M• A• R• S• H•

Marsh Awareness with Resources for Slough Habitats

TEACHER'S PACKET

second edition 1987

ijuana River National Estuarine Research Reserve

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WELCOME

Welcome to the Tijuana River National Estuarine Research Reserve.

Nestled between two of the fastest growing cities in the northern hemisphere, the swamps of Imperial Beach have been largely overlooked by all but the local citizens and several thousand bird watchers. No more! In 1979, the U.S. Fish and Wildlife Service purchased the Oneonta Sloughs for a wildlife refuge. In 1982, 2517 acres at the mouth of the Tijuana River, including the Refuge, Border Field State Park and other properties of diverse ownership, were declared a National Estuarine Research Reserve. This federal/state mantle means money, people and protective laws to preserve the finest remaining salt marsh in the Southern California region. These wetlands have been especially set aside by the U.S. Congress as "field laboratories" for research and education. The research provides guidance for wetland management throughout the state and nation. The education program plans to bring the wonders of this rich estuary and the excitement of the many research programs to the public.

Many of you will be new to the study of wetlands and will be learning along with your students. You will find it an adventure, albeit a muddy one. There is much to be seen and understood and we hope in your excitement you will not stop to worry about the names of things. These will come easily in time; until then, this curriculum has hopefully provided you with the basics-fundamental principles and adaptations-so that you will formulate questions, hypothesize, speculate. Always remember there is only one rule in the game of speculation - don't fall in love with your answer.

MARSH TEACHER PACKET

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In 1986, South Bay Union School District, with cooperation from the Tijuana River National Estuarine Research Reserve Staff, applied for and was awarded a California Environmental Education Grant to develop curriculum which includes field studies--M.A.R.S.H. In 1987, another C.E.E.G. grant was awarded to the Reserve through its' non-profit cooperative organization Southwest Wetlands Interpretive Association.

Each of the Southern California coastal wetlands are unique, but all operate under the same principles and share many of the same physical features. Consequently, we decided to build around a program developed by Fullerton College for Newport Back Bay. This excellent educational packet was also funded through a C.E.E.G. We are indebted to all those who worked on that fine program and hope they are pleased with our small changes. These few changes tailor the package to the Tijuana River Estuary but at no point change the general nature of the information. Teachers can feel secure in using this material wherever mudflats and salt marshes remain to grace the continental edge of Southern California.

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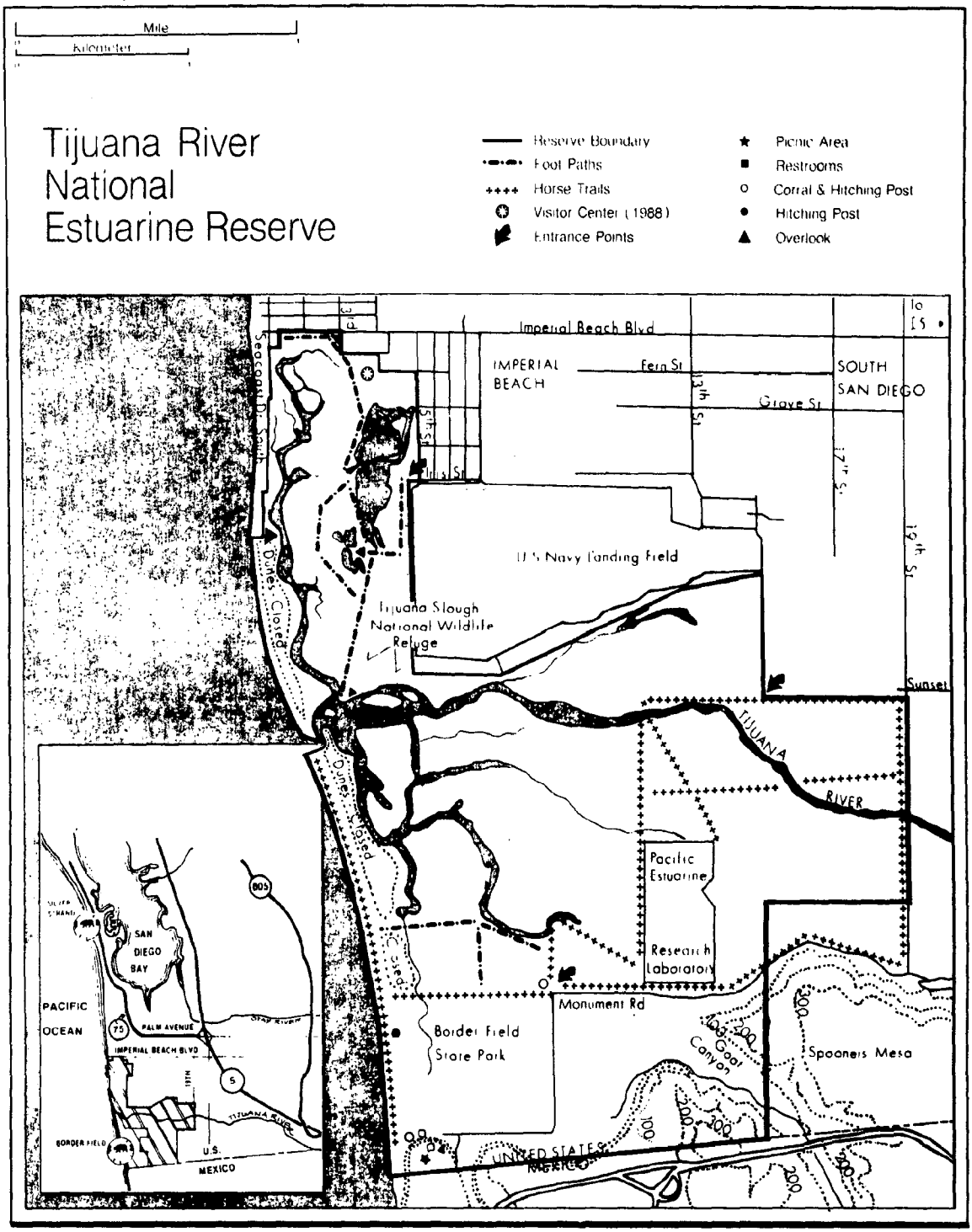
Mile
Kilometer
Tijuana River
National
Estuarine Reserve
Reserve Boundary
Foot Paths
Horse Trails
Visitor Center (1988)
Entrance Points
Picnic Area
Restrooms
Corral & Hitching Post
Hitching Post
Overlook
Imperial Beach Blvd
IMPERIAL
BEACH
Fern St
SOUTH
SAN DIEGO
Grove St
13th St
17th St
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U.S. Navy Landing Field
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National Wildlife
Refuge
Dunes Closed
Sunset
TIJUANA
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Research
Laboratory
Monument Rd
Border Field
State Park
Goat
Canyon
Spooners Mesa
UNITED STATES
MEXICO
SAN
DIEGO
BAY
PACIFIC
OCEAN
PALM AVENUE
IMPERIAL BEACH BLVD
BORDER FIELD
U.S.
MEXICO
805
75
5

THE RULES

HOW WOULD YOU RUN A RESERVE?

..... All animals, plants and physical features are protected and may not be removed or damaged.

..... Dogs are allowed only on the beach and must be on a leash.

YOU MAY FISH FROM THE BEACH, BUT....

..... Fishing, clamming, shrimping, and related activities are prohibited in all other areas.

THE SALT MARSH IS EASILY DAMAGED BY TRAFFIC. TRACKS MAY LAST YEARS.

..... Hike only on designated trails and along the beach.

..... Bicycles are not permitted on the trails and must stay on designated roads.

..... All vehicles must stay on designated roads.

..... Horses must remain on signed equestrian trails. Stay off the dunes!!

PLEASE RESPECT SPECIAL AREA CLOSURE SIGNS

..... The California Least Tern nesting sites (summer), and Sand Dune restoration areas (year-round).

IT WILL NOT SURPRISE YOU THAT...

..... No weapons or fireworks are permitted anywhere in the Reserve.

..... No littering or dumping. Instead, feel feel to pick up as much litter as you like!

The T.R.N.E.R. includes Border Field State Park and Tijuana Sloughs National Wildlife Refuge. The Reserve is operated by the California Department of Parks and Recreation and the U.S. Fish and Wildlife Service.

For information or to report a problem, call 435-5184/428-3034

To request educational information, call 237-6766

PLEASE READ THE RULES TO YOUR STUDENTS BEFORE THE TRIP TO THE RESERVE.

CHECKLIST

A trip to the Estuary is always an adventure. To make sure the adventures are pleasurable remind the students to:

1. Wear old clothes, especially shoes.

2. Bring binoculars, if possible.

3. Bring a camera to record the day.

There are no restrooms or drinking fountains on the reserve. There are restrooms and drinking fountains at Sports Park between 4th and 5th Street on Imperial Beach Boulevard.

You may enter the reserve at any time. The time to see the greatest number of birds is during low tide, when the mudflats are exposed for feeding. The salt marsh birds probe the mud for food. Ducks, herons, and egrets feed where the water is deeper.

It is a good idea to check a tide table for the day of your trip. Tide tables for the year can be purchased for 15¢ at fishing tackle stores. The library will have tide information published by the National Oceanic and Atmospheric Administration. The newspaper will have the day's tidal range on the weather page.

There is an hour lag between the stated tide time and when the effects are fully noticeable in the marsh. For instance, the tide charts says there will be a high tide of 5.4 feet at 9:06 a.m. It will be 10:00 a.m. before the tide is fully into the ponds and the northern ends of the sloughs (tidal channels that look like streams, but are full of ocean water.) Conversely, the tides will drain from the sloughs an hour later than the recorded low tide time.

SUGGESTED REFERENCES

Common Wetland Plants of Coastal California, Phyllis Faber

Salt Marsh Vegetation, Examples from the Tijuana Estuary, Dr. Joy Zedler. Sea Grant Publication, E-CSGCP-003

The Ecology of Southern California Coastal Salt Marshes: A Community Profile, Dr. Joy Zedler. Fish and Wildlife Service/OBS-81/54, March 1982

The Ecology of Tijuana Estuary: An Estuarine Profile, Dr. Joy Zedler and Chris Nordy. Fish and Wildlife Service/Rep. 85 (7.5). June 1986.

Field Guide to the Birds of North America, National Geographic Society

Seashore Plants of California, Dawson and Foster. University of California Press

Seashore Life of Southern California, Sam Hinton. University of California Press

ENVIRONMENTAL EDUCATION PACKET
THE COASTAL WETLANDS OF SOUTHERN CALIFORNIA

INTRODUCTION

The coastal wetlands of Southern California are among the most endangered habitat types in the United States today. Coastal wetlands are the marshes and mudflats found near the ocean. Often they are influenced by tidal action. A rich habitat, the wetlands function as a nursery for many fish of sport and commercial value and as a winter home for millions of birds.

In Southern California over ninety percent of the coastal wetlands have been lost to such uses as dredging, filling, development of marinas, power plants, and a variety of other uses. Coastal wetlands in Southern California may cease to exist unless the public can be informed about the wetlands role in nature and their long term economic value.

The materials in this packet are based upon the premise that environmental education is most effective when it is taught from an ecological perspective. Although ecological systems are enormously complex, an attempt has been made to develop an outline of basic concepts and generalizations. You may find it helpful to refer to this outline from time to time as you prepare for and teach the following lessons. By using the wetlands as an example of a functioning ecological system, students can learn ecological concepts and gain an understanding of these special needs.

BASIC CONCEPTS OF ECOLOGY

A. MATTER AND ENERGY LAWS

1. Law of Conservation of Matter: Everything must go somewhere. There can be no such thing as a throwaway society. All matter must go somewhere. (Matter is neither created nor destroyed, but merely changed from one form to another.)

2. First Law of Energy: You can't get something for nothing. (Energy is neither created nor destroyed, but merely changed from one form to another.)

3. Second Law of Energy: You can't break even. Energy cannot be recycled. (No transfer or transformation of energy is one hundred percent efficient.)

Summary:

Matter is recycled in an ecosystem but as energy flows through the ecosystem it is degraded in quality and cannot be reused. Unlike social law, these laws of nature cannot be broken. A summary "law" might thus be stated; You Can't Stop Playing the Game. In other words, we automatically function all the time within the laws of nature.

B. ECOSYSTEM STRUCTURE

1. Ecosystem: Self-sustaining and self-regulating community of organisms interacting with one another and with their non-living environment. The ecosystem is the unit of structure and function in ecology. Some examples of ecosystems are; a pond, a rotting log, a forest, a salt marsh, and an estuary.

2. Components of an Ecosystem:

   a. Nonliving (abiotic) - These are outside energy sources and physical factors. Examples include water, soil, rocks, air, sunlight, and wind.

   b. Living (biotic) - These are living organisms such as plants (producers) that make their own food by doing photosynthesis, animals (consumers) that eat plants or other animals, and decomposers (bacteria, fungi, and a variety of very small living things) that convert the tissue from dead animals into abiotic building blocks. These organisms form food webs, which help transfer and cycle matter and transfer energy.

3. Law of Limiting Factors: Too much or too little of any single factor may destroy an organism or limit its numbers or distribution. E.g. A lawn does not grow well if it has insufficient amounts of nitrogen and/or phosphate. Too much fertilizer (nitrogen and/or phosphate) will also inhibit growth. Other limiting factors include light, salt concentration, temperature, and wind.

C. ECOSYSTEM FUNCTION

1. Energy flows:

   a. Energy from the sun powers natural ecosystems.

   b. The sun provides energy for the global energy flow which results in the water cycle, winds and global heating.

   c. Energy flows through the living portion of the system in food chains or food webs. Green plants capture the sun's energy and convert it to chemical energy. Green plants are producers. Consumers eat the producers and each other. All are ultimately eaten by decomposers.

2. Matter is cycled within the ecosystem. Chemicals are converted from salts and gases into molecules which make up living tissues. When the organism dies these molecules are converted by decomposers to inorganic salts and gases.

3. Ecological niche. Each species fits into the ecosystem in a unique way. This includes not only the habitat or physical space where it lives but the way it makes its living (the species role in energy transfer and material cycling).

3. Changes in ecosystems. Ecological succession results in repeated replacement of one community of organisms with another community of organisms which are usually more diverse. The change is a result of environmental modification by living organisms. E.g. Grass must stabilize a sand dune before a forest can grow there.

D. LAW OF ADAPTATION - ADJUSTMENT TO ENVIRONMENTAL STRESS

1. Individual adaptation. Each organism must adjust to changing environmental conditions or perish. Organisms change their behavior to cope with changing conditions. E.g. When it's hot the organism may seek shade. When the wind blows the organism seeks shelter. Different behaviors are used to find and capture different prey.

2. Species adaptation. Natural selection causes a species to be better adapted to its environment. E.g. When mosquitoes are sprayed with the insecticide DDT, many will die. But some have genetic resistance to DDT. They reproduce and leave offspring which are resistant to DDT. The population is adjusting genetically.

E. LAW OF MULTIPLICATION

1. Either growth or consumption which is increasing at a fixed rate is said to be exponential.

2. Bacteria which reproduce every twenty minutes would show exponential growth as follows:

Generation	Time in Minutes	Nos. of Individuals
1	0	50
2	20	100
3	40	200
4	60	400
5	80	800
6	100	1600
7	120	3200
8	140	6400
9	160	12800
10	180	25600

3. All living organisms which are reproducing at a fixed rate of growth are increasing their numbers exponentially. More organisms require more resources.

4. If resource consumption is growing at a fixed rate, the growth is exponential. In the United States, energy consumption has doubled every ten years at a growth rate of 7%. In the 1950's, more oil was consumed than in all of the previous history of mankind. In the 1960's, more oil was consumed than in all the previous history of mankind including the 1950's.

INTRODUCTORY LESSON
WHAT IS AN ECOSYSTEM?

METHOD: Discussion

Take the class to a pleasant spot on the school grounds and have them sit on the grass. Choose a place where you can observe the most environmental diversity possible. (e.g. shade, direct sun, trees, open grass, paved play areas, etc.) Your discussion should be designed to develop the concept of an ecosystem by comparing it to a house.

Here are some questions you might ask (with a few possible answers).

1. How many of you live in a house?
   Of course all the children live in a house, that's the idea. They now have a reference for comparison.

2. How many of your houses are just alike?
   Encourage the children to think about the differences in their houses. Include color, shape, location (hill or valley), inside furnishings.

3. What materials were used to build your house?
   Go for variety. Cement, wood, bricks, plastic, paper, tar, metal, glass.

4. How many other kinds of houses throughout the world can you think of?
   Igloo, teepee, grass hut, houses on stilts, house boats, lean-to, hotel, cottage, castle.

