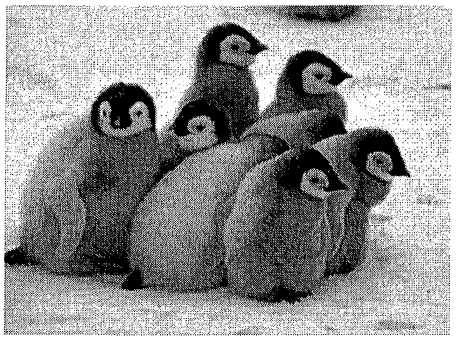
Name _____ Hour _____

UNIT 14: POPULATIONS

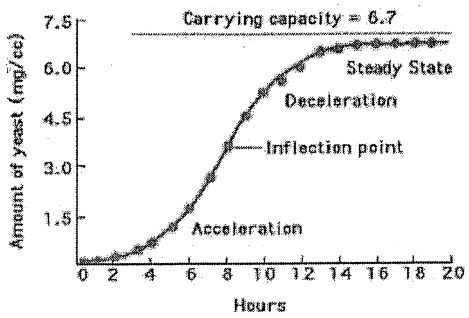
Learning Goals



1. I can list the characteristics used to describe a population.
2. I can identify several biotic and abiotic factors that affect population size and growth.
3. I can differentiate between exponential and logistic growth and describe the conditions in which each growth pattern would occur.
4. I can differentiate between density-dependent and density-independent limiting factors and give examples of each.
5. I can describe how the size of the human population has changed over time and explain why those changes occurred.
6. I can explain why population growth rates differ in countries throughout the world.
7. I can use survivorship curves and age- structure diagrams to make predictions about a population
8. I can describe the predator-prey cycle and explain why it occurs.

Vocabulary

- Age-structure diagram
- Carrying capacity
- Demographic transition
- Demography
- Density-dependent limiting factor
- Density-independent limiting factor
- Emigration
- Exponential growth
- Immigration
- Limiting factor
- Logistic growth
- Population density
- Predator-prey relationship
- Survivorship Curve



UNIT 14 WARM-UPS

Populations Notes

e four characteristics of a population are:

- Geographic distribution
- Density
- Growth Rate
- Age Structure

GEOGRAPHIC DISTRIBUTION –
a description of the area inhabited by a particular species

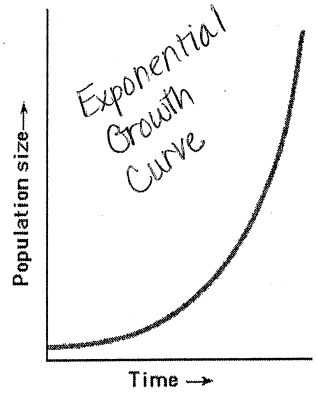
- What is the geographic distribution of humans?
  all land masses except areas around poles

POPULATION DENSITY –
# of individuals per unit area (example 100 people/mi^2)

- What areas of the US have the highest population densities? Why?
  ↳Along coastlines & river systems. ↳Humans need H_2O!

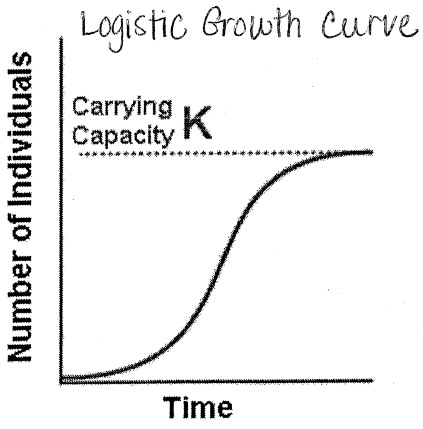
The **GROWTH RATE** of a population is affect by 3 factors:

births
deaths (entering) (leaving)
individuals immigrating / emigrating



- **Exponential Growth –** can only happen in the presence of unlimited resources and the absence of predation or disease.

