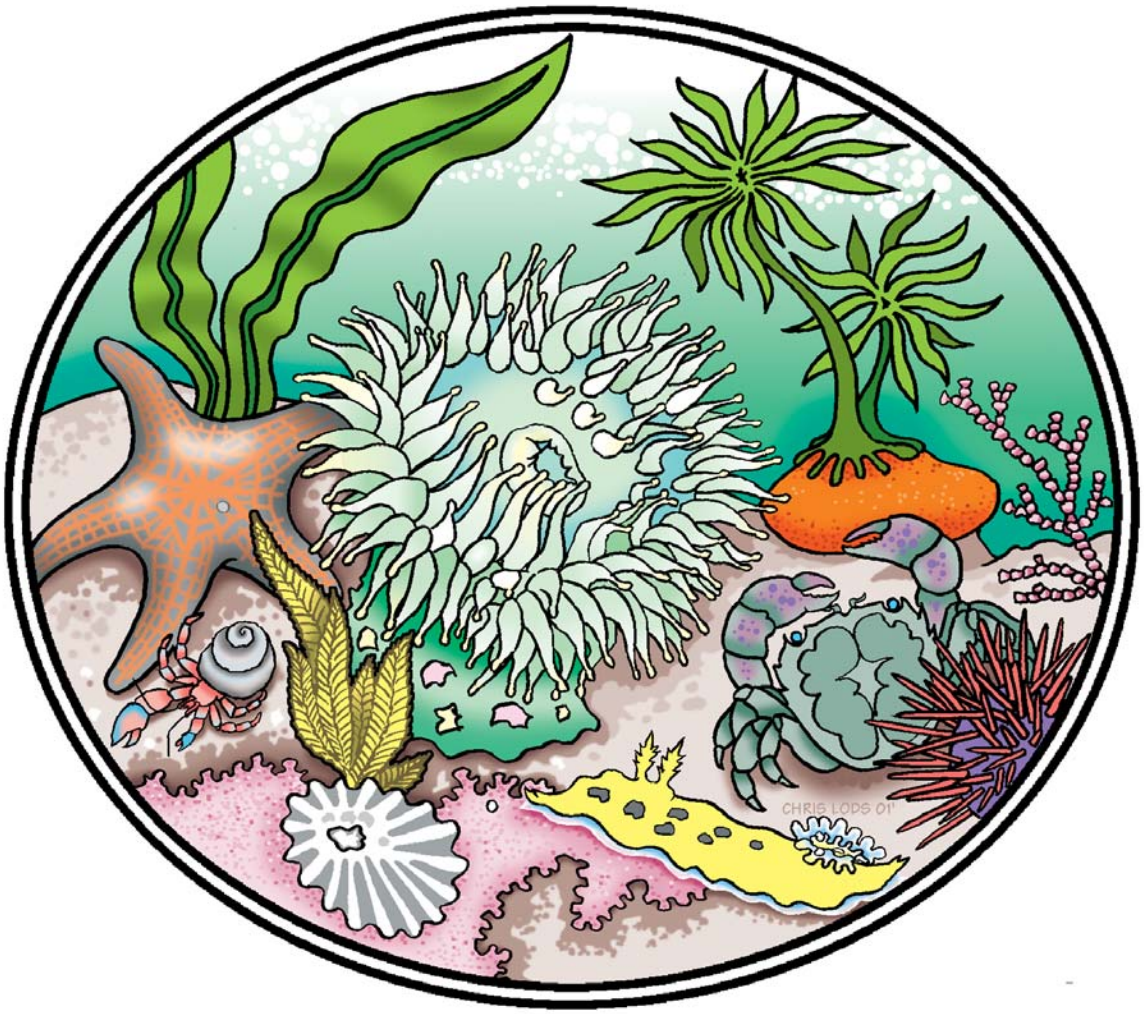
California State Parks



Tidepool Education Program

Docent Manual

Developed by Stewards of the Coast and Redwoods
Russian River Distirct State Park Interpretive Association

Tidepool Education Program

A curriculum- based program for Grades k to 8

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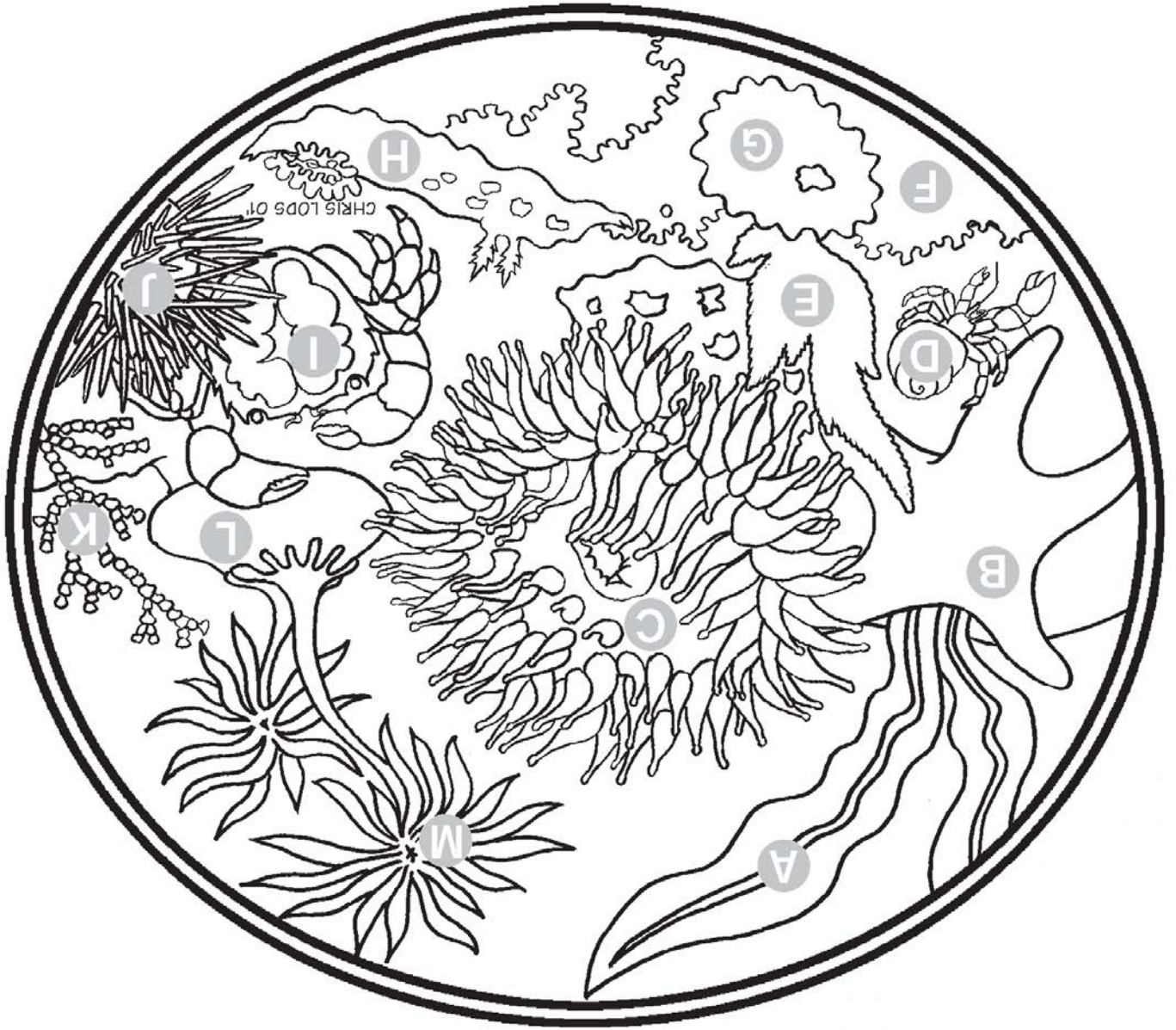
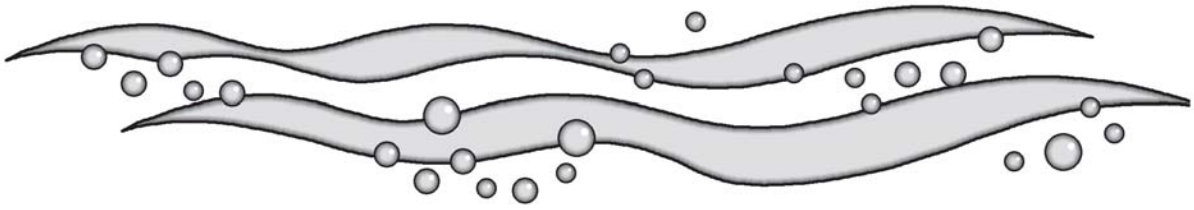
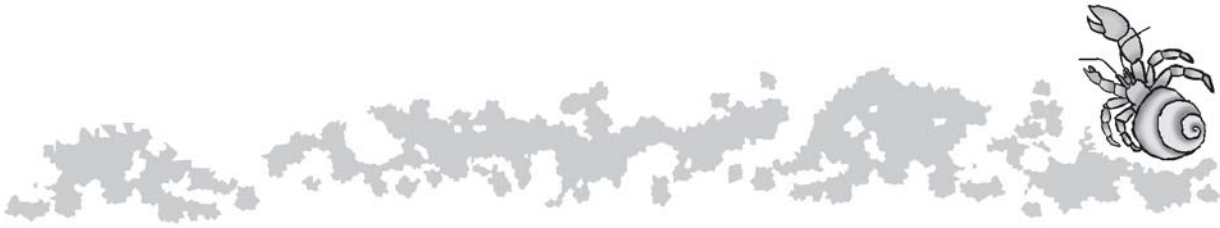
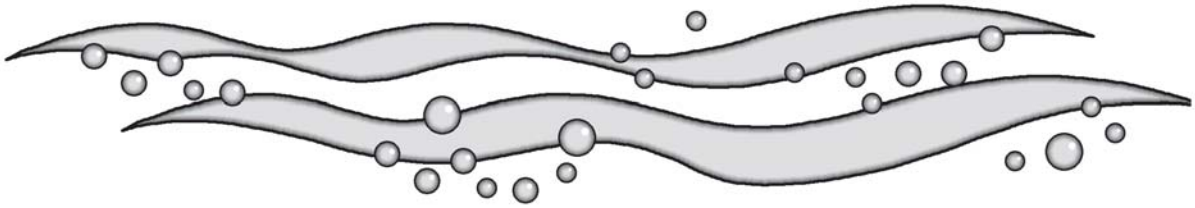


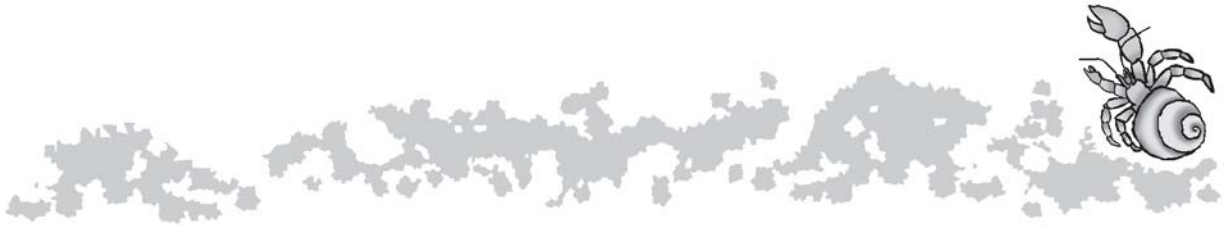


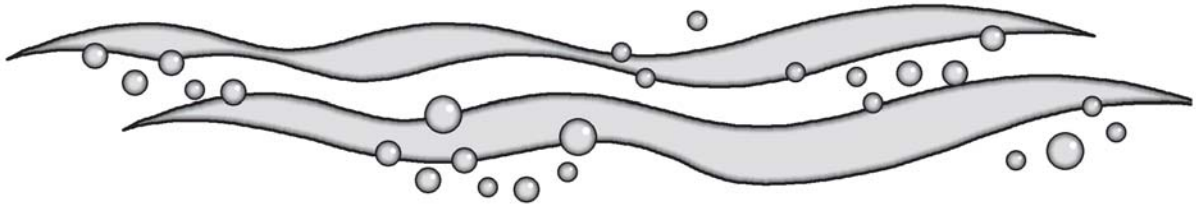
PART I
THE CALIFORNIA STATE PARK SYSTEM AND VOLUNTEERS





