MacGillivray Freeman's

Adventures in Wild California

An Educational Resource for Teachers

The large format film, *Adventures In Wild California*, is appropriate for all intermediate grades (4-8). This Teacher's Guide will be most useful when accompanying the film, but is a valuable resource on its own. Teachers are strongly encouraged to adapt activities included in this guide to meet the specific needs of the grades they teach and their students. All activities developed for this guide support National Education Standards for Science, Geography, Math and English, but are not referenced in this guide due to space constraints and differences in standard use throughout the nation.

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Introduction

California is a land of superlatives. It has the highest point in the 48 contiguous states and the lowest point in all of North America. It holds records for the highest temperature, greatest snowfall in a storm, and greatest depth of snowfall on the ground in North America. It is home to some of the tallest, largest, and oldest living things in the world. It was the site of one of the world's most famous gold rushes. California not only has the largest population in the United States, but if it were a country it would be one of the 35 most populous in the world and have one of the 10 largest economies. It is not surprising that so many people are wild about California.

With so much available, is it any wonder California has been a land of dreams and dreamers? In his 1510 novel *Las Sergas de Esplanadián* (The Exploits of Esplanadián), Garcia Ordoñez de Montalvo wrote of an island west of the Indies called California, ruled by the Queen Califia, where all of the people's weapons were made of gold. The early Spanish explorers, dreaming of the precious metal, named the Baja California peninsula, and eventually all of the area to the north, "California" for this imaginary island. For the early Spanish missionaries it was the dream of saving souls that inspired them to build a chain of 21 missions between San Diego and the San Francisco Bay area between 1769 and 1833. In 1849, the dream of gold fueled a massive movement of people from the Eastern U.S. and the world, each convinced that he would be the one to strike it rich in California. In the middle of the 20th century, a dreamer named Walt Disney and his "imagineers" broke creative ground with the building of Disneyland. Today, imagination is one of the driving forces in the state, from the high-tech imagination that powers Silicon Valley, to the imagination that fuels the movie industry, to the imagination that looks for new experiences sliding down mountains and jumping out of airplanes attached to boards.

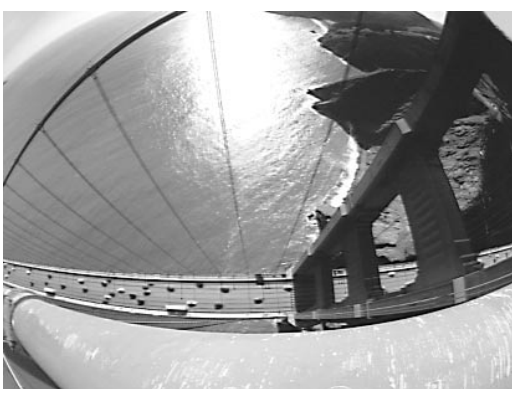
> *"When we try to pick out anything by itself, we find it hitched to everything else in the Universe."*
>
> ***John Muir, 1911***
> ***My First Summer in the Sierra,***

The Places

In *Adventures In Wild California* we visit some of the fascinating locations that make the state unique, from pounding surf to soaring trees, from man-made marvels to natural wonders. These include two of our oldest National Parks, an unusual ocean formation that creates monster waves during the winter storm season, a former cannery that gained new life as an aquarium, and one of the world's most recognizable bridges and an icon of California.

Sequoia National Park, established on September 25, 1890, is our second-oldest National Park. It was originally created to protect the Big Trees of Giant Forest, including the General Sherman and Washington trees, the two largest living things in the world. Less than a week later, on October 1, 1890, Yosemite National Park was established, through the efforts of naturalist John Muir. Between the two parks, hundreds of thousands of acres of California's amazing Sierra Mountain range have been protected for generations to come.

Off the coast of California at Half Moon Bay, just south of the peninsula that holds San Francisco, an unusual combination of rock formations, location, and weather patterns create a mainland haven for big-wave surfers. At a place called Maverick's, swells from winter storms pile up against a rock reef, causing waves that can reach 40 feet in height. But this is no Hawaiian surf with warm tropical waters and balmy breezes. Here the winds spin off of Arctic low-pressure cells, and the water is a bone-chilling 50° F (10° C). This is truly a place to challenge the best.



Whether conceptualizing them in their ultimate form, or rescuing them from oblivion and creating something new, California's dreamers have built many world-class structures. When others said it couldn't be done, bridge builder Joseph Strauss ignored them. His dream, the Golden Gate Bridge, has become the symbol of the City by the Bay. When others were ready to tear an old cannery down, dreamers like David Packard in Monterey saw the opportunity to create an aquarium that would not only display the wonders of the sea, it would tell the fascinating story of the bay and the creatures that live in it. Today the Monterey Bay Aquarium is a model for others around the world hoping to contribute to the preservation of ocean life.

The Dreamers and Risk Takers

Adventures In Wild California takes viewers around the state to meet some of the dreamers and pioneers who have contributed and are still contributing to the state's success. These people come from a variety of backgrounds and have a wide range of interests. What links them is their drive and dedication to ideas and dreams.

Some of these dreams bring people into contact with the fascinating variety of plant and animal life in the state. Among these are botanist Steve Sillett and aquarists Sue Campbell and Andy Johnson. Sillett is one of the few scientists who has been given permission to study the giant sequoia trees of California. With his assistant, Jim Spickler, he works to understand these rare and amazing trees. Campbell and Johnson, who work at the Monterey Bay Aquarium, have taken on the job of preparing orphaned sea otters to return to their natural homes in the Pacific Ocean. By becoming surrogate parents, they hope to teach the pups the skills they need to survive.

Ten Cool California Facts

1. **Highest elevation (48 contiguous U.S. states) Mt. Whitney: 14,494 ft/4,421m**

2. **Lowest elevation (North America) Death Valley: -282 ft/-86 m below sea level**

3. **Highest recorded temperature (North America) Death Valley: 134°F/57°C on July 10, 1913**

4. **Greatest snowfall in a storm (North America) Mt. Shasta: 189 in/480 cm on February 13 to 19, 1959**

5. **Greatest depth of snowfall on the ground (North America) Tamarack: 451 in/1,145.5 cm on March 11, 1911**

6. **Tallest living thing (world) Redwood National Park: a 367-ft/112 m coastal redwood (Sequoia sempervirens)**

7. **Largest living thing (world) Sequoia National Park: the General Sherman sequoia (Sequoiadendron giganteum), 272 ft/83 m high, 36.5 ft/11m diameter above the base, estimated weight 2,150 tons/1,935 metric tons**

8. **Oldest living thing (world) Eastern California: a Great Basin bristlecone pine (Pinus longaeva) estimated at nearly 5,000 years old**

9. **Largest population of all U.S. states: estimated at 32,666,550 in 1998**

10. **Largest agricultural exporter in U.S.: estimated $11 billion in agricultural exports in 1997**

One man who has become synonymous with protecting California's wild lands is the 19th century Scottish-born naturalist, John Muir. Originally hoping to explore the Amazon, Muir ended up instead in California where he would become the foremost champion of the High Sierra region. It was in large part through his efforts that Yosemite National Park was created in 1890. Muir was also one of the first to recognize the role glaciers had played in the creation of the Yosemite Valley.

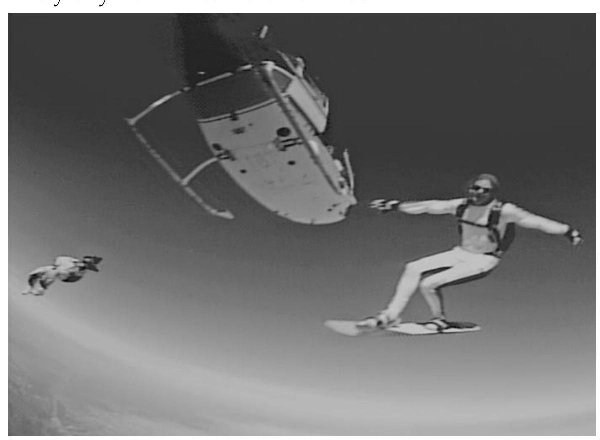
While some dreams take people into the wild to learn about the land, other dreams take people into the wild to learn about themselves. These are people like Jeff Clark, the first man known to have braved the monster waves at Maverick's; Bryan Iguchi, who thinks nothing of dropping down the nearly vertical snow-covered face of a mountain; or Troy Hartman and Joe Jennings, who have turned the skies themselves into a canvas on which they paint their intricate aerial ballets as sky surfers. These men take to the wild to challenge themselves, to learn just what they are capable of, and to satisfy their own California dreams.

Then there are the dreamers and risk takers whose actions affect, in some way, the lives of millions of people. These are men like Joseph Strauss, a strong-willed bridge builder who ignored the experts who said the entrance to San Francisco Bay couldn't be spanned for less than $100 million, if it could be at all. With over 400 bridges to his credit all over the world, Strauss was able to design, shepherd, and build the Golden Gate Bridge for a little more than a quarter of what the experts had estimated it would cost. Today that structure is tended by risk-taking ironworkers such as Bill Owens and Joe Van Bonn, who brave dizzying heights and capricious winds to maintain the bridge. And, of course, what discussion of California risk taking can be complete without a mention of Hollywood, where millions of dollars, as well as reputations and careers, are risked daily as producers, directors, and actors strive to make the next box office smash. Finally, there is the Illinois-born dreamer who believed he could make people happy by producing animated motion pictures, some of which starred, of all things, a mouse. But this was no ordinary mouse, nor your ordinary dreamer. As his dreams grew, so did the risks he took, going so far as to create a new and unimagined amusement park based on themes from his movies. In the creation of Disneyland, Walt's dreams really did come true.

Filming *Adventures In Wild California*: The Challenges

Sweeping vistas, towering trees, rugged landscapes: these are some of the sights typical to an IMAX® film, and they call for some of the typical methods of filming. Stationary cameras, cameras mounted on helicopters, and cameras mounted on dollies and vehicles are some of the ways filmmakers get the shots they want. But what if you want to show what it is like to be an ironworker on the Golden Gate Bridge? Or a sky surfer performing a routine high in the skies over San Diego? Or say you want to film a scientist as he crosses between giant sequoia trees while hanging upside down from a cable? These were some of the challenges the filmmakers faced in producing *Adventures In Wild California*, and they called for imaginative and inspired solutions.

To give viewers the feel of being 700 feet (213 meters) above the crashing waves on top of the Golden Gate Bridge, technicians strapped one of the large-format cameras to the waist of an ironworker as he made his inspection rounds on California's most recognized structure. With the camera pointing downward, we watch as the worker slowly descends along the main cable, then turns and looks over the side to the water below. A similar method was used to film the awesome aerial ballet of sky surfer Troy Hartman. Hartman's partner, cameraman Joe Jennings, had a 70-pound (32-kg) IMAX® camera strapped to his chest as he and Hartman performed their free-fall ballet. Imagine executing a technically challenging mid-air routine with extra weight attached, all the time you're falling at approximately 120 miles (192 kilometers) per hour! It's unlikely any IMAX® cameraman has faced this sort of a challenge before.



Filming botanist Steve Sillett going to work at the top of the Washington Tree, one of the world's largest sequoias, presented a totally different challenge. Because they are a protected species, special care must be taken when working in and around these giants. To get to the crown of the tree, Sillett crosses from another tree while clipped to a wire suspended between the trees. Upside down, he pulls himself across by hand. Using a helicopter to film his progress would be out of the question, since the wash from the rotors could endanger Sillett. To follow him on his crossing, crew members had to rig a wire dolly to suspend the camera between the two trees, above Sillett's wire. This had to be done in such a way that neither tree was damaged. The dolly then had to be carefully controlled as it followed Sillett across the gap, some 200 feet (61 meters) above the ground.

