EARTH, WIND & WILDFIRE
learning to live with fire

TEACHER'S GUIDE SAN DIEGO NATURAL HISTORY MUSEUM

Dear Educator,

Welcome to *Earth, Wind & WILDFIRE.*

The enclosed materials have been designed to provide an educational and enjoyable experience for your students. This guide includes background information; vocabulary; materials for pre-visit, Museum visit and post-visit activities; answers; and references. These materials are most appropriate for grades 3–7 and may be adjusted for other grade levels.

References to California Science Content Standards are included where appropriate.

If you should have questions related to this guide please call the Museum Education Department at 619.255.0311 or email saglietti@sdnhm.org.

Contents

Exhibition Overview

Both fire and people are powerful forces that shape the ecosystem in southern California. How can the two coexist? Why should the two coexist? Through objects, videos, photographs, and interactives, experience the beauty of southern California and examine the complex relationship between fire and people. Explore the power of fire, its historical context, and present challenges. Examine the range of human attitudes and actions that shape the ecosystem. Take a close look at ways to best manage wildlands based on sound science. Connect with the unique diversity of this region and find hope in the regenerative forces of nature, visible in this innovative exhibition which premieres on the one-year anniversary of the 2003 southern California wildfires.

Background

Biodiversity and the San Diego Area

What is unique about the San Diego area? Why do so many people want to live here? What role does fire play in our ecosystems? Can major wildfires be prevented? While answers to these questions are complex, examining San Diego's varied landforms, habitats, global placement, and climate will provide some clues.

San Diego County is a hotspot of biodiversity. The floristic diversity in this county is greater than that of some whole states. There also are more rare and endangered plant and animal species living here than in any other county in the continental United States.

Extreme topography plays a key role diversity of habitats. Over the course of millions of years, tectonic forces have caused mountains to uplift, lowlands to subside, and volcanoes to erupt. Rivers flow from eastern mountains toward the sea to create valleys and canyons across the landscape. Weathering, erosion, and rising and falling sea levels continue to move and shape the land. The current topography of San Diego County features coastal plains and terraces, foothills, mountains, and deserts—a multitude of habitats for plants and animals—the perfect setting for diversity of life.

Located in a temperate latitude, the climate of the area is mild—often classified as a semi-arid climate along the coast and Mediterranean in the inland foothills, valleys, and mountains. Moderated by its proximity to the sea, the coastal strip is cool, while inland is warmer. The peninsular mountain range provides a barrier for moisture moving west to east which results in desert habitats on the eastern side of the county. Most desert rains come from tropical summer storms that move north from the Sea of Cortés. These rain storms are intense, but usually of short duration. Moving across the county, climatic differences coupled with the varied landforms create habitats for numerous types of flora and fauna.

While not extreme, seasonal differences do occur. Rain falls mostly in winter and early spring: annual rainfall is less than 10 inches (25 cm) along the coast and up to 30 inches (75 cm) in the mountain areas. Summer and fall are normally dry and warm. The **Santa Anas**, hot dry winds that blow from the east, frequently occur in the fall. These easterly winds are heated by the desert and blow with intensity; this reduces the humidity and sets the stage for wildfires.

The interactions of topography, geographical location, and climate have created an area of rich biodiversity, a desirable place for human habitation, and an area highly susceptible to fire.

The Nature of Fire

To explain the phenomenon of fire and to illustrate fire prediction, many ecologists, teachers, and fire experts use two triangle diagrams. The first diagram, called the **combustion triangle**, shows that fire requires fuel, oxygen, and an ignition source. The second triangle is a **fire behavior triangle**, which depicts wildland fuel, topography, and weather to show how a particular wildfire will burn. How do these two triangles relate to conditions in the San Diego area?