PART II
SONOMA COAST STATE BEACH TIDEPOOL PROGRAM



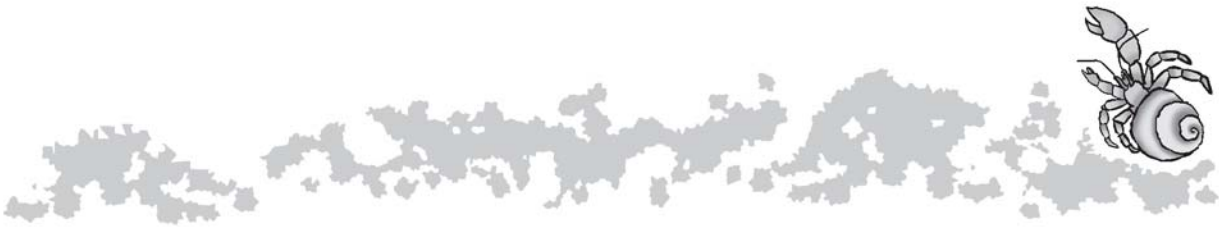


WELCOME TO THE SONOMA COAST TIDEPOOL PROGRAM

Each year hundreds of thousands of visitors come to enjoy the wonders of Sonoma Coast State Beach. One of the most fascinating habitats of the coast is the rocky intertidal zone. This unique area between the tides supports an incredible array of life. Unfortunately this ecosystem is a fragile one and the natural resources are in danger of being “loved to death.”

The Sonoma Coast Tidepool Education Program educates students in grades three through eight, as well as the public, about the wonders of the tidepools. It also focuses on teaching visitors of all ages how to be good Stewards of the Sea. This program offers engaging activities and includes hands-on tidepool exploration.

Your participation in this program is an invaluable contribution both to our community and to the marine environment.

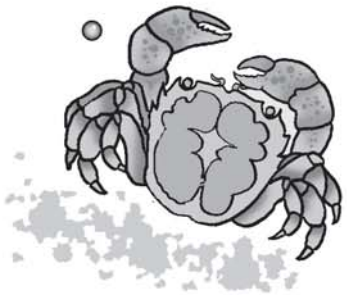


Insert Sonoma Coast State Beach info
Tidepooling at Sonoma Coast
Best Tidepooling Beaches - PDF

OCEAN SAFETY TIPS FOR TIDEPOOLING

Although very beautiful, the Sonoma Coast can be extremely dangerous if you are not careful. For this reason, we have included a list of things you can do to stay safe while visiting the park.

- Check with the park staff for ocean and beach conditions.
- Read and obey all warning signs.
- Keep small children away from the outer rocks in the tidepool area.
- Be aware of the tides, the long shore current, and any in-shore holes.
- Always use a three-point stance while exploring the tidepools (for balance).
- If you get caught in a rip current DO NOT PANIC! Relax. Swim parallel to shore and in the same direction as the long shore current for a short distance then return to the beach.
- Call and wave for help if you need it, never fake signals or calls for help <u>if you don't really need it</u>.
- If someone else is in trouble, DON'T GO IN TO THE WATER! Call 911 or alert a trained rescuer.
- Do not dive headfirst into the water or breaking waves.
- Use proper footwear to protect your feet.
- Protect yourself from the sun by using sunscreen and wear a hat.
- Have courtesy and respect for others.



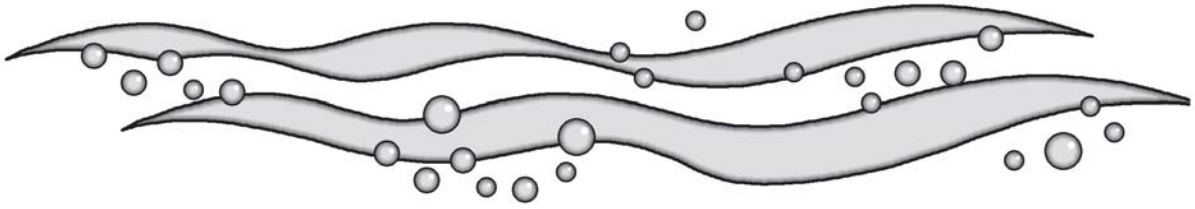
Going Easy in the Intertidal: Exploration without Devastation

Here are a few major impacts we humans have on tidepools and beaches and how we can explore with lesser impacts on the resources:

1. Where to walk:

The entire intertidal zone is teeming with life, beaches and rocky shores alike. Virtually everywhere you step there will be plants and animals underfoot, some very fragile, others more rugged. In addition, you need to watch your footing to avoid slips and falls. Try this:

- Stay on boardwalks, posted trails or other established paths.
- Avoid stepping on fragile dune plants going to and from the shore.
- On the rocky shore, try to step on solid, bare rocks. Stepping on seaweed is not only a slippery way to travel, but also may damage creatures that take cover under the seaweed during low tide. Stepping on loose stones is unstable and you may damage animals living underneath the stones.
- Walk in a line, placing your feet where other have stepped. If you spread out in the intertidal zone, you also spread the trampling effect.



2. Examining animals:

Many intertidal animals have exacting requirements for where they live, right down to a particular hole or depression in the rock that only they fit into. Many of these animals may be handled briefly to examine them, but should be treated with the following courtesies:

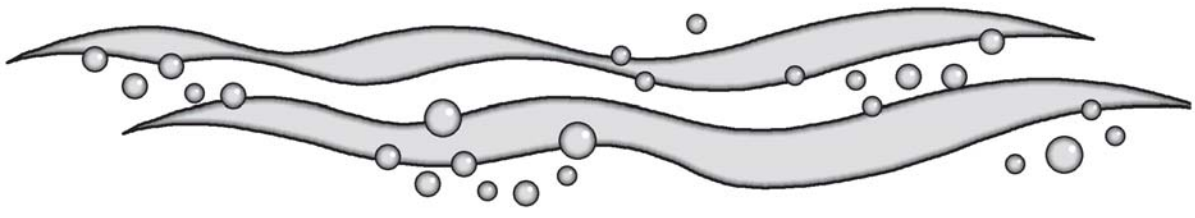
- **Always keep your hands wet when touching these animals**, and keep the animals wet as well.

- **It is always best to look at a plant or animal in place**: try bending over to get a closer look in a tidepool or rocky crevice rather than bringing the plant/animal out of the water up to your level.

- **If you must remove an animal** from the water, place it in a small clear plastic container with fresh seawater briefly to allow everyone to see it. Be sure to **replace the animal *exactly* where you found it.**

- If you must roll a stone or driftwood over to look underneath, try not to crush animals in the process. Always replace the stone or wood gently in its original position. Remember, a loose stone or wood turns into a wrecking ball with the next high tide and can do a lot of damage to intertidal animals.

- Similarly, if you lift up algae to look for creatures hiding underneath, replace it when you are done. The algae forms a vital wet blanket over the rocks to keep animals cool and moist, as well as hiding them from gulls and other predators.



2. Examining animals (continued):

- Do not remove limpets, snails, abalone, chitons, mussels, sponges, tunicates, or other attached animals or plants from the rocks. Most algae, mussels, tunicates (sea squirts) and sponges will not be able to reattach themselves before the next high tide and will be tossed up on the beach to fall victim to the sun or a predator. Many gastropods (limpets, abalone, and snails) easily succumb to internal bleeding if damaged when forcefully removed from the rocks. (Their internal cavity walls are easily torn and these animals lack clotting compounds in their blue-green blood to repair the damage).

- Some limpets and sea urchins have a shell or test that precisely fits a hole or depression in their "home rock." If you remove them and don't put them back in that same location, they just don't "fit" anywhere else and are easy prey for tidal surges and predators.

- Each tidepool is an established community of sorts, with each resident having established its territory, food source, shelter, and interrelationships with the other residents. Each time we add or subtract, move animals,or disturb the physical conditions (by moving stones, algae, littering, etc.) the entire community may be affected.

3.Collecting:

Nearly everybody that visits the beach or tidepools is fascinated by what they see and desires to bring some souvenir or an object of beauty or curiosity back home with them. However, we should consider nature's viewpoint when tempted to collect.

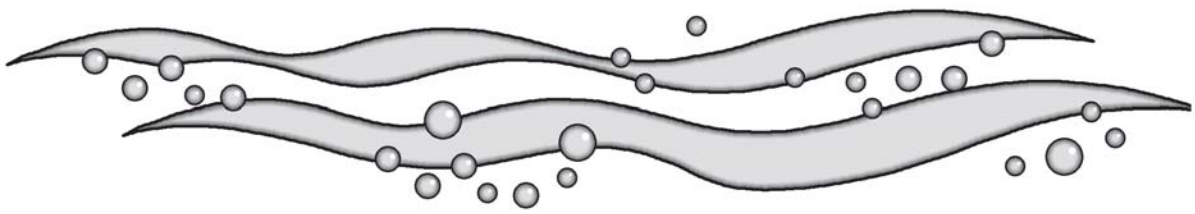
- Living marine plants and animals have complex requirements for food and general living conditions that can't be matched in most aquariums at home or at school. Removing live specimens from their intertidal homes is a certain death sentence for them.

- Dried specimens of certain algae or invertebrates may be attractive when properly prepared. However, preparation may be a complicated (and perhaps smelly) process you may not want to undertake.

- Collecting shells has been a popular hobby for many people. However, each shell is often a complex microcosm of creatures, many of which live on long after the "original owner" is dead. If you look closely at a shell, you are very apt to see tiny white *spirorbis tube worm* shells attached to the inside or outside, or perhaps some *boring sponge* or even a small *boring clam* living in tiny holes in the shell. There may be barnacles, colonies of bryozoans, or beautiful coralline algae encrusting the shell, and that shell may be just the right size for a naked hermit crab looking for a new house. In short, just about every shell is an important home for a multitude of organisms; when you take the shell home, you add to the housing shortage in the intertidal zone.

- For all of these reasons and many others, the state and many local governments have enacted strict regulations prohibiting collecting of plants, animals, shells, and even rocks from beaches and tide pools.

The single most important way we can minimize human impacts on intertidal areas is to educate everybody about better ways to treat these fragile resources. Please pass these tips along to others using beaches and tidepools. When you are in the intertidal, please model the best behavior possible for others; we all learn best by observing others.



