Our Natural Heritage, Bioregional Pride

San Diego County and Baja California

Teacher Guide

Second Edition

PROBEA
Proyecto Bio-regional de Educación Ambiental, A.C.

San Diego Natural History Museum

U.S. Fish & Wildlife Service

Colegio de Bachilleres del Estado de Baja California

Comisión Nacional de Áreas Naturales Protegidas

Islas del Golfo de California

Fundación La Puerta

Proyecto Fronterizo de Educación Ambiental A.C.

GobBC
Gobierno del Estado
Secretaría de Protección al Ambiente

The design and production of this curriculum was
funded by

U.S. Fish & Wildlife Service, Division of International Conservation
Wildlife without Borders /Mexico

San Diego National Wildlife Refuge Complex

Published by Proyecto Bio-regional de Educación Ambiental (PROBEA),
a program of the
San Diego Natural History Museum
P.O. Box 121390,
San Diego, CA 92112-1390 USA

Printed in the U.S.A.
Website: www.sdnhm.org/education/binational

Our Natural Heritage, Bioregional Pride

San Diego County and Baja California

Designed and written by: Araceli Fernández, Karen Levyszpiro, Judy Ramírez

Field Guide illustrations: Jim Melli, Juan Jesús Lucero Martínez, Callie Mack

Edited by: Doretta Winkelman, Delle Willett, Claudia Schroeder, Karen Levyszpiro, Judy Ramírez

Global Changes and Wildfires section: Anne Fege

Activity 2: What is an Ecosystem? Designed and written by: Pat Flanagan, Judy Ramírez

Ecosystem Map *(EcoMap),* graphic and illustration support: Callie Mack

Descriptions of Protected Areas: Protected Areas personnel of San Diego County

Ecological Regions Map: Glenn Griffith

Ecosystems Map: Charlotte E. González Abraham

Translation: Karen Levyszpiro

Formatting and graphics design: Isabelle Heyward, Christopher Blaylock

Project coordination: Doretta Winkelman

Acknowledgements

Our deep gratitude goes to the following organizations who granted us permission to use or adapt their materials.

General Guidelines for Field-Trip-Based Environmental Education from the *Catalog of Sites of Regional Importance* is included with permission from the Environmental Education Council of the Californias (EECC).

Grass Roots Educators contributed the *Plant, Bird and Cactus Observation Sheets*, the *EcoMap* Graphic Organizer for Activity 2, and other illustrations included in this curriculum.

Thanks to scientists from the San Diego Natural History Museum: Michael Wall, Ph.D, Director of the Norm Roberts Biodiversity Research Center of the Californias; Phil Unitt, Birds and Mammals Curator; Scott Tremor, Mammologist, Department of Birds and Mammals; Brad Hollingsworth, Ph.D., Herpetology Curator; and Jon Rebman, Ph.D., Botany Curator, who reviewed the *Field Guide*. Judy Gibson, the Botany Department's collections manager, who helped us to complete the final flora edits.

Thanks also to Jim Melli, Exhibits Designer, from the San Diego Natural History Museum Exhibits Department, for creating the majority of the *Field Guide* illustrations, and to Juan Jesús Lucero Martínez, a La Paz fisherman, who created some of the illustrations.

A very special acknowledgement goes to Exequiel Ezcurra, Ph.D., Director of the MEXUS Program at the University of California, Riverside, who advised us throughout the process of developing this curriculum; he offered resources and materials and clarified our questions. We will forever be in his debt for his guidance, contributions, recommendations and advice.

Thanks so much to Christopher Blaylock, our InDesign graphics specialist (with assistance from Isabelle Heyward of the Graphics Department at the San Diego Natural History Museum) for their unconditional support in the design of this *Teacher Guide* and its accompanying *Field Guide*. Thanks to Callie Mack, digital and traditional illustration specialist, for assisting us with our *EcoMap* graphic organizer illustrations.

Special thanks to Andy Yuen of the U.S. Fish and Wildlife Service, Carlsbad, for his financial support of this project, as well as to Brian Collins and Chantel Jiménez of the San Diego National Wildlife Refuge Complex, Sweetwater unit, for their collaboration.

Thanks to Glenn Griffith, geographer of the U.S. Environmental Protection Agency (EPA), Oregon, for creating the Ecological Region Map especially for us, and to Dave Fege, also of EPA, for recommending him.

A special acknowledgement goes to all the personnel of the San Diego County protected areas featured in this curriculum for providing us with the information included here.
A heartfelt acknowledgement goes to the following individuals:

Charlotte E. González Abraham who created the map of Baja California ecosystems that we use in Activity 3.

Anne Fege for providing her knowledge and texts about the effects of wildfires on our ecosystems and about global change.

Miguel Ángel Vargas of PRONATURA for his advice and information resources.

Laura Silvan, Executive Director of Fundación La Puerta, for 18 years of unconditional collaboration with PROBEA, and for providing information about the "Rancho Cuchuma" Binational Ecological Easement included in the Natural Protected Areas Activity of this curriculum.

Margarita Diaz, Executive Director of Proyecto Fronterizo de Educación Ambiental, for her collaboration with PROBEA, and for providing information about youth-service learning, as well as for invitations to participate in the Playas (Tijuana) bi-annual beach clean-ups.

And finally, thanks to the PROBEA team whose tireless efforts to do their best made possible the creation and production of this curriculum. Their dedication, commitment to excellence, desire to make a difference, and love for our natural heritage inspire us all.

Introduction

San Diego County and the northern part of Baja California are very rich in biodiversity. In fact, our shared region is among the top ten biodiversity regions on Earth, and San Diego County has more biodiversity than any other county in North America. The flora and fauna, the natural protected areas, valleys and sierras, and people, among many other things, make this a marvelous region that deserves our dedication to protect and conserve it.

For this reason PROBEA, in collaboration with its partners in San Diego County and Baja California, has adapted *Our Natural Heritage, Pride of Southern Baja California*, originally designed for Baja California Sur. This newly adapted version is called *Our Natural Heritage, Bioregional Pride, San Diego County and Baja California*.

This program is designed to encourage teachers and environmental educators to continue their tireless struggle to create environmentally literate and responsible citizens who will positively affect the environment of our binational region.

The curriculum explores the San Diego County/Baja California region's geography, natural history, human population, and the way many of our actions affect its environment. It also illustrates how we can find solutions to the San Diego County/Baja California border region's environmental problems through community collaboration and innovation.

Curriculum activities take workshop participants through the steps to environmental literacy: awareness, knowledge, skill development, attitude change, and active participation. They also include questions that promote reflection and participation. These questions create interest, encourage research, and foster the exchange of knowledge, ideas, and experiences, all of which allow for a thorough enjoyment of the teaching-learning process.

Some activities, including the school action project to benefit the local environment, represent an opportunity to analyze and discuss local environmental restoration and conservation. This process fosters the development of an environmental awareness in participants that can lead to life-long behavior change.

In summary, through enjoyable hands-on activities we encourage teachers and environmental educators of San Diego County and Baja California to develop and deepen their appreciation for their local environment and to communicate this to their respective audiences. With these efforts we seek to promote a commitment as individuals and as a society at large to conserve and protect our environment.

A Word About Our Words

Throughout *Our Natural Heritage, Bioregional Pride*, we employ several ecology-related terms. We have found that different authors give different shades of meaning to these terms. Following are the terms and definitions as we use them in this curriculum:

"*Bioregions* are geographic areas having common characteristics of soil, watershed, climate, native plants and animals that exist within the whole planetary biosphere as unique and intrinsic contributive parts. A bioregion refers both to geographical terrain and a terrain of consciousness—to a place and the ideas that have developed about how to live in that place..."

We can think of a bioregion as a "life-place, one's lived territory which provides contexts for daily living." The San Diego Natural History Museum's bioregion extends from Point Conception near Santa Barbara, California, to the tip of the Baja California peninsula. This explains why our scientists and environmental educators carry out their work throughout the Baja California peninsula, as well as in San Diego County.

An *ecological region* (also known as *ecoregion*) is a relatively large geographical area distinguished by the unique character of its morphology, geology, climate, soil, hydrology, flora and fauna. In contrasting the two terms, we can note that the term *bioregion* has a strong social and cultural element, whereas when we use the term *ecoregion*, we are referring to all the biotic and abiotic elements—plants, animals, climate, landform, surface water, soil, ground water, bedrock—with the emphasis on science and conservation.

The Ecoregion map in Activity 3 shows some general regions, at a coarse scale. These could be subdivided into smaller, more homogeneous units. There are regions within regions within regions, from continental to state to local scales.

In the curriculum we refer to four ecological regions and their corresponding ecosystems. The names of these ecosystems are based on their vegetative communities, for instance, chaparral. However, an *ecosystem* is made up of all biotic and abiotic elements and their interactions. In other words, when we talk about the coastal sage scrub ecosystems or the wetlands ecosystems, we are referring to all existing factors within those ecosystems, not only to the plant communities.

It is also important to note that some of the ecosystems, such as wetlands or riparian areas, occur in different ecoregions. The distribution, abundance and characteristics of those habitat types, however, will be different in each of the ecoregions.

In the *EcoMap*, our ecosystem list becomes a list of habitats. We consider nine habitats: kelp forest, beach/tidepools, coastal sage scrub, succulent sage scrub, chaparral, pine and oak forest, desert, wetlands, and riparian areas. They are the same ecosystems corresponding to our four ecological regions. They can be the same geographic area. Perspective is what distinguishes the terms *ecosystem* and *habitat*. When we talk about *ecosystems*, we refer to the above definition, whereas a *habitat* is a place where organisms can satisfy their survival needs.

How to Use This Curriculum

This curriculum is designed to raise the awareness of 4th–12th grade teachers and their students, as well as that of non-formal educators and their audiences, in San Diego County and Baja California.

We suggest that students work in teams when engaging in the curriculum activities. Cooperative work enhances learning. By working on a joint project or team activity, each team member has responsibility for completing a specific task. Each student is told what is expected of him or her, and knows that the success of the project depends on everyone's performance and attitude.

In addition, cooperative learning also provides a valuable social experience in which each individual's behavior serves as a model for others to follow. If there are teams or classes with different age groups, learning is enhanced because each member brings a different life perspective or experience to the group.

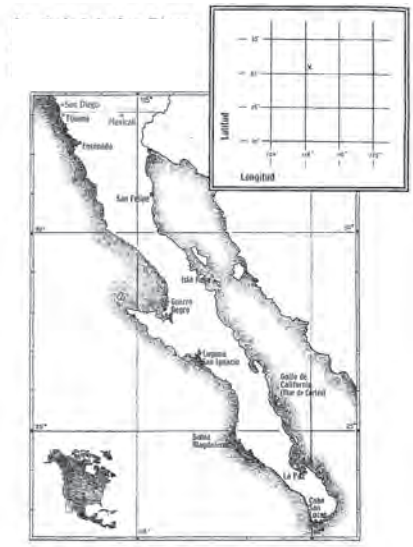
All activities are correlated to the California Content Standards in science, social studies and language arts.

Finally, we sincerely wish this resource is useful to you, your students, and your audience throughout the school year.

Enjoy!

Contents

Activity 1: Where Are We?
Location and a Sense of Place



Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Earth Sciences
- Geography
- Social Sciences
- Mathematics
- English
- History

Skills
- Observing
- Describing
- Comparing
- Inferring
- Communicating

Concepts
- Any place on the face of the Earth can be located using a system of latitude and longitude coordinates.
- We use cardinal points—North, South, East, and West—to describe the direction and location of a particular place.

Background Information

In order to find our way in unknown territory we need signs or reference points to indicate which way to go. The sun is a good reference because we can see it all day long. In addition, it always follows the same path—rises in the East and sets in the West.

At night, stars are also used as reference points. The North Star is the most important guide because it only slightly changes its position in the night sky. It is located in line with the Earth's axis. That is, if we draw a line through the South and North poles and extend that line into space, it will eventually touch the North Star.

To locate a place's direction and location we use **cardinal points**: North, South, East, and West. Between the main cardinal points there are other intermediate points such as the Northeast, Northwest, Southeast, and Southwest.

We can find the cardinal points when we place our right hand toward the rising sun at dawn; that would be the East. The West would be to our left, the South would be to our backs, and the North in front of us. The *rosette* is a graphic means of representing cardinal points, which serves to orient us on a map.

There is a great variety of landscapes on the Earth. Geography studies each of these landscapes; in order to do this, it requires methods to locate each of them on the planet.

A set of imaginary lines has been created to accurately locate any place in the world. These lines are called **parallels** and **meridians**. They are imaginary lines because they do not exist physically.

The set of parallels and meridians with their corresponding **latitudes** and **longitudes** are called **geographic coordinates**.

Vertical lines that run north to south are longitude lines, or meridians. These longitude lines come together at the North and South Poles, and the distance between them is greater at the Equator. The "main meridian" is 0° longitude, and is called Greenwich Meridian or Prime Meridian. It divides the Earth in half into East and West. West longitude is found to the left of the Prime Meridian; East longitude is found to the right of the Prime Meridian. Horizontal north/south latitude lines circle the Earth and are parallel to the Equator, the largest circumference. The remaining latitude lines become smaller as they approach the poles. The Equator is the latitude parallel that divides the Earth into a northern hemisphere and a southern hemisphere. To the north of the Equator, these parallel lines are called "north latitude." Parallel lines south of

- We develop a sense of place when we learn about our region.

Objectives

Students will:

- Locate the place where they live in San Diego County and/or the Baja California peninsula using geographical coordinates.
- Locate specific sites using cardinal points.
- Develop a sense of place that will foster a desire to take care of their region and conserve it.
- Locate specific sites they will visit on their field trips.

Time

Preparation time:

- 30 minutes

Activity time:

- 60 minutes

Materials

For the whole class:

- A world map or globe.

For each team or each individual:

- A map of the City of San Diego and the Baja California Peninsula with geographical coordinates and various cities located on the map.
- Compass
- Graph paper
- Pencil
- Ruler

Optional:

- A map of the city where you are teaching the curriculum.

the Equator refer to "south latitude." Thus, latitude indicates the distance to the north or south of the Equator. Any point on the Earth can be identified by using this system of longitude and latitude coordinates.

Due to its geographical location, the region where we live is one of the most important areas in terms of natural riches. Its climate, landscapes, flora and fauna, ecosystems, natural protected areas, and its people and culture make this a unique area in the world.

When we locate our area within the world, we can see that we share the same or similar characteristics with other countries. However, we consider our region unique because it is our own region; we live here, we grow and mature here, and we are proud to be a part of it, of belonging to this unique site located on our planet.

The geographic location of our region throughout geological history has given rise to a multitude of factors that make it unique and have given it worldwide importance. The way in which its very important flora and fauna have adapted to their typical landscape is a clear example of this.

When we study our region we develop our sense of place. As we learn about it, we will become more aware of what an honor it is to live here, how proud we should feel, and how grateful we should be, as well as how important it is to be able to get to know, love, guard, and protect this bioregion we inhabit.

Procedure

1. While engaging in this activity, students can work by themselves or in pairs.

2. Locate Mexico on a world map or world globe, then locate the Baja California peninsula; last, locate your city.

3. Discuss cardinal points and the use of the compass rosette to orient you on a map.

4. Talk to your students about the concepts of longitude and latitude and how the geographical coordinates system is an important resource to locate specific places on the planet.

5. Next, hand each student a map of the Baja California peninsula so they can find and record the Baja California coordinates (North latitude—32° 43′ to the north, 28 °00′ to the south; West longitude—112° 47′ to the east, 117° 07′ to the west) and/or hand out a map of San Diego County so they can do the same (W117o36′—W116 o 04′/N33 o 31′—N32 o 32′).

6. Next, ask students to locate the sites identified with coordinates 31°N, 114°52′ (San Felipe) and 32°42′54″N, 117°09′45″ (San Diego), and record the names of both places.

Vocabulary
Geographical Coordinates
Latitude
Longitude
Meridians
Parallels
Cardinal Points
Compass rosette or Compass card

Preparation
1. Make copies of maps.

Description
In this activity, students will work with various maps to orient themselves in space, going from the general to the specific. Among other things, this activity fosters in students a sense of belonging to their region, encouraging them to be good stewards.

7. Select two different locations in San Diego County and/or Baja California and have students determine and record their coordinates.

8. Hand out a map of San Diego County and/or the state of Baja California so that students can locate various sites, utilizing cardinal points (North, South, East, West and intermediate points) as a means of orienting themselves on the map. Use the compass rosette.

9. As an optional activity, give a simple map of their city to each student (any town in San Diego County and/or Baja California) where you are teaching the curriculum will serve; for instance, a map of Mexicali, Tijuana, Ensenada, Tecate, Bahía de los Angeles, San Diego, Imperial Beach, Chula Vista, etc.) so students can locate the sites they will visit on their field trip.

Reflection
To promote a sense of place in your students; encourage locating their home on a map of their city.

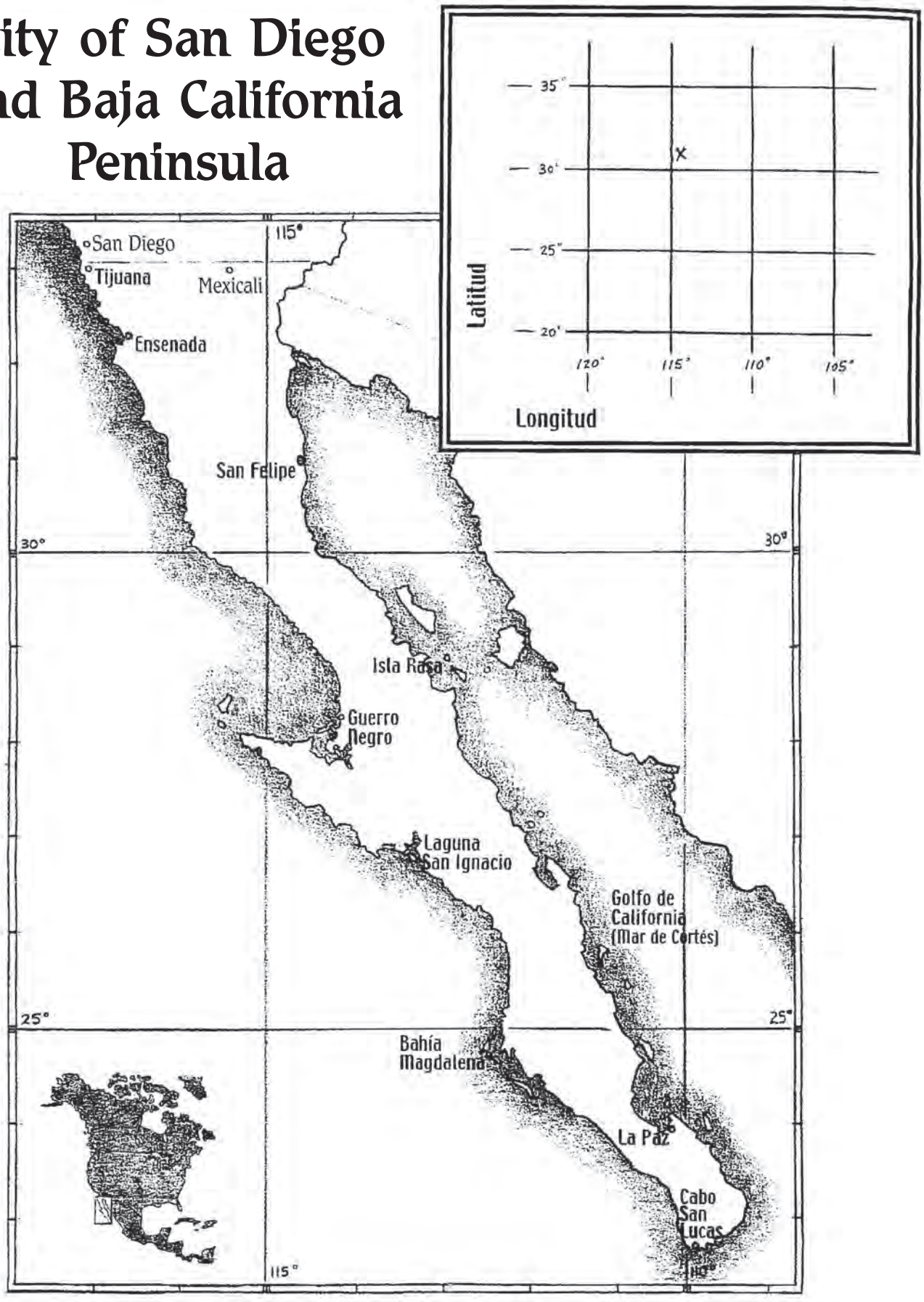
Ask the students the following questions: On your map, where is your school located? Where is your community located? What about your home? If they don't know, ask them to do some research. You can get a map of your city and do the research with the whole class if you wish. Otherwise, tell the students they can find information in the library or on the Internet: http://maps.google.com/; http://www.mapquest.com; http://www.sandag.cog.ca.us/ (maps and GIS).

Evaluation
1. Take your students to the schoolyard; first identify cardinal points without a compass, then with a compass.

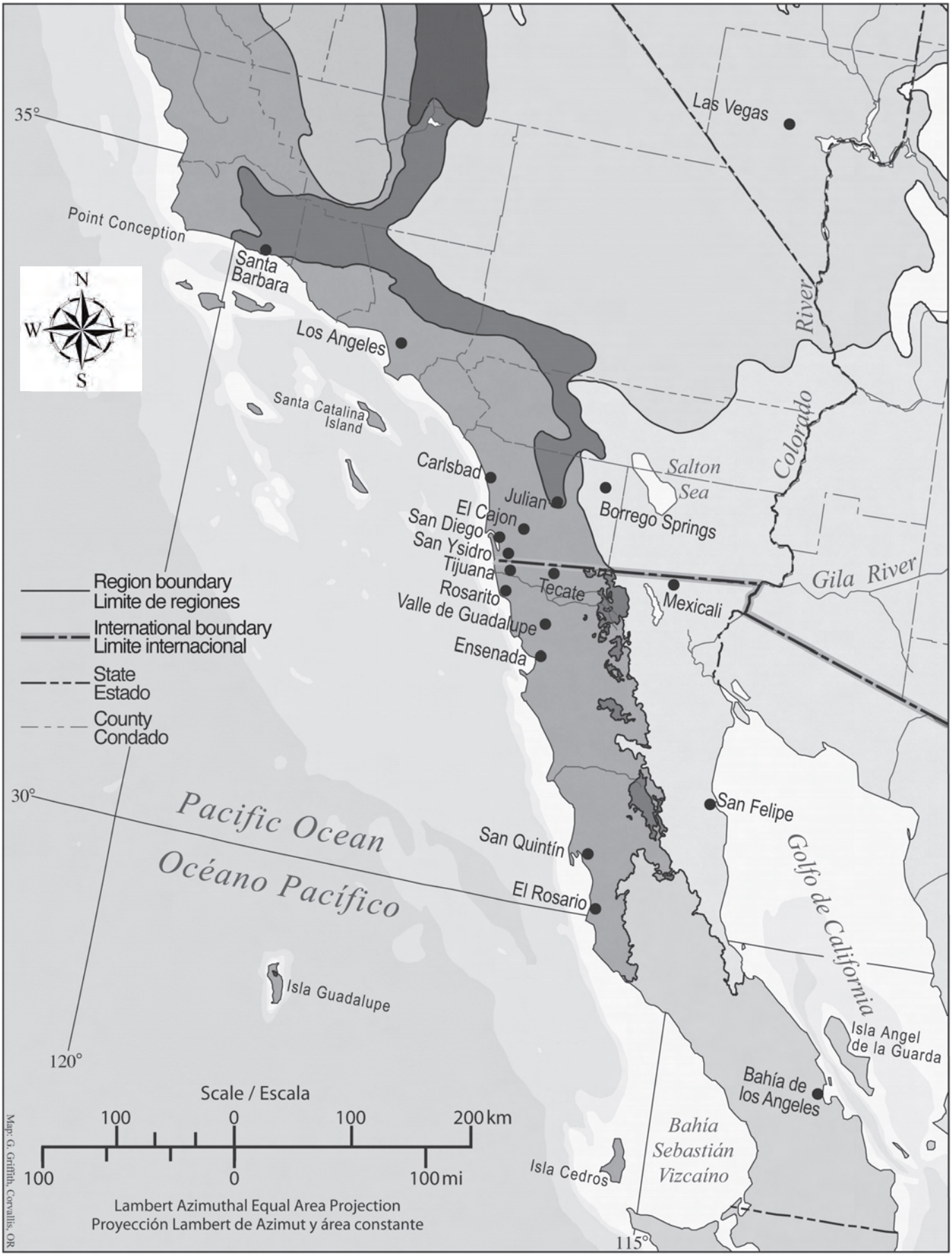
2. Encourage students to locate different places or buildings within the school grounds.

3. Ask students to trace a graph on graph paper and mark latitude on the vertical axis and longitude on the horizontal axis. Tell them they will mark with a dot and name the two places they located during the activity. Next, encourage students to answer the following questions: Is the second place located North, South, East or West of the first location? How many degrees North or South? How many degrees East or West?

City of San Diego and Baja California Peninsula

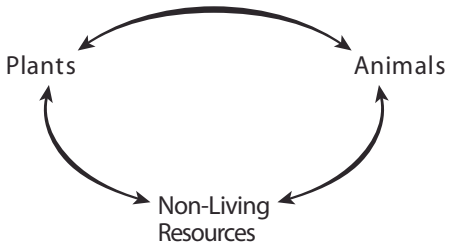


Map of our Bioregion



Activity 2: What is an Ecosystem?

THE ECOSYSTEM



Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Science
- Biology
- English

Skills
- Observing
- Describing
- Comparing
- Analyzing
- Communicating
- Predicting

Concepts
- An ecosystem is a community of plants and animals interacting with one another and with their physical environment.
- Some ecosystems are healthy, others are not.
- Feedback loops continually produce change within ecosystems.

Objectives
Students will:
- Identify the factors of an ecosystem and describe their interactions.

Background
Ecology is the science that deals with the interactions between living organisms and their environment. The unit of study of ecology is the ecosystem. An **ecosystem** is a community of animals and plants interacting with one another and with their physical environment. A **system** is a group of things that work together as a unified whole. In systems, parts and wholes continually interact with and influence each other through **feedback loops**. In the simplified diagram in the upper side bar, the double pointed arrows indicate the continuous feedback between all components in the system.

Feedback is the consequence that results from an action. It can be positive or negative. **Negative feedback** sounds like a bad thing, but it means an action that acts like the gears or brakes on your bicycle. When going downhill you shift to a lower gear or apply enough brake pressure to maintain control. That negative feedback keeps you at the speed you want to go. If your brakes failed, you would build up speed, finally going so fast that you would lose control and crash. That's **positive feedback**. It keeps adding (no brakes) creating uncontrollable situations.

Examples of positive and negative feedback
- The coyote, as a predator, provides negative feedback to rodent populations that could (and do) reproduce beyond the carrying capacity of their habitat.

- In Yellowstone National Park elk populations grew beyond the carrying capacity of the landscape because their main predator, the wolf, was extinct in the area (positive feedback). Because of public pressure, park rangers provided food to the elk, allowing otherwise unhealthy elk to survive. After the reintroduction of wolves to Yellowstone, the elk populations decreased over the years (negative feedback), and the vegetation the elk browsed near streams and rivers recovered. This plant recovery improved water quality and prevented erosion. With smaller elk populations it is not necessary for humans to supplement the elks' food during the long winter. The carrying capacity of the land, through the negative feedback of wolf predation, is returning to sustainability.

Feedback takes place within ecosystem **structure** and **function**. In the following discussion, the *Ecosystem Map (EcoMap)* and key, vocabulary words are in bold.

Ecosystem interaction and energy flow
Interaction is the flow of energy through the system. The flow begins when plants harvest and transform the sun's energy into plant food through photosynthesis. Energy is then passed on to animals through food webs

- Predict what changes may occur in an ecosystem as a result of human interactions.

Vocabulary

Abiotic
Adaptation
Biotic
Cycle
Climate
Community
Ecology
Ecosystem
Feedback
Food web
Habitat
Limiting factors
Niche
Population

Time

Preparation time:
- 90 minutes

Activity time:
- 3 activities of 45 minutes each, or longer if necessary

Materials

For the entire group:
- *EcoMap*, classroom size, provided with teacher workshop.
- Cards with the *EcoMap* words: Biotic and abiotic, Level 2.a, 2.b, 3.a, 3.b, and final words
- Sheets with characteristics of living things and their definitions

For each student:
- Copies of the *Student Guide: Our Natural Heritage, Bioregional Pride (Student Guide)*
- Copies of *The Ecosystem*, a simplified ecosystem diagram (*Ecosystem*), 2 per student

starting with the herbivores that eat plants. Energy is passed on again when carnivores eat the herbivores. When the animals either defecate or die their mineral nutrients cycle back into the reservoir of non-living resources by the action of bacteria, nematodes, fungi, and other such organisms. The interactions at all levels continually cycle the nutrients through the system.

Ecosystem Structure

The structure of an ecosystem consists of the **abiotic** (non-living) factors that support all life. If the structure changes, so do the conditions for life. Generally, structural factors are non-living, but occasionally they can be living, such as trees in a forest. The living trees serve as the structure in which the forest animals and plants live and interact.

Abiotic Factors (non-living)
- include water, minerals, sunlight, air, and soil;
- provide the conditions and as well as the limits for life;
- can be changed by their duration, intensity, quality and quantity; and
- can set the limits for organisms to live in an environment.

Energy
- **Solar Energy** is any form of energy radiated by the sun. Energy enters the ecosystem as sunlight, is transferred by producers (green plants) into chemical energy through photosynthesis and then from organism to organism through food webs.

- **Geothermal Energy** comes from deep inside the Earth. Geothermal energy can come from steam, from hot water, or directly from hot rocks that may be found close to the surface or several kilometers below. Technological innovations allow us to harvest this energy for human needs. The Cerro Prieto Geothermal Fields are located along the Cerro Prieto fault in Mexicali.

  The Imperial Valley is one of 14 areas in California where geothermal energy is used to make electricity. It is "green" energy because no greenhouse gases are released in the process. The Imperial Valley Geothermal Area consists of 10 generating plants with the combined capacity of 327 new megawatts.

Climate

The average weather pattern of a region including **temperature**, **precipitation** and **wind**. Seasonal variations are important. Differences in climate from place to place determine the living conditions. Climate is a key driver of changes in ecosystems.

- Copies of the Level 2 *EcoMap*, 2 per student

Preparation

Read the Background Information.

Part A

1. Make copies of *The Ecosystem* diagram
2. Make copies of the characteristics of living things.

Parts B and C

1. Cut apart and organize the *EcoMap* words according to their levels.
2. Make extra copies of the Level 2 *EcoMap*

Description

Using the graphic organizer, activities and student activity sheets, students will understand what the factors of an ecosystem are and how they interact through feedback loops.

- **Relative Humidity** is the measure of how much water vapor is in the air compared to the amount that will saturate the air. At saturation the vapor condenses into a liquid.

  In the mid-western states in the United States or on the eastern side of the Baja California peninsula during the summer, a temperature of 96 degrees F. (36 degrees C.) may hold nearly that same percent of water vapor. "It's not the heat, it's the humidity" is the reason people complain— there is so much water vapor in the air that sweat cannot evaporate, thus lowering the body's temperature.

  In deserts a temperature near or passing 100 degrees F. (38 degrees C.) can be accompanied by less than 30% humidity, allowing sweat to evaporate immediately, thus cooling the body. It works so fast you may not even know you are sweating. Swamp coolers that work by blowing air over water work perfectly to cool the air inside buildings. They are machines that sweat.

- **Wind-flow Patterns**
  Generally, the wind passing over the mountains flows from west to east. It travels from the ocean along the coastal plain and up and over the mountains. As it moves down the mountain slopes, it heats up and dries out. This is one of the factors that leads to the temperature extremes and dry desert climate of the Salton Basin (which extends from approximately Palm Springs, California, to the Colorado River Delta at the head of the Gulf of California) and the Sonoran desert.

  Wind controls **transpiration**, which is water loss from plants. It also controls **evaporation**, or water loss from the ground. **Evapotranspiration** refers to water loss from the ground up through the plant.

- **Floods**
  Deserts are famous for flash floods, which generally happen when summer storms release lots of water at one time. The storm water hits the rocky hillsides and runs off. The soils are too hard and dry to absorb the water. Under these conditions water rapidly gathers and "flashes" down from the mountains through arroyos and dry streambeds ending in the dry **playas**. Flash floods are very dangerous because they arrive with little warning, moving fast with great force and carrying lots of sediment, including large boulders.

  In contrast, many parts of Tijuana are vulnerable to flooding during winter storms. Due to urban growth there is a loss of vegetation, particularly on steep hillsides. The bare ground is hardened, causing rain to run off rather than penetrate the Earth. Occasional, but intense, rain causes flooding and severe damage.

- **Global Warming**
  The buildup of greenhouse gases, such as carbon dioxide (CO2), nitric oxide, and methane that trap heat in the atmosphere that would

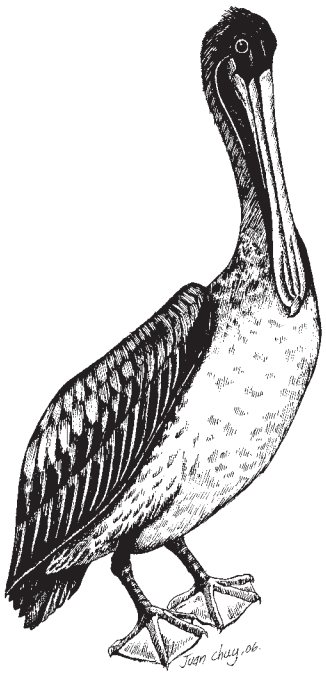
normally escape. Called "the greenhouse effect," this buildup raises temperatures and leads to global warming. The current rise in CO_2 emissions with increasing atmospheric temperature rise is an example of a positive feedback loop.

Fire

Fire is a natural and important part of the environment and occurs where there is 1) an accumulation of dry material to burn, 2) dry weather conditions to make the material flammable, 3) a source of ignition (lightening and humans). Fires help clear out dead leaves and branches and recycle nutrients. Certain biomes such as grasslands, savannas, chaparral, and some types of forests are adapted to periodic fires to maintain their structure. In these systems plant recovery is fairly rapid.

Ground or Substrate

Includes parent **rock**, **soil** type including texture, chemical composition, acidity, alkalinity (pH), **nutrients**, litter, and animal remains. Humus is the material in soil formed by the breakdown of plant and animal remains. It mixes with the bits of rock and adds nutrients to the soil and increases moisture retention. The type of rock determines its weathering capacity or its ability to breakdown into smaller pieces by natural processes such as rain, wind, plant roots, and temperature changes.



Geology

The science of studying the physical nature and history of the Earth. The study includes the structure and development of the Earth's crust, the composition of the interior, individual rock types, and the forms of life found as fossils.

- **Landforms** refer to topographic features on the Earth's surface such as mountains, basins, canyons, and **alluvial fans**. These features are caused by erosion, sedimentation, or movement (maybe all three over time).

- **Topography** refers to the Earth's surface and, on a local scale, considers the steepness of a slope, the evenness of the terrain, and whether the slopes are north or south facing. North slopes receive less sun and south slopes more sun during the day.

- **Faults** are breaks or cracks in the rocks of the Earth's crust along which movements take place. These cracks can be located along the boundary of tectonic plates. The San Andreas Fault Zone separates the North American Plate from the Pacific Plate. This fault begins on the eastern edge of the Salton Sea east of San Diego County and slips north.

- A **spreading center** is a divergent (moving apart) tectonic plate boundary where new seafloor is produced by emerging magma. The East Pacific Rise is a tectonic spreading center beginning in the Antarctic and continuing north. Its movement splits the Baja California peninsula from the mainland of Mexico, forming the Gulf of California.

Location
Describes the ecosystem's place on the planet. It includes its **longitude**, **latitude**, and **elevation**, which can determine the local climate. It can also define a **watershed**, which is the area from which water is drained, or the region that contributes water to a river or a river system.

Water
All living creatures require freshwater to live. Water, however, may not be available where it is needed or may be available only in a non-drinkable form. Water comes in three phases: **frozen**, **liquid**, or **vapor (steam)**. Water can be **fresh** or it can be **salty**. Water can be **contaminated** by pollutants and/or microbes, which can make the drinker ill. **Surface water** is above ground as in reservoirs, lakes, rivers, or ponds. **Groundwater** is stored in underground aquifers and pumped to the surface for use.

Cycles
A series of events that happen in the same order, over and over again.

- **Chemical** cycles. The cycles of elements that pass between the atmosphere and living things. There are two types of chemical cycles: gaseous and sedimentary. The main reservoir of nutrients for gaseous cycles is in the atmosphere and ocean. For sedimentary cycles, it is in the soil and rocks of the Earth's crust. Important cycles in nature are **carbon**, **nitrogen**, **oxygen**, **sulfur**, and **phosphorus**.

    - The **carbon** cycle provides an essential material for cells and helps to regulate atmospheric temperatures.
    - The **nitrogen** cycle provides an element needed for cells to build their proteins and genes.
    - **Oxygen** is contributed to the air through the respiration of green plants. Animals breathe in oxygen which is used in their bodies to burn food, which provides energy.
    - The **sulfur** cycle helps to regulate global temperatures (along with oxygen), in addition to providing an essential element in all living cells.
    - The **phosphorus** cycle provides material for cell membranes, genes, teeth and bones.

- **Life** cycles: The cycles of plants and animals as they are born, mature, reproduce, and die.

- **Time** cycles: The regular passages of time, on many scales, that affect life on Earth: daily (24 hours passing from night to day), seasonal, lunar, and more. Organisms can be adapted to particular parts of a cycle. For example owls hunt at night, and hawks hunt during the day.

- **Water** cycle: The water cycle is powered by the energy of the sun. Water is in continuous movement between Earth's surface and the air through the processes of evaporation, condensation, and precipitation.

Ecosystem Function

To function means that the system, organ or part of an animal or plant is working.

Biotic Factors (living)

- include all living organisms, from simple to complex and from producer to consumer;

- can be modified by the non-living factors such as weather, soil type, fire, or location; and

- affect co-actions (bio-interactions) ranging from complete cooperation and/or dependency to total antagonism and competition. An example of dependency is the adult monarch butterfly, which lays its eggs on milkweed plants. After hatching, the larvae feed exclusively on the milkweed. The plant is poisonous to most other insect and other grazers.

Habitat

A habitat includes the physical conditions of an area that supports the community of plants and animals adapted to those conditions. The physical conditions are the product of the regional climate and local weather that supply the temperature and moisture conditions of the habitat. The geologic processes, which operate over time, supply the habitat's landforms, topography, and soils. The biodiversity of the habitats within a region is determined by these and other abiotic factors (see *EcoMap*). Habitats are constantly changing and the living communities are continually adapting.

The area of the **habitat** that is most familiar and most frequently used by an animal is called the **home range**.

Niche

An ecological niche is the life style of an organism. It is the set of behaviors that it uses to obtain food, water, shelter, and a place to mate and raise its young. In other words, it is the manner in which the organism meets its biotic needs. A habitat is where a particular species lives; its niche is how it

lives. We could say that the habitat of a species is its address, and its niche is its job.

Adaptation
Adjustments to environmental stress. To increase their chances of survival, all living organisms are constantly adapting to changes in their environment. To be successful means an organism has offspring that have successfully produced offspring. The following is a list of the basic requirements for successful living (PASS) for any organism.

- **P**rotection against the elements and enemies
- **A**dequate nourishment. This refers back to the "**carrying capacity** of the ecosystem."
- **S**uitable place in which to live
- **S**uitable conditions for reproduction

The **carrying capacity** of an ecosystem is the maximum number of organism able to live on the resources available. Populations of organisms will tend to rise toward the carrying capacity and then readjust downward through feedbacks, such as disease, predation or starvation. Ecosystems, even small ones, are very complex with hundreds or thousands of species influencing each other's populations.

- **Behavioral Adaptations** Organisms can adjust to changing environmental conditions by adjusting their behavior. Animals learn. One population of woodpecker finches spends an estimated 10% of its time using twigs and cactus spines to pry insects and spiders out of tree holes. In Australia, 41 female dolphins, out of a population of several thousand, have been observed carrying sponges in their mouths to scrape away sand and frighten hiding fish. A dolphin will drop the sponge while eating the fish and pick it up again to continue foraging. Certain plants can adjust their leaf orientation by twisting the stem so that either the flat part or the edge of the leaf faces the sun. They can also change their size with leaves in the shade of other leaves growing larger. These adaptations allow the plant to acquire the right amount of sunlight for photosynthesis without losing moisture.

- **Species Adaptations** Individuals change genetically over time, allowing populations to live successfully in a new environment. For example, a landslide isolates a population of animals, providing new conditions for survival. Certain individuals already carry genes allowing adaptation to the new conditions. Over time, these individuals successfully have offspring that carry the genetic traits. As the population of successful individuals increases, they may become a new species. This is termed evolution by natural selection, and it is going on all the time. See **Populations** below.

Limiting Factors
If there is too much or too little of something, an animal or plant may not be able to live in a particular environment. Water is the limiting factor in the desert. Many plants and animals have adapted to living with very little water, and there is a lower limit beyond which they will die. In a salt marsh, salt or the degree of salinity, is the limiting factor. Plants there have adapted by secreting salt or by diluting it and storing it in their cells.

Sodium and potassium are salts necessary for metabolic activity:, in high concentrations they are toxic. Sea birds such as gulls, and desert reptiles like the desert iguana, have nasal glands that allow the animal to secrete ingested salt out of their body. Low nitrate levels in desert soils can limit plant growth. Refer to the **Cycles** section for the role of nitrogen and phosphorus in cellular metabolism.

Population
A population is the collection of individuals of one species in the same place at the same time. An individual has the genes of its parents that carry the specific adaptations that allow it to survive. Populations share a common gene pool. As an evolutionary unit they can adapt to specific environmental conditions over generations. See **Species Adaptation** above.

Life is never lived as single individuals. Individuals always reproduce to form populations large and small. Population numbers tend to expand as they take advantage of the available resources. Population numbers rarely reach the **carrying capacity** of the environment. The environment limits populations in several ways through the following **feedback loops**:

- Predation by other species
- Territoriality—for example, a male bird claims exclusive rights to an area and drives others away
- Elimination of rival offspring (a male lion or grizzly bear will kill the offspring of rival males)
- Competition between individuals for food in limited supply
- Dispersion—animals can move nesting places to a new area or adjust their feeding areas

If these methods don't work, then conditions will get worse. Disease and death rates, especially for the young, old, and weak individuals will increase. Birthrates will decrease. All these factors will lead to a decline in the population (negative feedback).

Communities
Communities in nature are all the interacting populations of species in a local area. Communities of plants and animals live in habitats. Community members will change as habitat conditions change. For example, narrow canyons may contain more water to support trees than an alluvial fan, which supports shrubs. In general, communities are named after the dominant plant or plant association but still include all the animals that are supported by the vegetation. For example, coastal sage scrub is an asso-

ciation of aromatic plants found from the Pacific coast to the foothills up to 1,500 feet.

Food Webs
Describe the complex relationships between the **primary producers** (plants), the animals that are eating the plants (**herbivores**), and the animals that are eating the animals that eat the plants (**carnivores**). **Consumer** refers to both herbivores and carnivores. Some animals, called **omnivores**, are both. For example, coyotes never miss an opportunity; they will eat anything including insects, small birds, rodents, reptiles, and domestic cats that stray from home.

Food Pyramid
A picture of the numbers. Consumers—humans, mountain lions, woodpeckers or mice—are the most visible animals on this planet. But ALL the consumers are no match in numbers and weight for the billions of leaves on plants and blades of grass required to nourish the animals. Second in weight is the clean-up crew, the largely unseen trillions of recycling microbes that process our dung and our dead. A food pyramid—with all the producers at the bottom, supporting the grazers in the middle, and their few predators at the top—is a picture of the numbers.

Producers
All food webs depend on the only truly **producing** organisms—photosynthetic plants, bacteria, and algae. Scientists call this primary productivity. They measure this productivity based on the leaf area available to catch the sun's energy. The unit of measurement is called the Leaf Area Index (LAI). In the shrubby areas of the Sonoran Desert the LAI is 1. In the tropical rain forests it is 11, and it is 4 in a cornfield.

Consumers
Include most animals and some carnivorous or parasitic plants that feed on the producers or on each other. They also include most bacteria and other single-celled organisms that live in the water or in the intestines of animals. For example, special bacteria in the intestines of termites digest the wood consumed by the termites. Consumers include insects like dung beetles that feed on the indigestible droppings of animals like cows, horses, and elephants. When cattle were brought to Australia there were no native dung beetles to decompose the cow pies, so they just piled up creating a carpet that prevented other plants and animals from living (positive feedback). This created a problem until dung beetles were imported and did their job of breaking up the cow pies and recycling the nutrients (negative feedback).

Decomposers
Are mainly bacteria and fungi that eat dead organisms and animal waste, returning their nutrient components to the chemical cycles.

Nature's Services
The health and wellbeing of human populations depends upon the services provided by ecosystems and their components—organisms, soil, water, and nutrients.

Natural ecosystems perform services upon which we are dependent. For example, they:

- provide us with clean water and air
- pollinate our crops and disperse seeds
- protect us from extreme weather and ultraviolet light
- control pests and disease-carrying organisms

Many important agricultural crops depend on bees to pollinate the flowers so that fruits will develop. Moving through clean soils purifies water, and plants contain natural pesticides.

Procedure

Introduction

This activity is divided into three parts. The lessons will require differing lengths of time, depending on the grade level and background of your students. It is important to maintain continuity. Therefore, we suggest that students engage in the activities three or more times per week for whatever length of time it takes to finish the activity in all its parts.

Activity: Part A What is an Ecosystem?

Part A serves as an introductory activity that is very simple. Nevertheless, we recommend that you carry it out even with groups at higher levels, since it provides a framework for the complete *EcoMap*. A thorough understanding of the simplified diagram of the ecosystem and the concepts of living (biotic) and non-living (abiotic) will facilitate student learning in the *EcoMap* activities.

1. Ask students what an ecosystem is. Note their answers on the board. Using the background information, help them to arrive at a simple, beginning definition of an ecosystem: "An ecosystem is a community of animals and plants interacting with one another and with their physical environment." Draw the simplified ecosystem diagram on the board. Point out that in this diagram, the double pointed arrows indicate the continuous feedback between all components in the systems.

2. Next, ask students to name some living and non-living things. If they have difficulty arriving at a correct scientific distinction between living and non-living, use the material provided at the end of this activity to carry out the following:

   Cut into strips the characteristics of living organisms and their corresponding definitions. Distribute the seven labels of characteristics to

seven students. Then distribute the definitions of the characteristics to the remainder of the class. You will need duplicate definitions in order to provide either a definition or a label to each student. Next, ask students to walk around the room and find the students who have the definition or label that corresponds to the one they have. For example, in a class of 30 students, seven students will have labels of the characteristics, and 23 students will have definitions: three sets of each definition, with an additional two definitions. When students have formed groups consisting of the labels and their definitions, have them sit down (not necessarily in their own seats). Tell students in advance how many members each group will have. In the above example, students will form groups of four or five. When all students are seated, ask students from each group to read the group's characteristic and corresponding definition. Ask the class if they are in agreement that the definition is correct. Continue the discussion until the group has a thorough understanding of the scientific definitions of living and non-living.

3. Next, distribute Activity Sheet 1, *The Ecosystem*, which is a simple diagram of the ecosystem. If possible, take the group outside. Instruct students to work in pairs to write under the words **plants, animals, and non-living resources** their observations of their immediate environment. (Note: although students work in pairs, each student should fill out his or her own activity sheet.) When they finish, hold a discussion about their answers.

4. For homework, distribute another copy of Activity Sheet 1, *The Ecosystem*, and direct students to fill it out according to observations they make in their neighborhood, their yard, or a vacant lot.

Activity: Part B

1. The next day, hold a class discussion based on the graphic organizers students bring to class. End the discussion by asking students if they think the ecosystem represented on their sheet is a healthy ecosystem. Why, or why not?

2. Next, show students the large *EcoMap* that you have mounted on the wall or the board. Point to the biotic and abiotic factors and inform students that they will complete the *EcoMap* with words that will help them to understand the concepts of an ecosystem in more detail.

3. Divide the students into 10 teams. Referring to the *EcoMap*, show students the spaces they will fill with the Level 2.a words. Distribute a copy of the *Student Guide*: Our Natural Heritage: Bioregional Pride (*Student Guide*) to each student and the Level 2.a *EcoMap* words, one to each team: **climate, fire, ground, geology, energy, geothermal energy, location, water, organisms,** and **adaptations**. Ask each team to come to agreement as to whether their factor is a biotic or an abiotic factor. Then have student teams prepare a short (1-minute) pre-

sentation about their factor based on the background information and choose a representative to share this with the class

4. Next, ask each group representative to place his or her Level 2.a word on the *EcoMap* simultaneously. When all the Level 2.a words are placed, ask the class if they agree with the placement of the words. Continue the discussion until all the words have been correctly placed. Emphasize that the sun's energy comes from outside the ecosystem using the following information:

   Energy is provided from the sun. When energy is transferred from one organism to another in the form of food a small part of that energy is stored as living tissue and the remainder is released back into the atmosphere as heat.

   Another source of energy, geothermal or heat energy, comes from deep inside the Earth. Geothermal energy can come from steam, from hot water, or directly from hot rocks that may be found close to the surface or several kilometers below. Technological innovations allow us to harvest this energy for human needs.

   During the 1970s, scientists discovered that the animals living near hydrothermal vents survive on bacteria that receive energy from chemicals from the lava. Hydrothermal vents are hot spots at the bottom of the ocean in spreading centers where lava comes to the surface.

   Finally, ask the representative of each group to share information about their Level 2 word with the class.

5. Continue by explaining to students that two of the factors on the *EcoMap* combine biotic and abiotic factors. They are **habitats** and **cycles** and they are already printed on the large *EcoMap* you have posted. Give students three minutes to refer to the *Student Guide*, and then discuss the definitions of each. Tell students that when they place more words on the *EcoMap*, they will see why habitats and cycles are related to both biotic and abiotic factors

6. Finally, place Level 2.b words **niche** and **limiting factors** on the *EcoMap*. Give student teams three minutes to hold a discussion about the meaning of each of these based on their *Student Guide*. Then ask the teams to share what they have learned.

   End the discussion by emphasizing that niches describe how the organism makes a living within its habitat. The limiting factors of a habitat set an organism's boundaries. For example, water is a limiting factor in

the desert. Plants and animals that require lots of water can not "make a living" in the desert unless they have a strategy. A cactus strategy is to conserve water within its cells. A rodent strategy is to dig a burrow and stay in it during the day and to extract water from the seeds it eats. Having a strategy does not mean the limiting factor goes away, it means you can live with it because you have adapted to it. This happens over time. See "Species Adaptation" under "Ecosystem Function" in the background information.

Activity: Part C

1. Refer to the ***EcoMap*** with the Level 2 words placed and review with students the biotic and abiotic factors, habitats and cycles.

2. Next, show students the Level 2.b words **chemical, life, time**, and **water**, and tell them that they are related to one of the words on the *EcoMap*. Ask them to refer to the *Student Guide* to discover information about these words. Then ask them which word on the *EcoMap* is the one these words relate to. Be sure that students understand that a **cycle** is a series of events that happen in the same order over and over.

   Now show students the next Level 3.a words and tell them they are related to one or another of the cycles. If necessary, give students more time to consult their *Student Guide*. Ask student volunteers to place each word. Ask the group if they agree with the placement and conduct a discussion until the words are correctly placed. The words are: **carbon, nitrogen, oxygen, sulfur, phosphorus, plant, animal, daily, seasonal**, and **lunar**.

3. Have the class work in their 10 teams, and distribute the Level 3.b words evenly among the teams. Tell students that the words they now have are related to one or another of the words already placed on the *EcoMap*. There may be more than one word related to each word on the map. Ask student teams to consult their *Student Guide* and decide where each of their words should be placed on the map. When they have decided, have each team send a representative to place the words. When all the words are placed, ask the entire group if they agree with the placements. Conduct a discussion until all the words have been correctly placed and understood.

4. Now show the entire class the last words, **hunting strategies, spines, succulence,** and **food webs**, and ask volunteers to place them. Refer to the *Student Guide* and be sure that students understand the difference between behavioral and species adaptations. Refer to the diagram on the next page.

5. Next, point to the Feedback Loop labels on the map. Ask students to consult their *Student Guide* and hold a discussion with the entire group about what a feedback loop is. Be sure to include plenty of examples.

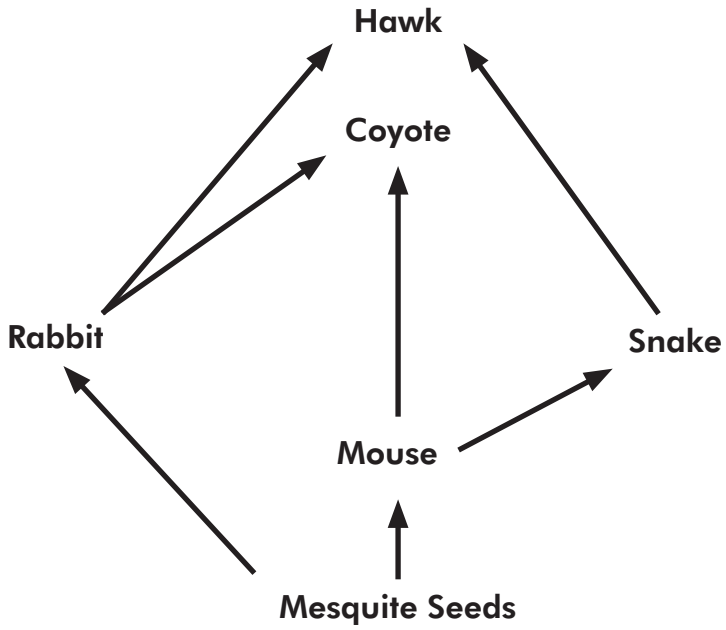
6. Finally, return to the initial question of the activity: What is an ecosystem? Guide a discussion so that students understand than an ecosystem is a set of biotic and abiotic factors and their interactions. Help them remember the definition of a system, which is the integration of components that function as a complete unit and that are related through feedback loops. Guide the discussion to a final definition of an ecosystem: *a system of live organisms and the medium through which they interchange matter and energy (they eat and are eaten). The medium is called the environment.*

There is another important aspect of ecosystems that has not been discussed, and this is a good time to mention it.

