Population Ecology

What is a population

- A group of individuals of a species that live in an area and rely on the same resources for survival often interacting and breeding with one another

Population Characteristics

- Density
- Dispersion
- Demography
  - Life Tables
  - Survivorship curves
  - Reproductive rates

Life Histories-Trade off between survival and reproductive traits

- When reproduction begins
- How often the organism reproduces
- How many offspring are produced during each reproductive episode

Reproduction Types

- Semelparity/Big Bang Reproduction
  - Ex. Pine Looper Moth

- Iteroparity/Repeated Reproduction
  - Lizards

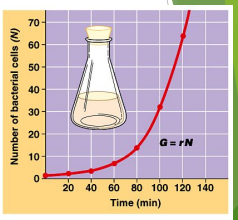
Why choose one over the other?

Studying Populations

- Exponential growth model – the rate of expansion of a population under ideal conditions
- Population-limiting factors – hunting, amount of space suitable for breeding, restricted population growth, food availability
- Logistic growth model – idealized population growth slowed by limiting factors as the population size increases
- Carrying capacity – the maximum population size that an environment can support at a particular time with no degradation to the habitat

Exponential Growth

Time	Number of Cells	
0 minutes	1	$= 2^0$
20	2	$= 2^1$
40	4	$= 2^2$
60	8	$= 2^3$
80	16	$= 2^4$
100	32	$= 2^5$
120 (= 2 hours)	64	$= 2^6$
3 hours	512	$= 2^9$
4 hours	4,096	$= 2^{12}$
8 hours	16,777,216	$= 2^{24}$
12 hours	68,719,476,736	$= 2^{36}$

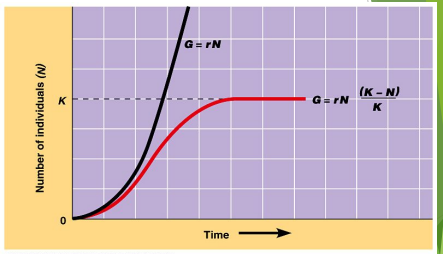


G= growth of population over time (dN/dt)

r=tells if the population is growing (per capita rate of increase) r=0 with ZPG

N= population size

Logistic growth and exponential growth compared

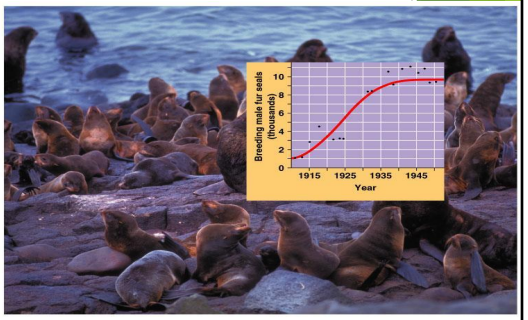


K= carrying capacity

K-N= the number of additional individuals the environment can accommodate

(K-N)/K= fraction of K that is still available for population growth

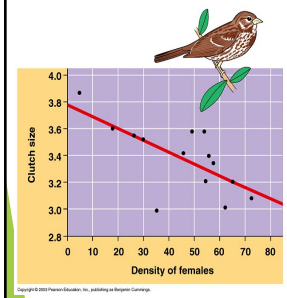
Growth of a population of fur seals



What does the logistic growth model suggest about real populations in nature?

- A population's growth rate will be small when the population size is either small or large and highest when the population is at an intermediate level relative to the carrying capacity.
- Limiting factors make the birth rate decrease, the death rate increase or both
- Eventually the population will stabilize at the carrying capacity when the birth rate equals the death rate
- These are mathematical models and no population fits either perfectly

Some factors that limit population growth



- As density of song sparrows increase, the number of eggs laid decreases because of food shortages
- Plants grown under crowded conditions tend to be smaller and less likely to survive
- Disease transmission or accumulation of toxic waste products can increase mortality

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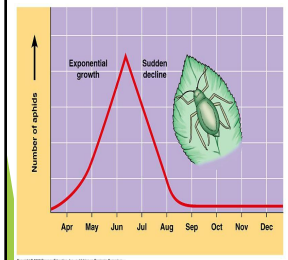

- A predator may capture more of a particular kind of prey as the prey becomes abundant
- White-footed mice stop reproducing at a colony size of 30-40 even when food and shelter are provided. Stress?
- The graph shows aphids which feed on the phloem sap of plants increase in population in the summer and then die-off in the fall and winter

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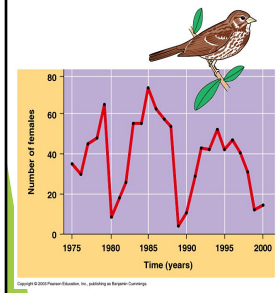
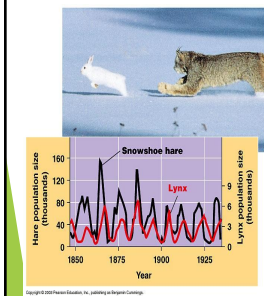