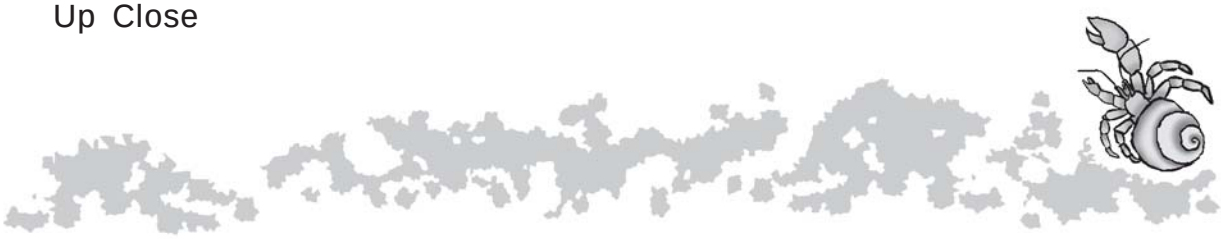
TIDEPOOL NATURALIST PACK CONTENTS

Tidepool Vest
Hand Lens
Transect Line Rope
Clipboards

FIELD GUIDES
Audubon F. G. to the Pacific Coast
Pacific Intertidal Life
Mac's Coastal Invertebrates
Sonoma Coast Invertebrates Sheet

EQUIPMENT
Intertidal Zone charts
Tide Tables
Blank Index Cards
Pencils
Crayons
Magnifying Lenses
Litter Bags
Rainbow Chips

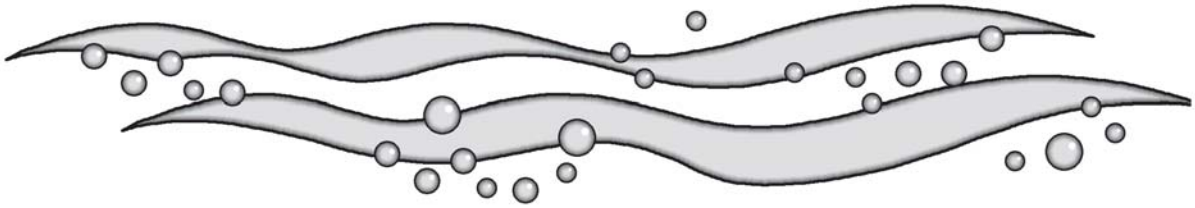
ACTIVITY CARDS
IMPORTANT: Read Me First
Critter Hunt Rules
Make Your Own Critter Card
Ocean Trivia
Rainbows of the Shore
Sand Shadow Art
Seashore Alphabet
"How Raven Made the Tides"
Tide Pool Charades
Tides-Highs & Lows
Up Close



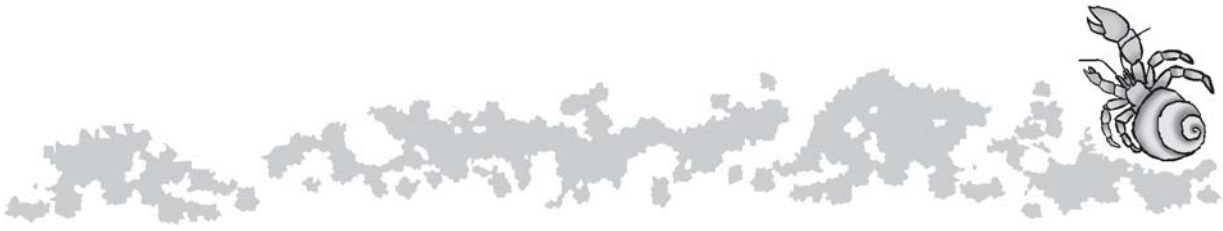
TIDEPOOL NATURALIST PACK CONTENTS (Continued)

CRITTER CARDS

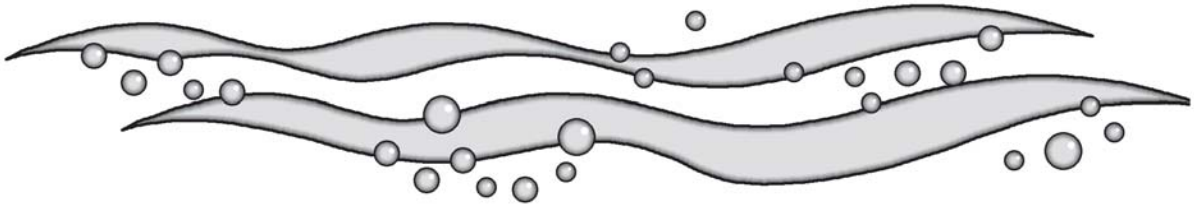
Acorn Barnacle
Aggregated Anemone
Black Turban Snail
California Mussel
Checkered Periwinkle
Common Starfish
Giant Green Anemone
Goose Barnacle
Green Lined Rock Crab
Hermit Crab
Mossy Chiton
Rock Crab
Rockweed
Sculpin
Sea Bat
Shield Limpet
Strand Line
Sunflower Star
Surf Grass
Tidal Zones



PART III
WELCOME TO THE INTERTIDAL ZONE
BACKGROUND INFORMATION

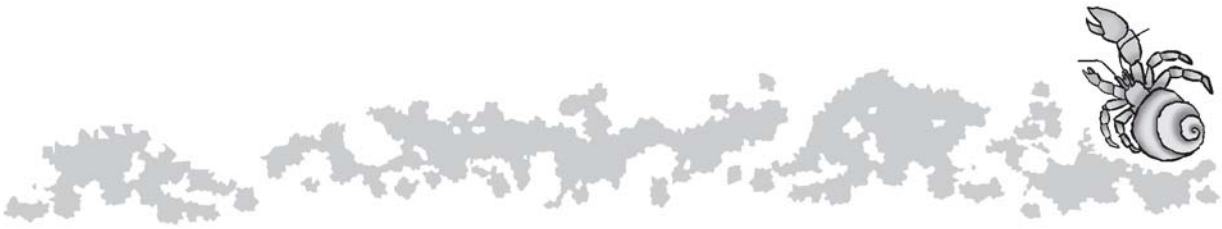


Insert Exploring Tidepool Handouts



TIDEPOOLS

When the ocean's tide recedes, isolated pockets of water- tidepools- are left behind in natural basins among the rocks. These rich and picturesque habitats usually teem with an amazing array of sea life, from snails and sea stars to sea anemones. Although their waters seem tranquil and protected, tidepools are in fact a demanding environment in which only the hardiest of creatures can survive. Alternately, they are drenched at high-tide and then exposed to the atmosphere during low-tide. Beneath hot summer sun, evaporation sometimes makes their water unbearably salty, while sudden downpours can make their waters too dilute for most creatures to endure. Yet many of them do survive making tide pools a fascinating place to explore. Common tidepool organisms have incredible adaptations to help them survive in this harsh environment.

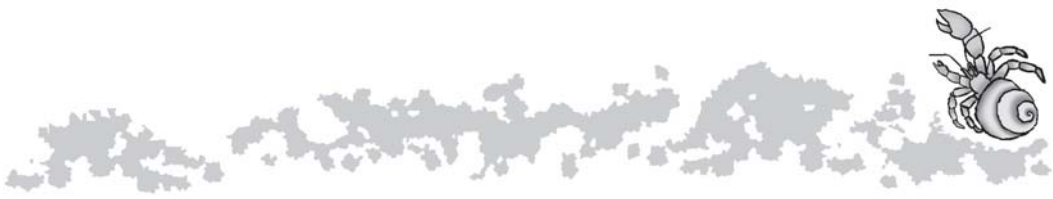


Intertidal Zonation

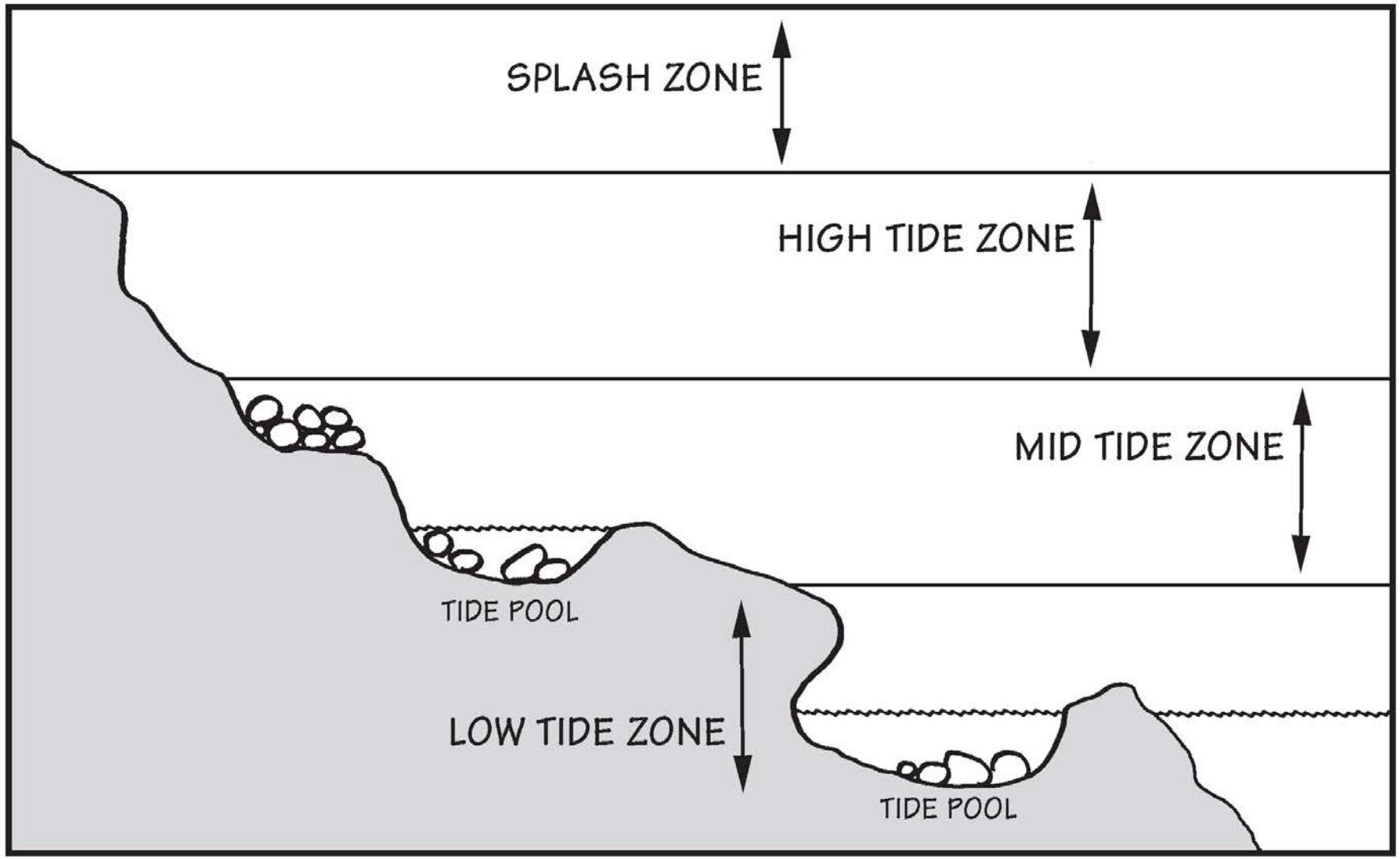
As a result of the variable nature of the tides (how high and low they are), the rocky intertidal area can be divided into zones based on the length of time each area is exposed to the air. This zonation essentially divides the intertidal area into horizontal bands.

Certain plants and animals are found only in a specific zone. We call these **indicator organisms** and can use them to tell which zone we are looking at. The indicator organisms need the specific set of environmental conditions present in that zone. For example, the rock louse must keep its gills wet but can't survive being totally submerged, so it lives in the splash zone.