- **Logistic Growth –** Eventually a population will run out of resources, causing the population's growth to slow and eventually stop

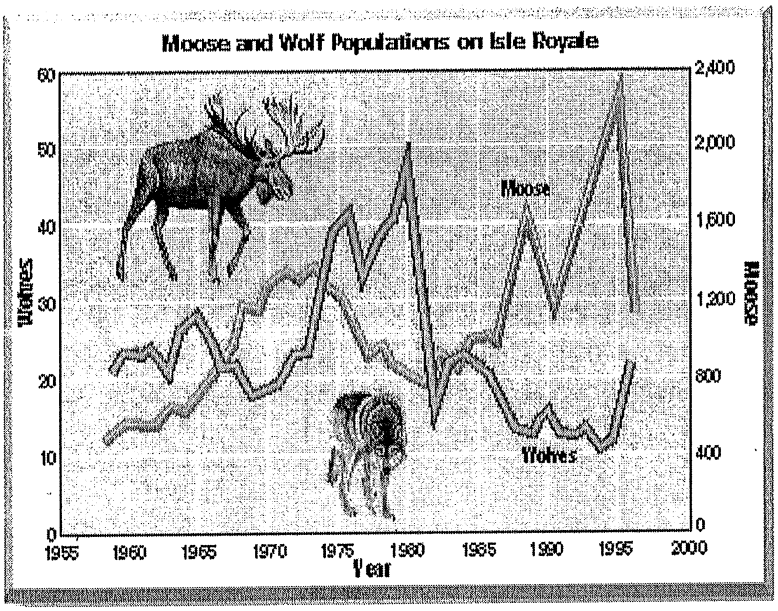


- **Carrying Capacity -** the largest # of individuals an environment can support
  - There is only a certain amount of food and space available for organisms. Then there isn't enough food then food is considered a limiting factor because it limits how many individuals a population can have
  - If humans continue on our current path we will find the carrying capacity of the Earth. What will happen then? Humans will die.

FACTORS AFFECTING THE GROWTH RATE OF A POPULATION

- **Limiting Factor** – some factor that causes population growth to decrease

- **Density Dependent Limiting Factor** – depends on the density of the population
  - Competition - for food, space, water, sunlight, etc. It can occur within or between species. It is a major force behind evolutionary change.
  - Predation - can be an effective way to control a population and is a cyclic process.
  - Parasitism and Disease - hosts must be in contact in order to transmit diseases or a parasites, so the more dense a population is, the more disease and parasites can spread. (college dorms are great incubators of disease :)



Describe the predator-prey cycle:
① Prey population increases
② Predator pop ↑
③ Prey pop ↓
④ Predator pop ↓

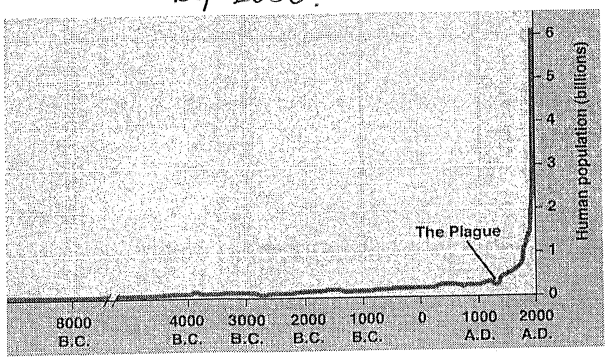
- **Density Independent Limiting Factors** – factors that affect the population in similar ways, no matter how dense it is
  - Unusual weather- drought, heat wave
  - Natural disasters - flood, tsunami, tornado, hurricane, earthquake, fire
  - Seasonal cycles - insect & plant pops decrease dramatically in winter months
  - Human activities - deforestation, agriculture, pollution

* UN projects 9.6 Billion people by 2050
* Current US growth rate 0.7% annually

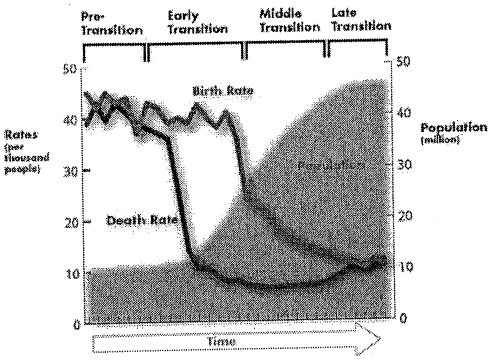
Niger 3.8
Kuwait 3.9
Oman 9.1
S. Sudan 4.3
Uganda 3.4
Zambia 3.2

HUMAN POPULATION GROWTH

- In the US and other developed countries, the growth rate is very low
- In some developing countries the growth rate is 3 people per second
- Projections show that the population will reach 9.6 Billion ~~in your lifetime.~~ by 2050.
- Humans had a long, slow start. We began to grow exponentially after improvements of medicine, sanitation, agriculture energy use & technology

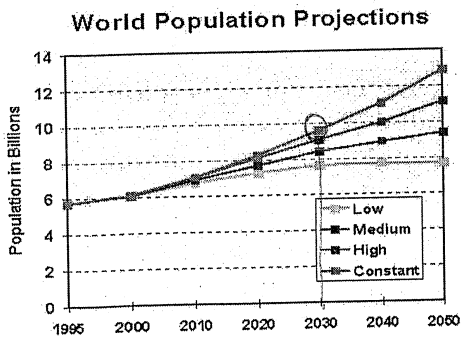


- **Demography** – the scientific study of human populations. It examines the characteristics of the human population and attempts to explain how those characteristics change over time.



