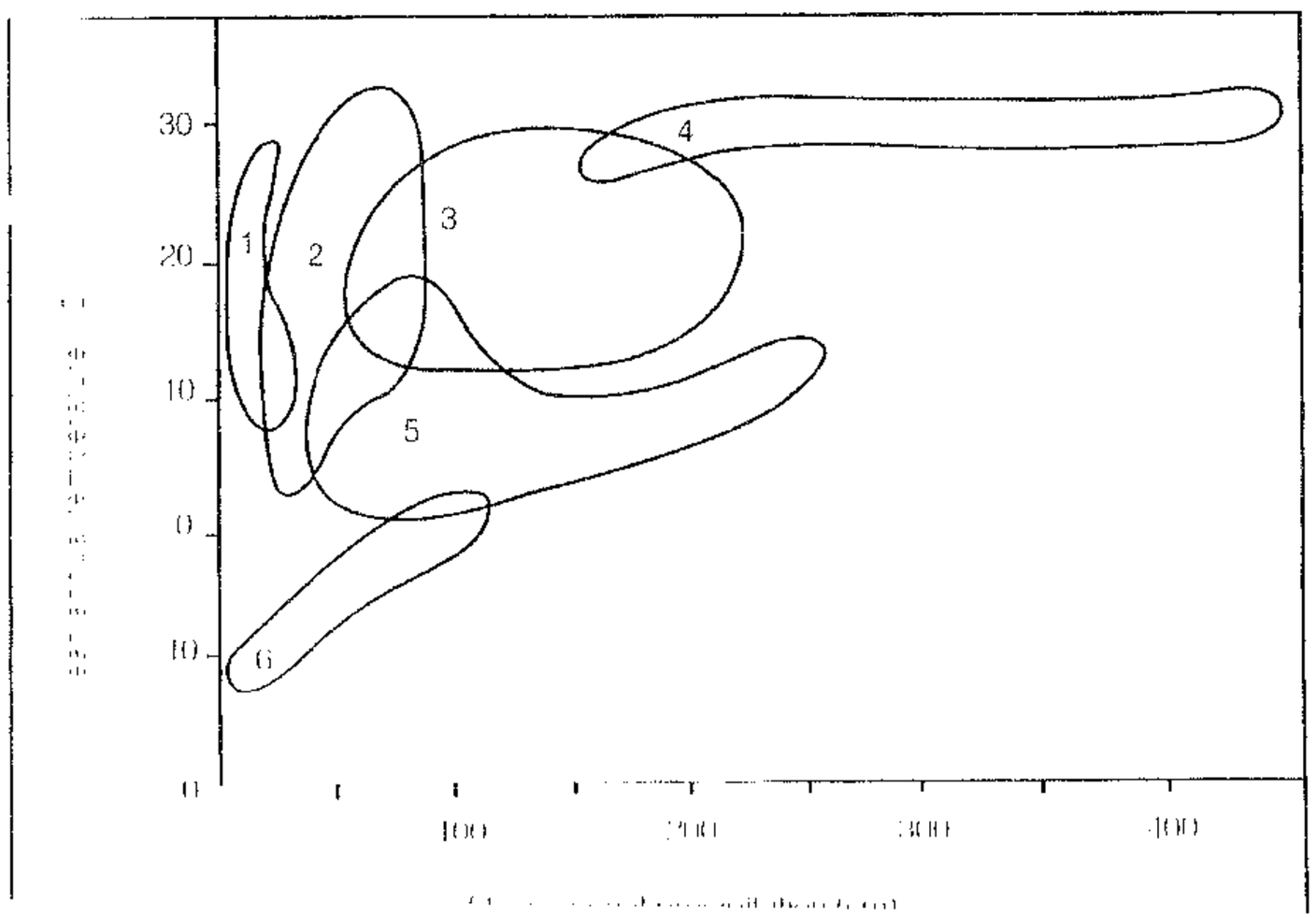
Exercise 5 (Modules 34.9 – 34.18)

...u read about the biomes, a good way to learn their characteristics is to make a chart ... compares them. Using a large sheet of paper, list the *name* of each biome in the left ...mn, and lay out columns for each of their characteristics across the top: *location, de-...ction, temperature, rainfall, special environmental conditions* (fire, etc.), *organisms*, and *...an impact*. Once you have covered all the biomes, look at the CD-ROM and do the next ... ercises, which compare biomes in various ways.

Exercise 6 (Modules 34.9 – 34.18)

CD Activity 34D *Terrestrial Biomes*

...mperature and precipitation are the most important factors shaping biomes. The figure ... a "climograph" outlining the temperature and rainfall limits within which each ... biomes occurs. Label the biomes on the graph. You do not need to know absolute ...peratures and rainfall amounts; just ask yourself which biomes are hotter or colder, ...ter or drier. Choose from **desert, tundra, temperate grassland, coniferous forest, tem-...ate forest,** and **tropical forest.** Then color the areas on the graph to match the colors ... the map in Module 34.9.