5. How do you use energy to help you live in your house?
   Electricity - lights, heat, cooking, T.V., small appliances. Gas - heating, cooking, heating water and drying clothes. Wood - fire in fireplace, charcoal for cooking outside. All of the furnishings of the house and the building materials of the house require energy to be manufactured.

Reinforce the idea that the students homes are functioning systems. Each home is composed of material put together in a special way. And although there is a huge variety of homes, all homes require energy for building and operation of the activities which take place in the home.

Continue the discussion to develop an analogy between an ecosystem and the student's home.

6. We are in "nature's house." What are the building blocks of nature's house?
   Encourage the students to think about the physical factors of the environment. The list can get long and seem complex, but that's how it really works.

Here are some examples:

PRECIPITATION: Kinds (rain, snow, sleet, hail, dew)
Amount
Direction
Humidity

WIND: Direction and speed

SUBSTRATE: Land (soft or hard, coarse or fine, rocks of various kinds).

MAN-MADE: Smog, cement, blacktop, bricks

7. How can living organisms be considered as building blocks in nature's house?

   Living organisms change the environment in which they live. Trees make shade, plants and animals die and help build soil, animals move materials from one place to another.

8. What is the source of energy for nature's house?

   LIGHT: Intensity (day and night), quality (make a shadow), angle, reflected (use a mirror if it helps).

   HEAT: (related to light) Changes from day to night, cloud cover, ground and water holding heat (feel ground and blacktop, place a black pan filled with water out an hour or two before your lesson) changes with seasons. (Remember last fall when it was hot?)

Nature's house is called an ECOSYSTEM. Each ecosystem is composed of material which is organized by using energy. Examples of ecosystems are: a rotting log, a school yard, a lake, a river, a coastal wetland. Each ecosystem is unique just as each house is unique. As a result, each kind of ecosystem supports a special assemblage of living organisms.

Encourage the students to think of as many examples of ecosystems as possible. If you can define boundaries easily, it is probably an ecosystem.

Refer to ecosystems as often as you can, both within and outside the classroom. Help students develop the concept of the ecosystem as the unit of structure and function in ecology.

BUILD AN ECOSYSTEM

MATERIALS: Large jars (1 gallon) with tight fitting lids, water, sand, guppies (5 per jar), elodea leaves, snails, microscopes or microprojector.

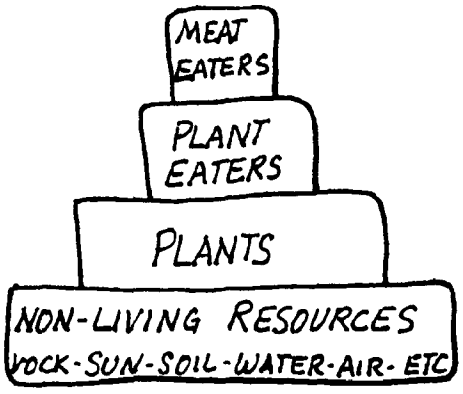
PREPARATION: If you are using beach sand wash it 5 times with fresh water to get all the salt out. If you are using tap water let it sit without a covering for 24 hours so the chlorine will evaporate. Prepare the diagram shown below for a bulletin board. Class time needed: 1 hour.

Prepare students by explaining that you will be making an ecosystem in the jars.

Begin the lesson by asking them to list those things needed to make an ecosystem. Write on the board their contributions (sun, soil, water, plants, animals, rocks).

Show the different sizes of rectangles. Which resource must be most abundant? That resource will be listed on the largest rectangle. Those things which must be in small supply will be listed on the smaller rectangles.

With limited discussion, students will probably reason that there cannot be more plants than there is available soil and water. There cannot be more plant eaters than there are plants.....



Introduce the concept of limiting factors: too much or too little of any single factor may destroy an organism or limit its numbers or distribution. (See examples B.3 of Basic Concepts of Ecology at the beginning of this packet.) Fill in the diagram and display it in the room.

ASK:

What happens if there are too many meat eaters?
They eat so many plant eaters that their food becomes scarce and they begin to starve.

What happens if there are too many plant eaters?
They eat so many plants that food becomes hard to find and they begin to starve. Fewer plant eaters means there will be less food for the meat eaters.

It will be readily apparent that a correct balance is needed. All of the interactions between living and nonliving components of the environment make an ECOSYSTEM. (See B.1, BASIC CONCEPTS OF ECOLOGY.)

Natural ecosystems which have not been disturbed by humans have a tendency to remain balanced. Human activities can often upset an ecosystem and cause it to become unbalanced or to collapse.

Since the ecosystem within a jar is small, the plants and animals will be small. The first step in building an ecosystem is to start with abiotic or nonliving resources. Fill the jar with a layer of sand along the bottom and then with water as shown. The contents will need time to settle.

During this period, discuss the concept of MICROORGANISMS. An ORGANISM is a living thing. Many organisms are so small that they can be seen through a microscope. These are called MICROORGANISMS.

MICROORGANISMS are all around us. We just don't see them. Some are plants, some are plant eaters and some eat other microorganisms. These tiny creatures will be the life forms in our jars.

Some MICROORGANISMS can remain in a dormant (sleep-like) state until living conditions are right. Plants and animals have many microorganisms living right on them. Elodea leaves, being plants, have microorganisms living on them too. If we put elodea in water, then those creatures that like to live in water will "wake up" and live. Rain puddles and ponds are rich in these life forms. Or you might experiment by putting grass cuttings in a cup of water and let it stand in a warm place.

When the jars have settled, students may add several sprigs of elodea, 5 guppies and some snails to each jar. Close lids tightly.

Slowly, the microscopic animals will multiply. Most jars will attain the correct balance and remain sweet smelling and fairly clear indefinitely. Some jars will sour and the fish may die. This results from some imbalance. Usually it is due to an excess of nutrients from the soil and water. Be sure to check the water in a sour jar for microorganisms and use for the DECOMPOSER lesson before throwing away. If the water is clear, but a fish dies leave it in and watch what happens.

KEEP THE JARS (at least some of them) IN THE CLASSROOM FOR FUTURE LESSONS.

THE WATER CYCLE

MATERIALS: The jar ecosystem and a leaf or piece of a green plant.

PREPARATION: Place the ecosystem in a sunny location along with a leaf or plant part. Class time needed: 15-30 minutes (depending on amount of vocabulary drill).

Call the students attention to the water droplets that form on the glass above the water level in the jar ecosystem. Explain that the world we live in also has water that is evaporating and condensing.

ASK:

Will the jar ever run out of water?
No. It has a lid to hold it in. In the same way our earth will not run out of water because the upper atmosphere holds it in.

How did the drops get on the sides of the glass above the water line?
Liquid water was changed to vapor by the sun's energy. It EVAPORATED. Then it changed back into liquid when it touched the glass. It CONDENSED.

How does water we use get back to us?
Energy from the sun evaporates the water. When it reaches the cooler layers or air, it changes back into droplets of liquid (CONDENSATION). Masses of condensed vapor in the sky are called clouds. When there is more vapor than the air can hold at a given temperature, the droplets fall from the sky (PRECIPITATION). The water (rain, snow, hail, sleet..) will either RUN OFF or soak into the ground (PERCOLATION) or be absorbed by living things.

Now look at the leaf or piece of green plant that has been in the sun. What has happened? It has lost water and wilted or dried up. The sun has caused the water to evaporate from it. This is called TRANSPIRATION. Living plants also lose water through transpiration, but they do not wilt because they replenish their supply through their roots.

This unending series of changes that water goes through is called the WATER CYCLE. The same molecules of water are used over and over again. They are RECYCLED.

If necessary, review vocabulary words with a simple blackboard drawing. Distribute the worksheet "The Water Cycle" for follow up.

THE WATER CYCLE
(use a dictionary if necessary)

What is evaporation? Label the arrow that shows this process.
Evaporation is the changing of liquid water to water gas.

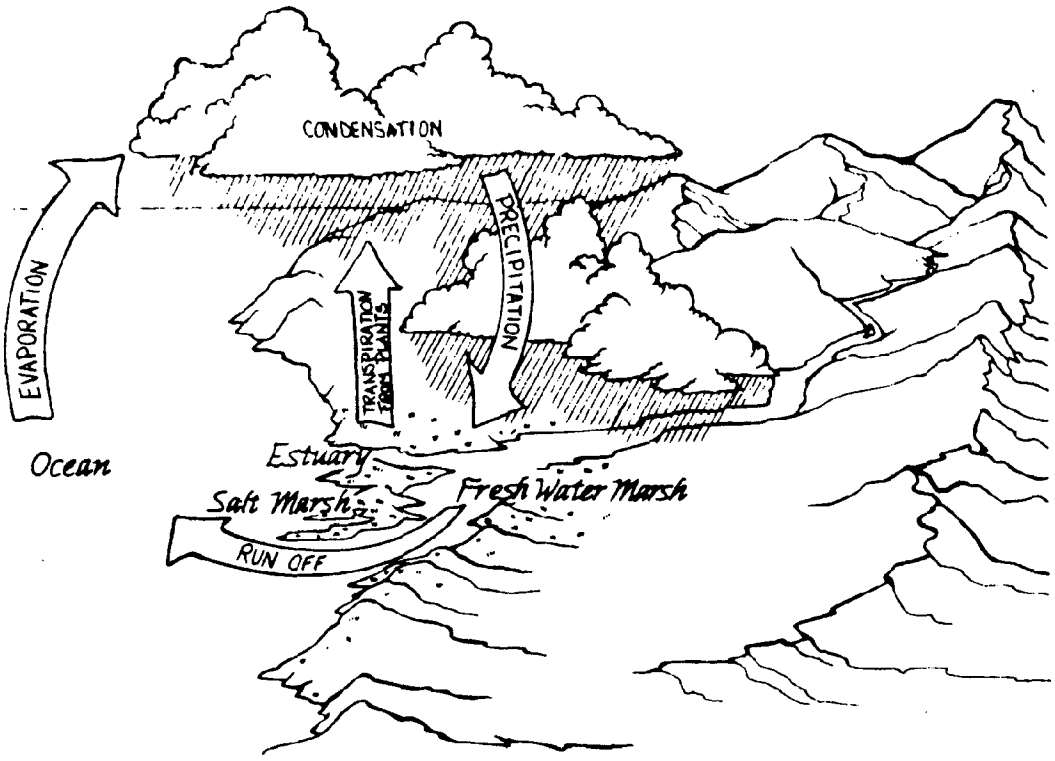
What is condensation? Label condensation in the atmosphere.
(clouds) Condensation is the process of changing water gas to liquid

Water returns to the land through precipitation. Label the arrow that shows this process and list some forms of precipitation.
Forms of precipitation are snow, sleet, hail, fog, dew and mist.

Water can seep into the ground or it can run off. Label the arrow that shows one thing water can do.
There are no arrows to show seepage or absorption. The only available choice is run off.

Water can return to the atmosphere from plants and animals. This process is called transpiration. Draw and label an arrow showing where this could be happening.
Arrow can be placed on any landform where plants can grow.

What is a cycle? How is the water cycle like a circular path?
The word cycle implies the changing from one form to another and then back to the original. Water continually changes from a liquid to a gas and back to a liquid again. The cycle removes fresh water from the sea and transports it to the land.



DECOMPOSERS

MATERIALS: The jar ecosystem, and paper arrows for a bulletin board as shown

PREPARATION: Correct the WATER CYCLE worksheets. Class time needed: 15 minutes

Ask the students what keeps the water cycle going?
The sun provides the energy.

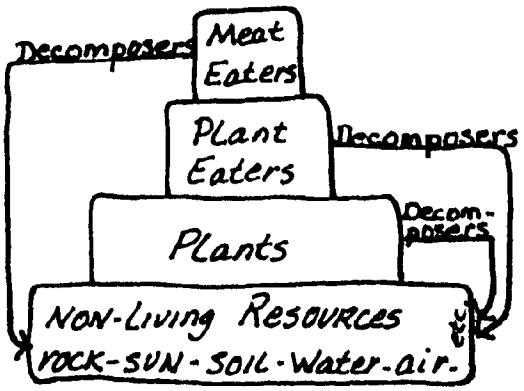
Look at the ecosystem. What happens when the plants and animals die? Do their bodies pollute the ecosystem? What does nature do with waste? Plants and animals are recycled much the same way as water. In this cycle, DECOMPOSERS do the work by breaking down wastes (dead things, or wastes from living things) into molecules that can be reused. Thus animal wastes are broken down into nutrients for soil.

Students can share examples of decomposition they have seen taking place (rotting leaves or plant clippings, decaying animals, molds on bread or fruit, worms or other insects in garbage). Though we often find these things unpleasant, the work being done is very important.

Decomposers in the jars, like the plants and animals, are MICROORGANISMS.

Add arrows to the bulletin board as shown to illustrate the way decomposers return all wastes to the non-living resources to be used again by living things.

The DECOMPOSERS keep the system in operation by recycling matter just as the sun recycles the water.



Give the students time to name the DECOMPOSERS they can think of, e.g. bacteria and fungi. Some may become confused with SCAVENGERS, which eat dead plants and animals. True DECOMPOSERS break waste down into the elemental parts, returning them to non-living resources.

COASTAL WETLAND HABITATS

MATERIALS: Posters of plants, birds and fish of the wetlands. Class time needed: 15 minutes + follow-up 15 minutes = 30 minutes

INFORMATION --- WETLANDS are areas that are flooded or soaked by water so much of the time that the water determines the types of plants and animals that live there. These areas may be called FRESH WATER MARSHES, SALT WATER MARSHES, MUD FLATS or ESTUARIES, depending on the water conditions.

FRESH WATER MARSHES are characterized by fresh water.

SALT MARSHES are characterized by periodic flooding by salt water during the tides.

MUD FLATS lack large plants and are covered by the tides for long periods twice each day.

ESTUARIES are places where fresh water from the land flows into the salty sea water of the bay.

EACH OF THESE IS A HABITAT A PLACE WHERE ORGANISMS LIVE

COASTAL WETLAND HABITATS include all of these habitats. They are extraordinary natural systems in which moving water redistributes nutrients and provides a rich place for organisms to live and grow. Some nutrients are washed out to sea and help marine organisms grow.

Introduce the posters. Show the rich variety of life forms there. Point out that just as the life in the jars may not be obvious at a glance, so the richness and life of the coastal wetlands may not be obvious at a glance.

Introduce the vocabulary: FRESH WATER MARSH, SALT MARSH, and MUD FLAT. Locate each on the plant and bird posters.

PLANT POSTER

The MUD FLAT habitat is pictured in the lower-left corner of the poster. The great blue heron and the shoveler duck are on the mud flat. A close-up of mud flat shells and algae is at the bottom-left margin of the poster.

The SALT MARSH is represented by the vegetation near the water. Looking to the right of the water, a banding effect can be observed. From the water to the right, the vegetation would be cordgrass, pickleweed, and salt grass. All of the lowland vegetation to the left of the main channel is also salt marsh.

FRESH WATER MARSH is represented by the band of vegetation which is growing progressively taller to the right of the water. The cattails grow taller as they are further removed from the salt influence. Finally, the willows replace the cattails. Sedges make the transition from fresh to salt marsh habitat.

BIRD POSTER

The MUD FLAT habitat is pictured in the lower foreground of the poster. The willet, long-billed curlew, marbled godwit, western sandpipers, dunlins and dowitchers are all pictured on the mud flat.

The SALT MARSH habitat is represented by the island which contains the great blue heron and the egrets. Another small bit of salt marsh is shown in the lower-right corner of the poster. The clapper rail is shown walking out of some cordgrass and Belding's savannah sparrow is singing from its pickleweed perch.

The FRESH WATER MARSH is at the left center of the poster. The red-winged blackbird, black phoebe and marsh wren are all pictured in the fresh water marsh.

FISH POSTER

The ESTUARY habitat is the dominant habitat type on the fish poster. An estuary is a place where fresh water from a stream enters a salt water bay. The fish poster shows many of the organisms found in the estuary.

Answer Key

COASTAL WETLAND HABITATS

Coastal wetland habitats are very special. There are many different kinds of plants and animals living together in the wetlands. Some organisms can survive ONLY in the coastal wetlands. Coastal wetlands produce ten times more than our most fertile farmland and twenty times more than the ocean. Many birds, fish, and animals live in the wetlands and many others find food and shelter there when they migrate to the wetlands.

Wetlands control flooding of the land around them. They recycle waste products and reduce the effects of pollution. Some wetlands are a natural source of peat and sphagnum which are used in our gardens and may produce a hay that can feed cattle.

Many people enjoy visiting the wetlands to see the plants and animals and to enjoy the peace and beauty. Others enjoy water sports or fishing there. Sometimes factories, homes or marinas are built on coastal wetlands. Other times, they are used for farming or transportation.