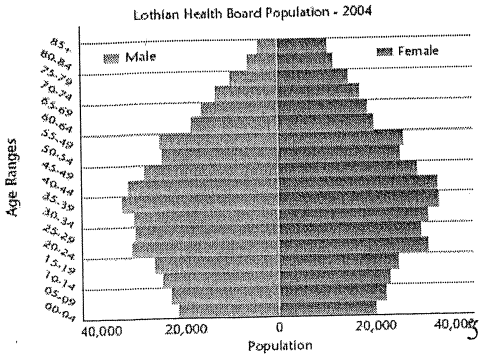
- **Demographic Transition** – change over time from ↑ Birth rates & death rates to ↓ Birth rates & death rates.

- According to the world population projections, what will the world's population be when you are 30 years old, if the population continues growing at its current rate?
  Between 9 & 10 Billion



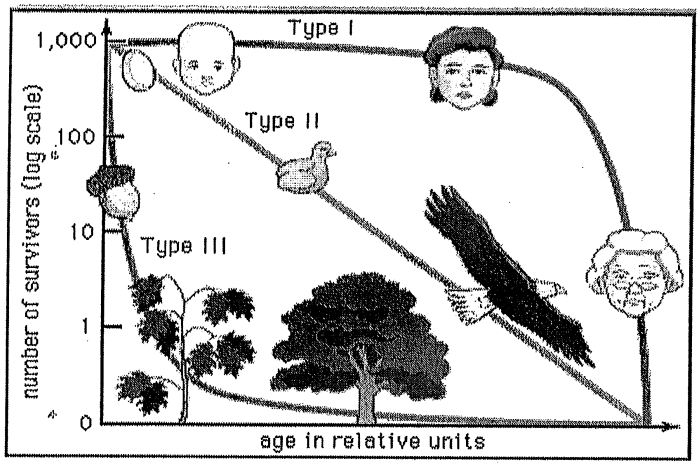
AGE STRUCUTRE

- What does an age structure diagram show?
  # of individuals in each age group in a population.
- What can we tell about a population based on the shape its age structure diagram?
  whether or not a population has undergone demographic transition



Population Patterns Notes

ANALYZING SURVIVORSHIP CURVES

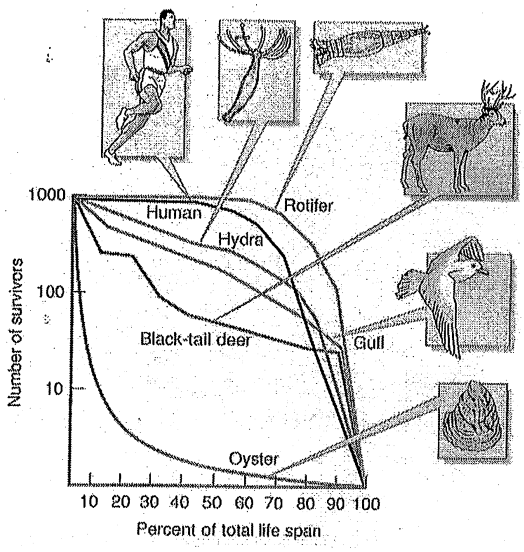


Type I: low infant mortality
most survive to old age

Type II: steady death rate
throughout lifespan

Type III: high infant mortality
few survive to adulthood

What does a survivorship curve show?