CALIFORNIA CRUISIN'

ACTIVITY 1

Objective: Students will use math, mapping, and language skills to plan, design, and report on a trip that will take them to several California locations.

In The Film: *ADVENTURES IN WILD CALIFORNIA* celebrates the geographic, biological, and human diversity of this land of contrasts and wonders. From the towering trees of Redwood and Sequoia National Parks to the towering skyscrapers of Los Angeles, from the massive cliffs of Big Sur to the massive waves of Maverick's Break, the movie leads the audience on an awesome tour of the state's sights and sounds. Whether it is walking the cable of the Golden Gate Bridge, descending into the heart of an ancient sequoia, or diving with sea otters, *ADVENTURES IN WILD CALIFORNIA* takes viewers where few people have been privileged to go. Through these extraordinary vistas and the experiences of the people we meet in the film, we come to understand and appreciate what it is that makes California a place of dreams and dreamers, and why people care about protecting its natural environment.

Materials:

- ☐ Planning Guidelines copy page (one per student or team)
- ☐ Maps and atlases of California
- ☐ Research resources (encyclopedias, books, magazines, Internet)
- ☐ String for measuring distances (one 6" piece per person or team)
- ☐ Lined paper for journal
- ☐ Blank paper for map
- ☐ Pens/pencils—regular and colored
- ☐ Calculators for working out mileage and expenses
- ☐ Optional: magazines with pictures of California sights and poster board for the extension

Teacher Prep Notes: This activity will take several days for research and completion of maps and journals. The activity may be done individually or in small groups of two or three. The types of maps that will be most useful for this type of an activity will include general reference maps of California, tourist maps showing various locations, thematic maps showing land features, and some topographic maps. Some of these maps will be found in various textbooks and reference books; others can be acquired from various stores and organizations such as book and map stores or the Automobile Club. Try to find maps that use bar scales, as these are easier to use than other types of scales. An atlas of California that includes information on missions, immigration, and farming, as well as basic maps and data, has been developed by the California Geographic Alliance. For details and information, contact Dr. Jerry Williams,
California State University, Chico;
(530) 898-6219, Fax (530) 898-6781,
E-mail JRWILLIAMS@csuchico.edu.

Another good resource for maps and related educational materials is the Thomas Bros. Maps Educational Foundation at (800) 899-6277, extension 561. If students would like to include information about agriculture in California, materials are available from the California Federation for Agriculture in the Classroom at (916) 561-5625, or online at http://www.cfaitc.org

Background: Maps are important tools that can be used to understand relationships between places, to learn where events have occurred, and for such every day uses as finding an address or planning a trip. There are many different types of maps, including reference maps, city maps, thematic maps, and tourist maps. Maps have certain features that allow the user to understand how to use the map and to find the information needed. These features, which can be remembered by using the acronym **DOGS TAILS**, are:

- **D**ate (when the map was created, which is important because the world changes)
- **O**rientation (which way is north, generally indicated by an arrow or a compass rose)
- **G**rid (a system of lines used to help find places on the map: latitude and longitude on a world or country map, or letters and numbers on a city map)
- **S**cale (used to convert distance on the map to distance in the real world, the most common and easiest to use is a bar or graphic scale)
- **T**itle (to tell the user the subject of the map
- **A**uthor (who made the map, which may help the user understand what is and what is not shown)
- **I**ndex (a list of items shown on the map and where they are on the grid)
- **L**egend (also called the Key, it shows the meaning of symbols used on the map)
- **S**ource (where the information used to create the map was obtained)

Two of the most useful of these elements are the legend and the scale. The legend shows the various symbols used in the map and what each symbol means. These may include dots to indicate cities, lines of various widths and colors to indicate types of roadways, and colors to indicate elevation. By looking at the legend a user can learn which symbols he or she needs to look for to find out the information needed. The scale helps the user to find the distance between points on the map. The easiest type of scale to use is a bar scale, which looks like a small ruler with lines and numbers. On this scale, the lines indicate what the actual distance in the real world would be for a measured distance on the map. For example, one inch on a map may indicate fifty miles actual distance, while one centimeter on another map may indicate three kilometers actual distance. A scale will normally include both miles and kilometers, so either measurement can be used.

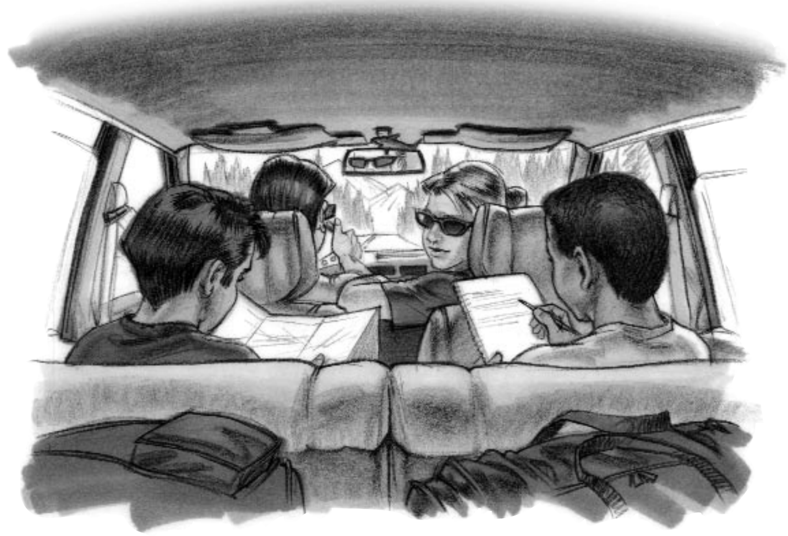
To Do:

1. Engage students in a discussion to find out what they know or think they know about California and the locations on the list (see next page). Try to separate facts from myths and legends. Include such areas as culture, geography, economy, and history.
2. Next, have students talk about vacations they have taken in the past. What is involved in planning a road trip? Discuss such topics as travel time, expenses (gas, food, lodging, sightseeing and souvenirs), how to decide what to see on a trip, and anything else that seems pertinent. Point out that the time of the year must also be considered when planning a trip (for example, snowboarding in the Sierras is only possible during the winter). Explain to students that they will be planning, researching, and reporting on a trip around California.
3. Provide students with maps and atlases of California, Planning Guidelines and List of California Locations handout, and string for measuring.
4. Have students choose four (4) locations from the list to visit on their trip and plan a route that will take them to all four places. If desired, students may choose one location not on the list. The trip plan must include the places to visit, the time and distance that will be traveled (daily and total), highways and major roads used, expenses, and the number of days at each location. As part of the trip plan, students must draw their own map showing the locations they will visit and the routes they will take.
5. Students should research the places they will visit and the routes they will take on their trip. What is the land like where they are going? What is it like on the route they will take? Are there any unusual sights to see or places to stop on the way? Are there any special cultural events or activities they might want to see on their trip? How will the weather and time of year influence the things they might see and do? In short, what will they experience on their trip?
6. Have students write a daily journal that describes their trip in detail, including the places they visit, the things they see and do along the way, how much money they spend, and how much time the trip takes. On their map, they should now include new information they have learned, including landforms, cultural activities, sightseeing stops, and anything else that they feel is important to explain their trip.

Key Words:

scale on a map, the relationship between distance on the map and actual distance.
legend on a map, a list of symbols used and their meanings.

What's Going On and Why? Because California is so diverse, it has something to interest just about everybody. While researching their trips, students are likely to find out about new places to visit and learn unusual facts. Encourage them to include these in their journal if they are appropriate to their trip. If you want to, you may allow them to revise their trip to include these new places and facts (after all, don't many people make last-minute revisions of trips because of something they hear about or learn?)



Taking It Further: As an extension to the activity, have students create a display board or poster for their trip. The board will feature their map and will include pictures of their trip. These pictures may be hand-drawn, cut out of magazines, or printed from CD-ROMs or the Internet. Instead of a display board, students may choose to include their illustrations directly in their journals.

(This activity is adapted from the activity in the article "Using a Travelogue to Learn a Region" by Scott Brady, Journal of Geography, March/April 1999, Vol. 98, No. 2.)

Planning Guidelines Activity Sheet

Activity 1

Plan a road trip around California, visiting four major locations (from the list below). You must visit one major city and at least one National Park.

Begin the trip from any city in California, and decide in which order you will visit the locations you choose. Figure out mileage, expenses for gas, food, lodging, and other items (souvenirs, etc.), and time taken for the trip (including sightseeing time).

Use the maps of California to plan your route and to draw your own map of your travel route. Measure the distances on the map by laying a piece of string along the roads you travel and then measuring the string against the map scale. You may travel a total of nine hours during the day. This includes a maximum of eight hours of driving and one hour stopping for food and rest breaks.
You must spend at least one day visiting each of your four locations. You may always choose to spend more time.

You may also choose to stop along your route to visit places you learn about while researching your trip. These are short (one-two hour) stops that count against your driving time.

As part of your planning, draw a map that shows the locations you will visit and the route you will take. Indicate which highways and major roads you will use, and the types of landforms through which you will travel (mountains, desert, forests, valleys, etc.).

FACT: What may be the world's oldest known map was discovered in Iraq, in the Middle East. The map may show a river valley, and is believed to be at least 4,000 years old.

After you have planned your trip, research the places you will visit or pass by using encyclopedias, books and magazines, or any other resource you have available. Write a daily journal telling about your trip in detail. Include the places you visit, the things you see and do along the way, how much money you spend, and how much time the trip takes. On your map, you should now include new information you have learned, including landforms, cultural activities, sightseeing stops, and anything else that you feel is important to explain your trip. Use the following guidelines for designing your trip.

Gas: $1.50/gallon
Auto mileage: 30 mpg
Average speed: 65 mph
Hotel rooms: $80.00 per night
Food allowance: $50.00 per day

[To find out how much gasoline you use during the trip, divide the number of miles by the auto mileage. For example 120 miles divided by 30 mpg gives a total of four gallons of gas used.]

List of California Locations Choose four of the following locations to visit on your trip. Remember that you must visit one major city and at least one National Park.

- ☐ *Major Cities:* Los Angeles, San Diego, San Francisco, San Jose, Sacramento
- ☐ *National Parks:* Redwood, Yosemite, Sequoia, Kings Canyon, Lassen Volcanic, Mojave, Death Valley, Channel Islands, Joshua Tree
- ☐ *Other Locations:* Monterey, Long Beach, Disneyland, Hearst Castle (San Simeon), Maverick's Break (Half Moon Bay), Donner Pass, Squaw Valley, Palm Springs

The Water Up There

Activity 2

Objective: Students will experiment with the dynamics of water pressure in a tube to learn the effect of height/depth on water pressure.