Exercise 7 (Modules 34.9 – 34.18)

Web/CD Activity 34D *Terrestrial Biomes*

Match each of the phrases on the right with one of the biomes from the list on the left.

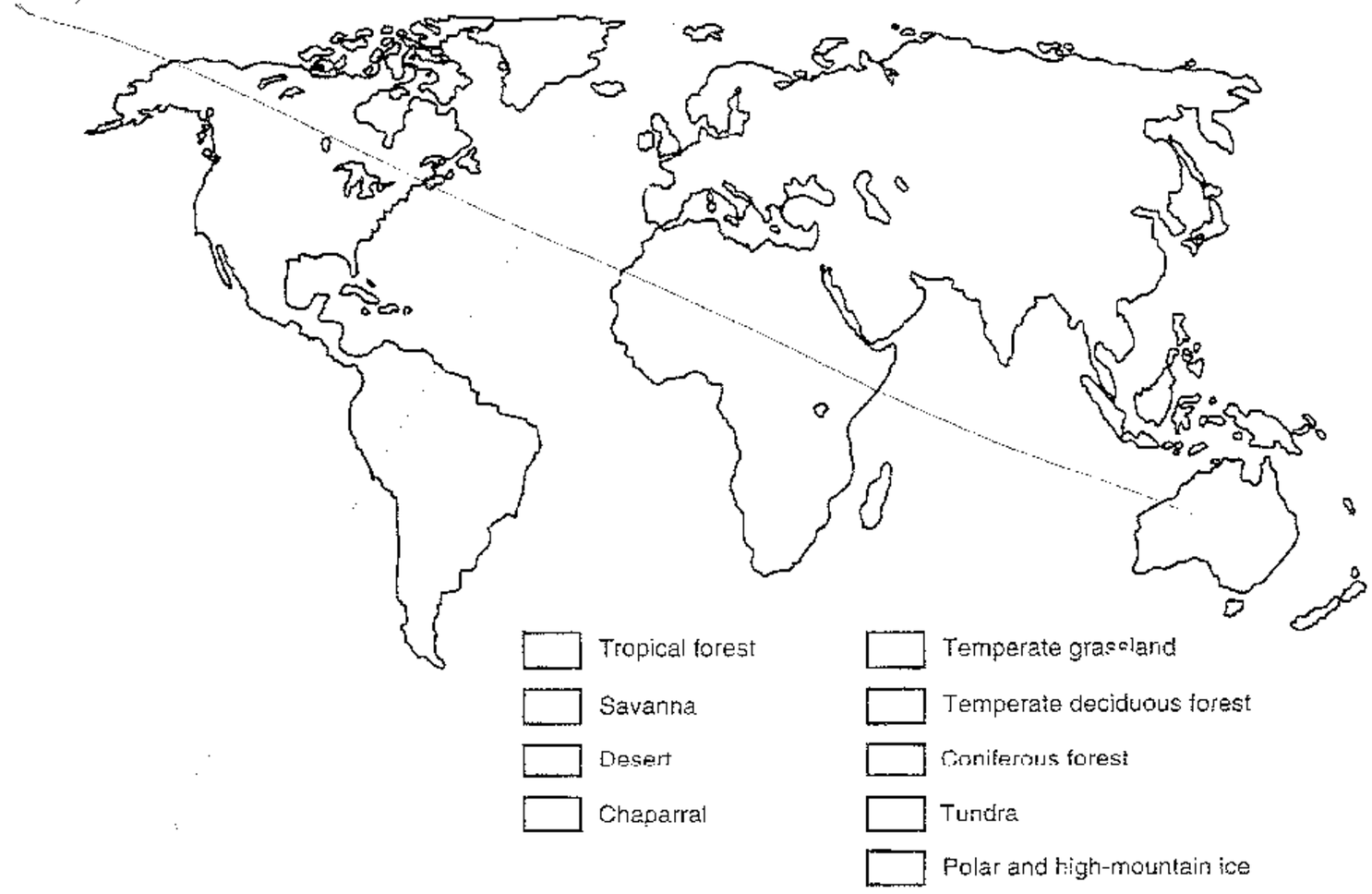
A. Tundra
B. Desert
C. Tropical forest
D. Temperate deciduous forest
E. Chaparral
F. Coniferous forest
G. Temperate grassland
H. Savanna