1. Which type of survivorship curve does the oyster have?

Type III

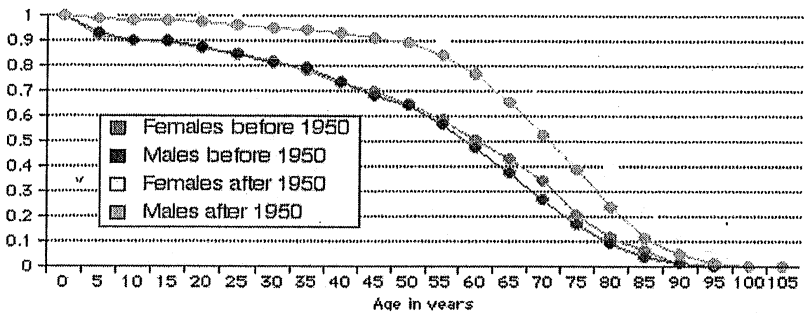
2. Which organism has a survivorship curve closest to type II? EXPLAIN

Gull - steady death rate up to a certain age at which most gulls die

3. Which organism has a lower infant mortality rate than humans?

Rotifer (freshwater zooplankton)

Human Survivorship Curves for the United States



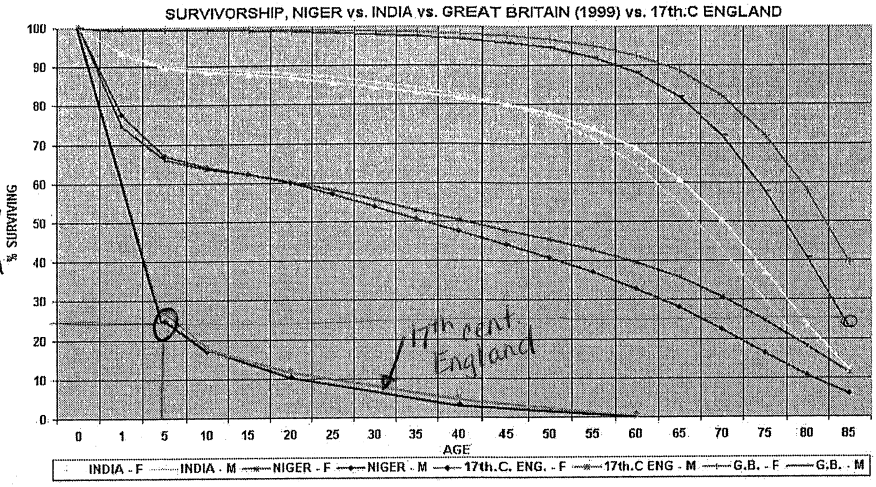
1. Who tends to live longer, males or females?

2. Before 1950 there was a steep drop in survivorship within the first few years. What does this show?

higher infant mortality

3. What are some reasons for the shape change in the human survivorship curve in the last century?

We have made major advancements in medicine, sanitation, food safety, safety regulations, etc.



1. Why does the survivorship curve drop so sharply for 17th Century England?

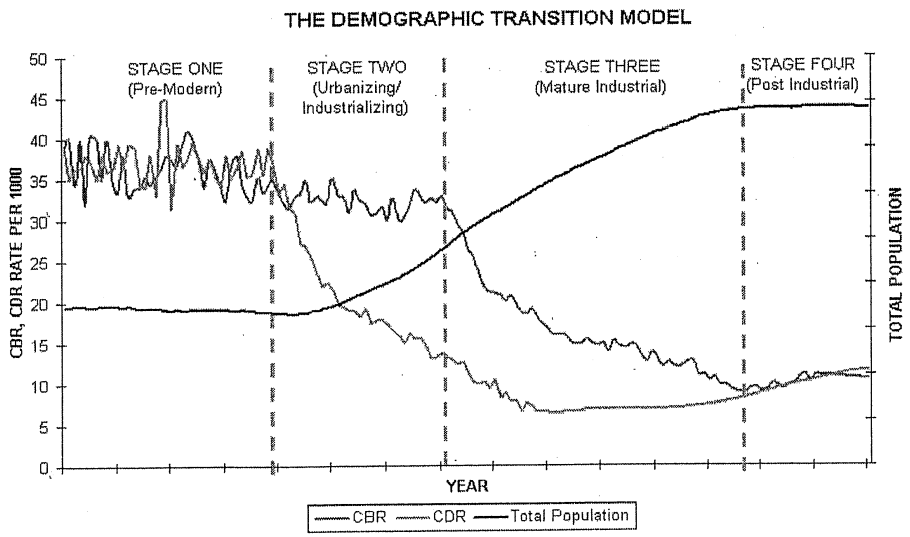
no medicine
poor sanitation
undependable food supply
no heating / refrigeration

2. What do the shapes of the survivorship curves for Niger, India and Great Britain tell you about the development of these countries?