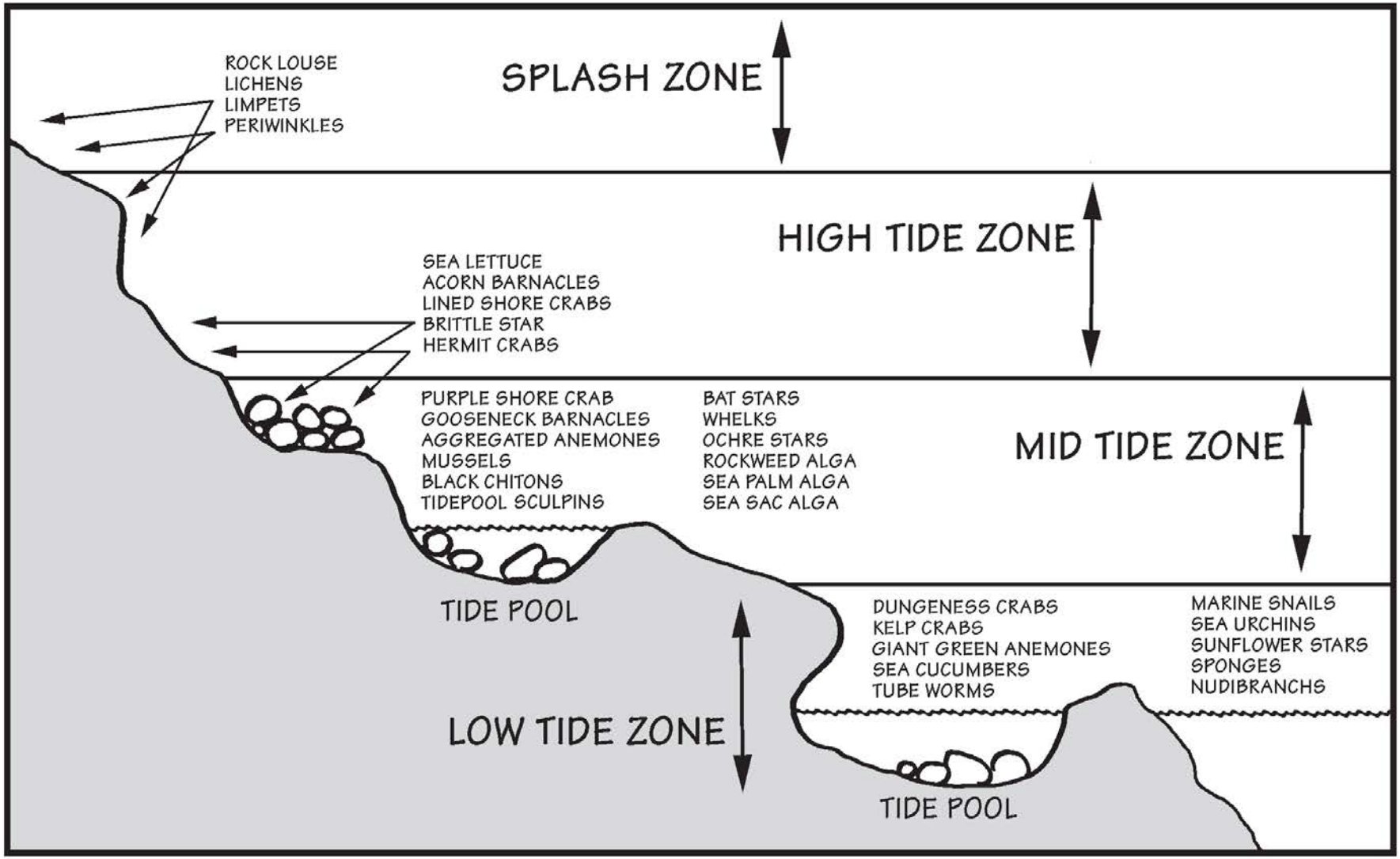
On our coast there are four distinct zones: the splash zone, the high-tide zone, the mid-tide zone, and the low-tide zone.



INTERTIDAL ZONES



INTERTIDAL ZONES

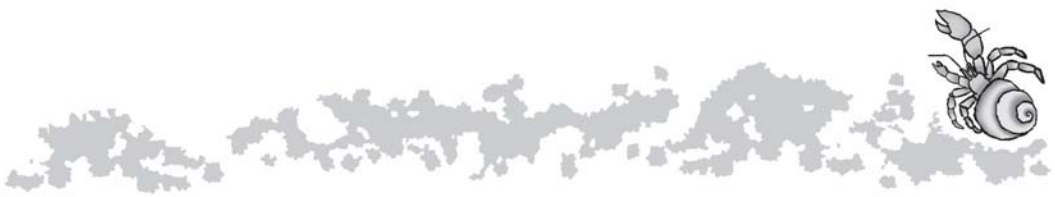


The Splash/Spray Zone

This zone is almost always out of the water except during the highest of high tides. This zone is wetted by the spray of the waves. The plants and animals that occur here need the saltwater spray, but most could not survive being completely submerged.

- This zone is exposed to the air 75-100% of the time.

- Common indicator organisms of this zone are the periwinkle snail, rock louse, and rough limpet.



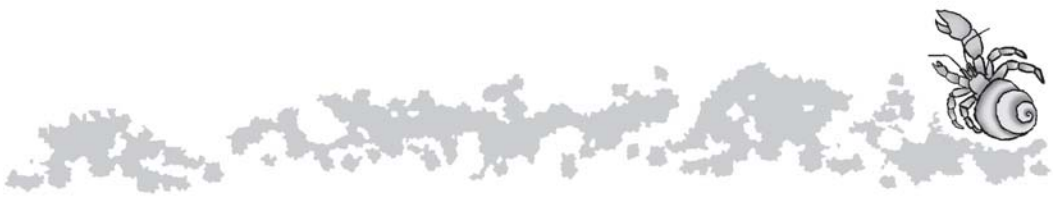
The High-Tide Zone

This zone is out of the water most of the time and completely covered only during high tides. The animals here can withstand a great deal of exposure to the air. Some of the animals in this zone might prefer the lower stress of living in the lower intertidal zone, however, they would likely get eaten or could not compete for space.

- This zone is exposed to the air 35-75% of the time (more than 12 hours a day).

- Common organisms include green-lined shore crabs,hermit crabs, and black turban snails. Hermit crabs and black turnban snails can also be found in the mid-tide zone.

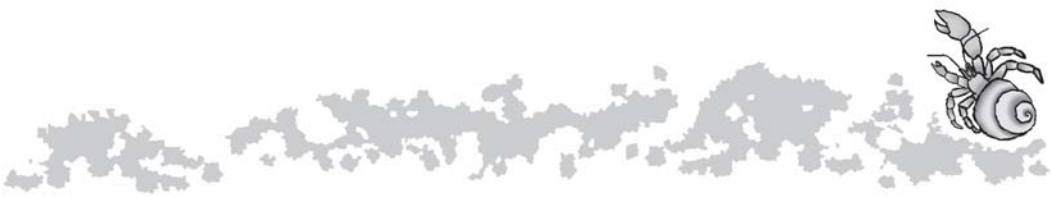
- Plants of this zone include sea lettuce (*Ulva*), rock weeds (*Fucus*) and brillo pad algae(*Endocladia*).



The Mid-Tide Zone

This zone is usually covered and uncovered each day. The animals in this zone are covered for a longer period of time than they are exposed to the air. This zone is usually characterized by a dense cover of algae.

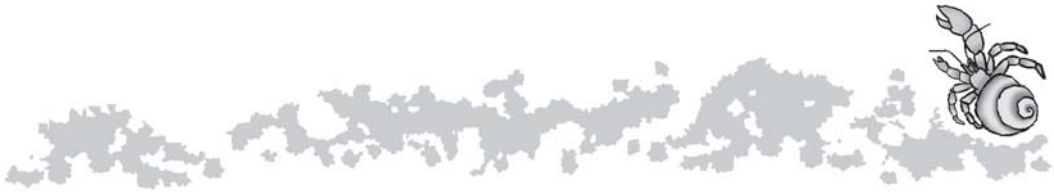
- It is hard to find bare rocks here.
- This zone is exposed to the air 7-35% of the time (at least once a day for 5 to 6 hours).
- Common indicator organisms of this zone include the aggregating anemone, gooseneck barnacle, mussels and the ochre sea star.
- Plants of this zone are plentiful and offer protection for many animals. Red algae and sea sack algae are found here.



The Low-Tide Zone

This zone is exposed to the air for only several hours a month during minus tides. The animals in this zone can not withstand much exposure to the air. Bright green surf grass often characterizes this zone.

- This zone is exposed to the air 7% of the time or less.
- Common indicator organisms for this zone include the giant green anemone, purple sea urchin, kelp crab, and abalone.
- Plants of this zone include surf grass and brown kelps (*Laminaria*).

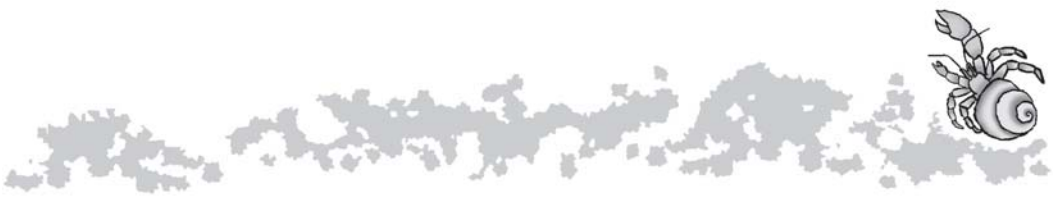


TIDEPOOL ZONATION

When we are looking at tidepools in particular, the organisms found in each zone may vary a bit.

This is due to the fact that tidepools trap water and hold it, even while the surrounding area is dry at low tide.

An example of this is the fact that surf grass (usually found in the low-tide zone) can be found in tidepools in generally mid- to high-tide zone tidepools.



Dear Tidepool Education Volunteer,

The intertidal area is a very unique environment that many school children have not been exposed to before. School age children have the need to explore and become comfortable in new surroundings. Videos or slide presentations about the area viewed prior to their visit can greatly speed up this phase.

To prepare students for their visit to the tidepools of Sonoma Coast State Beach we are providing teachers with the video “The World Between the Tides” to view in the classroom prior to their visit.

Please watch the video “The World Between the Tides” and review the following questions and activities. Think about how you can incorporate the material into a rewarding tidepool exploration for both the students and yourself.

"THE WORLD BETWEEN THE TIDES" VIDEO QUESTIONS

LEVELS: GRADES 1ST THROUGH 8TH

OBJECTIVES:
Students will be able to:

1. Anchor and articulate intertidal zone knowledge gained through watching the video "The World Between the Tides"

MATERIALS:

1. A copy of "The World Between the Tides" Video
2. A copy of the question sheet for each student
3. A writing implement
4. Additional resources such as marine field guides (if desired)
5. Teacher's answer sheet

TIME:

Preparation: 15 minutes
Activity: Video Run Time: 23 minutes
Questions: 15 to 30 minutes

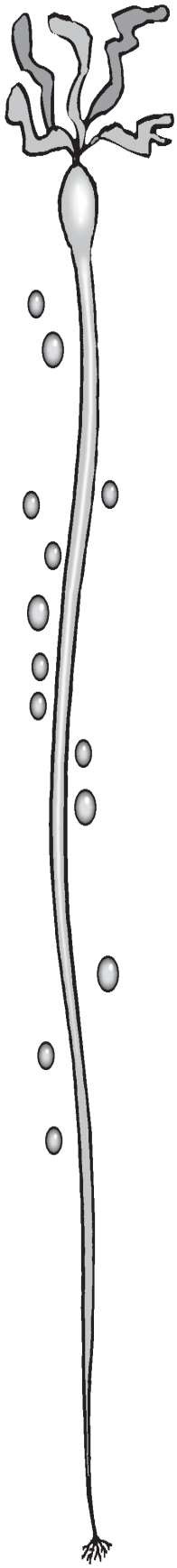
Directions:

1. **DISTRIBUTE** question sheets to students

2. **PLAY/SHOW** the video "The World Between the Tides" in each zone

3. **REVIEW** the information covered in the video with the class (for younger students you may want to answer the questions as a class)

4. **ANSWER**: have students answer the following questions.



TIDEPOOL PRE-SITE ACTIVITY

"THE WORLD BETWEEN THE TIDES" VIDEO QUESTIONS

1) Name three things that make the intertidal zone a "tough neighborhood."

2) Name some of the features that make the intertidal zone such a crowded place.

3) Name three examples of intertidal zone dwellers' adaptations to their environment.

4) What causes the tides?

5) What do most species of algae have in common?

6) How do barnacles withstand the conditions in the intertidal zone?

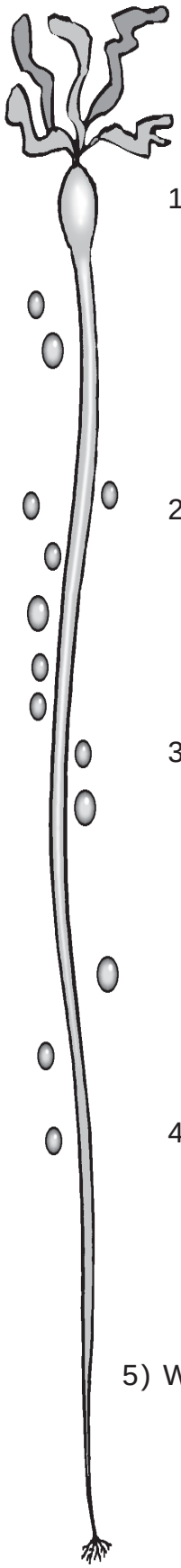
7) How do mussels stay in one place?