Ecosystems never stop; they are dynamic, always changing. The *EcoMap* is flat on a piece of white paper; there is no movement and there are no dimensions in the picture. This is exactly the opposite of a real ecosystem, which is always working in three-dimensional space* throughout time. If the ecosystem is not working, it is dead.

*The ability to see the world in three dimensions is called depth perception. For more see:
http://wikipedia.org/wiki/Three-dimensional_space

Desert Food Web



EcoMap Word Order Summary

	Word	Color/Level	Placement
1.	Climate, fire, ground, geology, energy, geothermal energy, location, water, organisms, adaptations	Green Level 2.a	Students
2.	Habitats, cycles, niche, limiting factors	Green Level 2.b	Teacher
3.	Chemical, life, time, water	Green Level 2.b	Teacher with students
4.	Carbon, nitrogen, oxygen, sulfur, phosphorous, plant, animal, daily, seasonal, lunar	Yellow Level 3.a	Teacher with students
5.	Kelp Forest; beach/tidepools; coastal sage scrub; succulent sage scrub; chaparral; pine/oak woodlands; desert; wetlands; riparian areas; weather; seasons; temperature variation; wind, floods; global warming; rock, sand, soil; nutrients; landforms, topography; faults; spreading center; longitude, latitude; elevation; watershed; frozen, liquid, vapor; fresh, salty; contaminated; groundwater; populations; communities, consumers, producers, decomposers, behavioral adaptations; species adaptations; salinity; water; potassium; nitrogen	Yellow Level 3.b	Students
6.	Hunting strategies; spines, succulence; food webs	Peach Last words (a)	Students

Reflection Excercise

1. Humans are also part of the ecosystem. For simplicity, the *EcoMap* does not include the effects of human actions on the landscape. However, modern humans and their ancestors have been a part of the living landscape for millions of years. They are a natural part of the ecosystem and their effects are noticeable over time. These effects can be detrimental, beneficial, or neutral. Where would you put humans in the *EcoMap*? Think of an example of how humans have affected ecosystem structure and function. From your experience, think of how a human action has become part of a feedback loop. Think of a situation where this feedback has been positive. Think of another situation where the feedback has been negative. Have students fill in the Level 2 *EcoMap* according to the changes they think might happen.

2. Feedback is described as the consequence that results from an action. Can you think of any activity that does not have a consequence? Now, think of an activity that had a consequence for you personally. Map the activity from the beginning through the consequence(s). How long before the consequence(s) were obvious?

Evaluation

Give students a copy of the Level 2 *EcoMap* and assign them to fill it in according to an area they visit, with special attention to changes introduced to the "original" ecosystem. The next day, hold a discussion about what students discovered. Did they notice changes introduced by humans? What were the effects of the changes?

Feeding
Respiration
Growth
Reproduction
Movement
Excretion
Sensitivity

All living organisms need to take substances from their environment to obtain energy, to grow and to stay healthy.
All living organisms show _____ of one kind or another. All living organisms have internal _____, which means that they have the ability to _____substances from one part of their body to another. Some living organisms show external _____ _____as well — they can move from place to place by walking, flying or swimming.
All living things exchange gases with their environment. Animals take in oxygen and breathe out carbon dioxide.
_____ is the removal of waste from the body. If this waste were allowed to remain in the body it would be poisonous. Humans produce a liquid waste called urine. We also _____ waste when we breathe out. All living things need to remove waste from their bodies.
When living things feed, they gain energy. Some of this energy is used in _____. Living things become larger and more complicated as they _____.
Living things react to changes around them. We react to touch, light, heat, cold and sound, as do other living things.
All living things produce young. Humans make babies, cats produce kittens and pigeons lay eggs. Plants also _____. Many plants produce seeds that can germinate and grow into new plants.

Based on: **http://www.saburchill.com/chapters/chap0001.html**

Climate

- Temperature,
- moisture,
- daily and seasonal changes
  (not the average, but extremes),
- solar energy,
- wind.

Ground

<u>The substrate or soil:</u>

- original rock,
- type and texture of soil,
- chemical composition,
- nutrients and acidity or alkalinity of the soil,
- erosion,
- the soil's ability to retain moisture,
- rubbish.

Location

Latitude/longitude and altitude:

- all help determine local climate.

Topography:

- the slope, the uniformity of the terrain and north/south exposure to the sun.

Limiting Factors

- Physical and chemical factors that limit or prevent an organism from thriving in a specific location.

Feedback

- The consequence that results from an action.

Biotic

- Refers to a living organism or any natural material that originated from a living organism.

Adaptation

- A characteristic that allows an organism to survive in its environment.

Cycle

- A series of events that are repeated regularly in the same order.

Habitat

- A place where organisms can satisfy their biotic needs to survive. Provides food, water, shelter and a place to raise young.

Abiotic

- Refers to non-living chemical and physical factors in the environment.

Niche

- The role that a species plays within the ecosystem.

Weather

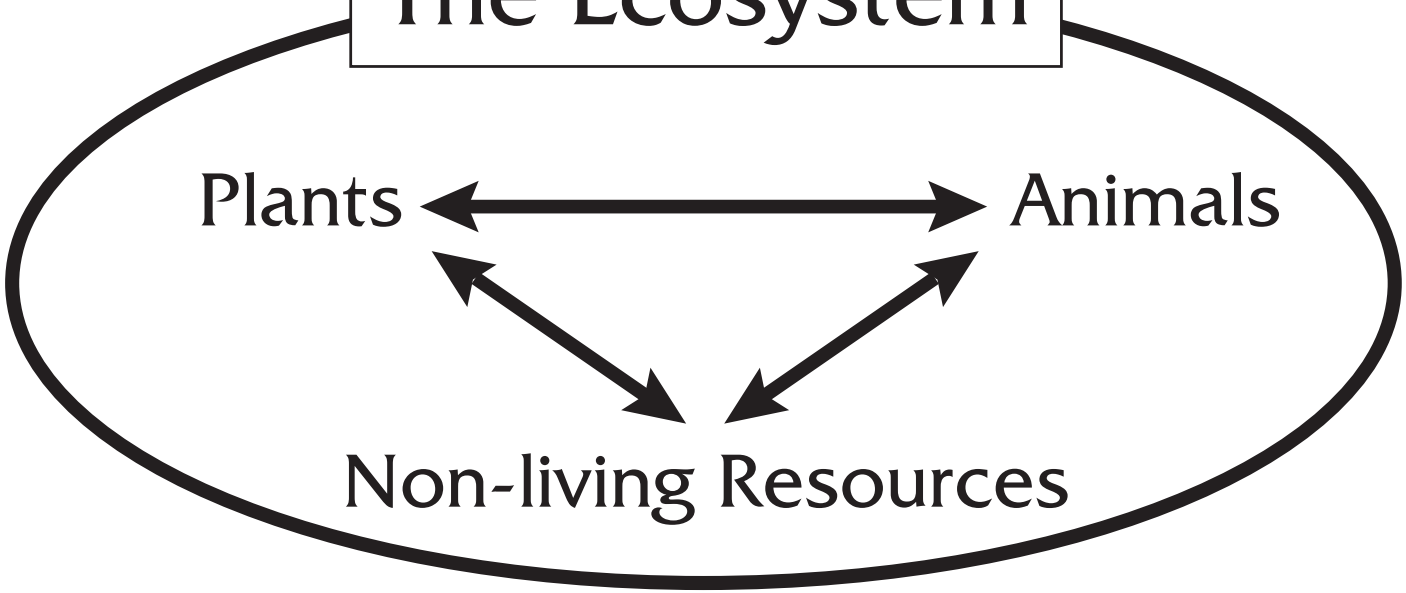
- The atmospheric state of a single day.

Time

- Related to astronomical cycles.

Name _____ Date _____

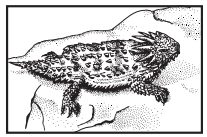
The Ecosystem

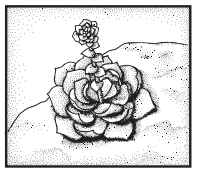


Plants	Non-living Resources	Animals

Name _____ Date _____

The EcoMap





STRUCTURE
Abiotic

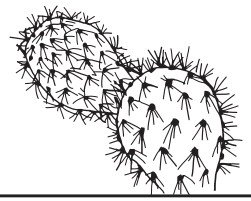
Habitats

Feedback Loop

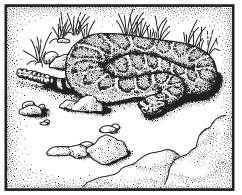
Feedback Loop

Cycles

FUNCTION
Biotic

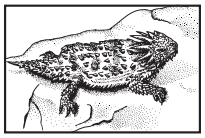


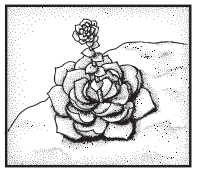
EcoMap: Level One



Name _____ Date _____

The EcoMap





Ground

Geology

Energy

Geothermal Energy

Location

Fire

Climate

Water

STRUCTURE
Abiotic

Feedback Loop

Feedback Loop

FUNCTION
Biotic

Habitats

Cycles

Chemical

Life

Time

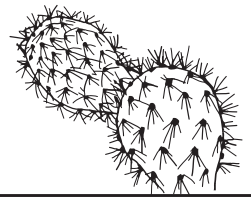
Water

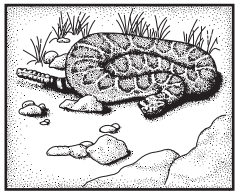
Niche

Limiting Factors
(Non-living)

Adaptations

Organisms

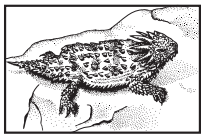




EcoMap: Level Two

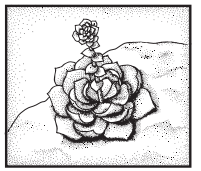
Name _____ Date _____

The EcoMap



- Landform, Topography
- Faults
- Spreading Center

- Longitude, Latitude
- Elevation
- Watershed



- Rock, Sand, Soil
- Nutrients

- Frozen, Liquid, Vapor
- Fresh, Salty
- Contaminated
- Groundwater

- Weather
- Seasons
- Temp. Variation
- Wind, Floods
- Global Warming

Ground

Geothermal Energy

Energy

Geology

Location

Fire

Climate

Water

- Kelp Forest
- Beach/Tidepools
- Coastal Sage Scrub
- Succulent Sage Scrub
- Chaparral
- Pine/Oak Woodlands
- Desert
- Wetlands
- Riparian Areas

STRUCTURE
Abiotic

Feedback Loop

Feedback Loop

FUNCTION
Biotic

Habitats

Cycles

- Chemical
  - Carbon
  - Nitrogen
  - Oxygen
  - Sulfur
  - Phosphorus
- Life
  - Plant
  - Animal
- Time
  - Daily
  - Seasonal
  - Lunar
- Water

Niche

Limiting Factors
(Non-living)

- Salinity
- Water
- Potassium
- Nitrogen

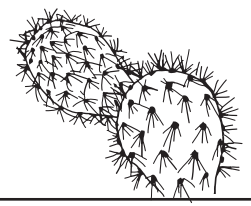
Adaptations

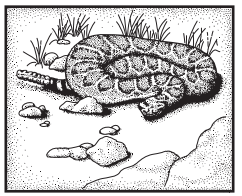
- Behavioral Adaptations
- *Hunting Strategies*
- Species Adaptations
- *Spines, Succulence*

Organisms
- Populations
- Communities

- Consumers
- Producers
- Decomposers

Food webs





EcoMap: Level Three

Climate

Fire

Ground

Geology

Energy

Geothermal Energy

Location

Water

Organisms

Adaptations

Niche

Limiting Factors

(Non-living)

Chemical

Life

Time

Water

Carbon

Nitrogen

Oxygen

Sulfur

Plant

Animal

Daily

Seasonal

Phosphorus

Lunar

Rock, Sand, Soil

Nutrients

Weather

Temperature Variation

Kelp Forest

Beach/Tidepools

Coastal Sage Scrub

Succulent Sage Scrub

Wetlands

Wind, Floods

Global Warming

Water

Behavioral Adaptations

Species Adaptations

Producers

Consumers

Decomposers

Longitude, Latitude

Fresh, Salty

Frozen, Liquid, Vapor

Elevation

Seasons

Landforms, Topography

Faults

Spreading Center

Watershed

Contaminated

Groundwater

Populations

Communities

Salinity

Potassium

Nitrogen

Chaparral

Pine/Oak Woodlands

Desert

Riparian Areas

Hunting Strategies

Spines, Succulence

Food Webs

Activity 3: Ecological Regions and Their Principal Ecosystems

Introduction

An ecological region, also called an ecoregion, is a relatively large geographic area that can be distinguished by the unique character of its morphology, geology, climate, soils, hydrology, and its flora and fauna.

The World Wildlife Fund defines an ecoregion as a "large area of land or water that contains a geographically distinct assemblage of natural communities that share a large majority of their species and ecological dynamics, share similar environmental conditions, and interact ecologically in ways that are critical for their long-term survival."

The use of the term *ecological region* is a result of a wave of interest in ecosystems and their function. People are becoming particularly aware of scale in landscape study and conservation. It is now widely recognized that interconnected ecosystems combine to form a whole that is greater than the sum of its parts. Several attempts have been made to respond to ecosystems in an integrated manner in order to obtain "multifunctional" landscapes. From agricultural researchers to ecologists, all use ecological regions as a unit of study.

The area included in *Our Natural Heritage, Bioregional Pride* extends from San Diego County in the north to El Rosario, Baja California in the South. Within this area we present four ecological regions: Marine, Mediterranean, Montane, and Desert. Each ecological region is composed of one or more vegetation communities. We refer to these communities as ecosystems, taking into account not only their vegetation, but all living and non-living components and the relationships that exist between them. The ecological regions and their corresponding ecosystems that are studied in the curriculum are:

A. Marine Region
1) Kelp Forest
2) Coastal Area (Beaches/Tidepools)
3) Gulf of California

B. Mediterranean Region
4) Coastal Sage Scrub
5) Succulent Sage Scrub
6) Chaparral

C. Montane Region
7) Pine/Oak Woodlands

D. Desert Region
8) Sonoran and Central Deserts

E. Ecosystems Independent of the Type of Ecological Region
9) Wetlands
10) Riparian Areas

These ecological regions can be located in the map following this introduction. A map of the ecosystems pertaining to the ecological regions of San Diego County and Baja California can be found on the page after the map of the general ecological regions.

California Floristic Province

The San Diego-Tijuana-Tecate binational region is located within the California Floristic Province, world renowned for its diversity and high level of endemism (endemic species exist only in a specific place). It includes 70% of California, and extends to the southwestern tip of Oregon and slightly into western Nevada in the United States. In Baja California, the Province includes the forests and chaparral in the Juárez and San Pedro Mártir Sierras (excluding their desert slopes to the east), the coastal areas to the south down to El Socorro, just north of El Rosario, and Guadalupe Island.

The climate in the California Floristic Province is known as a Mediterranean climate; it is characterized by mild and moderately humid winters alternating with hot and dry summers. Fog constitutes an important climatic factor affecting the biological development of the region's organisms. Annual species generally bloom in the late winter and spring, although it is possible to find many of them in bloom during the cooler, wet months. Vegetation communities present in this region are: wetlands, dunes, coastal sage scrub, chaparral, and pine forests. Except for the desert ecological region, all other land ecological regions in Baja California are located within the California Floristic Province.

The California Floristic Province is one of the most important regions for biodiversity. It contains a high diversity of flora and fauna species, and a considerable amount of threatened and endemic species. Of almost 3,500 species of existing vascular plants, more than 2,120 (61%) cannot be found anywhere else in the world. The California Floristic Province represents only 17% of the Baja California peninsula, but almost half of all plant species (44%) is found here. Around 1,323 native plants, 902 of which are not found anywhere else in the Baja California peninsula, are catalogued in the Province.

Biodiversity Hotspot

This important region is part of a set of worldwide biodiversity conservation hotspots. The California Floristic Province is one of five biodiversity hotspots with a Mediterranean climate. According to Conservation International, these places called "Biodiversity Hotspots" fill two basic criteria: a certain level of plant endemism, and a certain level of threat for the region. These hotspots have already lost at least 70% of their original vegetation. The deterioration of the California Floristic Province is due mainly to commercial agriculture, which has devastated a large area, transforming it into agricultural land (almost half of all the U.S. agricultural production is generated here). Numbers show that only approximately a fourth of all original vegetation is conserved here, which not only means the imminent disappearance of some of the endemic plants, but also the fragmentation and disappearance of the natural habitat of many species that become gradually more vulnerable as a result of this loss.

Generally speaking, the main problems each of the world hotspots face are habitat destruction and fragmentation, introduction of invasive species, direct human exploitation of flora and fauna (for industrial, pharmacological, and other purposes), illegal pet trade, climate change, and commercial deforestation.

This curriculum presents four ecological regions in our shared bioregion of San Diego County and the state of Baja California. Eight ecosystems within those ecoregions have been selected for study. Also included are wetlands and riparian areas, which exist independent of an ecoregion.

In this activity, students will learn more about the ecological regions of San Diego County and Baja California, as well as the characteristics of each of the ecosystems present in each one of these regions.

You will find background information for 10 ecosystems. Activities are included only for three of the ecosystems—beach, wetlands, and desert. Your students may engage in these activities after the corresponding background presentation to the class.

Procedure

1. Write the names of the four ecoregions on the board.

A. Marine Region

1) Kelp Forest
2) Coastal Area (Beaches/Tidepools)
3) Gulf of California

B. Mediterranean Region

4) Coastal Sage Scrub
5) Succulent Sage Scrub
6) Chaparral

C. Montane Region

7) Pine/Oak Woodlands

D. Desert Region

8) Sonoran and Central Deserts

E. Ecosystems Independent of the Type of Ecological Region

9) Wetlands
10) Riparian Areas

2. Tell your students that these are the ecological regions and their corresponding ecosystems that they will be learning about. Also tell them that they will go on a field trip to observe one or more of these ecosystems. Emphasize that this is the reason why it is important to learn the background information.

3. Divide the class into 10 teams and tell the students that each team will be assigned one of the ten ecosystems.

4. Number each ecosystem from 1–10 and hand each team a folded paper with a number corresponding to each ecosystem (one per team).

5. Once everyone knows which ecosystem each team has, instruct students to work on a presentation of the background information for their ecosystem based on the following directions and questions:

1) Locate your ecosystem on both the Ecological Regions map and the San Diego County/Baja California Ecosystems map. Both maps can be found in the booklet *Student Guide*: Our Natural Heritage, Bioregional Pride.
2) What are five main characteristics of your ecosystem?
3) What adaptations have the plants and animals in your ecosystem developed?
4) What are the conservation challenges that your ecosystem faces?
5) What conservation alternatives can be applied to your ecosystem?

6. Distribute *Student Guide*: *Our Natural Heritage, Bioregional Pride*, one copy for each student or pair of students.

7. Encourage students to develop visual presentations. Possibilities are posters, photographs, and images. Direct them to include a large *EcoMap* that visually represents the answers to the questions above. They can complete their *EcoMap* based on a healthy ecosystem, and later introduce the changes presented by the challenges their ecosystem faces.

   Before beginning, remind students that it is important that all teammates take part in the cooperative work to design, write, and present their presentation.

8. Inform your students that each team will present their work on the day designated to learn about that ecosystem. During their presentation to the class, direct students to pay attention to the presenters and take notes in order to ask pertinent questions at the end of each presentation. After each presentation all students will fill out a Level 2 *EcoMap* with the information they learned from the presenters.

9. Next, begin a discussion to review results and reinforce what was learned. Ask each team to post the visuals they created for their presentation on the wall so that everyone can refer to it as needed.

10. After the presentation, carry out the activity designed for the ecosystem you just studied with your class.

The *Field Guide*

After each team has had the opportunity to present its work, all students can assemble the related portion of the *Field Guide: Typical Flora and Fauna of the San Diego County/Baja California Region* (Field Guide). Under each ecosystem's background (and activity, if there is one) there is a list of organisms. Note that many of the species are found in more than one ecosystem. For example, the Common Raven is found in coastal sage scrub, chaparral, desert, and other ecosystems. Please also note that some of the animal species might have more than one common name.

1. Distribute copies of the *Field Guide* sheets, one for each pair of students. Copy the front and back of each page separately.

2. Have the students glue the *Field Guide* pages so that the front (illustration) is on one side of a piece of card stock and the back (text) is on the other. Have them cut out the pieces. Help younger students to align the front and back of each page so the cards are centered with the illustration on one side and the description on the other.

3. Next, have students punch a hole on the upper left corner of the cards with a hole-punch and tie all the cards with string or a binder ring.

4. Finally, students can carry out one of the following activities to familiarize themselves with the plants and animals they might see on their field trip.

Activity 1

a. The presenting team will state at least three characteristics, behaviors or details about a plant or animal featured in the *Field Guide*.

b. All teams will read the information referring to the organisms and will observe the illustrations. The first team to guess the correct organism gets a point. The winning team is the team that has the most points.

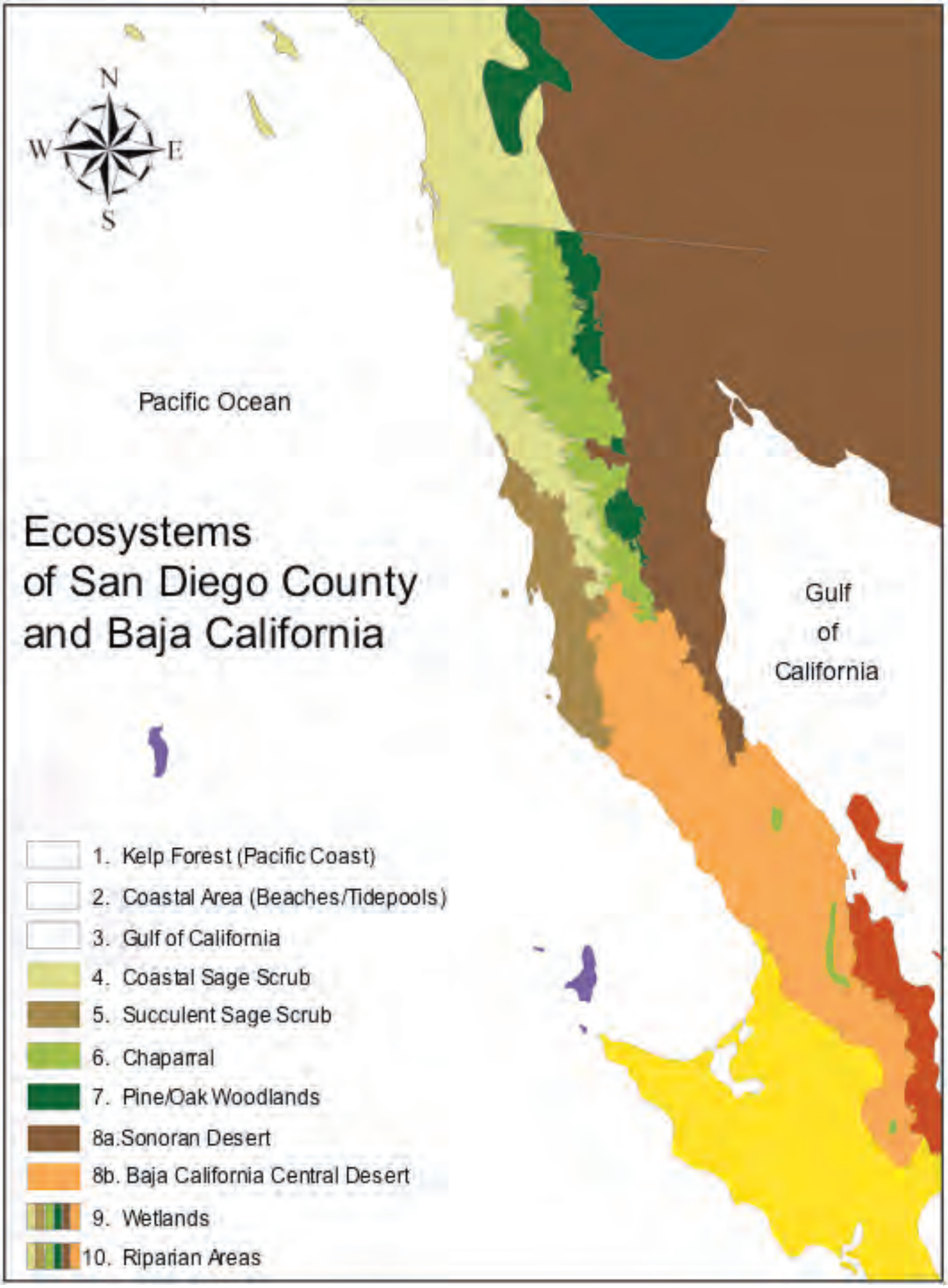
Activity 2

a. The presenting team selects an organism from the *Field Guide*. The remaining teams take turns asking the presenting team a "yes" or "no" question about the organisms. Each team can pose questions until they get a "no" answer.

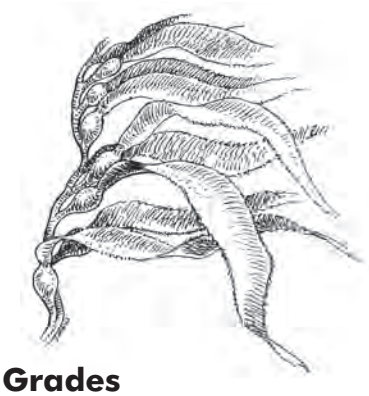
b. Then students from another team pose questions to the presenting team. The final question would be to ask the name of the organism. For example, "Is it a coyote?" The team that guesses correctly gets a point, and the team with the most points after all organisms have been named wins.

c. Direct students to keep their *Field Guide* in a safe place. They will be adding more organisms with each of the presentations of our region's ecosystems.


Ecological Regions
1. Marine Region
2. Mediterranean Region
3. Montane Region
4a. Desert Region (Sonoran Desert)
4b. Desert Region
(Baja California Central Desert)
35°
30°
120°
115°
Point Conception
Santa Barbara
Los Angeles
Santa Catalina Island
Carlsbad
Julian
El Cajon
San Diego
San Ysidro
Tijuana
Rosarito
Valle de Guadalupe
Ensenada
Tecate
Borrego Springs
Salton Sea
Colorado River
Gila River
Mexicali
San Felipe
San Quintin
El Rosario
Isla Guadalupe
Isla Cedros
Golfo de California
Isla Angel de la Guarda
Bahía de los Angeles
Bahía Sebastián Vizcaíno
Pacific Ocean
Océano Pacífico
Region boundary
Limite de regiones
International boundary
Limite internacional
State
Estado
County
Condado
Scale / Escala
1 : 4 000 000
100 0 100 200km
100 0 100mi
Lambert Azimuthal Equal Area Projection
Proyección Lambert de Azimut y área constante
N
W
E
S


N
W
E
S
Pacific Ocean
Ecosystems
of San Diego County
and Baja California
Gulf
of
California
1. Kelp Forest (Pacific Coast)
2. Coastal Area (Beaches/Tidepools)
3. Gulf of California
4. Coastal Sage Scrub
5. Succulent Sage Scrub
6. Chaparral
7. Pine/Oak Woodlands
8a.Sonoran Desert
8b. Baja California Central Desert
9. Wetlands
10. Riparian Areas

Activity 3a: Marine Region



Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Science
- Biology
- English

Skills
- Observing
- Describing
- Comparing
- Analyzing
- Communicating
- Predicting

1) Kelp Forests

Background Information

Underwater kelp forests are high-density marine algae zones. They are recognized for being one of the most productive and dynamic ecosystems on Earth. They provide a unique habitat for a wide variety of marine organisms, and they are the source of many ecological processes. Physically, these forests are formed by brown macro algae of the *Laminaria* order; among them is Giant Kelp (*Macrocystis pyrífera*), although there are many other genera, such as *Laminaria, Ecklonia, Lessonia, Alaria*, and *Eisenia*.

The body of an individual alga is called a thallus and its morphological structure is defined by three separate parts: rhizoid, stipe or stem and fronds. Its long wavy stems are held by gas filled bladders, called pneumatocysts, typically found at the base of the fronds close to the stem. These structures provide the required buoyancy so that these marine algae keep their vertical position in the water column.

Under ideal conditions, Giant Kelp can grow 1–2 ft. per day, reaching approximately 100 ft. high. Kelp forest habitat contains several communities that vary according to depth, and each community contains a different variety of creatures. While some fish such as the parrotfish, garibaldi fish and perch live among the stems and fronds, multiple invertebrates find food and shelter as they adhere to the twisted base formed by the kelp's rhizoid.

Kelp is mainly associated with a temperate climate and Arctic waters all over the world. The region with the highest diversity of kelp (> 20 species) is the Pacific Ocean, north of San Francisco to Alaska's Aleutian Islands. Giant Kelp forms thick forests along the central and southern California and northern Baja California coasts. Although kelp forests are unknown in tropical waters, it is a well known fact that other *Laminaria* species live exclusively in deep tropical waters.

Kelp forests have been important for human survival for thousands of years. In fact, it is believed that the first colonization of the Americas was due to the fact that fishing communities in the Pacific were established near kelp forests during the last Ice Age. Humans also directly harvest marine algae to feed species such as abalone in intensive fish farming, and they extract the alginic acid compound for use in products such as tooth paste and antacids. Kelp forests are very valuable for recreational activities, such as scuba diving and kayaking. Industries that support these types of sports maintain a beneficial relationship with the ecosystem by conserving it to obtain, in turn, the enjoyment derived from these recreational activities. All of the above are examples of ecological benefits specifically provided by marine algae forests.

Conservation Challenges

The main challenges to kelp forests include marine pollution and water quality, harvesting marine algae and fishing, invasive species, and climate change. The most pressing threat to marine algae forests is continuous overfishing on coastal ecosystems because, by eliminating top predators, the purple sea urchin moves in; this can cause damage to marine algae forests, since such sea urchins typically feed by ingesting the algae's rhizoid.

In many places, managers have chosen to regulate the harvest of marine algae and/or kelp forest species associated with marine algae, including fish. Although these practices may in a sense seem efficient, they do not necessarily protect the integrity of the ecosystem. In contrast, protection of entire marine areas offers a unique solution covering not only target species for harvest, but also the interactions around them and the local environment as a whole. The direct benefits of establishing marine protected areas for fishing have been well documented all over the world. Indirect benefits have also been demonstrated in several cases for species such as abalone and fish along the California coast. But most importantly, studies show that protected marine zones can be effective in protecting marine algae, and that regeneration of kelp forests can also allow the regeneration of entire affected ecosystems.

Field Guide: Typical Flora and Fauna of the San Diego County/ Baja California Region

Follow the instructions at the end of the introduction to Activity 3 for assembling the *Field Guide*, which will introduce students to the following flora and fauna:

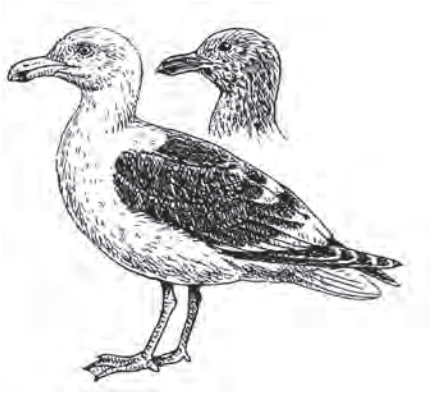
Organisms in kelp forests

Flora

Giant Kelp

Fauna

Brown Sea Urchin
Black Turtle
Brandt's Cormorant
California Sea Lion



Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- Science: Physics
- Biology
- English

Skills
- Observing
- Describing
- Comparing
- Analyzing
- Communicating
- Inferring

Concepts
- Water can rise on its own through a very thin tube. This phenomenon is called capillary action.
- Sand layers remain moist due to capillary action, which brings the water from the lower layers to the surface when water at the surface evaporates.
- Sand moisture allows numerous organisms to survive in the intertidal zone.

2) The Coastal Zone: Beach/Tidepools

Background Information

The seashore, or **coastal zone**, is the boundary between terrestrial and marine ecosystems. In some cases rocks extend into the sea. In others, the shore is made up of sandy or rocky beaches.

Scientists who study the ocean consider the coastal zone to be divided into sub-zones determined by the tides. These zones differ in temperature and moisture, and therefore support different organisms, which have adapted to conditions within each area. The different types of **substrate** (e.g., sand, rock or mud) in each zone determine which organisms can live in them.

The *supratidal (or supralittoral) zone* is the area of the shore that is never covered with water, but receives splash and spray from breaking waves at high tide, especially during storms.

The *intertidal (or littoral) zone* is the area of the shore between the highest high tide and the lowest low tide. It is covered with water and exposed to the sun twice a day.

The *subtidal (or sublittoral) zone* is the area of the shore that is always covered with water.

<u>Sandy Beaches</u>

Crashing waves and shifting sands make sandy beaches an **inhospitable** environment. Plants have difficulty rooting on sandy beaches, and the majority is found on the dunes. Animals that live on sandy beaches are adapted to burrowing into sand, avoiding waves, or running back and forth to avoid the waves.

The supratidal zone (or upper beach)

The upper beach extends from the high-tide line to the dunes; if there aren't any dunes, it extends a distance above the high tide line. Conditions on the upper beach are hot and salty; there is little food. Animals on the upper beach live in small burrows under the surface that they leave—generally in the early evening— to find food. The most common residents of the upper beach are phantom crabs.

The intertidal zone (or zone between tides)

When the high tide ebbs (goes out) in the intertidal zone, the layers of sand remain moist due to the force of capillary action that pulls water from below to the surface. The sand's moisture allows for a number of organisms to survive in the intertidal zone. Certain worms and copepods specialize in living among sand grains. Clams and crabs are other species common to intertidal zones.

The distribution of organisms on sandy beaches is dependent upon physical factors. The **physical factors** that govern life there are wave action and

Objectives

Students will:

- Closely observe the capillary action.
- Infer, based on the experiment, what effect capillary action has on a sandy beach.
- Compare a sandy and a rocky beach.

Time

Preparation time:

- 30 minutes

Activity time:

- 90 minutes

Materials

For all:

- Water tinted with blue food coloring
- Photo of sandy and rocky beach

For each team:

- Dropper
- Clear plastic cup
- Paper napkin
- Sheet of paper
- Piece of cardboard
- Scrap of fabric
- Piece of wood
- Sugar cube

For each participant:

- A copy of the chart "What Have We Learned about Our Ecosystems?"

For every pair of students:

- One notebook: *Student Guide, Our Natural Heritage, Bioregional Pride*
- One copy of *Typical Flora and Fauna of San Diego County/Baja California Region*

the size of the sand grains. Every time a wave breaks, particles are lifted, transported, and redeposited somewhere else, and therefore are constantly moved and resorted. Due to this incessant movement of surface layers, few organisms have been able to develop the ability to permanently occupy the surface of sandy or gravelly beaches. This is why beaches appear empty of life—they don't offer crevices, ledges, holes, or tidepools like rocky beaches do. As a result, environmental factors—temperature, desiccation, wave action—act uniformly in each of the sandy beach's levels.

Anyone who has ever been at the beach has noticed that the size of sand grains differs between beaches, and even within particular beaches in different seasons. The importance of the size of sand particles in terms of organism distribution and abundance is related to the sand's ability to retain enough water for burrowing. Fine sand, by way of its capillary action, tends to retain water within its spaces when the tide subsides. By contrast, thick sand and gravel allow the water to quickly drain when the tide ebbs. Therefore, organisms living in sandy intertidal zones are well protected against desiccation in a fine sandy beach, but exposed to it on a beach with thick sand.

The majority of organisms on sandy beaches are microscopic. When the tide ebbs, they survive under the soft, moist sand. Some worms, crustaceans, and **protozoa** are so thin that they feed underwater while living in tiny spaces in the sand. Larger animals, such as the spiny mole crab, clams, worms, and digger organisms (phantom crab), also live under the sandy surface. They provide a banquet for shorebirds who visit sandy beaches to feed.

The subtidal zone (or lower beach)
Organisms in the subtidal zone are always covered with water. In this zone the environment is more stable, and biodiversity is higher than in the intertidal zone. However, the majority of organisms still live under the surface because they are affected by the action of the waves. Sand dollars, moon snails and crabs are common species found under the sand.

Rocky Beaches

Rocky beaches are inhabited by organisms that have special mechanisms to adhere to solid substrate. They are also adapted to withstand the damage inflicted by waves, **desiccation**, extreme temperatures, and **salinity** changes. For this reason, the types of organisms found on rocky beaches depend upon the conditions available in each particular location. For example, the side of a rock that faces the sun supports different species than the shady side.

Supratidal zone (spray or splash zone): This zone receives spray during high tides and winter storms. As the tide recedes, rocks are completely exposed to the burning sun and cold winds. Few organisms can survive under these severe conditions. Examples are limpets and barnacles. Bar-

Vocabulary

Algae
Coastal zone
Desiccation
Diversity
Echinoderms
Inhospitable
Molecule
Nudibranchia
Nutrients
Physical factors
Protozoa
Salinity
Substrate

Preparation

1. Find a photo or poster of a sandy and a rocky beach.
2. Put blue food coloring in water.

Description

Capillary action can be demonstrated by dipping the bottom corner of a paper napkin in colored water and observing how the water rises up through the napkin. The teacher points out that this is the same phenomenon that happens on sandy beaches, and that it allows sand layers to be constantly moist. This constant moisture permits life to exist in the intertidal zone.

nacles are distributed in well-defined narrow areas; they group in rocks according to the level of the rock that remains above or under water. They are well adapted to alternating periods of inundation and desiccation. Their chalky shells are water-resistant and have two sliding plaques that block their opening when they are not feeding. These plaques also protect them from predators.

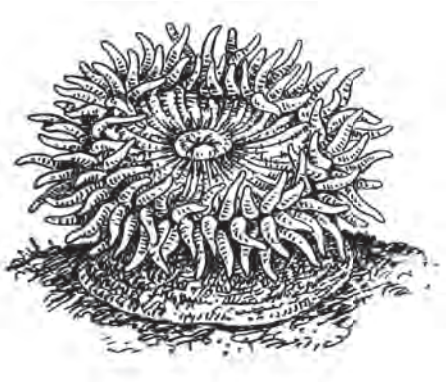
The *intertidal zone*, or the zone between the highest high tide and lowest low tide, is divided into the following three sub-zones: *High, mid* and *low intertidal*.

High intertidal zone: This is the uppermost sub-zone of the rocky shore; it extends partially into the supratidal zone. The high intertidal sub-zone is infrequently covered by extreme high tides, but more commonly bathed by splash and spray. Therefore, all organisms living in that zone are adapted to being exposed to air for long periods of time. Few plants and animals inhabit this zone, due to its severe conditions, including lack of **nutrients** and oxygen. Algae, found here in abundance, tolerate desiccation and wide temperature changes. The majority of animals, including some snail and limpet species, feed on algae.

Mid intertidal zone: This sub-zone is inhabited by more species than the high intertidal zone. The mid intertidal zone extends from below the highest tide level, to just above the lowest tide level. The mid intertidal zone is covered by waves with enough frequency to provide food and oxygen to a variety of plants and animals. Species that survive in the mid intertidal zone have the ability to adhere strongly to the substrate in order to withstand the pounding of waves. The most common species in this zone are barnacles and mussels, but there are also some limpet and isopod species. Hermit crabs live in the mid intertidal zone, although they can also survive in other zones.

Low intertidal zone: This sub-zone is underwater most of the time and is exposed only during very low tides. Therefore, the majority of species that survive in the low intertidal zone can't live out of the water for a long time. There is an enormous **diversity** of organisms in this zone compared with the other two. A few of the most common species are sea anemones, sea stars, brittle stars, sea urchins, sea cucumbers, **nudibranchia**, and sea snails.

Tidepools



Tidepools are rocky depressions that fill with seawater with the rising tide. They are a sort of puddle left over at low tide and are found on rocky beaches.

Numerous animals and **algae** inhabit tidepools. They are adapted to the difficult conditions of their environment, such as constant changes in temperature, salinity and oxygen availability. Huge waves, strong currents, half days of direct sun exposure, and predators are some of the risks that tidepool inhabitants have to face. For this reason, tidepools are the habitat of multiple species whose main characteristic is that they are very hardy organisms.

These species have followed an evolutionary process that has allowed them to adapt to this habitat and take advantage of the resources brought in by the tides. For this reason it is difficult to find an area of rocky beach that is not colonized. Some examples of tidepool inhabitants are algae, sea anemones, gastropod mollusks, oysters, mussels, cirripede crustaceans (for example, goose barnacles) or other moving crustaceans that live and seek shelter among them. Some **echinoderms**, such as sea urchins and sea stars, are also well adapted to these zones, and their morphology allows them to take advantage of any crack in the rocks that can offer them a firm grasp to defend themselves from the pounding of the waves.

Tidepools present a feast for animals further up the food chain. Gulls pick up sea urchins and drop them onto the rocks to open them and then eat them. Sea stars are the mussels' predators, and in turn, are food for gulls. Even larger predators, such as raccoons, cats, and others, come down to the tidepools at low tide to have a "seafood feast." Organisms that live in tidepools depend upon the constant changes in the pool to feed themselves.

Tidepools are found in the intertidal zone of rocky beaches. As we have mentioned, the intertidal zone is divided into three sub-zones: upper, mid, and lower.

The *upper* and *mid intertidal sub-zones* are flooded with water several hours a day. Organisms that live here need to survive the action of the waves, marine currents, and exposure to the sun. Examples are sea anemones, sea stars, chitons, crabs, green algae, and mussels. Marine algae provide shelter for organisms such as nudibranchia and hermit crabs. The waves and currents that make life difficult in this zone also provide food for filtering organisms and other tidepool inhabitants.

The *lower intertidal sub-zone* or *low tide zone* is completely submerged most of the time. It is filled with life, and organisms living in this area are

larger because there is more energy available in this ecosystem. The shallow water allows light to penetrate, which is essential for plants to perform their photosynthetic activities, and vegetation here grows larger compared to the other littoral zones. This area is also protected from large predators, such as big fish, because the action of the waves and currents make it relatively shallow.

Examples of organisms that inhabit this area are abalone, anemones, brown algae, chitons, crabs, green algae, hydrozoas, isopods, limpets, mussels, nudibranchia, sea cucumbers, sea stars, sea urchins, shrimp, snails, sponges, sea grasses, tubular worms, coralline algae, sea hares and octopus.

Conservation challenges

Almost 85% of ocean pollution is the result of human activities on land, such as agricultural and street run-off, and sewage. In addition, beach ecosystems have been damaged by human presence and activities. To protect our beaches it is necessary to implement actions that prevent deterioration and destruction: avoid polluting the beach with trash, respect birds and other wildlife (protect not destroy, capture, or bother wildlife); and report any toxic dumping or sewage dumping that can cause illnesses or death to the plants and animals that live there.

Procedure

For this activity, students will work in teams of 4–5 students each to observe capillary action, which can be seen when water rises on its own within a thin tube.

Many materials can absorb liquids by means of capillary action. The narrow spaces between molecules or in holes on their surface act as minute tubes where water rises as if it were pulled up by suction.

Tell students that they will be able to observe capillary action up close by doing some experiments.

1. Distribute materials to each team.

2. Ask students to pour colored water into one of the plastic cups.

3. Next, ask them to dip the tip of a paper napkin in the colored water. Ask them what they observe.

   Paper fibers act as capillary tubes that conduct water upward; water diffuses through the napkin causing it to get wet.

4. Now ask students to repeat the experiment with other materials: a sheet of paper, a scrap of fabric, a piece of cardboard, a piece of wood, a sugar cube. Ask them to observe closely what happens when each of these things is dipped in the colored water.

5. Next, discuss the results based on the following questions: Are you able to observe capillary action in all the materials? Is the speed of the rising water the same or different in all materials? Why is that?

   Finer materials absorb water more quickly.

6. Compare the results of the experiments you just did with what occurs in nature. Tell students that capillary action occurs in the intertidal zone of sandy beaches.

7. Highlight the importance of this phenomenon occurring in sandy beaches by referring to the background information (sandy beaches section).

8. Taking into account what students have learned, do the following activity: place pictures or posters of the two types of beaches (sandy and rocky) where students can observe them.

9. Ask students to comment on the differences they find between one and the other. Also ask them to recall their experience when they have been at either type of beach. Ask students which type of beach has more organisms. Why?

   Rocky beaches have more organisms. See background information.

10. According to the students, what is the reason for the apparent lack of life on sandy beaches? (Refer to background information.)

Field Guide: Typical Flora and Fauna of San Diego County/Baja California Region

Follow the instructions at the end of the introduction to Activity 3 for assembling the *Field Guide*, which will introduce students to the following flora and fauna:

Organisms in Beaches/Tidepools

Flora	**Fauna**
Sea Lettuce	Beach Hopper
	Brown Pelican
	Western Gull
	Striped Shore Crab
	Giant Green Anemone
	Giant Limpet

PFEA invites young people to become beach stewards

Proyecto Fronterizo de Educación Ambiental (PFEA) is a non-governmental organization that has been offering environmental education since 1991. PFEA helps young people to acquire knowledge, strengthen their skills, and obtain organizing tools to carry out activities that will benefit coastal resources, as well as beach users. Its curriculum, *The Beach, A Meeting Point*, has served as a tool to raise the awareness of young people about this important ecosystem.

For the past 15 years, PFEA has also been organizing beach clean-ups. It coordinates a collective effort called "Community Project to Save the Beach," which is a binational collaboration of 46 organizations with the active participation of 1,200 volunteers. Activities include bi-annual beach clean-ups, as well as recreational beach activities.

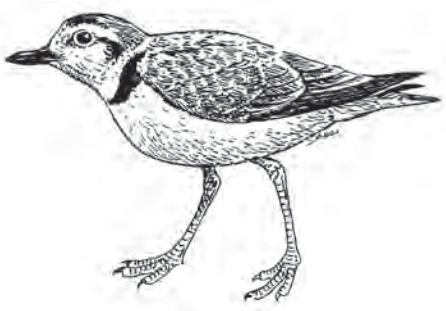
For additional information about beach clean-ups, workshops, or other PFEA activities, please visit their Web page www.proyectofronterizo.org.mx or call 011 52 664 630.0590 in Tijuana, B.C., Mexico

Reflection Exercise
Brainstorm with students about how water pollution affects organisms living in coastal zones. Refer to the *Conservation Challenges* section in the background information.

Plan a poster exhibit where students disseminate the important information they have learned during this activity. Encourage students to take part in a school/community project about managing hazardous materials in the school, featured in PROBEA's *School Projects Handbook*.

Evaluation
Ask students to fill out the section called Coastal Zone on their "What Have We Learned about our Ecosystems" chart.

NOTE: We suggest taking the interpretative walk proposed in the additional Activity 3a, Extra about the coastal zone included in the Appendix Section of this curriculum.



3) Gulf of California

Background Information

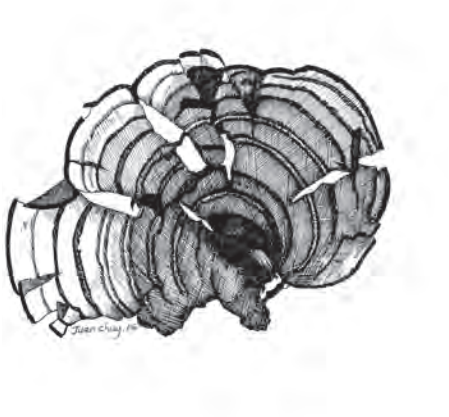
The Gulf of California, also known as the Sea of Cortés, is a unique marine ecosystem. Its oceanographic characteristics include deep basins in its central portions and shallow basins, as well as some of the most impressive tides in the world, in its higher portions. Strong upwelling of nutrient-rich cold waters is evident along both coasts.

The diversity of its geographic characteristics has produced a variety of habitats for marine life, resulting in high biodiversity and productivity levels. The Gulf is home to 7,070 endemic species (only found in this area) and 39 marine species listed as threatened or vulnerable. For these reasons, the large Gulf ecosystem has become one of the conservation priorities in the world.

Isolation is a recurrent theme throughout the Gulf's, as well as the Baja California peninsula's, natural history. During the past six million years, the Gulf has kept the long and dry peninsula separated from the rest of Mexico's mainland, and the Baja California peninsula has kept the Gulf separated from the Pacific Ocean. This landscape of ocean and land that mutually enclose each other preserves the genetic singularity of the life forms that inhabit it.

Biologically, the Sea of Cortés is one of the world's most diverse and productive seas. Its high biodiversity is due to two phenomena. The first is the large variety of habitats which include mangroves, coastal lagoons, coral reefs, shallow basins, and hydrothermal vents at the bottom of sea, as well as various beach and sub-tidal areas. The second one is the complex geological and oceanographic history of the Gulf, which includes past invasions of animals that immigrated from tropical South America, the Caribbean (before the Earth's tectonic forces created the Panama Isthmus), the cold California coasts (during past Ice Ages), and through the large stretch of the Pacific from the tropical West Pacific.

The Gulf is home to 907 fish species, 240 marine bird species, 35 marine mammal species, and 4,818 marine macro-invertebrates, known so far. Of all these species, 770 are endemic to the region, including totoaba (Totoaba macdonaldi), a giant sea bass, and the vaquita (Phocoena sinus), the original port marsupial found only in the Gulf of California. The Gulf has the largest diversity of great whales in the world, and they are legally protected in Mexico. In addition, the Gulf's sea bed, with its 9,600 square miles of coastal lagoons and 4,096 square miles of mangrove forests, serve as reproduction, nesting and nursing sites for thousands of resident and migratory species. An archipelago of 992 islands and islets hosts 90 endemic species, five of which are under critical threat of extinction.



Conservation Challenges

This vast natural wealth is not only of biological and conservation interest, but it also provides the socio-economic sustenance for the region's inhabitants.

Unfortunately, these inhabitants have developed systems of natural-resource use that often put the long-term sustainability of these resources in jeopardy. The increase of economic activity in the region has caused the deterioration of coastal marine ecosystems through decrease of fresh-water flow, pollution due to agro-industrial run-off and urban waste, sedimentation, and the use of inadequate fishing technologies, such as trawling. In addition, the invasion of exotic plants and animals is threatening native and endemic species on the Gulf islands and in the Sonora and Baja California deserts.

Activity 3b: Mediterranean Region

Grado Escolar
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- English
- Mathematics
- Biology

Skills
- Observing
- Describing
- Comparing
- Inferring
- Communicating
- Visualizing

Materials
For each participant:
- A copy of the chart "What Have We Learned about Our Ecosystems?"

For every pair of students:
- One notebook: *Student Guide, Our Natural Heritage, Bioregional Pride*
- One copy of *Typical Flora and Fauna of San Diego County/Baja California Region*

Vocabulary
Perennial
Deciduous
Secculent species

1) Coastal Sage Scrub and 2) Succulent Sage Scrub

Background Information

Foothills and coastal slopes below 3,000 ft. are covered with coastal scrub, a vegetation community that consists of a mix of aromatic shrubs. Some of the perennial shrubs are deciduous. There is a small portion of succulent species.

The coastal scrub community is considered transitional between desert and chaparral vegetation. It can be found in patches along the Pacific coast from the southern boundary of Oregon to El Rosario in Baja California. It occurs near beaches and along the coastline with uneven distribution inland in low elevation valleys and on alluvial fans. Alluvial fans are gently sloping, fan-shaped deposits of soil common at the base of mountain ranges in arid regions.

Coastal scrub is less dense than chaparral. Herbaceous plants grow in the open spaces among shrubs. Many of these scrubs sprout from fire-scarred seed and vary in size from 2 ft. to 7 ft. The soft, gray foliage of some species markedly contrasts with the green foliage of the adjacent chaparral. Many plants in coastal scrub, such as true sages (mint family *Lamiaceae*) and sagebrush (sunflower family *Asteraceae*), are aromatic. Their strong odor repels herbivores.

Coastal scrub is divided in two communities: **coastal sage scrub** and **succulent sage scrub**. To see the geographical distribution of these communities, please refer to the map, "San Diego County and Baja California Ecosystems," found following the introduction of "Activity 3, Ecological Regions and their Principal Ecosystems."

The most representative plants of coastal sage scrub are California Sagebrush (*Artemisia californica*), White and Black sages (*Salvia apiana, S. melifera*), Flat-topped Buckwheat (*Eriogonum fasciculatum*), Golden Yarrow (*Eriophyllum confertiflorum*), Hollyleaf Redberry (*Rhamnus crocea*), Desertbroom (*Baccharis sarothroides*), Sawtooth Goldenbush (*Hazardia squarrosa var. grindelioides*), Coast Prickly Pear (*Opuntia littoralis*); and other evergreen shrubs such as Lemonadeberry (*Rhus integrifolia*), Laurel Sumac (*Malosma laurina*), and Jojoba (*Simmondsia chinensis*).

Succulent sage scrub has a higher diversity of species than coastal sage scrub; succulents are dominant, especially the agave, cactus, stonecrop

and spurge families (*Agavaceae, Cactaceae, Crassulaceae* and *Euphorbiaceae*). With the marine layer as a primary source of moisture, lichens are common, as are plants with thick succulent leaves arranged in the shape of a rosette at the base for capturing water. Common species are Shaw's Agave (*Agave shawii*), Bursage (*Ambrosia chenopodifolia*), goldenbush (*Hazardia rosaric, H. vernicosa*), Cliff Spurge (*Euphorbia misera*) and *Dudleya* spp. Its distinctive cactus flora includes Golden Cereus (*Bergerocactus emoryi*), Candelabra Cactus (*Myrtillocactus cochal*), Pitaya (*Stenocereus gummosus*), *Cylindropuntia rosarica* (no common name) and several *Opuntia* species of cactus. Some deciduous trees and shrubs, such as the Baja California peninsula endemic Perry's Buckeye (*Aesculus parryi*) and Desert Apricot (*Prunus fremontii*), among others, may appear along rivers and streams. Coastal sage scrub plants may bloom all year, but the main flowering period is late winter and early spring.