Niger is least developed
G.B. is most developed (↓ bic infant mortality)

What percent of the population survived to age 5 in 17th century England? ~25% How old are people in modern day Great Britian before they reach the same % survivorship as 5 year olds in 17th century England? 85 years old

ANALYZING DEMOGRAPHIC TRANSITION



STAGE I: ↑ Birth rate
↑ Death rate
No population growth

STAGE II:
↑ B.R., falling D.R.
pop. growing

STAGE III:
falling BR, ↓ DR
pop. growing

STAGE IV:
↓ BR, ↓ DR
No pop. growth

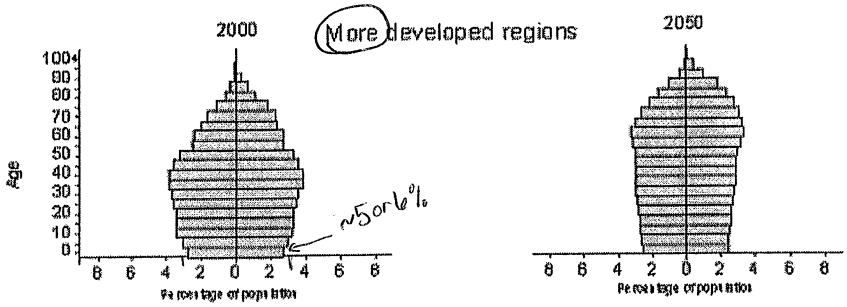
1. If the death rate is so low in stage four of demographic transition, why isn't the population growing?

the birth rate is very low as well.

ANALYZING AGE STRUCTURE DIAGRAMS

1. What does an age distribution diagram show?

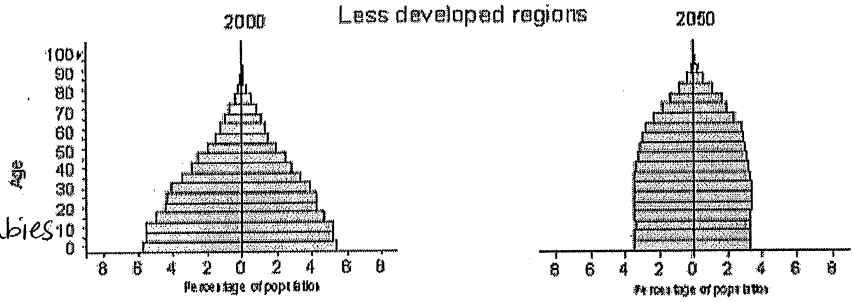
   # of % of individuals in each age group in a population



2. In 2000, what percent of the population did babies make up for the least developed country? For the most developed country?

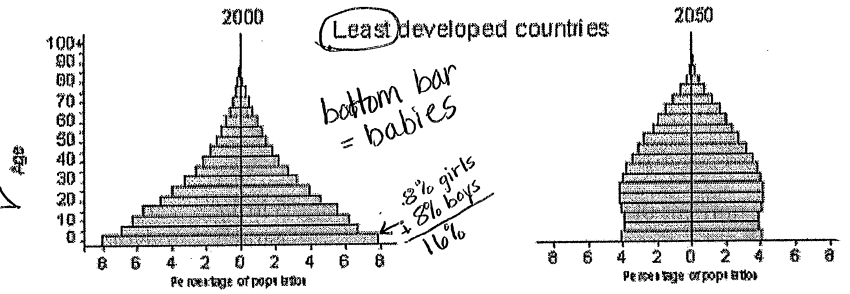
   least = 16% babies

   most = between 5 & 6% babies



3. As you move from the undeveloped country to the developed country, how does the shape of the age distribution diagram change?

   changes from pyramid shape to skyscraper shape



4. What does a pyramid shape tell you about birth and death rates?

   High birth rates, High death rates

5. What is happening to the bottom of the age distribution diagram for more developed countries?

   getting smaller

   What does this mean?

   lower birth rate

Human Population Video

1. On October 12, 1999 the world's population reached _____ billion people.
2. It is estimated that by the year 2050 the world's population will be _____ billion.

   How old will you be in 2050? _____
3. In 1965 the world's population was approximately _____ billion.
4. How much of the planet's population is under 25 years of age? _____
5. How many years is the average woman fertile? _____
6. What strategy was used in India to change the minds of the people with regard to family planning?

   Did it work? _____
7. Approximately how many years would it take you to count to 1 billion? _____
8. What drastic measures did China take to control its population? _____
9. Most populous nations in order:

   1. _____
   2. _____
   3. _____
10. What is the ideal replacement rate? _____ children per couple
11. American style consumption is very _____ of the earth's resources.
12. What is the replacement rate necessary to bring the population back down to 2 billion, where it was after WWII and what is required to sustain a high quality of life for the people on the planet?