8) Why is the ochre star called a Keystone Species?

9) What do the sea urchin, sea star, and sea cucumber all have in common?

10) Name three things we can do to avoid damage to intertidal animals and plants when we visit the shore.

TIDEPOOL PRE-SITE ACTIVITY



"THE WORLD BETWEEN THE TIDES" VIDEO QUESTIONS: ANSWER SHEET

1) Name three things that make the intertidal zone a "tough neighborhood."

-organisms are exposed to the air in very low tides
-waves pound the shore
-salinity in tidepools increases (due to evaporation)
-salinity in tidepools decreases (due to rainfall in tidepools)

2) Name some of the features that make the Northwest's intertidal zone such a crowded place.

-upwelling
-extensive habitat: rocks, crannies, and pools
-fog protects the zone from sun along the shore

3) Name three examples of intertidal zone dwellers' adaptations to their environment.

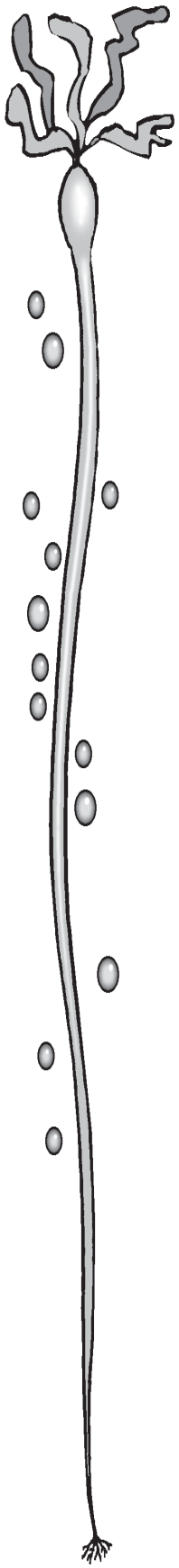
-a firm anchor
-special trap door (barnacle)
-coat of armor, tough skin (exoskeleton)
-2 shells that clasp together (mussels)
-tube feet (seastar)
-folds itself up (anemone)

4) What causes the tides?

-The pull of the sun and moon play tug of war with the tides. The moon has the greatest influence. The moon pulls the earth away from the water on the opposite side.

5) What do most species of algae have in common?

-They contain green chlorophyl with which they use the sunlight to photosynthesize.



6) How do barnacles withstand the conditions in the intertidal zone?

-They glue themselves to rocks.
-They have a trapdoor they can close to stay moist.

7) How do mussels stay in one place?

-They use very strong threads called byssal threads.

8) Why is the ochre star called a Keystone Species?

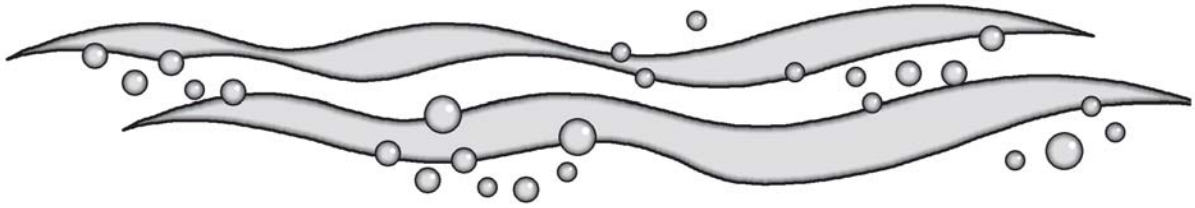
-Because its presence influences the distribution of mussels, goose barnacles, and many other creatures.

9) What do the sea urchin, sea star, and sea cucumber all have in common?

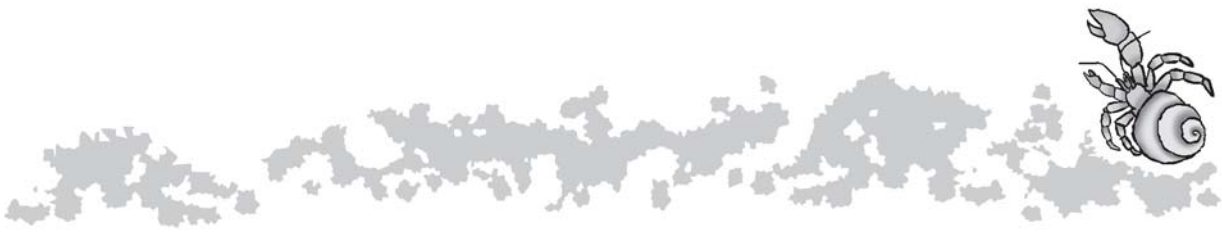
-tube feet

10) Name three things we can do to avoid damage to intertidal animals and plants when we visit the shore.

-walk with care - step only on bare rock
-look, don't touch
-if you turn over a rock, replace it exactly as you found it
-do not pick-up clinging "animals" such as limpets, snails and urchins - they need to hang on at all times



PART IV
INTERTIDAL ANIMALS



CLASSIFICATION OF INTERTIDAL INVERTEBRATES

Over time humans have cataloged and classified everything in the surrounding natural environment.

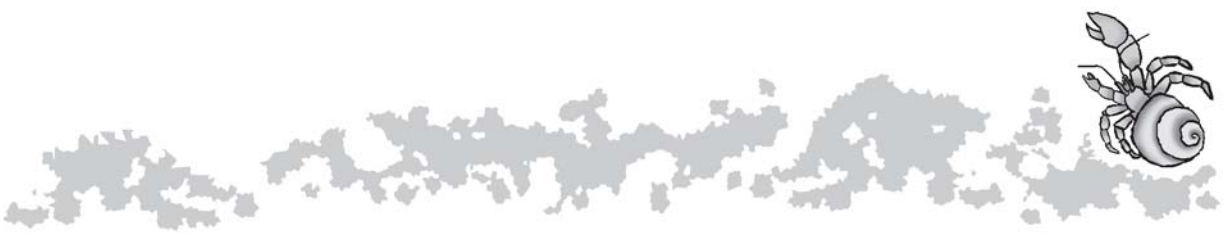
The current classification system begins at the top with the Kingdom level. There are five Kingdoms:Animals, Plants, Fungi, Protists, and Monerans.

The Kingdom are then divided into more specific categories based on specific characteristics. These categories are known as Phylum. In this manual we will use the Phylum level to discuss the types of intertidal animals found on Sonoma Coast.

If we wanted to get even more specific the classification system continues down to Class, Order, Family, Genera and Species.

The first thing to notice about most intertidal organisms is that they are invertebrates – they lack a backbone.

For our purposes we will discuss only the **phyla** of the most **common invertebrates** found in Sonoma Coast tidepools.



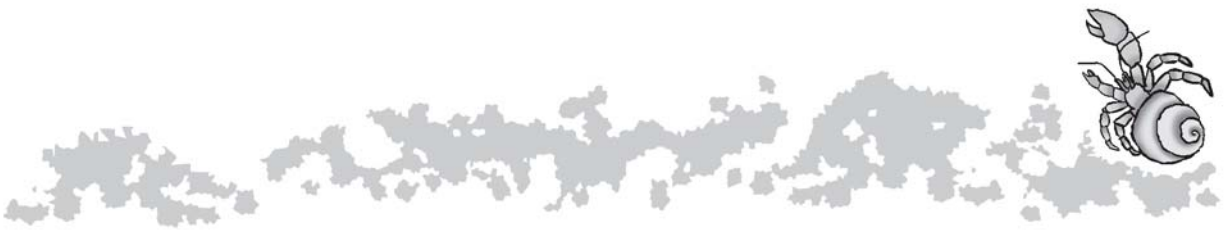
PHYLUM ARTHROPODA:

Animals:

Crab, Barnacle, Shrimp, Isopod, and Amphipod

Distinguishing Characteristics:

- A hard exoskeleton which must be molted as the animal grows
- Jointed legs
- Most have three main body parts: a head, a thorax, and legs
- Complete digestive system: food goes in the mouth and exits via the anus
- Sexual reproduction



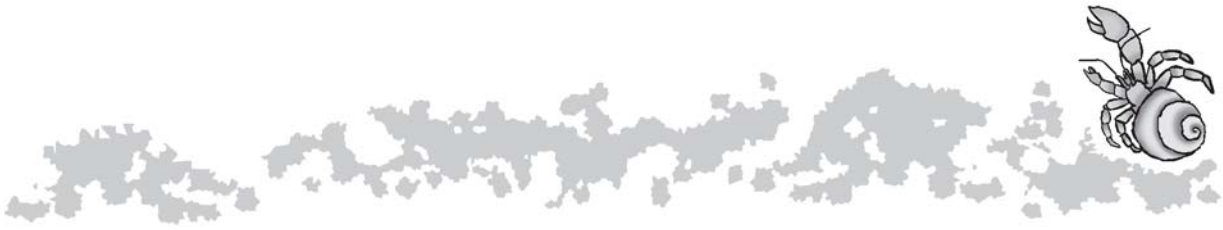
PHYLUM CNIDARIA:

Animals:

Sea Anemones, Jellyfish, Hydroids, and Corals

Distinguishing Characteristics:

- Stinging cells called nematocysts which are used for two purposes: to capture prey and to defend itself
- Mouth is surrounded by a ring of tentacles
- Display radial symmetry
- Food goes in and comes out through the mouth
- Some can reproduce asexually through cloning



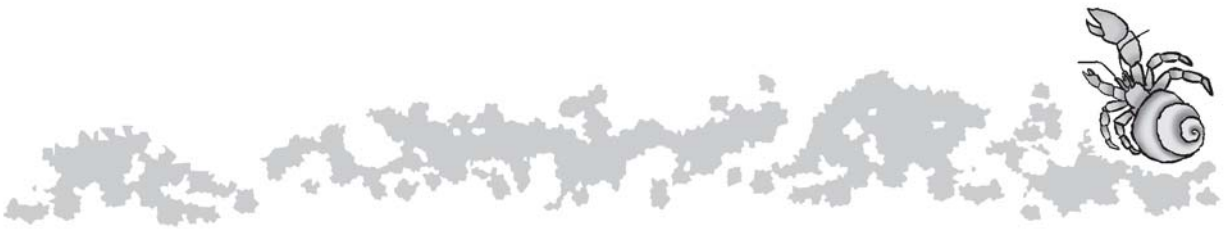
PHYLUM ECHINODERMATA:

Animals:

Sea Star, Sea Cucumber, and Sea Urchin

Distinguishing Characteristics:

- A water vascular system is used to operate tube feet: sea water is pumped through the body in a series of canals which operate the tube feet of these animals
- Spiny skins
- Radial symmetry in adults



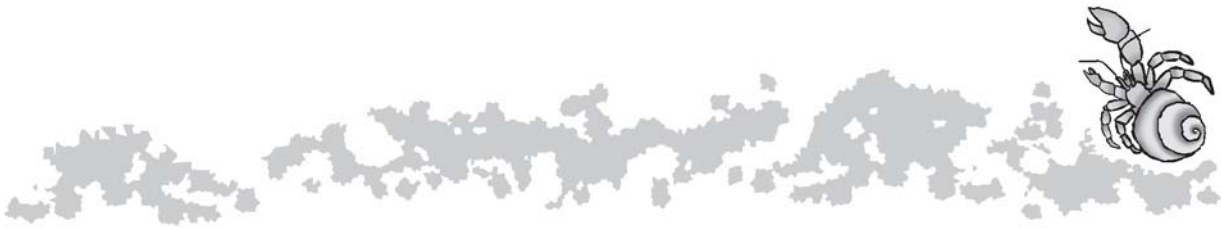
PHYLUM MOLLUSCA:

Animals:

Bivalves, Snails, Chiton, Sea Slugs, Squid, and Octopus

Distinguishing Characteristics:

- Use a radula – file-like tongue
- Muscular used for locomotion
- Unsegmented body
- Mantle tissue secretes a shell
- Special gills called ctenidia are used for respiration
- Have a complete digestive system: mouth and anus
- Reproduce sexually
- Bilateral symmetry



STRATEGIES FOR SURVIVAL

Animals (and plants) in the intertidal area face unique challenges for survival.