Most human uses of wetland areas spoil them for the wildlife that would have used them. Many rare and endangered species can live ONLY in such places. In California, seven out of ten acres of wetlands have been put to use by humans. The few coastal wetland areas that remain unspoiled are very important.

Not too many years ago people thought wetlands were useless. Now people are beginning to see their importance. Laws have been passed to protect some coastal habitats so that the fish and birds can be safe. In many places, though, it is impossible to protect the marshes from pollution because of the buildings and farms that surround them. Laws are needed to help restore the marshes in addition to protecting them.

1. What is special about coastal wetlands?
   Coastal wetlands are very productive. They are home for a large variety of wildlife, including fish and birds.

2. How do wetlands help mankind?
   Wetlands help control flooding and purify the water. They provide food and recreation for people.

3. Why would people think that marshlands are useless? (Think for yourself)
   Many of the benefits of the wetlands are not observed directly by humans. We must know their value to care.

4. Out of every ten acres of wetlands, how many have been changed? How many are left?
   7 of 10 have been changed. 3 of 10 are left.

5. What kinds of laws are needed to protect the coastal wetlands?
   Strong laws which will protect them from destruction.

A RICH ENVIRONMENT

MATERIALS: Worksheet, A RICH ENVIRONMENT. Class time needed: 15 minutes

Ask students to list the things a farmer has to do to have a productive farm. List on the board: plow, plant, fertilize, irrigate, harvest...

ASK:

Where does the farmer get his energy?
He eats food that keeps his body strong. He uses machines that burn gasoline or oil.

Can he get all the energy he needs from his own farm?
He may be able to get his food, but usually he has to buy fuel for the machines, in addition to manufactured parts and personal goods.

Explain that the coastal wetlands have a natural "farmer" who does all the work. Let the students guess what the natural "farmer" is and write their guess on a slip of paper to be passed in.

Distribute worksheet - A RICH ENVIRONMENT

Those who guessed TIDES are honor students for the day (appropriate reward).

A RICH ENVIRONMENT

Coastal wetlands are as rich in plant life as the tropical jungles. Fresh water flows into coastal wetlands from inland areas, bringing minerals from rocks and other natural fertilizers. Tides wash into coastal wetlands, bringing nutrients from the sea, washing waste products from some animals to feed others, and carrying away pollutants. Unlike fresh water sources which may stop in dry times, tides wash the wetlands twice a day.

Farmers have to fertilize and care for their land with tractors or other machines. These machines use energy sources that are running out. Tides fertilize and care for the wetlands with their own energy. Will the tides' energy run out?

The water sources make the wetlands a most rich environment.

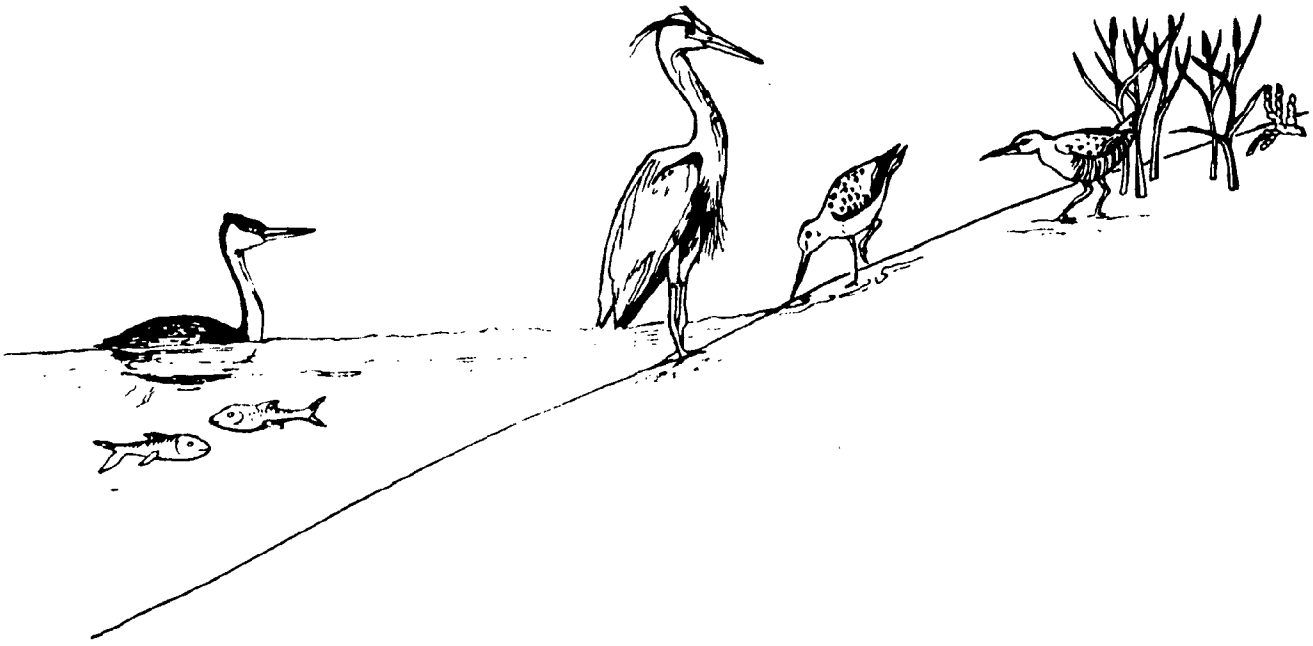
1. What makes the coastal wetlands able to support so much life?
   Nutrients enter the wetlands from the land, and tides move nutrients around and help plants and animals grow.

2. How do tides help the wetlands?
   Tides move waste from one organism to another which uses it for food. Tides help remove some pollutants.

3. How often do tides come to the wetlands?
   Each day there are two high tides and two low tides.

4. Does the same amount of fresh water enter the wetland all year long?
   Usually there is a greater amount of fresh water entering the wetland during the winter rains.

EXTRA CREDIT: Find out where the tides get their energy.



MARSH HABITATS

MATERIALS: MARSH HABITATS picture and the worksheet MARSH HABITATS. Class time needed: 10 minutes instruction + 10 minutes for the worksheet = 20 minutes.

EXPLAIN: We can't really see what soil and water conditions are like so we look at the plants. When we know the habitats of the plants, we can infer what the soil and water conditions are like.

Show the students a picture of a desert.

ASK:

What are the plants telling us about the soil and water conditions here?
There is dry, rocky soil which contains very little water.

How did the plants tell us this information?
We know that these plants grow in the desert, where there is very little moisture and the soil is sandy with many rocks.

Show the picture MARSH HABITATS. (It may be helpful to project a transparency.)

These are plants of the WETLANDS. Tell the students the habitats of these plants and let them tell you the soil and water conditions that they require to grow.

Cattails need soil saturated with fresh water and often grow out of standing water.

Saltgrass can grow in soil that has a fair amount of salt. It does not grow in standing water.

Pickleweed can tolerate salt and being covered for short periods of time by the tides.

Cordgrass can tolerate salt and being covered by the tides for long periods of time.

Knowing the habitats of these plants tells us the growing requirements for other plants that live with them.

Students may use their vocabulary words to fill in:
The cattail lives in the .. FRESH MARSH .... Saltgrass and pickleweed are found in the .. SALT MARSH .... Which plant lives nearest to the ocean water? .. CORDGRASS ....

EXPLAIN: In a desert, the environment may be the same for miles. In the coastal wetlands, however, the environment may change within a few feet, for there are many different environments in the coastal wetlands.

Distribute the MARSH HABITATS worksheet.

Answer Key

MARSH HABITATS

There are many different environments in a marsh. Some places are as salty as the sea. Other places may be saltier. Some places may have brackish or slightly salty soil and water. In still other places, the water won't be salty at all. When we know the habitats of the marsh plants, we can look across the marsh and know what the soil and water conditions are like. THINK FOR YOURSELF TO ANSWER THESE QUESTIONS.

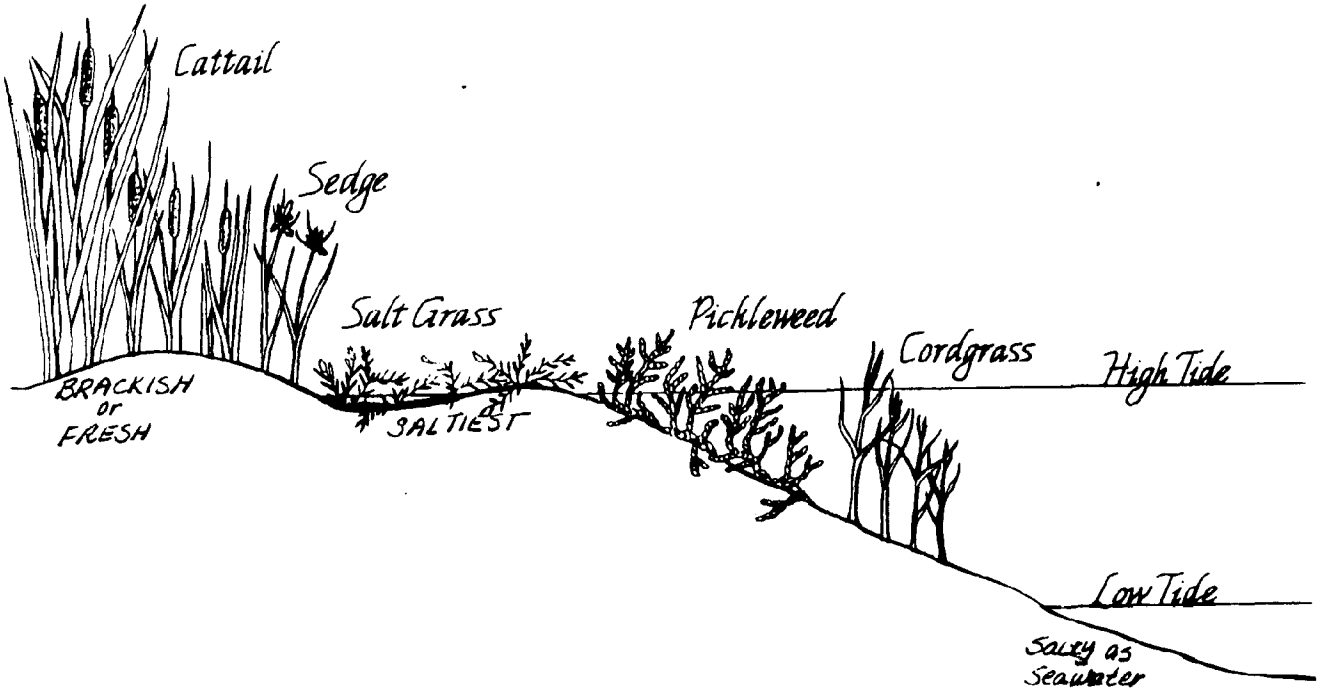
1. Where would soil and water be just like the sea?
   Conditions most like the sea would be found where the tidal waters wash across the habitat.

2. Where could soil and water be saltier than the sea? What could be the reason?
   Saltier conditions could be found where sea water is left in hollows during very high tides. As the water evaporates, the salt is left behind.

3. What would make the marsh the least salty? What time of year would this probably happen? (What season?)
   Rain or fresh water from springs or rivers would make the marsh less salty. The most fresh water normally enters the wetlands of Southern California during the winter rains.

4. How can the plants tell us what soil and water conditions are like?
   When we know what conditions are necessary for a plant to grow, then finding that plant tells us about the soil and water conditions.

Label the picture below with the words SALTIEST, SALTY AS SEAWATER, BRACKISH or FRESH.



LIFE OF THE MUDFLATS

MATERIALS: Illustrations of algae and diatoms (found behind this page)

PREPARATION: Remove illustrations and mount if desired. Class time needed: 10 minutes instruction + 10 minutes for the worksheet = 20 minutes.

Show the illustrations. Some students may have similar microorganisms in their ecosystems. Share the names of the microorganisms and the information on the illustrations. Remind the students that these are microscopic enlargements.

Distribute the LIFE OF THE MUDFLATS worksheet.

Food for a probing bird (Dowitcher) would include the striped shore crab, ghost shrimp and segmented worm. The bird with the upturned beak (Avocet) would eat crustaceans and other small organisms from the surface of the mud. The duck (Shoveler) strains diatoms, other algae such as Entromorpha, and sea lettuce and crustaceans from the surface of the mud.

Answer Key

LIFE OF THE MUDFLATS

Some regions of the wetlands are covered by water only at high tide. During low tide, they may be mudflats. Algae, a simple plant, and some tiny crab-like creatures live on the surface of the mud. Worms, clams and shrimplike animals live in the mud. All of these animals and plants are important food for birds. The organisms are all quite small and some of them cannot be seen without a microscope.

One very important creature of the mudflats is the diatom. This is a small plant that swims around like an animal. It has a glass shell around it and a drop of oil in its body. It doesn't sound very much like other plants we know, does it? Perhaps it should be thought of as an animal. Why do you think it is thought of as a plant?

Small animals and plants that are moved by the tides are called plankton. The tide brings them to the mudflats where they become food for the clams and worms.

Fill in the blanks with the words ALGAE, DIATOMS, CRABS, and WORMS. You may use more than one word in some blanks.

DIATOMS.....glass shell

ALGAE, DIATOMS.....simple plant

(ALL FOUR).....lives where tides almost always reach

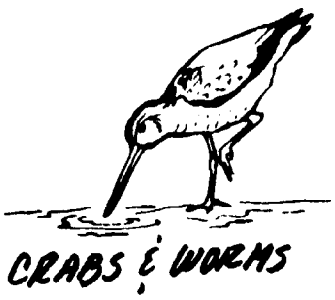
DIATOMS.....a swimming plant

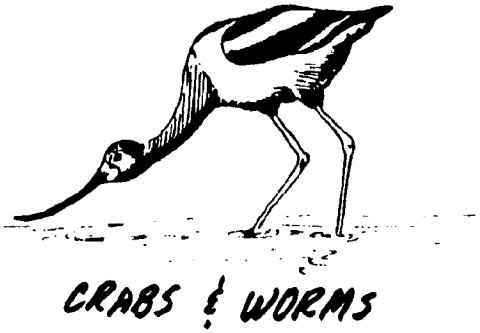
ALGAE, DIATOMS, CRABS.....food for birds

DIATOMS, SOME ALGAE AND SOME WORMS.....seen best with a microscope

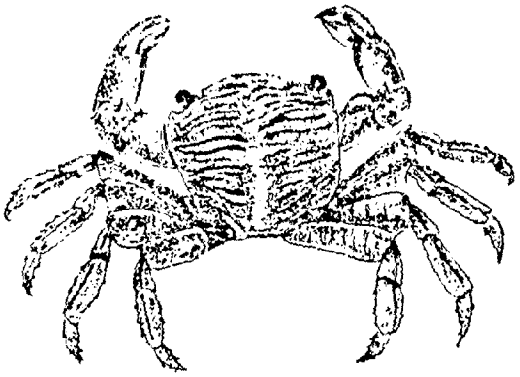
DIATOMS AND ALGAE.....food for crabs and worms

Next to each picture write the kind of food you think that bird would eat. Look at the pictures of MUDFLAT LIFE.

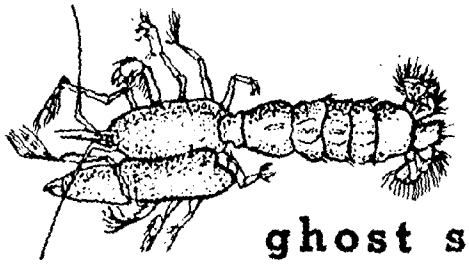




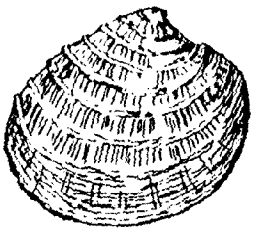
MUDFLAT LIFE



striped shore crab

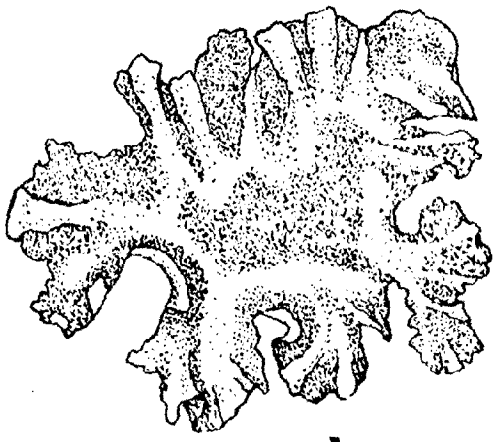


ghost shrimp



smooth cockle

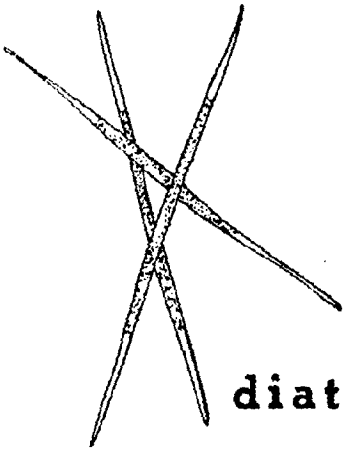
entromorpha



sea lettuce

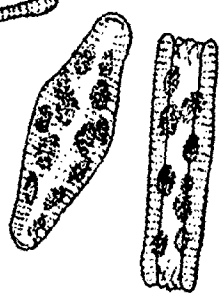
crustacean

segmented worm



diatoms

diatoms



diatoms

PLANTS OF THE SALT MARSH

MATERIALS: Salt Marsh Plants of California poster, and the worksheet PLANTS OF THE SALT MARSH

PREPARATION: Pre-read background information and worksheet. Class time needed: 10 minutes discussion + 15 minutes worksheet time = 25 minutes.