    _____ children per couple.

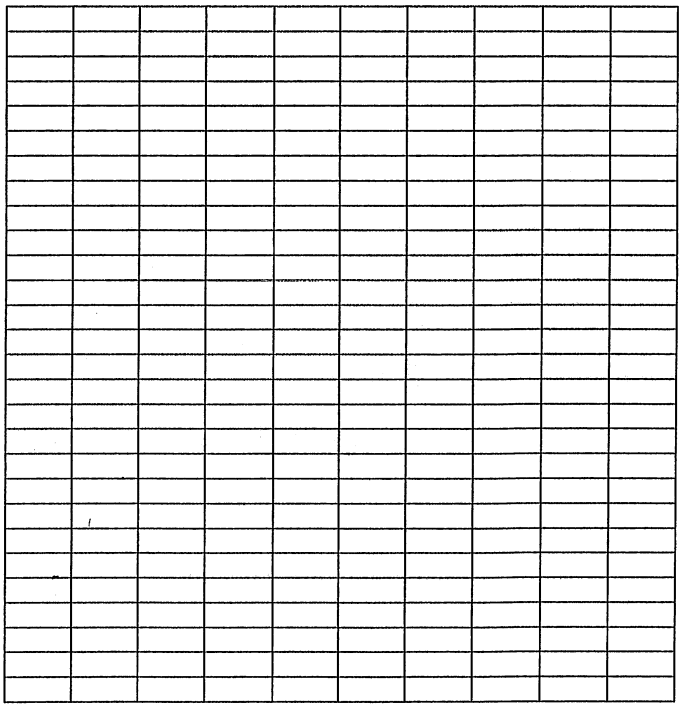
    How many years will it take to get down to 2 billion? _____

USING PREDATORS TO MANAGE POPULATIONS

In 1970, the deer population of an island forest reserve, about 518 square kilometers in size, was about 2,000 animals. Although the island had excellent vegetation for feeding, the food supply had limits. Thus, the forest management personnel feared that overgrazing might lead to mass starvation. Since the area was too remote for hunters, the wildlife service decided to bring in natural predators to control the deer population. It was hoped that, eventually, natural predation would eliminate the weakest deer, creating a smaller and higher-quality herd. In 1971, 10 wolves were flown into the island. The results of this natural predator program are presented below.

Year	Wolf Population	Deer Population	Deer Offspring	Predation	Starvation	Population Change
1971	10	2000	800	400	100	+300
1972	12	2300	920	480	240	+200
1973	16	2500	1000	640	500	-140
1974	22	2360	944	880	180	-116
1975	28	2244	996	1120	26	-150
1976	24	2094	836	960	2	-126
1977	21	1968	788	840	0	-52
1978	18	1916	766	720	0	+46
1979	19	1952	780	760	0	+20
1980	19	1972	790	760	0	+30

GRAPH: Make a graph of the deer and wolf populations for the years shown in the data table. You will need to make two Y-axes, one for the wolf population and one for the deer population. On the wolf axis make 1 square = 1 wolf. On the deer axis make 1 square = 100 deer. Your graph should have all of the appropriate titles, labels, units and keys.



ANALYSIS:

1. What was the purpose of introducing wolves into the island forest reserve?

2. What happened to the wolf population after the deer population started to decline? _____ WHY?

3. Which year was deer starvation the highest?

4. Is wolf predation a limiting factor for the deer population on this reserve?

5. What are some other limiting factors for the deer population? **List at least 4.**

6. Describe the predator-prey cycle in detail.

7. Judging from the data in the table above, was this project successful? Cite **specific data** from the table above to support your conclusion.

GRAPH: Using the data in the table to the right create a survivorship curve (on the following page). Make 1 square = 50 deer.

