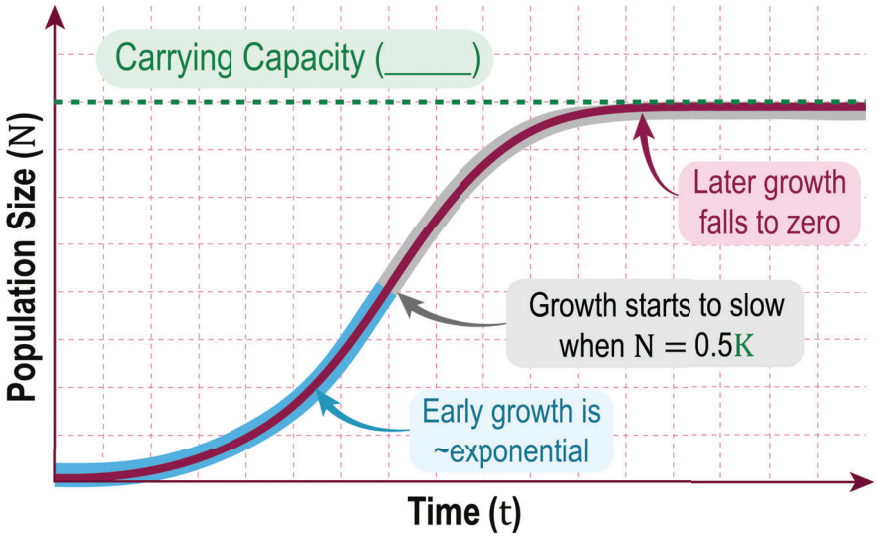
TOPIC: LOGISTIC POPULATION GROWTH

Logistic Growth in a Limited Environment

- In nature, unlimited/exponential growth does _____ occur for too long because of limited resources.
- **Logistic Growth:** accounts for environmental _____ on population growth.
  - Density-_____ factors prevent population size (N) from permanently exceeding carrying capacity K.
  - *Recall*: **Carrying Capacity (K)**: the theoretical _____ population an area can sustain at any given time.



$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

Instantaneous Growth Rate

Has a sigmoid (_____-shaped) curve.

When N is _____,

logistic growth ≈ exponential growth.

When N approaches K,

logistic growth → 0.

EXAMPLE

For a population of barn owls, the intrinsic growth rate (r) is 0.15 owls per year per owl and the carrying capacity (K) is 500 owls. Calculate the instantaneous population growth rate when the population size is:

- 50 individuals.
- 250 individuals.
- 450 individuals.

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PRACTICE

In some cases, a population can exceed its carrying capacity for a brief period of time. In a population of dragonflies that approaches its carrying capacity, many females use the last of their energy reserves to reproduce. As a result, the population size reaches 675 dragonflies, but the estimated carrying capacity (K) of the area is 550 dragonflies. The r_{max} value for this population is 0.5. Calculate the rate of population growth $(\frac{dN}{dt})$ & the per capita rate of growth, $r(1-\frac{N}{K})$.

a) $\frac{dN}{dt} = -97, r(1-\frac{N}{K}) = -0.14$

b) $\frac{dN}{dt} = -77, r(1-\frac{N}{K}) = -0.11$

c) $\frac{dN}{dt} = -153, r(1-\frac{N}{K}) = -0.23$

d) $\frac{dN}{dt} = 828, r(1-\frac{N}{K}) = 0.23$

PRACTICE

A population of spotted hyenas in a South African National Park currently has 87 individuals. The carrying capacity for spotted hyenas in the park is estimated to be 125 hyenas & the intrinsic growth rate (r) is 0.25 hyenas/year/hyena. What is the instantaneous rate of population growth of the spotted hyena population?

a) 22 hyenas/year.

b) 7 hyenas/year.

c) 15 hyenas/year.

d) 13 hyenas/year.