_____ 1. Grows around the Mediterranean
_____ 2. Among the most complex and diverse of all biomes
_____ 3. Prairies, pampas, veldts, and steppes
_____ 4. The taiga of Canada, Alaska, Siberia
_____ 5. May be hot or cold but is always dry
_____ 6. Permafrost occurs here
_____ 7. May occur in rain shadow
_____ 8. Characterized by broad-leafed deciduous trees
_____ 9. Richest farmland in the United States
_____ 10. Antelope, zebras, lions, and cheetahs live here
_____ 11. Closest to the North Pole
_____ 12. Unlike other biomes, this one is growing in size
_____ 13. Characterized by mild, rainy winters and hot, dry summers with fires
_____ 14. Some characteristics of savannas but in colder areas than savannas
_____ 15. Straddles the equator
_____ 16. Grassland with scattered trees
_____ 17. The biome of most of the northeastern United States
_____ 18. Scrubland of dense, spiny shrubs
_____ 19. Moose, elk, snowshoe hares, beavers, bears, and wolves live here
_____ 20. The warmest, rainiest biome

Exercise 8 (Modules 34.9 – 34.18)

Web/CD Activity 34D *Terrestrial Biomes*

Color and label this map to show the distribution of these major biomes: **tropical forest, savanna, desert, chaparral, temperate grassland, temperate deciduous forest, coniferous forest,** and **tundra.** (If you want to go into more detail, you can include polar and high-mountain ice areas.)



Population Dynamics

35

A marine biologist observes humpback whales in the Gulf of Alaska, zoologists band migrating shorebirds in Brazil, and a primatologist tracks orangutans in the forests of Borneo. Foresters map the spread of gypsy moths in a New England forest, a Peace Corps volunteer monitors crop pests in Kenya, wildlife biologists watch sea turtles lay their eggs on a Costa Rican beach, and United Nations public health workers compile statistics on the growth of the world's human population. The theme that unites all these activities is the study of population dynamics. We need to know where living things live; how numerous they are; the way they are distributed on land or in water; their birth rates, death rates, and life spans; the environmental conditions that affect them; and how they are adapted to these conditions. The many aspects of population dynamics are the subject of this chapter.

Organizing Your Knowledge

Exercise 1 (Modules 35.1 – 35.2)

Lab CD Activity 35A *Techniques for Estimating Population Density and Size*

This exercise will allow you to work with the concepts of population density, dispersion pattern, and sampling. The map represents a meadow on the edge of the city of Mapleton. It is surrounded by developed and farmed land but has remained relatively undisturbed. Developers plan to build a subdivision that would cover the meadow. The Mapleton Open Space Alliance would like the meadow to remain as public open land. They note that the dwarf hawthorn, an uncommon shrub, is found in the meadow. It is considered a "sensitive species" by the state conservation department. The city council has asked for a construction delay until the status of the shrub is determined. You have been sent to determine the density of the hawthorn population in the meadow, as well as that of a deer mouse that may also be present. Use the map of hawthorn distribution on the next page for your survey and answer the following questions.

The area of the meadow is 16.8 hectares. (A hectare is a metric unit of area equal to about 2.2 acres, so the meadow totals about 37 acres.) This is too big an area to count every shrub, so you will have to look at sample plots. On the ground, this would be done with ropes and measuring tapes. You can choose random samples by merely dropping a penny on the map, drawing a circle around it, and counting the "shrubs" inside. On the scale of the map, the area covered by a U.S. penny equals 0.2 hectare.

1. Take ten samples. How many hectares does this total? _____
2. What is the total number of shrubs in the ten samples? _____
3. What is the density of hawthorns in shrubs per hectare? _____
4. What is the total number of hawthorns in the meadow? _____
5. How could you make your count more accurate? Why not do this?

6. Look at the map again. What is the pattern of dispersion of the shrubs? What might cause this pattern of dispersion?

You would also like to know the number of deer mice in the meadow. For this, it will probably work best to use the mark-recapture method.