In The Film: Imagine pulling yourself along hand by hand while suspended from a cable stretched between two trees. Now imagine that this cable is over 200 feet (61 meters) above the ground! Welcome to biologist Steve Sillett's office: the crowns of California's giant sequoias (Sequoiadendron giganteum). As one of the few scientists who have received permission to do research on these rare trees, Sillett has had the opportunity to make some startling discoveries. Perhaps the most unusual of these is his discovery of a giant cavity in the top of the Washington Tree in Sequoia National Park. This as yet unexplained hole extends over 100 feet (30.5 meters) from the crown into the very heart of the tree. The first time he descended into the pit, Sillett was amazed not only by its size, but by its very existence in a normally decay-resistant tree. Sillett hopes to eventually learn what happened to the thousands of cubic feet of heartwood that once existed where the hole is now. Another important subject of Sillett's research is how the sequoia regulates changes in hydraulic pressure in the xylem.

Materials:

- ☐ One 1" diameter PVC tube, 36 in/91.4 cm long
- ☐ One 1" diameter PVC tube, 46 in/116.8 cm long
- ☐ Two 1" diameter PVC end caps to fit the tubes
- ☐ One roll of electrical tape (will still stick when the tube is wet)
- ☐ Water (2 gallons)
- ☐ Tape measure
- ☐ Electric or hand drill with 1/8" drill bit

Teacher Prep Notes: This activity can be done as a demonstration lesson, or several pairs of tubes can be made and students can be divided into teams of two or three to perform the experiments. Supply one set of tubes and an equivalent amount of water as above for each team. PVC pipe and caps and electrical tape are available at most building supply stores for reasonable costs.

Background: While it is not the tallest of all trees (that distinction goes to the closely related coastal redwood), the giant sequoia can easily top 200 feet (61 meters) in height. The largest of all of these, the 272-foot (83-meter) high General Sherman Tree, is estimated to weigh as much as 2,150 tons (1,935 metric tons) and may add enough new wood each year to construct a five-room house. Other giant sequoias, while not as massive, can range from 150 to over 300 feet (46 to 92 meters) tall. At this height, the mechanics of moving nutrients and water to its topmost branches become quite involved.

Even though they tower above their smaller relatives, sequoias are still plants, and their physiology is basically the same as that of a rose or a dandelion. Almost all plants (except for some parasitic species) depend on photosynthesis to change light energy into the sugars and starches needed for survival. This process requires that water be supplied to the site of photosynthesis: the leaves. Since the source of the water is the ground in which the plant grows, a vascular system is necessary to transport the water from where it is found to where it is needed. The first element of this system is the root structure, which, in addition to anchoring the plant, absorbs water and nutrients from the soil through the root hairs. In a fully-grown sequoia, the root system can spread out well over 100 feet from the tree. Once the water and nutrients have been absorbed by the roots, they are transported through the xylem up the stem to the leaves. The leaves are the primary site of photosynthesis in plants, and the stalk of each leaf is almost completely vascular tissue. (Plant leaves can vary in shape from spines to huge fan-shaped structures; the leaves of a giant sequoia lie close to the branch and are generally scale-like.) It is in the transporting of water from the root system to the leaves that the plant must compensate for the force of gravity and the hydraulic pressure of the liquid in the xylem. While this is relatively small in a rose, for a 200-foot (61-meter) sequoia the pressure at the base of the tree is quite large. The tree must overcome the great difference in vertical pressure in the xylem in order to move the needed water and nutrients to its leaves.

Key Words:

hydraulic pressure the pressure exerted by and on a fluid (such as water) in a container or vessel.
vascular system a system of tissues that transport food, mineral nutrients, and water throughout the plant.
xylem the part of the tree's vascular system that conducts water and mineral nutrients between the root system and the rest of the plant.

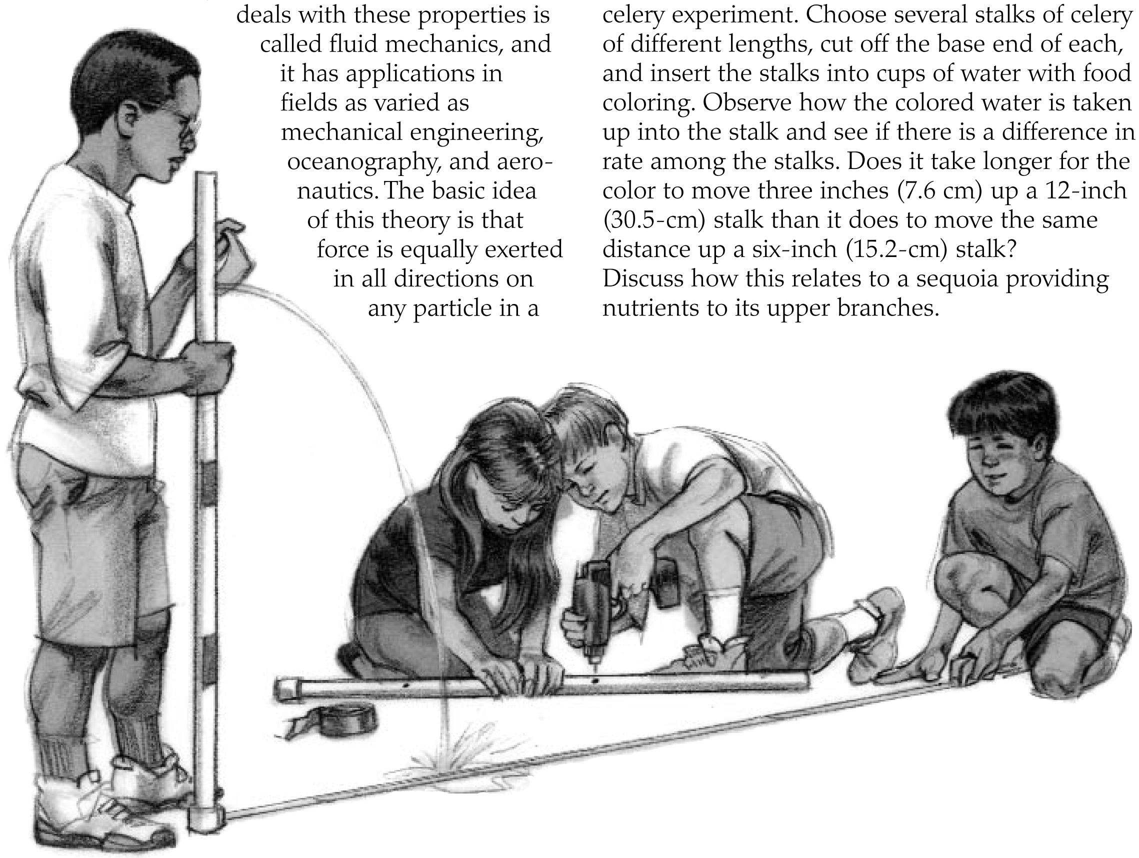
To Do:

1. Drill 1/8" diameter holes at 10", 20", and 30" (25.4 cm, 50.8 cm, and 76.2 cm) from one end of each tube, and place the cap over that end.
2. Put electrical tape over the holes in the shorter tube and fill the tube to the top with water.
3. Extend the tape measure at least six feet (at least two meters) and lock it, then lay it on the ground.
4. Place the tube upright at the end of the tape (the zero point) so the holes are pointing along the tape, and quickly remove the top strip of tape.
5. Mark and measure where the stream of water reaches its farthest point (not including any splash/splatter), and record the results. Try to keep the tube as vertical as possible during the experiment.
6. Replace the tape and repeat with the second hole, then with the third hole. Compare the distances and discuss.
7. Repeat the experiment with the longer tube and record the results. Compare these results with those from the first experiment.
8. Repeat the experiment again, but this time tilt the longer tube so that its top is at the same height as the shorter tube (36 in/91.4 cm above the floor). Discuss the results of this experiment.

What's Going On and Why? In 1647, Blaise Pascal, a French mathematician and philosopher, became the first person to develop a theory to deal with the question of how pressure is distributed in a container of fluid. His work led to the understanding of how various forces, including gravity, affect fluids. Today the branch of science that deals with these properties is called fluid mechanics, and it has applications in fields as varied as mechanical engineering, oceanography, and aeronautics. The basic idea of this theory is that force is equally exerted in all directions on any particle in a fluid at rest. This theory allows scientists to predict how a fluid will act in various conditions.

The pressure that a column of water exerts depends on the distance of the point in question from the surface (depth). This is because gravity exerts a downward vertical force on the water in each tube. When this is the only force acting on the water, the amount of pressure is in proportion to the amount of water vertically above it. Water in a 10-foot (3.05-meter) deep pond exerts the same pressure at selected points as water in a vertical 10-foot (3.05-meter) long tube at the same points. This is the reason for the difference in the distance the water reaches from the two tubes. Even though the holes are at the same distance from the ground, the difference in distance from the surface (the top of the tube) results in different pressures at the holes. The greater pressure causes a greater force to be exerted at the hole, thus a greater velocity resulting in a greater horizontal distance. A hole drilled six inches (15.2 cm) from the top of the 46-inch (116.8-cm) tube should have the same pressure as the 30-inch (76.2-cm) hole in the shorter tube, because both have the same amount of water above. In addition, if a tube of water is angled so that its top is even with the top of a shorter tube, the pressure at the bottom of each tube will be the same. In a 200-foot (61-meter) high tree, the force needed to overcome the pressure in order to move water and nutrients up 10 feet (3.05 meters) will be much more than would be needed in a 15-foot (4.6-meter) tall tree to move them the same distance.

Taking It Further: Perform the tried-and-true celery experiment. Choose several stalks of celery of different lengths, cut off the base end of each, and insert the stalks into cups of water with food coloring. Observe how the colored water is taken up into the stalk and see if there is a difference in rate among the stalks. Does it take longer for the color to move three inches (7.6 cm) up a 12-inch (30.5-cm) stalk than it does to move the same distance up a six-inch (15.2-cm) stalk? Discuss how this relates to a sequoia providing nutrients to its upper branches.



POPULATION PYRAMIDS

ACTIVITY 3

Objective: Students will use the Internet to access information from the U.S. Census Bureau to create population pyramids and ethnicity graphs.

In The Film: California is not only a land of natural wonders, it has perhaps the most diverse population in the entire United States. People of all types and backgrounds live, work, and play in the nation's most populous state. From 1984 to 1994, California welcomed over 30,000 new immigrants from each of over a dozen different countries. In addition, a half-dozen states each provided over 90,000 people to California just between 1990 and 1994. All of this has helped to bring California's population to nearly 33 million people. According to the 1990 U.S. census, about 79% of the state's population lives in the urban areas of one of 13 counties, with more than 46% living in Los Angeles, San Diego, and Orange counties combined.

Materials:
- □ Access to the U.S. Census Bureau web site (www.census.gov) or data from the site
- □ Copies of the Population Pyramids Activity Sheet (one per student)
- □ Graph or blank paper
- □ Compasses or protractors for drawing circles
- □ Pencils

Teacher Prep Notes: Students will need access to information on the U.S. Census Bureau site that will be used to create population pyramids of age groups and graphs of ethnic diversity in various California counties. If students do not have access at school, they can access the site at home or the teacher can acquire the information and supply it to the students. This activity may be done individually or in teams of two or three. For more information on the Census, check your phone book for your Regional Census Center.

Background: Every ten years, the U.S. Census Bureau conducts a census of the population of the United States. The goal of the census, which is required by the U.S. Constitution, is to count every man, woman, and child living in the country. The information is used to determine government representation, allocation of federal funds, and for many other uses by government, business, and other organizations. By law, this data must be made available to the public. One way this is done is through the U.S. Census Bureau web site. This site is a wealth of information about population and statistics for the United States. One section allows you to access data from the 1990 census on age groups (called cohorts) and ethnic makeup of any county in the country. You can also access recent estimates of populations.