Coastal sage scrub is habitat for a variety of small mammals, such as the Kangaroo Rat (*Dipodomys agilis*), Short-Eared Pocket Mouse (*Perognathus fallax*), Deer Mice (*Peromyscus maniculatus*), and the Desert Woodrat (*Neotoma lepida*). Mule Deer (*Odocoileus hemionus*) and Bighorn Sheep (*Ovis canadensis*) are the largest mammals of scrub communities, and the largest predator is the Mountain Lion (*Puma concolor*). Common birds include the Scrub Jay (*Aphelocoma californica*) and California Quail (*Lophortyx californicus*). It is also habitat for a number of species adapted to chaparral and desert scrub, such as various species of sparrows. Among the vertebrates, reptiles such as lizards, snakes, and rattlesnakes, are the most distinctive in this ecosystem. Insects are abundant.

Adaptations

Plants in the coastal sage scrub community have small, soft leaves that reduce the surface area exposed to the sun. These plants are well adapted to survive with little rain and the moisture provided by the marine layer typical of Mediterranean climates. Some plant leaves, such as those of Flat-topped Buckwheat, have sharp edges and are turned downward. By contrast, the taco-shaped leaves of Laurel Sumac (*Malosma laurina*) curve upward. They both create a microclimate—a cool area inside their leaves. Because they have to survive hot, dry summers, many of these plants loose their leaves completely, and even appear to be dead. However, they are only dormant and will regenerate their leaves after the fall and winter rains. Some plants in coastal sage scrub are aromatic and have a fragrance that protects their foliage from insects that may try to eat it.

Scrub communities present the same challenges to animals as does the desert. They are both hot, dry ecosystems in which food is scarce. Cold-blooded animals, such as arthropods and reptiles have low metabolic demands and many escape the harshest conditions by becoming dormant. Most mammals are small and escape the high daytime temperatures by being nocturnal. Deer mice have the ability to drop their body temperature every day while in their burrows. This lower metabolic rate means they require less food, and even serves to lengthen their lifespan to about five times that of other mice. Many species have very efficient kidneys and meet their requirements for water from the food they eat; mice from seeds they eat, woodrats from Prickly Pear Cactus.

Fire

The historical frequency of fire in coastal sage scrub is as common as in chaparral with approximately one fire every 20 years (Westman, 1982 in Dallman, 1998). This can be due to volatile oils that provide their fragrance to shrubs but are also flammable. After a fire, common plants, such as California Sagebrush, can re-sprout and

produce a large quantity of seeds that will sprout the following year. Herbaceous plant seeds, many of them annuals, germinate quickly when stimulated by heat, light and nutrients after lying dormant, sometimes for years. They co-exist with the scrub's larger plants and help re-colonize the areas adjacent to chaparral after a fire. On less damaged sites, the recovery of the ecosystem may take approximately 10 years, but on poor sites, recovery takes much longer. At high elevations, coastal sage scrub is always a seasonal phase in the ecological succession of the chaparral (Brown, 1994).

Conservation Challenges
For years, human settlements have increased in places that have a temperate climate and access to the ocean. The main challenge to coastal sage scrub is growing population and urbanization, which results in habitat fragmentation and loss (see Activity 3f, #1). In Southern California remnants of coastal sage scrub can be found at Border Field State Park and Torrey Pines State Reserve. Coastal sage scrub is considered an endangered plant community by the California Native Plant Society.

Although the coastal sage scrub of Baja California is less stressed than in Southern California, in Tijuana and Ensenada, as well as along the highway between the two cities, many coastal sage scrub areas have been developed. However, the biggest threat in Baja California has been clearing land for agriculture, as is the case for San Quintín where large areas of coastal sage scrub have been turned into agricultural fields requiring large amounts of irrigation. Many native plants are disappearing as a result. The few patches of original habitat still remaining are vulnerable to disturbances, such as the invasion of exotic species, predation caused by the introduction of domestic animals and people, fires caused by human activities, trash, and pollution. The loss of native species results in increasing growth of grasses and herbaceous plants that change the ecosystem radically, making it more vulnerable to fires caused by humans.

3) Chaparral

Background Information

Chaparral is the dominant vegetation community in southern California and northern Baja California. It covers tall mountains, hillsides and roadsides. It is also the typical vegetation on Guadalupe and Cedros Islands. Like other chaparral areas around the world, the Californias chaparral is found in a Mediterranean climate, which is characterized by cool, wet winters and hot, dry summers. From afar, chaparral appears as a soft surface covered in low, fine, delicate plants. However, up close, chaparral is high and almost impenetrable. It is characterized by very dense evergreen sclerophile (with hard leaves) shrubs, some of them aromatic, with deep roots, small, hard leaves, rigid branches that can withstand long periods of extreme drought, and varying in height from 3 ft. to 9 ft. These shrubs are well adapted to drought and fire. The word chaparral actually comes from the Spanish word "chaparro" meaning short, and refers to a vegetation community densely populated by shrubs.

Chaparral can be divided into three types according to its main characteristics and common species: coastal, intermediate, and high altitude. The first type is associated with coastal scrub and is typically present in canyons and ravines on the coastline. Intermediate chaparral is distributed inland and takes on the name of the characteristic species it features, which can either be Chamise, Manzanita, or Scrub Oak. Lastly, high altitude chaparral is present above 2,400 ft., at the transition with coniferous forests.

This type of vegetation is generally found above coastal sage scrub and on the coastline, up to 40 miles inland. Its distribution is quite irregular, and it can sometimes be found under similar environmental conditions—winds, fog, and breeze—as coastal scrub.

The physical structure and composition of the species growing in this community change with elevation, slope exposure, and distance to the Pacific (Minnich et al, 1983, in Fremontia, 1999). Coast hillsides exposed to winters with moderate rain and cool, foggy summers, present densely tree-populated communities both in California and in Baja California. Chamise (*Adenostoma fasciculatum*), as well as Laurel Sumac (Malosma laurina), wild lilacs (*Ceanothus verrucosus, C.greggii*), and Baja Birdbush (*Ornithostaphylos oppositifolia*) is dominant on slopes with southern exposure. Slopes with northern exposure are dominated by *Ceanothus oliganthus*, Toyon (*Heteromeles arbutifolia*), Mission Manzanita (*Xylococcus bicolor*), and Sugarbush (*Rhus ovata*). Other examples of chaparral vegetation are Redshank (*Adenostoma sparsifolium*), which is extensively distributed and accompanies several species of Ceanothus, manzanitas (*Arctostaphylos* spp.), and oak (*Quercus* spp). Other shrubs common to chaparral are Mountain Mahagony (*Cercocarpus betuloide*), Hollyleaf Redberry (*Rhamnus ilicifolia*), Chaparral Ash (*Fraxinus parryi*), Perry's Buckeye (*Aesculus parryi*), Golden Yarrow (*Eriophyllum confertiflorum*), and Broom Snakeweed (*Gutierrezia sarothrae*). Wildflowers are common to open areas on hillsides.

Chaparral is habitat for a large number of vertebrates, many of which are well adapted to their environment and can't be found elsewhere. Among these, the most important mammals are Brush Rabbit (*Sylvilagus bachamani*) and California Mice (*Peromyscus californicus*). Other species representative of chaparral are Mule Deer (*Odocoileus hemionus*), Grey Fox (*Urocyon cinereoargentus*), Merramum's Chipmunk (*Eutamias merrami*), Kangaroo Rat (*Dipodomys agilis*), California Pocket Mouse (*Perognathus californicus*), Cottontail Rabbit (*Sylvilagus floridanus holzeri*) and Brush Mouse (*Peromyscus boylii*). Bird species, such as California Quail (*Oreotyx pictus*), Wrentit (*Chamea fascista*), California Thrasher (*Toxostoma redivivum*), and some hummingbirds, such as Anna's (*Anna Calypte*), also occur in chaparral. Other birds found here are gnatcatchers, sparrows, crows, magpies, and roadrunners.

Reptiles are not typical to chaparral. However, in San Diego's southwestern region there are a few, such as Alligator Lizard (*Gerrhonotus multicarinatus webbi*), and Granite Night Lizard (*Xantusia henshawi*). Other reptiles that inhabit chaparral are rattlesnakes, snakes, and lizards.

In the Baja California peninsula chaparral is not limited to Mediterranean zones. Some communities are found on desert mountaintops in the Central Desert, including the San Borja, La Asamblea, and Libertad Sierras, as well as the Tres Vírgenes Volcano.

Adaptations

With adaptations to avoid the loss of water, chaparral plants survive in an arid environment. To limit evaporation, their leaves are smaller, and many shrubs have thick leaves with a leathery texture to reduce water loss. Others have a layer of a waxy substance that serves the same purpose. To reflect sunlight, leaves also tend to be shiny (reducing over-heating by the sun). The leaves of some shrubs can change their orientation with respect to the sun, reducing exposed leaf area. Chaparral's distinctive aroma comes from resins and oils that help the plants conserve moisture. These elements make chaparral extremely combustible when exposed to an open flame.

The majority of chaparral shrubs have two types of roots: a long tap root that extracts deep moisture and radial roots that extract moisture close to the surface.

Shrubs are adapted to the summer dryness and winter/spring rains. The active growing season is late winter and early spring. In spring, chaparral is beautiful with many of its species in bloom. Many plants are dormant during the summer. Some chaparral species are deciduous, shedding their leaves in the summer. Others are evergreen, able to conserve energy by keeping their leaves through the hot summer.

All chaparral plant species are adapted to periodic wildfires. For instance, some plants can sprout again from their root system, or have seeds that germinate as a result of a fire, even if the fire kills the adult plant.

Many chaparral animals are nocturnal, staying in their burrows during the daytime heat and coming out to feed at night. This allows them to conserve water and energy. They are also able to escape wildfires by staying underground. Other chaparral animals, like some mice and lizards, secrete a semi-solid urine, which reduces water loss.

Animal adaptations for all scrub communities are similar. For more details please refer to the "Adaptations" section of the "Coastal Sage Scrub and Succulent Scrub."

The Functioning of the Mediterranean Zone and Fire

The different types of vegetation that grow in the Mediterranean zone—coastal scrub, chaparral, and forest—create a biomass, which builds up and needs to be recycled. Cold rainy winters and hot dry summers are the fundamental characteristics of Mediterranean ecosystems. In this arid climate decomposers—fungi, insects, bacteria—can't break down matter. Instead, fires transform the energy in this ecosystem; stimulate seed germination and new plant growth, and aid in controlling plant illnesses and insect infestations. Many Chaparral plants survive wildfires and have developed reproductive strategies as a response to them.

For more information on fire in the chaparral ecosystem, see Activity 3f, #6, "Wildland Fire."

Conservation Challenges

Just as in coastal scrub, population growth and urbanization is the main challenge facing conservation, resulting in habitat loss and fragmentation, and creating a hostile environment for many native species. The loss of native species results in increasing growth of grasses and herbaceous plants that change the ecosystem radically, making it more vulnerable to fires caused by humans. The few patches of original habitat still remaining are vulnerable to disturbance, such as the invasion of exotic species, predation caused by domestic animals and people, fires caused by human activities, trash, and pollution.

Field Guide: "Typical Flora and Fauna of the San Diego County/Baja California Region"

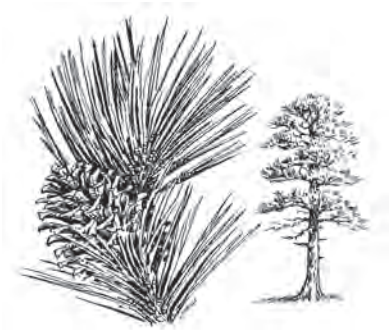
Follow the instructions at the end of the introduction to Activity 3 for assembling the *Field Guide*, which will introduce students to the following flora and fauna:

Flora and Fauna of the Mediterranean Region

Flora
Black Sage
California Sagebrush
California Buckwheat
Eastwood Manzanita
Ramona Lilac
Tecate Cypress
Golden Eardrops
Otay Mesa Mint
Red Brome, Foxtail
Black Mustard
Giant Reed

Fauna
Quino Checkerspot
Coast Horned Lizard
California Quail
California Gnatcatcher
Wrentit
Anna's Hummingbird
Western Scrub Jay
Western Brush Rabbit

Activity 3c: Montane Region



Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- English
- Mathematics
- Biology

Skills
- Observing
- Describing
- Comparing
- Inferring
- Communicating
- Visualizing

Materials
For each participant:
- A copy of the chart "What Have We Learned about Our Ecosystems?"

For every pair of students:
- One notebook: *Student Guide, Our Natural Heritage, Bioregional Pride*
- One copy of *Typical Flora and Fauna of San Diego County/Baja California Region*

Vocabulary
Angiosperm
Gymnosperms

Pine/Oak Woodlands

Background Information

A series of mountains run the length of the Baja California peninsula and extend as far north as Los Angeles, California. In southern California these mountains are called the Peninsular Ranges and in San Diego County they include Palomar, Volcan, Hotsprings, Cuyamaca and the Laguna Mountains. The mountains in this range in Baja California include the San Jacinto, Juárez, and San Pedro Mártir Sierras. Other forest patches in the peninsula are located in the Santa Isabel, Yubay, San Borja, and Blanca Sierras, as well as in Cedros and Guadalupe Islands, and Ejido Eréndira. In the city of San Diego a coastal forest patch is home to Torrey Pines (*Pinus torreyana*).

Mixed conifer and oak forests have a mild Mediterranean climate, bordered by a desert climate in some of the lower areas. The region has long, hot, dry summers and mild, wet winters. The annual temperature average ranges from approximately 42° F at the highest elevations to 62° F in the lowest elevations. The annual rainfall ranges from 8.66 to 49 in. with an average of 27 in.

Complex mountain topography creates conditions favorable for a variety of natural communities from chaparral, to oaks, to mixed conifers and alpine habitats. At higher altitudes chaparral shrubs, such as wild lilacs (*Ceonothus* spp.) and manzanitas (*Arctostaphylos* spp.), are mixed with California Juniper (*Juniperus californica*), Pinion Pine (*Pinus monophylla*), Sugar Pine (*P. lambertiana*), White Fir (*Abies concolor*), Jeffrey Pine (*P. jeffreii*), and Ponderosa Pine (*P. ponderosa*). Among the pines other trees such as poplars, firs, oaks, cypress, sycamores and madrone trees also grow. At higher altitudes (in Baja California) there are patches of aspen, whose leaves turn an intense yellow in contrast to the tree's white bark during the fall.

Forests exist at the higher altitudes and as the altitude lowers, they tend to disappear and are replaced by Mediterranean scrub: manzanitas, Chamise (*Adenostoma fasciculatum*), juniper trees, and here and there (in Baja California) mesquites (*Prosopis* spp.) that cover the majority of the hillsides.

Structurally speaking, these are very simple forests with two layers—the canopy and the undergrowth. In some cases there is also an intermediate shrub layer. The undergrowth contains a wide variety of herbaceous and shrub species with a very definite stratification which is dominated by

perennials and subject to ecologically important wildfires. Major growth and flowering in these herbaceous species occurs in spring. This ecosystem contains many intermittent streams, but few permanent ones.

In San Diego County and Baja California, mixed conifer forest vegetation can be classified according to its floristic components as follows:

1. ***Pine Forests***. Pine forests have three variations: a) mountain b) coastal, c) insular.

a) Mountain Forests These forests are distributed at an altitude between 4,000 and 9,100 feet. In Baja California they exist mainly on the Sierra de Juárez and Sierra de San Pedro Mártir. The dominant species are Jeffrey Pine as well as Single-leaf Pinion and Parry Pinion (P. quadrifolia), which cover a large area mainly in La Rumorosa, southeast Sierra de Juárez, Sierra de Calamanjué and Sierra de San Borja; Coulter Pine (P. coulteri), a very important species from an ecological standpoint, occurs in small areas in Sierra Blanca, Cerro Hanson and Sierra de San Pedro Mártir. In San Diego County pine forests are found in the Palomar, Hotsprings, Volcan, Cuyamaca, and Laguna mountains. Species include Coulter, Jeffrey, Ponderosa and Sugar pines.

b) Coastal Forests In Baja California, these forests are located in the northwestern coast at an altitude of 1,640 ft. in areas such as Cañón del Arce, Cañón de Doña Petra, San Vicente, and Ejido Eréndira. Knobcone Pine (P. attenuata) and Bishop Pine (P. muricata), both considered relict species, can be found within the coastal forests. A relict species is a once widespread natural species that survives only in isolated localities because of environmental changes.

In San Diego County the Torrey Pine grows along coastal bluffs. It is the most restricted and rarest pine in North America and is probably the remnant of an ancient coastal forest.

c) Insular Forests These forests are located on Cedros and Guadalupe Islands in Baja California. The dominant species within insular forests is Monterrey Pine (P. radiata), found in small relict populations with low percentages of natural regeneration.

2. ***Juniper Forests.*** In San Diego County, California Juniper is found along the edges of the Colorado Desert above 2000 ft. of elevation. (The Colorado Desert is the easternmost portion of the Sonoran Desert in California.) These junipers are showing the effects of global warming; they are noticeably dying in areas where they once thrived. In Baja California this juniper is found in La Rumorosa, Ejido Héroes de la Independencia, Valle Ojos Negros, Sierra de Juárez and Sierra de San Pedro Mártir, and on Cedros and Guadalupe Islands.

3. ***Cypress Forests.*** These forests are considered relict and are restricted to geographical areas with very specific ecological characteristics, such as those found in coastal ecosystems. In San Diego County, Tecate Cypress (C. guadalupensis var. forbersii) forests are found on Otay and Guatay Mountains and Tecate Peak (on both sides of the U.S./Mexico border). Cuyamaca Cypress (Cupressus arizonica var. stephensonii) is found on the southwest slopes of Cuyamaca Peak. In Baja California, characteristic species are Cuyamaca Cypress, Mountain Cypress (C. montana), which is endemic to Sierra de San Pedro Mártir, and Tecate Cypress. Incense Cedar (Calocedrus decurrens) is another species found in the Sierra de San Pedro Mártir. In San Diego County, Incense Cedar is found mixed with California Black Oak, Canyon Live Oak, and Coast live Oak.

Diversity

Forests are complex structures that support a high diversity of plant species that, in turn, provide both food resources and space for a high diversity of animals. Each individual type of forest supports its own set of plant and animal species. Conifer forests support different flora and fauna than do deciduous forests. Deciduous forests present the highest species diversity, especially insects.

Hiding in the midst of this mild Mediterranean forest are cougar, mountain lion, deer, fox, coyote, and golden eagles. Hares, quail, woodpeckers, chipmunks, and Red Squirrels, are also common to this area. Surrounded by other types of vegetation, the temperate forests of San Diego County and Baja California are a biological island where singular forms of mammals have evolved—at least two types of mice, one pocket gopher, a rabbit, and a mole are exclusive to the San Pedro Mártir Sierra. Rivers, ponds, and lagoons are home to migratory birds. Turtledoves, geese, mallards, and bald eagles have been seen in the region where once the California Condor, the largest of North America's birds of prey, once flew. This bird, which was on the brink of extinction, was re-introduced to San Pedro Mártir Sierra National Park in 2002. Today, 11 California Condors fly freely, and a couple bred in 2008 (wildlifeextra.com).

Adaptations

In pine and oak woodlands both, animal and plant life are closely related to the characteristics of the climate and soil where they live.

Plant Adaptations

Thin, wide **angiosperm** leaves are detrimental to trees during the long winter, because they allow loss of water and potential harm from the cold when they are not photosynthesizing. This is why broad leaf trees drop their leaves in the fall. On the other hand, the needle-like leaves of **gymnosperms** do not loose much water to evaporation, so the leaves remain on the tree during winter. This allows these trees to start photosynthesizing immediately after the onset of spring, since they do not have to wait for new leaves to grow. Needle-like leaves also help to shed the snow, so that its weight won't break tree branches. The fast growth and bloom of much forest understory vegetation allows it to take advantage of the brief warm spring season that provides abundant sunlight before the trees develop new leaves. This is very important for pollinating insects. In addition, simultaneous production of large amounts of seeds allows for many seeds to escape being eaten.

Animal Adaptations

Animals also present various types of seasonal adaptations. A large proportion of birds and some bats migrate south during the winter. Remaining bats and other mammals hibernate during this season of low food supply and adverse climatic conditions. Low temperatures make food storage possible. This is an important adaptation for some birds and squirrels that specialize in collecting tree fruit, such as acorns, to store for winter.

Fire

Fire is a natural part of forest ecosystems. To learn more about fire in forests, please refer to Activity 3f, # 6, "Wildland Fires."

Conservation Challenges

Land use and human activities include recreation, tourism, rural housing, some agriculture, and sheepherding. Large parts of the land are federal, state, and county protected areas. In San Diego County, forests are protected by the U.S. Forest Service, Bureau of Land Management, and California State Parks. In Baja California there are two Natural Protected Areas that protect forests: Parque Nacional Constitución de 1857 and Parque Nacional Sierra de San Pedro Mártir. Some important settlements in San Diego County forests are Julian, Mount Laguna, and Descanso, and in Baja California, La Rumorosa.

The west side of the Juárez and San Pedro Mártir Sierras in Mexico has one of the most unique types of vegetation in the country and is the area most at risk. Urban development in the border area has slowly invaded the mountain regions, and land speculation is beginning to affect the most remote areas. The increase in accessibility to the region presents challenges and opportunities.

Another conservation challenge for this important ecosystem is the improper use of the land such as:

Herding livestock: Livestock reduces the food available to deer and other native herbivores, encourages the elimination of cougars, lynx, and coyote, and slowly degrades the natural vegetation in grasslands.

Fires: Typically started accidentally in adjacent chaparral areas, they easily spread to forests.

Clandestine logging: Logging can destroy the habitat of numerous species and inevitably alters the characteristics of the landscape and the forest's ability to provide important environmental services.

Poaching: Poachers take advantage of the large area of land and lack of surveillance to kill wildlife—mainly mule deer and big horn sheep—illegally, even though these species are protected.

Field Guide: Typical Flora and Fauna of the San Diego County/ Baja California Region

Follow the instructions at the end of the introduction to Activity 3 for assembling the *Field Guide*, which will introduce students to the following flora and fauna:

Organisms in Montane Region

Flora

Canyon Live Oak
Nuttall's Scrub Oak
Jeffrey Pine
California Juniper
Deer Grass
Quacking Aspen
Mistletoe
White Fir

Fauna

Acorn Woodpecker
Dark-eye Junco
Mountain Chickadee
Mule Deer
Mountain Lion

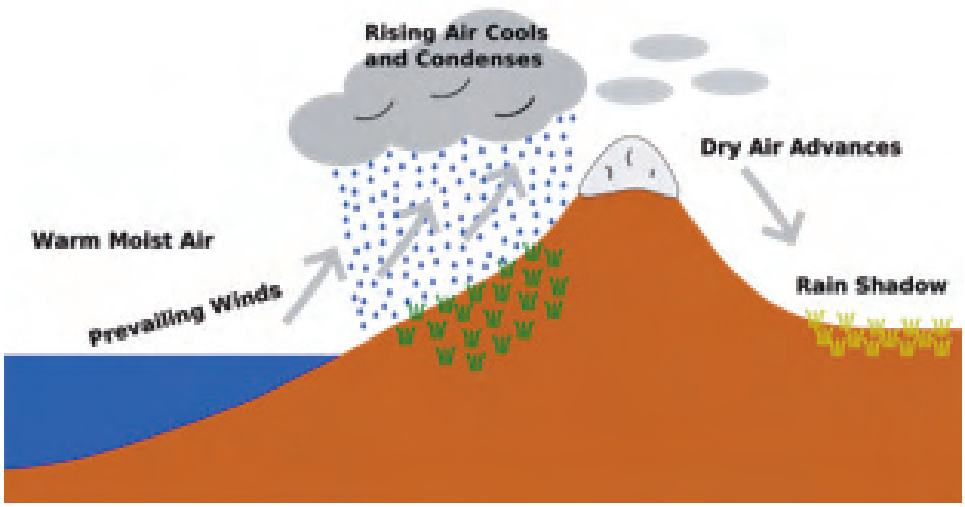
Activity 3d: Desert Region

Sonoran Desert and Central Desert

Background Information

Scientists define deserts as areas that get less than 10 inches (25 cm.) of rainfall a year and have a very high rate of evaporation. In fact, the annual evaporation is higher than the annual rainfall in a desert.

In San Diego County and Baja California the Sonoran Desert is considered a rain-shadow desert. Winter Pacific storms come in from the west and produce a rain shadow on the eastern side of the Peninsular mountain ranges (see Montane Region). Water-filled storm clouds cool as they travel up and over the mountains. Since this cooler air holds less moisture, the clouds lose water in the form of either rain or snow. As the air travels down the eastern side of the mountain, it warms up and is able to hold more moisture again. It draws that moisture from the ground and vegetation. The result is an extremely arid environment.



The reverse is true in the summer. Gulf storms come up the Gulf of California from east to west. The warm air is high in humidity and produces rain shadows on the western side of mountain ranges. However, more moisture is available from winter storms, and the cool sea breeze keeps temperatures down on the western side of the mountains. The evaporation rate is not higher than the rainfall. Therefore, the coastal region is characterized by a dry Mediterranean climate, but is not dry enough to be a desert. The precious rain that does fall in deserts is sporadic. It often comes in big bursts with long periods of drought in between. The heavy rain runs off and evaporates before it gets a chance to soak into the soil.

High temperatures characterize the Sonoran and Central Deserts. There is very little cloud cover and desert vegetation is scattered, so the sun's radia-

Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- English
- Mathematics
- Biology

Skills
- Observing
- Describing
- Comparing
- Inferring
- Communicating
- Visualizing

Concepts
- Heat, lack of water, and high evaporation rates are the primary characteristics of a desert.
- Organisms in the desert have adapted to living under the difficult conditions of their environment.
- Many desert animals utilize evaporative cooling to stablize their body's temperature.

Objectives

Students will:

- Associate the sensation of being out in the desert with the conceptual definition of this ecosystem.
- Be able to list and describe the basic characteristics of deserts.
- Be able to explain and demonstrate evaporation and "evaporative cooling" processes.
- Observe cacti and identify some adaptations they have developed to withstand the harsh desert conditions.

Time

Prep time: 30 minutes
Activity time: 70 minutes

Materials

For all:

- Imagining the Desert reading text
- Map locating the Sonoran Desert
- A world map or globe

For each team:

- A piece of red poster paper
- A bucket or large plastic container with water
- A sponge or piece of fabric
- A chronometer or watch with a seconds hand
- A partially sun-lighted sidewalk

For each participant:

- A copy of the chart "What Have We Learned about Our Ecosystems?"

tion hits the relatively bare desert floor. Almost half the heat is absorbed by the first few inches of soil and the other half is reflected back, heating the air. The hot, dry air causes what little water there is to evaporate very quickly. In addition, this rapid heating of the desert floor causes strong local winds to blow almost constantly in many desert areas, further increasing the rate of evaporation.

While the temperature in the desert can be high during the day, at night it can be extremely low. Heat irradiated by the sun warms the ground and the air quickly during the day; at night it escapes into the atmosphere equally quickly.

Adaptations

Desert flora and fauna have adapted to these harsh conditions. Limiting factors are water and heat.

Water scarcity forces plants to develop adaptations to capture as much water as possible. Plants may have superficial roots that extend over a large area and quickly absorb whatever surface moisture becomes available. Others have deep roots that allow them to reach the water table or the moisture found deep underground.

The small leaves of desert plants have less surface area, which prevents moisture loss. They may have hairy leaves to reflect light, or waxy leaves to reduce water loss. Some desert plants do not have leaves at all. Cactus leaves have become spines that protect them from animals that may want to eat them. Spines also reflect light from the plant's surface and provide shade. Some plants can orient their leaves so that there is less exposure to the sun; these leaves absorb less heat.

The majority of desert plants are light colored in order to reflect light. Shiny green stems are important because they allow plants to photosynthesize directly from the stem, eliminating the need for leaves.

Plants store water and prevent its loss in different ways. Many plants have a waxy thick cuticle or layer on their surface area, which prevents evaporation. Some plants photosynthesize at night. By opening their pores when it is cooler, they lose less moisture. Some cacti have the extraordinary ability to store water within their woody body, which expands when water is available.

Desert animals commonly escape from severe conditions in their environment. Some sleep for a long period of time during the summer months; this adaptation is called **estivation**. Birds and large mammals may **migrate** to escape harsh conditions.

For every pair of students:

- One notebook: *Student Guide, Our Natural Heritage, Bioregional Pride*
- One copy of *Typical Flora and Fauna of San Diego County/Baja California Region*

Vocabulary

Aridity
Climate change
Cryptic coloration
Desertification
Erosion
Estivation
Global warming
Migrate

Preparation

1. Locate a very sunny area in schoolyard.
2. Have world map or globe ready.

Description

With this activity students will be more able to recognize and describe the primary characteristics of a desert. We suggest focusing on the way students feel while being in the desert, and on the reactions that these feelings elicit. Describing their feelings will help students identify and describe desert characteristics more easily. During this activity students will feel hot and dry; they will look for a shady place, and will want to satiate their thirst. This exercise seeks to emphasize that whatever they experience in the desert is also, typically, what other animals and the plants that live in the desert experience.

Many animals are light colored to reflect light, or they may have **cryptic coloration** to camouflage or disguise themselves and avoid predators in places with little vegetation.

Hair and feathers, serving as insulation, protect mammals and birds from heat or cold. The majority of desert mammals have short hair. Birds stay warm by raising their feathers, creating air spaces that insulate them. In hot weather they keep their feathers close to their body.

Many desert animals are small, giving them the advantage of hiding more easily among the scarce vegetation. Larger mammals, such as coyotes or big horn sheep, have the ability to travel long distances to obtain water. In addition, animals can orient their bodies when resting to reduce the body area exposed to the sun, by aligning the long side of their body with the sun. Many desert mammals conserve water by having highly concentrated urine and, in general, very small and hard feces. They have small nasal orifices that allow them to absorb moisture from the air they breathe. They also get moisture from the food they eat.

Our Deserts: The Sonoran Desert and the Central Desert

The Sonoran Desert is located in southern Arizona, southeastern California, and the states of Baja California, Baja California Sur, and Sonora in Mexico. The Central Desert is located in the middle of the state of Baja California, between Cataviña to the north and Bahía de los Ángeles to the south. The entire Baja California peninsula, except for small portions in the north and south, lies within the boundaries of these deserts.

Of all the deserts in North America, the Sonoran and Central Deserts have the highest diversity of species.

Conservation Challenges

One of the principal conservation challenges to deserts, interestingly enough, is desertification. "Desertification is the degradation of soil. It is the process occurring in arid and semi-arid zones when a wild area is stripped, making it difficult for the spontaneous development of new vegetation to cover the affected area again, and causing it to be devoid of plants and animals for many years." (León de la Luz and R. Coria, 1992)

Desertification is partly due to climate changes that have reduced or decreased the amount of rain in certain areas. Some of these climate changes are natural; humans cause others. Together, decreased rainfall and the pressure placed by humans to increase food production to satisfy the growing population have increased desertification.

Imagining the Desert

You are outside in the desert.

You are outside in the desert. It is the month of July. How do you feel?

You are outside in the desert. It is the month of July. It is the middle of the day. Where is the sun? Are there any clouds?

You are outside in the desert. It is the month of July. It is the middle of the day. There is moisture on your skin
--why is it there?

You are outside in the desert. It is the month of July. It is the middle of the day. You see a mesquite tree nearby, what do you want to do?

You are outside in the desert. It is the month of July. It is the middle of the day. You are now in the shade of a mesquite tree. Still, you are very thirsty. What do you want?

You are outside in the desert. It is the month of July. You sit under the shade of the mesquite tree for a long time; hours pass by. What does the sun do? Do you have to move to stay in the shade? How do you feel? What else is under the shade of the mesquite with you? Are there other plants, animals, or people?

You are outside in the desert. It is the month of July. It is near the end of the day. Where is the sun? How are you feeling now?

The following challenges are common threats to deserts:

- The desert is not well suited for agriculture. When fields are abandoned due to lack of irrigation, the desert vegetation does not recover. Plants are very important to anchor the soil, and barren soils are easily eroded and desertified.

- In the majority of desert areas wildlife is threatened by human use. Animal populations, especially large mammals, have been considerably reduced.

- The exploitation of the scarce water resource in the desert further reduces the amount of available water for wildlife.

- Developments near water are very harmful to the environment if they are not well planned.

- Very large areas are needed to preserve desert habitats. There are very few protected desert areas in the world.

Procedure

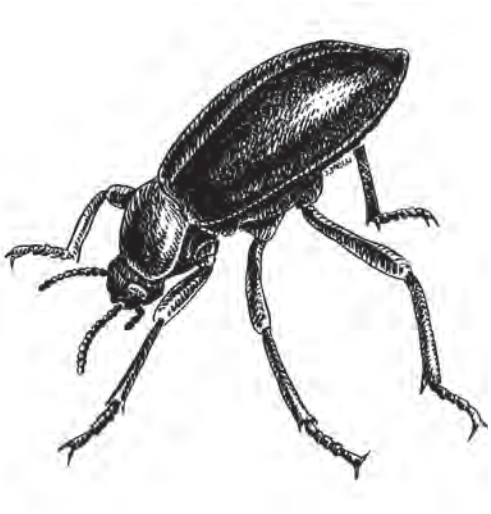
Part A: Imagining the desert

(Adapted from A Teacher's Guide to the Natural and Cultural Resources of Saguaro National Park http://www.nps.gov/sagu/forteachers/lesson-plansandteacherguides.htm)

1. Explain that this activity will remind students what they may already know about the desert. Tell the class that you are going to read a very short story and that they should use their imaginations to picture in their minds and "feel" the story. Through the story, some feelings and thoughts may arise which indicate some of the main characteristics of a desert (that is, what makes a desert, a desert). Have students close their eyes, relax, and listen very carefully. They will note that there are questions asked during the story; these are for them to consider quietly to themselves. After the story is finished, you will discuss it as a class.

2. Read the story found in the left side bar. Be sure to read the story with great expression.

3. After reading the story, have students slowly open their eyes. Conduct a class discussion in which students share their thoughts *and* feelings generated by the story. How many have had these feelings in real life? What did just about everyone feel and why? As a class, try to identify the main characteristics of the desert—heat, dryness, and lack of water (which correspond to students' feelings of being hot, dry, and thirsty). Help students define what makes a desert a desert.



In general, deserts are hot and dry; the desert sun is intense, evaporation is high and (except during the rainy season) there are generally few clouds and very little rain.

4. Ask students how they think the animals and plants "feel" in the desert. Do they experience heat and dryness? Explain that everything and everyone living in the desert is coping with the same conditions of heat, low rainfall, and high evaporation (and thus dryness).

5. Have a student locate the Sonoran Desert on the map found in their *Student Guide* at the end the desert section. Of all the deserts in the world, the Sonoran Desert is considered to be one of the most beautiful and has the greatest variety of plants and animals. While some deserts get less than an inch of rain each year, the Sonoran Desert receives an average of around 12 inches. However, even within the Sonoran Desert there is variation in rainfall. Some places (in the western Sonoran Desert near the coast) receive less than four inches per year while other areas may get up to 13 inches. It is this variation in rainfall as well as a variety of other factors that contribute to the high diversity of plants and animals in our desert.

Part B: What Makes a Desert a Desert?

<u>Activity 1</u>

This activity is best conducted on a sunny day. Have students stand in the sun for several minutes and "soak in the rays." After standing in the sun, have them move to a shaded area. Which do students prefer? Which feels hotter?

<u>Activity 2</u>

a. This activity illustrates just how dry desert air is as well as the principle of evaporation. Direct students to form teams of four to five participants each.

You will need:
A bucket or bowl of water, pieces of sponges or other rags, a watch with a seconds hand or a stopwatch, a sidewalk (part sunny and part shady).

b. Go to the sunny area. Hand out the sponges and have students dip them in the water. Have students write their initials on the pavement and time how long it takes for their letters to completely evaporate.

c. Do the same thing in the shade. In which place did the letters evaporate faster? Why? Where did the water go? Explain that the water **evaporated**—it changed from a liquid to a vapor, which is an unseen gas. Evaporation occurs faster in the heat. Can students think of other examples of evaporation? (*clothes drying on a line, a puddle drying up, etc.*) What would happen if this were done on a cloudy day?
Emphasise that students have now seen first hand a primary characteristic that makes a desert a desert: <u>evaporation in the desert is very high.</u>

Have students look around to find things in nature that are conserving water by taking advantage of shade and therefore reducing evaporation. The fact that water evaporates can be useful to animals (including humans) in the desert. This next activity demonstrates the effects of evaporative cooling.

Activity 3

a. Have students use their sponges to moisten one of their arms. Make sure the other arm is dry. They should then wave their arms all around. Which arm is cooler? Why? Explain that as the water evaporates from their skin, it has a cooling effect. This is why we sweat; it is our way to naturally cool off!

b. Many animals in the desert also use evaporative cooling to maintain their body temperatures. How? (sweating and panting). Plants are also affected by evaporation and have developed different ways to conserve water. For example, the waxy coating on cactus pads helps reduce water loss.

Conclusion

After students engage in all three activities, ask them "What makes a desert a desert?"

Low precipitation, and a high rate of evaporation. Not all deserts are hot, but the deserts in our region are.

Field Guide: Typical Flora and Fauna of the San Diego County/Baja California Region

Follow the instructions at the end of the introduction to Activity 3 for assembling the *Field Guide*, which will introduce students to the following flora and fauna:

Organisms in Deserts

Flora	Fauna
Silver Cholla, Chain-link Cholla	Darkling Beetle
Creosote Bush	Cactus Bee
Ocotillo	Sidewinder
Desert Sand Verbena	Greater Roadrunner
Shaw's Agave	Common Raven
White Bursage, Burroweed	Cactus Wren
Thurber's Stemsucker	Bighorn Sheep
Salt-Cedar	Coyote

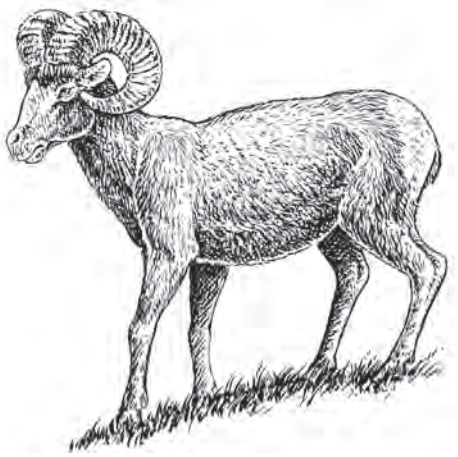
Reflection Excercise

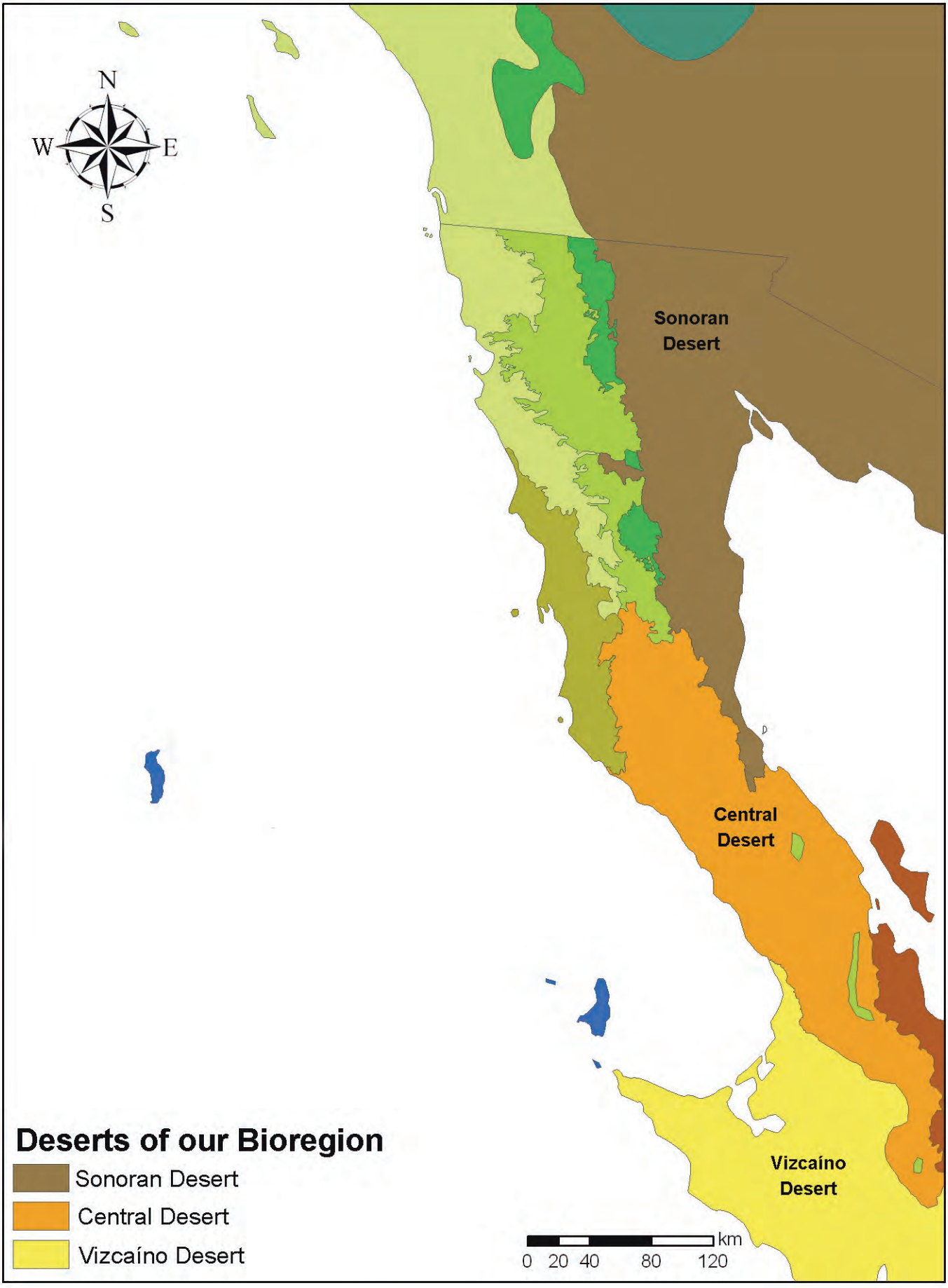
Explain to students that desertification is the degradation of soil. It is the process occurring in arid and semi-arid zones when a wild area is stripped, making it difficult for the spontaneous development of new vegetation to cover the affected area again, and causing it to be devoid of plants and animals for many years. Throughout time, the amount of land that has become a desert has increased significantly. Part of the explanation for this has to do with climate changes that have reduced the amount of rain in certain areas. When precipitation decreases, plants cannot tolerate the lack of water and die. Plants are very important to anchor and maintain the soil. Barren soils are easily eroded and therefore desertified.

Next, comment with students that these climate changes may be natural or caused by humans, and then ask: What human actions can cause **climate change**? What can each one of us do to stop the process of **global warming**? What adaptations would people need to develop to withstand the effects of desertification? Ask students to further research the subject and write a composition about it. Exhibit their work.

Evaluation

Ask your students to fill in the "Deserts" section in the *What Have We Learned About Our Ecosystems?* chart.




N
W
E
S
Sonoran Desert
Central Desert
Vizcaíno Desert
Deserts of our Bioregion
Sonoran Desert
Central Desert
Vizcaíno Desert
km
0 20 40 80 120

Activity 3e: Ecosystems Independent of the Type of Ecological Region

Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- English
- Mathematics
- Biology

Skills
- Observing
- Deducing
- Describing
- Comparing
- Hypothesizing
- Inferring
- Communicating

Concepts
- Wetlands are areas of land where we can find many characteristics and elements that can vary in each particular place depending on the climatic conditions of the land.
- Birds living in or around wetlands get their food in different ways depending on their beaks and the shape of their feet.

1) Wetlands

Background Information

Characteristics

Between land and sea a series of intermediate ecosystems share characteristics of both environments. These areas, called wetlands, are the most biologically diverse of all ecosystems.

The U.S. Environmental Protection Agency defines wetlands as areas that are flooded or saturated by surface or underground water and support vegetation adapted to life under saturated soil conditions. Wetlands include salt and freshwater marshes, swamps, sloughs, vernal pools, and mangroves. In Mexico, wetlands are defined as areas of land either temporarily or permanently covered with fresh or salt-water, and whose depth at low tide does not exceed six meters (18 ft.).

Wetlands differ considerably from their surroundings due to the soil characteristics, water, plants, and animals that live there.

- Plants grow and reproduce in either salt or freshwater environments. This type of plant is known as **hydrophilic** vegetation.
- Wet soils, known as **hydric**, are covered with water all or part of the time. They are saturated with water, have a low level of oxygen, and generally are black and contain decomposing matter.
- Wetlands are adjacent to bodies of water formed by natural forces, such as rain, tides, streams, etc.

Wetland Classification

Wetlands can be classified in several categories according to the type of plants they contain, whether the water is salt, fresh, or brackish, by the kind of soil, and by its shape and origin. Olmstead (1993) classified wetlands into:

1. Estuarine
2. Palustrine
3. Lacustrine

Estuarine wetlands are environments that are influenced by the tides, have access to the ocean (at least during a specific season of the year) and that receive freshwater run-off, at least occasionally. They include salt marshes.

Objectives

Students will:

- Discover how difficult it is to eat without the proper tool.
- Understand the relationship between a bird's beak and the food it eats (relationship between structure and function).
- Learn that the shape of a beak is an adaptation that allows birds to survive in the place they inhabit.

Time

Prep time: 60 minutes
Activity time: 30 minutes

Materials

For all:

- A board or flip chart
- Chalk or markers
- Bird poster or amplification of *Beaks and Feet* sheet

For each participant:

- A clear plastic disposable cup
- A copy of *Beaks and Feet* sheet
- A copy of the chart *What Have We Learned About Our Ecosystems?*

For each team:

- Toothpick
- Plastic spoon
- Scissors
- Clothespin
- 50 pieces of small pasta
- 50 pieces of foam packing peanuts
- 50 raisins
- 50 pieces of round cereal
- Deep plastic container with water
- White paper
- Pencil
- Color pencils

Palustrine wetlands are freshwater environments. They are dominated by freshwater hydrophylic plants, such as arrowroot, and vegetation found in meadows, palm groves, and low elevation rain forests.

Lacustrine wetlands are located in a topographic depression, channel or reservoir.

The majority of wetlands in our region are associated with bodies of water near the ocean known as estuaries, where the tides have a very important effect. These places contain a mixture of fresh and ocean water. Plant and animal characteristics vary in each site according to the salinity. Other coastal wetlands are swamps, deltas, lagoons, estuaries, mangroves, and salt marshes, among others.

Wetlands are very important to animals because they are ideal **breeding places** for many species, providing food, shelter, and protection for the youngest and most vulnerable animals.

Wetlands are also places where plankton, the fundamental element of the food chain, grows abundantly and provides food to a large variety of invertebrates (for example, shrimp, crabs, clams and worms) and small fish which, in turn, become food for the resident and migratory birds that nest or live in wetlands.

Benefits of Wetlands

Wetlands provide a great variety of goods and services to human populations. For example, during the rainy season, coastal and freshwater wetlands function as a sponge, absorbing excess water that can cause flooding in nearby areas and help replenish **water tables** that provide potable water. The roots of wetland plants function as a sieve that retains sediment and with it toxic substances. Wetlands support fishing and agriculture, wood production, energy resources, wildlife resources, transportation, and recreational and tourist activities. They also decrease strong river currents, reducing erosion along the shores.

In addition, coastal wetlands are nurseries for young fish. Halibut, Arrow Gobies, and Killifish spend the first years of their lives in estuaries before going out to sea. Common Round Stingrays have been spotted at the Tijuana River Estuary. Researchers believe that these rays utilize the safe areas within the estuary to raise their young. Coastal wetland plants buffer the force of the wind and waves that hit the coast.

Adaptations of Plants and Animals in Coastal Wetlands

In coastal wetlands, plants need to adapt to a salty environment. These plants are called **halophytes**, which means salt-loving. They do not require salt to grow, but they can thrive in salty environments because they have developed the means to neutralize salt. Plants like cordgrass can ex-

For every pair of students:

- One notebook: *Student Guide, Our Natural Heritage, Bioregional Pride*
- One copy of *Typical Flora and Fauna of San Diego County/Baja California Region*

Vocabulary

Alterations
Anemophilous
Aquatic
Azonal
Breeding place
Delta
Ecological succession
Halophyte
Hydric
Mangrove
Marsh
Migratory
Mollusk
Plankton
Riverbank
Ruderal
Semi-aquatic
Water table
Watershed
Wetlands

Preparation

1. Make sets of the different food "food" types.
2. Make necessary copies.
3. Obtain bird poster.

Description

Students collect different types of "food" and record and analyze data. Participation in this activity allows students to discover that the differences in birds' beaks have a direct relationship with the success in obtaining different kinds of food.

crete salt through special pores found in their leaves, and mangrove trees excrete salt through their roots. Other plants, such as pickleweed, store and then dilute salt in special cells.

In addition to salt, plants have to adapt to soil saturated with water. Cordgrass can survive in saturated soil because it has large specialized cells that form passages through which air travels from the atmosphere to the root system. Plants without this adaptation, such as the succulent pickleweed, live on higher ground. Just a few inches of elevation can make a difference in a wetland.

Birds that live in or around wetlands obtain their food in a variety of ways. Shorebirds probe for invertebrates in the mud, terns dive into the water for fish, and long-legged herons stand stark still or slowly wade while waiting for fish to swim by.

Conservation Challenges

Urbanization and development, hunting and fishing, and pollution (trash, wastewater, toxic chemicals from street runoff), are examples of major threats to wetlands. In California over 90% of coastal wetlands have been destroyed.

To protect wetlands it is necessary to implement actions that prevent their deterioration and destruction. These include preventing trash pollution, respecting the flora and fauna that depend on this habitat, and reporting toxic waste or sewage dumping. Information about controlled hunting and fishing programs in wetlands and surrounding areas can be obtained at the California Department of Fish and Game or the Procuraduría Federal de Protección al Ambiente (PROFEPA) in Mexico.

Field Guide: Typical Flora and Fauna of the San Diego County/Baja California Region

Follow the instructions at the end of the introduction to Activity 3 for assembling the *Field Guide*, which will introduce students to the following flora and fauna:

Organisms in Wetlands

Flora	**Fauna**
California Cordgrass	Marbled Godwit
Pacific Pickleweed	Clapper Rail
Orcutt's Bird's Beak	Savannah Sparrow
Saltwort	Snowy Egret
Saltgrass	California Horned Snail
	Least Tern
	Snowy Plover

2) Riparian Areas

Background Information

Riparian areas are the interface between land and a stream or river. The sediment left by the river on the waterway forms the soil where vegetation grows. The lack of structure, good aeration, and the constant presence of shallow water are the main characteristics of this environment. Plant communities along the river margins are called riparian vegetation.

Riparian areas are less affected by climatic factors, such as rain and temperature, than other kinds of vegetation that is dependent on larger climatic zones. This independence of the general Mediterranean climate gives riparian areas their **azonal** characteristics.

In general, San Diego County and Baja California riparian areas are characterized by broadleaf, winter deciduous trees reaching up to 45 ft. in height. Willow and alders grow with their roots in the water, cottonwoods and sycamores farther away.

The Arroyo Alamar is part of the hydrological system of the Tijuana River Watershed. Its physical and biological characteristics are one example of a riparian area existing in the **watersheds** in northwestern Baja California and Southern California. Currently, the Arroyo Alamar vegetation is constituted by three strata, arboreal (trees), shrub, and herbaceous in those areas where there is a good cover. In addition, there are some **aquatic** and **semi-aquatic** plants:

a. Arboreal: consists mainly of Gooding's and Arroyo willows (*Salix goodingii, S. lasiolepis*). These species are native, and reach heights varying from 12–45 ft. They are found along waterways and in contact with the water.

b. Shrub: consists mainly of Mule Fat and Desert Broom (*Baccharis glutinosa, B. sarothroides*); occurs primarily outside of the water channel in places that function as sand banks.

c. Herbaceous: variable in terms of native and introduced plants. Introduced plants invade the habitat when it is disturbed.

Aquatic and semi-aquatic plants are found in the waterway or in places where small ponds have formed.

Aquatic vegetation communities occur on the margins of streams or in bodies of water more or less stable, where the water current is minimal, and provide optimal conditions for floating, and/or submerged plants to grow. The distribution of this kind of vegetation is quite varied, although the majority is found in the Juárez and San Pedro Mártir Sierras, and in streams on the Pacific Slope. Some examples of this vegetation are cat-

tails, (*Cyperus spp.*), Bulrush, (*Typha latifolia*), and reeds (*Juncus spp.*), in addition to exotic (and harmful) reeds, such as (*Arundo donax*) and (*Phragmites australis*).

Riparian areas are found along the majority of coastal streams in northwest Baja California. These woodlands are habitat for Bell's Vireo (*Vireo belli*), the endangered Least Bell's Vireo (*W. bellii pusillus*), gnatcatchers (*Empidonax, sp.*), and Yellow-breasted Chat (*Icteria virens*).

Benefits of Riparian Forests

Riverbank vegetation, especially trees and shrubs, acts as a biological filter to absorb non-point-source pollution. This includes the excess of nutrients produced by fertilizers used in surrounding agricultural fields. The large **erosive** power of the river water, particularly in rivers with a torrential regimen, causes erosion and removal of herbaceous vegetation, including large woody vegetation. When riparian forests are well established, they tend to stabilize river margins. Otherwise, the abundance of suspended sediment can have detrimental effects on the environment, such as clogging river flows and decreasing the penetration of light into the water column. Due to the ability of riparian vegetation to retain sediment, the runoff into the aquatic system is substantially reduced.

Riparian forests are a preferential habitat for many mammal, bird, reptile, amphibious, and insect species. Plants provide food and shelter. The presence of abundant water added to healthy and diverse vegetation represents an ideal mix for the development of a strong animal community. Many areas on river banks constitute an essential habitat for certain migratory birds, and even constitute an important refuge in winter. This is especially true for many aquatic birds, but also for a multitude of small insectivorous birds that fly south from colder lands.

