KEY

ECOLOGY

1. Populations
   a. group of individuals of same species living in same area (size, density, distribution/dispersion)
   b. habitat (type of area organism lives) vs. niche (role in ecosystem)
   c. competition for resources
   d. age structure (rapid growth vs. declining vs. stable populations)
   e. population growth
      (1) density dependent limiting factors (competition for resources, parasites & diseases, waste products, stress, predation)
      (2) density independent limiting factors (climate = temperature & rainfall, natural disaster)
      (3) exponential growth (J-shaped, unlimited) vs. logistic growth curve (S-shaped, limited)
      (4) carrying capacity = maximum population supported by habitat
      (5) populations can cycle
   f. Population ability to respond to changes in the environment is affected by genetic diversity. Species and populations with little genetic diversity are at risk for extinction.

2. Communities
   a. measured and described in terms of species composition and species diversity
   b. symbiosis = species interaction
      (1) mutualism +/+ (acacia tree & ants; lichens, N-fixing bacteria & legume plants)
      (2) commensalism +/0 (egrets & cattle)
      (3) parasitism +/– (tapeworm, cowbird)
      (4) predation +/– (carnivores & herbivores)
      (5) competition

3. Ecosystems
   a. Free Energy
      (1) Reproduction and rearing of offspring require free energy beyond that used for maintenance and growth. Different organisms use various reproductive strategies in response to energy availability.
      (2) There is a relationship between metabolic rate per unit body mass and the size of multicellular organisms — generally, the smaller the organism, the higher the metabolic rate.
      (3) Excess acquired free energy versus required free energy expenditure results in energy storage or growth.
      (4) Insufficient acquired free energy versus required free energy expenditure results in loss of mass and, ultimately, the death of an organism.
   b. Energy flow/production = energy flows through; 90% lost at each level & 10% transferred to next level

(1) trophic levels = primary producers, primary consumers, secondary consumers, tertiary consumers, detritivores & decomposer
(2) ecological pyramids (pyramids of energy, biomass, numbers)
(3) food chains & food webs
(4) Biotic and Abiotic factors can both cause disruption and collapse of ecosystems

4. Biogeochemical Cycles

1. water cycle- water cycles between land and air; goes to air by evaporation and transpiration; goes to land by condensation and precipitation
2. carbon cycle- carbon cycles between air, organisms, and land; carbon dioxide in air taken up by plants, plants eaten by consumers; organisms give carbon off to air by respiration and by decomposition (soil to air)
3. phosphorus cycle- phosphorus is trapped in minerals in rocks and is released into water/soil by weathering (rain, snow, etc.)
4. nitrogen cycle- nitrogen cycles between air, organisms and soil; nitrogen in air is fixed by soil bacteria via nitrogen fixation; plants use nitrates; organisms eat plants; bacteria return gaseous nitrogen via denitrification and decomposition
6. Biosphere- the part of the earth with living organisms
*biomes- groups of organisms in common climate and with distinct vegetation
a. temperate deciduous forests- us; good soil; seasonal
b. taiga- coniferous forests; ex. Colorado
c. tundra- Arctic; little or no rainfall; short summers
d. grasslands- good for agriculture; little or no tall vegetation
e. deserts- very little rainfall; cold or hot
f. tropical rain forest- most biodiverse but worst soil; uniform temp and a lot of rain
7. Ecological succession- replacement of one community by another
a. primary succession- bare rock->lichens->moss->soil->grass->shrubs->pine ->hardwooods
b. secondary succession (result of natural disaster)- grass->shrubs-> pines->hardwoods

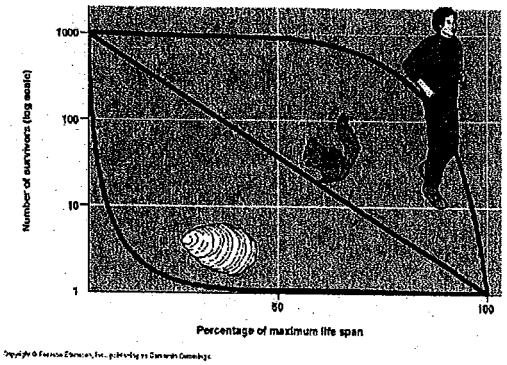
5. Population Ecology

a. Density- numbers of individual per unit area; dispersion patterns = clumped, uniform or random
b. Measurement methods
• quadrant sampling- count individuals in a sample plot
• mark and recapture- # marked first day x total caught next time
captured on second day with mark
c. Demographics- composition of population
• Sex
• Birth rate (fecundity) vs. death rate (mortality)
• birth rate= # of births/total pop x 100