The combustion triangle provides a general description of the requirements for any fire. **Oxygen**, of course, is present in the air. **Ignition sources** may be natural, such as lightning, or related to human activities. **Fuel** is anything combustible. In a wildland fire, fuel refers to the available vegetation and anything else that happens to be in the path of a fire. A number of conditions affect the fuel value of San Diego's vegetation:

- Natural oils in many chaparral plants make them highly flammable.
- Plant growth takes place in the wet winter season—vegetation has a higher moister content and is less flammable. Drying, through drought and winds, occurs in summer and early fall and contributes to the flammability of plants during the fire season.
- Overcrowding of forests, due to fire suppression, leads to a build-up of fuel.
- During extended periods of dryness, drought-stressed conifer trees may be attacked by beetles, creating large stands of dead and dying timber.
- Severe drought also leads to dying oaks and chaparral plants.

The fire behavior triangle uses the same fuel information as the combustion triangle. Southern California has the most extreme fire weather in the country. Summer and fall are normally dry. Strong desert winds dry the vegetation even more and reduce humidity. In a matter of hours, these winds may fan the flames of a small fire into a major wildfire. The varied topography of hills, valleys, and canyons create natural paths for fire and make accessibility difficult for fire suppression equipment.

Thus, San Diego County has all of the components—fuel, weather conditions, and topography—that foster wildfires. Indeed, evidence shows that wildfires have been occurring here for thousands of years. For our local forests and chaparral, fire is a part of a natural cycle.

Challenges

Years ago, in a sparsely populated southern California, native people made use of fire to promote growth of new vegetation and to flush out animals to hunt. Since the 1950s, the area has experienced phenomenal growth. With a population numbering in the millions, most coastal areas have been converted to housing, industrial, and commercial projects. There is little native vegetation remaining: only 40% the creekside woodlands, 25% of coastal sage scrub, 15% of grasslands, and 10% of coastal and freshwater marshes remain.

As housing developments extend inland they are frequently bordered by wildlands; other homes are completely surrounded by wildlands. It is at this **urban/wildlands interface** that we encounter the greatest fire risks. Should these wildlands managed to minimize fire danger? If so, how? What are the responsibilities of homeowners who live in high-risk areas?

While fire suppression was long in vogue, it is now realized that there are benefits in allowing remote areas to burn naturally. **Prescribed burns** similarly reduce the fuel load in strategic areas, minimizing risks to property and creating safety zones for firefighters. For areas of high risk, building codes now require the use of fire-resistant materials. Thinning brush and planting fire-resistant plants also help to minimize the impact of wildfires. Restrictions on building homes in fire-prone areas may be necessary.

Firestorms, such as those in the fall of 2003, are devastating in terms of loss of human life, property, and damage to ecosystems. In addition, wildfires contribute to air and water pollution. The loss of ground cover also creates conditions for soil erosion, mud slides, and sends runoff into our aquatic ecosystems. These soil disturbances can damage beneficial microorganisms and reduce plant productivity. Disturbed areas also encourage the growth of non-native plants that are often even more prone to devastating fires.

Recovery

In spite of this, there are benefits to periodic burns. Indeed, fire may be necessary to maintain healthy conditions in our forest and chaparral ecosystems as long as it doesn't occur too frequently. Throughout Southern California fires that occur too close together in time have contributed to the conversion of native coastal sage scrub and chaparral to annual grasslands dominated by non-native grasses. Normally a fire will occur about every thirty years, but when the interval becomes every two to three years the native shrubs are unable to recover and non-native grasses take over.

Wildflowers, called fire followers, may be seen blooming around San Diego County following a fire. Bulbs and seeds buried deep in the soil may escape the fire. In fact, many of our native plants are adapted to fire. Some stump-sprout or crown –sprout within a few days of a fire, and others have seeds that are stimulated to grow by smoke, ash or sunlight. Fire followers thrive as pioneers in open ground. In addition, fire releases **nutrients**, which promote new growth, back into the soil. After a fire, fire followers can be very important in helping to prevent erosion. They also provide much needed food and shelter for other organisms. While animal loss in a large fire may be extensive, there are survivors—some by virtue of being migratory or otherwise gone from the area, others by being able to move quickly enough to escape. Animals repopulate areas when there is sufficient food and shelter.