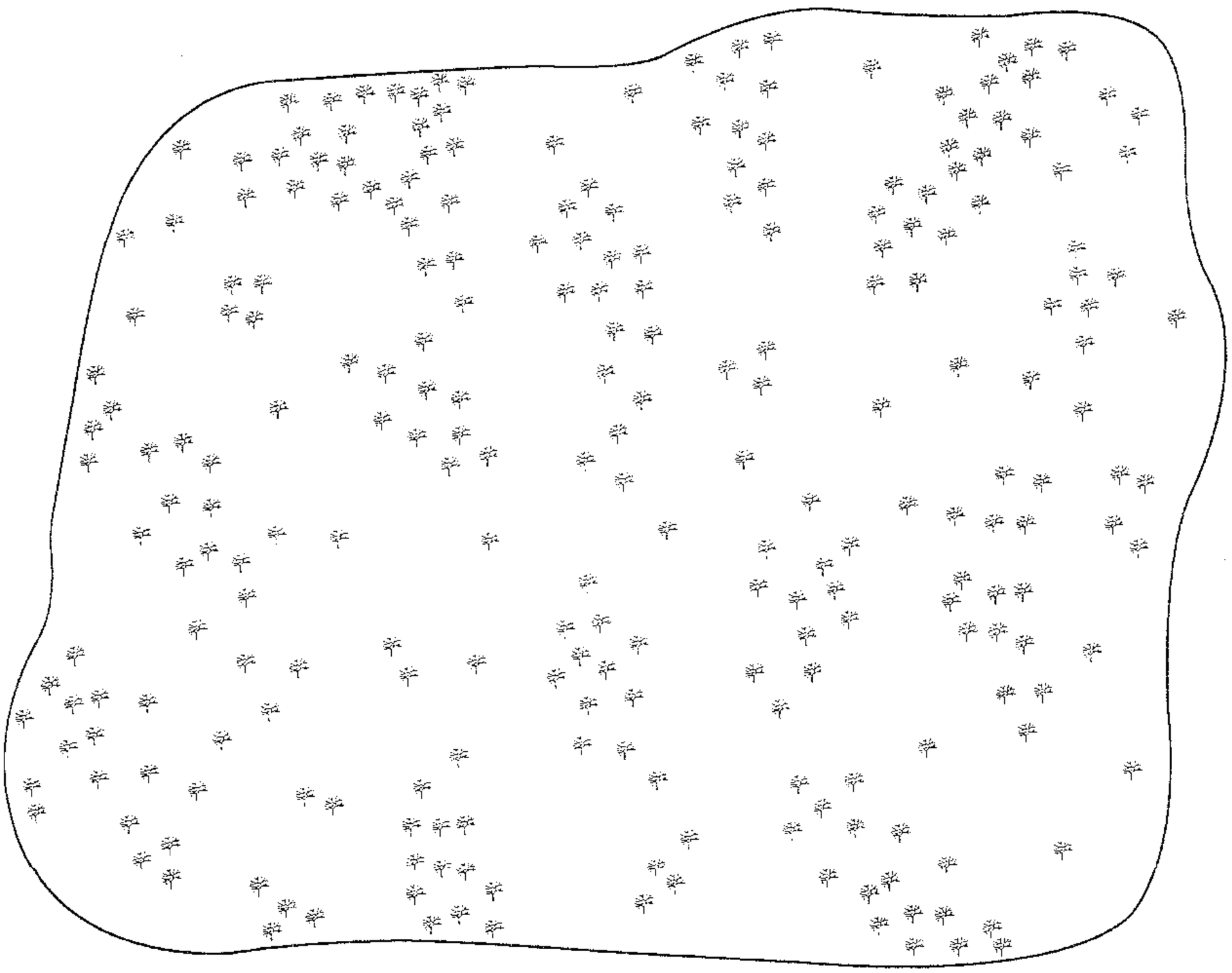
7. Why does this work better than the method used to count the plants?

8. One night, you trap 40 mice, mark them, and let them go. Two nights later, you again trap 40 mice, and ten of them are marked. What is the total number of mice in the meadow? _____

9. What is the population density of mice in the meadow, in animals per hectare?

_____

10. What do you have to assume about the mice and your method for your results to be valid? Could you be wrong? Why or why not?

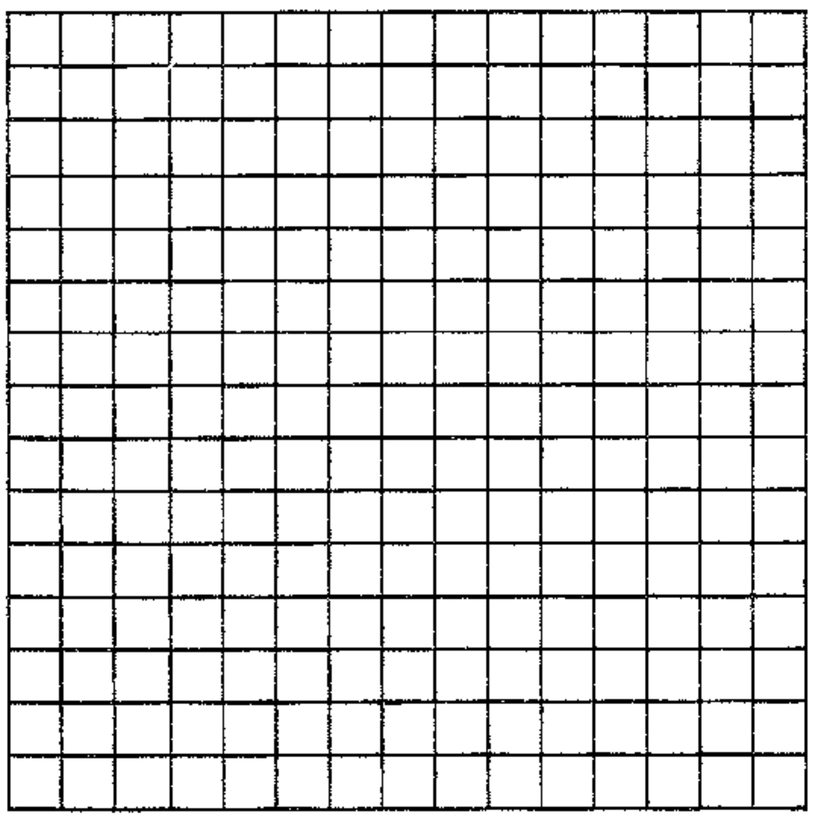


Exercise 2 (Module 35.3)