- Death rate = # of deaths/total pop x 100
- Growth rate (r) = births- deaths/total population;If r > 0, the population is growing, if r < 0,
- Doubling time= 70/growth rate (kept as a percetange, i.e. 10% = 10) or .7/r (keep r in
- dN (change in population)/dt (change in time)= B-D

6. Models of Population Growth

a. Survivorship Curves the population is declining, if r = 0, zero population growth (ZPG) decimal form)

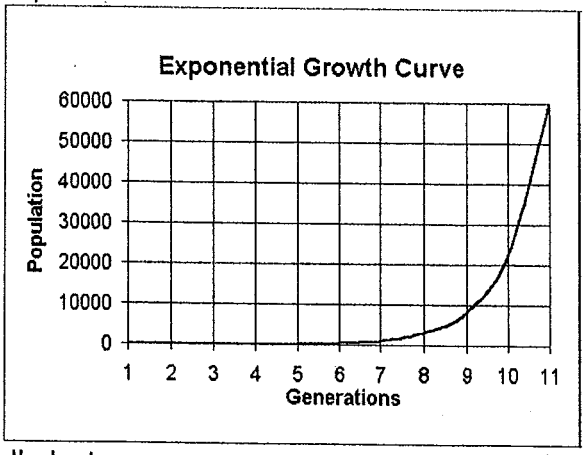


I= high adult mortality

II- uniform mortality

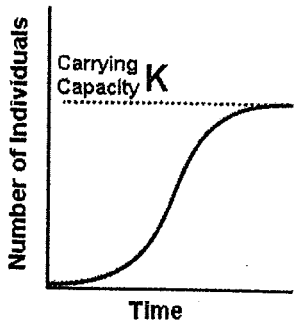
III- high infant mortality

b. Exponential Growth



- Called a J curve
- No limiting factors or carrying capacity
- Constant growth rate; larger population adds more individuals in next generation
- dN/dt= rmax N

c. Logistic Curve



- Called an S curve
- Modified by limiting factors
- Carrying capacity is where it levels off and can hold no more individuals; it is

d. Age structure curves- broad base = growing population; uniform = zero or slow growth, broad top= negative growth dynamic (changes generation to generation) but static carrying capacity is used in calculations dN/dt= rmaxN (K-N/K)

7. Disruptions

- Deforestation (disrupts carbon cycle)
- Acid rain (disrupts water cycle)
- Global warming (disrupts carbon cycle- TOO much greenhouse effect from excess carbon dioxide in atmosphere)
- Ozone depletion (damaging sun rays are not filtered) due to CFC's and destruction of 03

AP Biology Investigation 10- Energy Dynamics (simulated)

Overview Part I: Net primary productivity of Fast Plants- Data was given on fast plants that were grown over 14 days. Dry mass was divided by wet mass to obtain biomass. Bio mass was multiplied by 4.35 kcal to obtain net primary productivity per 10 plants and divided by 10 to get NPP per day per plant.

IV- Time

DV- NPP

Overview Part II: Energy flow between plants and butterfly larvae (caterpillars)- brussel sprouts and caterpillars were massed before and after 3 days of caterpillar consumption. Biomass (dry/wet) and energy constant were used to calculate how much energy from plant was used in cell respiration and how much was lost as water.

PLANT ENERGY CONSUMED PER INDVIDUAL (plant change in biomass)- ENERGY PRODUCTION PER

INDIVDUAL (larvae change in biomass) – FRASS ENERGY (energy lost in poo)= RESPIRATION ESTIMATE

IV- time

DV- change in energy (calculated by biomass)

AP Biology- Dissolved Oxygen Lab (old AP manual)- simulated

Overview: Bottles with algae were placed in varying amounts of light (screens used) to determine change in productivity. One bottle was placed in the dark and one bottle was measured before light was administered (initial bottle).

Equations: NPP= GPP- Respiration; NPP= Initial Bottle – Light Bottle; Respiration= Initial Bottle- Dark Bottle

IV= number of screens

DPP= NPP

Practice Multiple Choice Questions:

1. Which of the following is true of innate behaviors?
   a. Genes have very little influence on the expression of innate behaviors.
   b. Innate behaviors tend to vary considerably among members of a population.
   c. Innate behaviors are limited to invertebrate animals.
   d. Innate behaviors are expressed in most individuals in a population across a wide range of environmental conditions.
   e. Innate behaviors occur in invertebrates and some vertebrates but not in mammals.

2. A certain species of pine tree survives only in scattered locations at elevations above 2,800 m in the western United States. To understand why this tree grows only in these specific places an ecologist should
   a. conclude that lower elevations are limiting to the survival of this species.
   b. study the anatomy and physiology of this species.
   c. investigate the various biotic and abiotic factors that are unique to high altitude.
   d. analyze the soils found in the vicinity of these trees, looking for unique chemicals that may support their growth.
   e. collect data on temperature, wind, and precipitation at several of these locations for a year.