Fire in southern California is inevitable. The human population will undoubtedly increase. Wildland management, fire-resistant building materials, maintenance of survivable space around homes, education, and research are all factors that will prepare people to coexist with the natural environment.

Glossary

Biodiversity—variety of life on earth indicated by the variety and quantity of animal and plant species

Carbon dioxide—a gas, present in the air in small quantities, that does not support combustion

Chaparral—a vegetation type dominated by shrubs and small trees, especially evergreen species with small thick leaves, including chamise

Climate—weather of an area over an extended period of time

Coastal Sage Scrub—a vegetation type characterized by plants which include sage, buckwheat, and lemonadeberry

Combustion—rapid reaction between oxygen and a fuel

Crown fire—fire that burns the tree tops, jumping from tree to tree

Defensible space—area with reduced vegetation, usually around a home or some other structure

Erosion—the process of earth being worn away by flowing water, ice, or wind, especially common and more dangerous after fires removes vegetation, which stabilizes loose soil

Fire Follower- a term applied to certain kinds of plants that typically appear following a fire. Often these plants have special adaptations, such as seeds that are stimulated to germinate in response to heat; smoke and chemicals produced by a fire or the ability to resprout that allow them to recover after a fire.

Fuel—material that releases energy when it burns

Ignite—to set on fire

Mediterranean climate—mild climate, located in a temperate latitude, moderated by proximity to sea, characterized by warm to hot, dry summers and mild, wet winters

Nutrient—substance that provides the raw materials and energy to keep an organism alive

Oxygen—a gas present in air that supports combustion

Prescribed burn—a controlled fire set intentionally by land managers to reduce the amount of fuel and lessen the impact of a wildfire

Santa Ana winds—warm, strong, dry winds blowing from the desert causing extreme fire weather conditions

Urban/wildlands interface—where human development and natural habitat meet

Wildfire—uncontrolled wildland fire, started by lightning or human activity

Pre-visit Activities

Biodiversity—Studying an Outdoor Plot

Science Standard: Investigation and Experimentation—all grades
Scientific progress is made by asking meaningful questions and conducting careful investigations.

Objective
Students will be able to explain the concept of diversity.

Background
Quadrats are sample plots within a study site. They are usually square. A grid, formed by using stakes or flags and string is often used to define the area. Studying quadrats allows for the collection of data regarding topics such as the number of organisms present, relationships, and types of soil. Sites may be studied over a period of time to provide additional long-range data. These small plots also provide an opportunity for students to employ investigative skills, such as measuring, use of appropriate tools, asking meaningful questions, and record keeping. Grade-level adjustments should be made regarding size of plot, tools, type of data collected, etc.

Materials
journals for observations
measuring tools (meter sticks, tape measures)
cups for soil collection
flags
sticks and twine
field guides

Procedure
• Discuss the use of quadrats (sample plots).

• Describe the area you have chosen to study.

• Determine the size of your plot. For beginners, a thirty centimeter square plot is sufficient for one or two students.

• Before the field trip list questions for which you are seeking answers.
- What is the soil like?
- Is the area flat or sloped?
- Is the area exposed or shaded?
- Are there signs of **erosion**?
- What kinds of animals live here?
- What kinds of plants live here?

• Assign tasks to be completed by individuals or teams, such as measuring, staking, assigning plots, recording data.

• At the site select the study area and divide it into smaller plots. Mark the plots with appropriate markers (flags, sticks, tape). Draw a map of the site and plots in journals. Gather information related to your questions. Note other interesting facts about your site.

Follow-up
Back at school discuss your observations. Construct charts or graphs to illustrate your data.

Diversity— Likes and Differences

Science Standard: Investigation and Experimentation—grades 1–3
Scientific progress is made by asking meaningful questions and conducting careful investigations.

Objective
Students will be able to identify differences in human characteristics; discuss the concept of diversity.

Materials
paper
pencils

Procedure

• Introduce the concept of variety—different kinds of flowers, cats, dogs, rocks.

• Discuss physical attributes that characterize people, such as hair, skin, eye color, size. You may also consider hair styles, shoe types, clothing.

• Choose a list of human attributes.

