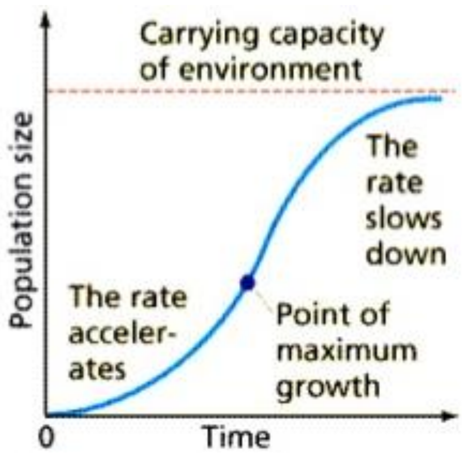
disease (Viruses, Bacteria)	competition
predation	migration



Formula: $$\frac{dN}{dt} = r_{max} N\left(\frac{K-N}{K}\right)$$

Exponential vs Logistic Growth





30. A certain population **A** is experiencing **exponential growth**.
Population size = **50**
Births = **10**
Death = **4**

$$\frac{dN}{dt} = r_{max} N$$

a) Calculate the individual growth rate (r_{max}). This is also known as *the maximum per capita growth rate of a population rate.*

$B - D = r_{max}N$

$\frac{10-4}{50} = r_{max}$

$\frac{6}{50} = r_{max}$

$0.12 = r_{max}$

b) Calculate the population growth rate.

$\frac{dN}{dt} = r_{max}N$

$\frac{dN}{dt} = (0.12)(50)$

$\frac{dN}{dt} = 6$

$B = \frac{10}{50} = 0.2$

$D = \frac{4}{50} = 0.08$

$B - D = 0.2 - 0.08 = 0.12$

31. A certain population **B** is experiencing **logistic growth**.
Population size = **50**
Use the same growth rate as in the previous question.

$$\frac{dN}{dt} = r_{max} N\left(\frac{K-N}{K}\right)$$

r_{max} = 0.12
Carrying capacity (**K**) = **400**

a) Calculate the population growth rate.

$\frac{dN}{dt} = (0.12)50\left(\frac{400-50}{400}\right)$

$\frac{dN}{dt} = (0.12)50\left(\frac{350}{400}\right)$

$\frac{dN}{dt} = 6(0.875)) = 5.25$

b) Given that the individual growth rates (r_{max}) of the populations above were equal, explain why the population growth rates were different between population A and B.

The growth rate for population A is 6 and the growth rate for population B is 5.25. Population A has a slightly higher growth rate because population A is experiencing exponential growth where limiting factors and carrying capacity do not come into play. The growth rate of Population B is only slightly lower because a population size of 50 is far from its carying capacity of 400 so may still be experiencing exponential growth where limiting factors have yet to come into play.

$\frac{dN}{dt} = (0.12)50\left(\frac{400-450}{400}\right)$

$\frac{dN}{dt} = 6(-0.125) = -0.75$

32. The following population, C, has no limits on food resources or space.
Population size = **500**
Births = **240**
Deaths = **170**

$$B - D = r_{max}N$$

a) Calculate the growth rate (r_{max}).

$$\frac{B - D}{N} = r_{max}$$

$$\frac{240-170}{500} = r_{max}$$

$$\frac{70}{500} = \underline{0.14} = r_{max}$$

b) How many individuals will be in the population at the start of the second generation?

(0.14)(500) = 70
70 + 500 = <u>570 individuals</u>

c) How many individuals will be in the population at the start of the third generation?

(0.14)(570) = 79.8 = 80
80 + 570 = <u>650 individuals</u>

(logistic growth)

$$\frac{dN}{dt} = r_{max}N\left(\frac{K - N}{K}\right)$$

33. Now consider population D, in which food resources are limited.
Population size = **500**
Use the same growth rate as in the previous question.

r_{max} = 0.14
Carrying Capacity **(K)** = 1,000

a) How many individuals will be in the population at the start of the second generation?

$$\frac{dN}{dt} = (0.14 \times 500)\left(\frac{1000 - 500}{1000}\right)$$

$$\frac{dN}{dt} = (70)(0.5) = 35$$

35 + 500 = <u>535</u>
individuals at the start of the 2nd generation.

b) How many individuals will be in the population at the start of the third generation?

35 + 535 = <u>570</u> individuals at the start of the 3rd generation.

34. There are **300** falcons living in a certain forest at the beginning of 2013. The population is under carrying capacity. If the maximum per capita growth rate **(r_{max}) = 0.1** falcons/year, predict the population size of the falcon population each year for the next four years.