3. How are matter and energy used in ecosystems?
   a. Matter is cycled through ecosystems; energy is not.
   b. Energy is cycled through ecosystems; matter is not.
   c. Energy can be converted into matter; matter cannot be converted into energy.
   d. Matter can be converted into energy; energy cannot be converted into matter.

4. Imagine that you are designing an experiment aimed at determining whether the initiation of migratory behavior is largely under genetic control. Of the following options, the best way to proceed is to
   a. observe genetically distinct populations in the field and see if they have different migratory habits.
   b. perform within-population matings with birds from different populations that have different migratory habits. Do this in the laboratory and see if offspring display parental migratory behavior.
   c. bring animals into the laboratory and determine the conditions under which they become restless and attempt to migrate.
   d. perform within-population matings with birds from different populations that have different migratory habits. Rear the offspring in the absence of their parents and observe the migratory behavior of offspring.

5. Long-term studies of Belding's ground squirrels show that immigrants move nearly 2 km from where they are born and become 1% –8% of the males and 0.7% –6% of the females in other populations. On an evolutionary scale, why is this significant?
   a. These immigrants make up for the deaths of individuals, keeping the other populations' size stable.
   b. Young reproductive males tend to stay in their home population and are not driven out by other territorial males.
   c. These immigrants provide a source of genetic diversity for the other populations.
   d. Those individuals that emigrate to these new populations are looking for less crowded conditions with more resources.
   e. Gradually, the populations of ground squirrels will move from a clumped to a uniform population pattern of dispersion.

6. Which of the following scenarios would provide the most legitimate data on population density?
   a. Count the number of nests of a particular species of songbird and multiply this by a factor that extrapolates these data to actual animals.
   b. Count the number of pine trees in several randomly selected 10 m x 10 m plots and extrapolate this number to the fraction of the study area these plots represent.
   c. Use the mark–and–recapture method to estimate the size of the population.
   d. Calculate the difference between all of the immigrants and emigrants to see if the population is growing or shrinking.
   e. Add the number of births and subtract the individuals that die to see if the population's density is increasing or decreasing.

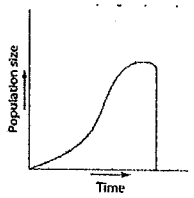
indiv / area

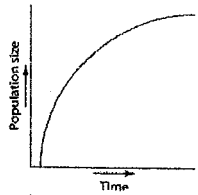
7. Starting from a single individual, what is the size of a population of bacteria that reproduce by binary fission every 20 minutes at the end of a 2–hour time period? (Assume unlimited resources and no mortality.)
   a. 6
   b. 64
   c. 128
   d. 512
   e. 1,024

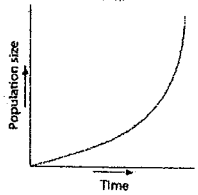
1 720
2 720
4 720
8 720
IV 32 720 20
64

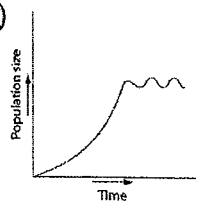
8. As *N* approaches *K* for a certain population, which of the following is predicted by the logistic equation?
   a. The growth rate will not change.
   b. The growth rate will approach zero.
   c. The population will show an Allee effect.
   d. The population will increase exponentially.
   e. The carrying capacity of the environment will increase.

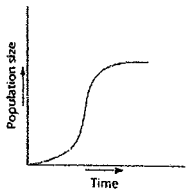
9. Which of the following graphs illustrates the REALISTIC growth curve of a small population of rodents that has grown to reach a static carrying capacity? D

a.


b.


c.


d.


e.


10. Please read the paragraph below and review Figure 53.2 to answer the following question.

Researchers in the Netherlands studied the effects of parental care given in European kestrels over five years. The researchers transferred chicks among nests to produce reduced broods (three or four chicks), normal broods (five or six chicks), and enlarged broods (seven or eight chicks). They then measured the percentage of male and female parent birds that survived the following winter. (Both males and females provide care for chicks.)

graph missing

Figure 53.2: Brood size manipulations in the kestrel: Effects on offspring and parent survival.

Which of the following is a conclusion that can be drawn from this graph?

a. Female survivability is more negatively affected by larger brood size than is male survivability.
b. Male survivability decreased by 50% between reduced and enlarged brood treatments.
c. Both males and females had increases in daily hunting with the enlarged brood size.
d. There appears to be a negative correlation between brood enlargements and parental survival.
e. Chicks in reduced brood treatment received more food, weight gain, and reduced mortality.