Temperatures range from hot to bitter cold. As tidepools heat up, oxygen levels go down and metabolic rates go up. For each 10-degree change, metabolic rates double.

Organisms must tolerate high/low salinity (animals who tolerate a wide range of salinity are called **euryhaline**)

Hot days = HIGH salinity
Rainy days = LOW salinity

Many organisms do not live in areas best suited for their needs, exposing them to more predation because they can't compete in a more hospitable zone.

1. AVOID DESICCATION

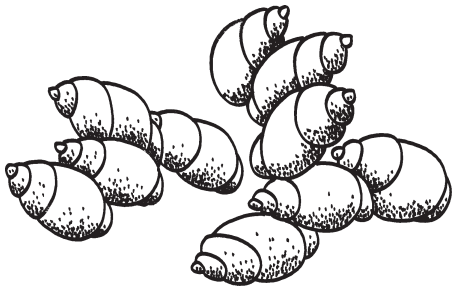
Animals must devise ways to stay moist (not dry out).

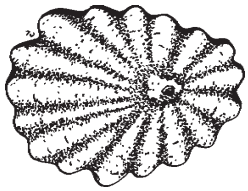
Locomotion - Lined Shore Crab, Snails
Exoskeleton- Mussels, Barnacles, Snails will close their shells tightly
Congregate - Anemones and Periwinkles gather in masses
Contract - Anemones
Hide in crevices / Moist depressions - Crabs, Snails, Anemones

2. SURVIVE EXPOSURE TO WAVE ACTION

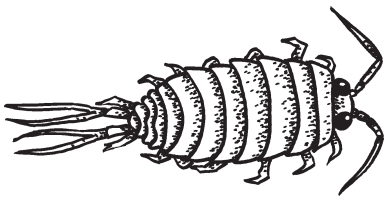
All organisms must protect themselves from wave action. Animals must have behavioral or structural adaptations.

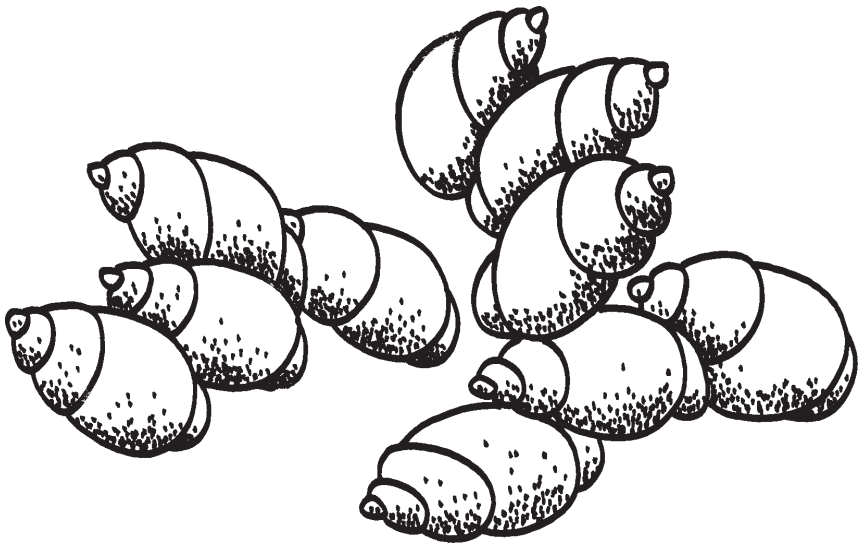
Locomotion, move between or under rocks - Lined Shore Crab, Snails
Depressions or Burrows, by mechanical or chemical means, burrow in the rocks - See Urchin and Periwinkles
Attachment - Sea Star (tube feet), Limpet (Basal foot), Algae - hold fasts (root like)
Cement - Barnacles
Guy Lines - Mussels





Splash Zone Animals





Periwinkle Snail

Mollusc

Littorina sp.

The tiny periwinkle snail is a common resident of the splash zone.

Adaptations: The periwinkle snail has a trap door that it can pull shut to avoid drying out. At the same time it uses a glue-like substance to stay attached to the rock.

The periwinkle snail is only able to survive splashes of mist and water to keep itself moist. They cannot live completely under water. This tiny black snail is often found in large numbers in the cracks and crevices of rocks in the splash zone. The periwinkle snail rarely wanders from the site where it was born. This snail uses a file like tongue called a radula to feed on the algal film on rocks. This snail can completely withdraw and close a trap door called an operculum to keep it safe from predators and water loss. It can then produce a mucus which acts like glue in keeping the snail attached to the rocks and keeping it moist.

Additional information can be found in Pacific Intertidal Life, page 20.

ROUGH LIMPET

Limpet

Mollusc

Collisella spp.
Notoacmea spp.
Lottia giganteus

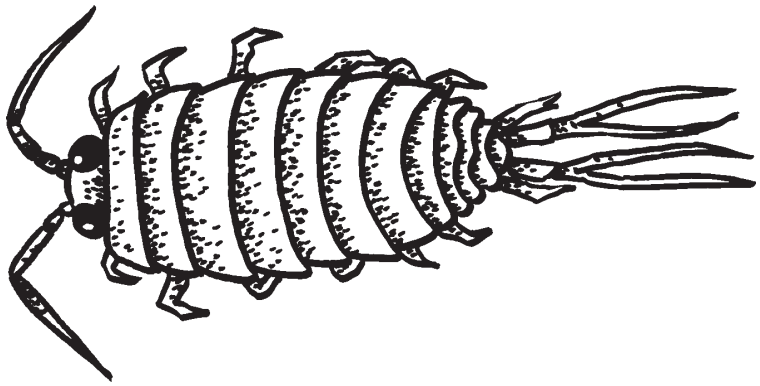
A variety of limpets are common residents in the intertidal area.

Adaptations: Limpets have a strong foot like a snail and a conical shell; they can cling tightly to rocks. Some limpets always return to a “home scar” where their shells have grown to fit the rock.

While they may look like barnacles, limpets are actually relatives of the snail. They use their strong foot to hold on tightly. Most limpets are grazers. Limpets are prey for sea stars, some snails, crabs, and shore birds.

The rough limpet is a common resident of the high-tide and splash zones. It is a browser that moves around and eats algae when the tide is in. It uses a file-like tongue called a radula to scrape algae from the rocks. It has no eyes, but can still return to exactly the same place “home scar” every day.

Additional information can be found in Pacific Intertidal Life, pages 8 - 11.



Rock Louse

Arthropod

Ligia occidentalis

The rock louse, a rock slater, is a common resident of the splash zone.

Adaptations: The rock louse is camouflaged to match its environment.

The rock louse resembles a cockroach, and may be seen scurrying around in the splash zone. This animal needs the spray to keep its gills wet, but it can not survive under water because it breathes air. During the day it hides in cracks and crevices. At night it forages on the film of algae in the splash zone.

Additional information can be found in Pacific Intertidal Life, page 37.

Acorn Barnacle

Arthropod

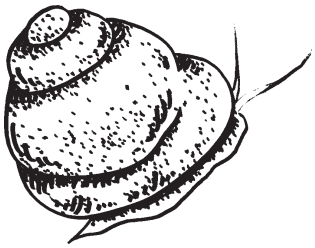
Balanus glandula

The acorn barnacle is a common resident of the splash and high-tide zones.

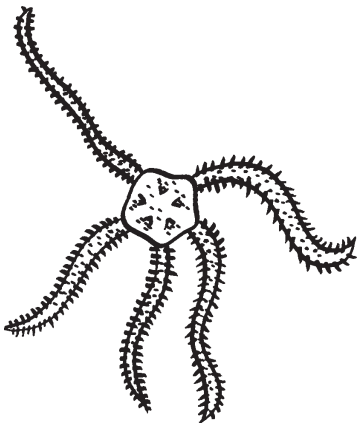
Adaptations: The acorn barnacle cements itself to a hard surface. It has a hard shell with two plates that it can pull shut to protect it from drying out.

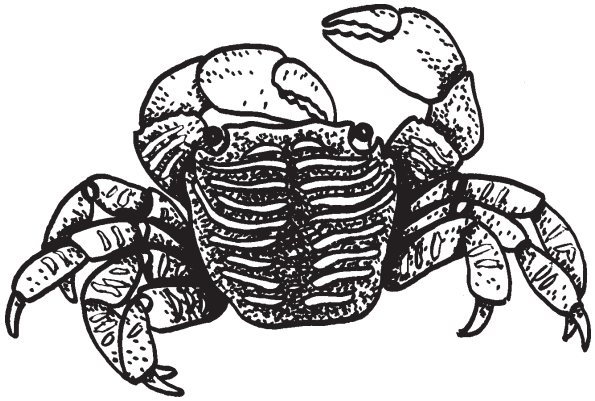
A relative of the crab, young barnacles are free floating for their first weeks of life. They can detect others of their kind (even though barnacles are blind), and when they do they settle by cementing their head to a rock or other surface they build a shell around themselves. The shell has plates that close up when the barnacle is exposed to the air. Once under water, the plates open up and the barnacle extends its feathery legs to get food (plankton).

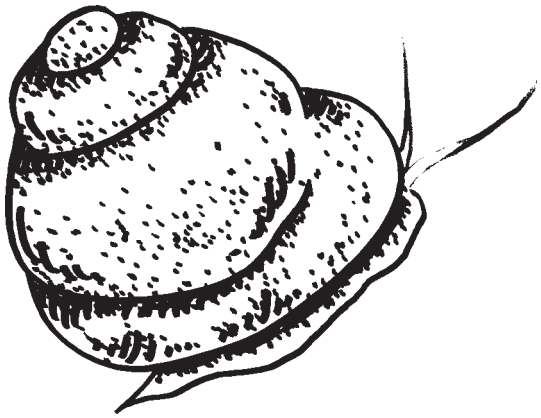
Additional information can be found in Pacific Intertidal Life, page 38.



High-Tide Zone Animals







Black Turban Snail

Mollusc

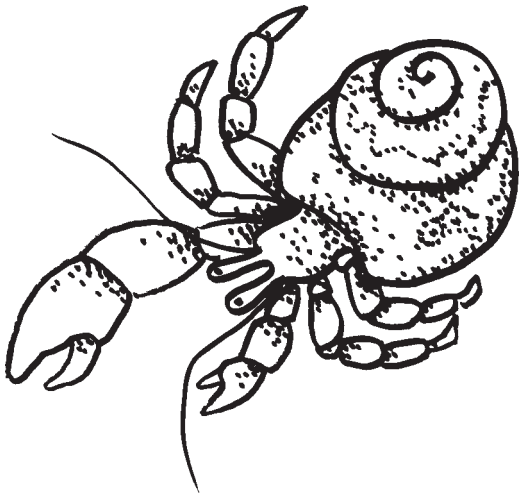
Tegula funebralis

The black turban snail is a very common resident of the high- to mid-tide zones.

Adaptations: The back turban snail uses a strong foot to cling to rocks; it can also right itself after being flipped over.

The black turban's shell is favored by hermit crabs. This snail clings to the sides of rocks and stays under water as much as possible. It is a grazer, using a file-like tongue called a radula to scrape algae from the rocks. One lick of its tongue can leave a visible mark on a piece of kelp. If tipped over by a wave, this snail can actually pick up sand with its foot, which it then uses to weight itself to help it flip back over. This snail is often found clustered in crevices under rocks to keep moist and avoid predators, which include the rock crab, ochre sea star, drills, and octopus. A unique adaptation of this snail is that if it touches an ochre sea star it will turn 180 degrees and head off as quickly as possible. This remarkable little snail can live up to 25 years!