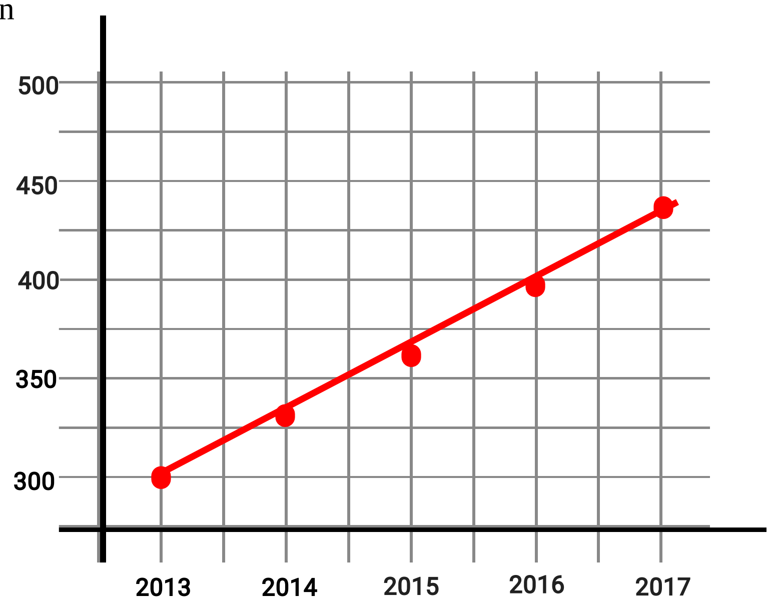
$$\frac{dN}{dt} = r_{max} N$$

Round your answer to the nearest whole number.

2014	2015	2016	2017
300 x 0.1 = 30 300 + 30 = 330	330 x 0.1 = 33 330 + 33 = 363	363 x 0.1 = 36 363 + 36 = 399	399 x 0.1 = 40 399 + 40 = 439

(a) Using the information from above, fill in the table below and construct the graph.

Year	Population Size
2013	300
2014	330
2015	363
2016	399
2017	439



(b) Find the **average rate of change** *(slope)* for the falcon population from 2013 to 2018.

Round your answer to the nearest tenth.

Slope = $m = \frac{rise}{run} = \frac{y_2 - y_1}{x_2 - x_1}$ = $\frac{439 - 300}{2017 - 2013}$ = $\frac{139}{4}$ = 34.8

35. Utica, NY had a population of **49,000** in the year 2013. The infrastructure of the city allows for a carrying capacity of **60,000** people. r_{max} = **0.9** for Utica.

(a) Is the current population above or below the carrying capacity? Below

(b) Will the population increase or decrease in the next year? Increase

(c) What will be the population growth for 2013?
Round your answer to the nearest whole number.

Formula: $$\frac{dN}{dt} = r_{max} N \left(\frac{K - N}{K} \right)$$

$$\frac{dN}{dt} = (0.9 \times 49{,}000) \left(\frac{60{,}000 - 49{,}000}{60{,}000} \right)$$

$$= (44{,}100)(0.183)$$

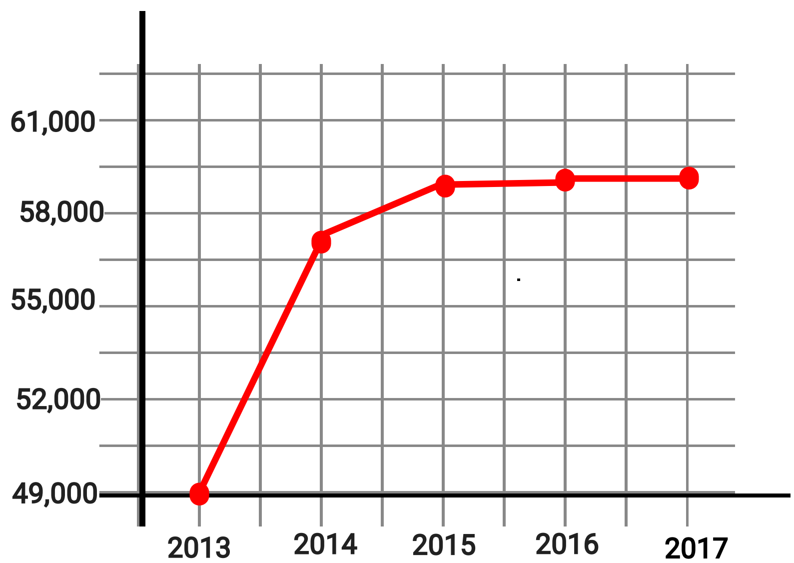
$$\frac{dN}{dt} = (44{,}100)(0.183) = 8070$$

(d) What will the population size be at the start of 2014?

8070 + 49,000 = 57,070

(e) Fill in the data table and construct a graph.

Year	Population size	Population growth
2013	49,000	8070
2014	57,070	2508
2015	59,578	377
2016	59,955	40
2017	59,995	4



(f) What happened to the population size over the years? Increased

(g) What happened to the population growth over the years? Decreased

(h) Explain your answer from f and g using what you know about carrying capacity.

Growth rate begins to decrease as the population continues to increases and approaches its carrying capacity (K).