Refer to Figure 53.4 and then answer the following questions.

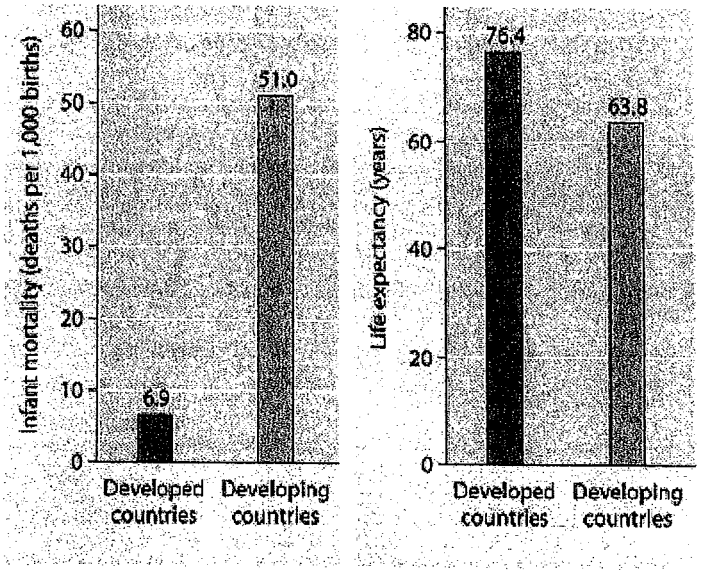


Figure 53.4: Infant mortality and life expectancy at birth in developed and developing countries (data as of 2005).

11. What is a logical conclusion that can be drawn from the graphs above?

a. Developed countries have lower infant mortality rates and lower life expectancy than developing countries.
b. Developed countries have higher infant mortality rates and lower life expectancy than developing countries.
c. Developed countries have lower infant mortality rates and higher life expectancy than developing countries.
d. Developed countries have higher infant mortality rates and higher life expectancy than developing countries.
e. Developed countries have a life expectancy that is about 42 years more than life expectancy in developing countries.

12. Approximately how many kg of carnivore (secondary consumer) biomass can be supported by a field plot containing 1,000 kg of plant material?
    a. 10,000
    b. 1,000
    c. 100
    d. 10
    e. 1

13. Elephants are not the most dominant species in African grasslands, yet they influence community structure. The grasslands contain scattered woody plants, but they are kept in check by the uprooting activities of the elephants. Take away the elephants, and the grasslands convert to forests or to shrublands. The newly growing forests support fewer species than the previous grasslands. Which of the following describes why elephants are the keystone species in this scenario?
    a. Essentially all of the other species depend on the presence of the elephants to maintain the community.
    b. Grazing animals depend upon the elephants to convert forests to grassland.
    c. Elephants prevent drought in African grasslands.
    d. Elephants are the biggest herbivore in this community.
    e. Elephants help other populations survive by keeping out many of the large African predators.

14. Which of the following is the most accepted hypothesis as to why invasive species take over communities into which they have been introduced?
    a. Invasive species are more aggressive than native species in competing for the limited resources of the environment.
    b. Invasive species are not held in check by the predators and agents of disease that have always been in place for the native species.
    c. Humans carefully select which species will outcompete nuisance native species.
    d. Invasive species have a higher reproductive potential than native species.
    e. Invasive species come from geographically isolated regions, so when they are introduced to regions where there is more competition, they thrive.

Use the following diagram to answer the next few questions.

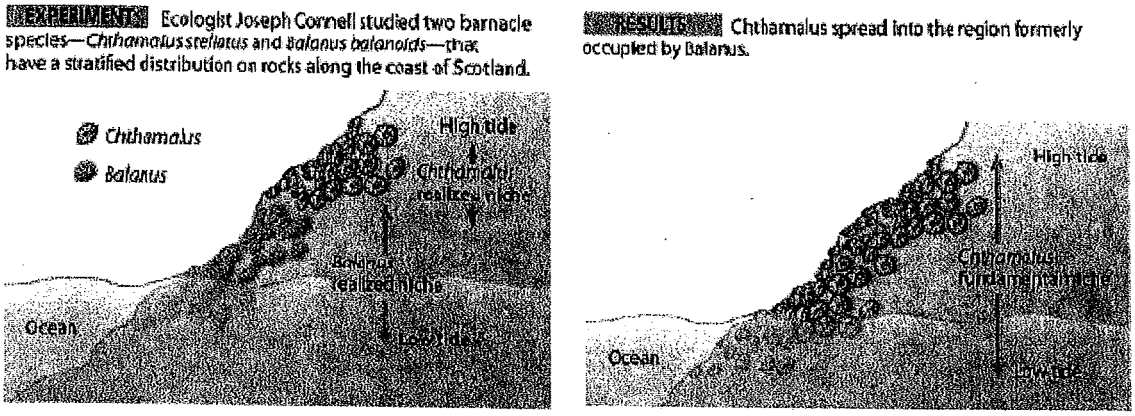


Figure 54.1

15. Connell conducted this experiment to learn more about
    a. character displacement in the color of barnacles.
    b. habitat preference in two different species of barnacles.
    c. desiccation resistance and barnacle species.
    d. how sea–level changes affect barnacle distribution.
    e. competitive exclusion and distribution of barnacle species.