A fundamental role played by the vegetation framing water courses is that of ecological corridor. Riverbanks constitute a network that connects adjacent ecosystems, therefore their conservation and restoration cannot be considered alone, but rather needs to be considered at the watershed level. It is not enough to conserve small isolated patches or tree rows; we need to maintain the forest's structure and its connectivity. In addition, in our region, riparian forests constitute one of the few refuges of deciduous vegetation which is an irreplaceable habitat for the flora. Riverbanks in Mediterranean climates are home to species that are found at the tip of their distribution area, and have evolved with changes that support their survival under conditions of higher sunlight and hydric deficit.

Riparian vegetation provides an indispensable shadow that controls numerous processes and modifies the river's or the stream's microclimate. This is especially important for fish that would be affected by increasing water temperature and the consequential reduction in dissolved oxygen. The scenic quality of the river landscape is linked to the presence of vegetation on the margins of watercourses, especially in Mediterranean

lands where the green vegetation contrasts with the dominant dryness of the landscape. (Based on: Antoni Aguilella. Jardí Botànic, Universitat de València. Segundo Ríos. Centro Iberoamericano de la Biodiversidad - CIBIO, Universitat d'Alacant en: http://es.wikipedia.org/wiki/Bosque_ripario).

Fire

Riparian forests show an ability to recuperate after a fire much superior to that of surrounding hills. **Ecological succession** is a response to disruptions, such as fire.

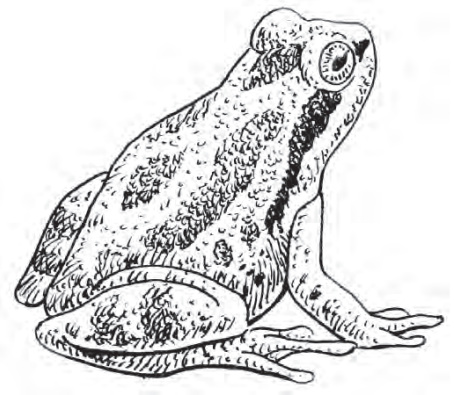
Adaptations

Riparian vegetation has no need to adapt to drought because the soil provides year-round moisture.

Riparian species stand out for their ability to disperse seeds a long distance to places with adequate moisture in dry zones, which is an adaptation to habitat fragmentation. Riparian trees with a more extensive distribution, such as cottonwoods and willows, have **anemophilous** seeds, capable of quickly establishing new colonies far away.

Conservation Challenges

Riparian areas are fragile ecosystems. This means that any **alteration** to the area directly affects the flora and fauna that depend upon this ecosystem's structure. Unfortunately, alterations to riparian forests due to the use of their resources by humans are very intense and there are few that remain intact.



The relationship of humans with riparian forests has always been negative for the forests, at least in areas more densely populated. Land use, including agriculture, extraction (potable water, wood, etc.), the growing pollution, urban and industrial waste, and sometimes some of the conservation infrastructures, built with techniques that have not been thoroughly studied and favor removing watercourses, are some of the main threats currently faced by our fluvial ecosystems.

Due to the loss of fresh water flows to the Colorado River delta, the remaining wetlands and riparian area located there has shrunk to 5% of its size a century ago. In addition, non-native species now jeopardize the health of a large portion of the remaining area (Glenn et al., 1996). Native cottonwood and willow forests have given way to sand, and marshes are dominated by salt cedar (*Tamarix spp.*), Arroweed (*Pluchea sericea*), and Iodine Bush (*Allenrolfia occidentales*).

Beaver and otter (Lontra canadensis sonorae) populations, as well as other species, have been disappearing from the Colorado River (Leopold, 1959) and other locations near the U.S./Mexico border (Río Gila, Arizona—Nuevo México; Hall 1981) due to deforestation. The otter species is considered extinct. (Gallo-Reynoso, 1997, en Delgadillo, 1998).

In California and Baja California many bird species who used to find adequate living conditions in riparian habitats have stopped nesting, and their numbers have greatly been reduced as a result of decreasing habitat due to the loss of willow and cottonwood woodlands, and depredation by the Brown-headed Cowbird (*Molothrus ater*), a native parasite species (Fremontia, 1999).

Field Guide: Typical Flora and Fauna of the San Diego County/Baja California Region

Follow the instructions at the end of the introduction to Activity 3 for assembling the *Field Guide*, which will introduce students to the following flora and fauna:

Organisms in Riparian Areas

Flora	**Fauna**
Willow	Common Green Darner
Freemont Cottonwood	Common Yellowthroat
Coast Live Oak	Raccoon
Sycamore	Pacific Tree Frog

Procedures

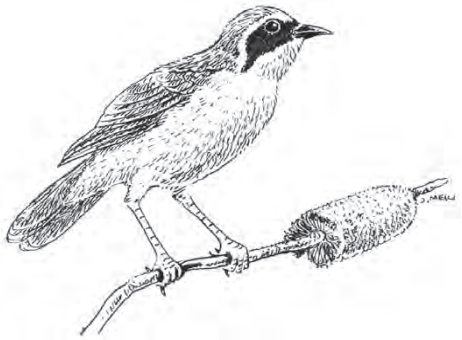
Introduction

1. Introduce the activity by asking students if they remember what animal adaptations are.
   Any body shape, process, or behavior that allows an organism to survive in its environment. Animals change over time to meet the demands of their environment. (If they don't, they perish and do not reproduce.)

2. Next, ask students to mention as many different shaped bird beaks as they can. Ask them why they think there is such a variety of beak shapes.
   Birds have many different kinds of beaks, depending on what they eat and where their food source is. Birds may find their food in water, mud, flowers, seeds, or in wood. The different shapes of beaks allow easier access to these various food supplies. For example, a hummingbird's long, thin bill allows it to sip the nectar from flowers. If an environment is altered, organisms within the area would need to change—adapt—in order to survive. Natural selection is the process by which organisms best suited to the environment survive and reproduce, thereby passing their genes to the next generation.

3. Tell students that birds living in or around wetlands look for food in different manners and in different places. Some birds live in water and swim to find their food. Others walk on the mud to find their food.

Other birds find food in shrubs and trees; and some others fly over the land, wetlands or water looking for food. Each of these birds has feet that help them get the food they need to survive.



4. Show the class the *Beaks and Feet* overhead transparency. Ask volunteers to choose a beak and guess what kind of food that bird might eat and how it uses its beak. Do the same with the feet. Use the information below to guide the discussion.

   Birds that capture flying insects have short and pointed fly-catching beaks. They also frequently have a kind of lint on the corner of their beaks.

   Long and pointy beaks serve as spears to get fish and frogs.

   The long and thin beaks of coastal birds are for probing the mud in search of worms and clams.

   Falcons and eagles have hooked beaks that serve to tear flesh.

   Birds that dive to find their food have longer beaks ending in a small hook-shaped tip that serves to catch fish.

   Birds that eat seeds (granivorous) have short and thick beaks that they use to break or pop seeds.

   Ducks' beaks are flat and serve to strain the water.
   Avocets have an upwardly curved beak to help filter mud to find tiny organisms to eat.

   An ideal foot for swimming is a paddling foot, that is, a foot that has membranes between the toes to join them to make a paddle shape.

   Raptors that hunt animals such as rabbits and squirrels have grasping feet, with large, strong toes and long, sharp nails.

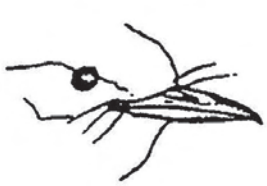
   Because mud can be soft, birds that walk on mud have wading feet with long toes that keep them from sinking.

   Feet that serve to climb shrubs and trees need to have long and thin toes, and sharp nails that can grasp branches.

The Activity

This activity provides students with a hands-on experience that will help them explore bird-beak shapes in relation to food source.

1. Divide the class in teams of four students each. Each team should sit around a table or desks pushed together.



2. Distribute to each team the four kinds of "beaks"—one for each participant (clothespin, toothpick, scissors, and spoon). Also distribute a cup for each participant and a copy of *The Best Beak* chart.

3. Ask students with scissors to hold them up, and explain that they are scissors-birds. Continue with the remaining implements (clothespin-birds, spoon-birds, etc.) and tell them that the implement functions as their beak.

4. Explain that they are going to participate in an activity to find out which beaks are best adapted to eat different kinds of food.

5. Tell students they are going to try to collect different types of "food" with their "beaks" and place them in their "stomachs" (cups). They need to try to place as much food in their stomachs as possible in 45 seconds.

6. Distribute the first type of food (for example, small pasta) to each team. Make sure that you give the same amount to each team. Have students hold their implements up until you say "start!" When you say "start," students will "eat" as much food as possible.

7. When time is up, have students place their implements on the table and count how much food they each have in their "stomach," and record it on their *The Best Beak* chart.

Table. The Best Beak

Beak / Food	Tweezer-beaks	Scissors-beaks	Spoon-beaks	Toothpick-beaks
Styrofoam	0	1	6	0
Macaroni	5	0	4	0
Raisins	0	7	0	8
Ball-Shaped Cereal (Kix)	2	0	3	0

8. Continue the activity with each type of food.

9. Draw a large copy of *The Best Beak* chart on the board (or post it using a large sheet of craft paper) and tally the total of collected food items per "beak" per team.

10. Finally, add all the totals for each team, and record the amounts on the class chart.

11. Ask participants which bird ate the most pasta pieces. Why? Continue the discussion so as to include all the types of food.

12. Ask students if the shape of a bird's beak limits their food supply. Discuss why certain bird beaks are better suited to collect certain types of food. Relate the activity to real birds and give examples of birds found in the students' environment.

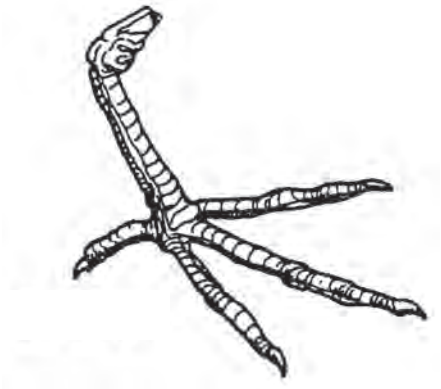
13. If you wish, give each student a *Beaks and Feet* handout to color.

Reflection

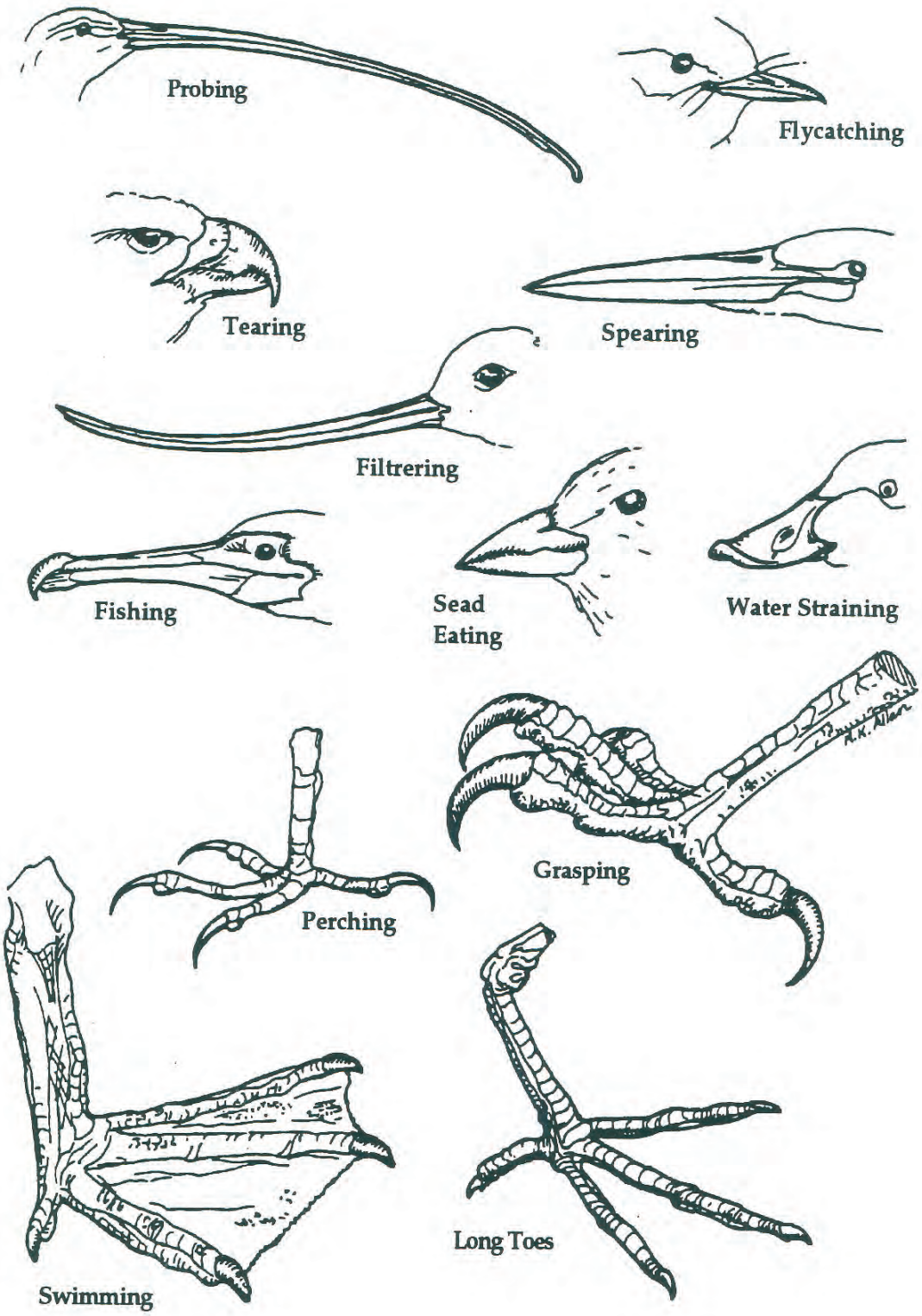
Take your students to the school playground and encourage them to silently observe the birds that come there. Ask them to observe their beak shape and, based on what they just learned, ask them to make predictions as to what kinds of food they eat. Next, ask students if they find a difference between the eating habits of wetlands birds and the birds that come to their school. What would happen if we brought some of the wetlands birds to the school to keep as pets? What threats do wetlands birds face when wetlands disappear?

Evaluation

Ask your students to fill the Wetlands section in the *What Have We Learned About Our Ecosystems?* chart.



BEAKS and FEET



Name(s) _____ Date _____

The Best Beak

Beak / Food	Tweezer-beaks	Scissors-beaks	Spoon-beaks	Toothpick-beaks
Styrofoam				
Macaroni				
Raisins				
Ball-Shaped Cereal (Kix)				

Name of Students _____ Date _____

What Have We Learned About Our Ecosystems?

Ecosystem	Predominant environmental conditions	Plants	Plant adaptations	Animals	Animal adaptations
Kelp forest					
Beach/ Tidepools					
Coastal Sage Scrub/ Succulent Sage Scrub/ Chaparral					
Pine/ Oak Woodlands					
Desert					
Wetlands/ Riparian Areas					

Activity 3f:
Global Changes and Our Ecosystems

Background Information

We are all aware that our ecosystems are undergoing multiple changes, many of them due to the effects of human activity. Here we have highlighted selected changes affecting the ecosystems in our region.

1) Habitat fragmentation

Habitat fragmentation is a process of environmental change important in evolution and conservation biology. As the name implies, it describes the emergence of discontinuities (fragmentation) in an organism's preferred environment (habitat). Habitat fragmentation can be caused by geological processes that slowly alter the layout of the physical environment, or by human activity such as land conversion, which can alter the environment on a much faster time scale. Geological processes are suspected of being one of the major causes of speciation, or the formation of new species. Human activity is the cause of extinctions of many species.
Habitat fragmentation is frequently caused by humans when native vegetation is cleared for human activities, such as agriculture, rural development or urbanization. Habitats that were once continuous become divided into separate fragments. After intensive clearing, the separate fragments tend to be very small islands isolated from each other by cropland, pasture, pavement, or even barren land.
The term habitat fragmentation can be classified in six categories:

- Reduction in the total area of the habitat
- Increase in the amount of edge
- Decrease in the amount of interior habitat
- Isolation of one habitat fragment from other areas of habitat
- Breaking up of one patch of habitat into several smaller patches
- Decrease in the average size of each patch of habitat

Habitat Destruction

One of the major ways that habitat fragmentation affects biodiversity is by reduction in the amount of available habitat for plants and animals like coastal scrub or chaparral. Habitat fragmentation invariably involves some amount of habitat destruction. Plants and other sessile organisms (those that are attached to the substrate) in these areas are usually directly destroyed. Mobile animals (especially birds and mammals) retreat into remnant patches of habitat. This can lead to crowding effects and increased competition.

The remaining habitat fragments are smaller than the original habitat. Species that can move between fragments may use more than one fragment. Species that cannot move between fragments must make do with what is available in the single fragment in which they ended up. Since one of the major causes of habitat destruction is agricultural development, habitat fragments are rarely representative samples of the initial landscape.

Reduced Viability

Area is the most important factor in the number of species in a fragment. The size of the fragment will influence the number of species that are present when the fragment was initially created, and will influence the ability of these species to survive in the fragment. Small fragments of habitat can only support small populations of plants and animals and small populations are more vulnerable to extinction. Minor fluctuations in climate, resources, or other factors that would be unremarkable and quickly corrected in large populations can be catastrophic in small, isolated populations. Thus fragmentation of habitat is an important cause of species extinction. In an unfragmented landscape a declining population can be "rescued" by immigration from a nearby expanding population. In fragmented landscapes, the distance between fragments may prevent this from happening. Additionally, unoccupied fragments of habitat that are separated from a source of colonists by some barrier are less likely to be repopulated than adjoining fragments.

Additionally, habitat fragmentation leads to edge effects. Microclimatic changes in light, temperature, and wind can alter the ecology around the fragment, and in the interior and exterior portions of the fragment. Fires become more likely in the area as humidity drops and temperature and wind levels rise. Exotic and pest species can establish themselves more easily in such disturbed environments, and the proximity of domestic animals often upsets the natural ecology. Also, habitat along the edge of a fragment has a different climate and favors different species from the interior habitat. Small fragments are therefore unfavorable for species that require interior habitat.

Conservation Implications

Habitat fragmentation is often a cause of species becoming threatened or endangered. The existence of viable habitat is critical to the survival of any species, and in many cases the fragmentation of any remaining habitat can lead to difficult decisions for conservation biologists. Given a limited amount of resources available for conservation, is it preferable to protect the existing isolated patches of habitat or to buy back land to get the largest possible continuous piece of land? This ongoing debate is often referred to as SLOSS (Single Large or Several Small).

One solution to the problem of habitat fragmentation is to link the fragments by preserving or planting corridors of native vegetation. This has the potential to mitigate the problem of isolation but not the loss of interior habitat. In rare cases, a threatened species may gain some measure of protection from disease by being distributed in isolated habitats.

Another mitigation measure is the enlargement of small remnants in order to increase the amount of interior habitat. This may be impractical since developed land is often more expensive and could require significant time and effort to restore.

The best solution is generally dependent on the particular species or ecosystem that is being considered. More mobile species, like most birds, do not need connected habitat while some smaller animals, like rodents, may be more exposed to predation in open land. These questions generally fall under the headings of metapopulations or island biogeography.

San Diego County's Multiple Species Conservation Program deals with this challenge. To learn more refer to http://www.sdcounty.ca.gov/dplu/mscp/.

2) Exotic Plants

The following is from an article by San Diego Natural History Museum Canyoneer, Reva Block. Canyoneer Bill Howell wrote the article that follows about mustards.

Alien Invaders Do Their Dirty Work!

They are not refugees from Area 51 of the X-Files, and they do not drop from the sky in saucers. Instead, they display lush green leaves or colorful flowers. Some add grace, beauty and shade to our area. However, looks are everything. While many of the aliens are benign, the outward appearance of some belies their destructive ways. They are among the many non-native plants that thrive in California's [and Baja California's] climate. Here are some definitions that help us understand their roles in our environment.

Native: Any plants that were here in their natural range and dispersal zone before European settlement and that can survive without human intervention.

Exotic/alien: Any species that grows beyond their natural range and dispersal zone. These plants were mostly introduced and cultivated after European settlement. Many have escaped cultivation to become weeds in our parks, preserves, along roads and in wildlands.

Naturalized: Any exotic plant that has escaped cultivation, has blended with the native environment, and proliferates without human intervention. Most naturalized plants do not cause damage to the ecosystem, and do not displace indigenous biological communities. Those that damage native ecosystems are in the next category.

Invasive/exotic: These plants proliferate rapidly and alter or displace indigenous biological communities. They thrive for several reasons: they complete their reproductive cycles before natives; diseases and pests in their original ecosystems do not come with them; many have tiny seeds that scatter easily with wind and water; some can also reproduce asexually from fragments of their vegetation or from root crowns. The invasive exotics are the ones to worry about.

So, how did these pests get here, anyway?

Many were brought in for commercial purposes—to use as thatch or windbreaks, for home décor, landscaping and erosion or fire control. Others came in accidentally through travel, tucked away in a ship's cargo, with seeds hiding in burlap wrapping. Before European crops were raised; seeds hiding in shipboard packing materials found their way into adobe bricks used to build missions. Following are some examples of the most widespread and aggressive invasive exotics.

Fennel (*Foeniculum vulgare*) Brought here by Southern Europeans about 120 years ago, this member of the carrot family was cultivated as a condiment. It escaped cultivation and invaded disturbed areas. Its dense, uniform stands crowd out coastal sage scrub, riparian plants and grasslands as it out-competes native species for light, nutrients and water. This aromatic weed disperses millions of tiny seeds by water, animals and humans. It also grows asexually, so simply cutting it down doesn't remove it; it re-sprouts from remaining root crowns. Its thick taproot can quickly slurp up the scarce water that our native plants need in our arid environment. The most effective removal method is spraying Roundup, an herbicide that quickly breaks down in the soil. As destructive as fennel is, there are some plants that are even worse: salt cedar, pampas grass and giant reed.

Mustards

Spring rains turn hillsides green and yellow with a pinch of red. The buttery tinge is mostly from members of the mustard family (*Brassicaceae*). Many are non-native weeds and have roots in other lands. Familiar members of this assemblage include cabbage, cauliflower, broccoli, brussel sprouts, radish and mustard. They all have a little "bite" to the taste. A botanical feature uniting the family is four petals forming a tiny cross, hence the old family name *Cruciferae* (Crucifix). Especially common are three members of the genus Brassica. This golden trio from Eurasia is well established in San Diego County and northern Baja California.

Short-pod mustard is first to flower in the spring and may, in mild times, bloom all year. Short-pod is a foot or more high, with pale yellow flowers in tight little heads about the size of a dime. Its short, 1/2-inch seedpods grip the stem.

Field mustard, the next to blossom, can reach up to two feel tall, with loose flower clusters about 1.5 inches in diameter. Intense canary-colored petals and leaves wrap around the stem. Three-inch-long seedpods stick out from the stem at a wide angle.

Black Mustard has yellow flower clusters about 5/8 inches in diameter. This mustard grows slowly at first and reaches up to 12 feet tall. Dried autumn stalks an inch across may form a forest of brush that can obstruct passage for a year. The small, 1/2 inch seed pods hug the stems.

Note: the following information on invasive species is added by PROBEA authors. Sahara Mustard (*Brassica tournefortii*) is an extremely invasive annual that has extended to large areas of the southwestern deserts. It can blanket whole areas, smothering our annual wildflowers and changing the appearance of the desert. Sahara Mustard has a basal rosette of large-lobed leaves that are covered with rough (and irritating) hairs. A bare branching flower stalk rises above the rosette. The small, pale yellow flowers have four petals that soon develop into long, narrow seedpods that stick out from the stalk at right angles. Saharan Mustard often grows along the roadside, and then extends inland. In addition to the desert habitat first invaded, Sahara Mustard is now growing in areas closer to the coast and in the Cuyamaca mountains.

3) Drought and Beetles in our Forests

Bugs and diseases are killing trees at an alarming rate across the West, from the spruce forests of Alaska to the oak woodlands near the San Diego/Tijuana border.

In San Diego County U.S. Forest Service officials recently announced that the gold-spotted oak borer has infested an area larger than they thought just a few months ago. The beetle could easily spread north into more of the estimated 33 million forested acres statewide.

The gold-spotted oak borer already is blamed for killing more than 10,000 oaks in the county, and the worst may be yet to come. Climate models show the Southwest becoming increasingly warm and dry over the next century, conditions that leave the Cleveland National Forest and others vulnerable.

Insects and disease are a normal part of the forest life cycle because they help break down plants and put nutrients back into the soil. Normally trees secrete a resin that helps ward off the pests. But during drought, trees lack sufficient water to manufacture the resin and are vulnerable to insect infestation. The insects kill the trees and the whole ecosystem can collapse, leaving dry timber that readily burns in forest fires. Bark beetles in Southern California peaked five years ago, when they killed drought-stressed trees across tens of thousands of acres and provided fuel for the catastrophic wildfires of 2003.

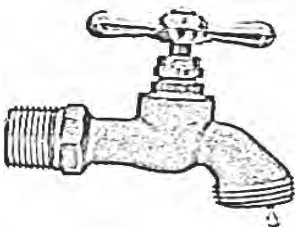
Global warming is responsible for the northward spread of the bark beetles from Mexico and the Southwest. In addition, slightly warmer winters allow more insects to survive from one year to the next, increasing their numbers. And warmer summers allow the insects to reproduce more quickly. Researchers also report that insects are moving higher up in the mountains because they can survive in areas that used to be too cold.

Scientists say that the effect of climate changes on forests is compounded by other factors, including decades of fire suppression that have left some forests too dense for the water available.

In San Diego County, the spread of the oak borer is a mounting concern. The metallic-green insect has hit particularly hard in and around Pine Valley, Laguna Mountain, Descanso and Cuyamaca Rancho State Park.

Tom Coleman, the Forest Service entomologist who announced the discovery of the oak borer in August, said the beetle probably arrived in the county on a shipment of firewood from Mexico. They recently banned taking oak firewood from the forest's Descanso Ranger District, but they can't control the movement of wood from private property. They have talked about other measures, including the removal of dead trees.

4) Water Scarcity in Baja California



Fossil water is groundwater that has remained in an aquifer for hundreds or even thousands of years. It is not recharged, so extraction of fossil water is sometimes referred to as water mining because it is a non-renewable resource. The construction of large-scale tourism development in the Baja California peninsula is based on the over-extraction of underground water.

This same approach has already been used in agricultural developments in the so-called "greening of the desert" during the 1950s–1960s in states around the Gulf of California, especially in Sonora and Sinaloa. Rivers were dammed and rainwater flowing from high up in the mountains ceased to flow into the Gulf of California. Wells were drilled all over the desert basins. While the immediate results did indeed turn the desert green, the long-term results were devastating. Seawater seeped into the coastal aquifers, poisoning the wells, and thousands of hectares had to be closed to agriculture, leaving behind a barren salty wasteland. Wetlands and coastal lagoons that provide critical nursery grounds for fisheries degraded. As pumping reached deeper into shrinking aquifers, arsenic appeared in the water, creating a health hazard.

Today's developers claim that the aquifer is being used sustainably, but they show no data that prove that. And the Comisión Nacional del Agua has admitted that all large aquifers in the region are being exploited beyond recovery.

In addition, converting water use into agricultural products and tourism services is very expensive. The table below depicts the expense in terms of electricity with the resulting carbon footprint.

	Water consumed	Description of water consumed	Electricity consumed
1 kilo of maize	2.5 m^3	Enough to provide for the needs of a family during one week	1.5 kilowatt hours
1 kilo of beef	20 m^3	Enough for a small swimming pool	20 kilowatt hours
15 hectare golf course	850 m^3/day	Enough for 3,000–5,000 people/day	33–66 Kilowatt hours daily

As we know, fossil fuel is burned to produce electricity, releasing greenhouse gases that contribute to global warming. Irrigating a hectare of golf courses or hotel lawns will contribute two to four metric tons of greenhouse gases to the atmosphere. More that 50 calories of fossil energy is used to produce each calorie of beef.

The cost in social upheaval is also high as aquifers gradually run out of water. Large numbers of poor people brought to the region to build resorts or tend the gardens will find themselves out of work, producing emigration from the region. Existing data show very clearly that fossil water is beginning to run out in Los Cabos, La Paz and Loreto with the possibility that other areas of the Baja California peninsula will soon follow.

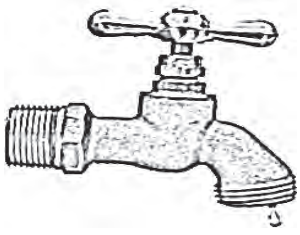
The supposed alternative of obtaining water from the sea through desalination has serious economic limitations, since it requires large amounts of electricity. At the current cost of electricity, a 15-hectare golf course used $200,000 worth of electricity and has a large carbon footprint.

Potential Solutions

In the long term, coastal developments will demand a more efficient use of water or risk their slow economic decline as water supplies dwindle. Following are some suggested solutions. Can you think of others?

- Protect the Baja California mountains that provide the water supply to the regional oases and aquifers
- Protect and restore coastal wetlands
- Use water-efficient landscaping, including xeriscaping and native-plant gardening
- Treat and recycle wastewater
- Establish clear, rigorous, independent evaluations of aquifer reserves and renewal rates
- Force local users to adapt to sustainable consumption

5) Water Scarcity in California



Much of the southwestern United States has been in a severe drought since 2000, according to a study released in the journal Science in April 2006. And the study's analysis of computer climate models shows that this is just the beginning of a long dry period, predicting a permanent drought by 2050 throughout the Southwest—one of the nation's fastest growing regions. The last period of significant, prolonged drought was from the years 900–1300 when the region experienced dry periods that lasted as long as 20 years, scientists say.

Air currents that arise from variations in sea-surface temperature in the Pacific Ocean, known as La Niña, determine periods of drought. During La Niña years, precipitation belts shift north, parching the Southwest. In addition, a global circulation pattern, called the Hadley cell, could cause drought. Within the cell, air rises at the equator, moves toward the poles and descends over the subtropics. Increasing levels of greenhouse gases warm the atmosphere, making the Hadley cell expand toward the poles. Dry air, which suppresses precipitation, then descends over a wider expanse of the Mediterranean region, the Middle East and from Kansas to California and south into Mexico. Global warming intensifies existing patterns of vapor transport, causing dry areas to get drier and wet areas to get wetter. When it rains, it is likely to rain harder, but scientists said that was unlikely to make up for losses from a shifting climate.

According to the State of California Department of Water Resources, climate change is already impacting California's water resources. The Sierra Mountains snowpack is expected to be reduced by 25% by 2050. This will affect the water supply available from slowly melting snow. More precipitation in the form of rain (rather than snow) will create changes in river flow, cause flooding and impacting water quality, fisheries and recreation. Overall lower levels of water in the reservoirs may decrease power generation. Lower water tables, due to hydrologic changes and greater demand, cause some shallow wells to go dry. California depends on the Sacramento Delta for much of its water supply and less fresh water flowing out of the Sacramento Delta in spring and early summer will allow more salt water to intrude, changing the ecosystem. Warmer temperatures create changes in habitat that stress cold-water species such as salmon.

The biggest problem will be water shortages. The seven Colorado River Basin states — Colorado, Wyoming, Utah, Nevada, New Mexico, Arizona and California — will battle each other for diminished river flows. Mexico, which has a share of the Colorado River under a 1944 treaty and has complained of U.S. diversions in the past, will join the struggle.

There are going to be some tough decisions on how to allocate water. Inevitably, water would be reallocated from agriculture, which uses most of the West's supply, to urban users, drying up farms. California would come under pressure to build desalination plants on the coast, despite environmental concerns.

The following two articles, "Wildland Fire" and "Climate Changes and Our Ecosystems," were written by Anne S. Fege, Ph.D., M.B.A., Retired Forest Supervisor of Cleveland National Forest and Botany Research Associate, San Diego Natural History Museum, December 16, 2008

6) Wildfires

Fire ecology is a branch of ecology that studies the relationship of fire with living organisms and their environment. Some natural communities are fire-dependent; that is, they are adapted to and rely on the effects of fire to make the environment more hospitable for that community's plants and animals. Other communities are fire-adapted, with traits that allow them to maintain their structure and not be altered by the fire, or that allow them to rapidly regenerate afterwards.

Southern California and the northern parts of Baja California are characterized by a Mediterranean-type climate, meaning a climate with cool wet winters and long dry summers. During winter and spring, mild temperatures and precipitation promote abundant vegetation growth. However, during the summer months this abundant vegetation dries out and overtime builds up to create a large amount of dry fuel on the landscape. When these fuels are ignited (either naturally by lightening, or by humans) large expanses of woodland, shrubland and grassland can burn.

Fires release nutrients (such as nitrogen, phosphorus, and carbon) from woody vegetation back into the soil in the form of mineral-rich ash, which makes the nutrients readily available for new plant growth. Plant regeneration begins almost immediately following a fire. At any given location, different types of vegetation develop over time in orderly stages called **succession**. The natural recovery of the vegetation following wildfire depends on plant species that either survive fire in place (re-growth through re-sprouting) or are capable of colonizing the immediate post-fire site from seed. As a result, the severity of the fire directly influences the types of species and number of plants that survive and recover afterwards. Each successive stage is also determined by climate, soil conditions, geography (location) and available sunlight.

Ecosystem Responses to Wildland Fire

Chaparral and Coastal Sage Scrub

When a fire burns through chaparral and coastal sage scrub, the above-ground parts of the majority of the shrubs are consumed. Post-fire recovery occurs through re-sprouting from underground parts (often referred to as root crowns or lignotubers) and the germination of seeds that are insulated from the fire in the soil or transported into the burn site from unburned areas. **Obligate resprouters** survive fires by re-sprouting only (Toyon and Scrub Oak). **Obligate seeders** require a fire cue to germinate (*Ceanothus*).

The first post-fire season often sees a flush of colorful herbs, some of which are only found following a fire (called fire-followers or fire-annuals). These species germinate and flower during the first post-fire growing season, then the seeds lay dormant in the soil—sometimes for decades—and wait for the next fire.

Fires that occur too close together in time (high fire frequency) have contributed to the "type-conversion" of coastal sage scrub to annual grasslands dominated by non-native grasses. Normally, a fire will occur in coastal sage scrub about every 30 years, but when the interval become every 2–3 years the native shrubs are unable to recover and non-native grasses takeover. Once established, these grasses inhibit the recovery of native species.

Old-growth chaparral stands represent some of the region's most valuable natural resources and need to be protected. Although there are still large tracks of chaparral throughout California, the combination of increased fire frequency and development will seriously compromise the ecosystem's health and integrity over the next century.

Mixed-conifer Forests

Fire is an important disturbance agent and plays an important role in the maintenance and composition of mixed conifer forests. Fire benefits these forests by preparing the soil for seed growth by clearing underbrush and adding nutrients through ash, and by eliminating dense thickets of small trees, thus maintaining a healthy density of large pine trees. Many of the tree species found in the mixed conifer forest are adapted to or even require fire to reproduce.

The natural fire regime of mixed conifer forests has been estimated using both fire records and fire-scar methods. Estimates range from a 4- to 30-year fire interval (number of years between two successive fire events at a specific site or an area of a specified size). These frequent fires are thought to have been low-intensity, surface burns that had minimal effect on large trees. This type of fire regime created an open, park-like forest dominated by large pine trees and a grassy forest floor.

Since the early 1900s, humans have changed the natural fire regime across the western United States by excluding and suppressing fire. As a result, the amount of time that passes between fires has gotten longer and longer. Fire exclusion has allowed the persistence of shade-tolerant species (species that can live in shade and do not need direct sunlight) that would otherwise be rare in a mixed conifer forest with a fire regime of frequent surface fires. These species, such as incense cedar and white fir, form a second layer of trees below the uppermost canopy in mixed conifer forests of the west, including the forests of Southern California. These thickets of shade-tolerant species act as "ladder-fuels," carrying fire from the ground up into the canopy of the tallest trees and causing a crown fire. Stand-replacing fires result in the mortality of even large, fire-tolerant trees (trees adapted to live through fires).

The Cedar Fire of 2003 was a stand-replacing crown fire in 25,000 acres of Cuyamaca Rancho State Park. The fire occurred under extreme weather conditions and was spread into the forest by the surrounding chaparral habitat and fanned by strong, westerly winds. Unfortunately for people who loved the mixed-conifer forests, most of the conifer trees died in the fire (95% conifer mortality). Most conifer species cannot re-sprout and either depend on their thick bark and other adaptations to protect them from fire, or respond by producing many seedlings. Along with re-sprouting oaks, there were many re-sprouting chaparral shrub species, many shrub seedlings, and lots of beautiful wildflowers.

Oak Woodlands

Fire is a natural part of California's oak-woodland habitat. Thus, native oak species have evolved mechanisms to survive periodic burning and suffer little long-term damage from the burning of their foliage. Their thick bark offers protection even from high-intensity fires and the trees are able to re-sprout (that is, to grow new stems and leaves) afterwards. Although an oak tree may appear dead (with brown leaves and black bark) following a fire, it may still recover and re-sprout new foliage up to a year after being burned. If the above-ground portion of the tree is completely consumed by a fire, most will still re-sprout from the base and, over time, results in a mature tree with multiple trunks.

Grasslands

Historically, fire was regularly used by Native Americans and early European settlers to convert shrubland into grassland for foraging and grazing purposes. Grasslands are quick to recover following a fire, typically regenerating after the first post-fire year.

Deserts

Fire was historically infrequent in most desert shrublands; estimates of the historical fire regime range from 50 to over 100 years. Desert plant communities historically lacked a large grass component, and the native vegetation of these regions did not provide sufficient fuels to carry fire. In addition, the bare spaces between widely dispersed shrubs prevented fires from spreading far beyond points of ignition.

Native shrubs are poorly adapted to fire, as evident in their low rates of recovery. Repeated fires may also be disastrous to some species of cactus, such as barrel cactus whose recovery may take more than 15 years. Frequent fires may gradually reduce succulent populations, although some are able to recover by re-sprouting.

With the invasion of species like non-native annual grasses, fuel loads have dramatically increased, the fire cycle has been significantly shortened and fires are more likely to spread. The result has been the conversion of desert scrub landscapes to "weedscapes" dominated by non-native, invasive plants.

Fire Effects on Wildlife

The effects of fire on a habitat, which includes an animal's surroundings or home, are generally more significant than immediate effects on the animals themselves. Most wildlife species have proved very adept at avoiding being burned in a fire either by moving out of the area or retreating below ground. As post-fire recovery of the vegetation proceeds, the types of animal species found in the burned area changes as the habitat changes. The grasses, seedlings, and re-sprouting shrubs and trees that cover burned areas provide an ideal environment for many small seed-eating mammals and birds, such as voles and sparrows. This abundance of small prey attracts larger predators like foxes, hawks, and weasels. Burned trees provide sites for birds like flickers, kestrels, and chickadees which nest in holes in dead, standing trees, while woodpeckers thrive on the insects that inhabit fire-killed trees. Some species found in a particular area prior to a fire may not return until the habitat recovers to its pre-fire state.

Wildland fire text is excerpted from the San Diego Wildfires Education Project, San Diego State University, posted at http://interwork.sdsu.edu/fire/resources.htm.

7) Climate Change

The scientific evidence for global climate change is abundant, and businesses, governments, and organizations are finally talking about how we must reduce our use of fossil fuels and our "carbon footprint." And we are all beginning to think about how climate change will affect our ecology, economy, and personal lifestyles. To start with, it's important to understand how climate change will affect our ecosystems.

Some plants may disappear

Changes in rainfall, temperature and extreme weather events are likely to affect the distribution and perhaps cause the extinction of local species. Many local plants are highly specialized and limited geographically, adapted to a narrow range of required physical conditions. Many are endemic, growing only in small areas of southern California and Baja California.

Animals may not find food, shelter, or breeding places

Phenology is the timing of seasonal activities of animals and plants, and some of these are changing. Records have been kept for decades (sometimes centuries) on the arrival of bird species from their winter migrations or the time that certain caterpillars emerge from their cocoons. Warmer temperatures and less rainfall will affect bird migration patterns, as well as wintering locations, food supplies, and predators. Birdwatchers report that some migrating birds are arriving earlier in the spring, compared with a few decades ago.

Insect pollinators may mature according to winter temperatures, and their host plants may still respond to day-length. If pollinators emerge before their host plants, the pollinators will not find their traditional nectar sources and the host plants will not produce flowers and seeds, and both could become extinct. On the other hand, insects that have other food sources and plants that are pollinated by several insect species will adapt to the new conditions induced by climate change.

Plants and animals may have nowhere to go

With gradual shifts in climate conditions, plants can grow in other sites where their seeds have dispersed and have the necessary growing conditions. Larger animals can move or fly to other locations with sufficient water, food, and shelter. With global warming, some plants and animals are shifting northward (or in the southern hemisphere, southward) or to higher elevations to habitats that more closely match their requirements. Locally,

high-elevation species will have no higher places to go. In many places in the world, some of the plants and animals will not be able to make these shifts because the potential habitat has been claimed by development, invaded by non-native species, or does not offer suitable soils or other necessary growing conditions.

Pollutants make plants more susceptible to drought

Pollutants from vehicles drift from the roads and freeways onto parks and natural areas. As more miles are driven in more cars, more pollutants are produced. Plants adapted to our Mediterranean and desert climates conserve water by closing their stomates (openings similar to pores) during the day. But pollutants such as ozone and nitrous oxide change the metabolism of plants, and they keep their stomates open longer. This allows water molecules to escape, and plants dry out much more quickly.

Drought makes plants more susceptible to insects

Bark beetles have always been present in forests, and healthy trees are adapted to low populations of beetles. With more frequent drought years in the past decade, the trees are less resistant to beetle attacks, and many trees have died in the mountains of southern California.

Warmer winters increase beetle populations

Many insects and plants have evolved together in ways that allow each to survive. For example, winter temperatures are often low enough to "knock back" insect populations at low levels. Warmer winter temperatures can increase insect survival and population levels, but the droughts and abnormally warm years that began in the 1980s have resulted in record pest outbreaks and tree dieback throughout western North America.

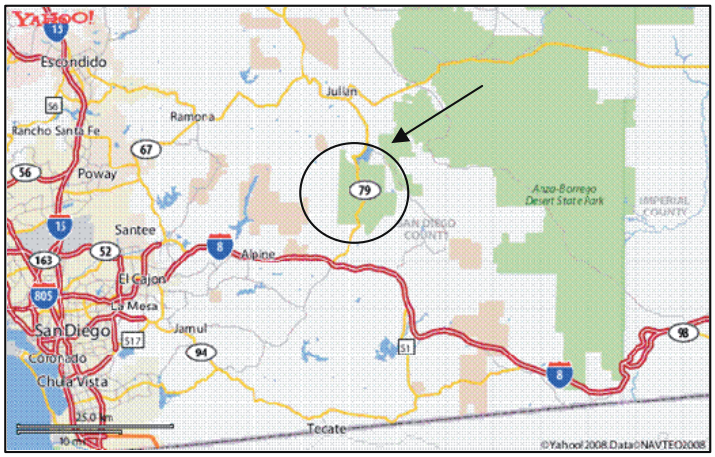
Extended droughts increase the severity of wildfires

Increased droughts are predicted for the entire western North America, which is likely to bring longer fire seasons and larger wildfire events. Scripps Institute researcher Tony Westerling analyzed the frequency and length of large wildfires, and found that both increased in the mid-1980s. During these years, there were much higher spring temperatures, less summer precipitation, drier vegetation, and longer fire seasons. Several years of droughts preceding the 2003 and 2007 wildland fires had drastically reduced the fuel moisture in local vegetation, and the fires burned quickly once they were ignited and carried by the Santa Ana winds.

Adapted from article, "Climate Changes in San Diego," by Anne S. Fege and Phil Pryde, *San Diego Earth Times,* April 2007, posted at www.sdearthtimes.com/et0407/et0407s2.html

Reforestation Project at Cuyamaca Rancho State Park

Project Description: This project consists of conifer forest restoration activities in Cuyamaca Rancho State Park in San Diego County, California. The purpose of the project is to re-establish patches of landscape with native conifer trees that will allow for progression of reforestation on acreage in the burned areas of the park. The project provides significant wildlife, recreation, climate, and watershed benefits. It includes four phases of reforestation involving 2500 acres. In addition, the reforestation work will be monitored to determine the impacts of regional climate change to recovery of vegetative cover. Fire risk management projects will be implemented to protect the project area from future catastrophic fire events. The project is being conducted by the California Department of Parks and Recreation (DPR) in partnership with the California Department of Forestry and Fire Protection (Cal Fire), San Diego State University (SDSU), and University of California, Santa Barbara.



Project Location: Cuyamaca Rancho State Park is located 50 miles east of San Diego on Highway 79 in California. The park consists of 25,000 acres located within the Peninsular Range of mountains with elevations that range between 3,500 feet and 6,500 feet. Vegetation in the park is a mix of grassland, chaparral, oak woodland, mixed conifer and hardwood forests (Coulter pine, canyon live oak, black oak) and coniferous forests (sugar pine, incense cedar, Jeffrey pine). Coniferous forests, mixed conifer forests, and hardwood forests once dominated the eastern and the northern aspects in the higher elevations. These forests were almost completely destroyed in the fall of 2003 by the Cedar Fire when over 24,000 acres, representing over 95% of the park burned. This fire was so intense that much of the original coniferous forest area is devoid of the original conifers and little natural regeneration has been observed.

Red Breasted Sapsucker

Co-benefits: The coniferous forest and mixed conifer/hardwood forest that existed prior to the 2003 Cedar Fire has largely been replaced with ceanothus. The ceanothus vegetative cover is expected to continue to dominate the forest area for the foreseeable future in the absence of the reforestation activities. Restored coniferous forest habitat in the park provide important protected areas for a wide variety of native mammal and bird species in a region experiencing strong and continuous development pressure. This kind of habitat is critical to forest dwelling species such as the red-breasted sapsucker, red-breasted nuthatch, and golden-crowned kinglet. The project will also assist in preventing the spread of invasive weeds and reducing erosion risks which protect watershed function, archaeological sites, botanical reserves and recreational capacity of the park.

Carbon Offset Quantity and Accounting: The benefits of the proposed project come from accelerated restoration of the forested landscape. The climate benefits include the ability to reduce atmospheric carbon dioxide at a rate of 1-3 metric tons per acre per year and the potential storage of over 200 metric tons of carbon dioxide equivalent per acre. DPR and Cal Fire are proposing to register the project with the CCAR, using CCAR's Forest Protocols.

Estimated CO2 Reductions due to the Project Activity at Cuyamaca Rancho State Park	
	Additional Carbon Dioxide Equivalent Metric Tons Sequestered
During Project Years	Total Project
1-5	11,731
6-10	47,658
11-20	92,383
21-50	204,929
51-100	147,373
Total Years 1-100	504,075

Lookout Fire Road Test Site
With Tubing for Browse Protection

Project Activities: Project activities include planting 3 initial test sites (completed in March 2008), and four phases of landscape level reforestation involving up to 2500 acres depending on funding. Seedlings will come from local seed sources (Zone 998) and include a mix of approximately 80% Jeffrey pine (Pinus jeffreyi), 15% Coulter pine (Pinus coulteri), and 5% incense cedar (Calocedrus decurrens). The planting will incorporate a random pattern with an average of 250 seedlings per acre. Species mix and spacing are designed to recreate historical healthy stand conditions over time. Areas targeted for reforestation include acreage with a lack of natural regeneration associated with burn intensity. Pine regeneration surveys in the park have been completed by graduate students at SDSU. In addition, acreage will be prioritized by soil conditions, and strategic position to assist in providing future seed sources for natural succession. The project includes work to reduce excess fuel buildup in the areas to be planted and in buffers around the planted areas. After ten years, the new reforested areas will be managed with thinning treatments to reduce stand density to approximately 100 stems per acre. Adaptive evaluation studies will be coordinated through a research project at University of California, Santa Barbara.

Reforestation Project at Cuyamaca Rancho State Park Reforestation Phases I, II, III, & IV			
	Acres	Cumulative	Planting Complete By:
Phase I	300	300	March 2009
Phase II	700	1000	March 2010
Phase III	700	1700	March 2011
Phase IV	800	2500	March 2012

For further information, please contact:
***Bill Herms**, Deputy Director*
California Department of Parks and Recreation
1-916-653-8380
1416 9th Street, Room 1405
Sacramento, CA 95814
bherms@parks.ca.gov

Activity 4: Protected Areas of San Diego County

Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- English
- Technology
- Biology

Skills
- Observing
- Describing
- Analyzing
- Computer
- Communicating

Concepts
- Governments have set aside natural areas that are protected and managed to conserve and manage their natural resources for the public benefit. Birds living in or around wetlands get their food in different ways depending on their beaks and the shape of their feet.

Introduction

As reports came back to Washington, D.C., from the first generation of explorers of the western United States, the idea began to grow that large tracts of this vast, pristine wilderness should belong, not to individual property owners, but to the public. Parts of these lands were already being exploited in ways that damaged the ecosystems and ruined the scenic beauty.

A response to the need for conservation and protection of these wild and beautiful lands came in 1872. Under President Ulysses S. Grant, Congress passed the Act of Dedication setting apart a large tract of land to be under the control of a governmental agency called the Department of the Interior. It was this agency's duty to make rules and regulations to protect and manage this land for the public benefit. The name of this wildland was, and still is, Yellowstone National Park.

Since then, government agencies have been established at various levels to manage other natural and culturally important areas, large and small, for the public benefit. In San Diego County the following agencies own and/or manage these protected areas: the National Park Service, the National Wildlife Refuges System, The National Estaurine Research Reserve system, the Bureau of Land Management, the U.S. Forest Service, California State Parks and Recreation, California Department of Fish and Game, San Diego County Parks, and municipal (city) parks, such as Balboa Park or the Chula Vista Nature Center.

Following the procedure section of this activity are descriptions of selected protected areas within San Diego County. We hope you will have an opportunity to visit each and every one of these places, for each has something unique and special to offer.

Procedure

1. Tell students that San Diego County is what we call a tourist destination, and part of what brings tourists to San Diego County is the opportunity to visit our many and varied natural areas. Further tell them that when people travel somewhere specifically to visit a natural area, it is called "ecotourism." We can say that San Diego County's natural areas not only provide habitat and protect wildlife, they also provide an economic benefit, because they attract tourists who spend money on hotels, restaurants, gasoline, and other things. For example, for every dollar that the State of

Objectives
Students will:
- Learn about and appreciate the value of protected areas in their local region.

Time
- Two class periods

Materials
For the whole class:
- White/chalk board
- Access to computers and PowerPoint program (optional)

For each team:
- Paper
- Pencils
- Posterboard
- Art materials, such as markers, crayons

Vocabulary
Ecotourism

Preparation
Schedule time for students to access computers.

Description
Students learn about selected San Diego County protected areas and "market" them to tourists.

California spends on its State Park system, it collects $2.35. Taxes paid on goods and services in communities adjacent to parks and park entrance fees combine to provide this revenue (income). This benefit is in addition to the direct benefits communities receive when community members make their livelihood by offering goods and services to tourists.

List the following protected areas on the board:

Tijuana Estuary
Chula Vista Nature Center
Mission Trails Regional Park
Tecolote Canyon Natural Park and Nature Center
Los Peñasquitos Reserve
Torrey Pines State Natural Reserve
Blue Sky Ecological Reserve
Cuyamaca Rancho State Park
Anza-Borrego Desert State Park

2. Divide the class into nine teams, one for each protected area. It is each team's job to convince San Diego visitors to spend a day at their protected area. They can do this by presenting, in an attractive manner, the assets of their area. Students may create a poster, a PowerPoint presentation complete with pictures taken from the Internet, or even dramatize a visit to their area.

3. Inform students that they can find information about each of these natural areas in their *Student Guide*. They may need to do Internet research to find additional information.

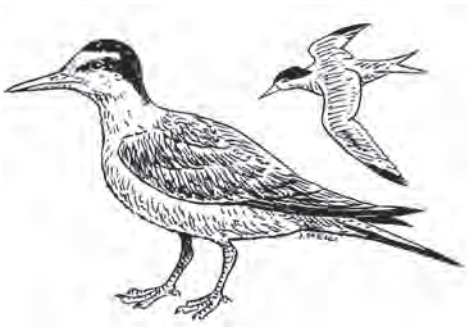
4. Allow student teams a class period to prepare their presentation. The following class period, each team should give a three to five minute presentation to convince their classmates, as potential "tourists," to visit their protected area.

5. After all the presentations have been given, have the class vote on which protected area they would most like to visit. Write the results of the board. Which protected areas were in the top three? Ask students, "Was it difficult to decide?" "Why or why not?"

Reflection

1. Ask students why they think we have so many and varied protected areas in San Diego County? (The varied geography of the county—beach, coastal areas, mountains, desert— provides varied habitats.)

2. Ask students to think of specific ways their community benefits economically from the protected area(s) that are nearby. For example, do any of their parents work in stores that provide goods tourists buy? Do taxes paid on goods and services support the community in any way (e.g., San Diego's hotel tax)?



Evaluation

Have student groups fill out an *EcoMap* with information from their protected area. Direct them to include humans on their map and show or tell ways that humans affect the protected area's ecosystem.

Enrichment

Tell students that the Mexican government also has established Natural Protected Areas (NPAs) and that the *Student Guide* contains descriptions of the NPAs in Baja California. Briefly discuss the types of NPAs in the Background Information. You may wish to emphasize the Cuchumá Easement, a different kind of natural protected area, and one that the U.S. and Mexico shares.

Student teams may select one of the NPAs and compare and contrast it with the San Diego County protected area they studied. They can then present their findings to the group. What are the differences? The similarities? Why do students think the two protected areas are similar and/or different?

San Diego County's National Wildlife Refuges Complex

The National Wildlife Refuge System, managed by the U.S. Fish and Wildlife Service, is the world's premier system of public lands and waters set aside to conserve America's fish, wildlife and plants. Since President Theodore Roosevelt designated Florida's Pelican Island as the first wildlife refuge in 1903, the System has grown to more than 150 million acres, 550 national wildlife refuges and other units of the Refuge System, plus 37 wetland management districts.

