B

Biology Standard
B.8.a.

Student Workbook

California Education and the Environment Initiative

Differential Survival of Organisms

California Education and the Environment Initiative
Approved by the California State Board of Education, 2010

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California Environmental Protection Agency
California Natural Resources Agency
Office of the Secretary of Education
California State Board of Education
California Department of Education
California Integrated Waste Management Board

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Barrier to dispersal: A geographical, environmental, or physical boundary that limits where organisms can disperse.

Bathymetry: The measurement of depths in a large body of water, such as the ocean.

Coastal wetlands: Wetlands, such as a tidal salt marsh or freshwater marsh, that are located in a coastal watershed that drains into an estuary, bay, or ocean.

Contaminant: A chemical or other factor, such as heat not naturally present in the environment, that can, if in sufficient quantity, adversely affect it.

Differential survival: Differences in survival rates of organisms resulting from variations in the genetic, physical, or behavioral traits that they possess.

Distribution: The geographic area inhabited by a species.

Kelp: Large brown algae that grow primarily in shallow ocean water in temperate and arctic regions.

Life span: The average length of time an individual of a given species is expected to survive.

Local extinction: The loss of a group of organisms from a particular area, which may or may not be permanent.

Mortality rate: The number of deaths in a population from a particular cause within a specified time period.

Phenotype: The observable characteristics of an organism, such as size, color, running speed.

Population dynamics: Changes in the size and age structure of a population.

Selection pressure: An environmental factor that tends to change the frequency of expressed, heritable traits in a population.

Sexual maturity: The stage of development at which an organism is able to reproduce.

Subspecies: A group of organisms within a species that has distinct characteristics resulting from geographical or physical isolation from other populations of their species.

Upwelling: The wind-driven movement of cold, usually nutrient-rich water from ocean depths to the surface.

Name: _____

Instructions: For questions 1 to 3, describe how the distribution of the sea otters in the northern Pacific Ocean would be affected by changes to the following environmental conditions. Explain why this change in distribution would occur. Complete the tasks in the spaces provided. (3 points each)

1. A decrease in the distribution of kelp around the Pacific Ocean basin:

2. An increase in sea surface temperature in the Pacific Ocean basin:

3. A drastic decrease in the nutrients (nitrates and phosphates) in the Pacific Ocean basin:

Name: _____

Instructions: Answer the following question in the space provided. (3 points)

4. If the distribution of sea otters decreased, would the distribution and survival of kelp forests change? Why or why not?

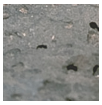
Name: _____

Part 1

Instructions: Read about the habitats and phenotypes of rock pocket mice, guppies, and house sparrows. After viewing the related visual aids, predict which phenotype would be favored under each specified condition. Record your answers in the spaces provided.

Rock pocket mice (*Chaetodipus intermedius*) live in the southwestern region of North America, where the environment tends to be rocky and arid. The fur of these animals can grow in several color variations (phenotypes), including black, salt-and-pepper (white and gray), and light brown.

1. Match the substrate (surface that a plant or animal lives upon) type with the phenotype you think is better adapted to survive on that particular substrate. (1 point each)

Substrate Type and Color	Fur Color Phenotype
Black basalt 	
Sandstone	
Granite	

2. What environmental factor most influences the phenotype of individuals in different groups of mice? (1 point)

Name: _____

Guppies (*Poecilia reticulata*) are native to small pools along the Aripo River system on the island country of Trinidad, as well as other locations in South America. The average body size and age of sexual maturity of guppies along the Aripo appear to change with the size of predators there. One predator, the killifish, preys on small juvenile guppies. Another predator, the pike-cichlid feeds on larger, more sexually mature guppies. In pools populated by pike-cichlids, the guppies that survive to reproduce are smaller at sexual maturity and reproduce at a younger age than the guppies in pools with killifish. These guppies also usually only produce one brood. In pools where the killifish is the main predator, the guppies that survive predation are larger at sexual maturity and often produce several broods.