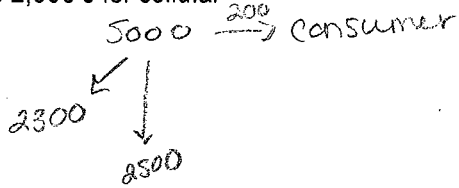
The symbols +, –, and o are to be used to show the results of interactions between individuals and groups of individuals in the examples that follow. The symbol + denotes a positive interaction, – denotes a negative interaction, and o denotes where individuals are not affected by interacting. The first symbol refers to the first organism mentioned.

16. What interactions exist between a lion pride and a hyena pack? (Hint: they eat the same prey species)
    a. +/+
    b. +/o
    c. +/–
    d. o/o
    e. –/–

17. Food chains are sometimes short because
    a. only a single species of herbivore feeds on each plant species.
    b. local extinction of a species causes extinction of the other species in its food chain.
    c. most of the energy in a trophic level is lost as it passes to the next higher level.
    d. predator species tend to be less diverse and less abundant than prey species.
    e. most producers are inedible.

18. Why is net primary production (NPP) a more useful measurement to an ecosystem ecologist than gross primary production (GPP)?
    a. NPP can be expressed in energy/unit of area/unit of time.
    b. NPP can be expressed in terms of carbon fixed by photosynthesis for an entire ecosystem.
    c. NPP represents the stored chemical energy that is available to consumers in the ecosystem.
    d. NPP is the same as the standing crop.
    e. NPP shows the rate at which the standing crop is utilized by consumers.

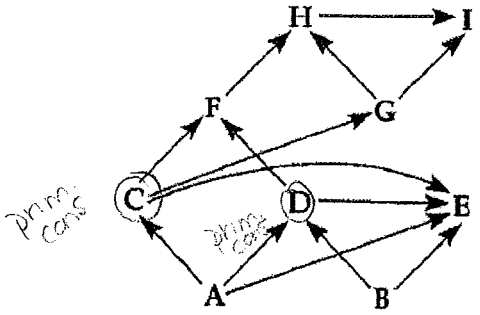
19. Owls eat rats, mice, shrews, and small birds. Assume that, over a period of time, an owl consumes 5,000 J of animal material. The owl loses 2,300 J in feces and owl pellets and uses 2,500 J for cellular respiration. What is the primary efficiency of this owl?
    a. 0.02%
    b. 1%
    c. 4%
    d. 10%
    e. 40%



100 10 1 .1 .01

20. Consider the food chain grass □ grasshopper □ mouse □ snake □ hawk. How much of the chemical energy fixed by photosynthesis of the grass (100%) is available to the hawk?
    a. 0.01%
    b. 0.1%
    c. 1%
    d. 10%
    e. 60%

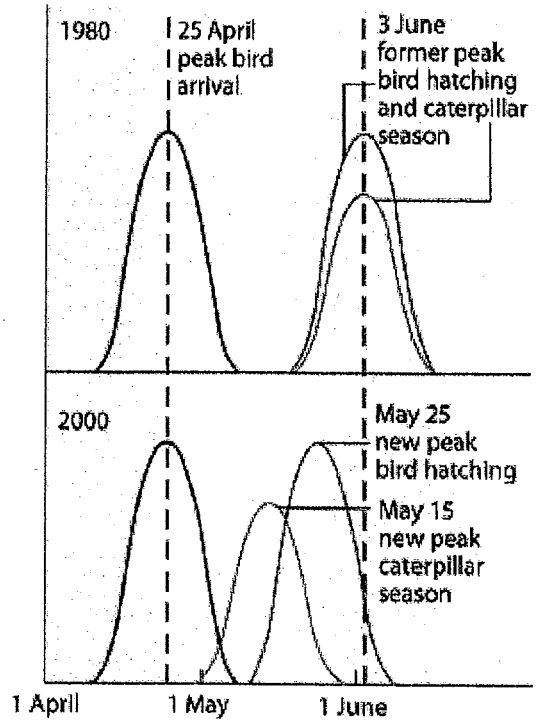
Diagram of a food web (arrows represent energy flow and letters represent species)



21. If the figure above represents a terrestrial food web, the combined biomass of C + D would probably be
    a. greater than the biomass of A.
    b. less than the biomass of H.
    c. greater than the biomass of B.
    d. less than the biomass of A + B.
    e. less than the biomass of E.