• Each student identifies himself or herself by the various attributes.

• Collect data for the whole class by making a table that shows the number of students who have each attribute. For example, how many students have brown eyes? Blue? Green?

• Construct graphs or charts to illustrate your data.

• Discuss similarities and differences.

• What makes an individual unique?

Extension
When your students understand the concept of diversity, try the same exercise using natural items such as leaves, pine cones, flowers, and seeds.

Diversity—Using Field Guides

Science Standards: Investigation and Experimentation—grades 4 and up
Scientific progress is made by asking meaningful questions and conducting careful investigations.

Objective
Students will be able to discuss the concept of diversity and to group living things or objects by observable attributes.

Materials
field guides—plant, animal, rock, mineral, tree, insect
paper
pencils

Procedure
Introduce the concept of diversity in life. Divide the class into teams of two to four students per team. Distribute a field guide to each team. Teams should seek answers to the following questions:

• What are the common characteristics of the organisms or objects found in the book? (*For instance: birds all have feathers.)*

• What are some differences you notice about these organisms or objects? (*The feathers are different colors.)*

• The information in the guide is organized into major groups (mineral families, orders of insects, etc.). How many major groups are in your book? What are they?

• Choose an object or organism in the book and list all of it properties.

• Exchange the list and book with someone else. Can they identify the object or organism from your list of properties?

Nature of Fire

Science Standard: Physical Science

K	Properties of materials can be observed, measured, and predicted.
Grade1	Materials come in different forms.
Grade 3	Energy and matter have multiple forms.

Objective
Students will be able to explain the requirements for fire.

Background
Three things are necessary to start and maintain a fire—oxygen, a heat source for ignition, and fuel to burn. This concept is often depicted as a Fire Triangle with one item on each point of the triangle. A fire cannot be sustained if any one of the components is removed.

Materials
small candle
glass jar
pie pan
matches
modeling clay
water
baking soda
vinegar
art supplies

Procedure
After performing the following demonstration, introduce the concept of fire as a chemical reaction requiring fuel, oxygen, and heat. Explain that these three things can be depicted as a triangle with each item on one point. Discuss each component in the demonstration.
What represented the fuel? *(wax in candle)*
What provided the heat? *(match)*
Where was the oxygen? *(part of the air in the jar)*
How do we know it was used by the fire? *(water level in the jar rose to replace the oxygen)*

1. Oxygen in the Air
   - Using a piece of modeling clay, stand a candle upright in the middle of a pie pan. Add water to the pan to a depth of about one-half inch.
   - Cover the candle with a glass jar and mark the position of the water on the jar.
   - Remove the jar, light the candle and again cover the candle with the jar.
   - Observe and note results. What is the position of the water level?
   (*The water level in the jar will rise as the oxygen is consumed)*

2. Carbon Dioxide as a Fire Extinguisher
   - Using a piece of modeling clay, stand a candle upright in an empty pie plate.
   - Place several teaspoons of baking soda in a beaker. Add vinegar to produce carbon dioxide bubbles.
   - Crease a long piece of heavy paper and "pour" the gas down the paper trough toward the candle flame.
   - Observe and record the results. How do carbon dioxide fire extinguishers work?
   (*The flame will be extinguished as the flowing carbon dioxide "pushes" the oxygen away from the flame.)*

3. Fire Poster
    • Create a poster based on the fire triangle (fuel, oxygen, ignition source). Explain the significance of each point.

Physical Maps

Standards
Social Studies—Grade 4
Students demonstrate an understanding of the physical and human geographic features that define places and regions in California by explaining and using the coordinated grid system of latitude and longitude to determine absolute locations of places.
Earth Science—Grade 4
Waves, wind, water, and ice shape and reshape Earth's land surface.

Background
Concepts related to using and interpreting maps appear in both science and social studies text books for fourth grade. Coordinate grid systems are also part of the fourth grade mathematics curriculum.

Materials
physical map of California or southern California
world map

Procedure
• Discuss degrees, latitude, longitude, and the use of coordinates to locate points on a map.