A population pyramid is a type of graph that shows a population by age groups as percentages of the total population of an area. It is called a "pyramid" because of the distinct shape of the graph for a region that has a rapidly growing population with a large number of younger people. A typical population pyramid breaks down the total population into five-year cohorts. Each cohort is graphed as a horizontal bar extending on either side of a central line; the left side indicates males and the right side indicates females. By analyzing a population on this type of graph, researchers can tell how fast the population might be growing, what services might be needed (schools, retirement homes, etc.), and how different regions compare.

Key Words:

census the counting of the population of the United States every 10 years, as required by the U.S. Constitution.
cohorts in demographics, age groups used to keep track of population statistics.

To Do:

1 Population Pyramids—Discuss with students why people count things, be it toys, animals, money, or people. Point out the importance of counting how many students there are in the classroom or the school. Tell students that there are people, called demographers, whose job is to count people and look for patterns. These patterns can then be used to help answer questions such as where most of a company's customers live or where a new school should be built. Explain that the United States counts its entire population every ten years during the census, and that this information is available for ordinary people to use.

2 Pass out copies of the *Population Pyramid Activity Sheet* and discuss with students how to access the U.S. Census Bureau web site. Show them how to convert numbers of people in age groups into percentages of the total. Graph these numbers on a sample population pyramid, assuming that 50% are male and

50% are female. (This assumption, though not exact, is close enough to actual and is easier for students to graph.)

3. Have students complete the steps for the population pyramid activity. Do population pyramids for several counties, or assign each student or team a different county. Compare the population pyramids, and discuss the results. What do the graphs indicate about the various counties? What questions can be asked from the graphs, and how could the answers be found?
4. Ethnicity Graphs—Have students repeat the steps for population pyramids until they reach "Summary Tape File 1A." At "Select the tables you wish to retrieve," have them select files P6 (Race) and P10 (Hispanic Origin by Race). These will give data by race for all recognized major census groups. Be aware that the census group "Hispanic" includes people of various races who also identify themselves, or have been identified, as having an Hispanic background (typically, people with Spanish surnames). Record this data for use in the next step.
5. Use the data acquired to create pie charts showing the ethnic makeup of various California counties. Again, each student or team can work with data from a different county and all graphs can be compared and discussed.

What's Going On and Why? Students should notice that certain counties have larger young populations, or older populations, than others do. This may be due to various factors, including overall population size, access to jobs, types of jobs available, or geographic location. For example, a newly opened corporate office will often attract workers with families into a county, adding to the population at the younger levels. On the other hand, the weather in a region may attract large numbers of retirees from colder states, increasing the population at the older levels. A county with a large population will show changes more slowly than a county with a small population.

Students will also notice that certain ethnic groups have larger populations in certain counties. This can be due to a number of factors. Perhaps there is an ethnic neighborhood such as Chinatown in San Francisco. Frequently immigrants are drawn to neighborhoods that already have members of their ethnic group. Here they will find others who share their heritage, language, religion, or other cultural traits, and so feel more certain of support than they might in another neighborhood. Ethnic concentrations may also reflect past history when foreign immigrants and members of other ethnic groups were forced to live in certain areas by the people who already lived in a city or county.

Taking It Further: Have students pose questions about the graphs and try to brainstorm answers. For example, why does a certain county have a large older population, or why does another have the ethnic makeup it does. Revisit the Census Bureau web site to do population pyramids and ethnicity graphs about other counties in the United States. Compare new graphs with the graphs from California counties.

Taking It Even Further: Geographic Information Systems (GIS) software is used to study various types of data in a spatial form, such as on a map. GIS allows people to take information, such as U.S. Census Bureau data, and present it in another visual form. Sample GIS software is available from the schools and libraries division of the Environmental Studies Research Institute (ESRI). For more information, check their web site at http://www.esri.com/k-12, or e-mail questions to k12-lib@esri.com.

Population Pyramids Activity Sheet

Part 1: Population Pyramids

Access the Census Bureau web site at www.census.gov

1. Click on "State & County QuickFacts" on the right hand side of the page to access a list of states.
2. Click on "California" to highlight it, then click the "GO" tab below the state name.
3. At the map of California, click to access a region of the state, either northern or southern.
4. On the region map, click on the county you want to search.
5. On the Resource List page, click on "Summary Tape File 1A."
6. Click on boxes P1 (Population) and P11 (Age), then choose "Submit." At preferences for format, click "Submit" again. The site will then provide population data by age group, as well as total county population. Record this data for use in the next steps.
7. Combine the population data into the following age groups: 0-9, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, and 80 and above.
8. To find percentages of total population, divide each age group by the county population and multiply by 100. For example, if the 10-19 age group has 1551 people and the total county population is 25,453, the group would be about 6% of the total population (6.09%).
9. Graph the percentages on the Population Pyramid Graph below. Divide the age groups evenly between males and females (50%-50%).

Part 2: Ethnicity Graphs

1. Follow steps 1-6 above.
2. At "Summary Tape File 1A," select boxes files P6 (Race) and P10 (Hispanic Origin by Race), and continue with the rest of step 7.
3. Record the data provided for use in the next steps.
4. Convert the numbers provided into percentages, using the total county population from Part 1.
5. Use the percentages to create pie charts showing ethnicity and diversity in the selected counties.

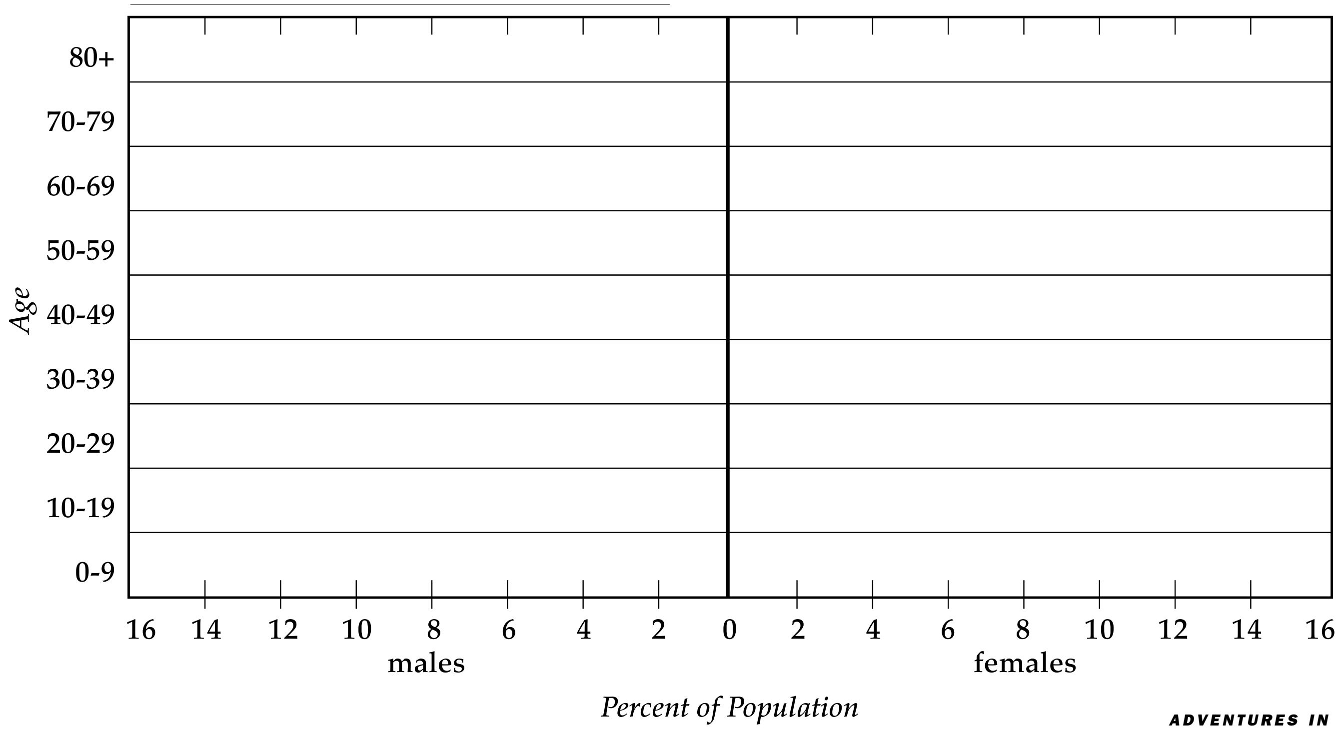
FACT: More Hispanics and more Asians and Pacific Islanders, live in California than in any other state. A 1999 U.S. Census Bureau report showed that during the 1990s, California had the nation's largest population of these two census groups, as well as the greatest increase by number and percent in the country.

Population Pyramid Graph

Location ______________________________

____

Year of Data:



BRIDGING THE GAP

ACTIVITY 4

Objective: Students will experiment with bridge designs to learn the advantages of a suspension bridge over a simple single-span bridge.

In The Film: When someone mentions California, a host of images comes to mind. You think of the sun and surf of the Pacific Coast, the arid deserts, the towering redwoods and sequoias, the magnificent Sierra Nevada, and the bustling cities. Be more specific and mention San Francisco, and the first image for most people will be the Golden Gate Bridge. No television show or movie set in San Francisco would be complete without a shot of the elegant sweep of the main cables and support towers framing the bay. This structure has become the foremost symbol of the City by the Bay, and one of the most recognizable landmarks in the entire world. Imagine seeing the bridge as few ever do: from the point of view of the ironworkers who work on the bridge. What might it feel like to stand 70 stories above the speeding cars and crashing waves as the wind swirls around, threatening to tear you off? In *ADVENTURES IN WILD CALIFORNIA*, we are able to experience the vertigo-inducing view from the top of one of the bridge's support towers as we join the men who brave the elements to maintain this landmark.

Materials:

- □ Several sheets of medium-weight cardboard for each team (approximately 8″ by 24″ (20 cm by 60 cm) and the thickness of a dime
- □ Lightweight rope
- □ String
- □ Tape (a heavy-duty tape such as packing tape)
- □ Chairs (in pairs)
- □ Weights (ounces/pounds or grams/kilograms)

Teacher Prep Notes: If possible, weights should be kept in small increments so that an accurate measurement can be made. If weights are not available, other items such as stones may be substituted. Try to keep items used relatively small and similar in size for ease of comparison. Chairs should be stable and the same height. It may be necessary to pile books on the chairs to prevent them from tipping during the activity. This activity is designed for students in teams of two or three.

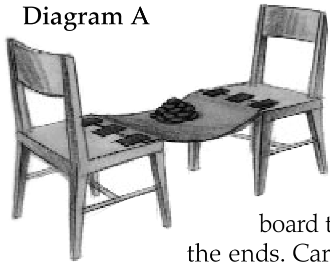
Background: The first bridges were probably logs that had fallen across streams, and so afforded a relatively safe and dry crossing for humans. Later, a log may have been dragged from its resting place and laid across a stream, possibly with one or more other logs to create a larger crossing surface. The single-span bridge probably developed from this simple form. From that beginning, human ingenuity has created a number of different types of bridges for spanning stretches of water or low points of land. One early bridge was the trestle bridge, with a road surface supported by multiple wooden piles or stone piers. An example of this type, built with stone supports and stone slabs for the road, spanned the River Meles in Turkey for over 2,000 years. Another early bridge was the pontoon bridge, which used boats to support the road surface. The armies of the Persian Empire used this type of bridge to cross the Bosporus between Asia and Europe when they invaded Greece some 2,500 years ago. In the Andes of South America, people wove thick cables of vines to make early suspension bridges across deep canyons. The Romans built many bridges supported by stone arches, some of which are still in use. Today the many types of bridges include modern arch-style bridges with supports of steel, concrete, or masonry; cantilever bridges; suspension bridges; and steel-truss and steel-girder bridges. Although the materials and methods have changed and improved, the basic idea remains the same: to get from "here" to "there" over "that."