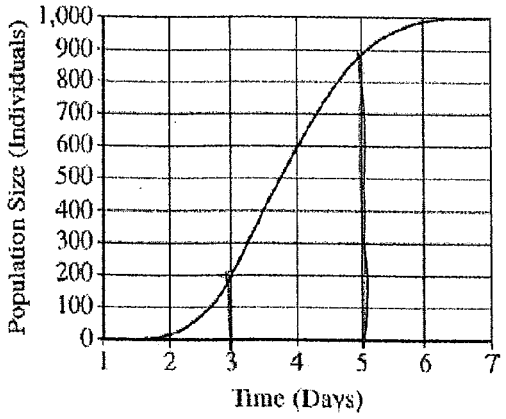
22. Suppose you are studying the nitrogen cycling in a pond ecosystem over the course of a month. While you are collecting data, a flock of 100 Canada geese lands and spends the night during a fall migration. What could you do to eliminate error in your study as a result of this event?
    a. Find out how much nitrogen is consumed in plant material by a Canada goose over about a 12 –hour period, multiply this number by 100, and add that amount to the total nitrogen in the ecosystem.
    b. Find out how much nitrogen is eliminated by a Canada goose over about a 12–hour period, multiply this number by 100, and subtract that amount from the total nitrogen in the ecosystem.
    c. Find out how much nitrogen is consumed and eliminated by a Canada goose over about a 12–hour period and multiply this number by 100; enter this +/– value into the nitrogen budget of the ecosystem.
    d. Do nothing. The Canada geese visitation to the lake would have negligible impact on the nitrogen budget of the pond.
    e. Put a net over the pond so that no more migrating flocks can land on the pond and alter the nitrogen balance of the pond.

Use the graph and information provided in the paragraph below to answer the following questions. Flycatcher birds that migrate from Africa to Europe feed their nestlings a diet that is almost exclusively moth caterpillars. The graph below shows the mean dates of arrival, bird hatching, and peak caterpillar season for the years 1980 and 2000.



23. Why were ecologists concerned about the shift in the peak caterpillar season from June 3, 1980, to May 15, 2000?
    a. The caterpillars would have eaten much of the foliage of the trees where flycatchers would have nested, rendering their nests more open to predation.
    b. The earlier hatching of caterpillars would compete with other insect larval forms which the flycatchers would also use to feed their young.
    c. The 2000 flycatcher nestlings would miss the peak caterpillar season and might not be as well fed.
    d. The flycatchers would have to migrate sooner to match their brood-rearing to the time of peak caterpillar season.
    e. Pesticides, which have a negative effect on the ecosystem, would have to be used to control the earlier outbreak of caterpillar hatching.

Practice Calculations Questions



$\frac{900-200}{2} = \frac{700}{2}$

350/day

1. Use the graph above to calculate the mean rate of population growth (individuals per day) between day 3 and day 5. Give your answer to the nearest whole number.