- Some populations remain fairly stable in size close to carrying capacity
- Most populations fluctuate as seen at the left
- This graph shows song sparrow populations, with periodic catastrophic reductions due to severe winter weather

Boom and bust cycles

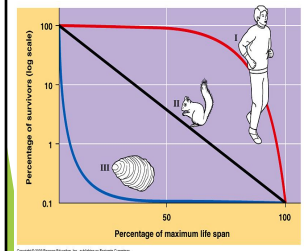


- Hare cycles may be caused by increasing food shortages during winter caused by overgrazing
- They may be due to predator-prey interactions
- Cycles could be affected by a combination of food resource limitation and excessive predation
- Predators reproduce more slowly than their prey so they always lag behind prey in population growth.

Regulation of Populations

- Density Independent
  - Birth and death rate does not change with population density
- Density Dependent
  - Death rate that rises as population density rises
    - Competition for resources
    - Territoriality
    - Health
    - Predation
    - Toxic Waste
    - Physiological factors
- Population Dynamics
  - Complex interactions between biotic and abiotic factors
- Population Cycles
  - Boom and bust cycles
    - Snowshoe hare and lynx

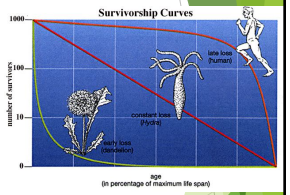
Survivorship curves



- Type I curve – produce few offspring and give them good care
- Type III curve – high death rates for very young then a period when death rates are lower for those who survive to a certain age

Logistic Model & Life Histories

- K-Selection
  - Occur near carrying capacity
  - Density dependent
  - Low reproductive rates and high care
  - Type I Survivorship Curve
- r-Selection
  - High Reproductive Rates
  - Unpredictable environments
  - Density Independent
  - Type III Survivorship Curve



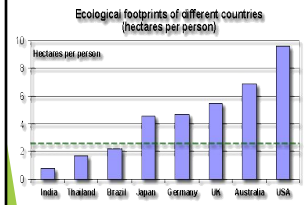
Life tables – compiled by life insurance agents

Table 2

Healthy life expectancy, for both sexes, based on self-evaluation of poor health. *World Health Survey*, Brazil, 2003.

Age			Traditional life table					Poor health	People-years		Life expectancy		
1	2	3	4	5	6	7		8	9	10	11	12	13
	Mortality rates	Probability of death	Survivors	Years lived between ages x, x+n	Years lived, starting at age x	Life expectancy		Prevalence (%)	With good self-rated health between the ages (x; x+n)	With good self-rated health starting at age x	Healthy since age x	In poor health state	Years lived in poor health state
x	${}_nM_x$	${}_nq_x$	l_x	${}_nL_x$	T_x	e_x		${}_nP_x$	$(1-{}_nP_x/100)^*L_x$	TH*	e'_x	$e_x-e'_x$	%
20	0.00188	0.0094	100,000	497,656	5,433,619	54.34		3.58	479,829	4,739,131	47.39	6.94	12.8
25	0.00216	0.0108	99,062	492,646	4,935,963	49.83		3.90	473,417	4,259,302	43.00	6.83	13.7
30	0.00256	0.0127	97,996	486,867	4,443,316	45.34		3.80	468,354	3,785,885	38.63	6.71	14.8
35	0.00318	0.0158	96,750	479,933	3,956,450	40.89		6.79	447,324	3,317,531	34.29	6.60	16.1
40	0.00432	0.0214	95,223	471,029	3,476,517	36.51		7.80	434,275	2,870,207	30.14	6.37	17.4
45	0.00602	0.0296	93,189	459,040	3,005,489	32.25		10.98	408,644	2,435,932	26.14	6.11	19.0
50	0.00829	0.0406	90,427	442,961	2,546,448	28.16		13.72	392,183	2,027,287	22.42	5.74	20.4
55	0.01193	0.0579	86,757	421,219	2,103,487	24.25		15.85	354,476	1,645,104	18.96	5.28	21.8
60	0.01700	0.0816	81,730	391,988	1,682,268	20.58		17.12	324,877	1,290,628	15.79	4.79	23.3
65	0.02450	0.1154	75,065	353,666	1,290,280	17.19		21.05	279,210	965,751	12.87	4.32	25.2
70	0.03660	0.1677	66,401	304,174	9,366,15	14.11		20.26	242,544	686,541	10.34	3.77	26.7
75	0.05437	0.2393	55,268	243,275	632,440	11.44		24.14	184,554	443,997	8.03	3.41	29.8
80	0.10803	1.0000	42,042	389,165	389,165	9.26		33.33	259,443	259,443	6.17	3.09	33.3

Human carrying capacity estimates



- Ecological footprint with multiple constraints such as food, fuel, water, housing, and waste disposal used.
- Calculates current demand on resources by each country in hectares of land per person
- World ecological capacity is 2.3 ha per person alive in 2005