One of the strongest, and yet most aesthetic, of all types is the suspension bridge. An advantage of a suspension bridge over many other types of bridges is that it reduces the need for support underneath the bridge. This allows for the easy passage of traffic beneath the bridge, without the interference of supporting piers or arches, which is why this type of bridge is frequently used to span the mouth of a bay or harbor. Instead, the huge main cables above take up the weight of the bridge. The load is then transferred to the towers at each end of the main span and to the ground beyond the towers where the main cables are anchored. This allows the suspension bridge to span a greater distance, elevate the roadway higher above the surface it crosses, and carry a heavier load.

To Do:

1. Place two chairs so that there is an open space between them, slightly smaller than the length of the piece of cardboard.
2. Construct a simple single-span bridge by placing

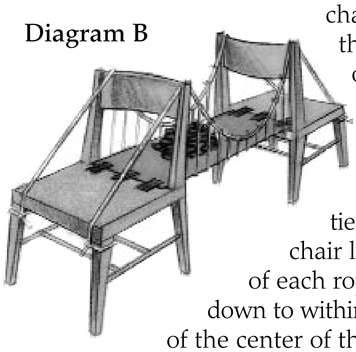
Diagram A



one sheet of cardboard between the two chairs so that about four inches (10 cm) of the cardboard is on each chair. Tape the cardboard to the chairs to secure the ends. Carefully place weights in the center of the bridge, continuing until the bridge begins to buckle. Record the amount of weight the bridge held. *See diagram A.*

3. Now construct a simple suspension bridge by placing a new sheet of cardboard across the chairs and securing the ends. Measure out two lengths of rope long enough to reach between the chairs and allow enough to tie the ends to the chair legs. The midpoint of each rope should hang down to within one inch (2.54 cm) of the center of the cardboard. Make sure the ends are tied securely to the legs. These are the main cables for the bridge. *See diagram B.*

Diagram B



4. Next fashion the hangers (also called suspenders) for the bridge using the string. First, measure out enough string to pass beneath the bridge and reach the rope main cables above. Begin with the center hanger, which will be about three inches (7.6 cm) longer than the width of the bridge. Tie one end of the hanger to one main cable, pass the string beneath the bridge, and tie it to the cable on the other side. Repeat this procedure for each hanger, progressively lengthening the string to reach between the support cables. Alternate from one side of the center hanger to the other to keep the bridge surface level. (In a real suspension bridge, the work is done from the towers out in both directions, but it is still important to keep the work level and evenly paced.)
5. Experiment with the amount of weight the suspension bridge can hold by placing weights in the center of the bridge as was done with the single-span bridge. Continue adding weight until the bridge begins to buckle. Record the amount of weight this bridge held and compare the load the suspension bridge held with the load the single-span bridge held. Discuss the results.

What's Going On and Why? Although a suspension bridge has some elements in common with a single-span bridge, the differences are profound. As with the suspension bridge, a single-span bridge has no supports underneath the span. The strength of this type of bridge depends on the strength of the span alone. Any stress placed on a single span bridge is carried completely by the span. In a suspension bridge, the stress placed on the bridge span is transferred through the hangers and the main cable to the support towers and anchors. This allows the suspension bridge to carry a much greater load than a single-span bridge, and over a longer distance.

Suspension construction has special requirements that need to be addressed. Because of the tension of the cable and the stress it places on towers and anchors, the placement of a suspension bridge may be more important than that of any other type of bridge. A solid base, preferably bedrock, is needed for the foundations and piers of the towers, and, if possible, for the anchors as well. The anchors must either be set in solid rock or attached to massive concrete structures so that the cables cannot come loose. It is the attachment of the cables to the anchors which prevents inward stress from the center span from pulling the towers down into the middle of the bridge. A good suspension bridge is a perfect balance of stress and load forces.

Key Words:

hangers cables used to suspend the roadway of a suspension bridge from a main cable.
single-span bridge a type of bridge made up of a single span of roadway supported at each end.
suspension bridge a type of bridge made up of a span of roadway supported from above by hangers attached to a main cable.

Taking It Further: Have students research, design, and build other types of bridges and compare the amount of weight each type can bear. Use similar sized cardboard surfaces for all bridges, so construction style will be the only variable. Invite students to come up with their own designs for bridges and build prototypes to test.

ENVIRONMENTAL DEFENDERS

ACTIVITY 5

Objective: Students will research various species of plants and animals in California that are on the endangered species list, then present their findings in one of two formats.

In The Film: For Sue Campbell and Andy Johnson, a typical day at work may include donning a wetsuit and taking to the cold waters of Monterey Bay with a young sea otter in tow. Another day may find them bottle feeding an otter pup or teaching a youngster how to crack open shellfish using a rock on its chest. These two aquarists at the Monterey Bay Aquarium are part of a concerted effort to help reestablish the sea otter in its original range along the California coast. The Monterey Bay Aquarium takes in orphaned and injured sea otters, rehabilitates them, and tries to return them to their natural habitat. While studying sea otters to learn how they can be protected and reestablished in their original ranges, researchers have found out many fascinating things about these creatures. For example, they have found that young sea otters depend on their mothers for more than just food. Sea otters are not born knowing how to swim, so the mother must teach her pup how to swim and to dive for food. She also has to teach it to groom its fur to maintain insulation. If a pup loses its mother at a young age, its chance of survival is very small. Campbell and Johnson have had to learn how to become surrogate mothers in order to teach their young charges how to be sea otters.

FACT: The fur that nearly caused the sea otter's demise is the animal's adaptation to its environment. Unlike most marine mammals, the sea otter does not possess a layer of insulating blubber. Instead it is the thick coat which serves to protect the otter from the frigid waters of the North Pacific Ocean, by trapping a layer of air which insulates the animal. To keep up this protection, the otter must spend much of its time grooming and cleaning its fur. When the oil tanker Exxon Valdez ran aground in Alaska's Prince William Sound in 1989, many otters died when oil coated their fur, ruining its insulating properties. In addition, as the otters attempted to clean their fur, they ingested large amounts of oil, thus poisoning themselves.

Materials:

- ☐ Resource materials for research (books, encyclopedias, magazines, Internet)
- ☐ Materials for creating visuals (paper, glue, colored markers, magazines, etc.)

Teacher Prep Notes: This activity will take several days for research and preparation of presentations. Teachers may wish to stretch this activity out over a week or more, with students providing reports on their progress. This activity is designed to be done individually, but students may work in small groups if desired.

Background: Along with the Giant Panda, the sea otter is a prime candidate for endangered species poster child. Cute, playful, and entertaining, they are instantly endearing to most people. In spite of this, these marine mammals were once an important target for hunters in the fur trade. With one of the most luxurious pelts of any animal, up to one million hairs per square inch, they were in great demand for use as trimming and for expensive luxury items. Thousands of sea otters were killed during the 18th and 19th centuries to satisfy the fur trade. By 1911, it is estimated that fewer than 1,000 sea otters were left throughout their entire range, including only 50 in California. Then, beginning in the early 1950s, humans began to try to save the species they had nearly wiped out. Attempts were made, at first with no success, to relocate sea otters from an area where there were too many to survive to areas where they had been exterminated by hunting. Through trial and error, methods were finally developed that allowed the otters to be successfully relocated.

In 1973, the U.S. Congress passed the Endangered Species Act, an effort to provide ways to conserve and protect animals and plants that had reached a point where their extinction seemed imminent. This Act allows for the protection of both the endangered species and its habitat. This is important, because habitat destruction is the primary reason a plant or animal species becomes endangered or threatened. Because of human actions, habitats are changing faster than species can adapt to the changes. These changes can include draining of wetlands, cutting and clearing of forests, building of cities, highways, and dams, and numerous other activities. By using the Endangered Species Act, the government can protect an area that is vital to the survival of a species faced with extinction. This, in turn, helps all of the plant and animal species in the area.

To Do:

1. Provide students with a list of endangered species (both animals and plants) native to California, or have students research and create their own list.
2. Assign each student (or have them choose) an endangered species to research. They should find out about its habitat, food (if an animal), natural enemies or predators, impact of humans, and when it was placed on the list. Try to have a good representation of plants and various species of animals (including insects, reptiles and amphibians, and fish).
3. Have students prepare one of the following types of presentations.
   My Life Story: The student becomes the endangered species and tells its "life story," including where and how it lives, why it is endangered, and what can be done to protect it. Students should be encouraged to create visuals such as maps and posters, or even design a costume, hand puppet, or other method of representing the endangered species.
   Animal Advocate: The student becomes a lawyer who is representing the endangered species in a civil action before a court. The student is, in effect, suing humans for creating the situation that has endangered the species. The student must argue in favor of protection of his/her client, and ask for some sort of damages from mankind. These damages could include the restoration of its habitat, monetary damages, or a combination. Jail time is not possible, since this is a civil, rather than criminal, action. If desired, another student may be assigned the role of defense attorney for the humans.

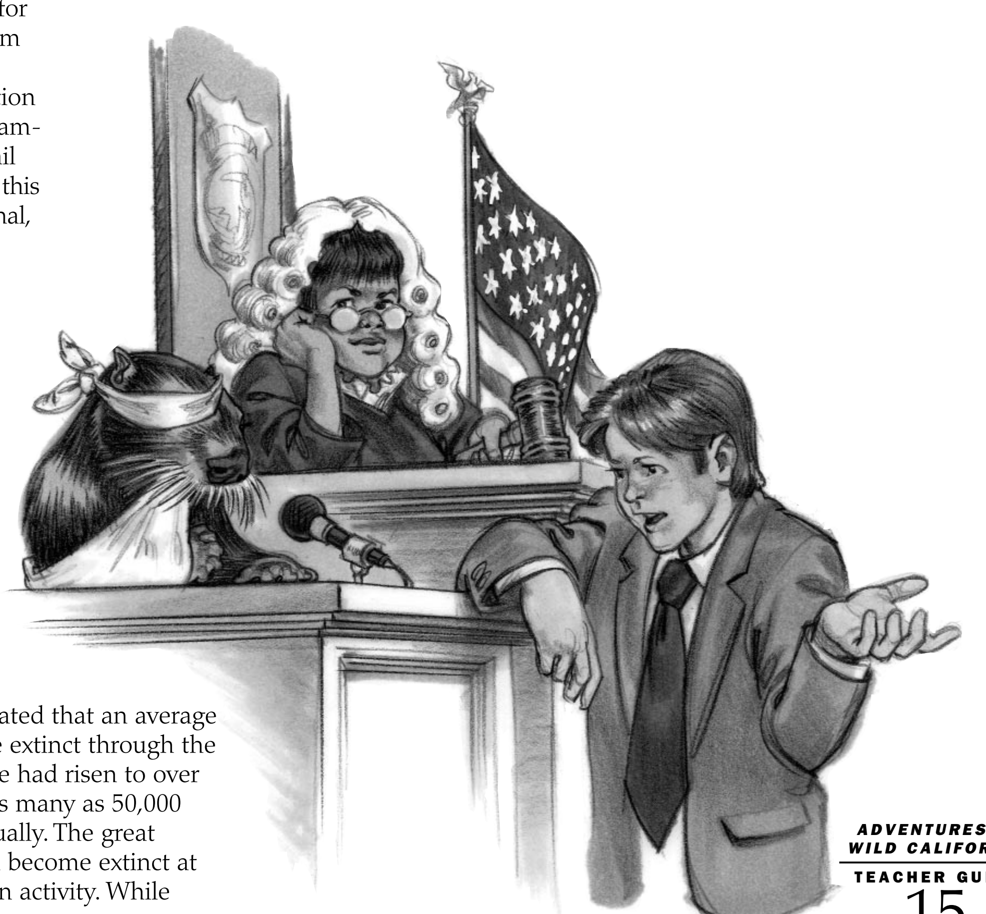
What's Going On and Why? Extinction has been going on for millions of years, and more species have died out on the earth than are alive now. However, since the 1600s the rate at which plant and animal species have disappeared has risen dramatically. For example, it is estimated that an average of one species a year became extinct through the 19th century. By 1990 the rate had risen to over 400 each year, and by 2000 as many as 50,000 species could disappear annually. The great majority of these species will become extinct at least partly because of human activity. While there are government and private organizations that work to protect and reestablish endangered and threatened species, it is important that ordinary citizens become aware of the need to protect plants and animals and their habitats. Too often it is everyday human activity that causes the most threat to ecosystems. Changing the oil in a car, spraying the yard for weeds, and introducing exotic plants into a garden can all cause serious problems if not done properly.