Because the ocean tides wash the salt marsh twice daily, the habitat is quite salty. Plants that can grow in this salty environment are called halophytes. Most halophytes would grow better in fresh water conditions, if they were not out competed there by other plants. As a result, the plants of the salt marsh are being forced into the sea by competition from other plants. Tides set a limit on how far the plants can grown into the sea. The result is a very narrow band of vegetation which is "caught" between the land and the sea.

The plants of the salt marsh help the marsh grow in size by causing silt and debris to settle between the plants. This raises the bottom of the marsh and allows the plants to grow further into the sea.

Suggestions:

Have the students look at the Salt Marsh Plants of California poster. Notice the three bands of vegetation from the water towards the land. These are the plants of the salt marsh. Explain that the band of vegetation closest to the water is cordgrass. The middle band is pickleweed, and the upper band is salt grass.

PLANTS OF THE SALT MARSH

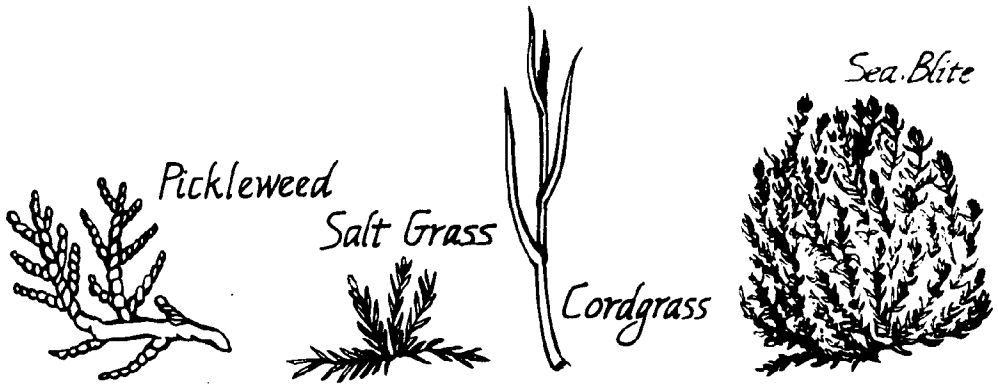
Most plants die if the soil and water are salty, but halophytes are plants that can survive the salt. Halophytes grow best and sprout their seeds when there is no salt in the soil or water. But other plants that grow in fresh water crowd the halophytes out. For this reason, we find halophytes in the salt marsh.

Cordgrass, a halophyte, is usually found at the edge of the mudflats where the soil is wettest. Cordgrass gets rid of extra salt through small openings in its leaves. On sunny days, the leaves sparkle with the crust of this extra salt. Most plants will die if they are covered with water for many hours each day, but cordgrass has special air canals in its stem. This allows the plant to breathe even when there is no oxygen in the soil. The air flows down to the roots and some leaks out. This oxygen-rich layer around the roots provides a home for many tiny organisms which spend their whole life in that tiny space.

Cordgrass make the marsh grow bigger by trapping mud and debris until there is enough soil to support more plants. When parts of cordgrass die, small animals eat the pieces that have dropped off. Cordgrass helps to feed some of the tiny creatures of the mudflats.

Pickleweed grows where it is not quite as wet. This plant looks like a bunch of pickles strung together. Pickleweed cannot stand to be underwater as long as cordgrass, but it can be underwater sometimes. Pickleweed can move the salt into its outermost stems. When the stems can hold no more, that part of the plant breaks off.

Halophytes that grow where the highest tides come are Salt Grass and Sea Blite. When pieces of these plants break off, they become food for tiny organisms in the mud.



1. What is a halophyte?
   A halophyte is a plant that can grow in salty soil. Most plants of the salt marsh are halophytes.

2. Where can cordgrass be found?
   Cordgrass is usually found in the lowest part of the salt marsh where the soil is covered twice a day by the tides. Cordgrass is a halophyte.

3. Most plants die if they are covered by water many hours each day. What allows cordgrass to survive this?
   Cordgrass has tiny tubes that run from the leaves to the roots. Oxygen gas travels through the tubes to the roots and carbon dioxide travels up the tubes from the roots.

4. How does cordgrass provide homes for other organisms?
   Some oxygen leaks out of the roots and provides oxygen to the mud. Some organisms live very close to the roots all their lives. Cordgrass is also used by birds.

5. How does cordgrass increase the size of the marsh?
   Cordgrass traps mud and debris and causes the land to rise. As the height increases the cordgrass grows further out, increasing the size of the marsh.

6. What organisms use cordgrass for food?
   Bacteria, fungi and crabs are some of the organisms that use cordgrass for food.

7. What does pickleweed look like?
   It looks like a string of tiny pickles.

8. Could pickleweed and cordgrass grow together?
   Yes. Both can withstand salt and some immersion in water. In many parts of the marsh they do grow together, but usually there is more cordgrass in the lower marsh.

9. How do halophytes protect themselves from too much salt?
   Most halophytes have salt glands that pump salt out of the plant onto the surface of the leaves. Pickleweed concentrates the salt in the tip of its stem and then breaks off.

THINK FOR YOURSELF:

1. Why are halophytes commonly found in salt marshes?
   Because they can withstand the salt in the soil and water. Other plants cannot.

2. Why wouldn't pickleweed and cordgrass grow at the beach near the tidepools?
   The force of the waves would break and destroy these plants, and the rocks would not provide good soil for them to grow.

THE FRESH WATER MARSH

MATERIALS: Plant Study Cards. Class time needed: 15 minutes instruction + 15 minutes worksheet time = 30 minutes

Use plant cards (see appendix) to share information about:

cattails
mulefat
black willow
arroyo willow

(Quiz and review until plants are familiar.)

Review the halophytes with plant cards if necessary.

Distribute THE FRESH WATER MARSH worksheets.

THE FRESH WATER MARSH

Plants of the fresh water marsh grow best when their roots are in or near fresh water. They do not tolerate salt like the halophytes, but some of them have air canals in the stem like cordgrass and can be covered by water for long periods at a time.

Marsh plants may be tiny as the dainty brass button flowers, delicate as the watercress, or as tall as the willow. Most of them have seeds that are carried by the breeze.

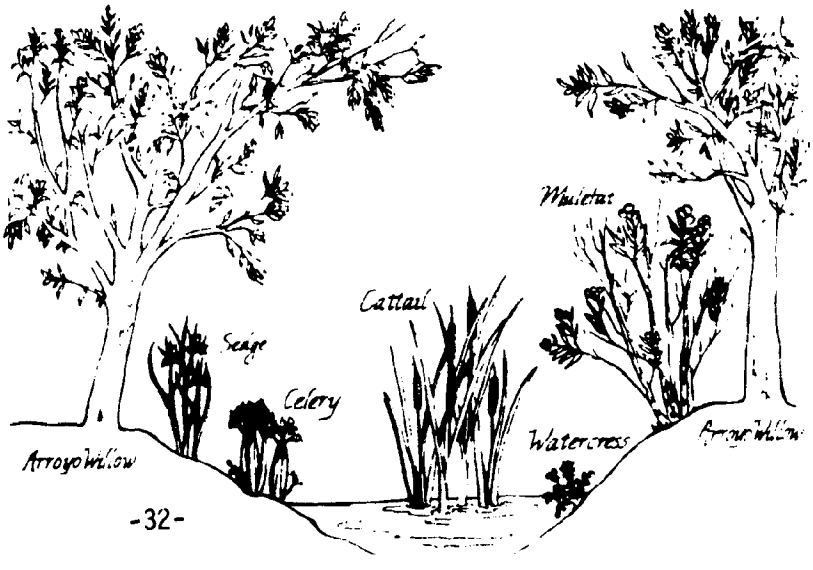
Many marsh plants are useful to humans. Indians used the cattail flower heads for food and the leaves for baskets and mats. They boiled the root like a potato. The willow was boiled and used as medicine like aspirin. Watercress and wild celery are good to eat.

Triangular stemmed sedges grow at the edge of the marsh in slightly drier places than the cattails. They can withstand more salt in the water as well. Mulefat and willow grow on higher ground and send their roots down to the water supply.

Mulefat is a tall, bushy plant with slender leaves. The early settlers noticed that their mules' stomachs swelled after eating this plant so they gave it its name. Two types of mulefat grow close together. The one with soft, fluffy flower parts is the male plant and the one with sticky flowers is the female. Gentle air currents caused by the cooling effect of the water help distribute the seeds, but mulefat can also grow new plants from pieces of broken stems that fall to the ground.

The arroyo willow is taller than mulefat with bigger, fatter smooth leaves. The arroyo willow is a home for many kinds of wasps. They lay their eggs in the leaves or stems of the willow. The willow then grows a protective coat or swelling around the egg. The swelling is called a gall. Different kinds of wasps make difference galls. Some are on the leaves, some on the stems and some in the buds at the ends of the stem. When the new wasps eat their way out, many different birds will have a feast.

The black willow is the tallest plant in the fresh water marsh. It has long, slender leaves that curve slightly sideways. In spring the flowers look like caterpillars. In summer they are fluffy.



THE FRESH WATER MARSH

1. What do plants of the fresh water marsh have in common with the halophytes?

   They commonly grow with their roots in water.

2. How did mulefat get its name? Tell one other interesting fact about it.

   The story is that the Spaniards' mules looked fat after eating it. Male flowers are on one plant and female flowers on another.

3. What creatures do the arroyo willow help? Explain what it does.

   Wasps use the stems and leaves for their young to develop (galls). Many birds make their nests in the willow. Also some birds eat the wasps.

4. Write the names of the plants that would grow in each of the following habitats.

   A POOL OF RAINWATER....celery, watercress, cattails, sedges.....
   A HIGH BANK AROUND THE POOL....mulefat, black and arroyo willow.....
   THE DAMP EDGE OF THE POOL....sedges and cattails.....
   SLIGHTLY SALTY WATER (brackish)....sedges.....

5. What is the tallest plant in the fresh water marsh? Tell one fact about it.

   The black willow. It has long curving leaves and flowers that look like caterpillars.

6. How do many marsh plants disperse their seeds?

   Their seeds are carried by the wind. Water cools the air and causes gentle breezes which carry the seeds.

7. What can be found on the arroyo willow that looks like a swelling? Explain.

   Wasp galls in the terminal stem buds take a form that somewhat resembles a rose.

THE FOOD WEB

MATERIALS: Worksheet, THE FOOD WEB, paper and crayons for making food chains. Class time needed: 20 minutes instruction and activity + 15 minutes for the worksheet = 35 minutes.

The food web is a concept that helps children understand the interrelated nature of all ecosystems. The food web is easier to understand by developing a number of concepts and putting them together.

FACTS:

1. Energy flows through the ecosystem.

2. The sun is the energy source for all living things.

3. Only plants can convert the energy from the sun into energy in living organisms.

4. Plants store the energy from the sun in materials in the form of sugars, fats and protein.

5. Animals eat plants or other animals which provide energy to live and materials to make new tissue and repair old tissue.

6. The flow of energy from the sun through a plant and some animals is called a food chain.

7. All plants and animals die. Decomposers (bacteria and fungi) breakdown the dead organisms and change these materials into basic elements. Plants use the energy from the sun to reuse these elements to make new plant tissue.

8. Energy can only be used once and must continue to reach the earth from the sun. Materials cycle. They are used over and over again.

9. Plants are eaten by many kinds of animals and each animal, in turn, may eat or may be eaten by many other kinds of animals. This complex series of food chains is called a food web.

CLASS ACTIVITY:

Have the students make pictures which show the following food chains. They may need to use pictures from other worksheets in the packet. (The arrow points to the organism that is doing the eating.)

FLOATING PLANTS (diatoms, other algae) ——— FILTER FEEDERS (clams) ——— BIRDS

NOTE: Filter feeders gather their food by pumping water through a net-like structure and filtering their food out of the water. They include clams and some worms.

FLOATING PLANTS _____ CRABS _____ BIRDS

BOTTOM DWELLING PLANTS _____ WORMS _____ FISH _____ BIRDS

BOTTOM DWELLING PLANTS _____ CRABS _____ BIRDS _____

DEAD PLANTS _____ BACTERIA _____ FILTER FEEDERS _____ BIRDS
AND ANIMALS

After the students have made their food chains help them learn facts about food chains. (Energy flow and material cycling.)

Hand out THE FOOD WEB worksheet.

THE FOOD WEB

Marsh plants take energy from the sun and change it into food. A few animals eat the plants as they grow, but most of the plant material drops off into the water where it is eaten by bacteria and other microscopic organisms called DECOMPOSERS. The decomposers are then eaten by crabs, snails, worms, insects and clams. Birds and other animals may eat these creatures. Waste products from all of the animals fertilize the plants.

1. What is the energy source of the food web? (YELLOW) SUN

2. What can change the sun's energy into food? (GREEN) PLANTS

3. Which animals break down plant materials? (BROWN) DECOMPOSERS

4. What are decomposers? BACTERIA AND FUNGI THAT CONVERT LIVING TISSUE INTO PLANT NUTRIENTS.

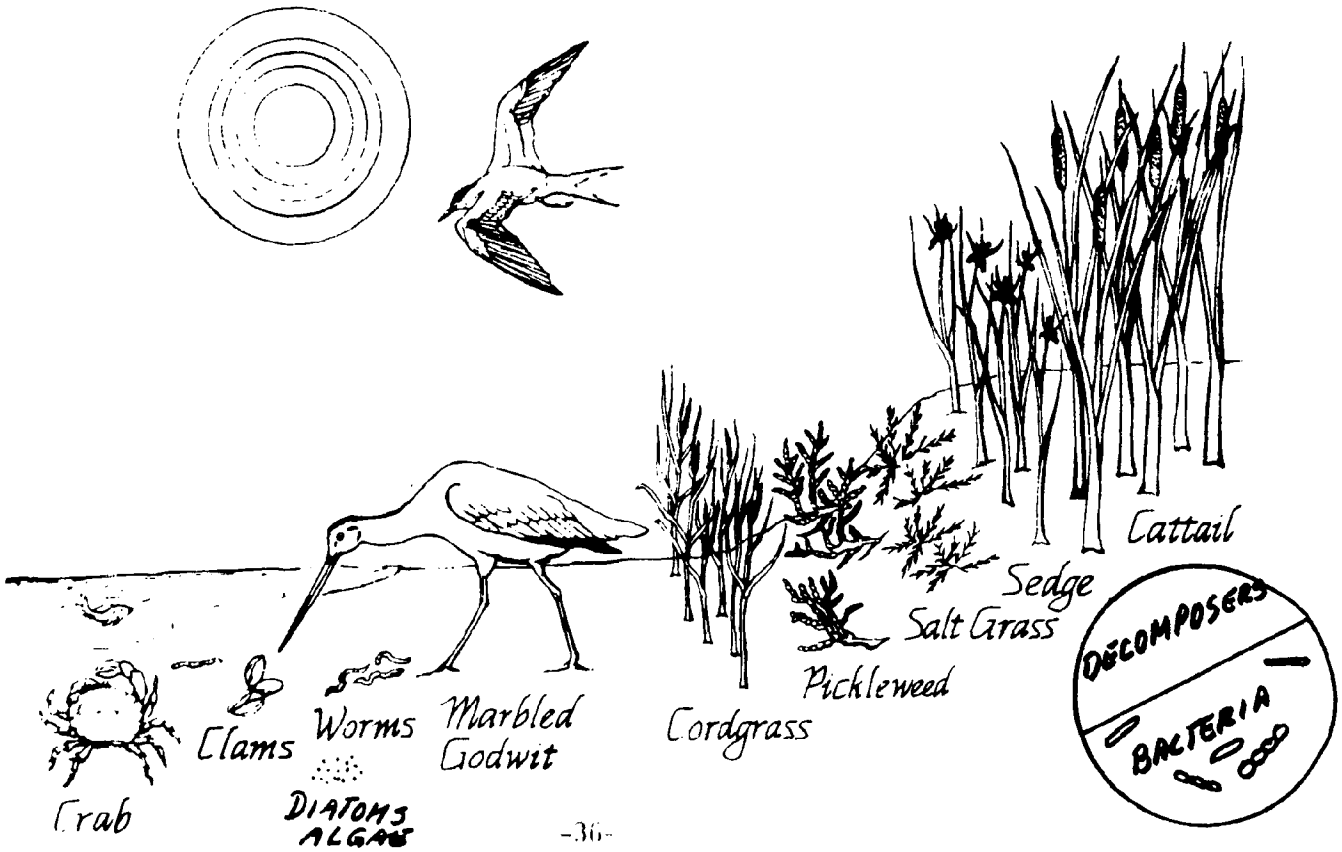
5. Where are the decomposers? DECOMPOSERS ARE FOUND IN THE MUD ZONE.