• Pose location-related questions appropriate for the map in use.

• Note the topography depicted on the map. Use the legend to locate mountains, rivers, lakes, lowlands. How is a varied topography related to biodiversity? Refer to the background information on page 2 of this guide.

• Locate the Mediterranean Sea on a world map. How does the latitude compare with that of southern California?

• Follow the latitude of southern California around the globe. Where else might a there be other Mediterranean type climates?

Museum Visit

1. List some benefits that nature provides us here in San Diego County.

_____

2. Look at the map overlays. Name some landforms found in San Diego County.

_____

3. Name three plant communities found in San Diego County.

_____

4. Describe one of the plant communities.

_____

5. A biodiverse area has many types of plants and animals. Regarding biodiversity, what is special about San Diego County?

_____

6. Fires need (circle all that apply)

fuel ignition source oxygen carbon dioxide

7. Name two ways plants adapt to fire.

_____

8. What is a fire follower? Name two common fire followers.

_____

9. Name two ways animals avoid fire..

_____

10. Name one way that Native people made use of fire.

_____

Post-visit Activities

Points of View

Science Standards: Investigation and Experimentation—grades 4 and up
Scientific progress is made by asking meaningful questions and conducting careful investigations.

Objective
Students will be able to present two opposing points of view to form opinions based upon the evidence.

Materials
paper
pencils
resource books
computer

Procedure
• Have students work as individuals or small teams. Two individuals or two teams choose a topic, and then divide the points—one choosing the "a" point of view the other selecting the "b" point of view.
• Using resource books, computer websites and information from visiting the *Earth, Wind & WILDFIRE* exhibition, the teams research and report on their points of view. Other class members listen to the debate and form an opinion based upon the evidence presented.

Topics
• Habitat or Homes
a. wants to build new homes in a wildlife area
b. wants to preserve the habitat as a natural area with no homes or streets

• Prescribed Burn or Eliminating Forest Fires
a. believes small areas should be burned on a systematic basis (prescribed burn) to preserve the health of the forest
b. believes that forest fires should never be set intentionally for any reason

• Dead wood in forest
a. wants to harvest dead trees to sell for various wood products
b. wants to leave dead wood in the forest to decompose naturally

• Recovery of the Natural Environment
a. believes that fire destroys and that recovery is impossible
b. believes that nature has adaptations to bounce back after a fire

• Fuel Reduction
  a. wants to harvest timber in the forest to reduce the amount of fuel
  b. wants to allow forest to grow without interference

• Homes in the Back Country
  a. wants to build a home in the back country surrounded by forest without regulations
  b. wants to establish rules for back country home owners regarding how close they may have trees and other vegetation

Safety Check List

Science Standards: Investigation and Experimentation—all grades
Scientific progress is made by asking meaningful questions and conducting careful investigations.

Objective
Student will be able to explain some procedures for home fire safety.

Materials
paper
pencil
art supplies
fire safety resource books
computer

Procedure
• Discuss elements of home fire safety.
• Provide fire safety books and a list of appropriate websites.
• Design a fire safety check-list for your home.
• Check your list with the "Firewise" list at www.firewise.org/edu.html.

Adaptations

Science Standards: Life Science—grade 3
Adaptations in physical structure or behavior may improve an organism's chance for survival. Appropriate for grades 2 and up.

Objective
Students will be able to explain some plant and animal adaptations to fire.

Materials
paper
pencil
resource books
computer

Procedure
• Refer to questions 7,8 and 9on the Museum Visit worksheet.

• Using information from the student Museum Visit worksheets and other resources to research some ways that plants and animals have adapted to survive in fire-prone areas.

• Discuss fire followers and make a list of several plants commonly seen after a fire.

• Compare plant and animal fire adaptations. Are there any similarities? How do they differ?

Fire Behavior Triangle

Science Standards
Energy and matter have multiple forms and can be changed from one form to another. Appropriate for grades 3 and up.

Objective
Students will be able to explain the fire behavior triangle.