San Diego National Wildlife Refuge Complex

Beginning in 1972, a series of small National Wildlife Refuges—Seal Beach, Tijuana Slough, and Sweetwater Marsh—were established to preserve and protect the rare birds of southern California's coastal marshes. In the mid-1990s, San Diegans joined with state and federal agencies to protect larger areas of open space including coastal uplands, rare vernal pool wetlands, and in San Diego Bay. San Diego Bay National Wildlife Refuge Complex includes the Sweetwater Marsh and South San Diego Bay Units. San Diego National Wildlife Refuge is located farther inland.

Tijuana Slough National Wildlife Refuge

Home to many endangered birds and one endangered plant, this beautiful 1051-acre wetland where the Tijuana River meets the sea is southern California's only coastal lagoon not bisected by roads and rail lines. The refuge is also part of the Tijuana River National Estuarine Research Reserve, one of only 26 NERRs in the entire U.S.

Over 370 species of birds have been recorded on the refuge and in the adjacent river valley. Tijuana Slough's habitats include open water, tidal salt marsh, beach dune, riparian, vernal pool and upland surrounded by residential neighborhoods. The endangered California Least Tern, Least Bell's Vireo, California Brown Pelican, Light-footed Clapper Rail and an endangered plant, Salt Marsh Bird's Beak can all be found on the refuge. The Western Snowy Plover, a threatened species, is a year-round resident and nests on refuge beaches.

Tijuana River National Estuarine Research Reserve

Tijuana River National Estuarine Research Reserve is located in the most southwestern corner of the contiguous United States. This 2,500-acre reserve is comprised of the Tijuana Slough National Wildlife Refuge and Border Field State Park. It is one of southern California's largest remaining salt marshes without a road or railroad trestle running through it.

This important salt marsh is surrounded by San Diego County and Tijuana, Mexico, with a population of over four million people. Within this international bioregion, the reserve maintains essential habitats for many migrating shorebirds and waterfowl along the Pacific Flyway.

Tijuana River Estuary provides critical habitat for the federally listed endangered California least tern, light-footed clapper rail, least Bell's vireo, and salt marsh bird's beak, an endangered plant species. Over 370 species of birds have been sighted within the reserve which was designated as a Wetland of International Importance by the Ramsar Convention on Wetlands.

The reserve's habitat and wildlife-management programs focus on the recovery of endangered species through research, habitat restoration, and environmental education.

Hours of Operation
The award-winning Tijuana Estuary Visitor Center is open to the public Wednesday through Sunday, 10 AM to 5 PM. The Center offers K–12 education programs, Junior Ranger programs, interactive exhibits, guided bird and nature walks along four miles of trails, as well as many other programs for people of all ages. Reserve trails are open daily from sunrise to sunset. For information, please call 619.575.3613.

Location
From Interstate 5, take the Coronado Avenue exit and head west to 3rd Street.
301 Caspian Way
Imperial Beach, CA 91932
http://www.tijuanaestuary.org

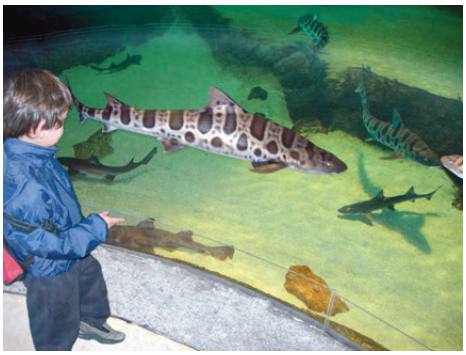
Chula Vista Nature Center

Like its wetland neighbors to the south, Sweetwater Marsh supports many of the same animals and plants as the Tijuana Slough and South Bay Refuges. Palmer's Frankenia, a rare salt-marsh plant, can also be found on this refuge.

Surrounded by numerous gardens, the Chula Vista Nature Center soars like an ark above the 316-acre Sweetwater Marsh. The Nature Center provides visitors with interpretive and interactive exhibits explaining the marsh habitat, environmental education programs, guided nature and bird walks, a shark and ray exhibit, and the opportunity to view native birds in outdoor aviaries that support burrowing owls, shorebirds, egrets and herons. Aviary dwellers are all birds that cannot be released back into their native habitats.

The Nature Center is located at the foot of E Street and Interstate 5 in Chula Vista. Hours are 10 AM to 5 PM. Tuesday-Sunday (closed Mondays). Please call the Chula Vista Nature Center for admission prices, special events and group reservations: 619.409.5900.

1000 Gunpowder Point Drive
Chula Vista, CA 91910-1201
Telephone: 619.409.5900
www.chulavistanaturecenter.org



Mission Trails Regional Park

Mission Trails encompasses over 6,000 acres of both natural and developed recreational acres. Its rugged hills, valleys and open areas represent a San Diego prior to the landing of Cabrillo in San Diego Bay in 1542.

Centrally located and only eight miles northeast of downtown San Diego, Mission Trails provides a quick, natural escape from the urban hustle and bustle.

With over 40 miles of hiking, biking and equestrian trails, boating on Lake Murray, camping at Kumeyaay Lake, free guided-nature walks, picnic areas, and a state-of-the-art visitor and interpretive center, Mission Trails Regional Park truly has something to offer everyone!

Inside the Visitor & Interpretive Center is a two-story museum, with exhibits on the local plants, wildlife, geology, culture and history of the park; a 94-seat theater, where informative videos about the park are shown upon request; a natural-history reference library; a small gift shop; and classrooms, which may be rented out for group use.

Teachers may make reservations for school field trips on-line, and special guided walks and talks may be arranged for organized groups. For more information, please contact the Education Ranger at 619.668.3279.

General Visitor Information

The Visitor & Interpretive Center is located off of Mission Gorge Road, just east of Jackson Drive, at:
One Father Junipero Serra Trail Road
San Diego, California 92119

Front Desk: 619.668.3281
Campground: 619.668.2748
Website: http://www.mtrp.org/

Hours of operation:
9 AM to 5 PM daily
Closed: Thanksgiving, Christmas and New Year's Day

Tecolote Canyon Natural Park & Nature Center

An Excellent Resource in Your Own Backyard

Centuries ago, the Kumeyaay Indians found food and shelter in Tecolote Canyon, a place that today is rich with history. It has been designated as a cartographic feature on area maps for nearly two centuries and was given the name Tecolote, or owl, for the diminutive raptor that lives in this canyon. Today, Tecolote Canyon Natural Park & Nature Center offers its visitors a variety of educational and recreational opportunities.

The Canyon has approximately six and a half miles of trails that can be used for jogging walking and mountain biking. The Nature Center is part of the City of San Diego's Park and Recreation Department, Open Space Parks Division, and offers a host of exhibits on the animal and plant life of the Canyon. The Nature Center is also available for meetings, workshops, classes and special events. Please contact the Center Director at 858.581.9959 for more information.

General Visitor Information

5180 Tecolote Road
San Diego, CA 92110
858.581.9944

http://www.sandiego.gov/park-and-recreation/parks/teclte.shtml

Blue Sky Ecological Reserve

Blue Sky Ecological Reserve (BSER) is one of 91 ecological reserves of the California Department of Fish and Game. The primary purpose of ecological reserves is the protection of special species and habitats. Many are closed to the public; however, Blue Sky, one of the jewels of the reserve system, is open year-round during daylight hours and offers great opportunities for people to get out and enjoy nature.

The Reserve's 700 acres contain lush riparian habitat, majestic oak woodlands, and hills covered with coastal sage scrub and mixed chaparral. Brilliant displays of wildflowers adorn the hillsides in spring. The closeness of the different habitats allows a greater number of species to exist in the area, as many animals will use several habitats to fulfill their needs.

Park Visits
Most ecological reserves are unstaffed. However, BSER has a full-time City of Poway naturalist on duty who coordinates with more than 40 docents to offer a variety of programs, including elementary school field trips, scout tours, guided hikes for the public every weekend, and several evening wildlife programs throughout the year.

Bicycles are not permitted in the Reserve.

Location
Blue Sky Reserve is located half a mile north of Lake Poway Road on Espola Road. From I-15, exit Rancho Bernardo Road and proceed east. Rancho Bernardo Road becomes Espola Road in Poway. Continue heading east on Espola Road, which will curve to the right just past Old Coach Road. The Reserve parking area is on the northeast (left) side of Espola Road, just beyond the curve. (If you reach Lake Poway Road you have missed the reserve.)

Information:
Telephone: 858.668.4781
http://www.poway.org/bluesky

Los Peñasquitos Canyon Preserve

A Resource-based Park

Los Peñasquitos (meaning little cliffs) Canyon Preserve lies between Rancho Peñasquitos and Sorrento Hills to the north and Mira Mesa to the south. Stretching approximately seven miles from the I-5 and 805 merge to just east of I-15, it encompasses some 4,000 acres of both Peñasquitos and Lopez Canyons. The Preserve is jointly owned and administered by the City and County of San Diego.

Los Peñasquitos Canyon and its tributary, Lopez Canyon, are characterized by varied natural resources. Over 500 plant species, more than 175 types of birds, and a great variety of reptiles, amphibians and mammals evidences the rich biodiversity of the canyon. Many of these species are rare or endangered and are protected within the Preserve.

General Visitor Information

There are several convenient entrances to the Preserve. The east entrance, or staging area, is located at the intersection of Black Mountain and Mercy roads. The western staging area is on the south side of Sorrento Valley Boulevard, approximately one mile east of Vista Sorrento Parkway. A convenient northern entrance is near Peñasquitos Creek Park at the intersection of Park Village Road and Camino Del Sur in Rancho Peñasquitos. A staging area for Lopez Canyon is located at the intersection of Pacific Mesa and Pacific Center boulevards in Mira Mesa. Look for the information kiosks located at each of these entry points that designate the trail head and provide additional park information.

For more information, please call the County Park Rangers at 858.484.7504.
http://www.sandiego.gov/park-and-recreation/parks/penasq.shtm

Torrey Pines State Natural Reserve

Torrey Pines State Natural Reserve is located within San Diego city limits and yet remains one of the wildest stretches of land on our Southern California coast! Because of the efforts and foresight of the people in this area, 2,000 acres of land are as they were before San Diego was developed—with the chaparral plant community, the rare and elegant Torrey pine trees, miles of unspoiled beaches, and a lagoon that is vital to migrating seabirds.

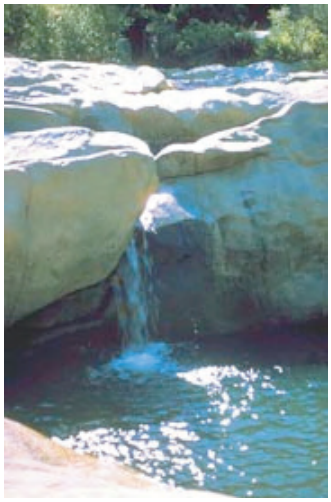
One can imagine what California must have looked like to the early settlers, or to the Spanish explorers, or even to the first California residents here, the Kumeyaay people.

There are eight miles of trails, a visitor center, and guided nature walks on weekends and holidays. Your group will see chaparral, coastal sage scrub, woodlands, cliffs, beaches, fossils, wetlands and rare trees all on one field trip!

General Visitor Information

12500 North Torrey Pines Road, San Diego CA 92037
GPS: 32.92183, -117.2497
858.755.2063
http://www.torreypine.org/

Cuyamaca Rancho State Park



Cuyamaca Rancho State Park is located approximately 50 miles east of the city of San Diego, California, in the Cuyamaca Mountains.

This beautiful park, sprinked with pines and lovely meadows with creeks, offers camping and hiking in an oak/woodland forest, There are over a 100 miles of trails which accommodate hikers, bikers, and equestrians. The two family camps, Paso Picacho and Green Valley, are open and on the reservation system spring through fall. Green Valley sits at an elevation of 4,000 feet and has a creek which runs through the middle of the campground.

The day-use area offers sets of cascades and shallow pools, great for water play on hot days. Green Valley has 81 campsites.

For the most current information on the park, go to www.cuyamaca.us . or http://www.parks.ca.gov/?page_ID=667

Location
East of San Diego, the park is on Highway 79, eight miles north of I-8,
13652 Hwy 79, Julian, CA 92036.
Phone: 760.765.0755.

Anza-Borrego Desert State Park

Anza-Borrego Desert State Park is the largest state park in California. Five-hundred miles of dirt roads, 12 wilderness areas and miles of hiking trails provide visitors with an unparalleled opportunity to experience the wonders of the California Desert. The Park is named after Spanish explorer Juan Bautista de Anza and the Spanish name Borrego, or bighorn sheep.

The Park features washes, wildflowers, palm groves, cacti and sweeping vistas. Visitors may also have the chance to see roadrunner, golden eagles, kit foxes, mule deer and bighorn sheep as well as iguanas, chuckwallas and the red diamond rattlesnake. Listening devices for the hearing-impaired are available in the visitor center.

Location and Directions

The Park is located on the eastern side of San Diego County, with portions extending east into Imperial County and north into Riverside County. It is about a two-hour drive from San Diego, Riverside, and Palm Springs.

Many visitors approach from the east or west via Highways S22 and 78. From the coast, these highways descend from the heights of the Peninsular Range of mountains with spectacular views of the great bowl of the Colorado Desert. Highway S2 enters the Park from the south off of Interstate 8.

Phone: 760.767.5311 (Monday–Friday)
Phone: 760.767.4205 (Seven days, October–May; weekends only in the summer)
http://www.parks.ca.gov/?page_id=638
abvc@parks.ca.gov

Activity 4: Protected Areas of Baja California

Background Information

The Earth's biological diversity is threatened by humans to such an extent that a fourth of current species now living are in danger of extinction within the near future. Some die due to habitat loss, others because of soil, water, and air pollution or due to excessive commercial exploitation (See Activity 3f: Challenges to our Ecosystems).

Many plants, larger animals, insects, and other species are becoming extinct at such an alarming and fast rate that it makes the world change on a day-to-day basis. To slow down this reduction of biodiversity, some governments have enacted norms and laws to protect species in danger of extinction.

Encouraging examples of this are the numerous protected areas that governments have set aside in the richest ecological areas of the world.

For example, the Mexican government has established Natural Protected Areas which are defined as places on Mexico's lands and waters representing diverse ecosystems, where the original environment has not been essentially altered, and that produce valuable ecological benefits.

In the state of Baja California there are eight very important Natural Protected Areas that represent a natural and cultural heritage for our bioregion, the country of Mexico in general, and the whole world.

These Natural Protected Areas are:

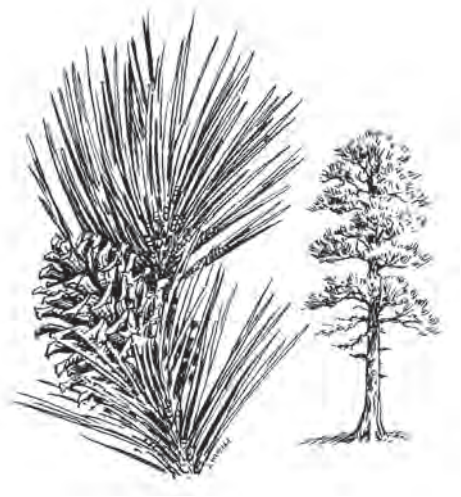
1. Reserva de la Biosfera Alto Golfo de California y Delta del Río Colorado
2. Parque Nacional Constitución de 1857
3. Parque Nacional Sierra de San Pedro Mártir
4. Reserva de la Biosfera Bahía de los Ángeles y Canales de Ballenas y Salsipuedes
5. Reserva de la Biosfera Isla Guadalupe
6. Área de Protección de Flora y Fauna Valle de los Cirios
7. Área de Protección de Flora y Fauna Islas del Golfo de California
8. Parque Nacional Archipiélago de San Lorenzo

For further information (in Spanish) about these protected areas please visit: http://www.conanp.gob.mx/

Another Kind of Protected Area – Rancho Cuchumá Conservation Reserve

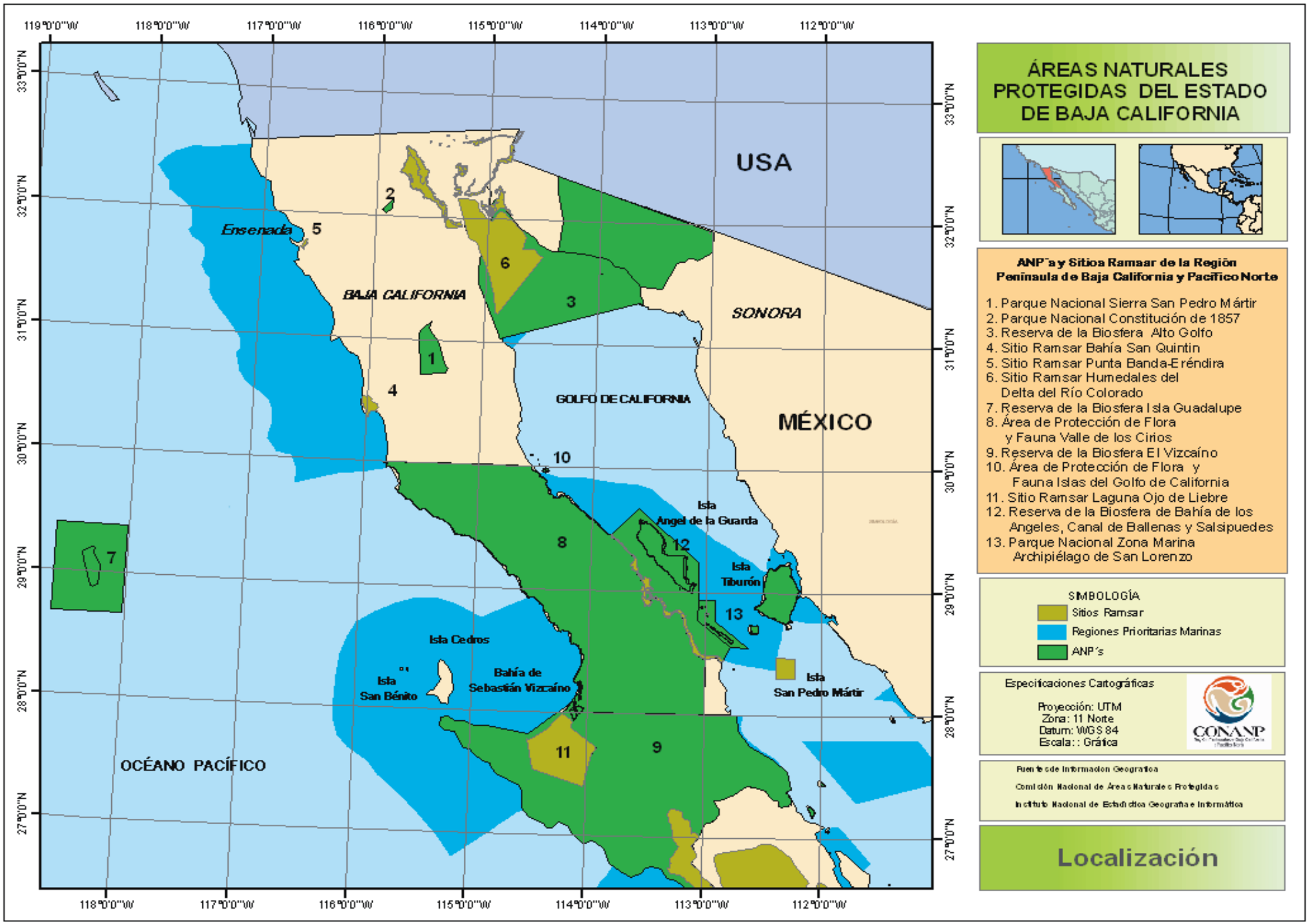
Tecate, California, and Tecate, Baja California, comprise a biologically diverse and culturally significant area. The point of interest is a mountain rising 3,881 feet (1,182.93 meters) above sea level that straddles the U.S./ Mexico border. It is known as Tecate Peak in the U.S. and Mt. Cuchumá in Mexico. Kumeyaay Indians believe that a holy power, for healing or harm, emanates from the mountain's granitic boulders. The Bureau of Land Management (BLM), California Department of Forestry and Fire Protection (CDF) and Fundación La Puerta in Mexico share ownership. The shared goal is to protect the area's valuable and unique habitat. In 2003, Pronatura, a non-profit/non-governmental organization in Mexico dedicated to land and natural-resource conservation, partnered with Fundación La Puerta to develop a conservation easement (*servidumbre ecológica*) creating the Rancho Cuchumá Conservation Reserve.

What is a conservation easement?
A conservation easement is an agreement between two or more landowners in which one or more is willing to limit or restrict land use in order to preserve, conserve, or restore its natural attributes, scenic beauty, and other environmental services, as well as protect the cultural and historical aspects present there.



Rancho Cuchumá Conservation Reserve and its surrounding lands are home to a wide variety of species (some sensitive or threatened), including the Tecate Cypress, Red-tail Hawk, Golden Eagle, Bell's Vireo, Northern Flicker, House Finch, Dark-eyed Junco, Spotted Towhee, and California Gnatcatcher.

The Parque del Profesor and the Centro de Educación Ambiental Las Piedras, where Fundación La Puerta carries out several recreational, educational, and cultural activities with an environmental focus, are located at the foot of the Rancho Cuchumá Conservation Reserve. An interpretative path begins at the Center and the Las Piedras staff leads students on educational tours through the Reserve and introduces visitors to the flora and fauna of the ecosystem. Respect and appreciation leading to environmental stewardship are among the primary objectives of the Nature Center.


ÁREAS NATURALES PROTEGIDAS DEL ESTADO DE BAJA CALIFORNIA
USA
MÉXICO
BAJA CALIFORNIA
SONORA
GOLFO DE CALIFORNIA
OCÉANO PACÍFICO
Ensenada
Isla Cedros
Isla San Benito
Bahía de Sebastián Vizcaíno
Isla Angel de la Guarda
Isla Tiburón
Isla San Pedro Mártir
ANP´s y Sitios Ramsar de la Región Península de Baja California y Pacífico Norte
1. Parque Nacional Sierra San Pedro Mártir
2. Parque Nacional Constitución de 1857
3. Reserva de la Biosfera Alto Golfo
4. Sitio Ramsar Bahía San Quintin
5. Sitio Ramsar Punta Banda-Eréndira
6. Sitio Ramsar Humedales del Delta del Río Colorado
7. Reserva de la Biosfera Isla Guadalupe
8. Área de Protección de Flora y Fauna Valle de los Cirios
9. Reserva de la Biosfera El Vizcaíno
10. Área de Protección de Flora y Fauna Islas del Golfo de California
11. Sitio Ramsar Laguna Ojo de Liebre
12. Reserva de la Biosfera de Bahía de los Angeles, Canal de Ballenas y Salsipuedes
13. Parque Nacional Zona Marina Archipiélago de San Lorenzo
SIMBOLOGÍA
Sitios Ramsar
Regiones Prioritarias Marinas
ANP´s
Especificaciones Cartográficas
Proyección: UTM
Zona: 11 Norte
Datum: WGS 84
Escala: : Gráfica
CONANP
Fuente de Información Geográfica
Comisión Nacional de Áreas Naturales Protegidas
Instituto Nacional de Estadística Geografía e Informática
Localización

Activity 5: Field Trip

Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- English
- Art
- Biology

Skills
- Observing
- Describing
- Comparing
- Inferring
- Communicating

Concepts
- We can learn to appreciate nature by making detailed observations outdoors.
- An attitude of appreciation of the environment generates environmentally responsible choices.

Objectives
Students will:
- Observe nature.
- Learn about nature through hands-on experiences and activities.
- Learn how to prevent or minimize negative impacts on nature and the environment.

Background Information

The National Outdoors Leadership School (NOLS) has more than 40 years experience guiding expeditions. Paul Petzoldt founded the school in 1965. The mission of the NOLS is "to take people of all ages on remote wilderness expeditions, teaching technical outdoor skills, leadership, and environmental ethics, in some of the world's wildest and most awe-inspiring classrooms." (See: http://www.nols.edu/about/). Today NOLS is a world leader in expeditions. Their international outdoor initiative called *Leave No Trace* (LNT) promotes the responsible recreational use of natural protected or non-protected areas, through education, research, and collaboration with other institutions and businesses related to outdoor activities.

The *Leave No Trace* principles help raise our awareness regarding the impact of recreational activities on the environment. They are not laws or regulations. Rather, they are principles that offer appropriate alternatives for each situation and each environment in order to conserve the natural areas that we visit. The nine principles are based on sound ecology so that users of protected areas have guidance in making appropriate decisions during their visit.

Leave No Trace is an educational program that seeks to minimize human impact to natural areas and ensure a positive recreational experience for all visitors. Natural protected areas are the pride of each country. Managers throughout the world strive to enforce the legal precepts of conservation and protection of these areas, while satisfying the increasing needs of the population to have quality outdoors recreational opportunities.

Educating visitors is vital to wildlife area management. The *Leave No Trace* program offers a simple way to transmit the ethical principles and techniques needed to reduce the impact on the protected areas that we visit.

Listed and described here are the nine basic principles of *Leave No Trace*.

The Principles of *Leave No Trace*

Leave No Trace is a nationally recognized outdoor-skills and ethics-education program. The Boy Scouts of America is committed to this program. The *Leave No Trace* principles might not seem important at first glance, but their value is apparent when considering the combined effects of millions of outdoor visitors. One poorly located campsite or campfire is of little significance, but thousands of such instances seriously degrade the outdoor experience for all. Leaving no trace is everyone's responsibility. It is important to follow these guidelines at all times.

Time
Prep time: 30 minutes
Field trip time: 2 hours (plus travel time)

Materials
For each student:
- Notebook
- Plant, flower, and cactus observation sheets (found in Appendix section of this curriculum)
- Copies of *EcoMap*, Level 2
- Hand lens
- Pencil
- Clipboard

For every pair of students:
- Copy of map of the San Diego County/Baja California Bioregion

Preparation
1. Review *Leave No Trace* principles.
2. Review *Behavior Rules* before field trip.
3. If the outdoor site you are visiting is very large, set boundaries to do the activity.
4. Divide students into teams or pairs.

Description
Students go on a field trip to observe nature by following the General Guidelines for Field-trip-based Learning, using field observation sheets, filling out an *EcoMap*, and putting in practice the *Leave No Trace* principles.

1. Plan Ahead and Prepare
Proper trip planning and preparation helps hikers and campers accomplish trip goals safely and enjoyably while minimizing damage to natural and cultural resources. Campers who plan ahead can avoid unexpected situations, and minimize their impact by complying with area regulations such as observing limitations on group size.

Proper planning ensures:
- Low-risk adventures because campers obtained information concerning geography and weather and prepared accordingly
- Properly located campsites because campers allotted enough time to reach their destination
- Appropriate campfires and minimal trash because of careful meal planning and food repackaging and proper equipment
- Comfortable and fun camping and hiking experiences because the outing matches the skill level of the participants

2. Camp and Travel on Durable Surfaces
Damage to land occurs when visitors trample vegetation or communities of organisms beyond recovery. The resulting barren areas develop into undesirable trails, campsites, and soil erosion.

3. Concentrate Activity, or Spread Out?
- In high-use areas, campers should concentrate their activities where vegetation is already absent. Minimize resource damage by using existing trails and selecting designated or existing campsites.
- In more remote, less-traveled areas, campers should generally spread out. When hiking, take different paths to avoid creating new trails that cause erosion. When camping, disperse tents and cooking activities—and move camp daily to avoid creating permanent-looking campsites. Always choose the most durable surfaces available: rock, gravel, dry grasses, or snow.

These guidelines apply to most alpine settings and may be different for other areas, such as deserts. Learn the *Leave No Trace* techniques for your crew's specific activity or destination. Check with land managers to be sure of the proper technique.

4. Pack It In, Pack It Out
This simple yet effective saying motivates backcountry visitors to take their trash home with them. It makes sense to carry out of the backcountry the extra materials taken there by your group or others. Minimize the need to pack out food scraps by carefully planning meals. Accept the challenge of packing out everything you bring.

5. Sanitation
Backcountry users create body waste and wastewater that require proper disposal.

Wastewater. Help prevent contamination of natural water sources: After straining food particles, properly dispose of dishwater by dispersing at least 200 feet (about 80 to 100 strides for a youth) from springs, streams, and lakes. Use biodegradable soap 200 feet or more from any water source.

Human waste. Proper human-waste disposal helps prevent the spread of disease and exposure to others. Catholes 6 to 8 inches deep and 200 feet from water, trails, and campsites are often the easiest and most practical way to dispose of feces.

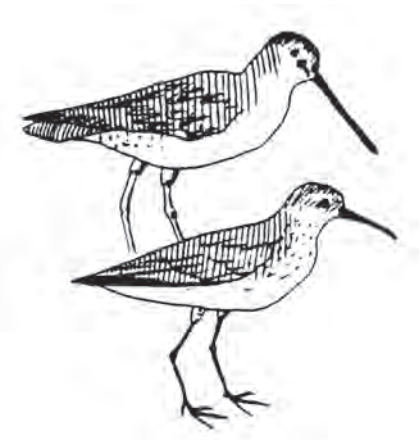
6. Leave What You Find

Allow others a sense of discovery: Leave rocks, plants, animals, archaeological artifacts, and other objects as you find them. It may be illegal to remove artifacts.

7. Minimize Site Alterations

Do not dig tent trenches or build lean-tos, tables, or chairs. Never hammer nails into trees, hack at trees with hatchets or saws, or damage bark and roots by tying horses to trees for extended periods. Replace surface rocks or twigs that you cleared from the campsite. On high-impact sites, clean the area and dismantle inappropriate user-built facilities such as multiple fire rings and log seats or tables.

Good campsites are found, not made. Avoid altering a site, digging trenches, or building structures.



8. Minimize Campfire Use

Some people would not think of camping without a campfire. Yet the naturalness of many areas has been degraded by overuse of fires and increasing demand for firewood.

Lightweight camp stoves make low-impact camping possible by encouraging a shift away from fires. Stoves are fast, eliminate the need for firewood, and make cleanup after meals easier. After dinner, enjoy a candle lantern instead of a fire.

If you build a fire, the most important consideration is the potential for resource damage. Whenever possible, use an existing campfire ring in a well-placed campsite. Choose not to have a fire in areas where wood is scarce—at higher elevations, in heavily used areas with a limited wood supply, or in desert settings.

True *Leave No Trace* fires are small. Use dead and downed wood no larger than an adult's wrist. When possible, burn all wood to ash and remove all unburned trash and food from the fire ring. If a site has two or more fire rings, you may dismantle all but one and scatter the materials in the surrounding area. Be certain all wood and campfire debris is dead out.

9. Respect Wildlife

Quick movements and loud noises are stressful to animals. Considerate campers practice these safety methods:

- Observe wildlife from afar to avoid disturbing them.
- Give animals a wide berth, especially during breeding, nesting, and birthing seasons.
- Store food securely and keep garbage and food scraps away from animals so they will not acquire bad habits. Help keep wildlife wild.
- You are too close if an animal alters its normal activities.

Leave No Trace Information

For additional *Leave No Trace* information, contact your local land manager or local office of the Bureau of Land Management, the Forest Service, the National Park Service, or the Fish and Wildlife Service. Or, contact *Leave No Trace* at 800.332.4100 or on the Internet at http://www.lnt.org. For posters, plastic cards listing the *Leave No Trace* principles, or information on becoming a *Leave No Trace* sponsor, contact *Leave No Trace* Inc., P.O. Box 997, Boulder, CO 80306, phone 303.442.8222.

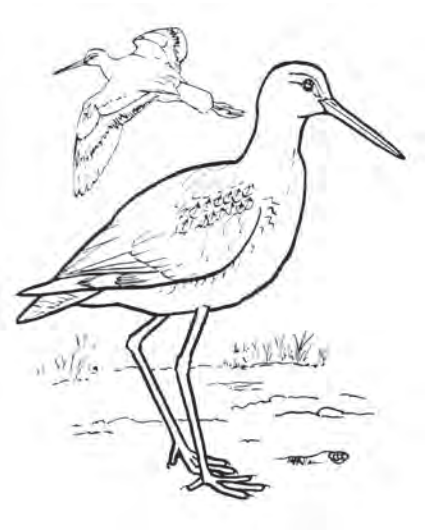
No environmentalist can question the importance of learning about our natural environment. However, recent research shows that learning about our natural environment is not enough to motivate us to make environmentally responsible choices. Although the motivation to do this is very complex and we have not yet been able to grasp its full meaning, researchers agree at least with one thing: to make environmentally responsible choices we need to develop a relationship of solidarity with our natural world.

How do we create this type of relationship? We do it through direct contact with nature. When students (and the rest of us) spend time in contact with nature, they learn to appreciate, value and take care of it. This, in turn, results in more supportive choices regarding environmental. For this reason, PROBEA strongly encourages teachers to take their students to the field. Following are guidelines to extend the student learning experience from the classroom to the field. These guidelines are taken from the Catalog of Ecologically and Educationally Significant Sites, General Guidelines for Field Trip-based Environmental Education, produced by the Environmental Education Council of the Californias (EECC). For more information about the EECC or the catalog, please visit http://www.eecc.net.

General Guidelines for Field-trip-based Learning

The Importance of Outdoor Learning Opportunities

No environmentalist can question the importance of learning about our natural environment. However, recent research shows that learning about our natural environment is not enough to motivate us to make environmentally responsible choices. Although the motivation to do this is very complex and we have not yet been able to grasp its full meaning,



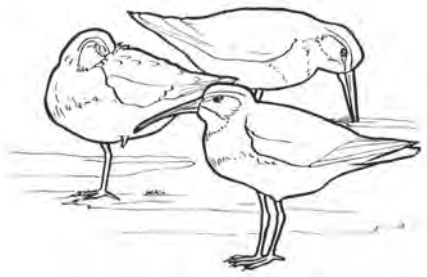
researchers agree at least with one thing: to make environmentally responsible choices we need to develop a relationship of solidarity with our natural world.

How do we create this type of relationship? We do it through direct contact with nature. When students (and the rest of us) spend time in contact with nature, they learn to appreciate, value and take care of it. This, in turn, results in more supportive choices regarding environmental. For this reason, PROBEA strongly encourages teachers to take their students to the field. Following are guidelines to extend the student learning experience from the classroom to the field. These guidelines are taken from the Catalog of Ecologically and Educationally Significant Sites, General Guidelines for Field Trip-based Environmental Education, produced by the Environmental Education Council of the Californias (EECC). For more information about the EECC or the catalog, please visit http://www.eecc.net.

All environmental-education field experiences should contain three components: activities before, during and after the field trip.

Pre-Field Trip Activities

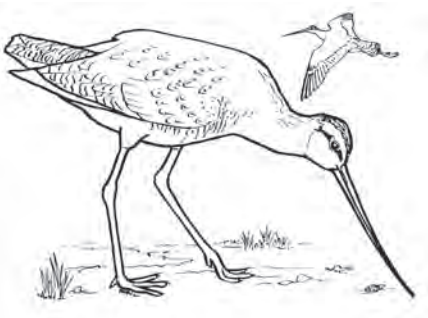
It is essential that sufficient information and educational materials be available in order to plan and prepare a field trip that, in the end, will result in successful learning.



Advance Planning:

1. If possible, visit the field trip site ahead of time to familiarize yourself with the area. If there is an employee or volunteer available at the site, ask about the public facilities, services and outreach materials such as brochures or field guides.
2. Investigate the availability of a guided tour (by an employee, site volunteer, ranger, etc.). If that service is not available, prepare to lead the entire field trip without assistance from onsite staff.
3. Create a checklist of important items that need to be completed before the field trip takes place. Examples include, but are not limited to:

    a) Develop an agenda for the trip
    b) Secure/reserving any special equipment such as video camera, 35mm or digital camera, magnifying glasses, bags, binoculars, etc.
    c) Ask parents to assist during the field trip as chaperones, and inform them of the required responsibilities and activities.
    d) Create a list of emergency contact information for all of the participating students, and have it readily available during the field trip in case of emergency.
    e) Bring other emergency phone numbers such as fire and rescue, lifeguard, police, etc.
    f) Prepare identification badges for everyone—students and adults—to wear during the entire field trip.
    g) Send a letter home to parents that includes the following information:
    -date, length and location of the field trip,



-transportation arrangements,
-academic goals of the field trip,
-precautions for students with special needs,
-associated cost(s), if any (buses, entrance fee, etc.),clothing recommendations,
-arrangements for a snack or lunch,
-field trip agenda, authorization and liability forms that may need to be signed by the parents.

IMPORTANT ITEMS TO BRING

- First Aid kit
- Sunblock
- Extra water bottles
- Extra caps or hats
- Extra food
- Extra paper and pencils
- Cell phone, if possible

Field Trip Classroom Preparation

1. Go over the field trip agenda, objectives, and activities with your students:
   - Inform students of the field-trip site.
   - Review field trip objectives.
   - Prepare logistics: agenda, time schedules, suggested appropriate clothing, food and drinks.
   - Materials: what students need to bring from the classroom to the field—paper, pencils, notebooks, crayons, magnifying glasses, etc.—and/or containers such as bags, boxes, etc.
   - Expectations: what the educator expects from the students and what the students can expect to get out of the field trip.
   - Topics and subjects that will be covered during the field trip.
   - Appropriate field-trip behavior and consequences, and any safety issues with regard your particular field trip site
   - Reinforce The *leave No Trace* guidelines with your students, as appropriate.

2. Present and review appropriate materials related to the field trip site. These may include materials provided by the site.
   - Review the field-trip site and show photos, maps and/or brochures of the area.
   - Describe the ecosystem(s) and type of environment(s) they will observe, as well as the intrinsic values of the site.
   - Discuss observation techniques and how to formulate investigative questions from their observations to learn more.
   - Introduce the subjects that will be covered during the field trip, including the natural history of the area, ecosystems, and the environmental impacts of human activities.
   - Prepare a field notebook and go over proper note-taking skills. You can also prepare a question/drawing worksheet that your students can complete during or after their field excursion.

Field Trip Activities

1. Have students work in pairs or teams, but have each student fill out his or her own activity sheets. Activities can include:
   a) Completing the prepared worksheet.
   b) Documenting observations and experiences in field notebooks.
   c) Drawing observations instead of, or in addition to, written observations.

SAMPLE BEHAVIOR RULES

- Stay with the group at all times and stay on the trails.
- Listen attentively; raise your hand to ask questions.
- Touch, but do not remove the vegetation.

ENJOY NATURE WITHOUT DAMAGING IT

- Bring back with you everything you take into the field.
- Observe the flowers and other natural objects in their natural state and location, without picking or moving them.
- Be mindful of walking only on designated paths to avoid destroying the vegetation.
- Observe the fauna from a respectful distance and in silence to avoid scaring or disturbing it.
- Do not feed any of the animals.
- Listen to the natural sounds—don't allow your students to bring in any unnatural noise (music, cell phones, etc.).

2. Have the students document (by drawing and/or writing) the flora and fauna (if it was visible), their similarities and differences, and their relationships and interactions.

3. Analyze with your students the relationships observed or assumed between the flora and fauna and humans, and discuss what effects our presence and activities have on that particular environment.

4. Carry out activities where your students can use their five senses. For example, having them close their eyes and draw what they hear around them; touching plants and trees—not just looking at them; safely tasting some of the fruits or seeds, but always under your supervision.

Post-Field Trip Activities

1. Complementary activities

Conduct activities to recall the observations and activities completed in the field by your students. For example, ask questions such as What did we do during the field trip? What image do you remember most? What did you like the best? What new thing did we learn? Did you talk to your family or friends about the field trip?

As a class, answer any questions that came up during or after the field trip, and/or anything that wasn't fully understood.

Ask your students to write short composition, make a drawing or compose a song.

2. Educator Evaluation

1. What was the educational value of the field trip?
2. Were the planned objectives met?
3. Did you have enough time for all of the activities?
4. Was there adequate supervision from the educator(s) and the chaperone(s)?
5. What can be changed or adapted to make a future field trip better?
6. What topics or aspects should you remember to emphasize on future field trips?
7. What problems arose and how can you plan for them, or avoid them, next time?
8. What other general improvements can be made to make the field trip better?

3. Student evaluation

By reviewing the field-trip topics, you will be able to evaluate to what extent the field trip facilitated learning, and if the experience-based learning was successful in teaching the desired subject material.

A questionnaire asking your students for feedback on their field-trip experience will also be useful to you.

The following questions could be helpful in creating one:

1. What is the most important idea or lesson you learned during the field trip?
2. What are the differences you noticed between the plants you observed in the field-trip site, and the plants you see at school or at home?
3. Why is wildlife important to us?
4. Draw a picture of the place we visited as you see it now and another picture as you imagine it will look in the future if houses, buildings, and businesses are built nearby.
5. Do you think it is important to protect the native plants and animals living in the site? Why?
6. How can you help protect the site?
7. Would you like to return to the site someday?

Specific guidelines for field trips related to *Our Natural Heritage, Bioregional Pride*

To prepare for their field trip, students will need to have covered Activities 1–4 of the curriculum. Next, follow the directions in Preparing Students for a Field Trip Number 1.

On the next page you will find a chart listing suggested field-trip sites, what ecosystems can be found, and what materials students should bring on their field trip.

During the field trip, students can work in pairs or teams, but each student will have to have his/her own clipboard and materials. This increases the attention paid to the field-trip goals and objectives and reinforces learning. The material included in the following chart is also found in the Appendix section of this curriculum.

Make sure that students know how to utilize all the materials before the field trip. You may want to bring some plants to the classroom or take the students outdoors to practice observing plants and birds.

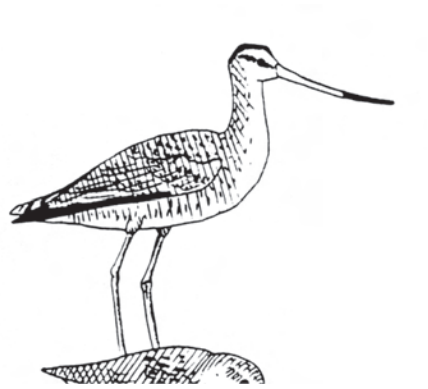
Suggested Field Trip Sites

Field Trip Site	Localization	Ecosystems	Materials needed
San Diego County*			
Tijuana River National Estuary Research Reserve, 301 Caspian Way Imperial Beach, California 91932 619.575.3613 www.trnerr.org/	Imperial Beach	Wetlands Mediterranean Riparian	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Plant observation sheets
Chula Vista Nature Center 1000 Gunpowder Point Drive, Chula Vista, CS 91910 619.409.5900 www.chulavistanaturecenter.org/	Chula Vista	Wetlands Mediterranean	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Plant observation sheets
Mission Trails Regional Park One Fr. Junipero Serra Trail, San Diego, CA 92119 619.668.3281 www.mtrp.org/	San Diego	Mediterranean Riparian	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Plant observation sheets
Tecolote Canyon Natural Park and Nature Center 5180 Tecolote Road, San Diego, CA 92110 858.581.9944 www.sandego.gov/park-and-recreation/parks/teclte/shtml	San Diego	Mediterranean	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Cactus observation sheets
Blue Sky Ecological Reserve, 858.668.4781 www.blueskyreserve.com	San Diego	Mediterranean Riparian	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Plant observation sheets
Los PeñasquitosCanyon Preserve 858.484.7504 www.sandiego.gov/park-and-recreation/parks/penasq.shtml	San Diego	Riparian	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Plant observation sheets
Torrey Pines State Reserve 12600 North Torrey Pines Road, San Diego, CA 92037 858.755.2063 www.torreypine.org/	La Jolla	Mediterranean	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Plant observation sheets
Cuyamaca State Park 12551 Hwy 79, Descanso, CA 91916 760.765.0755 www.cuyamaca.us	East San Diego County	Montane	Ecosystem Map, level 2 *Field Guide* Bird observation sheets
Anza-Borrego Desert State Park 760.767.5311 www.parks.ca.gov/?page_id=638	East San Diego County	Desert	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Cactus observation sheets

Baja California			
Playas de Tijuana**	Tijuana, B.C.	Beach, Tidepools	Ecosystem Map, level 2 *Field Guide* Bird observation sheets
Posada Esperanza, La Gloria (Large native plants garden) (011-52) 664.636.2742 info@esperanzademexico.org	Tijuana, B.C.	Mediterranean	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Cactus observation sheets Plant observation sheets
Ecoparque (Green non-native plants, large area) (011-52) 664.624.0531 http://www.colef.mx/ecoparque/ecoparque.asp	Tijuana, B.C.	Some Mediterranean	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Plant observation sheets
Centro de Educación Ambiental Las Piedras Km 48, Tecate-Tijuana Hwy (011-52) 665. 521.2958, 654.4125 www.fundacionlapuerta.org	Tecate, B.C.	Mediterranean	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Plant observation sheets
Punta Banda (011-52) 646.178.6050, 178.0162 proester@telnor.net	Ensenada, B.C.	Wetland	Ecosystem Map, level 2 *Field Guide* Bird observation sheets
Río Hardy Campo Mosqueda, Km 53.5, Mexicali-San Felipe Hwy (011-52) 686. 566 1520, 565 1475 Campo_mosqueda@yahoo.com.mx http://www.mexicaliturismo.com/es/ToDo-ThingsTo Do-Camping.php	Mexicali, B.C.	Wetland, Desert	Ecosystem Map, level 2 *Field Guide* Bird observation sheets Plant observation sheets Cactus observation sheets

*For complete information about each of the San Diego sites, simply Google each site's name.

**Web site for tide's information:
http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate=20081127&edate=20081127&datum=6&unit=0&shift=d&stn=9410170+San+Diego%2C+CA&type=Tide+Data&format=View+Plot



Post-Field Trip Activities

(These activities can also serve as evaluation.)

1. Have students work in teams to create a presentation about something they observed and learned during the field trip. For example, one team might give a presentation about birds, another about plants. Students can paint murals, produce a drama, write a report, an essay, or poetry, or create a PowerPoint presentation.

2. Have students complete an *EcoMap* based on what they saw and learned. What are the conservation issues at their field trip site? How can students reflect these on their *EcoMap*?

Additional Field Trip Activity

If possible, we suggest that students engage in Activity 3a, Extra "The Coastal Zone" (found in the Appendix), and go on a field trip to the beach.

Activity 6: Integrating What We Have Learned

Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- English
- Biology

Skills
- Observing
- Describing
- Analyzing
- Comparing
- Inferring
- Communicating
- Evaluating

Concepts
- Today, many citizens and environmental groups take part in decision-making processes as a more effective way of promoting or seeking solutions to environmental problems.
- Environmental education guides people toward environmental action, through the Environmental Literacy Strands, as well as through awareness, reflection and participation.

Background Information

Every region on our planet has some kind of environmental problem. To address these challenges, it is first necessary to guide students toward environmental literacy. The North American Association for Environmental Education *Excellence in Environmental Education: Guidelines for Learning (Pre K–12),* (2004), identifies the following four levels for environmental literacy:

1. Developing questioning, investigating, and analyzing skills,
2. Acquiring knowledge of environmental processes and human systems,
3. Developing skills for understanding and addressing environmental issues, and
4. Practicing personal and civic responsibility for environmental decisions.

At PROBEA, we like to add an *awareness* strand that refers to coming in contact with an environmental issue for the first time. We then proceed to provide general information, and seek to encourage students to share their own knowledge and experience about such an issue. We also add a *reflection* strand, which requires people not only to be well informed, but also to think about how to achieve changes that promote environmental stewardship.

Once students become aware of the kinds of environmental issues their region faces, they are guided through all four levels of environmental literacy until they achieve a level of active commitment and conscious and permanent *participation* that manifests itself in life-long behavior change.

This formative process can be promoted through environmental education that takes place inside and outside the classroom.

We do not expect educators to be environmental-education experts, but it is certainly recommended that they be aware of their influence upon students, have a personal interest in contributing to a better quality of life, and be committed to supporting their students in seeking solutions to environmental issues.

The teacher can foster critical thinking in their students by allowing them to discover and build upon their own knowledge through observation, experimentation and reflection. *

*Adapted from the *Manual of Environmental Education Teaching Suggestions for Elementary Education,* National Environmental Education Program, Secretariat of Public Education (SEP), Secretariat of Urban Development (SEDUE), Secretariat of Health (SSA), Mexico.

Objectives
Students will:
- Experience being part of a group that will make an important decision.
- Recognize the complexity of deciding if a natural protected area needs to be created or not.
- Experience the process of becoming environmentally literate.

Time
- 60 minutes

Materials
For the whole class:
- White/chalk board

For each team:
- Paper
- Pencils

Preparation
- Place chairs or desks in a small circle for each team.

Description
Students will take part in a role-playing activity in which special-interest groups get together to decide whether to create or not a natural protected area, experiencing in the process the awareness, reflection and participation levels of environmental literacy.

Students can exercise their critical thinking skills when they discuss environmental issues; they can understand environmental concepts more easily when they come in contact with nature and/or when they engage in hands-on activities, and when they take part in school or community projects where they have to make informed decisions. This is why it is important to provide experiences and hands-on activities that encourage students to address environmental issues. In addition, these kinds of activities encourage the development of observation and analytical skills in the students.

We frequently think that the environmental issues that pervade our times are too many, too big, and too difficult to solve. This, to a certain degree, might be true. However, we feel this way as a result of seeing our actions as individual rather than collective actions, when in fact what's needed is to reflect and act together as a whole. The sum of our efforts will be larger and the results will be greater, especially if we agree beforehand how we will work to solve each problem. A way of reaching solutions can be found in the ability and wish to organize ourselves in working teams that will take part, for instance, in decision making processes regarding environmental issues.

Today, many citizens and environmental groups are involved in this process to try to balance human needs with the needs of wildlife, while at the same time trying to minimize the impact of new developments on our natural habitat.

Procedure
Tell students that now that they have observed a natural site through the lens of the *EcoMap* and they have collected pertinent data, they are ready to apply what they have learned.

Divide students in teams of 4–6 students each. There should be at least five teams.

1. Tell students that they will write a report answering the questions below:

   a) Describe the area. What plants and animals can be found in this site?
   b) What are the area's ecological benefits?
   c) What are the area's problems?
   d) How would they solve these problems?

   Write the questions on the board so that students can refer to them.

2. After the students have written their report with the answers to the four questions, guide a discussion that serves as a review of what students observed and learned on the field trip.

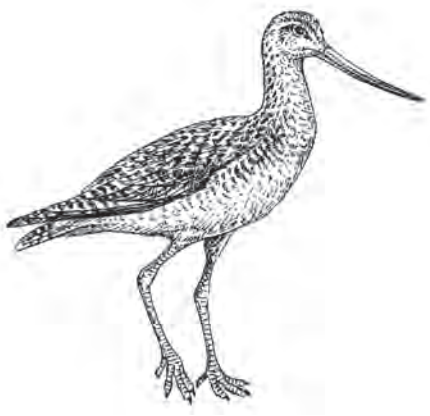
3. Now tell students that as a society we are still in the process of defining new protected areas or adding to areas already protected. For example, Anza-Borrego State Park recently acquired an area called Vallecito that was adjacent to the park. Ask students to think of a place where they would like to have a protected area extended, or of one they would like to create. For example, are there any canyons in San Diego that are not yet protected? Would they like to see a city park there?

4. Now ask the students to work in their teams again. Each team will take the perspective of a special-interest group that has come together to actively participate in a decision-making forum.

5. Tell them that the answer to the question or whether or not the protected area would be extended or created will be arrived at considering the perspective of the special-interest group. Following are some suggestions for special-interest groups: biologists, environmentalists, community residents, tourists, developers, and public officials. Make sure all special-interest groups are represented. (Depending on the number of students in your class, there will be a repeated special-interest group represented).

6. Have students research how each of these special-interest groups would feel if this site were to be declared a natural protected area. If possible, have students interview a biologist, environmentalist, community resident, tourist, developer, and/or public official. Ask students to write an essay or news report to convince others about the merits of their position on this issue.

7. Finally, engage the students in a discussion where each team presents its own viewpoint. Give each team the opportunity to respond to the others. When a conflict arises, point out how it is not always easy for us to communicate with others when there are different perspectives and intense feelings to consider with respect to a particular issue.



8. Suggest to the teams that they adopt the following process to continue the discussion:

   a. Teams will reflect upon their feelings. When students agree on which feelings the team has, they will share them with the class.

   b. Teams repeat in their own words what "the others" said, but without any emotional load. They will have to check with "the others" to see if what they accurately understand the "other" viewpoint.

   c. Students will reflect upon their team's values. What is important to them and why? Have a spokesperson state each team's values to the whole class.

d. Each team will reflect upon its own needs. Once the team members have agreed upon what these needs are, the spokesperson will state the team's needs to the whole class.

e. Once the teams have respectfully listened to each other, have them explore ways in which they could recognize the values and satisfy the needs of all the people involved.

Reflection Exercise

Ask students to reflect upon their feelings…
—when preparing to take their team's stand,
—during the discussion, and
—when teams agreed (or did not) on a solution.

Evaluation

Have students write a few paragraphs about whether it can be determined that the site needs to be declared a natural protected area. They should include a paragraph about how their writing supports their values and satisfies the needs of each special-interest group.

Activity 7: Doing Our Part

Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- English
- Biology

Skills
- Observing
- Describing
- Analyzing
- Collaborating
- Communicating

Concepts
- We can collaborate to carry out a project to benefit our region and/or the natural protected areas found there.

Objectives
Students will:
- Carry out a project to benefit our region and/or the natural protected areas found there.

Time
See *School Projects Handbook*

Materials
- *School Projects Handbook* produced by PROBEA
- "Project Presentation Rubric"
- Materials for project

Background Information

When they studied their region, students learned about the natural protected areas. They learned what they are, where they are located, and what their importance is as part of our natural heritage. They also learned about the effects of humans on natural areas and the challenges these areas face. Students have learned the importance of protecting their environment—those parts that have been formally protected, other natural areas, and even urban areas. In this final lesson, students apply what they have learned by working in teams to carry out a school project to benefit their region's natural heritage.

Procedure

The *School Projects Handbook*, produced by PROBEA, serves as a guide to carry out a project with your class. It provides information about how to correlate what you are teaching with the project you select, how to organize the class to carry out a project, the best places to carry out the project, what time frame is needed, the required materials, etc. In other words, it provides everything you need to work with your class on an environmental project to benefit your school or community.