6. What eats decomposers? FILTER FEEDING CLAMS, WORMS, AND SOME CRABS.

7. What fertilizes the plants? THE NUTRIENTS RELEASED BY THE DECOMPOSERS.

8. Which part of the food web do you think is most important? Tell why.
   A FUNCTIONING SYSTEM IS IMPORTANT, PLANTS ARE NECESSARY.

COLOR THE DRAWING AND DRAW ARROWS IN RED TO SHOW THE FOOD WEB. (NOTE COLORS IN PARENTHESES () NEXT TO THE STUDY QUESTIONS.)



BIRD BEAKS AND FEET

Birds that live in and around wetlands gather their food many different ways. They also look for their food in different ways and in different places. Some birds live in the water and swim to search for food. Others look for food by walking across the soft mud. Many birds find their food in trees and bushes. A few birds look for their food by flying over the land, wetlands, or water. Each of these birds have feet that help them gather food.

Use the BEAKS AND FEET study sheet to do the following activities.

1. Find the foot that would be good for swimming. Color it blue. Write the word SWIMMING next to the foot.

2. Find the foot that would be good for catching animals like rabbits and squirrels. Color it brown. Write GRASPING next to the foot.

3. Mud can be soft. Find the foot that has long toes that would hold a bird up on the mud. Color it yellow. Write the words LONG TOES next to the foot.

4. Find the foot that would be good for holding onto branches. Color it black. Write the word PERCHING next to the foot.

Beaks are also important for gathering food. Your BEAKS AND FEET study sheet shows beaks which are used to gather food in a number of different ways. Birds which catch flying insects have a short pointed beak. Hairlike bristles are often found at the corners of the beak. Long pointed beaks are used to spear fish and frogs. Long thin beaks of shorebirds are used to probe the mud for worms and clams. Hawks and eagles have short hooked beaks for tearing flesh. Birds which dive under water to catch food have longer beaks with a small hook on the end for catching fish. Seed-eating birds have short heavy beaks for crushing seeds. Duck beaks are flat and are used for straining water. The avocet has an upturned beak that is used to filter tiny creatures from the surface of the mud.

Use the BEAKS AND FEET worksheet to do the following activities.

1. Write the word PROBING under the beak that would be used to probe the mud for worms and clams.

2. Circle the beak that would be used to catch flying insects. Write the word FLYCATCHER next to the beak.

3. Find the beak of the seed eater. Color it brown. Write the words SEED EATER under the beak.

4. Find the duck beak. Color it blue. Write the words WATER STRAINER under the beak.

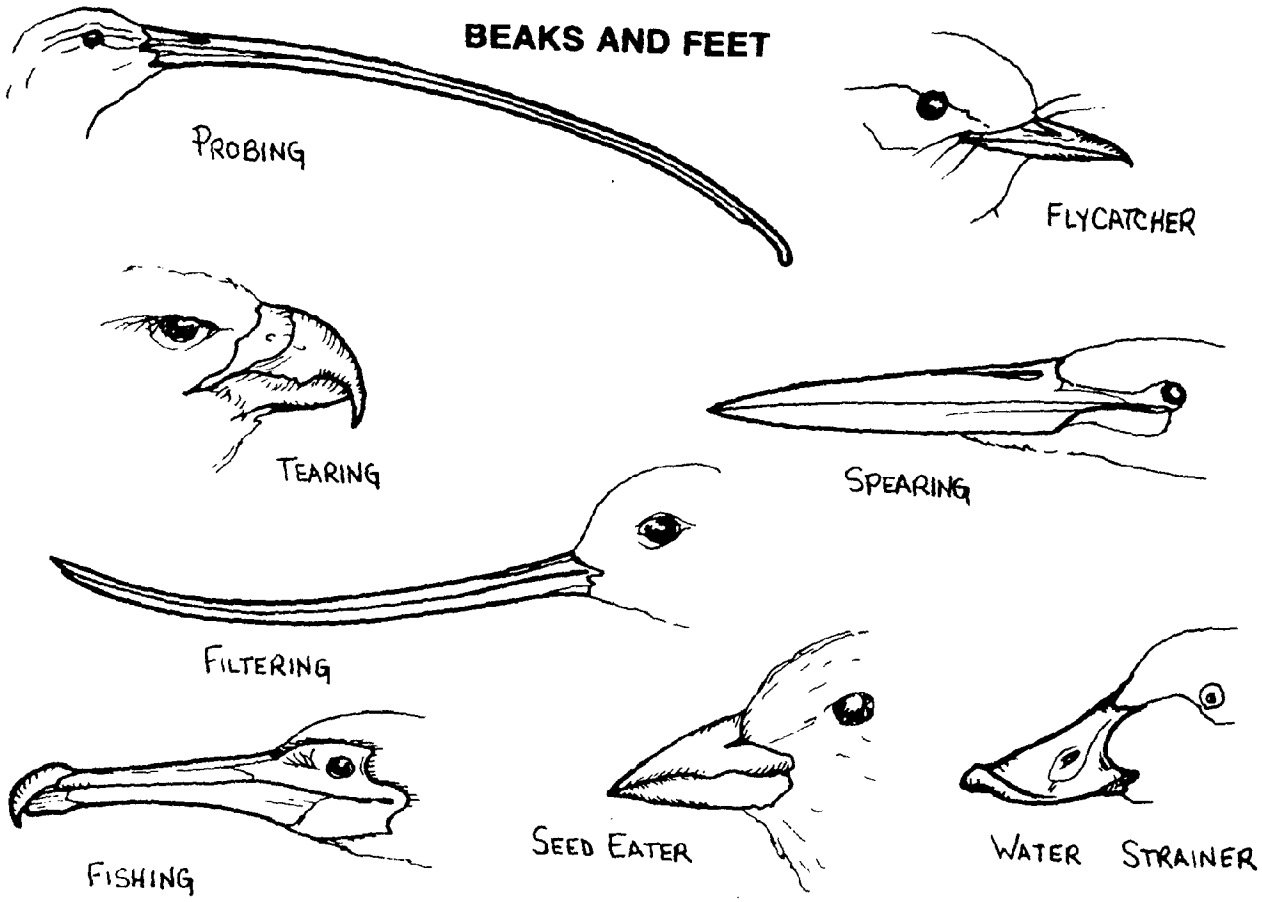
5. Find the beak that is used to spear fish. Color it yellow. Write the word SPEARING under the beak.

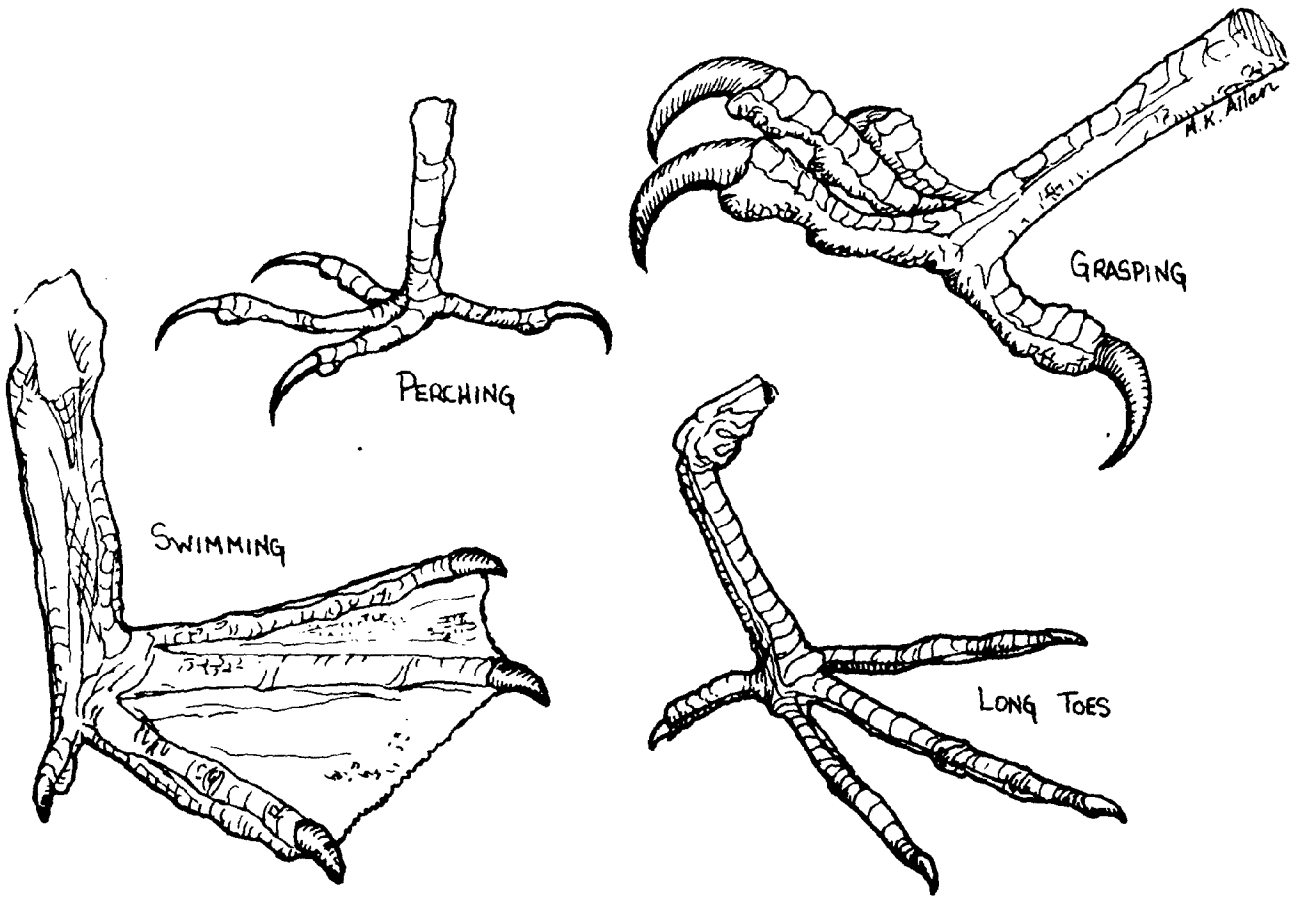
6. Find the beak of the avocet. Color it green. Write the word FILTERING under the beak.

7. Find the beak that is used to tear flesh. Color it red. Write the word TEARING under the beak.

8. Find the beak that is used to catch fish. Color it orange. Write the word FISHING under the beak.

BEAKS AND FEET





POLLUTION IN THE WETLANDS

MATERIALS: Worksheet POLLUTION IN THE WETLANDS. Class time needed: 10 minutes for the worksheet + 15 minutes for follow-up discussion = 25 minutes.

Pass out the worksheets.

Discuss the answers to the questions on the worksheet. Help the children understand that pollution not only harms the wetlands and the organisms that live there, but is harmful to all living things.

Have the students make a list of how they can help reduce pollution.

POLLUTION IN THE WETLANDS

The Coastal Wetlands are an important home for many different kinds of birds and fish. In Southern California, little of the original wetlands remain. Many have been destroyed by putting buildings where the animals used to live. Some wetlands have been set aside as a refuge for wildlife. We would think the animals and plants would be safe in a refuge, but we are finding that many of them are in danger. Many plants and animals are dying of POLLUTION.

There are many kinds of pollution which are harmful to the wetlands. Human sewage and animal waste can cause unusual growth in the plants of the wetlands, and the natural balance can be upset. Heavy metals are poisons that are harmful to the creatures of the wetlands. Some heavy metals come from the gasoline that some cars and trucks burn. Others come from paints and factories.

One of the most serious pollutants in Southern California is the soil and debris that wash into the wetland from the land. Often the natural plants are removed from the land when people build new houses. Then when it rains, the fine soil is washed from the land into rivers and into the wetland. The washing of soil from the land is called EROSION. When the soil is very fine it is called SILT. Silt buries the living creatures of the wetlands and they die. Sometimes the silt comes from farm fields. It too is harmful to the life in the wetland.

If the wetlands and the plants and animals that live there are going to be healthy and not be destroyed, humans must be much more careful with pollutants.

1. Name three kinds of pollutants that are harmful to the living creatures of the coastal wetlands.
   Sewage, heavy metals and silt.

2. How do you think farmers and building could do their jobs without causing silt to flow into the wetlands?
   By using careful farming and building practices. They could build small ridges around their fields and the construction sites to keep the water and the silt from entering the rivers and the wetlands.

3. Where have you seen erosion taking place? Where do you think the soil went when it was washed away?
   Each child may have a different answer. This is a good time to help them become aware of soil erosion and the fact that it not only harms the farmland but can harm other ecosystems as well.

4. Can you think of any other kinds of pollutants that could be harmful to the wetlands?
   Trash, pesticides, oil, hot water, etc.

ZONES OF THE COASTAL WETLANDS

MATERIALS: Worksheet, ZONES OF THE COASTAL WETLANDS and the picture of ZONES OF THE COASTAL WETLANDS. Class time needed: 10 minutes for the worksheet + 10 minutes for discussion = 20 minutes

Have the students do the worksheet. Then discuss their results. Use this discussion to prepare the students for their field trip to the wetlands. Students should be looking for organisms in the different zones of the wetlands. Upon their return to the classroom, students should do the WETLANDS SORT as a follow-up. Students can also do the SORT in the field.

Answer Key

ZONES OF THE COASTAL WETLANDS

Answer each of the following questions with the words SUBTIDAL, INTERTIDAL, or SUPRATIDAL.

1. In which tidal range is the salt marsh found?
   INTERTIDAL

2. In which tidal range is the marine zone found?
   SUBTIDAL

3. In which tidal range is the fresh water marsh found?
   SUPRATIDAL

Do the following activities on your ZONES OF THE COASTAL WETLANDS picture.