Additional information can be found in Pacific Intertidal Life, page 19.



Hermit Crab

Arthropod

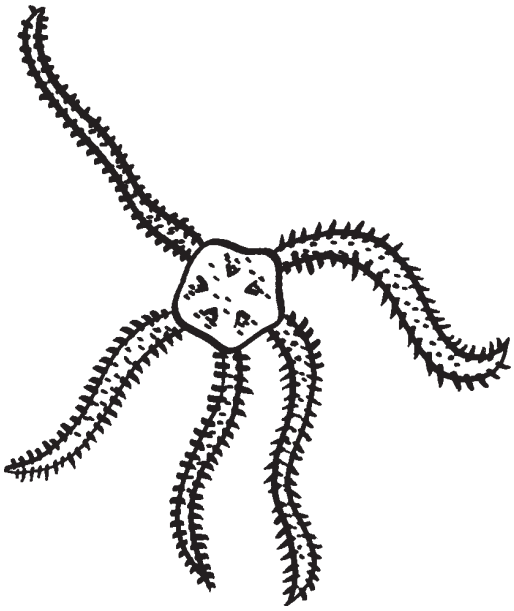
Pagurus spp.

Hermit crabs are a common resident of the mid-tide zone as well as lower zones.

Adaptations: The hermit crab lives its whole life in the discarded shells of other animals.

The hermit crab is not a true crab. It is born without a home and uses the shells of others (most often black turban snail shells along our coast). As it grows, it must find bigger shells. Hermit crabs will fight over shells and even steal shells from each other. The hermit crab is not a hunter. It is a scavenger and herbivore. Hermit crabs are the clowns of the tidepools.

Additional information can be found in Pacific Intertidal Life, page 43.



Brittle Star

Echinoderm

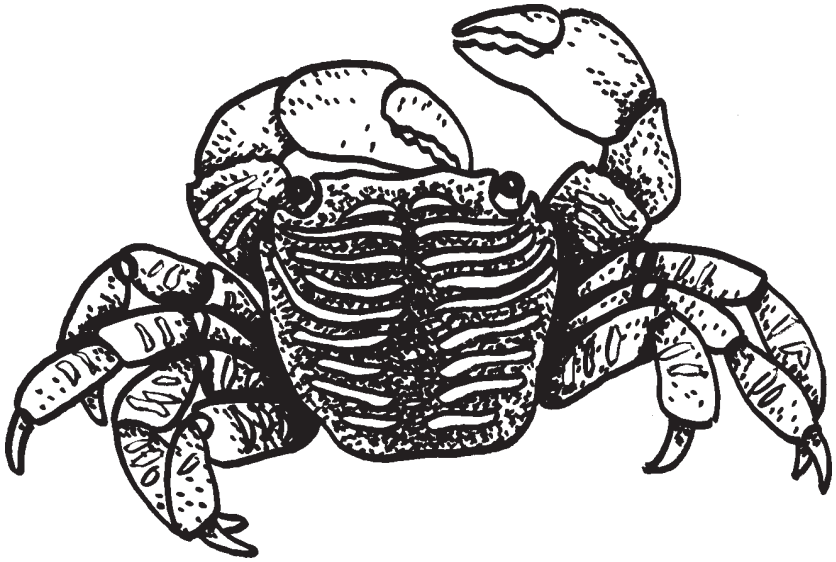
Amphipholis pugetana

Brittle stars are a resident of the high-tide zone (under rocks) and the lower zones.

Adaptations: The brittle star is a fast mover.

The brittle star is a small, fast moving sea star often found in groups under rocks for protection. It is the smallest sea star on our coast. It drops its arms easily, and does not extrude its stomach like other sea stars do. It feeds on detritus.

Additional information can be found in Pacific Intertidal Life, page 33.



Lined Shore Crab

Arthropod

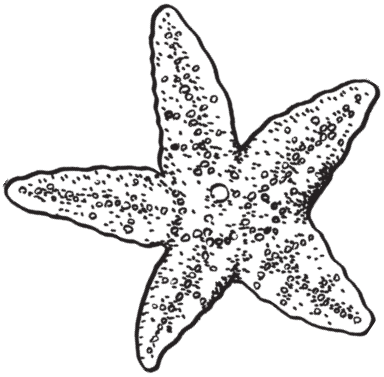
Pachygrapsus crassipes

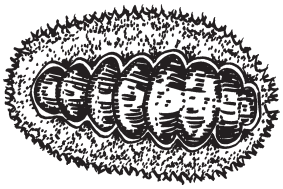
The lined shore crab is a common resident of the high-tide zone.

Adaptations: The green-lined shore crab is very flat so it can hide in crevices. It also has good eyesight and can move quite quickly out of harm's way.

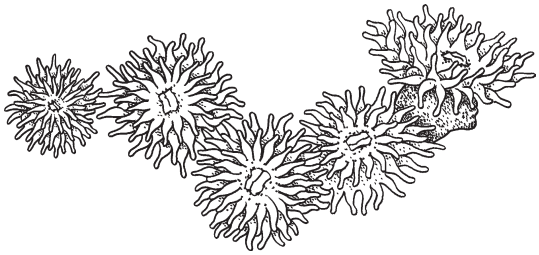
The green lined shore crab is the dominant crab of the high tide zone from Oregon to Mexico. This crab is out of the water much of the time and is able to survive in a variety of temperatures. Its flat body allows it to hide in rock crevices. It is very active (it actually runs sideways) and will run away if threatened. If it is unable to run away, it will raise its pinchers (which are 40 times as strong as a man's hand in proportion to its size). This crab is able to lose its claw and grow a new one. This crab eats mostly algae,but will scavenge as well. It uses tiny suction cups on its pinchers to scrape small plants off rocks.

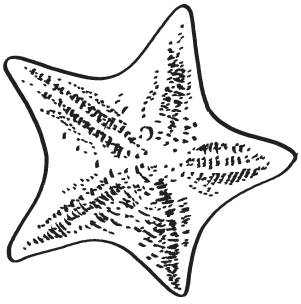
Additional information can be found in Pacific Intertidal Life, page 40.

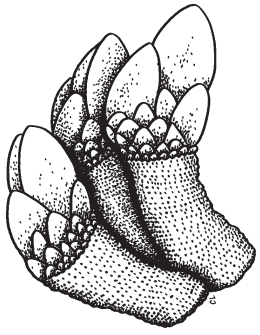


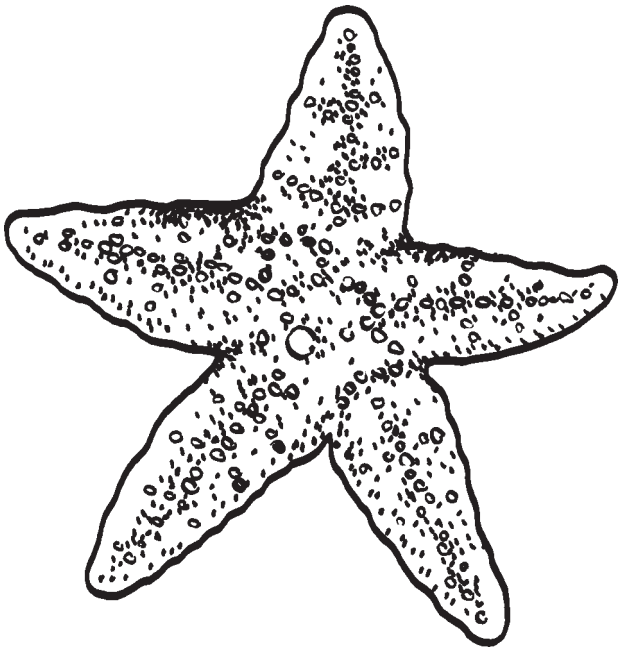


Mid-Tide Zone Animals









Ochre Sea Star

Echinoderm

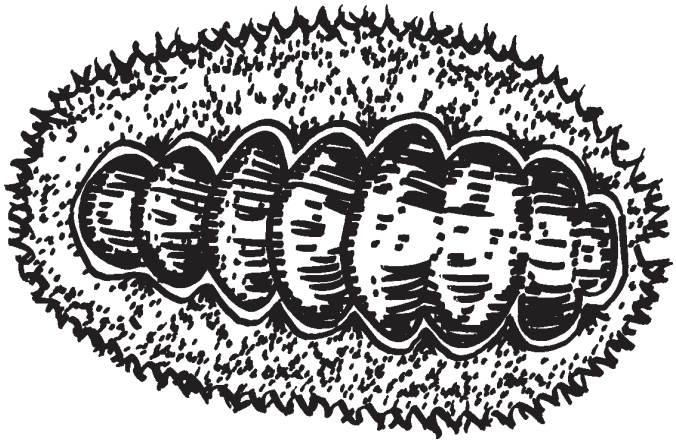
Pisaster ochraceus

Ochre sea stars are common residents of the mid-tide zone. They can occur in other zones as well.

Adaptations: The ochre sea star has strong tube feet to hang on with and to use to open its prey.

The ochre sea star is the most common sea star from Canada to Mexico. It uses hundreds of tiny tube feet to hang onto rocks and to pry open mussels. It is a predator whose favorite food is mussels. It will also eat a variety of other foods, including barnacles, limpets, snails, and sea urchins. Ochre sea stars have the ability to extend their stomachs outside of their body into or onto their prey to eat it. The ochre star needs only a small opening (of less than a mm.) to insert its stomach into the shell and eat the animal it has captured.

Additional information can be found in Pacific Intertidal Life, page 31.



Mossy Chiton

Mollusc

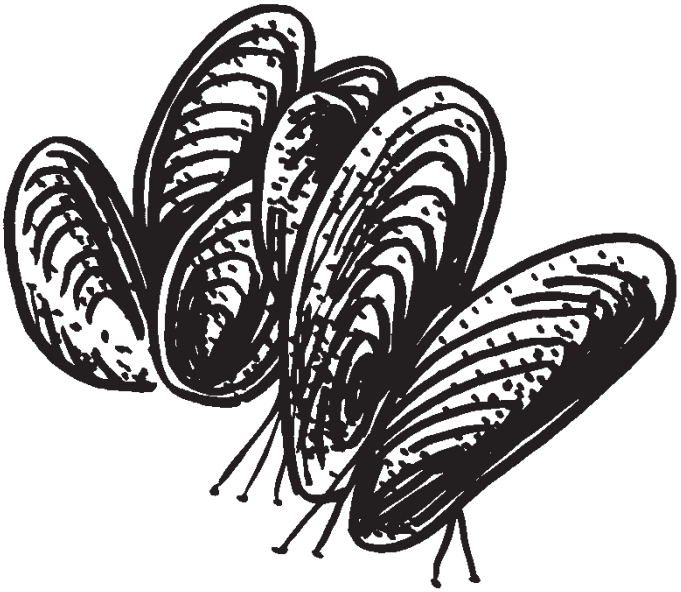
Mopalia muscosa

The mossy chiton is a fairly common resident of the mid- to low-tide zones.

Adaptations: The mossy chiton has a shell that is a series of eight plates. It has a strong foot that allows it to conform closely to the shape of a rock. If a chiton is dislodged, it can roll up like a pill bug to protect its soft underside.

Chitons that are rolled up are known as “sea cradles.” The mossy chiton is primarily a grazer, using a file-like tongue or radula to feed. The mossy chiton will eat seaweed and sometimes mussels and barnacles. It is eaten by sea stars, crabs, and shore birds.

Additional information can be found in Pacific Intertidal Life, page 15.