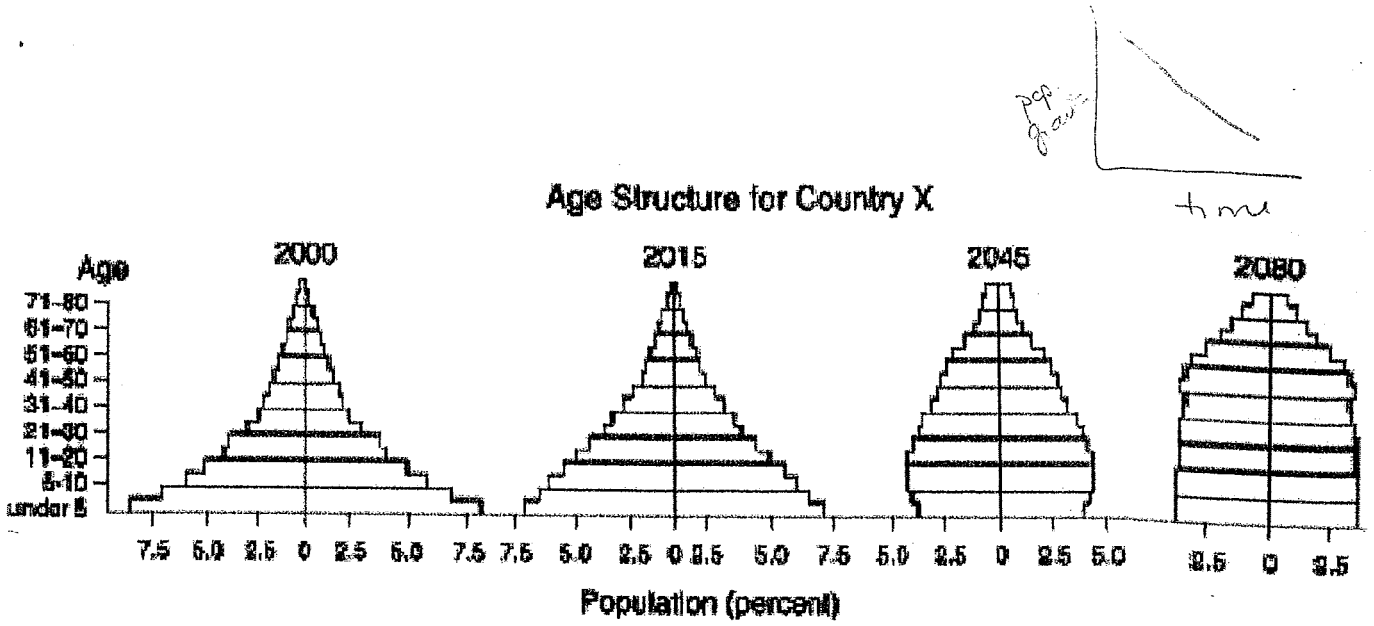
Thinking Questions

1. Invasive species are species that are introduced into an environment but are not naturally found in that environment. One example of an invasive species is the American gray squirrel, introduced into Britain at the end of the 18th century. Until 1876 the only native squirrel in Britain was the European red squirrel, which was found in deciduous and coniferous forests. By 1940 the gray squirrel had displaced the red squirrel across most of the British Isles, and by 1984 the red squirrel was only found in isolated coniferous woodland areas. After its initial introduction, the gray squirrel population increased rapidly; however, in recent years population sizes within specific environments have become stable.
   a. Explain why the newly-introduced gray squirrel initially showed rapid population growth and why the native red squirrel showed a population decline.

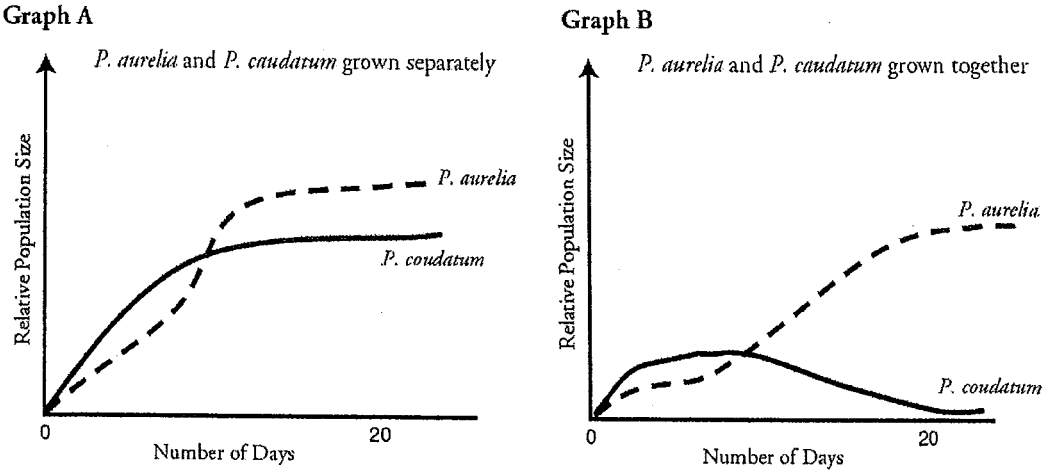
   • no natural predators

   b. Why has the population size of the gray squirrel become stable in recent years?

   • reached carrying capacity, possible predators now
2. The first age structure graph below for country X shows the percent of the population in each age group for the year 2000. The remaining three graphs are projections of how the age structure of country X will change. From these age structure diagrams construct a graph of population size vs. time for 2000-2080 and justify your prediction.