4. Color the water of the fresh water marsh blue.

5. Color the water of the marine zone green.

6. Draw a red arrow to the high tide line.

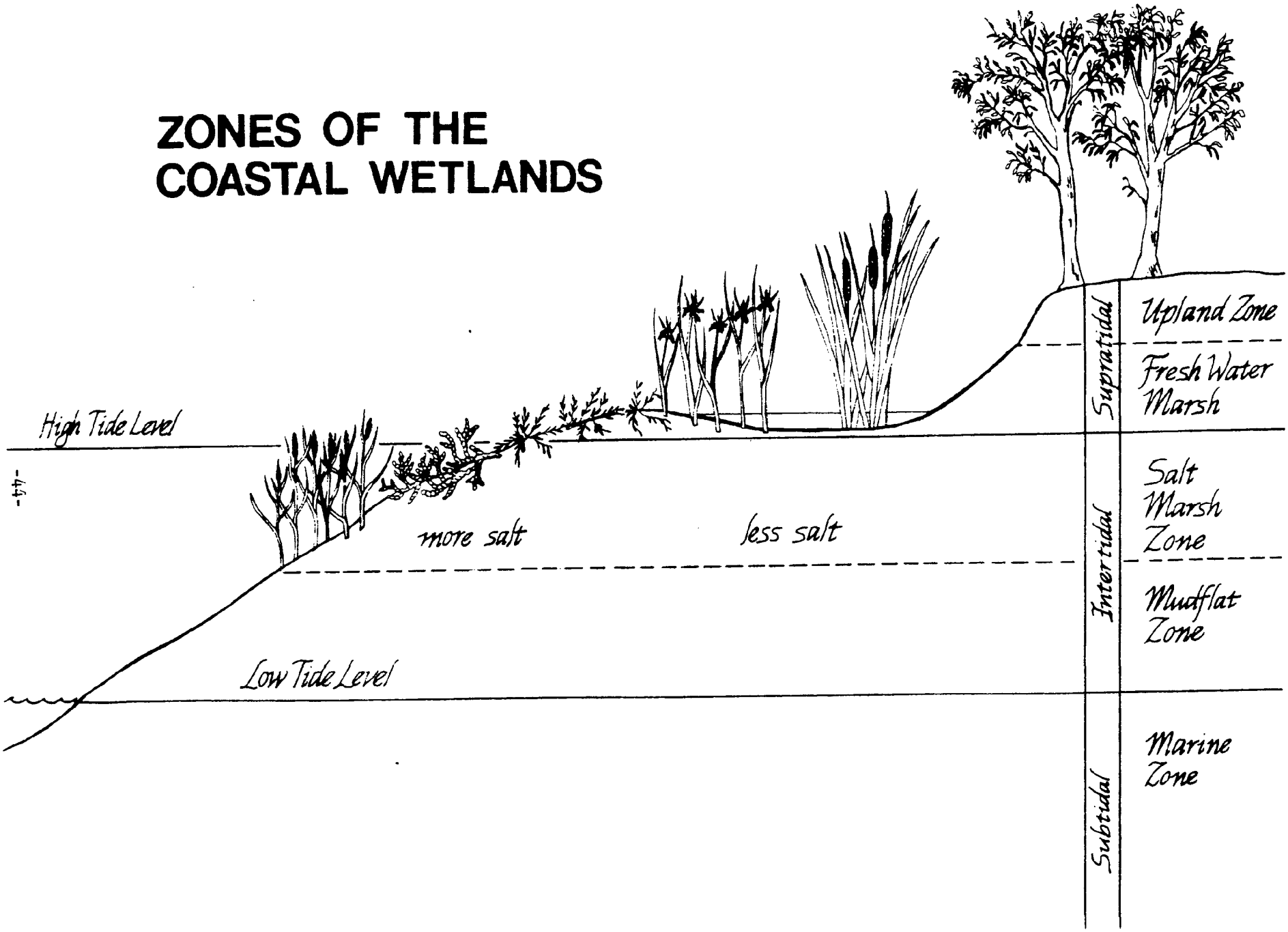
7. Draw a blue arrow to the low tide line.

Answer the following questions:

8. From your other studies, name one animal that would live in each zone.
   MARINE: any of the fish from fish poster. MUDFLAT: birds of the mudflat or examples from the MUDFLAT LIFE picture sheet. SALT MARSH: Clapper Rail or other birds from the bird poster. FRESH MARSH: any of the birds from the fresh water marsh section of the bird poster. UPLANDS: any of the terrestrial mammals, reptiles, or birds. (E.g. fox, rabbit, squirrel, lizard, snake, owl, mocking bird.)

9. Explain how the tides help determine the zones of the coastal wetlands.
   Tides cover different regions of the coastal wetlands for different amounts of time each day. The salt water makes it possible for some plants to grow and others not to grow.

ZONES OF THE COASTAL WETLANDS



Answer Key

WETLAND PLANTS

Using the plant names at the bottom of the page, write the name of the plant on the line next to the accurate characteristic.

1. tall shrub with large, shiny leaves.....LAUREL SUMAC
2. a bad-smelling shrub with bladder-like seed pods.....BLADDER-POD
3. four-petaled, purple flowers with spicy pods.....RADISH
4. flowers are yellow and spicy.....MUSTARD
5. succulent stems with many sharp spines.....CHOLLA CACTUS
6. feathery plant with a strong, sweet scent.....SAGEBRUSH
7. poisonous plant with yellow trumpet flowers that hummingbirds like.....TREE TOBACCO
8. this plant's cousin is used to make pancakes.....BUCKWHEAT
9. cows act crazy if they eat this silvery plant.....LOCOWEED
10. grain (food for animals).....OATS
11. salt sparkles on the leaves.....SALTBUSH
12. sour, red fruits used to make a refreshing drink.....LEMONADEBERRY
13. upland shrub with small, succulent leaves.....BOX THORN
14. little, purple "tomatoes" are poison.....NIGHTSHADE
15. this plant's cousin was once used in marshmallows.....MALLOW
16. tumbleweeds.....RUSSIAN THISTLE
17. curly and rhymes with "sock".....CURLY DOCK

SALTBUSH, MUSTARD, RUSSIAN THISTLE, RADISH, TREE TOBACCO, SAGEBRUSH, CURLY DOCK, BLADDERPOD, OATS, MALLOW, NIGHTSHADE, LAUREL SUMAC, CHOLLA CACTUS, BUCKWHEAT, LOCOWEED, LEMONADEBERRY, BOX THORN

Answer Key

SCIENTIFIC NAMES

Scientific names of plants have two parts: a genus name and a species name. Using the plant poster to help you, write the common plant name on the line next to the scientific name.

Scirpus robustus.....SEDGE

Cotula coronopifolia.....BRASS BUTTONS

Monanthochloe littoralis.....MONANTHOCHLOE

Salix lasiolepis.....ARROYO WILLOW

Spartina foliosa.....CORDGRASS

Juncus acutus.....RUSH

Salicornia virginica.....PICKLEWEED

Salicornia subterminalis.....PICKLEWEED

Salicornia bigelovii.....PICKLEWEED

Batis maritima.....SALTWORT

Cuscuta salina.....DODDER

Mesembryanthemum crystallinum.....ICE PLANT

Encelia californica.....BRITTLEBRUSH

Atriplex semibaccata.....AUSTRALIAN SALTBUSH

Atriplex patula.....SALTBUSH

Notice the three plants with the genus name *Salicornia*. What common name is given to all of these? PICKLEWEED

Do you think they are all alike? THEY ARE CLOSE RELATIVES

How do scientific names tell us more information than common names? PLANTS WITH THE SAME GENUS NAME ARE CLOSELY RELATED. THEY MAY HAVE THE SAME COMMON NAME AND NOT BE CLOSE RELATIVES. E.G. SAGE CAN BE FROM THE MINT FAMILY OR SUNFLOWER FAMILY.

There are two plants with the genus name *Atriplex*. Only one has its common name labeled on the poster. What common name might the other one have? SALTBUSH. OFTEN PLANTS OF THE SAME GENUS HAVE THE SAME COMMON NAMES.

The same scientific names are used all over the world. Why do you think this is important? BY USING SCIENTIFIC NAMES PEOPLE CAN BE SURE THEY ARE TALKING ABOUT THE SAME PLANT.

WETLANDS SORT AND FILL-IN

MATERIALS: Worksheets WETLANDS SORT and WETLAND FILL-IN. Class time needed for individual sheets: 20 minutes for worksheet + 5 minutes for discussion = 25 minutes

Have the students fill out the worksheets either during or as a follow-up to a visit to the wetlands. This exercise gives students practice in sorting and organizing observations they have made.

WETLANDS SORT

INTERTIDAL		SUPRATIDAL	
MUDFLAT	**SALT MARSH**	**FRESH WATER MARSH**	**UPLANDS**
Sea Lettuce	Salt Bush	Heron	Snake
Heron	Sea Lettuce	Cattail	Salt Bush
Avocet	Sea Blite	Blackbird	Sagebrush
Algae	Heron	Algae	Tree Tobacco
Crabs	Pickleweed	Sparrow	Bladderpod
Diatoms	Clapper Rail	Willow	Cucumber
Horn Snails	Algae	Kite	Cactus
Sea Cucumber	Saltgrass	Bulrush	Laurel Sumac
	Cordgrass	Diatoms	Worms
	Crabs	Brass Buttons	Harlequin Bug
	Savannah Sparrow	Curly Dock	Deerweed
	Diatoms	Worms	Locoweed
	Sea Lavender	Sedge	Box Thorn
	Rove Beetle		

Fill out during or after a visit to the coastal wetlands

	PICKLEWEED	CORDGRASS	CATTAILS	SEA LAVENDER	BUCKWHEAT	OTHER
HABITAT	Grows in the salt marsh.	Grows in the lowest levels of the salt marsh.	Grows in fresh water marshes and ditches. Requires fresh water to grow.	Grows in upper salt marsh.	Grows on dry soils with sagebrush.	
APPEARANCE	Low, dull green. Looks like many small pickles strung together.	Grass - two to three feet tall. Forms broad, dense patches in the staff marsh.	Tall thin leaves. After blooming it looks like it has a hot dog growing on its top.	Large leaves at base of tall, lacy flower stalk with tiny, blue flowers.	Shrub 1-2 feet high. Needle-shaped leaves, clusters of pink flowers.	
REPRODUCTION	Grows from seeds and root from the stems. Perennial	Grows from broken pieces of plants. Also grows from seeds. Perennial	Grows from seeds that are carried by the wind or from broken pieces of roots or stems. Perennial	Grows from seed. Perennial	Reproduces from small, naked seeds. Perennial	
ADAPTATION TO SALT	Stores water in the stems and dilutes salt.	Has special cells in its leaves that push salt out of the plants.	They do not grow in salty places.	Has special cells in its leaves to push salt out of plant.	Does not grow in damp, salty soils.	
ECOLOGICAL RELATIONSHIPS	Nesting sites for two endangered species. Clapper Rail. Belding's Savannah Sparrow	Nesting place for the Clapper Rail. Important food source for many tiny organisms of the salt marsh.	Roots are edible. The roots stabilize the shore edge. Nesting places for birds. (Long-Billed Marsh Wren)	Indicates upper marsh. Two cousins with blue straw-flowers indicate disturbed areas.	Is an indicator of upland areas.	

WETLANDS FILL-IN

	MUDFLAT AND MARINE	SALTMARSH	BIRDS	FRESH MARSH
C	Crab Clam Cucumber	Clapper Rail Cordgrass	Curlew Coot	Cattail
A	Anchovy Arrow Goby	Atriplex Alkali Weed	Avocet	Arroyo Willow
L	Least - Tern	Limonium	Long-Billed Curlew	Long-billed Marsh Wren
I		Ice Plant		Insects
F	Fish	Frankenia	Foster's Tern	Frog
O		Owl	Owl	Oppossum
R	Ruddy Duck	Rail	Red-winged Blackbird	Rush
N				Nightshade
I		Ice Plant		Insects
A				

WETLANDS SCAVENGER HUNT

UPLAND PLANTS

Sagebrush .....
Bladderpod .....
Cucumber .....
Locoweed .....
Box Thorn .....
Globemallow .....
Laurel Sumac .....
Cholla Cactus .....
Flat-Top Buckwheat .....
Deerweed .....
TOTAL .....

ANIMALS

Bees pollinating .....
Harlequin bug .....
Jack Rabbit (5) .....
Savannah Sparrow (5).....
Clapper Rail (10) .....
Hummingbird .....
Snake ..... Duck .....
Avocet ..... Heron .....
Hawk ..... Worm .....
Crab ..... Rove Beetle.....
TOTAL .....

RIPARIAN PLANTS

Mulefat .....
Arroyo Willow .....
Galls .....
Black Willow .....
Cattail .....
Celery .....
Watercress .....
Sedges .....
TOTAL .....

HALOPHYTES

Pickleweed .....
Saltbush .....
Salt grass .....
Cordgrass .....
Salt on leaves .....
Sea lavender .....
Batis .....
TOTAL.....

GRAND TOTAL .....

VOCABULARY

Write the definition of each of the following words.

ECOSYSTEM...A self-sustaining system with an outside source of energy.

ORGANISM....A living thing.

MICROORGANISM..A living thing that is so small that it can only be seen with the aid of a microscope.

WATER CYCLE....The conversion of liquid water to a gas and back to a liquid again. Ocean water evaporates and moves over the land. It then condenses and falls to the earth as rain or snow.

EVAPORATION....Liquid changing into a gas (vapor).

CONDENSATION...Vapor changing into a liquid.

PRECIPITATION...Rain or snow from condensation of water vapor

RUN OFF.....Liquid water moving across the surface of the land

TRANSPIRATION...Water vapor being lost from a living plant

DECOMPOSERS....Organisms that break waste materials into their elemental parts. These parts become nutrients for plants.

WETLANDS....Lands which are periodically or permanently covered by water. If not disturbed, such areas support plants which grow in or near water or saturated soils.

MARSH...Part of a wetland where water tolerant plants can grow.

ESTUARY....Where a fresh water stream enters the sea.

SALT MARSH....A marsh that is periodically covered by the tides.

COASTAL WETLANDS....Wetlands that are found near the sea.

HABITAT.....The place where an organism lives (its home).

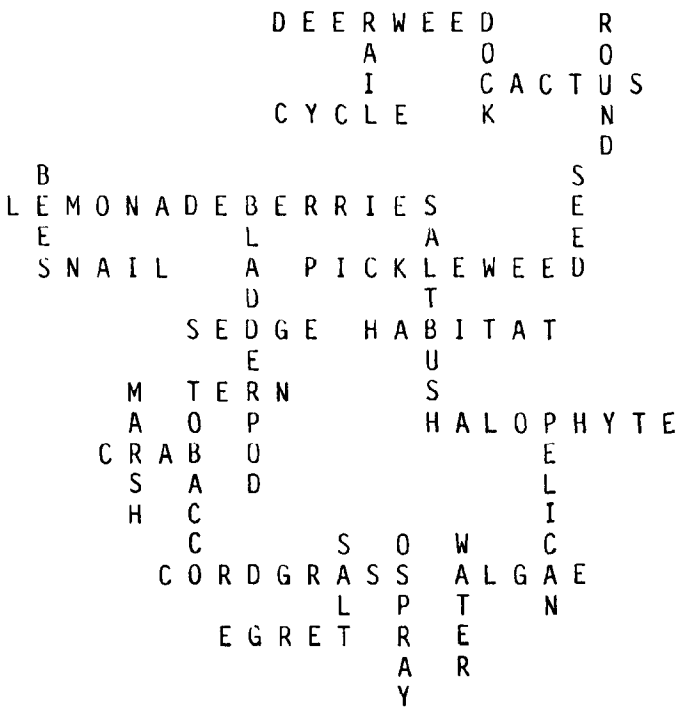
ALGAE....A simple plant found in all wetlands.

DIATOMS...Simple algae with glass shell and a droplet of oil in its body.

FOOD WEB...The sum total of all the interacting food chains in an ecosystem.

PERENNIAL...A plant which lives for more than two years.

WETLAND CROSSWORD PUZZLE



ACROSS

1. Yellow and orange flowers signal bees
2. Pokes when picked
3. Regularly repeats itself
4. Berries make a delicious, tart drink
5. Vacuums its dinner from the mud
6. Halophyte where the Savannah Sparrow nests
7. ..... have edges
8. home sweet home
9. AN ENDANGERED SPECIES
10. Plants that can tolerate salt
11. Fiddles
12. Salt marsh plant in the wettest soil
13. Simple plant
14. Snowy marsh bird

DOWN

1. Thin as a . . . .
2. Rushes are . . . .
3. Pollinates flowers
4. Carries new life
5. Stinky, but pretty
6. An upland halophyte
7. Where water-tolerant plants grow
8. Tree with yellow trumpet flowers
9. Can hold more in its mouth, than its belly can
10. A chemical from the sea
11. Fish eagle
12. Life can't live without it

What are "wetlands?"

Wetlands are low places which are covered by shallow water all or part of the time.

What is an estuary?

An estuary is the area in which salt water and fresh water meet.

What are halophytes?

Halophytes are plants that can withstand salt in the soil and/or water.

What is the water cycle? Where does the water come from?

The water cycle is the unending series and changes water goes through. The water comes from condensing vapor; the vapor comes from evaporating water. The changes continue.

What is a food web?

A food web is the pattern shown by following the transfer of energy (or food) through the organisms in a system.

What is a habitat?

A habitat is the space or area where a given living thing is naturally found.

How do plants tell us about soil and water conditions?

When we know how much moisture and salt a plant can stand, we can judge how much moisture and salt must be in the soil we find it growing in.

How do tides help the wetlands?

Tides bring in nutrients for plants and plankton to feed animals. They recycle waste products by washing detritus to decomposers. They carry away and filter other wastes or pollutants.

Why is the coastal wetland such a rich environment - what is so special about it?

It is the most productive of all environments and it supports rare and unique life forms as well.

SALT MARSH BIRDS AND SHORE BIRDS

These pages can be used in a number of ways.

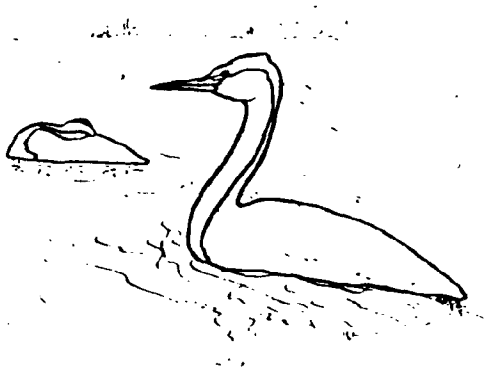
..... Analyze the bills and suggest possible food items for each bird.