3. What would happen to the average phenotype of a group of guppies from a pike-cichlid pond that is transplanted into a killifish pond? (3 points)

4. What would happen to the average phenotype of guppies from a killifish pond if the guppies were transplanted into a pike-cichlid pond? (3 points)

5. What factor do you think most influences these shifts in the average phenotype? (2 points)

Name: _____

House Sparrow (*Passer domesticus*) arrived in the United States when they were introduced to New England in the 1880s. These birds currently live throughout North America. The size of individual sparrows varies greatly; an individual's size can significantly affect its ability to survive. An organism's surface area-to-volume ratio affects its ability to retain body heat. Small animals have a larger surface area-to-volume ratio, so they lose body heat faster than large organisms.

6. Based on the map of sparrow body sizes, how does the average body size of sparrows vary across North America? (3 points)

7. What factor most influences this regional shift in the average house sparrow phenotype? (3 points)

Name: _____

Part 2

Changes in environmental conditions can lead to the differential survival of organisms; the environment can shift to favor one species over another.

Instructions: Read the following two examples of environmental change and record your predictions below.

Great Barrier Reef, Australia
Along the Great Barrier Reef, typhoons (cyclones that occur in the Pacific Ocean) occur regularly. The frequency of typhoons affects the ability of some species of coral on the reef to survive. During periods of low typhoon frequency the larger, slower-growing coral eventually dominates the reef. This type of coral outcompetes the smaller, faster-growing coral. In periods with high typhoon frequency the smaller, faster-growing coral dominates the reef.

8. Recently few typhoons have occurred along the Great Barrier Reef. Predict what would happen if typhoon frequency increased significantly and typhoons continued to hit the reef for several years. (3 points)

California's Central Coast
Boulder fields, wide areas that consist of a bedrock base covered with boulders, occupy several areas along the coast of central California. Two types of macroalgae, *Gigartina* spp. and *Ulva* spp., grow in the same area. When undisturbed, *Gigartina* always outcompetes *Ulva,* but *Ulva* grows quickly and is better at colonizing newly opened areas. During winter storms incoming waves move the boulders in this area, and the friction from the movement rubs nearby algae off the rocks. In years with many storms *Ulva* grows on the rocks. In years with fewer storms *Gigartina* dominates and *Ulva* grows only on smaller rocks, which are moved more easily by the waves.

9. Explain this pattern. (3 points)

Name: _____

10. Describe what would happen if storm frequency increased and continued for several years. (3 points)

Part 3

Instructions: Complete following task in the space provided. (3 points)

11. Describe one environmental factor that changes over time and can lead to a shift in the average phenotype of a group of organisms. Identify the group of organisms by name and explain in detail the shift in the average phenotype.

Name: _____

Part 1

Instructions: Use the **Adaptations to Selection Pressures Cards** to complete the following chart. Some characteristics may appear more than once. (1 point for each correct answer)

Organism: Jelly (Jellyfish)

Selection Pressures and Adaptation Chart			
Need for Energy	**Predation**	**Need to Reproduce**	**Abiotic Environmental Factors**
Adaptation: Function:			

Organism: Sea urchin

Selection Pressures and Adaptation Chart			
Need for Energy	**Predation**	**Need to Reproduce**	**Abiotic Environmental Factors**
Adaptation: Function:			

Name: _____

Organism: Shark

Selection Pressures and Adaptation Chart			
Need for Energy	**Predation**	**Need to Reproduce**	**Abiotic Environmental Factors**
Adaptation: Function:			

Organism: Whale

Selection Pressures and Adaptation Chart			
Need for Energy	**Predation**	**Need to Reproduce**	**Abiotic Environmental Factors**
Adaptation: Function:			

Name: _____

Part 2

Instructions: Read the following information, then apply what you know about adaptations, selection pressures, and the differential survival of organisms to the questions below. (5 points each)

Scientists have been studying the finches of the Galapagos Islands since Charles Darwin first describedthem in 1835. One species, the medium ground finch, lives on Daphne Major, a desolate, uninhabitedvolcanic cone. The population of these birds displays a variety of phenotypes of beak sizes. Smaller beaks are best for eating small, soft seeds, while large beaks can crack large, hard seeds. In times of drought, small seeds become rare on the island. When El Niño occurs and heavy rains fall, vines and other plants thrive, choking out the plants that produce large seeds.