Models devised by ecologists describe two kinds of population growth. Exponential growth is described by this equation: $G = rN$. The rate of growth, G, depends on N, the size of the population, multiplied by r, the population's intrinsic rate of increase, which is calculated by subtracting the death rate from the birth rate. Exponential growth is unregulated. The bigger the population, the faster it grows. This cannot be sustained for long in real populations, but it is interesting as a theoretical possibility. Populations of fast reproducers like bacteria and insects can grow at near-exponential rates for short periods.

Let's calculate and graph the exponential growth of a population of aphids for which $r = 40\%$ per week. Remember that $G = rN$. If there are 10 aphids to start with, the number of aphids added by the end of the first week (G) is equal to rN, or 0.4×10, which equals 4. So the total population (N) after one week is $10 + 4 = 14$.

1. Starting with the new total (N) of 14, how many aphids will be added (G) in the second week? _____ (Round off fractions.)
2. What will the total population (N) be at the end of the second week? _____
3. Aphids added in the third week? _____ Total after third week? _____
4. Aphids added in the fourth week? _____ Total? _____
5. Total at end of the fifth week? _____ sixth week? _____ seventh week? _____ eighth week? _____ ninth week? _____ tenth week? _____
6. Graph the size of the aphid population (N) versus time (in weeks) below. Population size was 10 at time = 0. Label the axes of the graph.



7. How would you describe the shape of this graph?

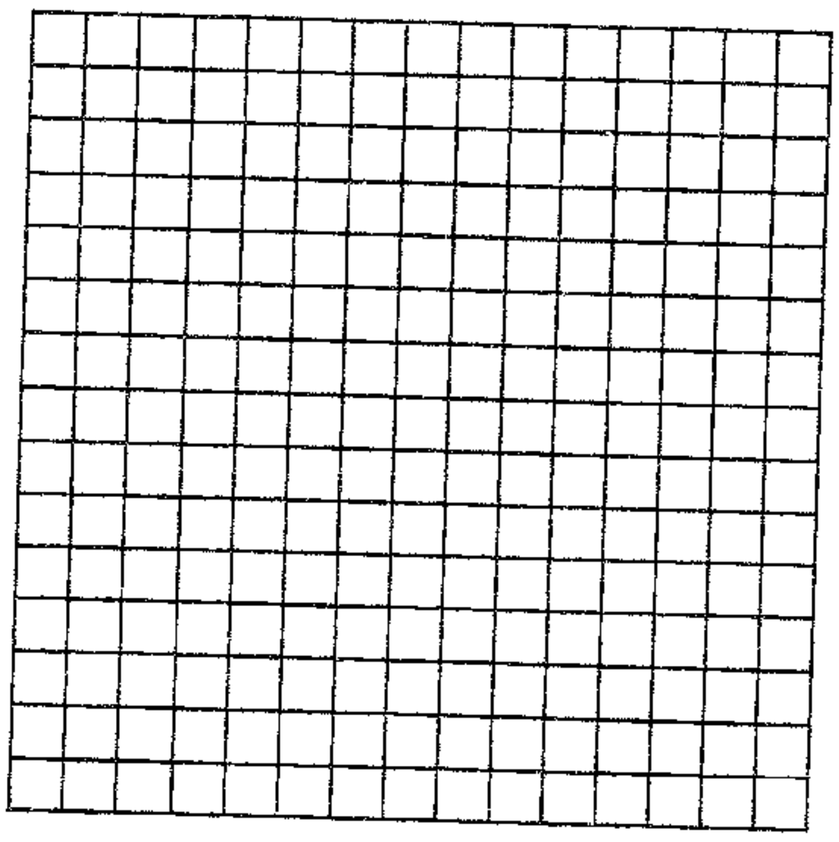
8. Could this kind of growth continue indefinitely? Why or why not?

environments will not support exponential growth. Populations are limited by space, supply, or other factors that slow growth. The population may level off at a density the environment can maintain—carrying capacity. This so-called logistic growth is described by the equation $G = rN(K - N)/K$, where K represents carrying capacity.

The following data chart the growth of a population of deer on a small protected island off the coast of Alaska, recorded over a 50-year period:

1940	92	1970	814
1945	151	1975	765
1950	295	1980	688
1955	603	1985	740
1960	861	1990	729
1965	920	1995	738

9. Graph the growth of the deer population below. Label the axes. How would you describe the overall shape of the graph?



10. What happened to the population during the 1960s and early 1970s?

11. What may have caused the population density to level off?

12. What is your estimate of the carrying capacity of the island for deer?

13. What is the biological term for this kind of population growth?

Exercise 3 (Modules 35.4 – 35.5)

Population growth is limited by both biotic and abiotic environmental factors. Biotic and abiotic factors affect birth rates and death rates in different ways. State whether each of the following words or phrases relates more to biotic factors or to abiotic factors.