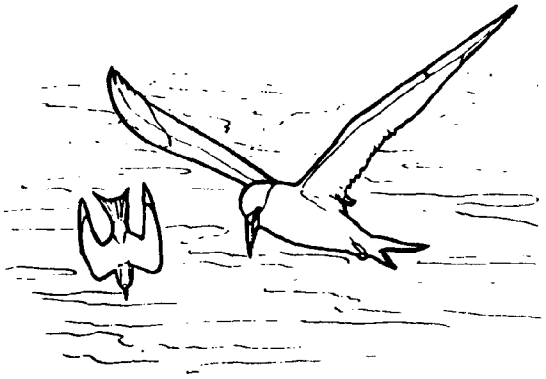
..... Use the Bird Key or Flash Cards to identify each bird, where does each bird breed in the summer?

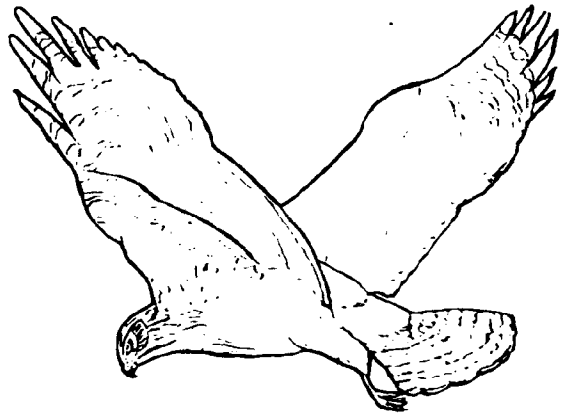
..... Color the birds using the Bird Poster or A Field Guide to Birds of North America, National Geographic Society, or any other bird guide for the Western United States for the colors.

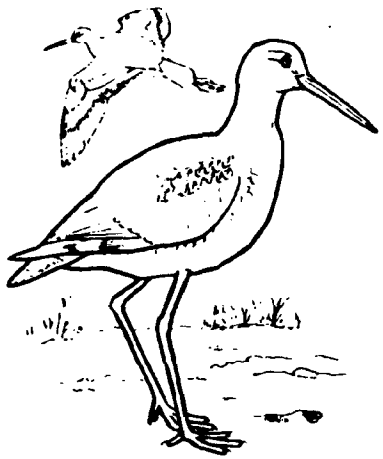
..... Which habitat will each bird be found in? Would any be found in more than one?

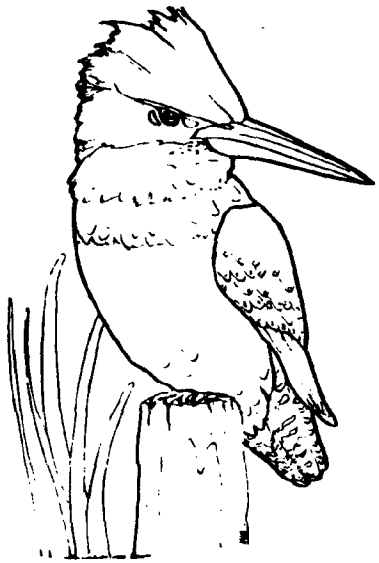
Salt Marsh Birds

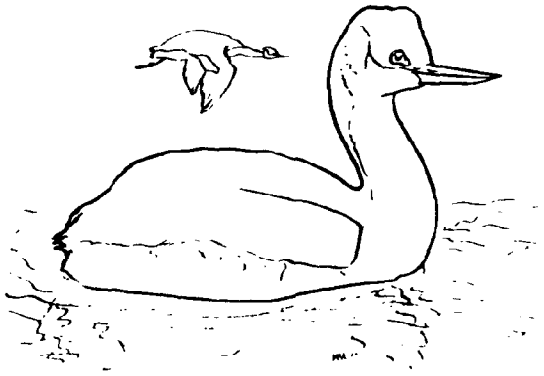












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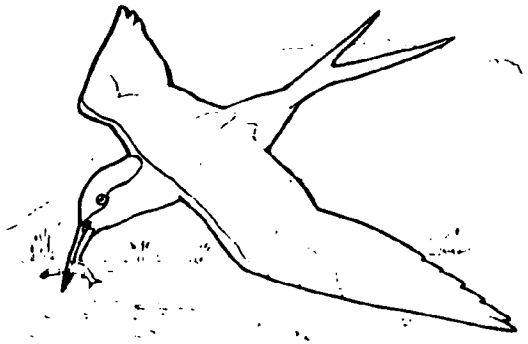

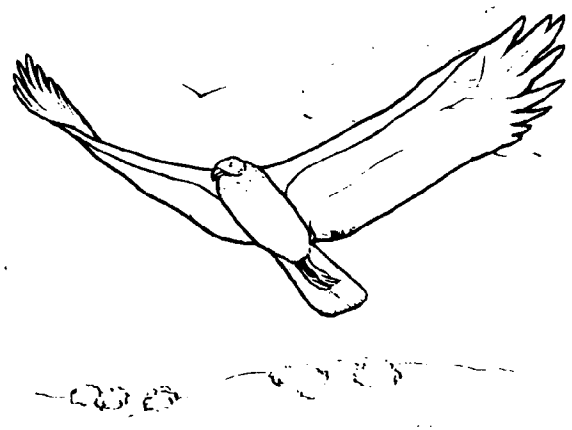

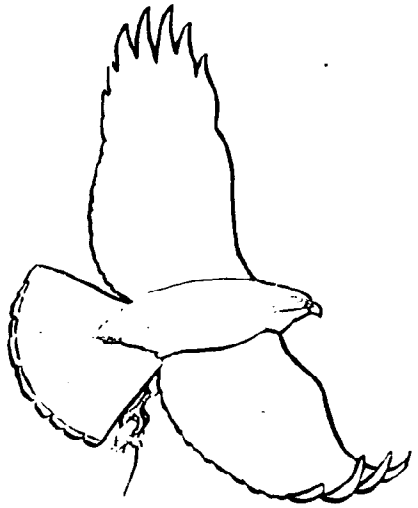

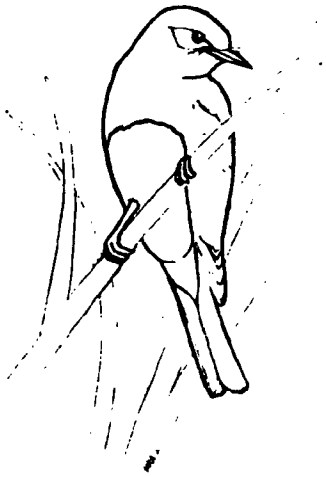

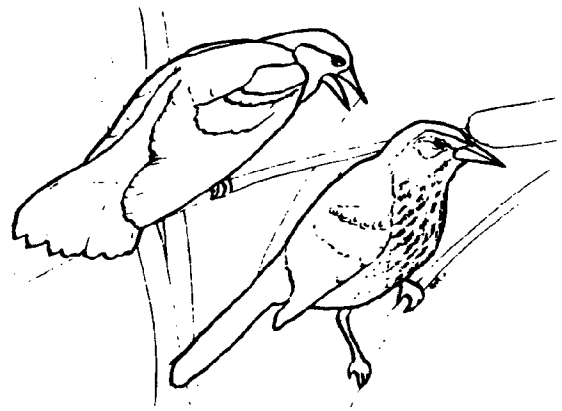

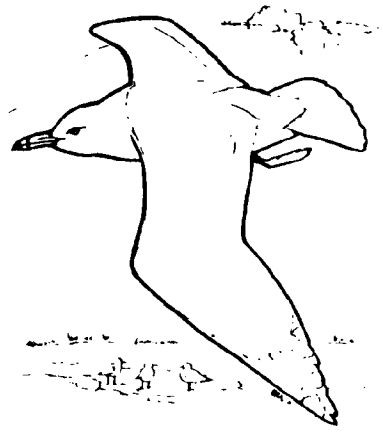

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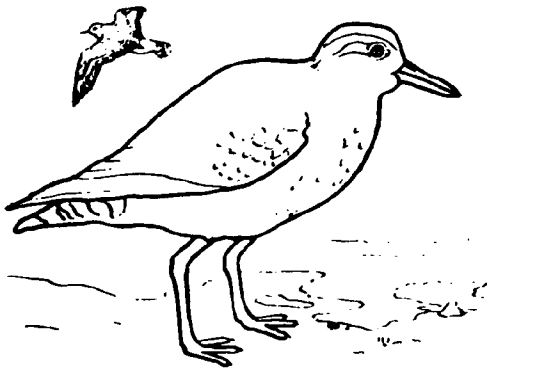

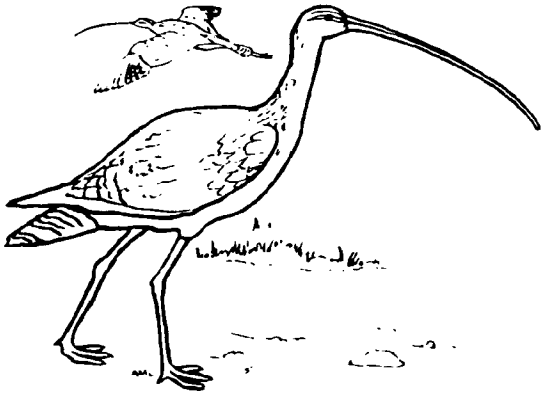

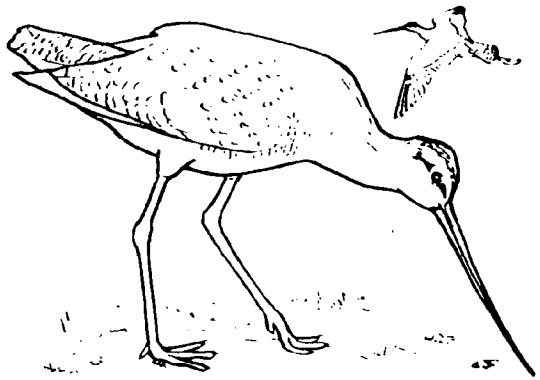

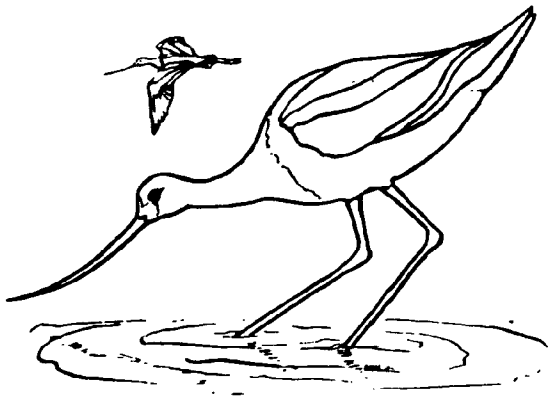

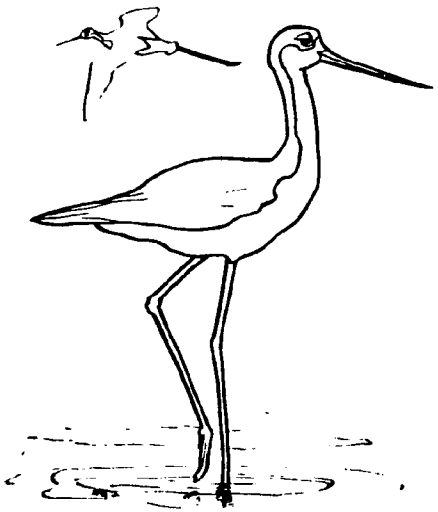

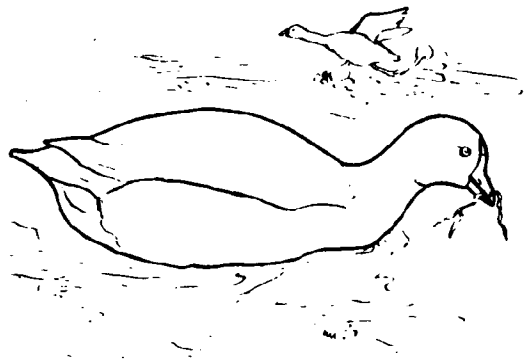

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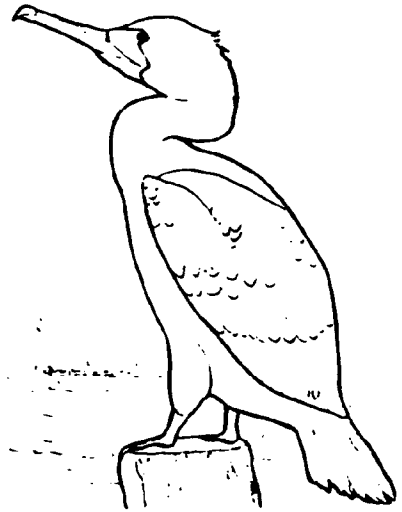
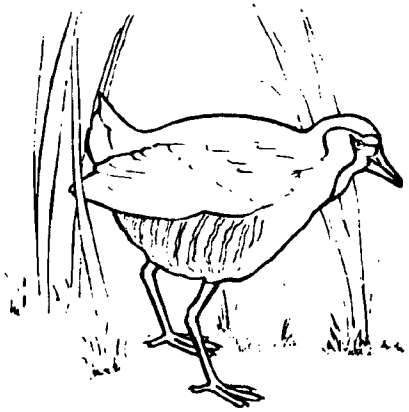
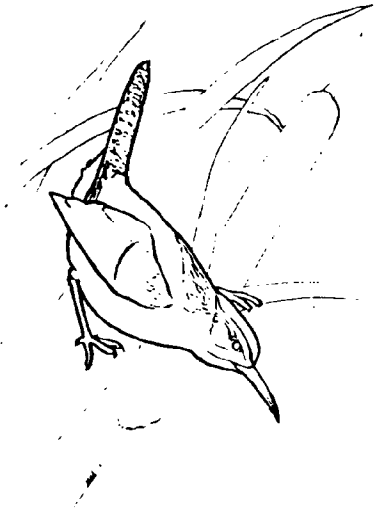
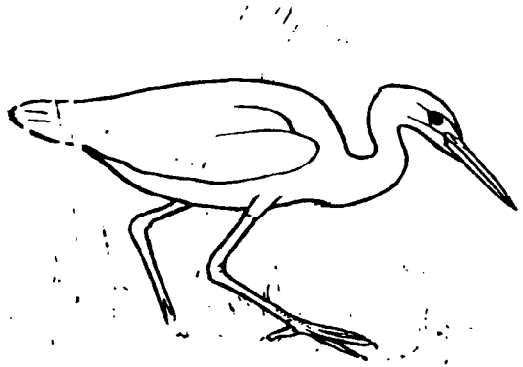
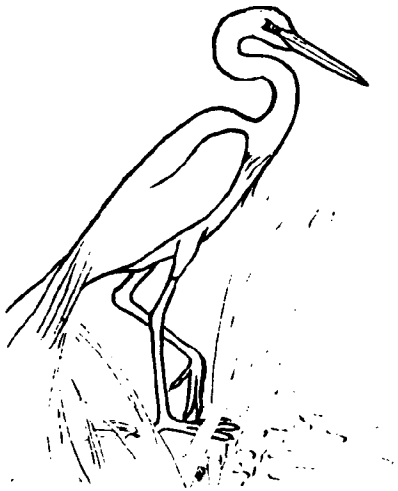
Salt Marsh Birds











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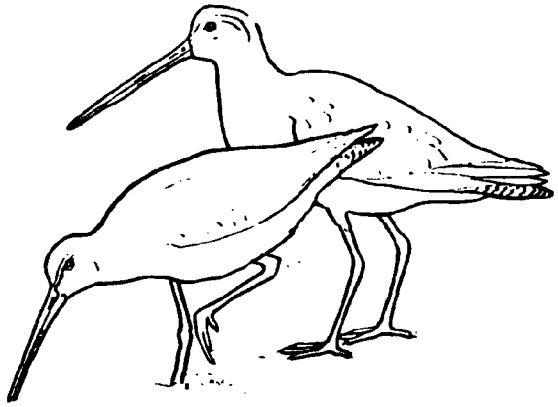