Projects suggested in the *School Projects Handbook* have three levels of difficulty: simple, intermediate, and advanced. Carrying out a project may raise the awareness of other students in the school and even the whole community. Your students will be very enthusiastic about working together to improve the quality of life in their school and their community, and you will have the satisfaction of doing your part in civic and social participation by educating students to become environmentally literate citizens. In addition, these school projects can support your teaching objectives, because they are correlated with the California Content Standards.

Once students carry out a project, they realize that they can apply the knowledge they have acquired while studying other subjects or doing the activities from this curriculum to their project.

Based on the content of the *School Projects Handbook*, guide your students to carry out a project to benefit their local environment. At the end of the semester or school year, hold a celebration of accomplishments. This celebration is a good opportunity to communicate to other students, parents and the rest of the community that we all have the responsibility to be aware of how our actions can affect our natural heritage. Students will also learn about actions we can take as individuals. Together we can have a significant impact on the quality of life in our community.

Preparation
Varies depending on selected project.

Description
Students will work in teams to carry out a project to benefit our region and/or the natural protected areas found there.

Once the project has been completed, PROBEA will give each teacher a completion certificate and an original to reproduce for each student.

Reflection Exercise

Ask students to keep a journal and records of their project. **Please note that it is important to collect quantitative data during the course of the project.** Which steps did students follow to complete their project? What were their accomplishments? What challenges did they face? Was it difficult to work as a team to carry out the project? What was their experience during the project and how did they feel when the project was completed?

Evaluation

Students can present their projects at PROBEA's completion celebration. The teacher can evaluate those presentations, which will reflect what students learned during the course of the project, using a rubric. A sample can be found on the next page.

Project Presentation Rubric

Project name: _____ Date:_____

Team members: _____

	1	2	3	4	Comments
Preparation 10 points	Little evidence of planning. Team does not work together 0–1 points	Some evidence of planning. Team works together sometimes 2–5 points	Evidence of planning and organization. Team works mostly together. 6–8 points	Evidence of planning and organization. Team works together. 9–10 points	Team works together sometimes, some evidence of planning 2–5
Content 50 points	Minimally developed topic. Little or no organization. Had little or no relevant facts or examples. 0–12 points	Organization and expression of topic not fully developed. Somewhat organized and accurate or relevant facts. 13–25 points	Satisfactory development and expression of topic. Good organization. Accurate and relevant facts or examples. 26–38 points	Topic fully and clearly developed. Good logical organization. Accurate and relevant facts or examples. 39–50 points	Content is broken down logically, and is well organized, but that thermometers have mercury is irrelevant 3–36
Response to questions 10 points	Unable to respond. 0–1 points	Responded to some questions. 2–5 points	Answered most questions. 6–8 points	Answered all questions. 9–10 points	Able to answer most questions 3–7
Multi-media 10 points	Lacked visuals, text, and/or sounds. Showed little or no multimedia skills 0–1 points	Some visuals, text and /or sounds. Showed some multimedia skills. 2–5 points	Good use of visuals, text and sounds. Showed good multimedia skills. 6–8 points	Excellent use of visuals, text and sounds. Showed creative multimedia skills. 9–10 points	Visuals enhanced presentation, proved great use of multimedia skills 4–9
Presen-tation 10 points	Does not remember content. Barely reads. 0–1 points	Sticks to text on slides. 2–5 points	Remembers content, only reads slides 6–8 points	Elaborates beyond text on slides, has excellent voice. 9–10 points	One student at 1, another at 4, average team at 3–7
Literacy 10 points	Mostly incorrect spelling, punctuation, and grammar. 0–1 point	Evenly mixed correct and incorrect spelling, punctuation, and grammar. 2–5 points	Mostly correct spelling, punctuation, and grammar. 6–8 points	100% correct spelling, punctuation, and grammar. 9–10 points	Spelling mostly correct. Spanish presentation, so understandable 3–8

Adapted from work of Gary Grover Tuttle, Ithaca City (NY) School District, Jan./Feb. 1996 MultiMedia Schools

Appendix

Glossary

Algae	Primitive chlorophyll-containing, mainly aquatic simple organisms lacking true stems and roots and leaves
Alterations	Changes to an organism's form or essence; changes, disruptions
Anemophilous	Plants pollinated by wind
Angiosperms	Plants that have flowers and produce fruit with seeds
Aquatic	Operating or living or growing in water
Aridity	Quality of arid; excessively dry
Azonal	Largely refers to ecosystems or vegetation communities not mainly defined by their climatic characteristics
Biological diversity	The variation of life forms within a given ecosystem, biome or for the entire Earth
Biome	An area within a bio-geographical region with a predominant type of vegetation and fauna
Breeding place	A place that provides shelter, food and protection to animals in the first stage of their life
Bluff	A high steep bank (usually formed by river erosion)
Canopy	The uppermost level of a forest, formed by the tree crowns
Cardinal points	Any of the four principal directions: north, east, south, or west of a compass
Climate change	Variations in climate with respect to climatic history at the global or regional scale
Coastal zone	The interface between the land and water. These zones are important because a majority of the world's population inhabit such zones
Compass rose	A graduated circle, usually marked in degrees, indicating directions north, south, east, and west
Copepods	Minute marine or freshwater crustaceans usually having six pairs of limbs on the thorax; some abundant in plankton and others parasitic on fish
Cryptic coloration	Coloration that makes an organism resemble the substrate or some inanimate object with the goal of achieving protection

Deciduous	Trees and shrubs shedding all leaves annually at the end of the growing season and then having a dormant period without leaves
Delta	A low triangular area where a river divides before entering a larger body of water
Desertification	The degradation of land
Desert Playa	A dry lake bed at the bottom of a desert basin, sometimes temporarily covered with water. Desert playas have no vegetation and are among the flattest geographical features in the world. Also called sink
Desiccation	The state of extreme dryness or the process of extreme drying
Deterioration	Process of changing to an inferior state
Dioecious	Having the male and female reproductive organs borne on separate individuals of the same species
Echinoderm	Marine invertebrates with tube-feet and five-part radially symmetrical bodies
Ecological benefit	Refers to a gain for the ecosystem
Ecological succession	A gradual process incurred by the change in the number of individuals of each species of a community and by establishment of new species populations that may gradually replace the original inhabitants
Endemic species	A biological species exclusive to one place, geographical area or region not found in its natural form anywhere else in the world
Endemic	In a broad sense, can mean "belonging" or "native to," "characteristic of," or "prevalent in" a particular geography, race, field, area, or environment; native to an area or scope
Energy transfer	The flow of energy through the food chain from producers (plants) to primary consumers (animals that eat plants), to secondary consumers (animals that eat other animals), and so on. Energy is stored in the tissues of plants and animals. When animals eat plants or other animals, energy is transferred
Erosion	The displacement of solids (soil, mud, rock a l other particles) usually by the agents of currents such as, wind, water, or ice by downward or down-slope movement in response to gravity
Estivation	To become dormant for a long time during the summer

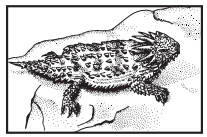
Geographical coordinates	Set of parallels and meridians and their corresponding latitudes and longitudes
Global warming	The gradual increase of the temperature of the Earth's lower atmosphere as a result of the increase in greenhouse gases since the Industrial Revolution
Gymnosperms	Vascular plants that produce seeds
Halophytes	Plants adapted to living on saline soils
Hydric	Something that is moist or damp, for instance, hydric soils
Hydrophytes	Plants adapted to living in or on aquatic environments
Inhospitable	Disagreeable or uncomfortable; providing no shelter or sustenance.
Latitude	The angular distance north or south from the equator of a point on the earth's surface, measured on the meridian of the point
Law	A rule of conduct or action prescribed or formally recognized as binding or enforced by a controlling authority
Longitude	Angular distance on the earth's surface, measured east or west from the prime meridian at Greenwich, England, to the meridian passing through a position, expressed in degrees (or hours), minutes, and seconds
Mangrove	An area where mangrove trees grow
Meridians	A great circle of the earth passing through the poles and any given point on the earth's surface
Metamorphosis	A transformation or profound change
Migration	The periodic passage of groups of animals (especially birds or fishes) from one region to another for feeding or breeding
Molecule	The simplest structural unit of an element or compound
Mollusks	Invertebrate animals, with a non-segmented soft body, sometimes covered by a shell
Monograph	Work of writing upon a single subject, usually also by a single author
Norm	Standard or model or pattern regarded as typical
Nudibranchia	Comprising numerous marine gastropod mollusks lacking a shell in the adult state and usually having a body like a slug

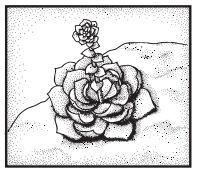
Nutrients	Any substance that can be metabolized by an organism to give energy and build tissue
Overexploitation	The disappearance of so many individuals that the population cannot maintain itself; since the 1600s, worldwide overexploitation of animals for food and other products has caused numerous species to become extinct or endangered
Parallels	Imaginary lines around the Earth parallel to the equator
Perennial	1) Streams with water throughout the entire year. 2) Plants having a life cycle lasting more than two years
Pest	A plant or animal detrimental to humans or human concerns (as agriculture or livestock production)
Phreatic surface	The level at which groundwater pressure is equal to atmospheric pressure. Usually coincides with the surface of the water table
Physical factors	Non-living factors affecting an ecosystem, such as soil, light, temperature, and water
Plankton	The passively floating or weakly swimming, usually minute animal and plant life of a body of water.
Poaching	Illegal hunting.
Protozoa	A single-cell organism that can only divide within a host organism
Relict	A surviving species or community of an earlier time in an environment that has undergone considerable change
Riverbank	The slopes bordering a river
Ruderal	Describing a plant growing in vacant lots, along roadsides or in rubbish
Salinity	The relative proportion of salt in a solution
Salt marsh	An area protected from the ocean with typical vegetation that gets flooded by tides twice a day
Semi-aquatic	Plants sharing some of the characteristics of aquatic plants
Sessile	Permanently attached or established; not free to move about
Stoma	A minute epidermal pore in a leaf or stem through which gases and water vapor can pass

Substrate	In biology a substrate is the surface a plant or animal lives upon. The substrate can include biotic or abiotic materials. For example, encrusting algae that lives on a rock can be substrate for another animal that lives above the algae on the rock
Succulent species	Water-retaining plants adapted to arid climate or soil conditions. Succulent plants store water in their leaves, stems and/or roots
Thermohaline circulation	The density-driven convective circulation system of the world's oceans
Threatened species	Any zoological or botanical species (animals, plants, fungi, insects, arachnids, etc.) susceptible to extinction in the near future
Tide	The alternate rising and falling of the surface of the ocean and of water bodies (as gulfs and bays) connected with the ocean that occurs usually twice a day and is the result of differing gravitational forces exerted at different parts of the Earth by another body (moon or sun).
Topography	Term for the description, mapping or other representation of the features of a given area
Tree felling	Cutting a tree at the base
Undergrowth	Low growth on the floor of a forest, including seedlings and saplings, shrubs, and herbs
Upwelling	A process in which cold, often nutrient-rich waters from the ocean depths rise to the surface
Urbanization	The process by which large numbers of people become permanently concentrated in relatively small areas, forming cities.
Vascular plants	Plants having a specialized conducting system for circulating water, minerals, and the products of photosynthesis through the plant
Water table	The level below which the ground is saturated with water
Watercourse	A natural or artificial channel through which water flows
Watershed	The area of land where water drains into a common watercourse, stream, river, lake or ocean
Wetland	An area of land whose soil is saturated with moisture either permanently or seasonally
Xerophytic scrub	A community of plants adapted for life and growth with a limited water supply

Name _____ Date _____

The EcoMap





STRUCTURE
Abiotic

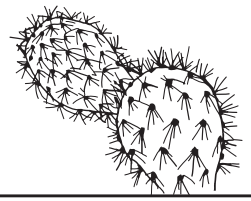
Habitats

Feedback Loop

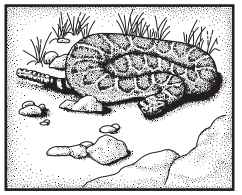
Feedback Loop

Cycles

FUNCTION
Biotic

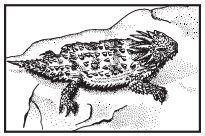


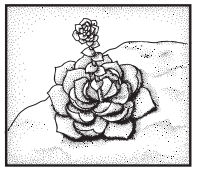
EcoMap: Level One



Name _____ Date _____

The EcoMap





Ground

Geology

Energy

Geothermal Energy

Location

Fire

Climate

Water

STRUCTURE
Abiotic

Feedback Loop

Feedback Loop

Habitats

Cycles

FUNCTION
Biotic

Niche

Chemical

Life

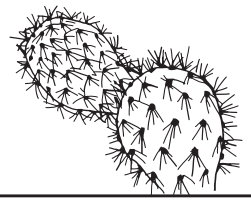
Time

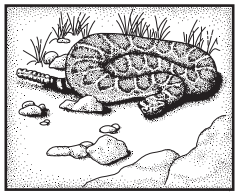
Water

Limiting Factors
(Non-living)

Adaptations

Organisms

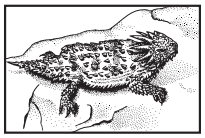




EcoMap: Level Two

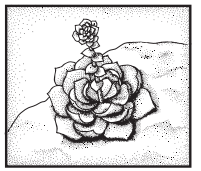
Name _____ Date _____

The EcoMap



- Landform, Topography
- Faults
- Spreading Center

- Longitude, Latitude
- Elevation
- Watershed



- Rock, Sand, Soil
- Nutrients

- Frozen, Liquid, Vapor
- Fresh, Salty
- Contaminated
- Groundwater

- Weather
- Seasons
- Temp. Variation
- Wind, Floods
- Global Warming

Ground

Geothermal Energy

Energy

Geology

Location

Fire

Climate

Water

- Kelp Forest
- Beach/Tidepools
- Coastal Sage Scrub
- Succulent Sage Scrub
- Chaparral
- Pine/Oak Woodlands
- Desert
- Wetlands
- Riparian Areas

STRUCTURE
Abiotic

Feedback Loop

Feedback Loop

FUNCTION
Biotic

Habitats

Cycles

- Chemical
  - Carbon
  - Nitrogen
  - Oxygen
  - Sulfur
  - Phosphorus
- Life
  - Plant
  - Animal
- Time
  - Daily
  - Seasonal
  - Lunar
- Water

Niche

Limiting Factors
(Non-living)

- Salinity
- Water
- Potassium
- Nitrogen

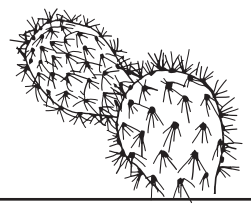
Adaptations

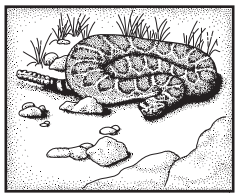
- Behavioral Adaptations
- *Hunting Strategies*
- Species Adaptations
- *Spines, Succulence*

Organisms
- Populations
- Communities

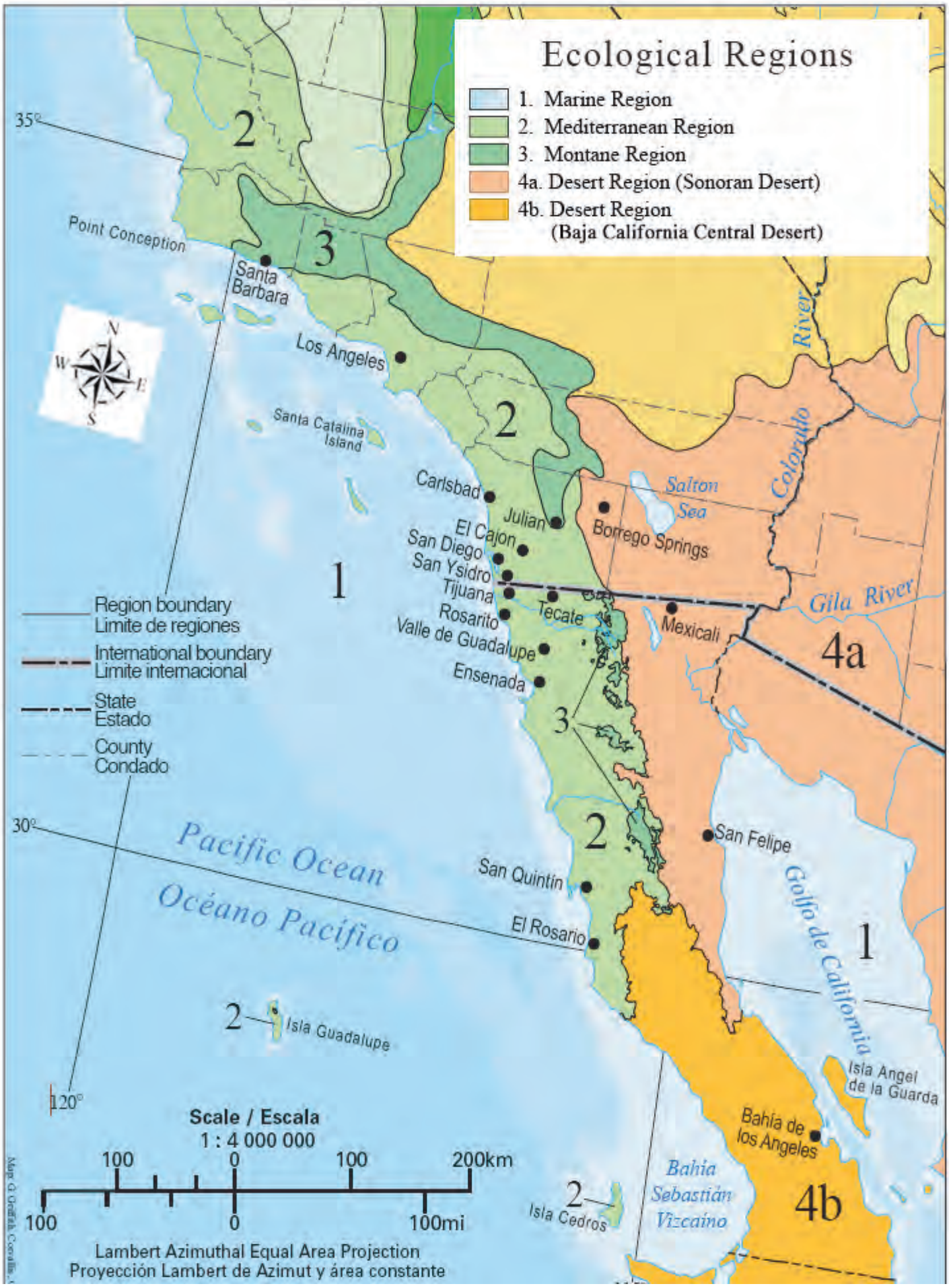
- Consumers
- Producers
- Decomposers

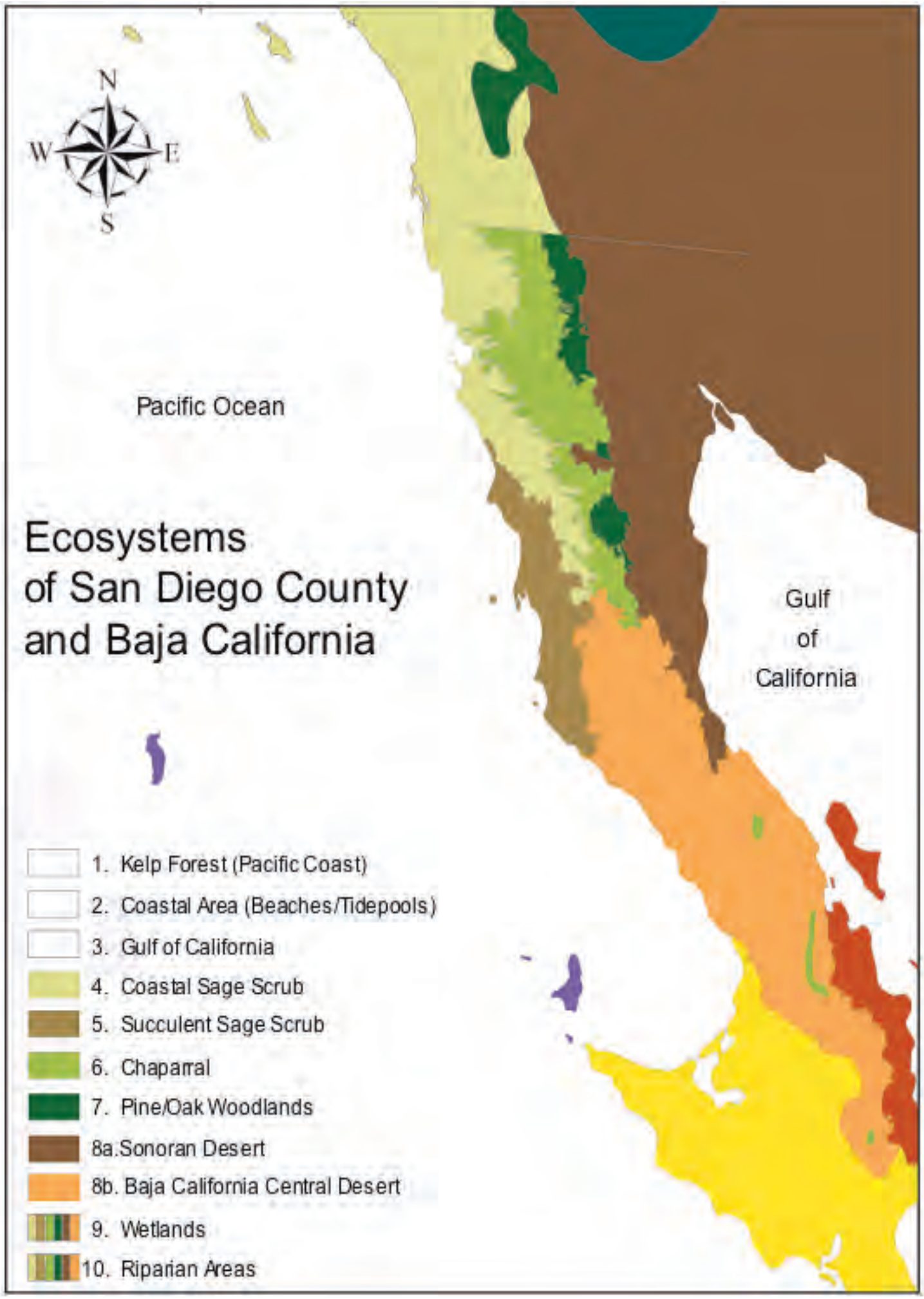
Food webs





EcoMap: Level Three


Ecological Regions
1. Marine Region
2. Mediterranean Region
3. Montane Region
4a. Desert Region (Sonoran Desert)
4b. Desert Region
(Baja California Central Desert)
35°
30°
120°
Point Conception
Santa Barbara
Los Angeles
Santa Catalina Island
Carlsbad
Julian
El Cajon
San Diego
San Ysidro
Tijuana
Rosarito
Valle de Guadalupe
Ensenada
Tecate
Mexicali
Salton Sea
Borrego Springs
Colorado River
Gila River
San Felipe
San Quintin
El Rosario
Isla Guadalupe
Isla Cedros
Isla Angel de la Guarda
Bahia de los Angeles
Bahia Sebastián Vizcaíno
Golfo de California
Pacific Ocean
Océano Pacífico
Region boundary
Limite de regiones
International boundary
Limite internacional
State
Estado
County
Condado
Scale / Escala
1 : 4 000 000
100 0 100 200km
100 0 100mi
Lambert Azimuthal Equal Area Projection
Proyección Lambert de Azimut y área constante


N
W
E
S
Pacific Ocean
Ecosystems
of San Diego County
and Baja California
Gulf
of
California
1. Kelp Forest (Pacific Coast)
2. Coastal Area (Beaches/Tidepools)
3. Gulf of California
4. Coastal Sage Scrub
5. Succulent Sage Scrub
6. Chaparral
7. Pine/Oak Woodlands
8a.Sonoran Desert
8b. Baja California Central Desert
9. Wetlands
10. Riparian Areas

Plant Observation

Name _____ Date _____

The Plant

First, check out the plant's environment.

Where is it found –
- wet, damp or dry habitat
- rocky, sandy, compacted or clay soil
- with what other trees, shrubs and flowers does it grow

_____

Then, look at the plant.

Is it –
- tall (how tall?) or low to the ground
- slender or bushy

Last, look at the stem.

Is it –
- woody or herbaceous (not woody)
- with or without leaves
- smooth, hairy, sticky, or thorny
- one or many
- round or angled
- solid or hollow
- erect or prone

Draw a circle around the correct answers. Write the plant's name if you know it. Draw a sketch of it.

Plant Name: _____

P-1

Plant Observation

Name _____ Date _____

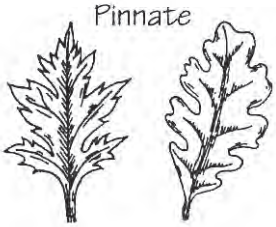
Simple leaf

Compound leaf

Venation

Parallel

Pinnate



Palmate

Leaves, Part One

Look at the leaves on the plant.

Are they – ◆ simple ◆ compound

Look at the veins in the leaves (venation).

Are they – ◆ parallel ◆ palmate ◆ pinnate

Draw a circle around the correct answers to the above. Write the plant's name if you know it. Draw a sketch of one or more of its leaves. Label your drawing.

■■■

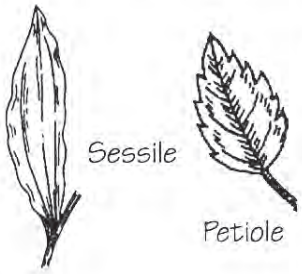
Plant Name: _____

P-2

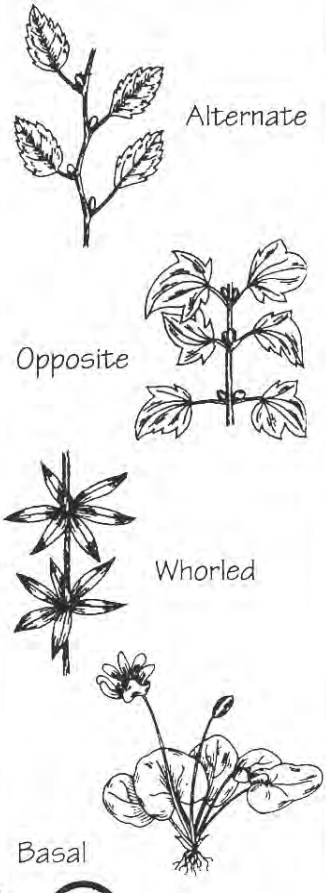
Plant Observation

Name _____ Date _____

Leaf Stems



Leaf Arrangement



Leaves, Part Two

Look at the way leaves are arranged on the stem of the plant.

Are they – ◆ alternate ◆ opposite ◆ whorled ◆ basal

Look at the leaves.

Are they – ◆ with stems (petioles) ◆ without stems (sessile)

◆ thick ◆ thin ◆ smelly

Is the texture – ◆ sticky ◆ waxy ◆ smooth ◆ hairy ◆ glandular

Draw a circle around the correct answers to the above. Write the plant's name if you know it. Note whether the leaves are simple or compound and note their venation. Draw and label a sketch of the leaves and stem of your plant using all your observations. ■■■

Plant Name: _____

P-3

Plant Observation

Name _____ Date _____

Leaves, Part 3

Look the shape of the leaves.

Are they –

- linear
- lanceolate
- scale-like
- ovate
- grass-like
- oval
- oblong
- elliptical
- deltoid
- oblanceolate
- needles
- wedge
- obovate
- cordate

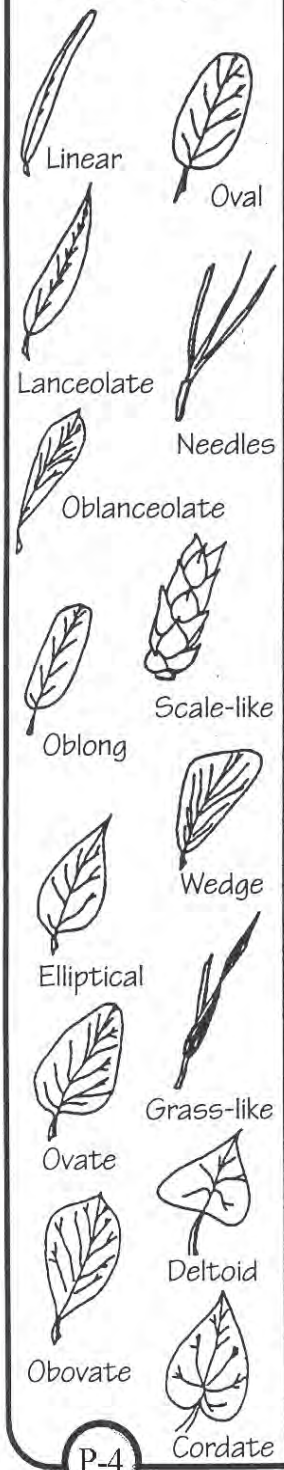
Look at the margins of the leaves.

Are they –

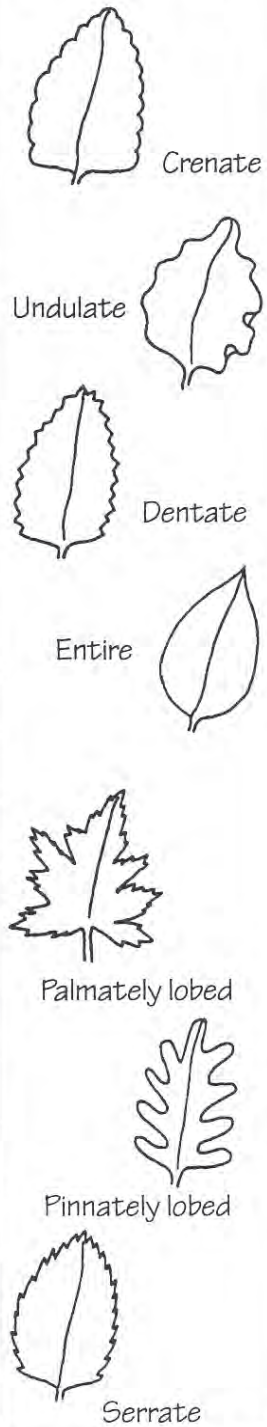
- crenate
- entire
- serrate
- undulate
- palmately lobed
- pinnately lobed
- dentate

Add Labels which describe the leaf shape and margin to your drawing on Plant Observation Sheet #3. On the lines below write a complete description of your plant using the scientific terms you have just learned. Use the back of this page if you need more space. ■■■

Leaf Shapes



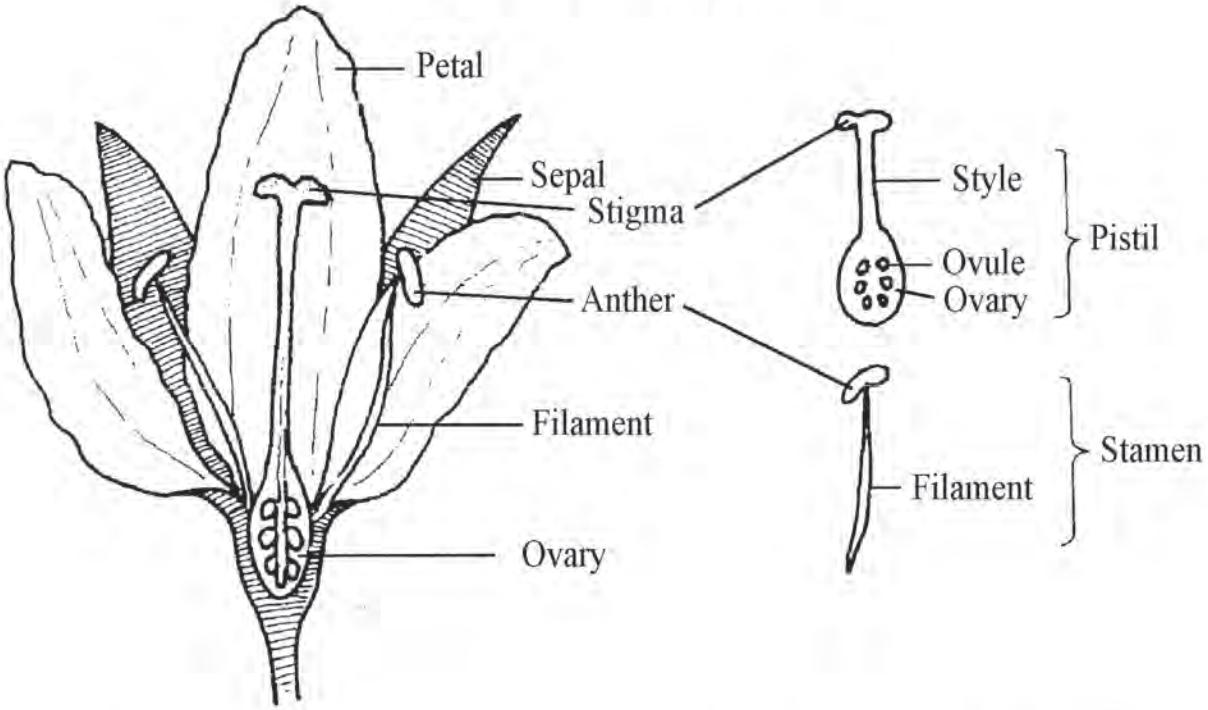
Leaf Margins



Plant Observation

Name _____ Date _____

The Parts of a Flower



A flower is the reproductive organ of a plant.

The flowers of some plants are bisexual, that is both male and female. They have both stamens and pistils. The flowers of other plants may be either male or female. Male and female flowers may be on the same plant or on separate plants. The stigma from one flower has to receive pollen from another flower for the plant to be able to produce seeds.

Stamens are the male sex organ. They have two parts:

1) **anthers,** which produce the pollen
2) **filaments,** which attach anthers to the flower

The pistil is the female sex organ. It has three parts:

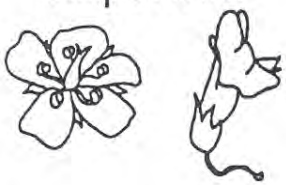
1) the **stigma,** which receives the pollen grains
2) the **ovary,** which produces seeds
3) the **style,** which connects the stigma and the ovary

Plant Observation

Name _____ Date _____

Composite Flower

Simple Flower



Regular Flowers
(All petals the same)

Funnelform

Tubular

Urn shaped

Irregular Flowers
(All petals not the same)

Labiate

Pea-shaped

Flowers, Part One

Look at the sepals. (Refer to "The Parts of a Flower").

Are they –
- present or absent
- separate or united
- green or petal-like
- straight or reflexed (turned down)

What else–
- Do they stay on or fall off after flowering?
- How many are there?

Look at the petals. (Refer to "The Parts of a Flower").

Are they –
- present or absent
- separate or united

What else–
- What color are they?
- Do they have an odor?
- Do they have a distinctive outline or appendages?
- How many are there?

Look at the corolla (the sepals and petals together).

Is it –
- regular or irregular
- If the petals are united, is the shape
  - funnelform
  - tubular
  - labiate
  - urn shaped
  - pea-shaped
- other _____

Look at the nectar guides.

Are there –
- lines or colors that guide the insect to the nectar
- brightly colored glands at the base of the petals that secrete nectar

What else –
- Does the shape of the flower direct the pollinator to the nectar?

■■■

Plant Observation

Name _____ Date _____

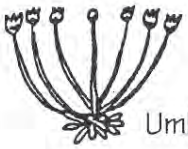
Flower Arrangements


Spike


Raceme


Panicle


Corymb


Umbel


Head


Catkin

Flowers, Part Two

Look at the flower arrangement (inflorescence).

Is it a–
- ◆ spike ◆ raceme ◆ panicle
- ◆ corymb ◆ umbel ◆ head
- ◆ catkin ◆ other_____

Look at the stamens. (Refer to "The Parts of a Flower").

Are they –
- ◆ present or absent
- ◆ equal or unequal in length
- ◆ separate, united to each other or to the corolla
- ◆ longer or shorter than the corolla

What else–
- ◆ How many stamens are there?
- ◆ Are any of them sterile?

Look at the pistil. (Refer to "The Parts of a Flower").

Is it –
- ◆ present or absent
- ◆ Is there more than one?

Is the stigma–
- ◆ single or divided

Is the style–
- ◆ present or absent
- ◆ single or divided

Is the ovary–
- ◆ above (superior) or below (inferior) the place where it is attached to the sepals

What else–
- ◆ How many compartments (locules) are there?
- ◆ How many seeds (ovules) are there?

■■■

Cactus Observation

Name _____**Date**_____

Introduction

Cacti have developed many adaptations to survive the arid conditions of deserts and to keep their moist tissue from being eaten.

Stems
Their succulent stems store water and are covered with a thick waxy coat to reduce water loss.

Cacti, like most plants, use the sun's energy to convert carbon dioxide and water into sugar. During this process, called *photosynthesis*, small pores (stomata) on the surface of the leaves and stems open to absorb carbon dioxide and release oxygen. Whenever stomata open during the day, water is lost by evaporation. So, during the hottest dryest times, the amazing cactus can open their stomata at night—when temperatures are cooler—to take in carbon dioxide. Then during the day, their pores remain closed while they slowly use the stored carbon dioxide to make sugar. When temperatures fall they will photosynthesize during the day

Spines
Cacti always have aeroles which produce spines in bundles. The bundles can look very different—long, short, think, or sparse. Long spines can shade the fleshy stems protecting the soft tissue from hot, drying winds and reflecting the sun's rays outward. Spines can also act as drip tips or gutters, guiding rain water or morning dew to thirsty roots.

All spines make it difficult, but not impossible, for grazing animals to feed on the juicy stems. Even the very short spines on beavertail cactus, called glouchids, look soft as fir, but they are not and can be very irritating to the lips or finger tips.

Roots
The roots of cacti reach both out, away from the plant, and down to find water. After rains, new root hairs develop quickly to take advantage of the moisture.

References:
Roberts, Norman C., *Baja California Plant Field Guide*

Barrel Cactus

Capon, Brian, *Plant Survival: Adapting to a Hostile World*
National Wildlife Federation, *NatureScope: Discovering Deserts*

Cactus Observation

Name _____**Date**_____

The Plant

First, check out the cactus' environment.

Where is it found?
- wet, damp or dry habitat
- rocky, sandy, compacted or clay soil
- on a hillside or on level ground
- With what other trees, shrubs, flowers, and cactus is it found?

_____

Then look at the cactus.

Is it
- tall (how tall) or low to the ground
- swollen and full of water or shriveled and thirsty

Draw a circle around the correct answers. Write the name of the cactus if you know it. Sketch the cactus in its habitat.

Name of the cactus:_____

C–2

Cactus Observation

Name _____**Date**_____

The Stems

Stem Forms

Cylindrical jointed

Flat jointed

Columnar

Branched

Basal

Caespitose

Look at the cactus stems.

Are they

- basal
- columnar
- caespitose
- flat jointed
- branched
- cylindrical jointed

Draw a circle around the correct answer. Write the name of the cactus if you know it . Sketch the stems paying special attention to how they are attached.

Name of the cactus:_____

C–3

Cactus Observation

Name _____ **Date**_____

Spine Position


Nipples


Tubercles


Flat surface


Ribs

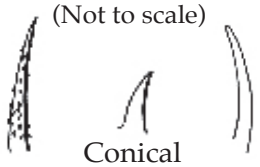
Spine Placement in Areoles


Spine cluster
Central and radial spines


Areole
spines in axil


Areole glochids and spines

Spine Shape
(Not to scale)


Glochid with barbs
Conical
Acicular


Subulate
Cross-ribbed

Spines and Areoles

Cactus have **areoles,** places where spines are attached. The areoles are usually oval to round and made up from two buds close together. The lower bud develops spines, and the upper bud produces the flowers, fruits, and branches.

Look at the spines.

Are they located on

• tubercles • nipples • flat surface • ribs

Check out the arrangement of the spines in the areoles
(the organs that bear the spines).

Are they
- clustered with one central spine and radial spines
- in the axil (the angle formed by the spine with the stem)

Are there
- glochids only (short barbed hairs or bristles)
- spines together with glochids

Look at the shape of the spines

Are they • conical • auricular • subulate • cross-ribbed

Draw a circle around the correct answers. Write the name of the cactus if you know it. Draw an enlarged picture of the spines on your cactus. Label it.

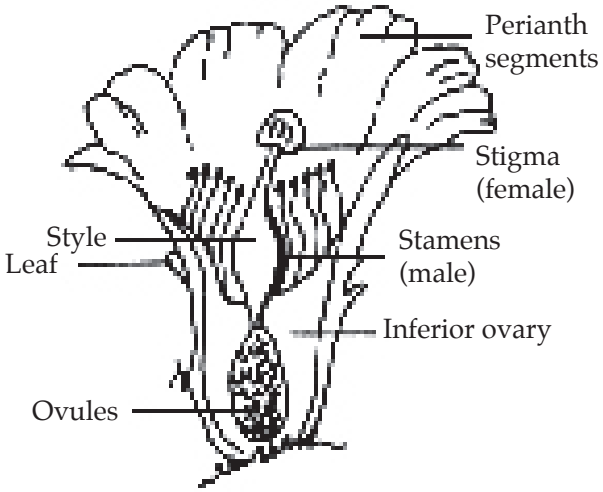
Name of the cactus:_____

C–4

Cactus Observation

Name _____**Date**_____

Reproduction



A flower is the reproductive organ of the plant. The flowers of some plants are bisexual, that is both male and female. They have both stamens and pistils. (See above.) The flowers of other plants may be either male or female. Both male and female flowers may be on the same plant or on separate plants. Usually the stigma from one flower has to receive pollen from another flower for the plant to be able to produce seeds.

Although cactus produce flowers which in turn produce seeds, many cactus reproduce through vegetative reproduction. Cactus such as cholla easily shed their stem segments. When this piece of cactus plant falls of the ground, it can grow roots and becomes a plant exactly like its "parent" plant.

The perianth segments form the outer part of the cactus flower (what we commonly call the "petals").

Stamens are the male sex organ. They have two parts:

1) **anthers,** which produce pollen
2) **filaments,** which attach anthers to the flower

The pistil is the female sex organ. It has three parts:

1) the **stigma** , which receives the pollen grains
2) the **ovary,** which produces the seeds
3) the **style,** which connects the stigma and the ovary

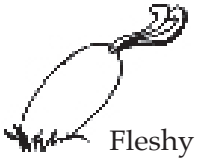
Hedgehog Cactus

Cactus Observation

Name _____ **Date**_____

Flowers and Fruits

Fruit Types


Fleshy smooth

Fleshy spiny 


Smooth fleshy with glochids

Fleshy tuberculate with glochids 


Dry tuberculate

Dry scaly 

(Refer to "Reproduction," p. C–5.)

Look at the stamens

Are they • present or absent • even or uneven
• longer or shorter than the petals

How many are there? ***Are some of them sterile?***

Look at the pistil

Is it • present or absent •Is there more than one?
Is the stigma • single or divided
Is the style • present or absent • single or divided
Is the ovary • above (superior) or below (inferior) the place where the ovary joins the sepals

Look at the fruits

Are they • present or absent
• fleshy smooth • fleshy spiny
• smooth fleshy with glochids
• dry tuberculate • dry scaly
• fleshy tuberculate with glochids

Draw a flower and or fruit if present on your cactus. Label your drawing. Use the back of the page to write a description of your cactus using all the information you have gathered.

Name of the cactus:_____

Bird Observation

Data Sheet

Feeding = E
Loafing = L
Flying = F
Maintenance = M
Interactions = I
Other = O

Name: _____

Date:_____ Site:_____ Time:_____ Temperature:_____

Cloud Cover:_____ Visibility:_____ Precipitation:_____

Air Quality:_____ Tide:_____ Wind Speed:_____

Fill in the information indicated in each box below.

Bird:	Habitat:
	Behavior: How many activities per unit of time, e.g. 4E/1 min.
	Number of Birds:
Bird:	Habitat:
	Behavior: How many activities per unit of time, e.g. 4E/1 min.
	Number of Birds:
Bird:	Habitat:
	Behavior: How many activities per unit of time, e.g. 4E/1 min.
	Number of Birds:
Other birds seen:	

B-1

Activity 3a (Extra)
The Coastal Zone (Beaches): Beach Field Trip

Grades
- Upper elementary grades
- Middle School
- High School

Subjects
- Natural Sciences
- English
- Mathematics

Skills
- Observing
- Describing
- Comparing
- Inferring
- Communicating
- Analyzing
- Synthesizing

Concepts
- The seashore is the boundary between terrestrial and marine ecosystems. It is called the coastal zone; this zone can be rocky, sandy, or gravelly.
- Marine animals and plants are adapted to living in the ocean.

Objectives
Students will:
- Appreciate and know the intertidal zone in a beach.
- Will become interested in

Procedure

Information
For this session, it is very important to take a walk on a beach's inter-tidal zone, considering the high, medium, and low areas. Therefore, the walk needs to be scheduled on day with a good low tide.

Students need to dress comfortably, wear sandals or sneakers that can get wet, a cap or hat, and must wear sun block.

The main concept that will be explored during this walk is how organisms have adapted to life in the ocean and to the specific habitats they inhabit. This is why it would be useful to familiarize students with the concept of adaptation to life in the ocean. Before the walk, give students a brief introduction to the subject using the background information in Activity 3a and do the warm-up activity that follows.

Warm-up Activity
The reality that exists in regards to living organisms stems from the fact that they need to perform certain functions to survive. Some of these functions are:
- Breathing (or gas exchange)
- Feeding
- Defending against the enemy
- Perception of surroundings
- Maintenance of a position (through movement or adherence)
- Reproduction
- Communication, and
- Temperature regulation

Animals that live on land and those that live in the ocean perform these functions in a very different manner.

Before the walk on the beach ask students to do the following visual imagery exercise to begin thinking about adaptations to different habitats. Ask them to think about how, as land organisms, they perform each of the vital functions listed above. Next, ask students to visualize what would happen if they fell into a pool and had to survive in an aquatic environment, would they be able to perform the same vital functions in the water?

learning about and conserving organisms living on rocky and sandy beaches.
- Become familiar with the basic concepts of evolution and adaptation.
- Be able to appreciate some relationships and interactions between organisms in the intertidal zone and their environment.
- Learn about the ecological and economic importance of this ecosystem.

Time
Prep time: 60 minutes
Activity time: 90 minutes

Materials
For each team:
- Large shallow clear plastic container to place organisms to be observed
- 2 wooden coffee stirrers to manipulate organisms
- 2 collecting jars

For each participant:
- A copy of the questionnaire A walk on the Beach
- Pencil
- Clipboard
- Magnifying glass

Vocabulary
Adaptation
Algae
Coastal zone
Desiccation
Habitat
High tide
Invertebrate
Low tide
Predator
Tide
Vital functions
Zoning

1. Use background information and other materials to talk to students about important aspects of the coastal zone: habitat, zoning, general aspects of moisture and temperature effects on animals and plants found at the beach, and main groups of organisms that live there. You can also create a photography or poster exhibit using the coastal zone and the organisms that live there as a theme. You may want to invite a researcher or university professor as a speaker. Students may want to interview the expert and obtain further information on the coastal zone of their region, its ecology, its importance, and the challenges it faces today. In addition, a network between students, scientists and academics can be established.

2. The area where you and your students will be working — a rocky, sandy, or gravelly beach, or all three — will be selected for the diversity of organisms that live there and for its safety.

3. After the warm-up activity, inform participants about behavior rules during the walk. In the case of a rocky beach, highlight the importance of placing rocks and animals back into their exact original place. Tell students they need to be careful with not keeping organisms out of the water for too long. Also ask them not to take animals that are permanently adhered to the substrate, such as barnacles, anemones, chitons, etc. Also, discuss with students how important it is to impact the area the least possible, and stress that they can't take any organisms with them.

4. Prior to the walk make teams of 4-5 students. Teams need to be under adult supervision.

5. The walk will last approximately one and half hours. This is enough time for students to have the opportunity to observe the large variety of organisms in the intertidal zone.

6. The walk needs to cover a small area parallel to the coastline, and a larger area perpendicular to the coastline to observe the adaptations of organisms according to the division of the inter-tidal zone (high, medium, low).

The Walk
1. During the walk encourage students to pick-up organisms and examine them closely and carefully, placing them in the shallow plastic container, if possible, and using their magnifying glasses. Highlight the importance of placing rocks, as well as animals, and algae back into their exact original positions. Tell students they need to be careful not to keep organisms out of the water too long because they can't breath and get desiccated by the action of the sun and wind. Also ask them not to take animals that are permanently adhered to the substrate, such as barnacles, anemones, chitons, etc., because they can get hurt and will, very probably, not be able to adhere to the rocks again, and may even perish.

Preparation

1. Find a place on the coastal zone that has a large diversity of marine organisms and is safe.
2. Prepare a photography or poster exhibit using the coastal zone as a theme.

Description

With an outdoors experience students will learn about the different organisms that live in the coastal zone. They will examine the most important structures and will determine which kind of organism they are observing, their adaptations, and their distribution in the area they are visiting, and their importance.

2. Encourage students to talk about the shape of the organisms that they are observing, and to give ideas about the adaptations to marine life that they imagine each of these organisms has come to develop,

3. Discuss adaptations and the situations to which organisms adapt (potential situations: to avoid predators and defend themselves, to find food and eat it, to move, to perceive the environment that surrounds them, to find a mate and reproduce, to handle changes in the environment, etc.). What adaptation must organisms find for each particular situation? (Possible answers: gills to breathe, camouflage to avoid predators, large teeth to feed on meat, suckers to adhere to substrate, legs or fins to move, shells for protection, etc.). Reinforce students' answers with background information.

4. At the end of the walk, inform students that they will answer the questionnaire "A Walk on the Coastal Zone."

5. The activity ends when students produce and present dioramas of the coastal zone; it may be a rocky, sandy or gravelly beach.

Reflection Exercise

Discuss with your students the experience of taking a walk on the intertidal zone. Did the walk increase their interest on the ocean environment and its plants and animals? In what way? Do they think it's important to take care of the marine zone they just learned about? Why? Have a brainstorm about how water pollution affects organisms living in the coastal zone.

Evaluation

Ask students to fill out the section called *Coastal Zone* on their "What Have We Learned About Our Ecosystems" chart.

Typical Flora and Fauna of Our Region

Ecological Regions/ Ecosystem	Flora		Fauna	
	Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Marine Kelp Forest				
	Giant Kelp	*Macrocystis pyrifera*	Brown Sea Urchin	*Strongylocentrotus purpuratos*
			Black Turtle	*Chelonia mydas (=agassizii)*
			Brandt's Cormorant	*Phalacrocroax penicillatus*
			California Sea Lion	*Zalophus californicus*
Beach/ Tidepools				
	Sea lettuce	*Ulva lactuca*	Beach Hopper	*Ochestoidea californiana*
			Brown Pelican	*Pelecanus occidentalis*
			Western Gull	*Larus occidentalis*
			Striped Shore Crab	*Pachygrapsus crassipes*
			Giant Green Anemone	*Anthopleura xanthogrammica*
			Giant Limpet	*Megathura crenulata*

ECOLOGICAL REGIONS/ Ecosystem	Flora		Fauna	
	Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
MEDITERRANEAN Coastal Sage Scrub/Succulent Sage Scrub/Chaparral				
	Black Sage	*Salvia mellifera*	Quino Checkerspot	*Euphydryas editha quino*
	California Sagebrush	*Artemisia californica*	Coast Horned Lizard	*Phrynosoma coronatum blaiinvillii*
	California Buckwheat	*Erigonum fasciculatum*	California Quail	*Callipepla california*
	Eastwood Manzanita	*Arctostaphylos glandulosa*	California Gnatchatcher	*Polioptila californica*
	Ramona Lilac	*Ceanothus tomentosus*	Wrentit	*Chamaea fasciata*
	Tecate Cypress	*Callitropsis forbesii*	Anna's Hummingbird	*Calypte anna*
	Golden Eardrops	*Dicentra chrysantha*	Western Scrub Jay	*Aphelocoma californica*
	Otay Mesa Mint	*Pogogyne nudiuscula*	Western Brush Rabbit	*Sylvilagus bachmani*
	Red Brome, Foxtail	*Bromus madritensis* ssp. *rubens*		
	Black Mustard	*Brassica nigra*		
	Giant Reed	*Arundo donax*		

ECOLOGICAL REGIONS/ Ecosystem	Flora		Fauna	
	Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
MONTANE Pine/Oak Woodlands				
	Canyon Live Oak	*Quercus chrysolepis*	Acorn Woodpecker	*Melanerpes formicivorus*
	Nuttall's Scrub Oak	*Quercus dumosa*	Dark-eye Junco	*Junco hyemalis*
	Jeffrey Pine	*Pinus jeffreyi*	Mountain Chickadee	*Poecile gambeli*
	California Juniper	*Juniperus californica*	Mule Deer	*Odocoileus hemionus*
	Deer Grass	*Muhlenbergia rigens*	Mountain Lion	*Puma concolor*
	Quaking Aspen	*Populus tremuloides*		
	Mistletoe	*Phoradendron bolleanun*		
	White Fir	*Abies concolor*		
DESERT				
	Silver Cholla, Chain-link Cholla	*Cylindropuntia cholla*	Darkling Beetle	*Eleodes* sp.
	Creosote Bush	*Larrea tridentata*	Cactus Bee	*Diadasia rinconis*
	Ocotillo	*Fouquier splendors*	Sidewinder	*Crotalus cerastes*
	Desert Sand Verbena	*Abronia villosa var. villosa*	Greater Roadrunner	*Geococcyx californianus*
	Shaw's Agave	*Agave shawii*	Common Raven	*Corvus corax*
	White Bursage, Burroweed	*Ambrosia dumosa*	Cactus Wren	*Campylorhunchus brunneicapillus*
	Thurber's Stemsucker	*Pilostyles thurberi*	Bighorn Sheep	*Ovis canadensis*
	Salt Cedar	*Tamarix ramosissima*	Coyote	*Camis latrans*

ECOLOGICAL REGIONS/ Ecosystem	Flora		Fauna	
	Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
WETLANDS				
	California Cordgrass	*Spartina foliosa*	Marbled Godwit	*Limosa fedoa*
	Pacific Pickleweed	*Salicornia pacifica*	Clapper Rail	*Rallus longirostris*
	Orcutt's Bird's Beak	*Cordylanthus orcuttianus*	Savannah Sparrow	*Passerculus sandwichensis*
	Saltwort	*Batis maritima*	Snowy Egret	*Egretta thula*
	Saltgrass	*Distichlis spicata*	California Horned Snail	*Cerithidea california*
			Least Tern	*Sterna antillarum*
			Snowy Plover	*Charadrius alexandrinus*
RIPARIAN AREAS				
	Willow	*Salix* sp.	Common Green Darner	*Anax junius*
	Freemont Cottonwood	*Populus fremontii*	Common Yellowthroat	*Geothlyphis Trichas*
	Coast Live Oak	*Quercus agrifolia*	Raccoon	*Procyon lotor*
	Sycamore	*Platanus racemosa*	Pacific Tree Frog	*Pseudacris regilla*

Typical Flora and Fauna of the San Diego County/Baja California Region

Field Guide
Complement to the Teacher's Guide

Our Natural Heritage, Bioregional Pride

PROBEA is a program of the San Diego Natural History Museum. This material was designed and produced with funds provided by U.S. Fish & Wildlife Service.