_____ 1. Have more effect when the population is larger (density dependent)
_____ 2. Have less effect when the population is smaller
_____ 3. Effect does not depend on density of population
_____ 4. Competition for food
_____ 5. Fire
_____ 6. Predation
_____ 7. Stress produced by crowding
_____ 8. Competition for nest sites
_____ 9. Storms
_____ 10. Drought
_____ 11. Disease
_____ 12. Heat and cold
_____ 13. Habitat disruption by humans
_____ 14. Cause populations to stabilize in size, presumably near carrying capacity
_____ 15. Cause rapid population growth followed by unpredictable crashes
_____ 16. Seem to cause boom and bust cycles among predators and prey
_____ 17. Limit the snowshoe hare population
_____ 18. Limit the lynx population
_____ 19. Effects of the nonliving environment
_____ 20. Effects of other organisms

Exercise 4 (Module 35.6)

Web/CD Activity 35B *Investigating Survivorship Curves*

Check your understanding of life tables and survivorship curves by matching each phrase on the right with a term on the left. Answers may be used more than once.

A. Life table
B. Survivorship curve
C. Type I survivorship
D. Type II survivorship
E. Type III survivorship

_____ 1. Graph of percent alive at the end of each age interval
_____ 2. Tabulation of deaths and chance of surviving
_____ 3. Most young die, but a few live to old age
_____ 4. Originally used to set life insurance rates
_____ 5. Characteristic of oysters
_____ 6. Death rate constant over life span
_____ 7. Characteristic of *Hydra* and gray squirrels
_____ 8. Most offspring live a long life and die of old age
_____ 9. Characteristic of humans and many other large mammals

Exercise 2 (Modules 36.2 – 36.5)

Web/CD Activity 36A *Interspecific Interactions*

The structure of a community is shaped by interactions among the populations making up the community. The most important kinds of interactions are predator/prey relationships, competition, and three kinds of symbiosis—parasitism, commensalism, and mutualism. State which of these five interactions is described in each of the examples below.

_____ 1. Small fish called remoras accompany sharks and dine on scraps left over when sharks feed.

_____ 2. Sheep liver flukes feed on bile and can weaken or kill their hosts. They are passed on to other sheep in the animals' droppings.

_____ 3. Grazing by introduced mountain goats has reduced the numbers of alpine wildflowers in Olympic National Park.

_____ 4. Pest-control specialists have brought in a destructive moth to eat tansy ragwort, a poisonous weed.

_____ 5. Mistletoe obtains nutrients from a tree host.

_____ 6. A small shrimp takes shelter inside a sponge, which is apparently unaffected by its tenant.

_____ 7. Mycorrhizal fungi associated with roots obtain carbohydrates from a tree, while enabling the tree to absorb water and minerals more efficiently.

_____ 8. In many parts of North America, the starling has displaced the bluebird from its nest sites.

_____ 9. A bee pollinates a tropical orchid by being tricked into "mating" with the flower; the bee uses a perfume from the flower to attract a mate.

_____ 10. The influenza virus attacks the lining of the respiratory tract and is passed from person to person by contact or airborne droplets.

_____ 11. Red-winged blackbirds arrive earlier on the breeding grounds but are forced to the edges of a marsh by larger, later-arriving yellow-headed blackbirds.

_____ 12. Lions hunt large herbivorous mammals such as zebras and wildebeest.

Exercise 3 (Modules 36.2 – 36.5)

Web/CD Activity 36A *Interspecific Interactions*

You can think of an organism's niche as its "role" or "job" in the community. The niche includes the sum of the organism's functions, abilities, and tolerances. It is possible to describe the niche as a sort of "job description" for a species, as you might see in a classified ad: "Applicant will be required to travel in herd, drink through nose, and knock down trees for food" could only describe the job of an elephant!

Identify the organism whose niche is outlined in each of the following job descriptions. Some are from the text; others are not but will probably (like the elephant) be familiar to you.

_____ 1. "Ability to build trap to catch flying insects. May or may not need to devour mate."

_____ 2. "Ability to cling tightly to rocks, withstand wave action, and outlast competitors at low tide."

_____ 3. "Will be traveling and working outdoors in cold weather. Must have the patience to wait long periods to catch and eat seals through hole in ice. Some swimming ability and camouflage helpful."

_____ 4. "Will be stabilizing tide pool community through predation. Must like mussels."

_____ 5. "Must be able to withstand coastal storms and forest fires while maintaining species' reputation as world's tallest tree."