1. What is a selective pressure that influences the survival of the medium ground finch?

2. Predict and explain how drought would affect the differential survival of the medium ground finch.

3. Consider the phrase “Bigger beaks are always better.” Do you agree or disagree? Why or why not?

Name: _____

Instructions: Complete the following tasks in the spaces provided.

1. Identify five abiotic and five biotic factors that can affect a coastal wetland ecosystem. (1 point each)

Abiotic Factors	Biotic Factors

2. Record the information from your group system chart in the space below. Include at least four biotic factors and four abiotic factors. Draw arrows between the factors that you think might affect each other to create as many connections as possible. Include a minimum of four connections. (1 point each factor or connection, with a maximum of 20 points)

Name: _____

3. Describe how two biotic and two abiotic natural factors can change this coastal wetland ecosystem. (2 points each)

How Natural Factors Cause Change

Abiotic:

Abiotic:

Biotic:

Biotic:

4. Identify four human activities that can influence this environment. Include examples of both beneficial and detrimental influences. (2 points each row)

Human Activities

Activity	How Activity Influences the Environment

Name: _____

Sea Otters and Human Activities

Part 1

Appearance

The sea otter (*Enhydra lutris*), belongs to the family Mustelidae and is closely related to the weasel. Like other members of this family, the otter has thick fur with approximately 1 million hairs per square inch. This thick fur insulates the otter from the cold waters of its habitat. Unlike other marine mammals the otter does not have a layer of blubber to keep it warm. This animal spends a good portion of its day grooming because soiled or clumped fur makes it difficult to maintain body temperature. Marine biologists consider a lack of grooming in sea otters to be a sign of disease.

Sea otter

Habitat

The sea otter prefers to spend its time in the nearshore habitat of kelp forests. It usually lives in waters shallower than 131 feet (40 meters). Studies on the food webs of kelp forests show that this animal plays a major role in the biodiversity of this habitat. For this reason, scientists identify the otters as a keystone species of the kelp forest.

Sea otter floating on back

Feeding

The sea otter has a fast metabolism that helps it stay warm. The average otter consumes nine pounds of food per day, the equivalent of 20 to 25% of its body weight. That is the equivalent of a human who weighs 150 pounds eating 30 pounds of food per day! The otter consumes a variety of invertebrates, such as urchins, clams, mussels, oysters, octopi, and sea stars.

Life Span and Reproduction

Female sea otters live between 15 and 20 years; males live only 10 to 15 years. Females become sexually mature (able to reproduce) between three and five years of age, while males reach sexual maturity slightly later, at five to six years. Females usually give birth to one pup per year.

Name: _____

Part 2
Population Dynamics

1700–1900s Extensive hunting of sea otters occurs.

Early 1900s Otters hunted almost to extinction. An estimated 1,000 otters remain in Alaska.

1911 International Fur Seal Treaty of 1911 established to protect fur seals.

1938 A population of 50 sea otters spotted off of Central California coast near Big Sur.

1971 Atomic bomb testing off Amchitka Island in Alaska kills thousands of otters.

1972 Marine Mammal Protection Act becomes law.

1973 Endangered Species Act becomes law.

1977 California group of sea otters classified as a subspecies and placed under protection of the Endangered Species Act.

1980s Legislation enacted to reduce the number of sea otters that drown in gillnets (a form of fishing net).

1989 Thousands of sea otters die in the *Exxon Valdez* disaster off the coast of Alaska. This was one of the largest oil spills in U.S. history.

1995 California population of otters declines; new research indicates pollution from runoff is partly to blame.

2004 Forty percent of sea otter deaths off the coast of California since 2001 are attributed to two parasites: *Toxoplasma gondii* (from cat feces) and *Sarcocystis neurona* (from opossum feces).