Typical Flora and Fauna of the San Diego County/Baja California Region

Field Guide
Complement to the Teacher's Guide
Our Natural Heritage, Bioregional Pride
PROBEA is a program of the San Diego Natural History Museum. This material was designed and produced with funds provided by U.S. Fish & Wildlife Service.
Typical Flora and Fauna of the San Diego County/Baja California Region

Field Guide
Complement to the Teacher's Guide
Our Natural Heritage, Bioregional Pride
PROBEA is a program of the San Diego Natural History Museum. This material was designed and produced with funds provided by U.S. Fish & Wildlife Service.
Typical Flora and Fauna of the San Diego County/Baja California Region

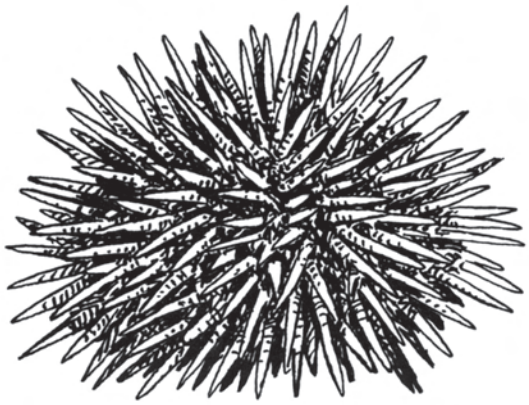
Field Guide
Complement to the Teacher's Guide
Our Natural Heritage, Bioregional Pride
PROBEA is a program of the San Diego Natural History Museum. This material was designed and produced with funds provided by U.S. Fish & Wildlife Service.

Giant Kelp

Macrocystis pyrifera

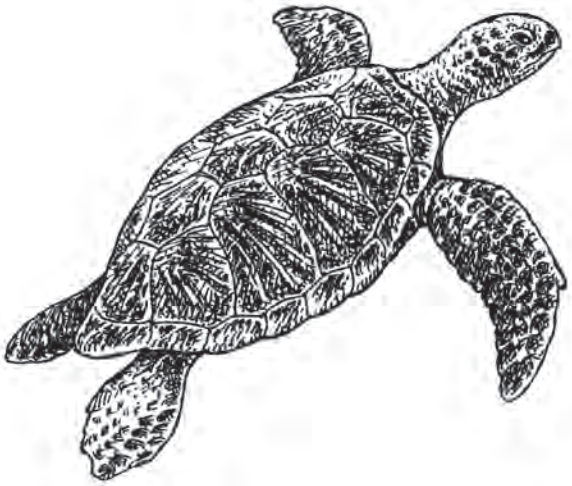
Brown Sea Urchin

Strongylocentrotus purpuratus



Black Turtle

Chelonia mydas (=agassizii)



Brandt's Cormorant

Phalacrocroax penicillatus

Brown Sea Urchin

Strongylocentrotus purpuratus

HABITAT/RANGE: Commonly found in splash zones with moderate to strong surf. These animals inhabit depressions in the rocks. As they grow, they use their teeth to enlarge these depressions. They also live everywhere on sea bottoms down to a depth of 8,200 ft. (2,500 m.).

DESCRIPTION: Globe-shaped, lacking arms. They have an internal skeleton covered by the epidermis, comprised of rigidly united calcareous plates that form a carapace. Their spines facilitate orientation. They project podia ("feet") through the calcium carbonate covering of the spines. The feet function in locomotion, capture of food, respiration, etc.

REPRODUCTION: Reproduction is sexual, and the sexes are in separate individuals.

ECOLOGICAL RELATIONSHIPS: Brown Sea Urchins are herbivorous, and control overgrowth of seaweed and many small fish. Organisms classified as equinoderms represent a potential food resource for future generations. For this reason it is important to increase studies about their biology in order to harvest them sustainably.

Giant Kelp

Macrocystis pyrifera

HABITAT/RANGE: Found along the Pacific coast from central California to Baja California and in the sub-antarctic waters of South America. It inhabits the areas from the intertidal zone to a depth of 100 ft. (30 m.) and can form submarine forests.

DESCRIPTION: It has a root-like holdfast that fixes to rocky surfaces; a long slender stalk or stipe; and long, leaf-like blades or fronds, which are the major site of photosynthetic activity. The kelp plant is supported in the water by gas-filled bladders on each frond called nematocysts. In favorable conditions giant kelp can grow to over 100 ft. (30 m.) long.

REPRODUCTION: Giant Kelp reproduction is very complex. It has alternate generations that each take different forms. In the final stage, microscopic plants on the sea floor fertilize to give rise to the long leaf-like blades.

ECOLOGICAL RELATIONSHIPS: Giant Kelp releases oxygen through photosynthesis. Abalone and sea urchins eat this alga. Kelp is the primary producer in the food chains of various communities of microbes and invertebrates.

Brandt's Cormorant

Phalacrocroax penicillatus

HABITAT/RANGE: West coast of the United States, Baja California, and the Gulf of California.

DESCRIPTION: Adults are all black with a patch of beige feathers on the chin. The bare throat pouch turns bright blue during breeding. Immature are all dark brown.

REPRODUCTION: Nests in colonies. Saucer-like nest of seaweed and other marine vegetation, placed on cliff ledge or rocky ground.

ECOLOGICAL RELATIONSHIPS: Feeds by diving and swimming underwater, eating small saltwater fish.

Black Turtle

Chelonia mydas (=agassizii)

HABITAT/RANGE: Gulf of California and Pacific coast. These turtles have been seen along the Pacific coast as far north as Alaska and as far south as Chile.

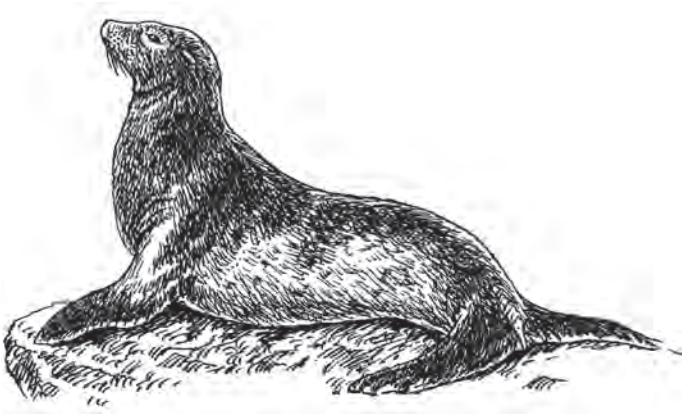
DESCRIPTION: Some authors consider the Pacific form of Chelonia mydas a species separate from the Gulf form Chelonia agassizii. Black and Green Turtles are not recognized as separate species. However, there are significant differences. The Black Turtle's head is black, and the turtle is medium-sized (smaller than the Green Turtle), with a flattened carapace. The jaws are serrated along the edge. The legs and feet are predominately black or greyish. The carapace measures 3 to 3.5 ft. (90–100 cm.) and weighs an average of 155 lbs. (70 kg.). The young have a black carapace; in adults it can be black or with black blotches over a greyish background. The plastron is white in the young, grey in adults.

REPRODUCTION: The nesting period is from August to January. Female turtles lay an average of three nests at two- to three-year intervals. Incubation is 48 to 55 days.

ECOLOGICAL RELATIONSHIPS: Adults feed on seaweed and juveniles on invertebrates.

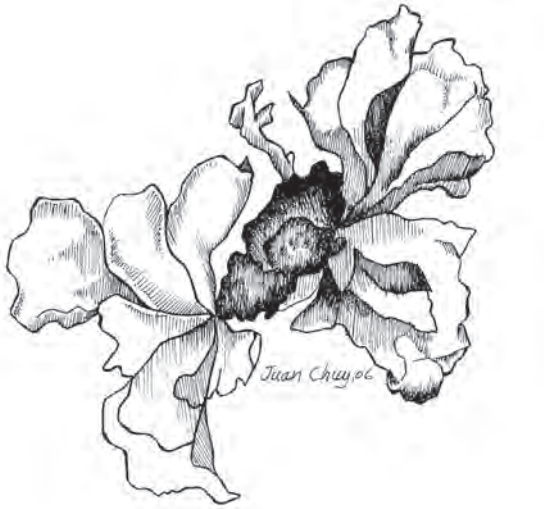
California Sea Lion

Zalophus californicus



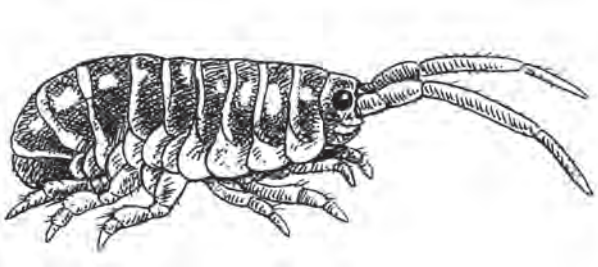
Sea Lettuce

Ulva sp.



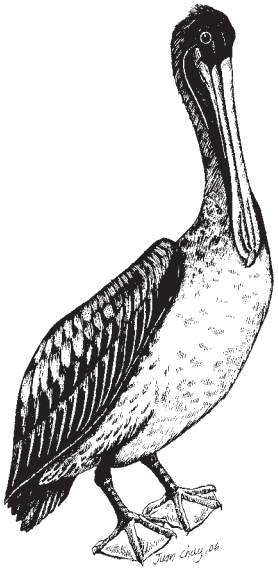
Beach Hopper

Orchestoidea californiana



Brown Pelican

Pelecanus occidentalis



Sea Lettuce

Ulva sp.

HABITAT/RANGE: Intertidal in tidepools and rocks or down to a depth of 65 ft. (20 m.). Able to tolerate low salinity and found in estuaries and in areas where there is a high level of nitrogen.

DESCRIPTION: A bright green alga composed of lobed, ruffle-edged leaves formed by two layers of cells. Leaves are coarse and sheet-like and resemble a leaf of lettuce. Sea Lettuce may be found attached to rocks and shells by a holdfast, and it is also commonly found free floating. Leaves can be up to 6 in. (15 cm.) long.

REPRODUCTION: A dioecious (sexes in separate plants) species. Male and female leaves can be distinguished by the color of their edges: yellow-green in males and dark green in females.

ECOLOGICAL RELATIONSHIPS: This species produces oxygen and serves as food for many fish and herbivorous mollusks. It can actually thrive in areas where there is nutrient loading (high nitrogen levels), and is used as an indicator species to monitor pollution. It can be used in salads and soups, and to make ice cream, other foods products, and medicines.

California Sea Lion

Zalophus californicus

HABITAT/RANGE: Coastlines along both sides of the Pacific Ocean.

DESCRIPTION: Color ranges from chocolate brown in males to a lighter, golden brown in females. Males average 850 lbs. (390 kg.) and 7 ft. (2.1 m.) in length. Females are smaller. They have a dog-like face, and at around five years of age, males develop a bony bump on top of their skull called a sagittal crest. They have external ear flaps and large flippers that they use to "walk" on land.

REPRODUCTION: California Sea Lions are found from Vancouver Island, British Columbia, to the southern tip of Baja California. They breed mainly on offshore islands. Most pups are born in June or July and weigh 13 to 20 lbs. (6–9 kg.).

ECOLOGICAL RELATIONSHIPS: California Sea Lions are opportunistic eaters, feeding on squid, octopus, herring, rockfish, mackerel, and small sharks. In turn, sea lions are preyed upon by orcas (killer whales) and great white sharks.

Brown Pelican

Pelecanus occidentalis

HABITAT/RANGE: Marine bird, awkward on the ground, agile when flying and capturing prey.

DESCRIPTION: In the adult, the head and neck are white, frequently mixed with yellow. The body is grey to brown. Pelicans have a brown neck pouch that turns bright red during breeding season.

REPRODUCTION: Breeding is in winter and spring.

ECOLOGICAL RELATIONSHIPS: They eat fish, and their guano fertilizes the ocean.

Beach Hopper

Orchestoidea californiana

HABITAT/RANGE: Beaches with fine sand and backed by dunes along the west coast of North America, from Vancouver Island, British Columbia, south into Baja California-

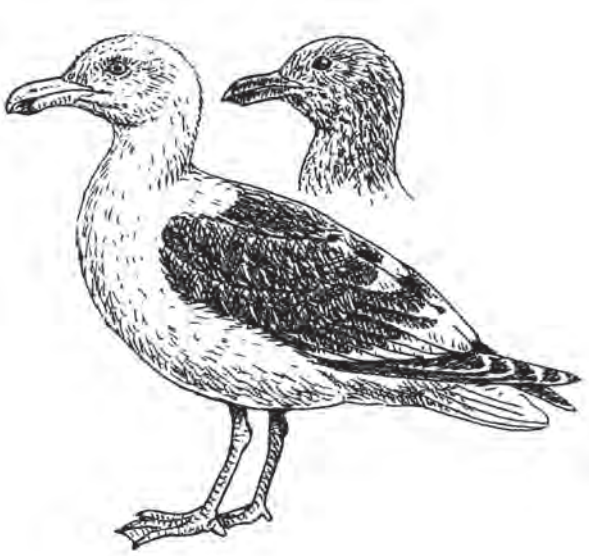
DESCRIPTION: Beach Hoppers can be up to 1 in. (28 mm.) long. They have curved bodies that are flat from side to side. Their compound eyes are very small. The long second pair of antennae is bright orange to rosy red.

REPRODUCTION: Adults mate in their burrows from June until November. The male deposits a jelly-like mass of sperm on the underside of the female and soon leaves the burrow. The dark blue eggs are brooded inside a pouch made by broad, leaf-like appendages on the thorax. Newly hatched juveniles closely resemble the adults.

ECOLOGICAL RELATIONSHIPS: Beach Hoppers eat seaweed that has washed up on the shore. During the day, they escape heat and predators by burrowing into the sand.

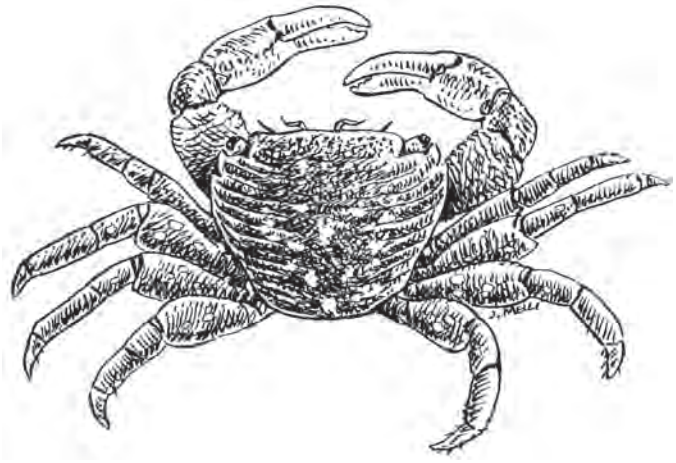
Western Gull

Larus occidentalis



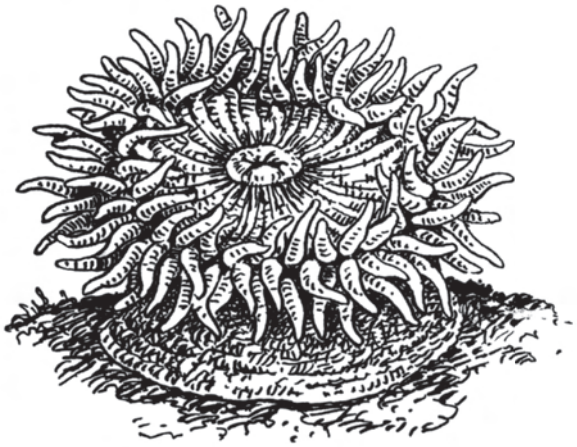
Striped Shore Crab

Pachygrapsus crassipes



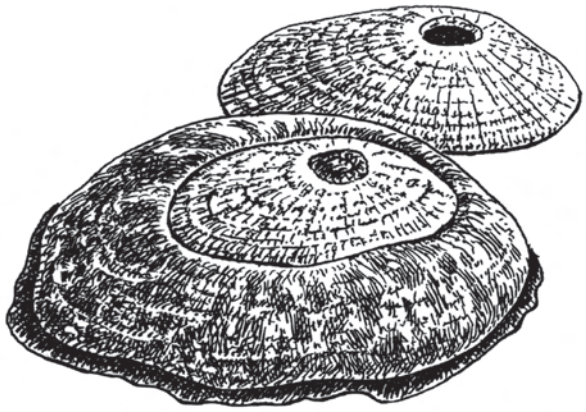
Giant Green Anemone

Anthopleura xanthogrammica



Giant Limpet

Megathura crenulata



Striped Shore Crab

Pachygrapsus crassipes

HABITAT/RANGE: Lives in crevices, under rocks, in tidepools and sometimes on muddy beaches and estuaries from Oregon to Baja California, and in the Gulf of California.

DESCRIPTION: Transverse lines on its carapace characterize this crab in the Grapsoidea family. Striped shore crabs are sexually dimorphic; the males and females look different. They feed on algae and diatoms that they scrape from the rocks or mud with their mouth parts. They occasionally eat dead animals and small, intertidal invertebrates, especially limpets.

REPRODUCTION: Mating occurs after the female molts, while she is still soft-shelled. The male rolls over on his back and the female walks above him. He inserts his sperm into the oviducts of the female. Mating season is from March to September, with maximum reproduction being in June and July.

ECOLOGICAL RELATIONSHIPS: The most semi-terrestrial of all the shore crabs. It spends half its time out of the water, and returns periodically to the tidepools. Predators include gulls, raccoons, anemones, and fish.

Western Gull

Larus occidentalis

HABITAT/RANGE: West coast of the United States and Baja California.

DESCRIPTION: Adult is the only common dark-backed, white-bodied gull on the Pacific coast. Massive bill is yellow with red spot near lower tip; legs pink. Young birds are all heavily mottled dark-grey-brown.

REPRODUCTION: Nests in colonies. Nest of sticks and grasses, on ground or rocky ledge.

ECOLOGICAL RELATIONSHIPS: Eats fish, shrimp, and eggs of other nesting seabirds and garbage.

Giant Limpet

Megathura crenulata

HABITAT/RANGE: Giant Limpets anchor themselves to rocks and pilings. They live in costal zones exposed to low tides. They are benthic animals, associated with the sea bottom.

DESCRIPTION: Limpets are the simplest gastropods. They typically have a well-defined head with two or four sensory tentacles and a muscular ventral foot, from which they get their name (gastropod, from the Greek gaster, "stomach," and poda, "foot"). They have a one-piece dorsal shell.

REPRODUCTION: Spawning occurs once a year, usually during winter, and is triggered by rough seas which disperse the eggs and sperm. Larvae float around for a couple of weeks before settling onto a hard substrate.

ECOLOGICAL RELATIONSHIPS: Giant Limpets are herbivores, using the tip of their rough tongues, called radulas. Limpets scrape rocks to obtain their food, consisting of algae, sponges and other invertebrates. They breathe through branquias.

Giant Green Anemone

Anthopleura xanthogrammica

HABITAT/RANGE: Coastal zones exposed to low tides. When they're exposed to air, they fold in their tentacles and fill their cavities with water to avoid drying out. They can attach themselves to the sandy bottom, but the majority anchor themselves on rocks or pilings.

DESCRIPTION: Anemones look more like plants than animals. Giant Green Anemones measure up to 2.75 in. (7 cm.) tall and 10 in. (25.4 cm.) in diameter. They have radial symmetry, like the spokes of a wheel, and an opening to their central cavity. They possess nematocysts, or stinging cells, that project poison darts on contact. These paralyze small fish, which the anemone passes to its central cavity with it tentacles. There are more than 800 species of anemones.

REPRODUCTION: Giant Green Anemones release brownish eggs and sperm into the sea. When the larvae are formed, they swim or float for a period of time and become dispersed. Breeding season is late spring and summer.

ECOLOGICAL RELATIONSHIPS: Giant Green Anemones get their bright green color from symbiotic, microscopic green algae living in their column. Anemones that live in the shade of piers or rocks are white because their algae die.

Black Sage

Salvia mellifera

California Sagebrush

Artemisia californica

California Buckwheat

Eriogonum fasciculatum

Eastwood Manzanita

Arctostaphylos glandulosa

California Sagebrush

Artemisia californica

HABITAT/RANGE: Found in dry sunny locations in coastal sage scrub and chaparral communities from sea level to 2,600 ft. (800 m.). Native to California and Baja California. In our region, this species is found mostly in northwestern Baja California, but is distributed south on the peninsula into the northern Central Desert.

DESCRIPTION: California Sagebrush is a strongly aromatic, densely branched shrub that grows to 8 ft. (2.5 m.) tall. It is dominant and representative of coastal sage scrub of southern California and northwestern Baja California. The light green to grey, thread-like leaves and tiny, green flowering heads give this shrub a distinctive appearance and make it easy to recognize.

REPRODUCTION: By seed

ECOLOGICAL RELATIONSHIPS: Provides excellent cover for small birds and other animals, which can live in its branches and provides seeds for birds. It has been used as a treatment for colds and cough. This species is drought-deciduous, losing its leaves in hot weather to prevent water loss.

Black Sage

Salvia mellifera

HABITAT/RANGE: Native to southwest California and northwestern Baja California. Found on sunny dry slopes.

DESCRIPTION: Black Sage is a strongly aromatic shrub that grows to 6 ft. (2 m.) tall. Oblong leaves, 1 to 2.75 in. (2.5 to 7 cm.), dark green above, lighter beneath, with a slightly warty upper surface. The flowers are two-lipped with pale blue to lavender or white corollas. This species is common and dominant in coastal sage scrub and lower chaparral in extreme northwestern Baja California and north into southwestern California.

REPRODUCTION: Pollination is by bees and butterflies. New plants grow from seed.

ECOLOGICAL RELATIONSHIPS: Most Salvia species are excellent sources of nectar and have edible seeds. Butterflies and hummingbirds sip its nectar. Quail love the seed. A tea made from the leaves of some species is used for stomach trouble.

Eastwood Manzanita

Arctostaphylos glandulosa

HABITAT/RANGE: Occurs in northwestern Baja California in chaparral and in the high Sierras, and north into California and southern Oregon.

DESCRIPTION: This highly variable species is represented in Baja California with six different subspecies, two of which are endemic and were recently named and described. Eastwood Manzanita is a shrub, 3 to 8 ft. (1 to 2.5 m.) tall, usually with a large, wide, flat-topped, basal burl that allows it to regenerate quickly following a fire.

REPRODUCTION: The fruits of this species are usually depressed globose, .25 to .4 in. (6–10 mm.) wide, and often sticky on the outer surface

ECOLOGICAL RELATIONSHIPS: Manzanitas sprout from the crown (just above the ground) after a fire.

California Buckwheat

Eriogonum fasciculatum

HABITAT/RANGE: Found in coastal sage scrub, succulent sage scrub and chaparral plant communities, mountain woodlands, and the desert from central California to Baja California.

DESCRIPTION: A small shrub with leaves in bundles (fascicles). The small pink or white flowers are in groups.

REPRODUCTION: By seed. This species quickly colonizes cleared or disturbed terrain.

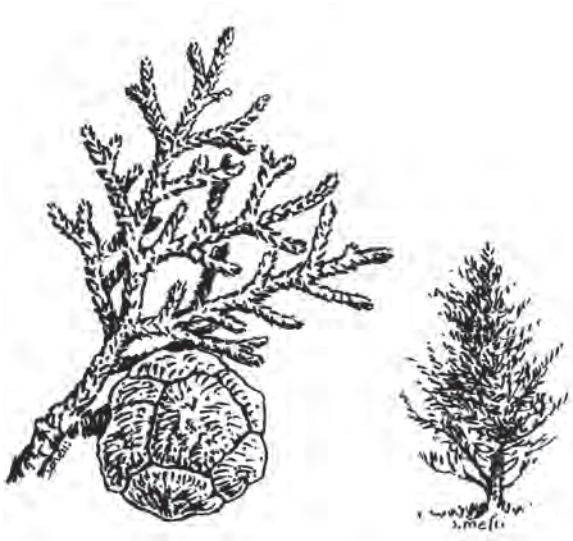
ECOLOGICAL RELATIONSHIPS: California Buckwheat is an important nectar plant visited by a wide variety of insects, especially the blue butterflies. Birds eat the seeds and Native Americans harvested them. The genus Eriogonum is one of the largest and most diverse genera in the southern California and northwest Baja California region.

Ramona Lilac

Ceanothus tomentosus

Tecate Cypress

Callitropsis forbesii



Golden Eardrops

Dicentra chrysantha

Otay Mesa Mint

Pogogyne nudiuscula

Tecate Cypress

Callitropsis forbesii

HABITAT/RANGE: Occurs in northern Baja California on the Pacific slopes of the Sierra Juárez and the west of Valle San Vicente, between Ensenada and San Quintín, and north to Orange County, California. An extensive population is found on Otay Mountain (U.S. side) and Mt. Cuchumá (Mexican side), also known as Tecate Peak.

DESCRIPTION: A short, shrubby, multi-stemmed, evergreen tree that grows up to 30 ft. (10 m.) tall. Leaves are small, scale-like, and light to dull green. The bark peels off in narrow shreds.

REPRODUCTION: This species has serotinous cones, meaning they usually open only after fires.

ECOLOGICAL RELATIONSHIPS: Tecate Cypress is used as windbreaks and hedges in hot, dry, interior locations. The species is fire-adapted, but populations can be completely destroyed by frequent fires. The Tecate Cypress is of conservation concern due to its restricted distribution, threats of habitat loss by urbanization, and the increase in fire frequency effecting its reproduction.

Ramona Lilac

Ceanothus tomentosus

HABITAT/RANGE: Native to San Diego County in chaparral environments.

DESCRIPTION: A perennial evergreen plant that grows to a height of 6.5 to 10 ft. (2 to 3 m.) and a width of 3 to 6 ft. (1 to 2 m.). The flowers are azure-blue to nearly white and appear in early spring. The stems are erect and reddish-brown. The Ramona Lilac is also called the Wooly-leaf Mountain Lilac.

REPRODUCTION: Seed, especially following fires

ECOLOGICAL RELATIONSHIPS: When rubbed together in a little water, the flowers produce suds.

Otay Mesa Mint

Pogogyne nudiuscula

HABITAT/RANGE: Found in vernal pools on Otay Mesa in California and in extreme northern Baja California. Vernal pools are shallow depressions that fill with winter and spring rains, and then dry up in late spring.

DESCRIPTION: Plants are less than 6 in. (5 cm.) tall and have a strong fragrance and purple flowers.

REPRODUCTION: Bee- and butterfly-pollinated

ECOLOGICAL RELATIONSHIPS: The plant is highly restricted in distribution and endangered due to loss of habitat. It is estimated that approximately 95% of all vernal pools are gone in our region.

Golden Eardrops

Dicentra chrysantha

HABITAT/RANGE: Foothill chaparral and pine woodlands in California and northern Baja California up to 5,000 ft. (1524 m.).

DESCRIPTION: Bushy plants grow to 6 ft. (2 m.) tall and have finely divided blue-green basal leaves and many tall, naked stems. Bright yellow flowers are narrow with four petals, the outer pair with pouched bases.

REPRODUCTION: By seed.

ECOLOGICAL RELATIONSHIPS: Seeds remain in the soil until they are scarified by wildfire heat. This plant is a great example of a "fire-follower." Plants are abundant on burned areas and small pockets may remain long after wildfires have burned an area.

Red Brome, Foxtail

Bromus madritensis ssp. rubens

Black Mustard

Brassica nigra

Giant Reed

Arundo donax

Quino Checkerspot

Euphydryas editha quino

Black Mustard

Brassica nigra

HABITAT/RANGE: Native to the Mediterranean region, but has naturalized in a good part of the world. Wild mustards grow in meadows, vacant lots, along roadsides, or any sunny and somewhat dry location.

DESCRIPTION: An annual plant, erect, with a branched stem. It can grow up to 8 ft. (2.5 m.) high. The flowers are terminal, small and showy. The fruit can be .75 in. (2 cm.) long, with conical points; it contains numerousreddish-brown tiny seeds, covered with a network of veins.

REPRODUCTION: By seed.

ECOLOGICAL RELATIONSHIPS: The ingredient that gives mustard seeds their flavor is similar to that found in white mustard, radishes and wasabi. The plant produces the chemical to defend itself from herbivores. Unfortunately, the mustard family has many species that are non-native, weedy, and invasive to many natural areas of our region such as Black Mustard (*Brassica nigra*), Sahara Mustard (*B. tournefortii*), Wild Radish (*Raphanus sativus*), and London Rocket (*Sisymbrium irio*).

Red Brome, Foxtail

Bromus madritensis ssp. rubens

HABITAT/RANGE: Red Brome is an annual grass introduced from Europe that has become naturalized throughout Baja California and southern California and can be quite invasive in disturbed areas of coastal sage scrub and succulent sage scrub.

DESCRIPTION: A grass to 18 in. (46 cm.) high with short, hairy leaves. The inflorescence is dense like a foxtail.

REPRODUCTION: By seed.

ECOLOGICAL RELATIONSHIPS: This species is one of the exotic, annual grass species that is contributing to an increase in fire frequency in arid regions. Many of the non-native grasses (e.g., Red Brome and Buffalo grass) that have naturalized in Upper and Lower California are invasive and not only compete with and exclude native plants, but can alter the entire vegetation of an area by changing ecological factors like fire frequency.

Quino Checkerspot

Euphydryas editha quino

HABITAT/RANGE: Once widespread throughout coastal sage scrub in Southern California and Northern Baja California. It inhabits openings on clay soils within or in the vicinity of scrublands, grasslands, meadows, vernal pools, and lake margins. Its presence is closely tied to its larval host plant, dwarf plantain (*Plantago erecta*) or owl's clover (*Orthocarpus purpurescens*).

DESCRIPTION: A medium-sized butterfly with a wingspan of about 1 in. (3 cm.). The wings are a patchwork of brown, red and yellow spots.

REPRODUCTION: Females lay egg masses ranging from 20 to 180 eggs, which hatch in seven to 10 days. Larvae feed on Plantago erecta and other plants. When their host plants die, larvae go into a dormant phase that lasts until it rains in late fall or winter. (This phase can last for years in times of drought.) Adults emerge in two weeks.

ECOLOGICAL RELATIONSHIPS: An endangered species in the U.S. due to loss of habitat. In addition, the October 2003 fires in San Diego County and the ensuing disruption of its habitat may have had a devastating impact on this butterfly.

Giant Reed

Arundo donax

HABITAT/RANGE: Permanent or seasonal wetlands. Seems to be native to India and has colonized Mediterranean areas.

DESCRIPTION: A non-native, invasive grass that reaches from 6 to 43 ft. (2 to 13 m.) tall with thick, hollow stems. The bright green leaves wrap around the stem-like sheets. The flowers appear on violet or yellow spikes 1 to 2.5 in. (3–6 cm.) long. Each spike has one or two flowers, flowering in late summer and fall.

REPRODUCTION: Vegetative by rhizomes.

ECOLOGICAL RELATIONSHIPS: Grows very rapidly, especially during floods, because it reproduces vegetatively. The root balls become so large they act as small dams that worsen flood damage by directing water out of river courses. It absorbs a lot of water, reducing water tables in semi-arid aquifers. Giant Reed threatens riparian habitats, particularly willows, which are nesting sites of the endangered Least Bell's Vireo.

Coast Horned Lizard

Phrynosoma coronatum blainvillii

California Quail

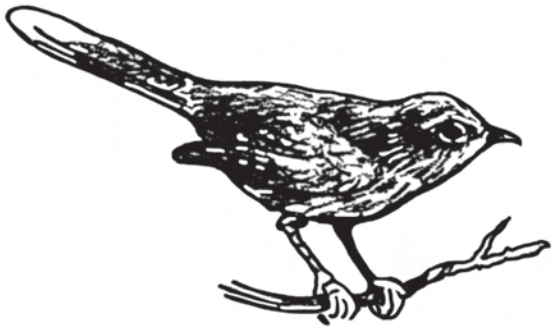
Callipepla californica

California Gnatcatcher

Polioptila californica

Wrentit

Chamaea fasciata



California Quail

Callipepla california

HABITAT/RANGE: Open woodlands or shrubby areas with patches of bare ground, usually near water, in the western U.S. and Baja California. Also occur in the desert.

DESCRIPTION: Black plume on forehead curls forward. The male's plume is larger than the female's. Males have a dark brown cap, black face, grey back, and a blue-grey chest. Females are mainly brownish grey. Both sexes have a scaly pattern on the belly and neck.

REPRODUCTION: Concealed nest lined with grasses and dead leaves, placed in a scraped depression near a log, rock, or stump, or in the low fork of a tree.

ECOLOGICAL RELATIONSHIPS: Eats seeds (especially those of legumes), other vegetable matter, and insects (especially chicks). Primary predators are birds of prey, especially Cooper's Hawks.

Coast Horned Lizard

Phrynosoma coronatum blainvillii

HABITAT/RANGE: Extends from northern California to the tip of Baja California. The subspecies *blainvillii*, is distributed throughout the foothills and coastal plains from the Los Angeles, California, area to northern Baja California. It lives on the ground in areas with abundant, open vegetation such as chaparral or coastal sage scrub.

DESCRIPTION: Relatively large and less rounded than other horned lizards. An individual's snout-to-vent length can reach four inches (10.16 cm.). Numerous pointed scales stick out along the sides of the body and over the back, though only the horns around the head are rigid.

REPRODUCTION: Produces clutches of 6 to 49 eggs from April to July. Hatching occurs in August and September.

ECOLOGICAL RELATIONSHIPS: Native ants are the favorite food of Coast Horned Lizards, making up most of their diet. The lizards also eat termites and a variety of other insects.

Wrentit

Chamaea fasciata

HABITAT/RANGE: Chaparral, tangled brush, and dense shrubs in western Oregon, California, and northwestern Baja California

DESCRIPTION: Plain greyish-brown bird, tinged tawny on under parts. Long tail (often cocked), pale eye, faint streaking on breast.

REPRODUCTION: Nest of spider web, bark, and grasses lined with fine fibers and hair placed in the twigs of a shrub or bush 1 to 15 ft. (.3 to 5 m.) above the ground.

ECOLOGICAL RELATIONSHIPS: Gleans food from trees and shrubs. Eats insects and small fruits and berries.

California Gnatcatcher

Polioptila californica

HABITAT/RANGE: Sage scrub and coastal scrub in southern California and northern Baja California; desert scrub in central and southern Baja California.

DESCRIPTION: Male has a black cap during breeding. Otherwise, upperparts all dark grey; back brownish in female. Tail long and black with thin white edges and small white patch on outermost feather.

REPRODUCTION: Nest of plant down, leaves, and fibers lined with fine materials. Placed in the branches of shrubs 1 to 4 ft. (.3 to 1.2 m.) above the ground.

ECOLOGICAL RELATIONSHIPS: Gleans insects and spiders from foliage. Moves about very actively, constantly flicking its tail. Endangered in the U.S. due to loss of habitat.

Anna's Hummingbird

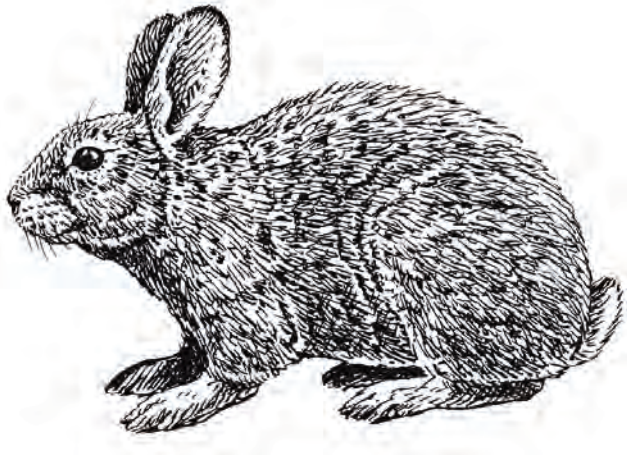
Calypte anna

Western Scrub Jay

Aphelocoma californica

Western Brush Rabbit

Sylvilagus bachmani



Canyon Live Oak

Quercus chrysolepis

Western Scrub Jay

Aphelocoma californica

HABITAT/RANGE: Chaparral and oak woodland in the western U.S., mainland Mexico, and northwestern Baja California; desert scrub in central Baja California.

DESCRIPTION: Blue head, wings and tail, grey back and belly, throat streaked white.

REPRODUCTION: Bowl-shaped nest of twigs, grass, lined with fibers, rootlets, placed in a shrub or tree.

ECOLOGICAL RELATIONSHIPS: Eats insects, acorns, pine seeds, invertebrates, eggs and nestlings of birds, frogs, berries, and fruit. Stores food to eat at a later time when food is scarce.

Anna's Hummingbird

Calypte anna

HABITAT/RANGE: Chaparral, woodlands, parks, and gardens in western U.S. and northern Baja California

DESCRIPTION: Male has glittering rose-red crown and throat, green back, and mottled grey chest and belly. Female has no red on the crown and less red on the throat.

REPRODUCTION: Female constructs nest of bits of plant matter, bound together with spiders' silk and decorated with flakes of lichen. Nest is placed in a tree or shrub usually 5 to 10 ft. (1 to 3 m.) high.

ECOLOGICAL RELATIONSHIPS: Hovers and takes nectar from flowers. Eats small insects, spiders. Male and female defend separate territories and mate on neutral ground.

Canyon Live Oak

Quercus chrysolepis

HABITAT/RANGE: Occurs on the mountain slopes of California and Baja California, often near creeks and drainages in moist, cool microhabitats.

DESCRIPTION: An evergreen shrub or tree with a spreading crown to 60 ft. (20 m) tall and smooth to scaly grey bark. The thick, leathery, oblong leaves are shiny dark green above with a lower surface that is golden hairy or white waxy.

REPRODUCTION: Flowers April to May. Acorns are about 1 in. (2–3 cm.) long. After forest fires, Canyon Live Oak regenerates vigorously by basal sprouting.

ECOLOGICAL RELATIONSHIPS: The oak gall wasp lays its eggs in the bark tissue of small branches, causing the oak to form a protective gall. Various moths and butterflies eat young buds and leaves. Other insects found in the oak include tree hoppers, juice-sucking scale insects, yellow jackets, ichneumon wasps, wood borers, and termites. Other organisms that feed, nest, hang, or bore into oak trees include squirrels, jays, woodpeckers, spiders, mistletoe, fungi, and lichens. Indigenous peoples and wild animals prized the acorns of various oak species as a food source.

Western Brush Rabbit

Sylvilagus bachmani

HABITAT/RANGE: Found in the western coastal regions from Oregon to the tip of the Baja California peninsula. Inhabits dense, brushy cover, most commonly in chaparral vegetation. It also occurs in oak and conifer habitats, and it will live in brush or grassland and form networks of runways through the vegetation.

DESCRIPTION: The upper side of the Brush Rabbit's fur varies from light brown to grey in color, while the underside is usually always white. The desert cottontail (Sylvilagus audbonii) is very similar in appearance. The Western Brush Rabbit has a thick dark line on the outer edge of the ear and is slightly larger. Adult rabbits measure anywhere from 10 to 14 in. (25 to 35 cm.) long and rarely weigh over two pounds.

REPRODUCTION: Peak breeding seasons are between February and August. Two to three litters per year are common. The average number born per litter is three.

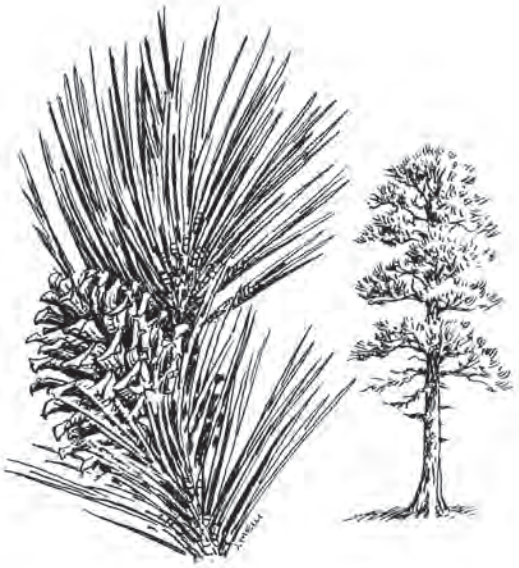
ECOLOGICAL RELATIONSHIPS: The Brush Rabbit feeds mainly on grasses and forbs (herbs that are not grasses), especially green clover, though it will also take berries and browse from bushes. Its predators include the mountain lion, coyote, fox, bobcat, weasel, and various raptors and snakes. Its survival strategies include remaining immobile when in brushy areas, and zigzag running when found in open spaces.

Nuttall's Scrub Oak

Quercus dumosa

Jeffrey Pine

Pinus jeffreyi



California Juniper

Juniperus californica

Deer Grass

Muhlenbergia rigens

Jeffrey Pine

Pinus jeffreyi

HABITAT/RANGE: Found in the San Pedro Mártir and Sierra de Juárez mountains, in Baja California, and throughout California to Oregon. In Baja California it grows from 4,500 to 6,000 ft. (1,500 to 3,000 m.) tall. The farther north it is found, the larger it grows.

DESCRIPTION: A large symmetric pine that grows from 60 to 150 ft. (20 to 50 m) tall with blue-green needles bundled in groups of three. The sweet pineapple-vanilla fragrance of Jeffrey Pine sap helps to identify this species, especially on warm days.

REPRODUCTION: The reddish-brown cones appear in May and June.

ECOLOGICAL RELATIONSHIPS: Squirrels eat the seeds from the cones. The Jeffrey Pine was formerly logged in the Sierra Juárez and is used in the U.S. for construction. An important chemical, abietin (nearly pure heptane), has been isolated from Jeffrey Pine and was used to assay gasoline to obtain an octane rating.

Nuttall's Scrub Oak

Quercus dumosa

HABITAT/RANGE: A rare species that is threatened by coastal development because it only occurs in a few populations along the immediate Pacific coast below 60 ft. (200 m.).

DESCRIPTION: Densely branched, evergreen shrub growing up to 15 ft. (5 m.) tall. Leaves are about an inch (1 to 3 cm.) long, grey-green, and curly with short, irregular spines on the margin. The undersurface is covered with short, pale green hairs.

REPRODUCTION: Flowers March to May. Acorns are about 1 inch (1 to 3 cm.) long, pointed or egg-shaped with thin caps.

ECOLOGICAL RELATIONSHIPS: The Native Americans did not like the acorns, and only used them when there weren't sufficient Live Oak acorns. This species is often confused with other scrub oaks such as Q. berberidifolia, and Q. acutidens that are more common in chaparral vegetation at higher elevations in southern California and northwestern Baja California.

Deer Grass

Muhlenbergia rigens

HABITAT/RANGE: Found in sandy or well-drained soil below 7,000 ft. (2,150 m.) in grassland, riparian, chaparral, mixed conifer, and oak woodland communities. Its range extends from central California to Baja California.

DESCRIPTION: Large bunch grass that makes masses of leaves to 3 ft. (1 m.) tall and thin spikes of flowers to 5 ft. (1.75 m.).

REPRODUCTION: By seed.

ECOLOGICAL RELATIONSHIPS: Deer graze on the leaves and take cover in areas of Deer Grass during fawning season. Many species of butterflies and lady bird beetles over-winter in the tall leaves. Other insects and birds eat the seeds. The Native Americans made baskets from the leaves.

California Juniper

Juniperus californica

HABITAT/RANGE: Occurs on dry slopes and flats mostly below 5,100 ft. (1,700 m.) in Piñon-Juniper woodlands and chaparral in California and Baja California.

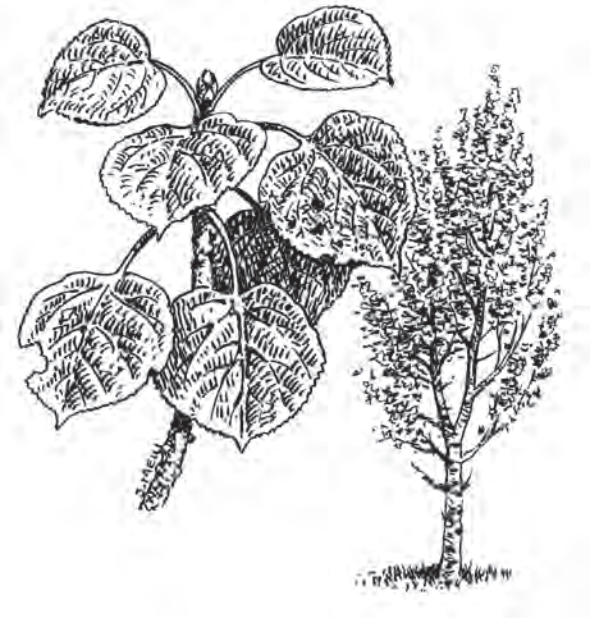
DESCRIPTION: A resinous, fragrant, evergreen shrub, 12 ft. (305 m.) tall, with ashy-grey, thin, shredding bark and a rounded crown. The scale-like leaves are .15 in. (3–4 mm.) and mostly occur in whorls of three. The cones are globe-shaped; young cones with tightly closed scales resemble bluish berries.

REPRODUCTION: Seed cones are dispersed by birds.

ECOLOGICAL RELATIONSHIPS: Natives ate the bitter berries after drying and grinding them, forming the meal into a mush or cake. The leaves can be used to make a soothing tea. The wood is soft and fine-grained and is often used by ranchers to make fence posts.

Quaking Aspen

Populus tremuloides



Mistletoe

Phoradendron bolleanum

White Fir

Abies concolor

Acorn Woodpecker

Melanerpes formicivorus

Mistletoe

Phoradendron bolleanum

HABITAT/RANGE: Found on juniper and cypress trees. Other species are found on oak, pine and mesquite trees.

DESCRIPTION: True mistletoes are parasitic, flowering plants with clumps of aerial shoots that are easily visible on the host plant. Shoots vary in length from several inches to several feet.

REPRODUCTION: When a seed germinates on its host plant, the Mistletoe penetrates the host directly. The parasitic Mistletoe plant develops inside its host for about two years before producing aerial shoots. Mistletoe shoots and leaves contain chlorophyll and carry on photosynthesis but depend on their host plant for carbohydrates as well as water and mineral nutrients.

ECOLOGICAL RELATIONSHIPS: Seeds are disseminated by birds that eat or transport berries and deposit the seeds on host plants. All parts of the plant in most species of this family are toxic and have been known to cause death.

Quaking Aspen

Populus tremuloides

HABITAT/RANGE: Grows above 7,000 ft. (2,300 m.) in California and Baja California in full sun.

DESCRIPTION: Smooth white- to cream-colored bark with black markings and a long narrow trunk. Grows 25 to 60 ft. (20 m.) tall. Leaves are dark green with dull green undersides and serrated edges. The leaves tremble in a light breeze because of their flattened petioles (stems).

REPRODUCTION: Typically grows in large clonal colonies derived from a single seedling, and spreads by means of root suckers. New stems in the colony may appear from 10 to 13 ft. (30 to 40 m.) or less distant from the parent tree. Each individual tree can live for 40 to 150 years above ground, and the root system of the colony is long-lived. In some cases, this is for thousands of years, sending up new trunks as the older trunks die off above ground.

ECOLOGICAL RELATIONSHIPS: Deer and other mammals browse the leaves. Re-colonizes burned or disturbed areas quickly. This is a sky- island species that is separated from more northern populations in the U.S.

Acorn Woodpecker

Melanerpes formicivorus

HABITAT/RANGE: Woodland and forest containing oak trees from the western U.S. south to Panama.

DESCRIPTION: Clear black back, red on crown, white eye surrounded by black. White forehead and cheek and yellowish throat. Male's red crown touches white forehead. On the female the red on back half of crown is separated from white forehead by black. In flight, note white rump and white patch near wingtip.

REPRODUCTION: Nests in colonies. Excavates nesting cavity in dead or live tree 6 to 25 ft. (2 to 8 m.) above ground.

ECOLOGICAL RELATIONSHIPS: Lives in communal groups and breeds cooperatively in parts of range. Acorn Woodpeckers drill holes in the trunks of mature pines and cedars, as well as trunks and branches of dead trees. They collect acorns, find holes that are just the right size to fit an individual acorn, and jam the acorn in. As they dry out, the acorns are moved by the woodpeckers to smaller holes. Up to 50,000 acorns may be stored in a single dead tree, and the woodpeckers spend a significant amount of their time maintaining their "granary."

White Fir

Abies concolor

HABITAT/RANGE: Found above 6,000 ft. (2,000 m.) in juniper-pine forests of the San Pedro Mártir and in the southwestern U.S., ranging north to Oregon and south to Arizona and New Mexico, also in Sonora.

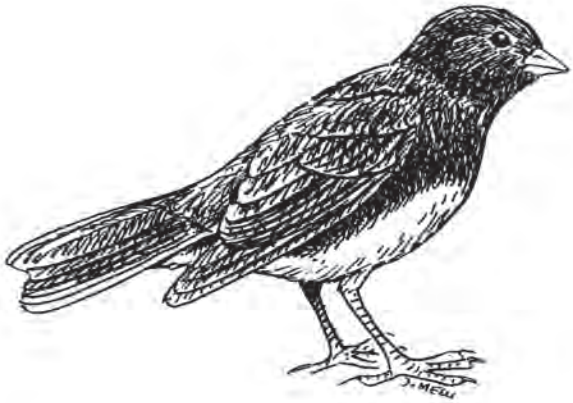
DESCRIPTION: It has a root-like holdfast that fixes to rocky surfaces; a long slender stalk or stipe; and long, leaf-like blades or fronds, which are the major site of photosynthetic activity. The kelp plant is supported in the water by gas-filled bladders on each frond called nematocysts. In favorable conditions giant kelp can grow to over 100 ft. (30 m.) long.

REPRODUCTION: The brown, oblong cones stand erect on the ends of upper branches.

ECOLOGICAL RELATIONSHIPS: Local ranchers use the resin from young bark to dress cuts and abrasions on both humans and livestock.

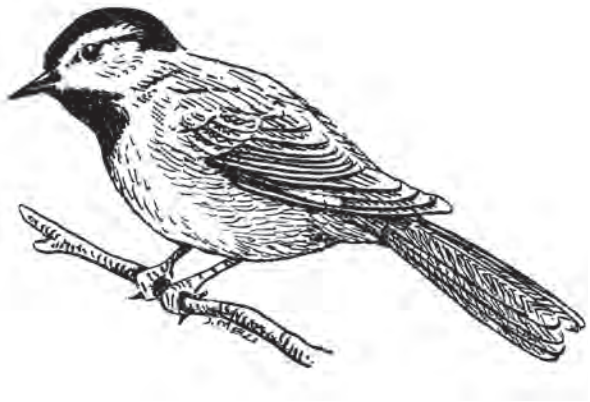
Dark-eye Junco

Junco hyemalis



Mountain Chickadee

Poecile gambeli

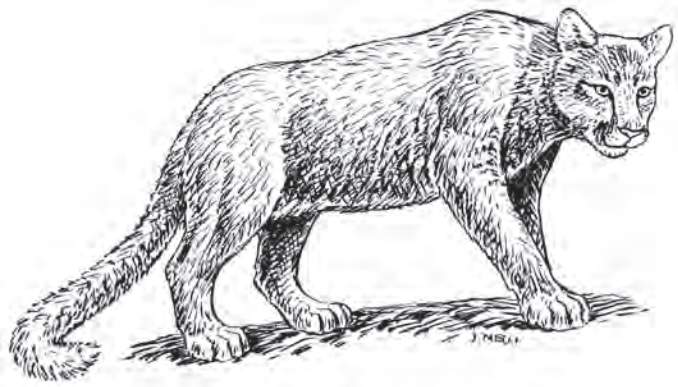


Mule deer

Odocoileus hemionus

Mountain Lion

Puma concolor



Mountain Chickadee

Poecile gambeli

HABITAT/RANGE: Open coniferous forests in mountains of the western U.S., western Canada, and northern Baja California.

DESCRIPTION: Black cap and bib, white cheek, thin white line over eye, grey back and flanks.

REPRODUCTION: Nest of wood chips, hair, feathers, placed in natural or excavated cavity

ECOLOGICAL RELATIONSHIPS: Mountain Chickadees cling to the undersides of branches and to tree trunks, searching for insects in the bark or breaking seeds open by hammering them with their beaks.

Dark-eye Junco

Junco hyemalis

HABITAT/RANGE: Widespread in Canada, the U.S., and northern Baja California in forests. More northern birds are migratory and invade our region in winter, when they are found in chaparral and areas of scattered trees as well as in mountain forests.

DESCRIPTION: Pale bill, dark eye. Plumage varies by region; in our area head usually blackish in male, grey in female, contrasting with a salmon-colored back and sides and whitish belly. Tail dark with white outer feathers conspicuous when bird flies.

REPRODUCTION: Cuplike nest of grasses, moss, and pine needles, lined with rootlets and placed in a depression in ground within the forest

ECOLOGICAL RELATIONSHIPS: Feeds mostly on the ground, eating weed and grass seeds. Flocks return to same areas each winter.