_____ 6. "Must live in South American rain forest, eat insects, and have poison glands and bright coloration."

_____ 7. "Will work closely with legume. Will be required to fix nitrogen in exchange for daily carbohydrate allowance."

_____ 8. "Important position as keystone predator, consuming sea urchins and evading killer whales."

Exercise 4 (Modules 36.6 – 36.7)

Web/CD Activity 36B *Primary Succession*

Gradual transition in the species composition of a community that occurs after a disturbance is called ecological succession, described in Module 36.6. Module 36.7 describes how fire—normally considered a disturbance—actually maintains the character of certain communities. State whether each of the following represents a relatively early stage in succession or a relatively late stage. (Hint: Ask yourself if the community were left untouched, whether it would look the same or different in a hundred years. If it would look different, it is in an early stage—there are later stages to come.)

_____ 1. Lichen-covered rocks near a melting glacier in Alaska

_____ 2. The Pacific Northwest forest described in Exercise 1

_____ 3. A vacant lot near your college

_____ 4. An oak-maple-beech forest in Ohio

_____ 5. A lava flow on the island of Hawaii

_____ 6. A lawn in a suburb in New Jersey

_____ 7. A cornfield in Virginia

Exercise 5 (Modules 36.8 – 36.10)

Web/CD Activity 36C *Energy Flow and Chemical Cycling*
Web/CD Activity 36D *Food Webs*

The trophic structure of an ecosystem is the pattern of feeding relationships by which energy and chemicals flow through the system, from trophic level to trophic level. Name the trophic level of each of the organisms in the following description of a freshwater marsh food web: producer (P), primary consumer (1C), secondary consumer (2C), tertiary consumer (3C), quaternary consumer (4C), or detritivore (D). (Note that a consumer can function on more than one level, depending on what it eats.)

Marshes and other wetlands are among the most endangered of habitats. They are productive "nurseries" for many wildlife species, but many of our wetlands have been drained for agriculture or filled for development.

The freshwater marsh food web starts with plants like cattails, arrowleaf, and various floating or submerged "water weeds" ([1]_____). They provide food for muskrats ([2]_____) and mallard ducks ([3]_____), both of which may in turn be eaten by hawks ([4]_____) or mink ([5]_____). Microscopic algae ([6]_____) make much of the food in the marsh. Small shrimplike crustaceans ([7]_____) and insect larvae ([8]_____) graze on the algae. The insects are eaten by ducks ([9]_____), frogs ([10]_____), and sunfish ([11]_____). A frog or sunfish might be eaten by a larger yellow perch ([12]_____), a great blue heron ([13]_____), a water snake ([14]_____), or a mink ([15]_____). The heron ([16]_____) also eats perch and snakes, and the hawk ([17]_____) will also occasionally devour a snake.

This is a highly simplified description of a marsh food web. There might be hundreds of species of large plants and animals making up the community of a marshy roadside pond, not to mention a swarm of microscopic creatures. In addition to this grazing food web, many inconspicuous worms, insect larvae, and snails ([18]_____) get their food from the dead material produced by the other plants and animals of the marsh.