2007 California legislation enacted a law that requires warning labels on cat litter packages to help diminish transfer of parasites to sea otters.

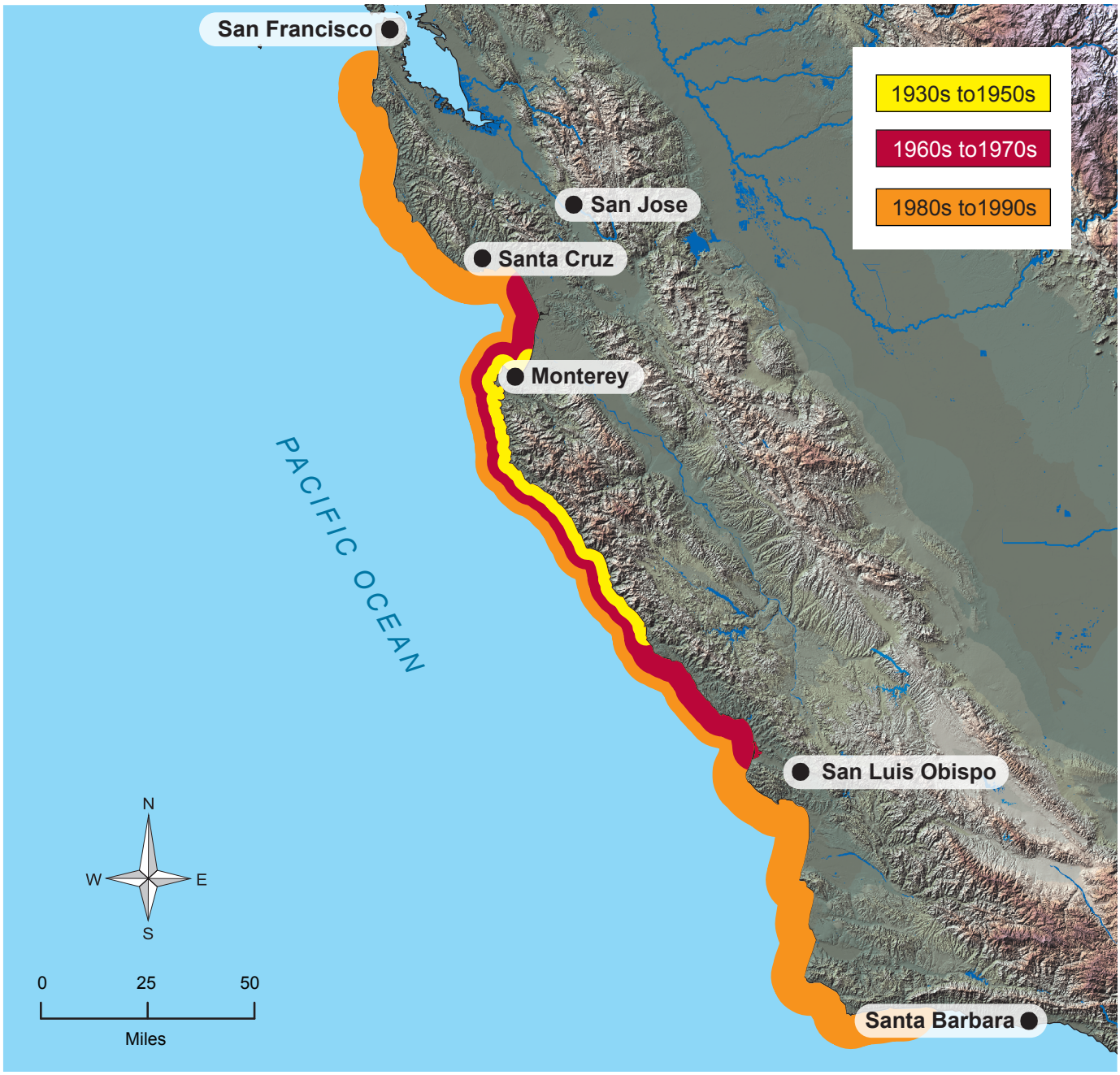
Sea Otter Population Changes Over Time

Year	British Columbia	Russia	Alaska	Washington	California
1900	Estimated 1,000–2,000 otters worldwide				
2004	2,700	13,000	75,000	800	2,000*

* Current population is descended from the original 50 individuals off the coast of Big Sur.