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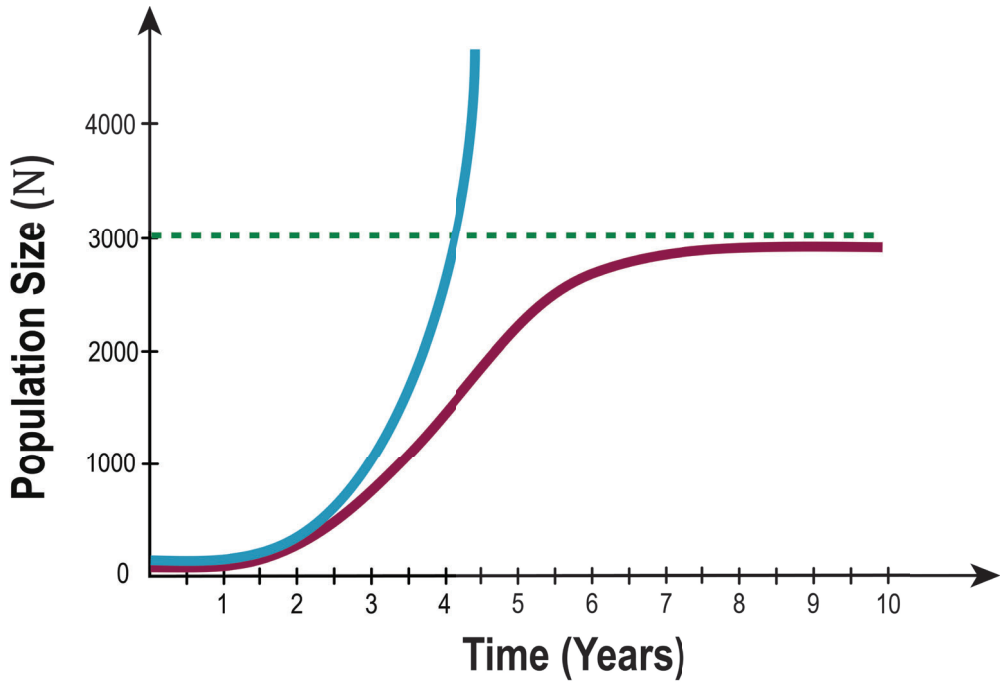
Exponential Growth vs. Logistic Growth

- Let's observe how the exponential & logistic growth models differ if we apply them to the same population:
  - We'll set the initial population size (N) as 50, intrinsic growth rate (r) as 1.0, & carrying capacity (K) as 3000.



Total Population Size (N)	Exponential Population Growth Model			Logistic Population Growth Model		
	r	$\frac{dN}{dt} = rN$	Time (Years)	$r(1-\frac{N}{K})$	$\frac{dN}{dt} = rN(1-\frac{N}{K})$	Time (Years)
50 (Start)	1.0	+50	0 (Start)	0.983	+49	0 (Start)
200	1.0	+200	1.39	0.933	+187	1.44
1,000	1.0	+1,000	3.00	0.667	+667	3.38
1,500 = 0.5K	1.0	+1,500	3.40	0.500	+750	4.08
2,000	1.0	_____	3.69	0.333	_____	4.77
2,500	1.0	+2,500	3.91	0.167	+417	5.68
3,000 = K	1.0	+3,000	4.09	0.000	+0	∞
4,000	1.0	+4,000	4.38	-0.333	**-1,333**	N/A

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Summary of Key Features & Assumptions for Each Population Growth Model

Features/Assumptions	Linear Model	Exponential Model	Logistic Model
Constant Population Growth Rate ($\frac{\Delta N}{\Delta t}$)?	_____ (Constant $\frac{\Delta N}{\Delta t}$ regardless of N).	_____	_____
Population Growth Rate ($\frac{\Delta N}{\Delta t}$) is Proportional to Population Size (N)?	_____	_____ (Directly $\propto$).	_____
Population Growth Rate ($\frac{\Delta N}{\Delta t}$) initially increases but then decreases as population size (N) gets large?	_____ (Constant $\frac{\Delta N}{\Delta t}$ regardless of N).	_____ ($\frac{\Delta N}{\Delta t}$ continually increases).	_____
Constant Per Capita Population Growth Rate (r)?	_____ (Ignores Per Capita Growth).	_____	_____ (r modified by $(1 - \frac{N}{K})$).
Unlimited Resources?	_____	_____	_____ (Resources are limited).
Carrying Capacity (K)?	_____	_____	_____
Considers Density-Dependent Factors?	_____	_____	_____
Closed Population?	All the Same (_____)		
Homogenous Environment?			
Ignore Age Structure?			
Ignore Sex Ratio?			
Ignore External Factors Affecting (N) (ex. Density-Independent Factors)?			