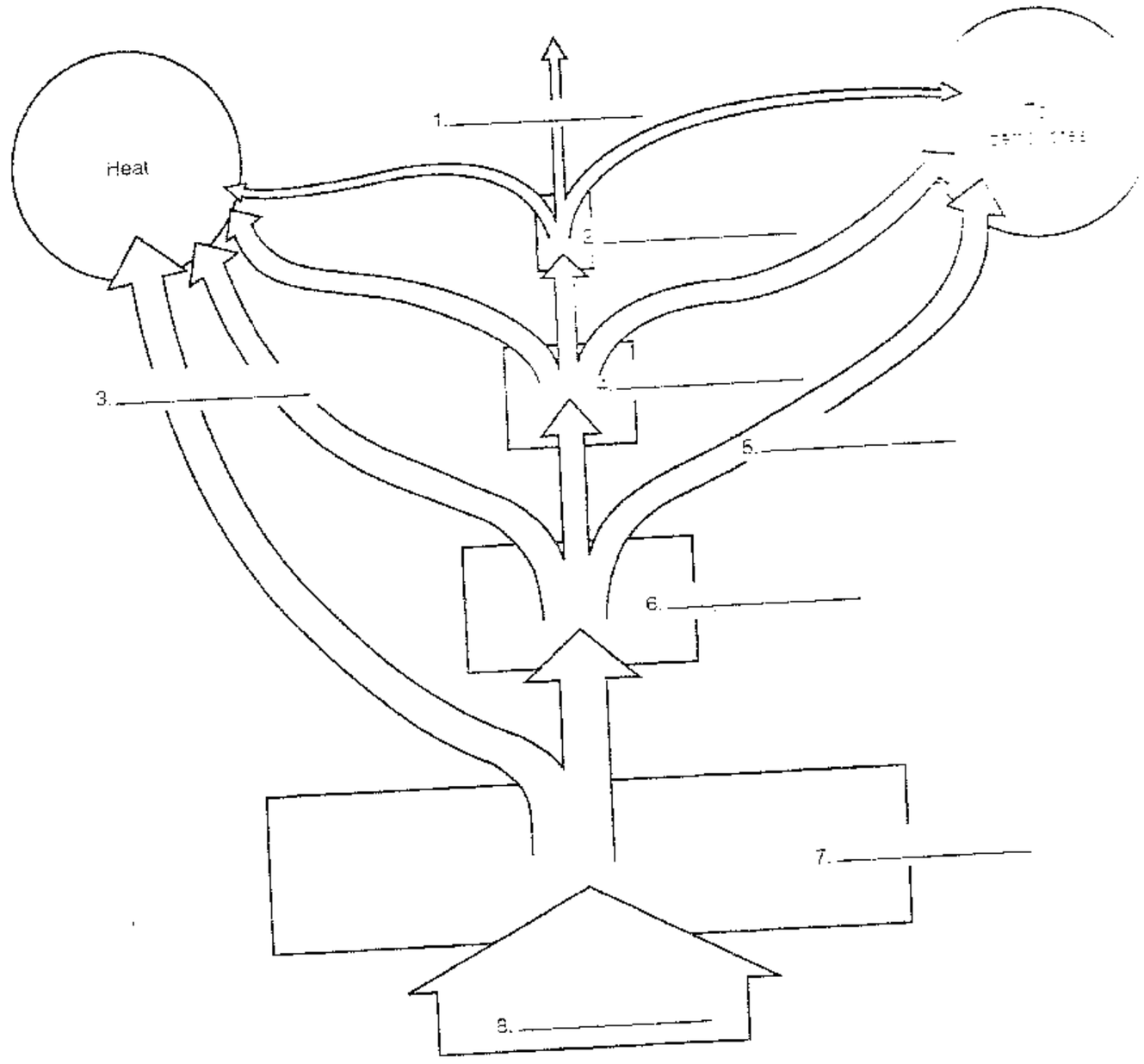
On a separate sheet of paper, sketch the marsh food web. It is *not* the same as the example in Module 36.10. Write the names of the organisms at their appropriate trophic levels, and connect the names with arrows. (Where in your diagram should the producers be? The top consumers? Which way do the arrows point? Why?)

Exercise 6 (Modules 36.8 – 36.12)

Web/CD Activity 36C *Energy Flow and Chemical Cycling*
Web/CD Activity 36D *Food Webs*
Web/CD Activity 36E *Energy Pyramids*

The flowchart on the next page illustrates the movement of energy through an ecosystem. The boxes represent the total mass of organisms at each trophic level. The arrows show the amount of energy passing through each trophic level. Energy enters the producer level as sunlight. Some of this energy is stored in molecules produced in photosynthesis. Energy enters each of the consumer trophic levels when the consumers feed on the level below. Much of the energy in the food entering any level is used to power life processes; the food is used as fuel in cellular respiration, and its energy ends up as heat. Some energy is wasted; it is lost to the detritus food web in the form of dead leaves or droppings.

a small portion of the energy is stored up in tissue when organisms grow or reproduce; this production—about 10% of energy intake at any trophic level—is the only energy available to the next level. Label and color the trophic levels on the diagram: **producers** (green), **primary consumers** (blue), **secondary consumers** (pink), and **tertiary consumers** (orange). Label and color the pattern of energy flow: **sunlight** (yellow), **production energy** (orange), **energy used in cellular respiration** (red), and **energy in wastes** (brown).



Exercise 7 (Modules 36.13 – 36.18)

Web/CD Activity 36F *The Carbon Cycle*
Web/CD Activity 36G *The Nitrogen Cycle*
Web/CD Activity 36H *Water Pollution from Nitrates*

The biosphere receives a constant supply of energy from the sun, uses this energy for a while, then loses it to space as heat. Unlike energy, the chemicals necessary for life are present on Earth in fixed amounts, and these chemicals are used over and over. These chemicals, such as water, carbon, and nitrogen, occur in various forms and are changed from one form to another by various physical and chemical processes. The story below traces a nitrogen atom as it moves through the various reservoirs and processes of the nitrogen cycle. Fill in the blanks as you follow its journey.

The nitrogen atom, N, had been in the atmosphere for more than 2 years. It was paired with another identical nitrogen atom, forming a molecule of [1]_____ gas, which makes up about 80% of the air. During its time in the atmosphere, N had circled the Earth several times, from the skies over the Philippines, to Africa, to the Antarctic, to South America, and now over a sand dune in North Carolina. There it was captured by [2]_____ in a nodule on the root of a legume called a beach pea. There N was split away from its partner and combined with hydrogen atoms, eventually