Background
Three things are necessary to start and maintain a fire—oxygen, a heat source for ignition, and fuel to burn. This concept is often depicted as a Fire Triangle with one item on each point of the triangle. A fire cannot be sustained if any one of the components is removed.

Additionally, a Fire Behavior Triangle is sometimes used to describe how fuels ignite, and flames develop and spread in wildland fires. Fire behavior is influenced by the type and quantity of fuels present, by weather conditions, and by the elevation and slope of the land.

Materials
art supplies resource books computer

Procedure
• Refer to question 6 on the student Museum Visit worksheet. Use this information to explain the "Fire Triangle" (heat, oxygen, fuel).

• Introduce the "Fire Behavior Triangle" (weather, topography, wildland fuel)

• Design a poster showing the fire behavior triangle (weather, topography, wildland fuel).

• Explain the significance of each point as it applies to the San Diego/southern California area.

Post-fire Erosion

Science Standards
Investigation and Experimentation—grades 4 and up
Scientific progress is made by asking meaningful questions and conducting careful investigations.

Objective
Students will be able to explain the relationship between fire and soil erosion.

Background
Soil—the loose, weathered material on Earth's surface—supports the growth of plants. Erosion is the movement of Earth's surface materials caused by wind, water, ice, and gravity. Soil, unprotected by plant growth is easily eroded. As wildfires destroy vegetation, large areas of soil are left unprotected. In southern California, the fireseason (fall) is frequently followed by winter rain. Thus, the soil is set for erosion.

Materials

paper	resource materials	long, narrow tray
pencil	dirt	water

Procedure
• Discuss the effects of fire on vegetation, soil, and erosion.

• Design an experiment to show how burned areas might be affected by heavy rainfall.

Note: a wallpaper tray works wells for this experiment. Elevate one end to promote run-off.

Answers (Museum Visit)

1. mental health, beauty, recreation, purifies air and water, provides medicines 2. mountain, desert, river, beach, hill 3. coastal sage scrub, chaparral, grassland/meadows, riparian forest, desert 4. Answers will vary. 5. San Diego County has more rare and endangered species than any other county. 6. fuel, ignition source, oxygen 7. resprout from roots or crown, seeds that need heat to germinate 8. migration, escape to unburned area, estivate 9. use non-flammable materials, build with a fire-wise design fire-resistant plants near house, thin vegetation within 100 feet of house 10. increase food production, encourage new growth, flush out prey

Resources

Books

Arnosky, Jim. *Arnosky's Ark: Beginning a New Century with Old Friends.* ISBN 0792271122 (ages 6–11).
Beil, Karen Magnuson. *Fire in Their Eyes: Wildfires and the People who Fight Them.* ISBN 0613157850 (ages 9–adult).
Cone, Patrick. *Wildfire.* ISBN 0613240111 (ages 7–12).
Halsey, Richard W. *Fire, Chaparral and Survival in Southern California*_ISBN 0-932653
Patent, Dorothy Hinshaw. *Biodiversity.* ISBN 0395687047 (ages 14–adult).
Patent, Dorothy. *Fire: Friend or Foe.* ISBN 0395730813 (ages 8–14).
Pryde, Philip. *San Diego: An Introduction to the Region.* ISBN 0916251683
Pyne, Stephen*. Fire: A Brief History*. ISBN 0714127620
Pyne, Stephen. *Fire in America: A Cultural History of Wildland and Rural Fire*. ISBN 029597592X
Simon, Seymour. *Wildfires.* ISBN 0688139353

CD ROM

Cal Alive: Exploring Biodiversity.

Websites

www.sdnhm.org/exhibits/fire	San Diego Natural History Museum
www.pbs.org/wgbh/nova/fire/	Public Broadcasting System
www.cdfg.gov	California Dept. of Fish and Game
www.firewise.org/edu.html	Firewise
www.nifc.gov	National Wildland Fire Home Page
www.nfpa.org	National Fire Protection Association
www.wildfire.discovery.com	Discovery Communication
www.burninstitute.org	Burn Institute

www. kenbowles.net/SDwildflowers

Video

Wild California. ASIN B00006J02G.

Credits

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