ANALYSIS:

8. In which stages of life do deer have the highest mortality? Suggest at least 3 reasons that this is so.

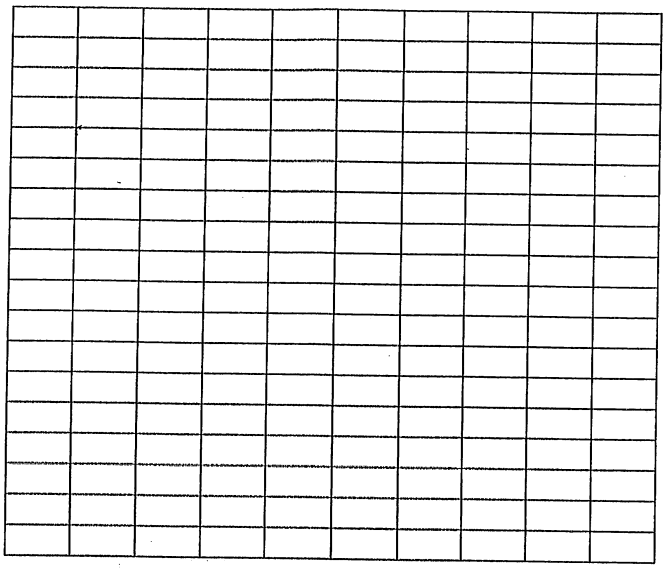
Age Structure of Herd in 1980

Age	# of Deer
0	860
1	345
2	262
3	168
4	105
5	88
6	68
7	56
8	42
9+	6
Total	2000

9. What type of survivorship curve is this?

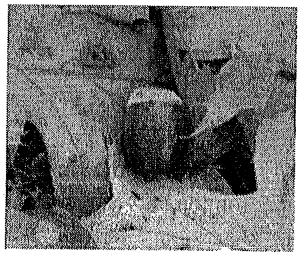
10. How would a survivorship curve for humans look different? Suggest at least 3 reasons to support your answer.

11. What percent of the herd are fawns? (Show your work)



Forest Carrying Capacity Lab

Background Information



An ecosystem can be as small as a drop of water or as large as the entire Earth. The productivity of an ecosystem limits its carrying capacity, that is, the mass of living organisms that the ecosystem can support. Carrying capacity can be applied to any life form and to any part of the biosphere, such as the number of deer that can be supported by an oak forest. As any population increases in size, the same resources must be shared by a greater and greater number of individuals. The decreasing supply of resources may lower the population's birth rate, increase its death rate, or both – until births and deaths are in balance. At that point of balance, and as long as the resource supply remains constant, the population should stabilize at some equilibrium size. Ecologists call this equilibrium the carrying capacity of the environment inhabited by that particular species.

Ecologists use the carrying capacity to define the maximum population of a particular species that a given area of habitat can support. The ecological principles that govern a habitat's carrying capacity are the same for all species. A sustainable supply of resources – including nutrients, energy, and living space – defines the carrying capacity for a particular population in a particular environment.

Acorns produced by oak trees are a favorite food for deer, as well as for squirrels, jays, quail, crows, woodpeckers, raccoons and rabbits. In areas with mild winters, acorns may be available for 8 months of the year and constitute about 75% of the diet of deer. Acorns are higher in fat and easily-digested carbohydrates that other food sources, such as leaves, twigs, small green plants, and fungi. In areas with hard winters, reproductive success of deer decreases with greater snow cover, when acorns may be harder to find. Deer have reduced birth rates and lower survival of fawns when acorns are less available.

In this activity, you will create a model of an oak forest and estimate the number of deer than can be supported by the forest. This is modeled after a forest in Virginia which covers 19,535 acres (7906 hectares)

Procedure

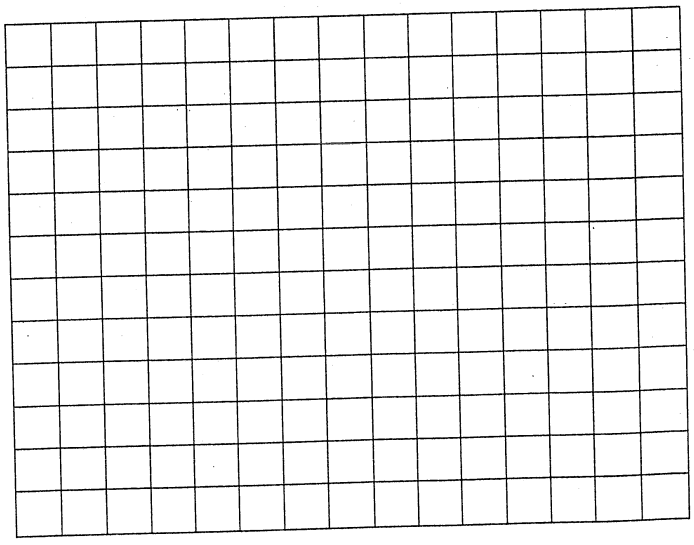
1. Using the data in TABLE 2, make a graph of acorn yield in kilograms (Y-axis) versus diameter at shoulder height in centimeters (X-axis) for the five species of oak. Use a different colored pencil for each line. Be sure to label each axis including units, create a key and give the graph an appropriate title.
2. Use the information is BOTH data tables to answer the discussion questions.