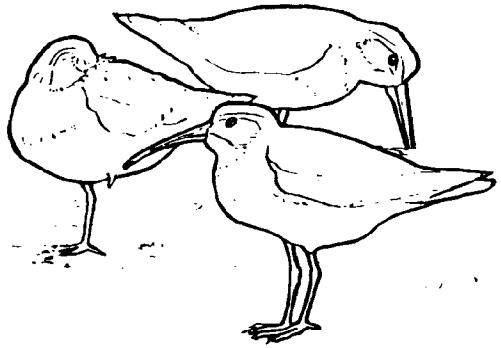

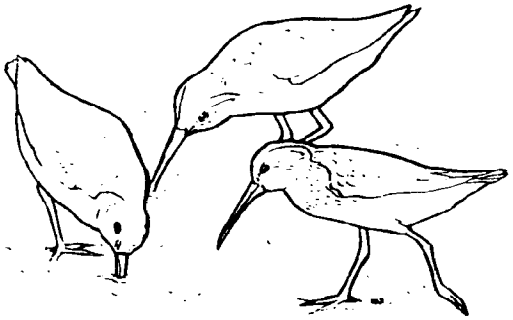

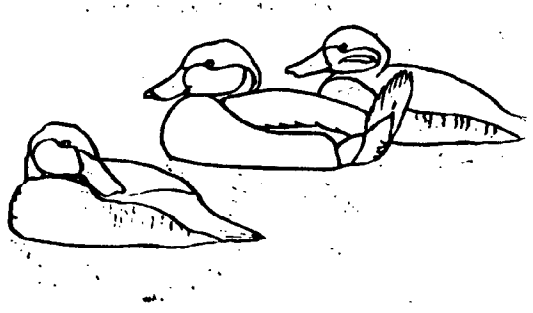

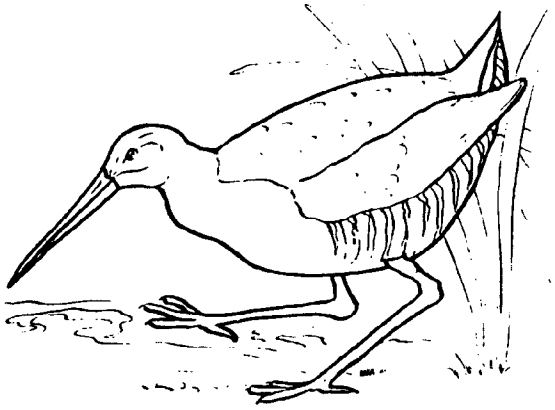

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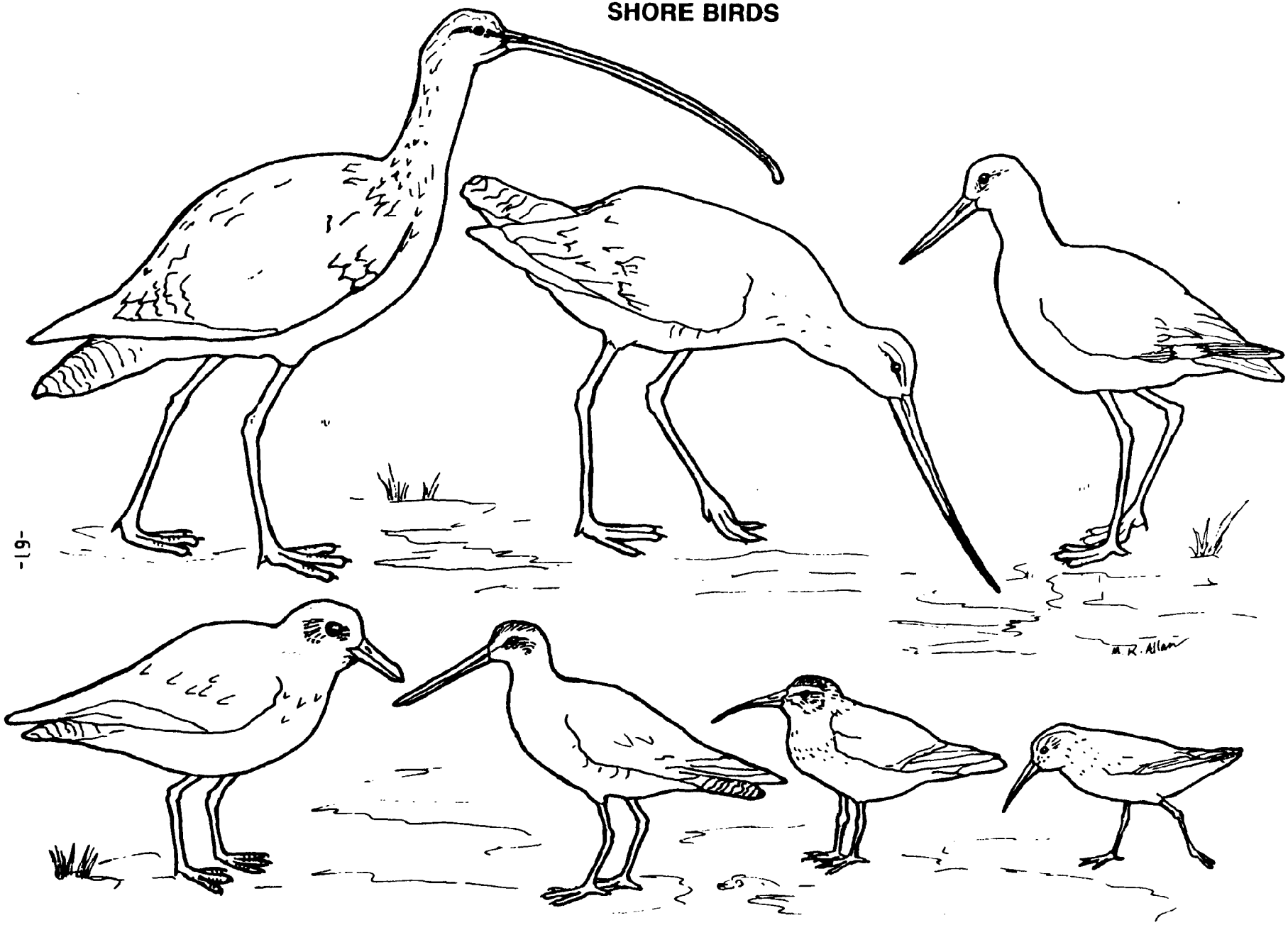
SHORE BIRDS



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1—Red Tailed Hawk
2—Turkey Vulture
3—Forster's Tern
4—Ring-Billed Gull
5—Red-Winged Blackbirds
6—Black Phoebe
7—Long Billed March Wren
8—Sora
9—Double-Crested Cormorant
10—Great Blue Heron
11—Great Egret
12—Snowy Egret
13—Marsh Hawk
14—Least Terns
15—Western Grebes
16—Eared Grebe
17—Belted Kingfisher
18—Willet
19—Marbled Godwit
20—Long-Billed Curlew
21—BlackBilled Plover
22—American Coot
23—Black-Necked Stilt
24—American Avocet
25—Western Sandpipers
26—Dunlins
27—Dowitchers
28—Savannah Sparrow
29—Clapper Rail
30—Ruddy Duck

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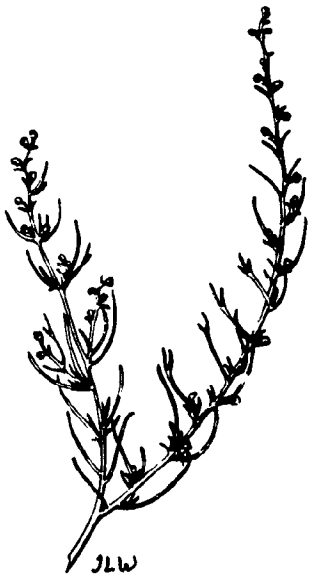
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SALTBUSH — Pigweed Family

Atriplex 3 kinds

Example: Atriplex lentiformis Griarl Brush

HABITAT: Saltbush can grow on fine, poorly-drained soil, but cannot stand being underwater. They do best in coarse soils where there is air for the roots.

APPEARANCE: Glands on the surface of the leaves give saltbush a pearly-gray luster. If you are uncertain if your plant is a saltbush or another gray plant like sagebrush, check to see if the leaf covering is gray hair (sagebrush) or scales (saltbush). While checking the leaf, break a small piece off and you will see the bright green of chlorophyll underneath.

REPRODUCTION: Like other members of this family, the flowers are of different sexes, small and greenish. The developed fruits form flattened discs. The plants are pollinated by the wind.

ADAPTATION TO SALT: Saltbush does not grow in the lower areas of the salt marsh, but they are tolerant of salts because of special glands on the surface of the leaf. Under a powerful microscope, these glands look like tiny balloons. When a gland is full of the salts which are excreted out of the leaf, it falls off + another takes its place.

..GICAL RELATIONSHIPS: Saltbush seeds contain lots of protein and oil. They are a favorite food for birds. People can eat them as emergency food.

LEMONADEBERRY — Sumac Family

Rhus integrifolia

LAUREL SUMAC

Rhus laurina

HABITAT: Both are common chaparrel shrubs found on dry uplands. They are not tolerant of salt marsh conditions.

APPEARANCE: Look for thick, green leathery leaves. The smaller lemonadeberry leaves have teeth along the edge. The numerous, small flowers are rose colored. The red fruits are covered with an acid, sticky substance.

The larger leaves of laurel sumac are smooth-edged and folded up along the midrib. Masses of small, white flowers are at the tip of the branches.

REPRODUCTION: Both of these Rhus reproduce by seed only.

ECOLOGICAL RELATIONSHIPS: As is true of most chaparrel shrubs, these Rhus are hard to kill and sprout from the crown of the root following a fire.

FLAT-TOP BUCKWHEAT — Buckwheat Family

Eriogonum fasciculatum

HABITAT: Common on the dry uplands. Grows on the edge of the salt marsh, but the land is elevated beyond the reach of the tides.

APPEARANCE: A low shrub with many, leafy branches. The edges of the leaves turn under; green above and grey wooly beneath. The leaves come in bunches. The flower heads look like white or pink balls on the end of a stick. The flowers turn brick red after pollination and stay on the plant.

REPRODUCTION: Buckwheat reproduces only by seeds.

ECOLOGICAL RELATIONSHIPS: The nectar and pollen are used by the insects, and birds eat the seeds. It is an important ground cover. There are over 100 species of Eriogonum in California, and the Indians have harvested the seeds from many of them.

CALIFORNIA SAGEBRUSH — Sunflower Family

Artemisia californica

HABITAT: Sagebrush is common on upland slopes and does not tolerate salty soils well.

APPEARANCE: This shrub can be from two to five feet tall. It has gray-green leaves that are very fine and linear.

REPRODUCTION: Sagebrush blooms from August to December. The tiny, hard-to-see flowers are pollinated by the wind. It grows from seeds.

ECOLOGICAL RELATIONSHIPS: The best way to identify Sagebrush is to rub the leaves and smell them. It will remind you of the seasoning for your Thanksgiving turkey. And it can be used for just that purpose. Sagebrush was an important herb for Indian women. It was made into a tea that was believed to help them during childbirth.

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BLADDERPOD — Caper Family

Isomeris arborea

HABITAT: Bladderpod is a common shrub in the desert as well as the coast. In both places, it grows in slightly salty areas.

APPEARANCE: Bladderpod is a bad-smelling shrub that is usually three to four feet tall with three leaflets like a clover. The flowers can be the size of a quarter and are yellow and very showy. They have four petals. The fruit is a swollen, hanging pod. The pods start developing long before the petals wither.

REPRODUCTION: Bladderpod reproduces by seeds.

ECOLOGICAL RELATIONSHIPS: Harlequin Bugs live on the Bladderpod. These are red and black "stink bugs" which concentrate a toxic chemical from the plant in their bodies. They are not bothered by the chemical, but predators avoid them.

WILD RADISH — Mustard Family

Raphanus sativus

HABITAT: Wild Radish is a common plant in disturbed soil and fields throughout much of California. Wild Radish cannot grow in sea water.

APPEARANCE: Wild Radish has a four-petaled flower from pale white to pink to yellow. All colors can be found in the same area. To be sure of your identification, look for the cylindrical fruits which are narrow between each seed.

REPRODUCTION: Wild Radish can spread only by seeds.

ECOLOGICAL RELATIONSHIPS: Wild Radish is a native of Europe and the supermarket radish is a cultivated form. The Wild Radish root is edible. This plant is pollinated by bees.

NIGHTSHADE — Tomato Family

Solanum

HABITAT: Nightshades seek the high, dry ground. They are not tolerant of salt marsh conditions.

APPEARANCE: The showy flowers have five continuous petals which make a colorful plate under the pillar-like, yellow stamens. Often there are green nectar glands surrounding the stamens. Our common species has deep purple flowers. The fruits are small, dark berries.

REPRODUCTION: The flowers are insect-pollinated, and plants reproduce from seeds.

ECOLOGICAL RELATIONSHIPS: This is one of the early spring flowers which provide nectar and pollen for numerous emerging insects. In order to protect developing fruits from predators, many members of this family produce a toxin which attacks the nervous system. Nightshade berries are very toxic.

DEERWEED — Pea Family

Lotus scoparius

HABITAT: This common shrub grows on dry slopes.

APPEARANCE: It is a low, bright green shrub with straight, spreading branches. It can look wild and disorganized. The flowers are yellow, fading to red after pollination. Since the red petals do not fall off, the plant has a two-tone look.

REPRODUCTION: This plant reproduces from seed only. The flowers are an important nectar source for bees.

ECOLOGICAL RELATIONSHIPS: Deerweed is frequently found growing on disturbed land. Disturbance can mean a trail or road edge, vacant lot or burned areas. It is one of the first important plants to follow a fire. Bacteria living on the roots are able to change nitrogen from the air into a form which plants can use.

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BLACK WILLOW — Willow Family

Salix gooddingii

HABITAT: Willows grow in wet ground. They probably bring air to their roots through small holes in the bark.

APPEARANCE: The Black Willow looks like the Arroyo Willow, but has a rough, dark bark. The leaves are greyish-green.

REPRODUCTION: Flowering catkins appear on the branch tips before the leaves. The Black Willow is wind-pollinated. The leaves would get in the way if they came before the flowers.

ECOLOGICAL RELATIONSHIPS: Like other fresh water plants that grow on the edge of streams and marshes, roots of the Black Willow help to keep the bank stable and the soil from washing away.

ARROYO WILLOW — Willow Family

Salix lasiolepis

HABITAT: Arroyo Willow does not like salt water. It grows where fresh water is getting to its roots. Where you find willows, you are sure to find fresh water.

APPEARANCE: Arroyo Willow is a low-spreading tree from six to thirty feet tall. Its branches are slightly drooping. The leaves are lance-shaped and several times longer than wide. They are from two to four inches and drop off in the fall. They are smooth and dark green on top and hairy underneath. The bark is smooth and the twigs are yellowish to dark brown and usually hairy.

REPRODUCTION: Arroyo Willow flowers are in male and female catkins. A catkin is a slender cluster of flowers. The tree is wind-pollinated so there are no petals. Arroyo Willow can grow from seeds or from pieces of willow plant that are in contact with the soil.

ECOLOGICAL RELATIONSHIPS: Birds use the Arroyo Willow as a place to nest, gather food, hide from enemies and rest. Insect galls grow on the leaves and stems.

MULE FAT — Sunflower Family

Baccharis glutinosa

HABITAT: These shrubs are common in moist places and dry stream beds.

APPEARANCE: Mule fat is a shrub that grows from six to twelve feet high. Its leaves are one to four inches long, lance-shaped, with small teeth at the edge. The leaves remain on the plant all year long. To distinguish from willows, look for three long veins in the leaves.

REPRODUCTION: Mule fat has clusters of whitish flowers arranged at the tip of the branches. Seeds are carried by the winds.

ECOLOGICAL RELATIONSHIPS: Mule fat is not tolerant of salt and is another indicator of fresh water seepage. Its name comes from the belief that mules like to eat the foliage.

TREE TOBACCO — Nightshade Family

Nicotiana glauca

HABITAT: Tree Tobacco grows well wherever there is disturbed soil, and along stream banks that have been scoured by rushing water.

APPEARANCE: Tree Tobacco is a shrub that grows from six to fifteen feet tall. It has long, slender stems. The leaves are covered with a whitish bloom. The flowers are long, slender yellow tubes and many grow on the end of the stems.

REPRODUCTION: Tree Tobacco grows only by seeds.

ECOLOGICAL RELATIONSHIPS: The nectar inside the TREE tobacco flower is a favorite food for the Anna's hummingbird. The tube is about the same length as the bird's bill. BUT THE NECTAR AND ALL PARTS OF THIS PLANT ARE POISONOUS TO HUMANS. Like the name says, the plant is full of nicotine. Nicotine is a powerful poison. Tree Tobacco is native to Argentina and was introduced into California from Mexico during the period of the Spanish Missions. It probably would have made it to North America without help, because it is an excellent traveler.

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