Many other organizations are working to help endangered species. In 1997, Sea World of San Diego rescued an orphaned baby gray whale. The whale, named J.J., later recovered enough so that Sea World was able to release it back into the ocean during the following year's migration period.

Key Words:

endangered species a species of animal or plant that is in danger of extinction without human intervention to protect it.
habitat the natural environment where a particular plant or animal can be found.

Taking It Further: Have students research their own area or a state of their choice to find out what types of endangered species live there. Students may choose to write letters to support the protection of a local area that is important to a threatened or endangered species, or create a campaign to clean up a habitat.



Does It Pan Out?

Activity 6

Objective: Students will research and report on the Gold Rush, then take part in a gold-panning simulation.

In The Film: Imagine the chance to make your wildest dreams come true. That was the lure to many people when word came of the 1848 discovery of gold in California. The territory had recently been ceded to the United States by Mexico, and thousands came from the East to try their luck in the gold fields. They had heard the stories of the ease with which you could make your fortune and were willing to risk much for their chance to strike it rich. As word spread beyond the U.S., people from Europe, Asia, and South America began to arrive, all trying for their own piece of the dream. It is estimated that some 100,000 people, mostly unmarried men, came to California to seek their fortune. Most of them would be disappointed.

> **FACT:** According to the U.S. Ski Association, the forty-niners were the first to hold organized ski races in the United States. Scandinavian immigrants taught the miners how to use the huge wooden "shoes," as the skis were called then, some of which were as much as 13 feet long.

Materials:
- ☐ Clean sand, such as for a sandbox (a 25-pound bag should be sufficient)
- ☐ B-Bs or small fishing sinkers
- ☐ Large bucket for mixing sand and B-Bs/sinkers
- ☐ Medium-size buckets for water (at least one for every three students)
- ☐ Small bucket or large scoop
- ☐ Metal (aluminum) pie pans
- ☐ Water

Teacher Prep Notes: This activity is best conducted outside or in an area where any cleanup will be relatively easy.

Background: In California, gold was mined using one of four major methods. The most commonly depicted of these was placer mining. In this method, miners would take advantage of the fact that gold is a very heavy material, generally much heavier than the sand and gravel it might be mixed with in a stream. Whether the miner used a pan, a sluice box, or a rocker, the idea was to let running water wash away the sand and gravel, leaving behind the gold. Another well-known method is lode or hard rock mining. Here miners would dig traditional tunnel and shaft mines into the mountains in search of gold-bearing ore. This ore would then be processed to remove the gold. Another, though less well-known, method was dredge mining. This method involved using machines to dig up sand, gravel, and soil from the bottoms of rivers and from the banks. The material was then processed to remove any possible gold. The last, and possibly most destructive method was hydraulic mining. Knowing that the gold in the streams was the result of erosion, miners used technology to speed up the process. By harnessing the power of moving water and directing it through hoses and nozzles, miners could erode away hillsides at a breathtaking pace. One water cannon with an eight-inch nozzle could erode 4,000 cubic yards of hillside a day. After the material was processed for gold, the soil, rock, and gravel was allowed to follow its natural course downhill, into rivers and streams and eventually to the ocean. At one point, so much material was running downstream into the Sacramento River that the soil-laden waters reached all the way to the San Francisco Bay.

To Do:

1. Have students research the Gold Rush to find out what motivated people to leave their homes and travel to California to search for gold. Was it only the gold, or was there something more that caused them to leave? What did people give up in order to try for instant riches? What hardships did they experience on their way to California, when they arrived, and while searching for gold?
2. Have each student create a persona for him/herself based on the research done. This should include who they are (real or fictitious person), what their life was like before, where they lived, why they left, who and what they left behind, and what they experienced on the way to the gold fields. Students may even want to create a costume for their persona. Students then present their persona to the class.
3. Mix the B-Bs/sinkers with the sand, but not so much that they are evenly distributed. It should work out that some students get "gold" while others get nothing.
4. Provide each student with a pie pan to use to search for gold. With the scoop, place about a cup of sand in each student's pan.
5. Have students carefully swirl their pans in the

bucket of water to wash away the sand. Remind them to work carefully so as not to lose any "gold" into the water. (Any "gold" that falls into the water can be claimed by another student.)

3. If time allows, repeat the panning activity once or twice. Have students keep track of the amount of "gold" they find. Discuss the results of the activity. Point out to students that some of the "Forty-Niners" found a little gold, some found a lot, and some found none at all.

What's Going On and Why? The simplest method of mining for gold is panning, a type of placer mining. In placer mining the miner sifts through loose deposits of gravel, sand, or other materials. This may be done in a gold-bearing stream where deposits are mixed with the gravel on the bottom, or it may involve excavating large amounts of deposits using machinery. In either method, running water is used to wash away the worthless material, leaving the gold behind. In large-scale placer mining, the washing is done using sluices and screens. This method of mining is possible because gold, with an atomic weight of 196.9665, is heavier than the sand and gravel with which it is found. The movement of the water washes away the lighter materials, leaving the heavier gold at the bottom of the pan or sluice.

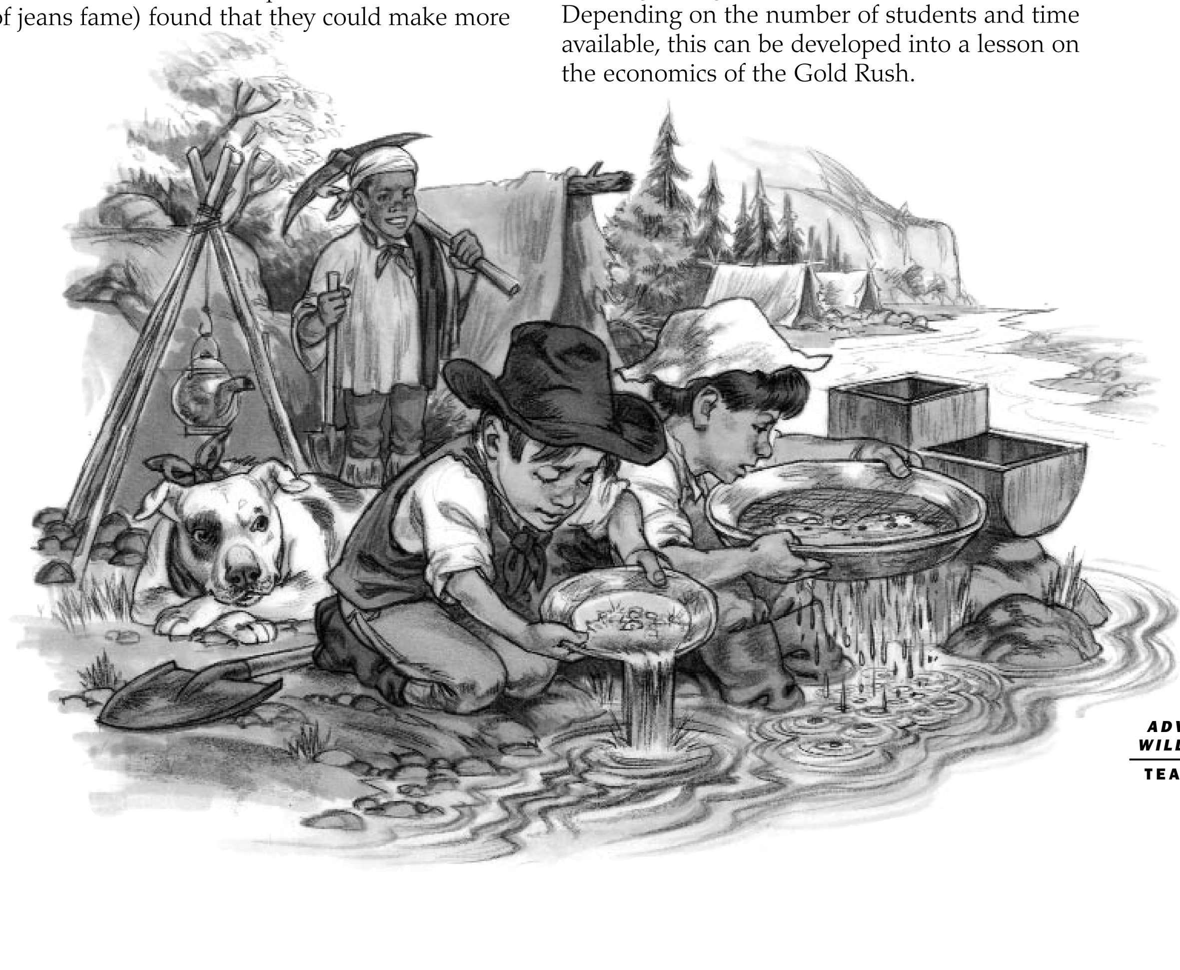
Taking It Further: Many people who came to California during the Gold Rush became rich not from finding gold, but from supplying goods and services to the miners. People such as Levi Strauss (of jeans fame) found that they could make more money by selling to those miners lucky enough to find gold than they could if they had joined the thousands in the fields. Others, such as Henry Wells and William Fargo, saw the need for a reliable bank where miners could have their gold dust assayed, or evaluated to determine its purity and true worth. This was necessary because, though valuable, gold dust was not considered legal tender for many transactions. In addition, those merchants who would accept dust generally did so at a devalued rate and by measuring it by the "pinch." The bank Wells and Fargo founded, and other assay offices, would determine the purity of the gold, then exchange the dust for gold coins or certificates that could later be cashed in for coins.