TABLE 1: OAK SPECIES IN VIRGINIA

Common Name	Scientific Name	Habitat
White Oak	*Quercus alba*	Moist woods
Post Oak	*Quercus stellate*	Dry soil
Blackjack	*Quercus marilandica*	Dry, barren soils
Spanish Oak	*Quercus falcata*	Mild wooded areas
Water Oak	*Quercus nigra*	Coastal plain

TABLE 2: ACORN YIELD PER YEAR (kilograms)

	Oak Species				
Diameter (cm)	White Oak	Post Oak	Blackjack	Spanish Oak	Water Oak
10		0.3			
15		0.6			
20	0.2	1.0		0.5	0.7
25	1.2	1.3	0.8	1.4	1.8
30	2.2	1.6	1.5	2.3	3.1
35	3.2	1.9	2.2	3.2	4.2
40	4.2	2.3	3.0	4.1	5.4
45	5.2	2.6	3.7	5.0	6.6
50	6.2	3.0	4.6	5.9	7.8
55	7.2	3.3	5.2	6.7	9.0
60	8.2	3.6	5.9	7.6	10.1
65	9.2	4.0	6.7	8.5	11.3



Calculations/Discussion Questions

1. What is the relationship between diameter and acorn yield for oak trees?

2. Extrapolate: If a Post Oak was found with a diameter of 70 centimeters what is its probable acorn yield?

3. Based on the information about the oak species in TABLE 1, what is necessary to produce a high acorn yield? Explain how you came to this conclusion.

4. Which species of oak tree at what diameter will yield the greatest supply of acorns for a deer population?

   Species:_____ Diameter:_____ Yield: _____

5. A hectare is equal to an area of about 2 football fields. Assume there is a population density of 25 oak trees per hectare. Using the species and diameter of tree you selected for #1, calculate the acorn potential for *each hectare* of the forest for one year.

   (_____kg of acorns per year) x (_____oak trees per hectare) = _____ kg of acorns produced each year per hectare

6. Assuming that the average deer requires 3 kilograms of food per day, and that 75% of the diet is acorns, calculate how many deer **each hectare** of this forest could support for a year.

   (_____kg of food each day per deer) x (_____% of food is acorns) = _____kg of acorns needed each day per deer

   (_____ kg of acorns needed each day per deer) x (_____ days per year) = _____ kg of acorns needed each year per deer

   (_____ kg of acorns produced each year per hectare) ÷ (_____kg of acorns needed each year per deer) = _____ deer per hectare

7. How many hectares are needed to support one average deer?
   How many football fields is that?

8. The entire forest in Virginia covers 7906 hectares. Calculate how many deer the **entire forest** could support.

   (_____deer per hectare) x (_____ hectares) = _____deer per entire forest

9. Is it realistic to assume that the forest will be made up of only one species of oak? _____ If the forest was made up of a variety of the oak species shown in TABLES 1 and 2, how would thins affect the carrying capacity? Explain how you came to this conclusion.

10. How would the presence of other animals that eat acorns from the ground, affect the number of deer the forest can support?

If there is not enough nitrogen in the soil then plants will not grow very big. So the nitrogen is a _____ _____ for the plants.	When a country moves from having high birth rates and high death rates to low birth rates and low death rates.	One of the four characteristics of a population: the number of individuals per unit area. For example: 1,300 squirrels per square kilometer.	Diseases can limit the size of a population. Diseases are more easily transferred when organisms live in close contact with one another so disease is an example of a ...
When a population has unlimited food, space, nutrients, etc. the population will continue to grow at a constant rate. This is called...	A type of graph that shows the number of individuals in a population in each age group.	Five emu left the herd. This is an example of ...	A type of graph that shows the percent of the population that is surviving at each age.
The people who work for the census study the human population. They are studying ...	A population's growth will slow or even stop when the population hits the carrying capacity of its environment. This type of growth is ...	A pack of coyotes moved into the Grand Ledge area. This is an example of ...	Seasonal changes limit the populations of insects and plants. The seasons will kill insects and plants regardless of how many insects and plant there are. Therefore, seasonal changes are ...
The maximum number of organisms that an ecosystem can hold.	A relationship where one population feeds on another population and keeps it under control.		