3. The graphs below display the growth rate for two species of bacteria when grown separately and together.



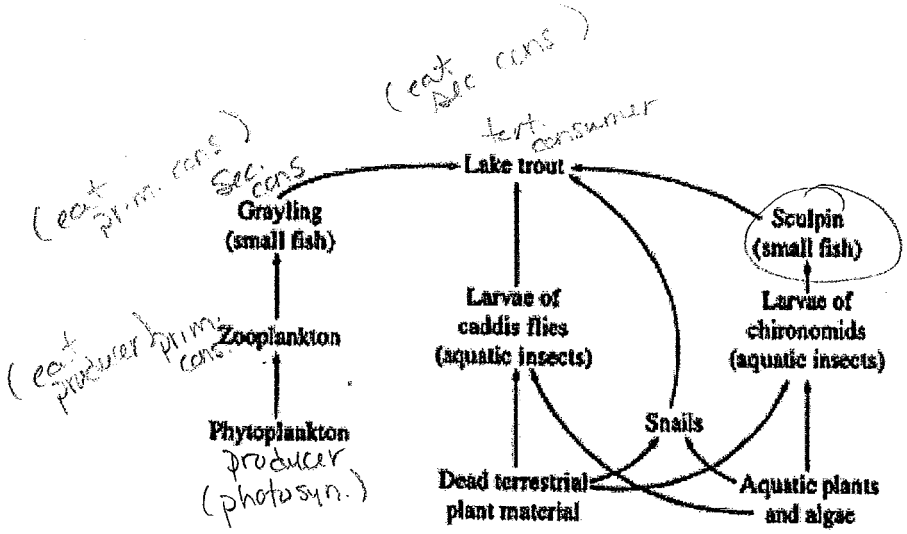
a. The population growth of which bacteria is more affected by growing conditions? Explain how you know.

P. caudatum declines when grown together

b. Using the information provided in the graphs, make a prediction as to why the bacteria identified in part a is more affected by growing conditions than the other bacteria.

- competition for resources
less adapted

4. Interdependence in nature is illustrated by the transfer of energy through trophic levels. The diagram below depicts the transfer of energy in a food web of an Arctic lake located in Alaska.



a. Identify an organism from each of the 5 trophic levels (producer, primary consumer, secondary consumer, teritiary consumer and decomposer) and explain how energy is obtained at each level.

b. Describe the efficiency of energy transfer between trophic levels of this food web.

10% transfer

c. Explain how the amount of energy available at each trophic level affects the size of each population.

Smaller populations can be supported as you move up food chain

d. If the cells in the dead terrestrial plant material that washed into the lake contained a commercially produced toxin, what would be the likely effects of this toxin on this food web? Explain.

higher concentrations as you move up the food chain

e. If all of the Sculpin in this ecosystem were removed, predict how it would impact the following and explain each prediction:

- The population of lake trout

decrease

- The population of snails

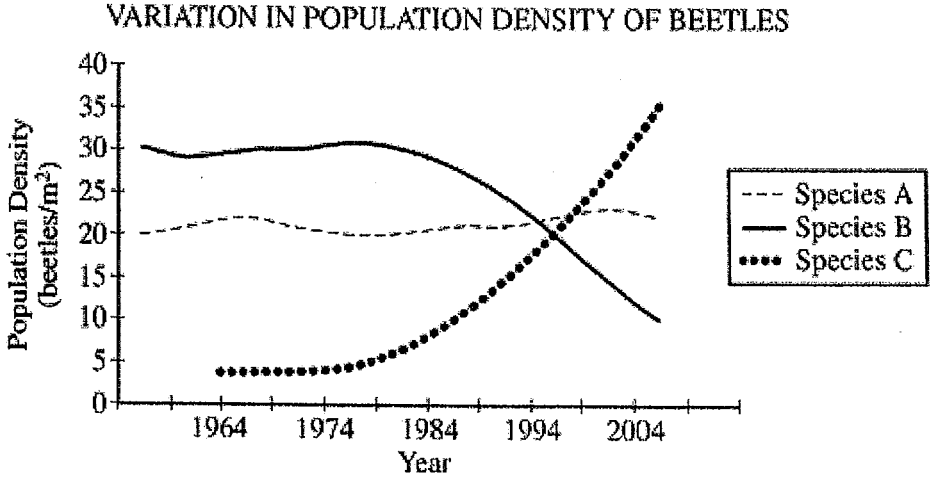
decrease

- The population of algae

decrease

- The amount of oxygen produced in the ecosystem decrease
- The amount of light energy absorbed by the ecosystem decrease

Ecology Long Free Response (10 points)



According to fossil records and recent published observations, two species of leaf-eating beetles (species A and B) have existed on an isolated island in the Pacific Ocean for over 100,000 years. In 1964 a third species of leaf-eating beetle (species C) was accidentally introduced on the island. The population size of each species has been regularly monitored as shown in the graph above.

(a) **Propose** an explanation for the pattern of population density observed in species C.

(b) **Describe** the effect that the introduction of beetle species C has had on the population density of species A and species B. **Propose** an explanation for the patterns of population density observed in species A and in species B.

(c) **Predict** the population density of species C in 2014. Provide a biological explanation for your prediction.

(d) **Explain** why invasive species are often successful in colonizing new habitats.

a) unlimited resources, exponential growth

b) No impact on A, decreased pop. B. Must compete for resources w/ B or prey on B. No competition with A.

c) no natural predators