Key Words:

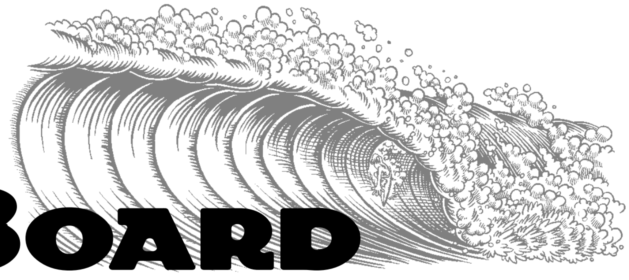
placer mining a form of mining that uses the power of moving water to separate gold from the gravel and rock with which it may be deposited.

hydraulic mining a form of mining in which water is directed through a nozzle and used to quickly erode possible gold-bearing hillsides for processing.

As an extension to the activity, designate several students to be merchants and assay agents. Assign each student merchant a commodity to sell (food, clothing, mining equipment, and so on), and let them set the prices. For example, a clothing merchant might charge one "pinch" of gold for a shirt, two for a pair of pants. Remind the miners that they can only go so long without basic necessities. Have student miners take their "gold" to be assayed and weighed by agents, who can then exchange the gold for coins
Depending on the number of students and time available, this can be developed into a lesson on the economics of the Gold Rush.



Build A Better Board



Activity 7

Objective: Students will research surfboard history and design in order to create a surfboard to match a chosen surf condition.

In The Film: For many people around the world, surfing has become synonymous with the California lifestyle. Movies such as *Gidget* and *5 Summer Stories*, and groups such as the Beach Boys, Jan and Dean, and the Surfaris have spread the image of tanned young men and women catching waves along the California coast. But something was always missing from California surfing: the big waves that have made places such as Hawaii's Banzai Pipeline famous. Then came the discovery of Maverick's. Located off Half Moon Bay south of San Francisco, the monster waves of Maverick's are formed when winter storms drive the ocean against a submerged reef. The waves that are formed average 20 feet (6.1 meters), but can easily reach 40 feet (12.2 meters) during exceptional conditions. This measurement is from the back of the wave to the crest, and the face of a 20-foot (6.1 meters) wave can be 30 feet (18.3 meters) or more in total height because of the wave trough. Because of this, it takes a determined, experienced surfer to tame these monster waves. The men and women who dare to ride these aquatic mountains know that the right board is crucial to their success. Not just any surfboard will hold up to the pounding that these waves can dish out. It has to be designed with these types of conditions in mind.

> **FACT:** According to one story, Maverick's got its name from the man who first discovered this unusual surf spot. He named it for his dog, Maverick.

Materials:
- ☐ Resource materials (surfing magazines and Internet sites-see list at end)
- ☐ Drawing and graph paper
- ☐ Styrofoam sheets (coated on both sides), cut into 8 in by 24 in (20 cm by 61 cm) strips
- ☐ Scissors (regular metal, not plastic safety type)
- ☐ Colored markers
- ☐ Glue (white or other liquid)

Teacher Prep Notes:
Relatively inexpensive sheets of insulating styrofoam in various sizes can be purchased at many building supply stores, although some brands have printing on one side. It is best to use styrofoam that is coated on both sides, as this makes a better surface for decorating. When cutting the styrofoam, instruct students to work slowly and to avoid using the tip (which will cause cracks and splits). Shaping the board can be done by angling the scissors and cutting very slowly and carefully. Because of a lack of books on surfboard design in most libraries, students will probably need to resort to surfing magazines and the Internet. The sites listed have information, but the teacher might want to review them before offering them to the students. Surfing has a language all its own, and some terms may have more than one meaning. The teacher can print off the relevant material and make it available to students.

Background: Surfboards have come a long way from the Polynesian solid wood longboard to today's high-tech foam and fiberglass boards. The earliest known surfboards, used in Oceania where the sport originated, were slabs of hardwood that could weigh as much as 150 pounds (67.5 kilograms). Because of this, strength was a prerequisite for taking part in the activity. English captain James Cook may have been one of the first Europeans to observe surfing when he arrived in the Hawaiian Islands in 1778. About 150 years later, surfboard design had advanced to the point where plywood and balsa wood were being used in place of the hardwood. In addition, fins had been added to improve steering and control. Beginning in the 1960s surfboard designers began to use styrofoam and fiberglass to produce a strong, yet lightweight board. The size and shape of the board had begun to change as well, to fit different styles of surfing. Today surfboards are designed for such activities as trick surfing, recreational surfing, and big-wave surfing.

To Do:
1. Have students research the history of surfboards, including any information on design changes. It is likely that libraries will have few books on the subject, so students may need to look for surfing magazines and Internet sites. Explain that they will be designing their own board, and will need to know not only the basics of design, but what designs are best for specific styles of surfing and conditions. They will need to choose a surfing style and wave condition for the board they will design.

2. Students should use the graph paper to design their surfboard. Their designs should show top, side, front, and back views. They need to pay attention to all areas of design (see information below) in order to create a board that fits the style and conditions they choose.
3. Once students have designed their boards, they need to create prototypes. They will use the graphed designs as templates for their boards. The templates should be cut out, then taped onto the surface of the Styrofoam using a tape that will not tear the surface when removed.
4. Using the scissors, the students cut out and shape their board. Fins can be cut out of scrap pieces left over from cutting the board. To set the fins, measure and mark a line on the bottom where the fin(s) will be. The line should be the same length as the distance from the front edge of the fin to the back edge. Make parallel cuts about 1/8 inch (0.32 cm) on each side of the line. Be careful not to go too deep, or you will cut through the top of the board. Carefully remove the Styrofoam from between the cuts, forming a groove. Trim the base of the fin so that the sides angle in to form a blunt wedge. Push the base of the fin into the groove on the bottom of the board. The fin should fit tightly, but glue should be used to make it permanent.
5. Once the boards are complete, students can decorate them using markers. Encourage them to personalize their designs.

What's Going On and Why? The design of a board has everything to do with the way it handles in the water. Some of the variables include length, number of fins, bottom design, tail design, rail design, and rocker. Each design variable has its own influence on the performance of the board.

Length The length of the board will affect several different elements. Shorter boards tend to be quicker and easier to maneuver. Longer boards have more stability and straight-line power. Short boards range from 5′6′ to 6′11″ (1.7 to 2.1 meters), long boards range from 7′0″ to 11′0″ (2.1 to 3.4 meters), and a "gun" (a specialized big-wave board) ranges from 8′6″ to 11′0″ (2.6 to 3.4 meters).

Fins The number of fins affects control and stability. Typically, boards have one or three fins. On a three-fin design the middle fin provides stability and the outer fins provide maneuverability for turns. The size of the fin is also important. Small fins allow for more slide of the tail, whereas large fins provide more "grip" in the wave. A large single fin is considered more stable. Short boards generally have three fins and long boards generally have one.

Bottom Design The shape of the bottom affects the way the board rides on the wave. Four common bottom designs are flat, single concave, double concave, and vee. The amount of curve on the bottom affects how water is channeled beneath the board.

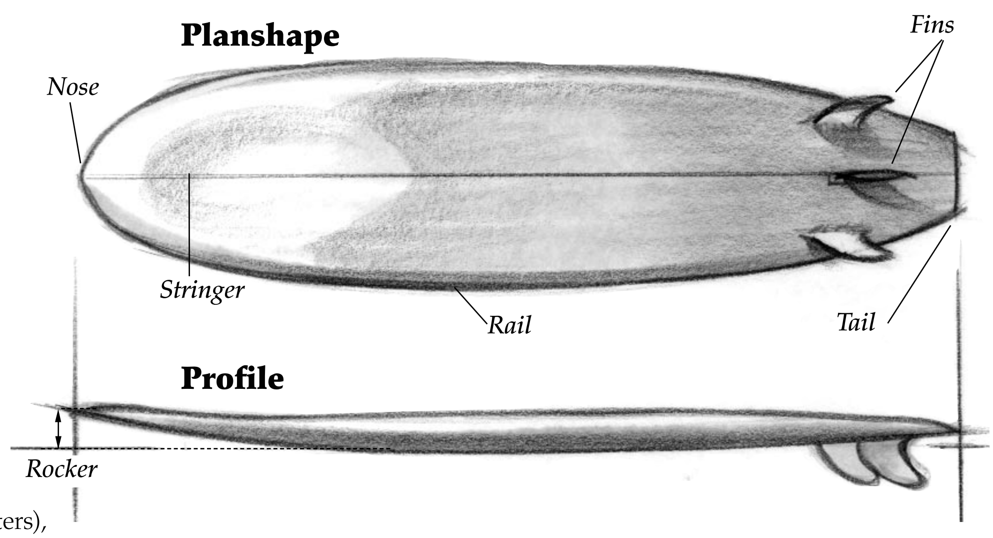
Tail Design Tail design affects maneuverability, since a surfer usually "drives" off of the tail when turning. Designs include rounded square, round, swallow, pin, and square. At the extremes, a pin tail grips the wave for speed but is harder to turn; a square tail is very maneuverable and can "pivot on a dime."

Rail Design Basically, the rail is the edge of the board where top and bottom meet. The design of the rail affects the way water moves over and around the board and how the board "bites" into the wave during turns. Rail designs include rolled, mid, boxy, and low. Typically, the rail tapers from nose to tail.

Rocker The rocker is the curve of the board at the nose and tail. A board with more rocker is easier to maneuver, while a board with low rocker gives more speed. Too much rocker pushes water in front of the board and slows it down.

Key Words:

longboard a surfboard typically seven feet (2.1 meters) or more in length; the earliest surfboards made by the Polynesians were longboards.
prototype the first example created of a new design.
shortboard a surfboard typically less than seven feet (2.1 meters) in length, frequently used for trick surfing.



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TAKE A DEEP BREATH

ACTIVITY 8

Objective: Students will conduct experiments to learn about lung capacity and function.

In The Film: With a roar, it grabs you, chews you up, rolls you around, and finally, an eternity later, it spits you out. "It" is the monster wave at Maverick's that you didn't quite catch. When one of these multi-story mountains wipes a surfer out, it could be a matter of minutes rather than seconds before the churning water releases its prey. During that time, the hapless surfer may be underwater long enough for two sets of waves to pass over. In order to survive this type of a situation, surfers such as Jeff Clark and Grant Washburn practice holding their breath. They practice at the bottom of a pool, in the shower, while driving to Maverick's, and any other chance they get. Their goal is to condition themselves both physically and mentally for the inevitable time when the wave wins.

> **FACT:** In order to survive conditions high in the Andes Mountains of South America at elevations above 10,000 feet (3000 m), people there have developed special adaptations. Larger lungs allow them to bring in more air, which at that elevation holds one-third less oxygen than at sea level. They also have a faster heartbeat, 30% more red blood cells, and a capillary system that is more highly branched than that of people living at lower altitudes.

Materials:
- ☐ Stop watch
- ☐ Tape measure
- ☐ Small balloons
- ☐ 5-gallon Bucket
- ☐ Large tub (large enough to set the bucket in to catch spilled water)
- ☐ Water (about 8-10 gallons)
- ☐ Graduated beaker or other marked container (preferably cubic centimeters/milliliters)
- ☐ Small step stool or crate
- ☐ Lined paper for recording data
- ☐ Graph paper for charting results

Teacher Prep Notes: If any student volunteer becomes lightheaded or dizzy during the activity, stop the test and have the student sit down until feeling better. Choose a new volunteer to complete the activity. Volunteers should rest several minutes between activities in part two.