Mountain Lion

Puma concolor

HABITAT/RANGE: This animal ranges throughout the Americas, from British Columbia to Patagonia. In San Diego County, Mountain Lions can be found wherever there are deer and bighorn sheep populations. They den in any concealed or sheltered spot. Wooded and rocky terrain is prime Mountain Lion habitat.

DESCRIPTION: The Mountain Lion is tawny or reddish brown to a dusky or slate grey. Its undersides and inside the ears are white. Dark- brown coloration appears on the tip of the tail, backs of the ears, and sides of the nose. It has claws that retract into protective coverings in its paws.

REPRODUCTION: Mountain Lions begin to breed between two and three years old, then every two to three years thereafter. They may breed at anytime during the year. A litter usually consists of three spotted kittens. Their eyes open about ten days after birth.

ECOLOGICAL RELATIONSHIPS: The primary food of Mountain Lions is deer, but they will also take bighorn sheep, coyote, fox, skunk, rabbits, rodents, and sometimes livestock. Mountain Lion will hide uneaten meat and return to eat it when they are hungry.

Mule deer

Odocoileus hemionus

HABITAT/RANGE: Throughout the western United States, including the deserts. It may migrate in response to rainfall.

DESCRIPTION: Dark-grey-brown with a black-tipped white tail. Generally 4 to 6.5 ft. (1 to 2 m.) long and 3 to 3.5 ft. (1 m.) high at the shoulder. Its large ears are able to move constantly and independently from each other. The antlers begin growing in spring and are shed in December and January.

REPRODUCTION: Mule Deer mate in November and December with the antlered males fighting for possession of the females. Fawns are born from April through July. Twins are common.

ECOLOGICAL RELATIONSHIPS: Mule Deer have a multi-part stomach that helps them digest plant matter. They browse on fresh green leaves, twigs, grasses, herbs, weeds, berries, vines, grapes, mistletoe, mushrooms, ferns, and cactus fruit. Natural predators include coyote, mountain lion, and bobcat.

Silver Cholla, Chain-link Cholla

Cylindropuntia cholla

Creosote Bush

Larrea tridentata

Ocotillo

Fouquieria splendens

Desert Sand Verbena

Abronia villosa var. villosa

Creosote Bush

Larrea tridentata

HABITAT/RANGE: Deserts through the southwest U.S. and Baja California

DESCRIPTION: A many-branched evergreen, growing as tall as 12 ft. (4 m.). The small leaves vary in size according to the amount of moisture available. During hot periods the leaves turn their edges toward the sun to reduce heat effects. Under certain conditions the leaves are covered with a varnish-like substance that makes them shiny and sticky. They give off a resinous, musty odor during and after rain. This resin retards water loss and reflects light to help keep the leaf's surface temperature down.

REPRODUCTION: Clones new bushes in the form of rings that widen as they age. One ring is estimated to be about 11,700 years old, making it the oldest living organism on earth.

ECOLOGICAL RELATIONSHIPS: Can survive years without rain. It is distasteful to animals, which helps to reduce browsing. The creosote gall-midge lays its eggs in the plant tissue. As the eggs hatch and larvae develop, the stem swells into a growth that houses the larval stage.

Silver Cholla, Chain-link Cholla

Cylindropuntia cholla

HABITAT/RANGE: Valley floors, bajadas, or rocky slopes in the desert. Withstands high temperatures and is often the only cactus seen growing in an area.

DESCRIPTION: A bush from 2 to 5 ft. (.70–1.5 m.) tall. The short 1–3 in. (2.5–7.5 cm.) stem joints give it a brushy appearance. The small tubercles account for the crowding of the spines, which hide the pale green stem surface. The flowers are yellowish-green. The spines produce a sheath covering which, when new, gives the plant a golden look. When the sheaths fall off the white-to-grey spines give the plant a silvery look.

REPRODUCTION: From seeds.

ECOLOGICAL RELATIONSHIPS: The nectar of the flowers is food for small beetles and bees. The stamens are thigmotropic, meaning they move in response to being touched. This assures that the pollenizers carry away a maximum load of pollen.

Desert Sand Verbena

Abronia villosa var. villosa

HABITAT/RANGE: Desert sand dunes and washes of the Mojave and Sonoran Deserts, the Lower Colorado Desert and Central Desert.

DESCRIPTION: A showy, low, desert plant, prostrate, with many branches. Leaves are sticky and hairy, and leaves and stems are somewhat succulent. Many small, pink to magenta flowers appear in clusters.

REPRODUCTION: Seeds can wait decades in the sand for the next rain.

ECOLOGICAL RELATIONSHIPS: Pollinated by insects.

Ocotillo

Fouquieria splendens

HABITAT/RANGE: Found up to 3,000 ft. (1,000 m.) on desert slopes and plains in southern California, Arizona, Texas and Mexican deserts, including in Baja California.

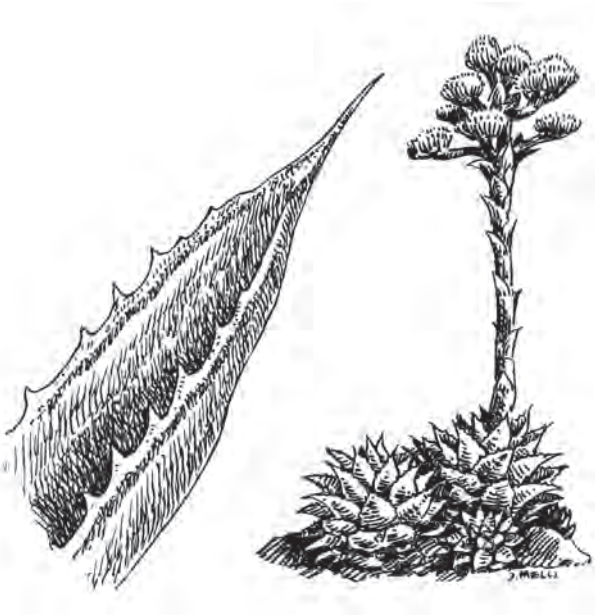
DESCRIPTION: No main trunk, but many slender, 9 to 12 ft. (3–4 m.) long, whip-like branches that spread fan-like from the base. Spines cover the grey-to-green barked, stiff stems. Small leaves appear after rains and fall off when the soil is dry between rains. Red, tubular flowers appear in spring.

REPRODUCTION: By seed. Flowers are pollinated by hummingbirds and bees.

ECOLOGICAL RELATIONSHIPS: Native Americans used it to wash clothes and prepared a tea by soaking the flowers and seeds in water. "Living" fences are often made from Ocotillo stems planted in the ground, which then take root. Powder made from the roots is reported to alleviate painful swellings and relieve fatigue when added to a bath.

Shaw's Agave

Agave shawii



White Bursage, Burroweed

Ambrosia dumosa

Thurber's Stemsucker

Pilostyles thurberi

Salt Cedar

Tamarix ramosissima

White Bursage, Burroweed

Ambrosia dumosa

HABITAT/RANGE: This species is one of the most common plants in our desert regions, especially in the Lower Colorado Desert and south on the eastern side of the peninsula to the Gulf Coast ecoregion and on several islands. Found on arid plains, mesas, slopes and arroyos.

DESCRIPTION: A low, rounded, grey-green shrub 6 to 12 ft. (2 to 6 cm.) high. Grey-white stiff branches intertwine and become spiny with age. The leaves have rounded lobes and grey, hairy surfaces. Leaves appear in spring with the rains and persist on the plant after they die. Small white to slightly purplish flowers.

REPRODUCTION: The small bur-like fruit is armed with sharp pointed spines that cling to animals and clothing.

ECOLOGICAL RELATIONSHIPS: This species is a favorite food of horses, burros, and sheep. White Bursage and Creosote Bush (Larrea tridentata) are the dominant species of the Lower Colorado Desert, often comprising nearly 90% of the total vegetation. Ecological research has demonstrated that the growth of White Bursage roots is inhibited by secretions from the roots of Creosote Bush thus creating a rather even-spaced appearance across the desert landscape.

Shaw's Agave

Agave shawii

HABITAT/RANGE: Pacific coastal areas and desert plains.

DESCRIPTION: Many large, glossy, green leaves are thick and fleshy with rigid marginal spines and spine-like tips. Leaves are borne in a basal rosette and may be 6 ft. (2 m.) long. The 3 to 12 ft. (1 to 4 m.) flower stalk has a mass of brilliant greenish-yellow, tubular flowers crowded toward the tip.

REPRODUCTION: Blooms September to May. Grows very slowly for years, then produces a towering stalk of flowers and dies.

ECOLOGICAL RELATIONSHIPS: Due to its dominant and widespread distribution in Baja California, this species probably provided the most accessible and abundant food available in this region for Native Americans. Although unpopular because of the bland taste, it was often the only food available during much of the year. Cattle also eat the flowering stalks, but not the leaves.

Salt Cedar

Tamarix ramosissima

HABITAT/RANGE: A shrub or tree from the Mediterranean that has become naturalized in arid regions of Baja California and California.

DESCRIPTION: Bark is a dark-reddish-brown, and the green leaves are scaly and thread-like.

REPRODUCTION: Flowers bloom in spring in a pink catkin-like arrangement.

ECOLOGICAL RELATIONSHIPS: Planted in the desert for windbreaks. Often takes over along desert stream beds. Uses large amount of moisture, lowering the water table and robbing desert streams, native vegetation and farmers of irrigation water.

Thurber's Stemsucker

Pilostyles thurberi

HABITAT/RANGE: Sonoran and Central deserts.

DESCRIPTION: A tiny stem parasite. It is rarely seen because it lives completely embedded within the stems of a small, leguminous desert shrub called Dyeweed. The tiny, 2 to 3 mm. reddish-brown flowers appear once a year and are either male or female. It is unknown if both sexes are found on the same plant. The blooming flowers resemble a fungus infection. Each minute flower produces a cluster of at least 100 tiny seeds.

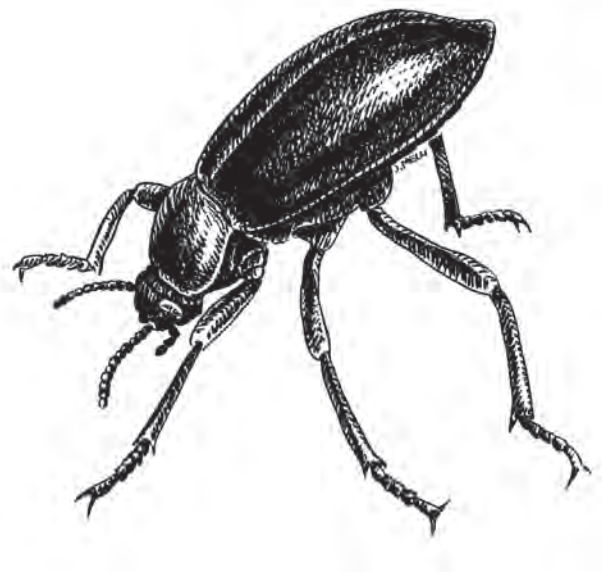
REPRODUCTION: No one knows how the plants are pollinated but some believe it could be harvester ants or other crawling insects that walk over the male and female flowers on their way to the branch tips for the Dyeweed flowers.

ECOLOGICAL RELATIONSHIPS: Harvester ants are often found living near Dyeweed plants. The ants carry the Dyeweed flowers back to their nest and new plants can come from seeds that have germinated in the nest. The Thurber's Stemsucker seeds are sticky and stick to the Dyeweed branches easily.

This tiny flower is related by family to the largest flower in the world, the parasitic "Stinking Corpse Flower" which grows only (and rarely) in the rain forests of Borneo and Sumatra. Its tiny seeds are dispersed by many animals ranging in size from ants to squirrels to wild pigs and Asian elephants.

Darkling Beetle

Eleodes sp.

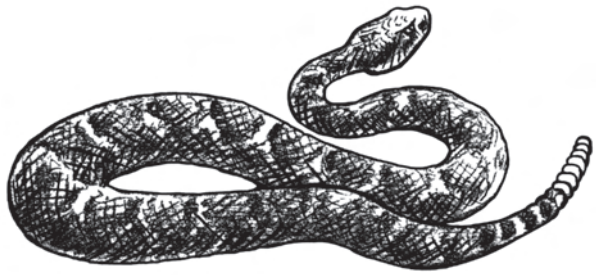


Cactus Bee

Diadasia rinconis

Sidewinder

Crotalus cerastes



Greater Roadrunner

Geococcyx californianus

Cactus Bee

Diadasia rinconis

HABITAT/RANGE: Occurs wherever you can find Opuntia cactus but is most common in the desert in Texas, New Mexico, Arizona, California and Baja California.

DESCRIPTION: These robust bees are about .6 in (1.5 cm.) long. Their bodies are black with amber hairs covering their head and thorax. The abdomen has bands of pale hairs, making them look striped.

REPRODUCTION: The males emerge from their underground nests before the females. When a female emerges, the males fight each other to get access to her. Sometimes this results in a ball of males surrounding the female.

ECOLOGICAL RELATIONSHIPS: Cactus Bees specialize in collecting cactus pollen to feed their young. They alight first on the flared, over-size, green stigma that is borne above the stamens, thus depositing some grains of pollen from the last-visited flower. Finally, they push down through the forest of stamens to get at the nectar deep inside. Their hairy bodies gather more pollen and their long tongues lap the nectar. They are solitary bees; they do not live in hives.

Darkling Beetle

Eleodes sp.

HABITAT/RANGE: Darkling Beetles are found throughout the world in a wide range of habitat types.

DESCRIPTION: Also known as stinkbugs, these beetles are dark brown to black with hardened front wings that are not used in flight. The antennae, which arise from under a ridge near the eyes, have many segments and are enlarged near the tip. Darkling Beetles are about 1 in. (2.5 cm.) long. The larvae are a type of mealworm. They average 1 in. (2.5 cm.) in length and have a tough, yellowish-brown exoskeleton.

REPRODUCTION: Females lay their eggs in soil.

ECOLOGICAL RELATIONSHIPS: Darkling Beetles eat dead and decaying plants that have fallen to the ground. A stinky fluid exuded from their rear deters predators.

Greater Roadrunner

Geococcyx californianus

HABITAT/RANGE: On the ground in broken chaparral, sage scrub, and desert scrub.

DESCRIPTION: Long legs and tail, streaked brown. Tail feathers have green gloss. Blue and red streak behind eye. When stopped, often raises crest and tail.

REPRODUCTION: Platform nest of sticks lined with roots, feathers, grasses, snake skins, and mesquite pods, placed in a low cactus, tree or bush 3 to 15 ft. (1 to 5 m.) high.

ECOLOGICAL RELATIONSHIPS: Can run up to 15 miles per hour in pursuit of lizards or insects. Pair lives on its territory year round.

Sidewinder

Crotalus cerastes

HABITAT/RANGE: The Sidewinder's range extends through the sandy desert habitats of southern Nevada, to northeastern Baja California and northern Sonora, Mexico, east into central Arizona, and west to the base of the desert side of California's mountains.

DESCRIPTION: The Sidewinder rarely measures more than 2.5 ft. (75 cm.) in length. Its back is patterned with small, dark, square-shaped blotches. A dark stripe extends from the outer corner of the eye to the corner of the mouth. A horn-like process protruding over the eye is characteristic of the Sidewinder.

REPRODUCTION: The female Sidewinder gives birth to 2 to 18 live young.

ECOLOGICAL RELATIONSHIPS: Early in the spring the Sidewinder may be active during the day, but as soon as the weather warms up, it becomes nocturnal. Sidewinding is an adaptation for moving over soft sand. When sidewinding, the snake applies vertical pressure to the ground, which minimizes slippage, and leaves a distinctive parallel series of "J" shaped tracks. Sidewinders are venomous.

Common Raven

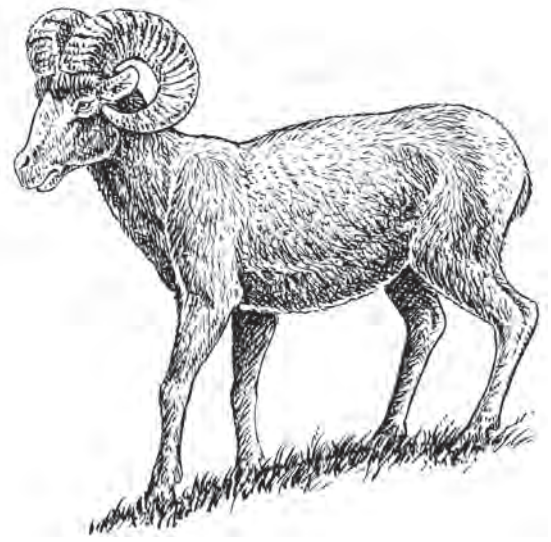
Corvus corax

Cactus Wren

Campylorhynchus brunneicapillus

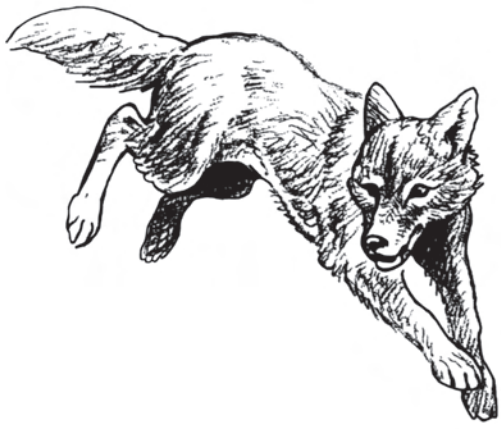
Bighorn Sheep

Ovis canadensis



Coyote

Canis latrans



Cactus Wren

Campylorhynchus brunneicapillus

HABITAT/RANGE: Deserts and semi-deserts with cactus, such as prickly pear and cholla, throughout the southwestern U.S., Baja California, and northern and central mainland Mexico.

DESCRIPTION: Dark crown, wide white eyebrow, heavily spotted breast (and belly, in Baja California), barred wings. Long tail prominently barred black and white underneath.

REPRODUCTION: Large football-shaped nest of plant stems and grasses has side entrance leading through small passage to inner chamber lined with feathers. Nest is placed in a thorny plant, in our region cholla or prickly pear cactus, almost exclusively.

ECOLOGICAL RELATIONSHIPS: Forages on ground or in shrubs. Eats insects, spiders, small lizards, berries, and seeds. Threatened in our region by urban development and increasingly frequent fires.

Common Raven

Corvus corax

HABITAT/RANGE: Diverse habitats in both Eurasia and North America, including deserts.

DESCRIPTION: Large, all black, with massive bill. Tip of tail is wedge-shaped. Long shaggy feathers on the chin and throat.

REPRODUCTION: Nest is bulky mass of trigs, branches, earth, lined with roots, moss, hair, placed mostly on cliffs but also in trees and on buildings.

ECOLOGICAL RELATIONSHIPS: Eats carrion, shellfish, rodents, insects, seeds, fruit, food scraps, bird eggs and nestlings. Hides food.

Coyote

Canis latrans

HABITAT/RANGE: Currently found across most of the continental United States and Canada, and southward to the Isthmus of Panama in a wide range of habitats

DESCRIPTION: The color of the Coyote's pelt varies from greyish brown to yellowish grey on the upper parts, while the throat and belly tend to have a buff or white color. The black-tipped tail has a scent gland located on its dorsal base.

REPRODUCTION: Coyotes form pair bonds that last for years. They prepare a den for the pups, which are born in the spring. Litters consist of 5 to 10 pups.

ECOLOGICAL RELATIONSHIPS: When hunting, Coyotes often work in pairs to procure their prey. One animal will set off in pursuit of a rabbit, or other prey item, while the other animal cuts the prey off as it attempts to flee. This tactic is repeated until the prey animal becomes exhausted and is readily subdued. In addition to hunting rabbits and rodents, which comprise the majority of the Coyotes' diet, they will consume whatever they can catch. Coyote readily consume carrion, and also eat vegetable material and invertebrates.

Bighorn Sheep

Ovis canadensis

HABITAT/RANGE: Occurs in deserts of the southwest U.S. and Mexico.

DESCRIPTION: Stocky, heavy-bodied sheep weighing from 125 to 200 lbs. (57–90.7 kg.) Older rams have impressive sets of curling horns measuring over 3 ft. (91.4 cm.) long with more than 1 ft. (30 cm.) of circumference at the base. Due to their unique padded hooves, Bighorn are able to climb the steep, rocky terrain of the desert mountains with speed and agility.

REPRODUCTION: Lambs are usually born in late winter.

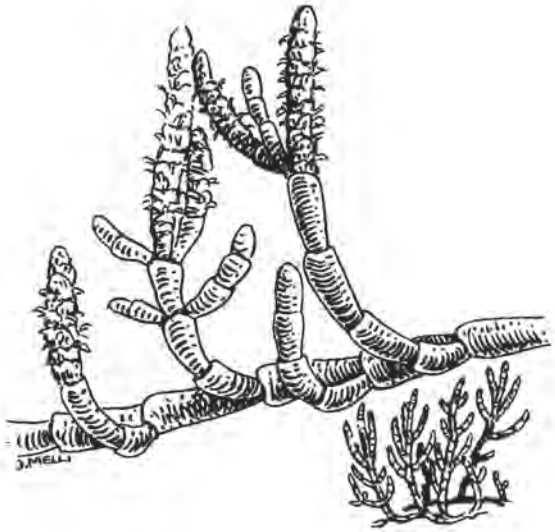
ECOLOGICAL RELATIONSHIPS: Bighorn rely on their keen eyesight to detect potential predators such as mountain lion, coyotes and bobcat, and they use their climbing ability to escape. Southern Desert Bighorn Sheep are typically found in small, scattered bands adapted to a desert mountain environment with little or no permanent water. Some of the Bighorn may go without visiting water holes for weeks or months, sustaining their body moisture from food and from rainwater collected in temporary rock pools. They may have the ability to lose up to 30% of their body weight and still survive. After drinking water, they quickly recover from their dehydrated condition.

California Cordgrass

Spartina foliosa

Pacific Pickleweed

Sarcocornia pacifica



Orcutt's Bird's Beak

Cordylanthus orcuttianus

Saltwort

Batis maritima

Pacific Pickleweed

Sarcocornia pacifica

HABITAT/RANGE: Pacific Pickleweed is a widespread shrub that grows to 11 in. (50 cm.) tall, with erect to ascending stems that grow from creeping rootstocks. It occurs in saline habitats on both coasts along the Baja California peninsula, on several adjacent islands, and on both the east and west coasts of the U.S. and Mexico.

DESCRIPTION: Opposite, scale-like leaves on fleshy or succulent stems that are mostly vegetative and have an opposite branching pattern. The stems look like a little chain of pickles.

REPRODUCTION: The small flowers are wind-pollinated and have no colorful petals.

ECOLOGICAL RELATIONSHIPS: Frequently, Pickleweed is the commonest plant in the salt marsh. It provides shelter and food for invertebrates.

California Cordgrass

Spartina foliosa

HABITAT/RANGE: Grows in the low salt marsh where the roots are continually bathed in ocean water.

DESCRIPTION: A tall grass that is higher than the other plants in the salt marsh.

REPRODUCTION: All grasses are wind-pollinated. Cordgrass has straw- colored spikes of densely packed flowers. Male flowers have pollen, and the female flowers show graceful, waving stigmas to catch the pollen.

ECOLOGICAL RELATIONSHIPS: Cordgrass is home for the endangered bird, the Lightfooted Clapper Rail. A spider lives its entire life inside the blades. It is important food for grazing animals.

Saltwort

Batis maritima

HABITAT/RANGE: Most frequently found in the low salt marsh. Grows with cordgrass and pickleweed.

DESCRIPTION: Saltwort is a light-green to yellow-green, low-growing woody perennial with prostrate or ascending branches that grows in salt marshes along both coasts and on many adjacent islands. The leaves are opposite, succulent, and .5 to 1 in. (1 to 2 cm.) long.

REPRODUCTION: This species is dioecious, meaning there are separate male and female plants. The flowers (male flowers on the male plants, and female flowers on the female plants) are arranged in small cone-like structures. The fruits, which look like little potatoes with bumps, are dispersed by water. Late in summer thousands of the bright green fruits can be found in the high-tide-line debris.

ECOLOGICAL RELATIONSHIPS: It is reported that Native Americans used this species as a food with stems or leaves eaten raw, cooked, or pickled, and the roots were chewed or boiled into a beverage.

Orcutt's Bird's Beak

Cordylanthus orcuttianus

HABITAT/RANGE: Seasonally dry drainages and upland adjacent to riparian habitats. Populations are found in San Diego County and south as far as Rosarito, Baja California.

DESCRIPTION: Annual, 6 to 30 in. (15–75 cm.) tall with green- or red-tinged, stiff, hairy stems. The flowers are clustered at the head of the stem with pinnately dissected bracts. The small flowers are white with yellow-tipped stamens. If you pinch the flower between your fingers it opens like a bird's beak.

REPRODUCTION: Pollinated by ground-nesting bees that build their individual nests in the loose soil found in trails that are seldom used.

ECOLOGICAL RELATIONSHIPS: This is a rare plant due to a limited distributional range and habitat loss from agricultural and urban development. Cordylanthus are root parasites (called hemiparacites) with green leaves, meaning that they are capable of photosynthesis but also tap into the roots of neighboring plants for water and nutrients.

Saltgrass

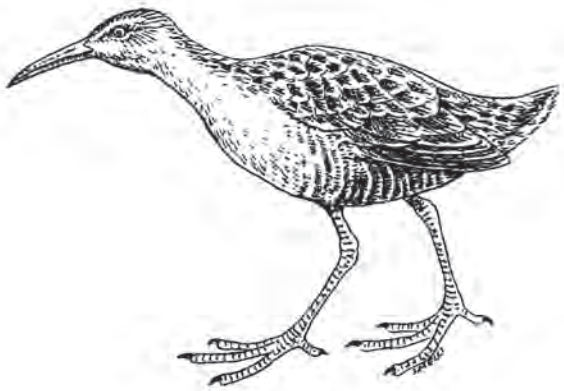
Distichlis spicata

Marbled Godwit

Limosa fedoa

Clapper Rail

Rallus longirostris



Savannah Sparrow

Passerculus sandwichensis

Marbled Godwit

Limosa fedoa

HABITAT/RANGE: Overwinters in salt marshes and on beaches and mudflats of central and southern California, the Baja California peninsula, and the Gulf of California. Nests in meadows near lakes and ponds in the northern central U.S. and southern central Canada.

DESCRIPTION: A large bird (18 in. or 46 cm.) with a downcurved, bicolor beak. Its body is a mottled brown with black on its back. Its wings are cinnamon colored.

REPRODUCTION: Breeding season begins in May. Marbled Godwits nest in dispersed colonies.

ECOLOGICAL RELATIONSHIPS: Eats whole animals buried in the mud, mainly worms, small clams, and crustaceans. Usually found in small groups.

Saltgrass

Distichlis spicata

HABITAT/RANGE: Coasts and saline and alkaline soils below 4,600 ft. (1550 m.).

DESCRIPTION: A single row of leaves on opposite sides of the main stem.

REPRODUCTION: A dioecious grass with male and female flowers on different plants.

ECOLOGICAL RELATIONSHIPS: Insects live between its leaves, taking advantage of this excellent refuge. This plant helps stabilize the sand. It can survive in salty habitats because it is able to excrete salt.

Savannah Sparrow

Passerculus sandwichensis

HABITAT/RANGE: Widespread in North America; some populations migratory. Year-round resident in southern California and Baja California, breeding in the salt marshes.

DESCRIPTION: Streaked breast and back, variable yellowish eyebrow, thin white central stripe in brown crown, short, notched tail.

REPRODUCTION: Builds small cup-like nest of grasses and stems lined with hair or finer grasses, placed in or under pickleweed.

ECOLOGICAL RELATIONSHIPS: Feeds on the ground, eating mostly seeds but also insects, spiders, and snails in summer. Endangered in our region.

Clapper Rail

Rallus longirostris

HABITAT/RANGE: Year-round resident of coastal salt marshes from San Francisco Bay and New England south to South America, also along the lower Colorado River

DESCRIPTION: Large rail (14 in. or 36 cm.) with slightly downcurved bill. Back feathers dark-centered with broad grey edges, giving a greyish look. Breast color in our region is reddish brown. Chicks are all black.

REPRODUCTION: Builds a domed platform nest of grasses and aquatic plants that is attached to cordgrass and floats up and down with the tide.

ECOLOGICAL RELATIONSHIPS: Feeds in shallow water and on mudflats, eating crabs, crayfish, small fish, insects and some plants. Endangered in our region.

Snowy Egret

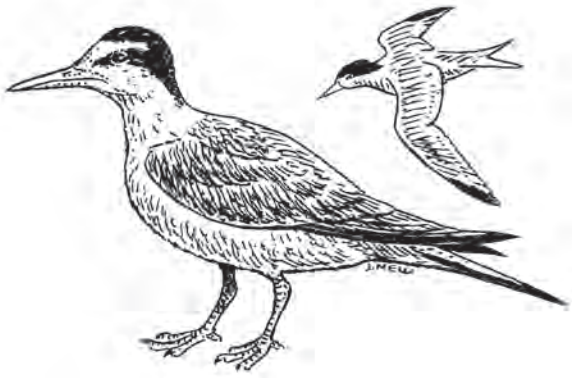
Egretta thula

California Horned Snail

Cerithidea california

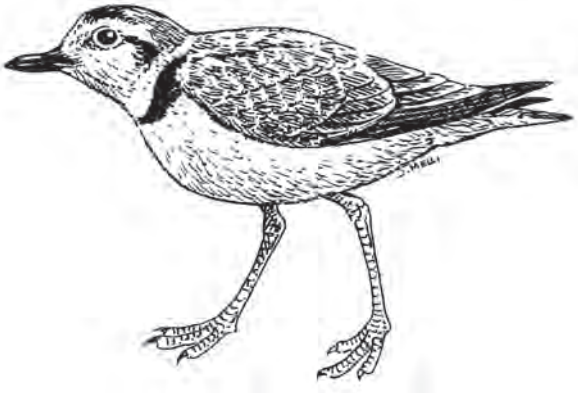
Least Tern

Sterna antillarum



Snowy Plover

Charadrius alexandrinus



California Horned Snail

Cerithidea california

HABITAT/RANGE: Benthic invertebrates associated with a muddy substrate. Inhabits the coastal zone exposed to low tides, such as coastal lagoons and estuaries.

DESCRIPTION: The California Horned Snail is a gastropod with a spiral-shaped shell, giving it the appearance of a cone. The body is soft with a muscular ventral foot, and it has a feeding organ called a radula. When it retracts into its shell, it covers the entrance with a structure called the operculum.

REPRODUCTION: They are hermaphrodites, with male and female organs in the same individuals. However, they cannot fertilize themselves and need to copulate.

ECOLOGICAL RELATIONSHIPS: They have many natural predators, including other species of snails, turtles, fish and birds, such as rails, and other aquatic birds. Humans can also cause harm by stepping on them.

Snowy Egret

Egretta thula

HABITAT/RANGE: Resident in coastal areas, marshes, river valleys, and lake edges through most of the Americas.

DESCRIPTION: White egret with a thin black beak, black legs and bright yellow feet. Elegant feathers grace the head, neck and back of breeding adults.

REPRODUCTION: Nests in large colonies of thousands, singly, or with other herons in small colonies. Builds a platform of sticks and twigs on the ground or in a tree or shrub 5 to 10 ft. (1.5 to 3 m.) high.

ECOLOGICAL RELATIONSHIPS: Active feeding habits. Walks slowly, or quickly runs and hops through shallow water and uses its feet to stir up food from the bottom.

Snowy Plover

Charadrius alexandrinus

HABITAT/RANGE: Widespread in the world's temperate and tropical zones, in our region it overwinters primarily coastal on beaches, mudflats, and salt flats. Migrates to northern Canada and Alaska for breeding season.

DESCRIPTION: Upper parts the color of dry sand; under parts white. Dark patches on crown, sides of head, and sides of breast vary with age and sex. Dark bill and legs.

REPRODUCTION: The nest is just a scrape in the sand.

ECOLOGICAL RELATIONSHIPS: Feeds on small worms, insects, crustaceans, and mollusks picked from the surface of the sand or mud. Often fly and roost in flocks but scatter when feeding.

Least Tern

Sterna antillarum

HABITAT/RANGE: Warmer parts of the Americas. In our region primarily coastal, ranging north to San Francisco Bay and south to the tip of the Baja California peninsula. Present for breeding season from April to September only. It overwinters along the coasts of Mexico, Central America, and northern South America.

DESCRIPTION: Very small (9 in. or 23 cm.), black cap, white forehead, yellow bill with tiny black tip. Narrow wings, rapid wing beats, black leading edge of outer wing, short, shallowly forked tail.

REPRODUCTION: Colonial on beaches and dry salt flats. The nest is a shallow scrape in the sand.

ECOLOGICAL RELATIONSHIPS: Catches small fish by plunge-diving into water.

Willow

Salix sp.

Fremont Cottonwood

Populus fremontii

Coast Live Oak

Quercus agrifolia

Sycamore

Platanus racemosa

Fremont Cottonwood

Populus fremontii

HABITAT/RANGE: Moist mountain and desert slopes along stream banks of beds and in moist places below 6,500 ft (1,981 m.).

DESCRIPTION: A tree 40–90 ft. (12–27 m.) tall with a broad open crown. Leaves are yellowish green on the upper surface, lighter on the under surface. They measure 1.5 to 3.5 in. (3.8–8.9 cm.) long, and are broadly heart-shaped at the base, tapering to a point at the apex. Leaves fall off in the fall. The bark is light grey and deeply furrowed with flat-topped ridges.

REPRODUCTION: Flowers are two- to four-inch male and female catkins (see Willow). The fruit is a light brown, small egg-shaped capsule that splits (three parts) to disseminate numerous, small, cottony seeds. New trees grow from seeds or from pieces that fall on wet ground.

ECOLOGICAL RELATIONSHIPS: Supports insects that birds eat; provides shelter and nesting places for birds. Roots stabilize stream banks and prevent erosion.

Willow

Salix sp.

HABITAT/RANGE: Along stream banks and in wet soil below 2,000 feet (609.6 mm.).

DESCRIPTION: A tree from 6 to 30 feet (1.8–9.14 m.) tall. Leaves are lance-shaped, from two to four inches long. Leaves fall off in the fall and winter.

REPRODUCTION: Flowers are male and female catkins. A catkin is a slender cluster of flowers that don't have petals. (The tree is wind- pollinated, so it doesn't need showy flowers to attract pollinators.) The catkins appear on the branch tips before the leaves. Willows can grow from seeds or from pieces that fall on wet ground.

ECOLOGICAL RELATIONSHIPS: Birds nest, gather food, hide from enemies and rest among its leaves. Insect galls grow on the leaves and stems. The roots help to keep the stream bank stable and prevent soil erosion. Willows are host plants for the Mourning Cloak butterfly.

Sycamore

Platanus racemosa

HABITAT/RANGE: Abundant at elevations below 4,000 ft. (1,219 m.) along streams and near springs, or in moist gullies where water from streams or ground-water supplies are perennial or intermittent.

DESCRIPTION: Tree growing 40–90 ft. 12.19–27.43 m.) tall, with thick, barrel-shaped trunks that support a massive crown of wide-spreading limbs. Leaves turn a beautiful golden color in the fall and fall off. Leaves are broad, 5 to 11 in. (12.7–27.9 cm.) long, and wide. The bark is ash white with greenish-grey patches.

REPRODUCTION: The tiny, unisexual wind-pollinated flowers appear in a ball-like cluster on the same tree. The large, globular fruit breaks up at maturity, releasing numerous small nutlets that drift on the wind in fall.

ECOLOGICAL RELATIONSHIPS: Birds eat the small fruits, glean insects from the leaves and branches and nest in this tree. Sycamores provide shade over streambeds and their roots stabilize the banks.

Coast Live Oak

Quercus agrifolia

HABITAT/RANGE: Found on well-drained soils of coastal hills and plains, often near year-round or perennial streams below 6,500 ft (1,981 m.).

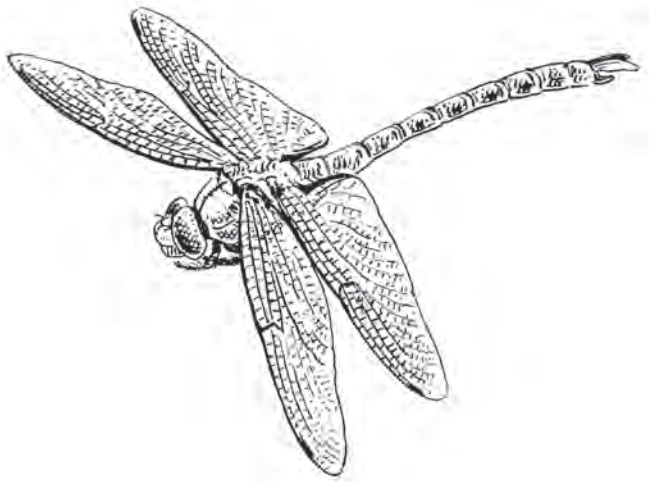
DESCRIPTION: A picturesque evergreen tree 30 to 75 ft. (9.14–22.86 m.) tall with spreading stout branches, forming a broad-headed crown. The leaves are oblong to oval, 1 to 3 in. long, stiff, leathery, frequently convex on the upper surface. The under surface is paler.

REPRODUCTION: Flowers are male and female catkins (see Willow). The fruit is a slender reddish-brown acorn .78–1.37 in.(2–3.5 cm.) long and .39–.59 in. (1–1.5 cm.) broad, with the basal quarter enclosed in a cupule. The acorns mature seven to eight months after pollination.

ECOLOGICAL RELATIONSHIPS: The California Oak Moth (*Phryganidia californica*) caterpillar subsists entirely on living and fallen leaves of the Coast Live Oak. Acorn woodpeckers excavate nests in dead trees and collect and store acorns in holes drilled, usually in conifers whose wood is less dense than oak.

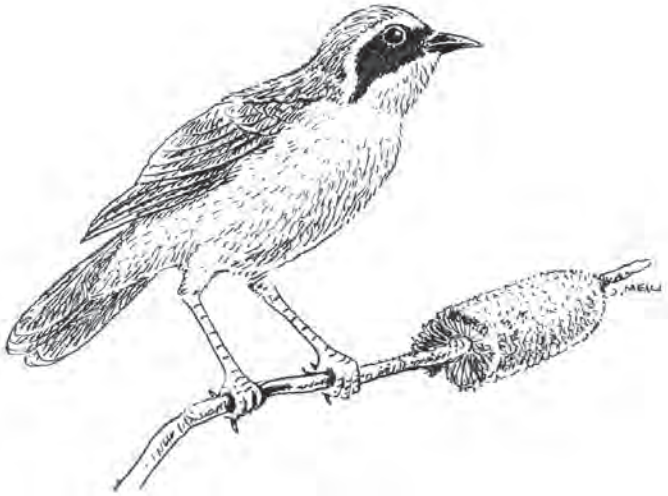
Common Green Darner

Anax junius



Common Yellowthroat

Geothlyphis trichas

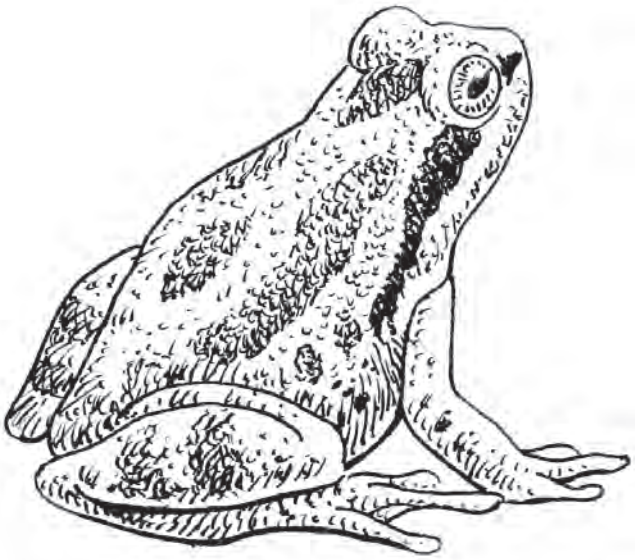


Raccoon

Procyon lotor

Pacific Tree Frog

Pseudacris regilla



Common Yellowthroat

Geothlyphis trichas

HABITAT/RANGE: Brushy habitats near wet areas. They are one of the most common birds in riparian habitat. Their range extends along the Pacific coast into northern California, and they winter in the Baja California peninsula.

DESCRIPTION: Male: Yellow throat and upper breast; black mask with greyish-white border. Female: Yellow throat and breast; olive-brown face and upperparts, whitish eye ring.

REPRODUCTION: Common Yellowthroats build their nests in dense, low undergrowth, sometimes on the ground. The nest is made of coarse grasses, dead leaves and lined with fine grasses or hair. They lay three to four eggs.

ECOLOGICAL RELATIONSHIPS: Eat insects, spiders and seeds gleaned from the ground or shrubs.

Common Green Darner

Anax junius

HABITAT/RANGE: The Common Green Darner is a type of dragonfly. They prefer permanent and temporary ponds, lakes, bays, estuaries and slow-moving streams and riparian areas.

DESCRIPTION: Green Darners are about 3 inches (7.6 cm..) long with a wingspan of 4.5 inches (11.4 cm.). They have a green head and thorax. The abdomen is yellow and brown on females and bluish on males. They have large, compound eyes, strong jaws, and spiny legs. Their wings are clear with a yellowish tint toward the tips and are strongly veined with a net-like pattern. They are able to fly up to 53 miles per hour.

REPRODUCTION: Eggs laid in aquatic vegetation hatch in the spring. The nymphs (aquatic larvae) pass through 11 to 12 stages before metamorphosing into dragonflies. The adults immediately begin the cycle again. Green Darners spend a few years in larval form, and only live four to seven weeks as adults.

ECOLOGICAL RELATIONSHIPS: Larvae eat fish eggs, tadpoles and other small aquatic animals. Adults eat wasps, butterflies, mosquitoes, and other flying insects (including other dragonflies). Fish, turtles, frogs, and wading birds eat the larvae. Birds, fish and frogs eat the adults.

Pacific Tree Frog

Pseudacris regilla

HABITAT/RANGE: Found in a wide range of habitats: grasslands, chaparral, woodland, desert oases, agricultural regions and residential areas. Ranges from British Columbia, Canada, to the tip of the Baja California peninsula.

DESCRIPTION: Small .75 to 1 in. (1.9–2.5 cm.) with a highly variable color pattern on the back, ranging from unicolor to mottled greens, tans, reds, greys browns or blacks. They can change from light to dark. The throat is dusky colored and wrinkled. When calling, the vocal sac expands the throat into a round, balloon-like membranous pouch. This is the most common frog, and the call is the "rib bit" that you may hear singly or in a chorus. Tadpoles have a round body, eyes slightly protruding. Larger tadpoles are mottled with a white belly.

REPRODUCTION: Breeds from November to July. Egg clusters are attached to the bottom of marshes, ponds, lakes, etc., or to sticks or vegetation. Tadpoles, or larvae, hatch within a week and metamorphosis may take up to 2.5 months.

ECOLOGICAL RELATIONSHIPS: The Pacific Tree Frog eats a wide variety of arthropods. A number of predators rely on the Pacific Tree Frog as a food source, garter snakes being the most noteworthy.

Raccoon

Procyon lotor

HABITAT/RANGE: Usually found along watercourses or lakes that are near wooded areas. A raccoon may den in caves or crevices, in hollow trees or under rock piles. While it may wander far from the water during the hunt, most of its life is spent near the water.

DESCRIPTION: The raccoon is a short, stout animal, with a pointed muzzle and small, erect ears. Its most easily recognized features are the black mask across its eyes, and the alternating black and grey strips that completely encircle its tail. A raccoon can weigh between 5.4 and 15.8 kg. (12–35 pounds).

REPRODUCTION: Raccoons may breed any time during the late fall into early spring. The gestation period lasts about two months, and an average of four young are born between December and April. The mother cares for her young for almost a year.

ECOLOGICAL RELATIONSHIPS: Raccoons feed mostly along streams and lakes, finding food under rocks and in the mud. Their diet includes crayfish, fish, lizards, frogs, small mammals, birds, eggs, various fruits, nuts and grains. They are nocturnal.

References

Alcocer de Ross Irma, Alcocer de Ricalde Tere. 1997. *Un mundo mejor. Actividades para fomentar la conciencia ecológica en los niños*. México, Editorial Trillas, 167 pp.

Alcock, J. 1985. *Sonoran Desert Spring*. The University of Chicago Press. Chicago.

Arana, Federico. 1995. *Ecología para principiantes*. Editorial Trillas, México D.F. México.

Baldwin, et. Al, 2002. *The Jepson Desert Manual*.

Carvajal, M.A., E. Ezcurra and A. Robles. 2004. *The Gulf of California: Natural Resource Concerns and the Pursuit of a Vision*. In: L.K. Glover and S. Earle (eds.) *Defying Ocean's End. An agenda for Action*. Island Press, Washington, D.C. pp. 105–124.

Callenbach, Ernest. 1998. *Ecology: a Pocket Guide*. University of California Press. Berkeley.

Caso, M., C. González-Abraham, and E. Ezcurra. 2007. *Divergent Ecological Effects of Oceanographic Anomalies on Terrestrial Ecosystems of the Mexican Pacific Coast*. *Proceedings of the National Academy of Sciences* 104(25): 10530–10535.

Caso, M. E. *Asteroideos, ofiuroideos y equinoideos de la Bahía de Mazatlán, Sinaloa*. Instituto de Ciencias del Mar y Limnología. Universidad Nacional Autónoma de México, Apartado Postal 70-305, México, D. F. 04510, México. Contribución No. 750 del Instituto de Ciencias del Mar y Limnología, UNAM.

Caso, M. E. 1974. *Contribución al estudio de los equinoideos de México, morfología de Tripneustes depressus agassiz y estudio comparativo entre T. ventricosus y T. depressus*. Centro de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México.

Caso Muñoz, M. E.; A. Laguarda-Figueras; F. Alonso Solís-Marín; A. Ortega Salas; A de la L. Durán González. *Contribución al conocimiento de la ecología de las comunidades de equinodermos de la Bahía de Mazatlán, Sinaloa, México*. Instituto de Ciencias del Mar.

Colección La pandilla científica. 1990. *Más experimentos por el profesor Cientifix y su adjunto Bernard Larocque Tomo 5*. Editorial Alahambra Mexicana, S.A. de C.V., México, 120 pp.

Commission for Environmental Cooperation. 1997. *Ecological Regions of North America: Toward a Common Perspective*. Commission for Environmental Cooperation, Montreal, Quebec, Canada. 71p.

Commission for Environmental Cooperation. 2006. *Ecological Regions of North America, Levels I-III, map scale 1:10,000,000*. Commission for Environmental Cooperation, Montreal, Quebec, Canada.

Consejo de Educación Ambiental para las Californias (CEAC). 2005. *Catálogo de sitios de interés ecológico y educativo. Lineamientos generales para la educación ambiental basada en las salidas de campo*. http://www.ceac.net/.

Escalante, Patricia, et.al. *Listado de nombres comunes de las aves de México*. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad.

Ezcurra, E. (lead authors; E. Mellink, E. Wehncke, C. González, S. Morrison, A. Warren, D. Dent and P. Driessen (contributing authors). 2006. *Natural History and Evolution of the World's Deserts*. In: Ezcurra, E. (editor). *Global Deserts Outlook*. United Nations Environment Programme (UNEP), Nairobi, Kenya. Pp. 1-26.

Ezcurra, E. 2007. *Water Use, Ecosystem Health and Viable Futures for Baja California*. *Biodiversity* (Newsletter of the Consultative Group on Biological Diversity) 17(4): 1–4.

Doug Struck. *Warming Will Exacerbate Global Water Conflicts*. Washington Post, August 20, 2007.

Felger, Richard Stephen. 2000. *Flora of the Gran Desierto and Río Colorado of Northwestern Mexico*. The University of Arizona Press.

Grass Roots Educators. 1995. *El Joven Naturalista*.

Hernández V., F. y L.E. Villaseñor G. (Eds.). 1996. *Manual para la realización de talleres de educación ambiental en la Reserva de Colola-Maruata, Michoacán. México*. Morevallado Editores, Morelia, Mich. 86 pp.

Herrera Escalante, T. H. Reyes Bonilla, F. A. García Domínguez y M. D. Herrero Pérezrul. 2006. *Dinámica poblacional y reproducción de la estrella de mar Phataria unifascialis (Gray 1843) en Bahía de La Paz, Baja California Sur, México. III* Congreso mexicano de arrecifes de coral.

Kerrod, Robin. 1990. Secretos de la ciencia. Agua y fuego. Coedición CONACYT-MÉXICO SITESA. México, 31 pp.

Lee, Mike. *Drought, Beetles Killing Forests*. *San Diego Union Tribune*. October 25, 2008.

Letras. 2001. *Enciclopedia interactiva de los conocimientos. Tomo 2, Ecología*. España. Ediciones Credimar, S.L.

Lightner, James. 2004. *San Diego County Native Plants*.

McAuley, Milt. 1985. *Wildflowers of the Santa Monica Mountains*.

Morhardt, Sia and Morhardt Emil. 2004. *California Desert Flowers.*

Munz, Philip A. 2004. *Introduction to California Desert Wildflowers.*

Munz, Philip. A. 2004. *Introduction to California Spring Wildflowers of the Foothills, Valleys and Coast*.

National Geographic Society. 2002. *Field Guide to the Birds of North America,* Fourth Edition. Washington D.C.

National Geographic Society. 1999. *Handbook of the Birds of the World, Volume 2*.

National Outdoor Leadership School.

Nussbaum et al. 1983.

Omernik, J.M. 1987. *Ecoregions of the Conterminous United States*. Map Supplement (scale 1:7,500,000). Annals of the Association of American Geographers 77(1):118-125.

Pro Esteros. 2000. *El Humedal…un lugar de vida*.
Tiraje 1000 ejemplares, PRONATURA (Noroeste), AC. *Programa de Involucramiento Público y de Educación Ambiental para la Conservación de Humedales Costeros del Noroeste de México (PIE)*.

Proyecto Bio-regional de Educación Ambiental (PROBEA). 2004. *Visita a Ecoparque. Manual de actividades y Guía para el maestro*. http://sdnhm.org/education/binational.

Peterson, Roger Tory. 1990. *Western Birds*. Peterson Field Guides. Third Edition. Houghton Mifflin Company. Boston, U.S.A.

Proyecto Bio-regional de Educación Ambiental (PROBEA). 2006. *¿Qué me cuentas de la cuenca? Guía para el maestro*. http://sdnhm.org/education/binational.

RARE. 2000. *Guía para curso de biología y ecología general*.

Reserva Nacional para la Investigación del Estuario del Río Tijuana. 1995. *Proyecto M.A.R.S.H*. Tijuana Estuary Visitor Center www.tijuanaestuary.com.

Roberts, Norman C. 1989. *Baja California Plant Field Guide*. Natural History Publishing Co., La Jolla, CA.

Rosenburg, Marshall B. 2004. *We can Work It Out: Resolving Conflicts Peacefully and Powerfully*. Puddle Press.

San Diego Natural History Museum. 2000. *Oasis Marino. Dos Mundos Un Paraíso. Guía del Maestro*. http://www.oceanoasis.org.

Schoenherr, Allan A. 1992. *A Natural History of California*.

Secretaría de Educación Pública. *Ciencias naturales. Libro de texto gratuito para 4º año*. Gobierno de la República, México, D.F.

Secretaría de Educación Pública. *Geografía. Libro de texto gratuito para 5º año*. Gobierno de la República, México, D.F.

Secretaría de Educación Pública. *Geografía. Libro de texto gratuito para 6º año*. Gobierno de la República, México, D.F.

SEMARNAT. 2001. *Guía técnica de identificación de aves canoras y de ornato autorizadas por la SEMARNAT para su aprovechamiento*.

Stokes, Donald and Lilian. 1996. *Field Guide to Birds: Western Region*

Stewart, Jon Mark.1993. *Colorado Desert Wildflowers*

Stuart, John D. and Sawyer John O. 2001. *Trees and Shrubs of California*.

U.S. Environmental Protection Agency. 2007. *Level III Ecoregions of the Continental United States*, Map M-1 (revision of Omernik, 1987). U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Corvallis, OR,

Valov, Debra. *Personal Communication*. 2007.

Wiggins, Ira L. 1980. *Flora of Baja California*. Stanford University Press. Stanford, CA.

Zarembo, Alan and Boxall, Bettina. *Permanent Drought Predicted for Southwest*. LA Times, April 6, 2007.

Peterson, P. Victor. 1966 *Native Trees of Southen California*. University of California Press.

Raven, Peter H. 1982. *Native Shrubs of Southern California*. University of California Press.

Unitt, Philip.2004. *San Diego County Bird Atlas*. Ibis Publishing Company.

Anza-Borrego Desert State Park. "Guidelines for the Removal of Saharan Mustard".

Websites:

www.epa.gov/wed/pages/ecoregions.htm.

www.nols.edu.

www.proesteros.org

www.natureserve.org

www.puntoverde.org

www.en.wikipedia.org

www.bajacalifornia.gob.mx/ecologia

www.sagarpa.gob.mx/dlg/bajacalifornia

www.baynatives.com/plants

www.sdnhm.org/fieldguide/plants

www.calflora.org

www.cals.arizona.edu

www.sdplantatlas.org

www.bajaflora.org

www.fws.gov/refuges

www.arizonensis.org/sonoran/fieldguide/

www.seaturtles.org

www.marinemammalcenter.org

www.animals.jrank.org/

www.water.ca.gov/climatechange/

www.agua.org.mx

www.nationalgeographic.com/news

www.zipcodezoo.com

www.desertmuseum.org/invaders/invaders_saharamustard.htm

www.californiachaparral.com

www.epa.gov/owow/wetlands/what/definitions.html

www.torreypine.org/plants/plants.html#torrey

www.sdnhm.org/education/binational

www.sdnhm.org

www.fundacionlapuerta.org

www.proyectofronterizo.org.mx

www.fws.gov

www.sandiegorefuges.fws.gov

www.ine.gob.mx

www.conanp.gob.mx