Name: _____

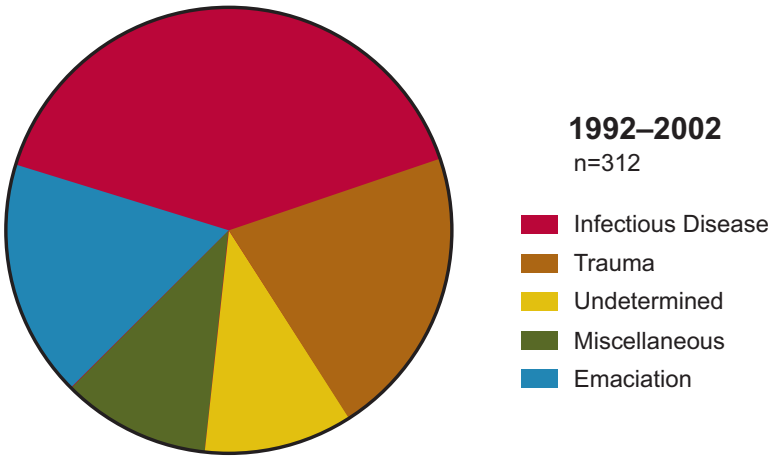
Historical Changes in Sea Otter Distribution



Name: _____

Mortality

Many factors contribute to mortality in sea otters. Occasionally bald eagles and white sharks eat otter pups; in Alaska killer whales feed on otters when their regular food sources of seals and sea lions are not readily available. Trauma caused by boats or gunshots also contributes to otter mortality; however, disease caused by a combination of parasites and infection appears to be the main cause of death of sea otters today. Scientists have identified two main parasites in sea otters. These parasites are *Toxoplasma gondii* (spread through cat feces) and *Sarcocystis neurona* (from opossum feces). Contaminants in coastal runoff, such as polychlorinated biphenyls (PCBs) also poison sea otters and can compromise their immune systems, making them susceptible to disease.



Source: http://www.nwhc.usgs.gov/publications/fact_sheets/pdfs/SeaOtter2005.pdf

Killer whale (*Orcinus orca*)

Name: _____

Instructions: Complete the following task in the spaces provided. (1 point)

1. Describe the geographical changes that have taken place in the distribution of sea otters over time.

Instructions: Use the information in Part 1 of **Sea Otters and Human Activities** to answer the following questions in the spaces provided. (1 point each)

2. Why is the sea otter's thick fur important to its survival?

3. What happens when the fur is soiled or clumped?

4. Why is a healthy kelp forest essential to the sea otter's survival?

5. How long do sea otters live?

Name: _____

6. When can a female sea otter reproduce? How many pups does a female produce a year?

7. If the average age of sea otters decreased, what would happen to the sea otter population?

Instructions: Use information in Part 2 of **Sea Otters and Human Activities** to answer the following questions in the spaces provided. (1 point each)

8. In 1989 and 1995, what human activities caused thousands of sea otters to die?

9. How can human activity affect the sea otter's thick fur and diminish its insulating qualities?

10. What happens to sea otters if human activities decrease the distribution or productivity of the kelp forest ecosystem?

Name: _____

11. What is the cause of almost half of the sea otter deaths off the coast of California since 2001?

12. In what ways can human activity affect how long sea otters live?

Instructions: Consider what you have learned about adaptations, sea otters, human activities, and differential survival and complete the following tasks in the spaces provided. (2 points each)

13. Give one example of a way that human activities might affect the sea otter's habitat and chances for survival.

14. Give one example of an adaptation that might help sea otters survive this change.

15. Give one example of another organism, human activities that might affect this organism, and what adaptations might allow some members of the population to survive.

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