Background: The lungs are the main element of the respiratory system, which, along with the circulatory system, provides the body with the oxygen it needs to survive. An average adult human's lungs can take in about 12 to 30 cubic inches (200 to 500 cu cm) of air while breathing, which is actually only about 12% of a healthy young adult's full capacity. In addition to this amount, called tidal flow, forced inspiration (a deep breath) can add about another 90 cubic inches (1500 cu cm) of what is known as complemental air. This air is taken in through the trachea and bronchi into the bronchioles, the alveolar ducts, and finally the alveoli. It is in the body's 600 million alveoli that the actual exchange of oxygen and carbon dioxide takes place. The alveoli and the capillaries that surround them have walls that are so thin that gases can easily pass between them. The oxygen diffuses from the alveoli into the capillaries and is taken up by the red blood cells, which contain hemoglobin. This happens because the hematin in the hemoglobin is an iron-based pigment with an affinity for oxygen and forms a loose combination with the gas. This in turn causes a change in the acidity of the blood and a release of carbon dioxide into the blood stream. Chemical reactions due to the acidity cause the exchange of oxygen and carbon dioxide in the blood stream. The carbon dioxide is then carried to the lungs where it diffuses into the alveoli and is expelled from the body.

To Do:
1. *Lung Capacity I* Have each volunteer take a deep breath, then blow up a small balloon as much as possible on one breath (try to blow out as much air as possible without stopping). Tie a knot in the balloon without releasing any air (if any air escapes have the volunteer blow up a new balloon).
2. Place the bucket in the tub and fill the bucket to the top with water. To measure the volume of the balloon, insert the balloon completely into the bucket. Hold on to the knot, and try not to insert your hand into the water.
3. Remove the balloon, and refill the bucket using the graduated container. Record the amount of water needed to completely refill the bucket. This is the volume of water displaced by the air blown into the balloon.
4. Measure the height of each volunteer and make a comparative graph of height and lung capacity. Discuss any patterns discovered.

1. *Lung Capacity II* While sitting, have each volunteer take two deep breaths, holding the second one. Time each volunteer until he/she needs to exhale. Record the time for each student.
2. Repeat the experiment for each volunteer while walking in place, running in place, and stepping up and down on the stool/crate. Record all results on the experiment sheet.
3. Graph the results both individually and by activity. Is there a correlation between lung capacity from part one and the results here?

What's Going On and Why? A person's breathing rate is controlled by the respiratory center in the brain, and is dependent upon the amount of carbon dioxide in the blood. Carbon dioxide is a byproduct of normal cellular activity. Increased activity, for example during physical exertion, produces an excess of carbon dioxide in the blood stream. Blood with a higher than normal concentration of carbon dioxide is more acidic than blood with normal concentrations. The respiratory center is sensitive to acidity, and reacts by stimulating increased activity in the respiratory muscles. This continues as long as carbon dioxide levels are above normal. Interestingly, the respiratory center is much less sensitive to higher levels of oxygen in the blood.

During exercise, the muscles use a large amount of oxygen and produce a large amount of carbon dioxide. This causes a severe imbalance in the acidity of the blood stream, leading to faster breathing to replace the oxygen and remove the carbon dioxide. Holding your breath thus becomes much more difficult during activity. It is possible, though, to increase the lungs' capacity and efficiency through regular exercise.

Key Words:

alveoli small air sacs in the lungs where the actual exchange of oxygen and carbon dioxide takes place.
tidal flow the average amount of air taken into the lungs during normal respiration.

Taking It Further: Compare the above results with the amount of regular exercise student volunteers get. Have volunteers increase their activity for two weeks, then repeat the activities in part two.

FACT: The alveoli are quite remarkable parts of the body. Because of their shape and their numbers, if the alveoli in an average person's lungs were opened and spread out flat, they would cover an area about the size of a tennis court. Watch where you step, Andre!

FALLING FOR YOU

ACTIVITY 9

Objective: Students will experiment with rates of fall of different shaped objects to understand the affect of air resistance on the rate of fall.

In The Film: Imagine how it must feel to perform a ballet in the sky. Spinning, looping, pirouetting, gliding effortlessly through the sky. This may be the ultimate feeling of freedom, the feeling that you are free of all constraints and can move any way you like. Although it looks like a matter of jumping out of an airplane with a board attached to your feet, creating a successful sky surfing routine is a much more involved process. Sky surfer Troy Hartman and cameraman Joe Jennings work hard to choreograph their fifty-second free-fall routines. In order to get their timing down perfectly, the two will practice their routine on the ground in "dirt dives" before they ever go up in the airplane. One very important element of this preparation is matching Jennings' free-fall rate to Hartman's. The large surface of Hartman's board causes a great deal of air resistance, which slows his rate of fall. In order to compensate for the resistance caused by Hartman's sky board, Jennings must attach air resistance wings to his jumpsuit.

FACT: Sky surfing started in 1980 in Southern California when skydivers decided to try something new by jumping with Styrofoam boogie boards. During free fall, a skydiver would lie on the board, holding on to the sides. They called this "air surfing."

Materials:
- □ Identical sheets of aluminum foil
- □ Directions for making foil people (below)

Teacher Prep Notes: Foil sandwich sheets works well for this activity, because all of the sheets are the same size.

Background: Air resistance is a force that acts in the opposite direction of an object moving through the air, such as a sky surfer free-falling toward the earth or a rock dropped from the roof of a building. This force helps to counteract, to some extent, the rate at which an object falls toward the earth. Without this force, gravity would cause a falling object to accelerate at a constant rate until the object struck the earth. Air resistance increases with the speed at which an object falls, until the point is reached where the forces of resistance and gravity become equal and the object stops accelerating. At this point the object has reached its terminal velocity, the fastest speed at which it can fall. This velocity depends on the relative proportion of weight to surface area of the object.

To Do:

1. Take two identical size sheets of foil and show them to the class. Have students discuss the properties of the sheets, focusing on the fact that, since they are the same size and shape, they have the same mass and weight.
2. Crumple one sheet into a ball, leaving the other sheet alone. Discuss the fact that, even though the shapes are no longer identical, the two sheets of foil still have the same weight. Drop both pieces of foil at the same time, from the same height, making sure the full sheet is parallel to the floor. Discuss the results of this experiment. Explain to the students about air resistance and its affect on falling objects.
3. Use two more sheets of foil to create two similar foil figures. *(see diagram)*
4. Discuss the fact that these two figures will have the same weight, and relatively the same air resistance because of the similar shapes. Drop the two figures at the same time from the same height. (Hold the figures by the head when you drop them, to simulate a person falling feet-first.) Discuss the results of this experiment.
5. Take a new sheet of foil and cut it exactly in half (width-wise). Fold one piece in half lengthwise three times to form a rectangle. Tape this rectangle to the feet of one figure to simulate a sky board. Fold the second piece into a small square and tape it to the hands of the second figure to simulate a camera. Drop both figures at the same time from the same height, holding both figures by the head. Discuss the results of this experiment.

What's Going On and Why? Air, like water, behaves like a fluid. This fact helps to explain why objects moving through both experience a resistance. Anyone who has ever tried swimming, or just moving an arm in the bathtub, has felt the resistance of the water. Air resistance is not as obvious, in part because air at sea level is only 1/800 the density of water and this density decreases with altitude. Still, the movement of an object through the air is affected by the same types of physical laws that would affect it if it were moving through any other fluid.

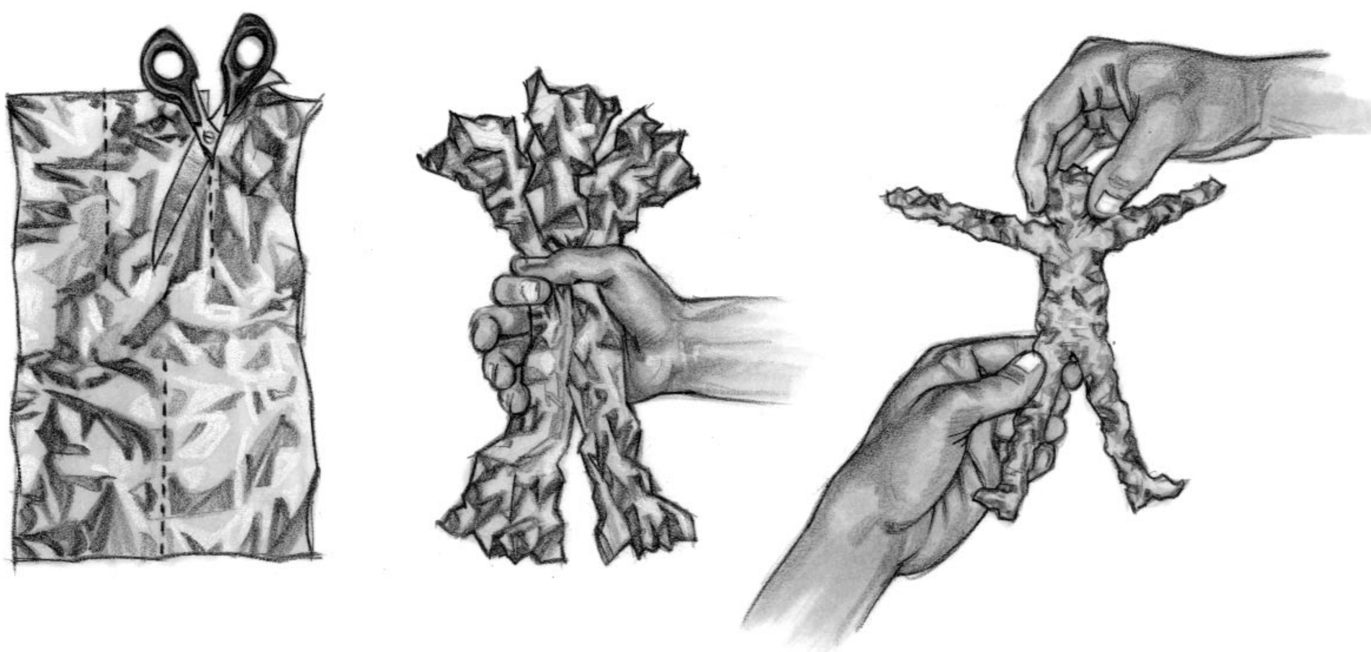
The air resistance that affects a falling object depends a great deal on the shape of the object. Streamlined objects cause little disturbance when moving through the air. (This is why automakers spend so much time and money on the shapes of their cars.) Round objects experience more air resistance than streamlined objects, and flat objects, such as sky boards, experience even more. A falling human, because of the more rounded shape, experiences less resistance than a person on a sky board, which has a large flat surface. The air resistance wings a sky surfer's cameraman uses help to add drag to his body and bring his rate of fall in line with that of the sky surfer.

Taking It Further: Have students fold sheets of foil into different shapes to test the air resistance. Have them predict before dropping, which shapes will fall faster and which will fall more slowly. Compare the different shapes and chart them in order from fastest falling to slowest.

Key Words:

air resistance a force that acts in the opposite direction of an object moving through the air.
terminal velocity the fastest speed at which an object can fall.

Making A Foil Figure



STEP 1: Take a sheet of foil lengthwise and make two cuts at one end 1/3 of the way in from each side, almost to the middle of the sheet, making three strips. On the other end, make one cut in the center, the same length as the first two cuts, to make two strips.

STEP 2: Grasp the sheet in the middle and bunch the foil up, being careful not to loose track of the cut areas. The end with three strips will make the head and arms, while the end with two strips will make the legs.

STEP 3: Twist the middle strip on the top into a rounded head and the arm and leg strips into long, narrow shapes. Your finished product will look somewhat like a three-dimensional stick figure.

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