California Mussel

Mollusc

Mytilus californianus

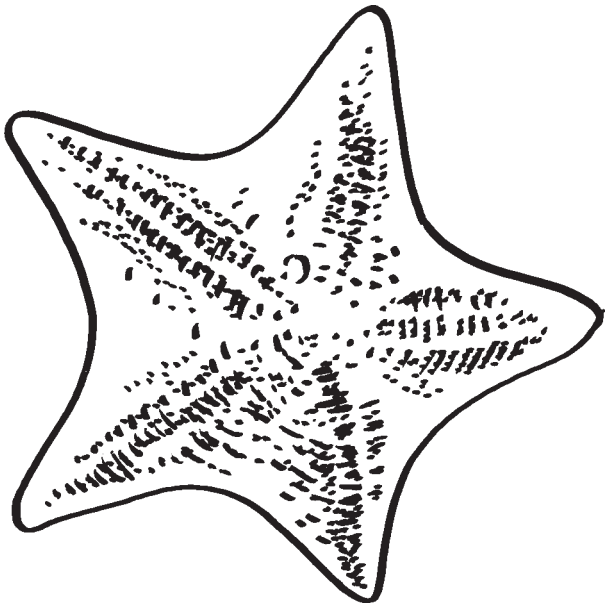
The California mussel is a common resident of the mid-tide zone.

Adaptations: Mussels are adapted to life in the intertidal zone by having strong byssal threads with which to attach to rocks and two shells that can clamp tightly shut. The byssal threads look like plastic, but are stronger than super glue.

This animal is free floating at first and then finds a spot to settle with other mussels. The mussel is a bivalve mollusk (it has two shells). Mussels are filter feeders who eat plankton. A mussel has to filter two to three quarts of water an hour. As a result, they prefer areas with lots of wave action. Mussels often occur in large colonies. Mussels are the favorite prey of ochre stars.

CAUTION: Humans enjoy eating mussels as well. However, from May until October there is quarantine on eating mussels. During this time the mussels filter a toxic phytoplankton that does not harm the mussels, but is poisonous to other animals and humans. The mussels accumulate a great deal of this toxin in their bodies by filter feeding.

Additional information can be found in Pacific Intertidal Life, page 17.



Bat Star

Echinoderm

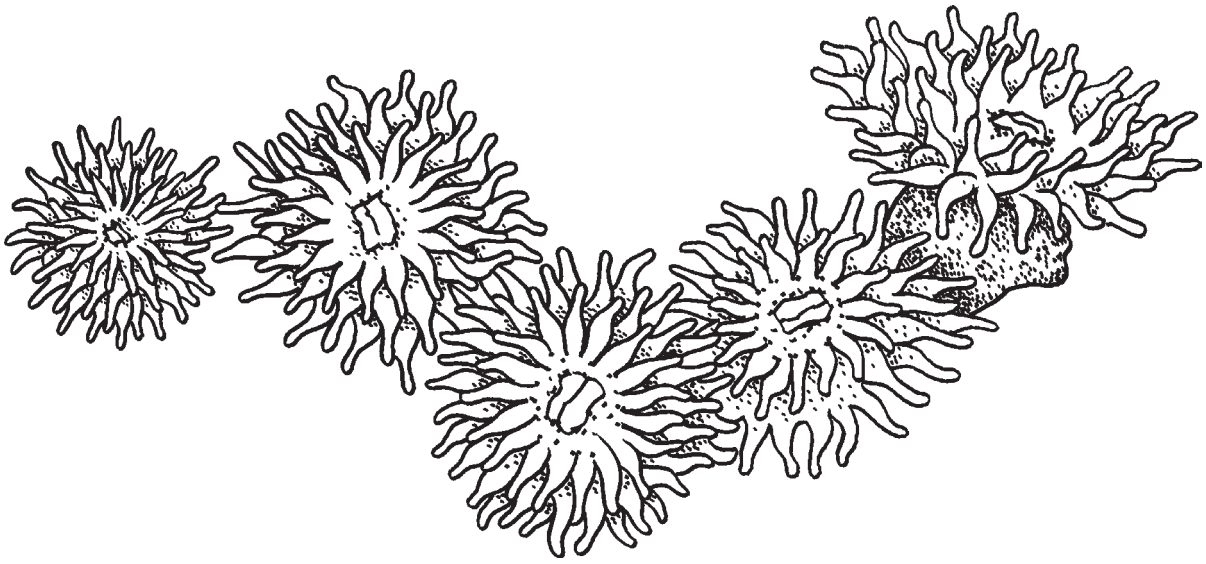
Patiria miniata

The bat star is a resident of the mid- to low-tide zones.

Adaptations: The bat star wedges itself between rocks in rough water.

This creature gets its name due to the webbed nature of its arms, which resemble bat's wings. It has tiny tube feet that make it mobile, help it hang on to rocks, and help it eat. It is a scavenger and an omnivore. It actually extrudes its stomach over rocks to eat the clinging algae. It has the most vegetarian diet of any sea star. Small animals run away from most sea stars, but not the bat star.

Additional information can be found in Pacific Intertidal Life, page 30.



Aggregating Anemone

Cnidarian

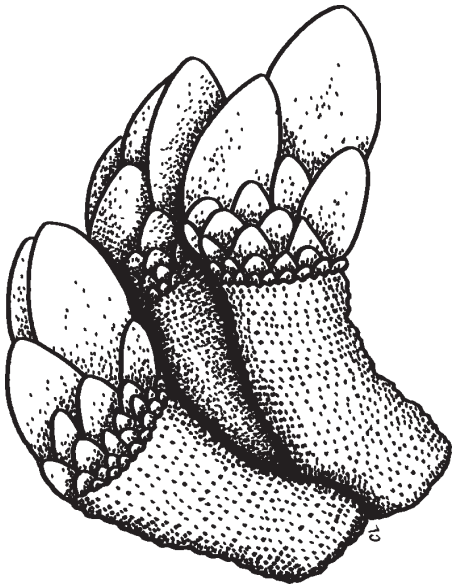
Anthopleura elegantissima

The aggregating anemone is a common resident of the high- to mid-tide zones.

Adaptations: The aggregating anemone covers itself with sand and can pull its tentacles in and close up to avoid drying out and to elude predators.

Although it looks a great deal like a flower when submerged, the anemone is actually an animal. It often appears that rocks are covered with sand, but upon closer examination, the sand is squishy and squirts water, meaning the rocks are actually covered with aggregating anemones. These animals reproduce by asexual reproduction in a process called budding, where they pinch off a bit of themselves, and it grows into another anemone. This animal is often found in large colonies (many times all clones from the same individual). Anemones have tentacles that contain stinging cells (nematocysts), which inject a paralyzing poison, into their prey (such as rocklice and small fish). The anemone's stomach i surrounded by its tentacles. If threatened, the anemone will close up.

Additional information can be found in Pacific Intertidal Life, page 29.



Goose Barnacle

Arthropod

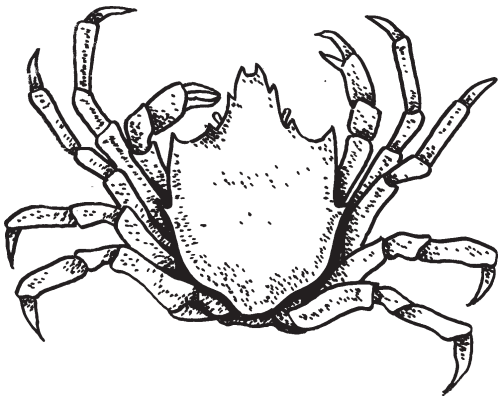
Pollicipes polymerus

The goose barnacle is a common resident of the mid- to low-tide zones.

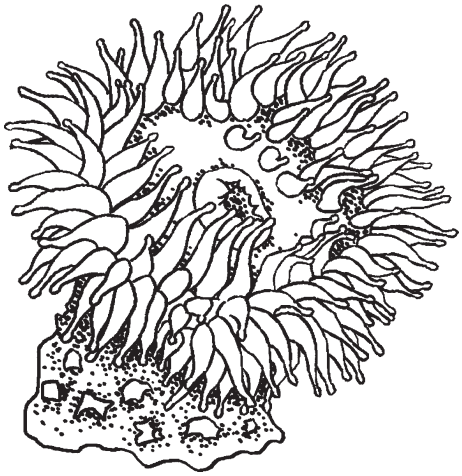
Adaptations: This barnacle has a flexible neck that allows it to turn to face the direction of incoming water to help it get the most food. It can also clamp its hard shells shut to keep wet when the tide is out.

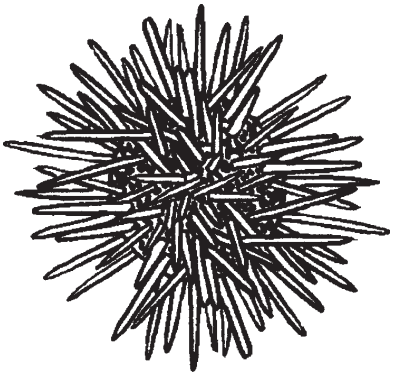
The goose barnacle is often found with the California Mussel in areas of high wave activity. It consists of plates at the end of a fleshy neck. This flexible neck allows the barnacle to rotate in different directions. Groups of this barnacle are often all facing the same direction. When submerged under water, the barnacle opens its plates and extends feathery legs to feed on plankton.

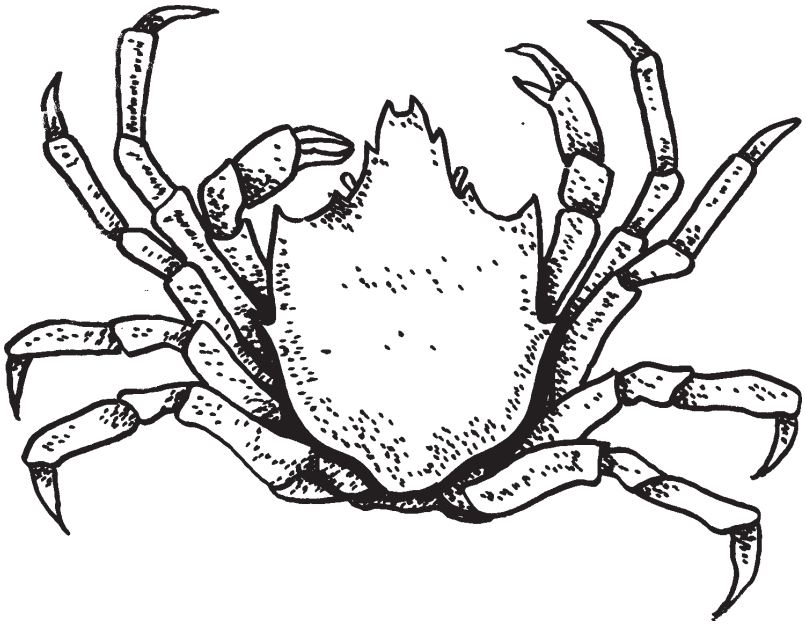
Additional information can be found in Pacific Intertidal Life, page 39.



Low-Tide Zone Animals







Kelp Crab

Arthropod

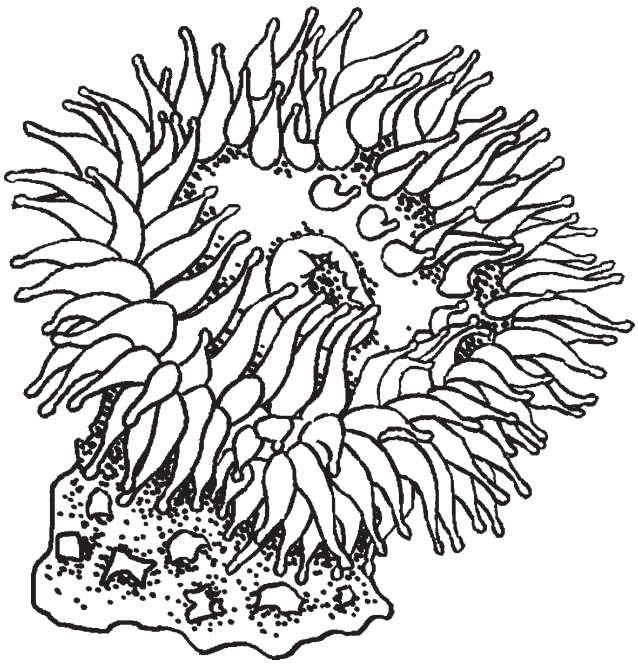
Pugettia producta

The kelp crab is a resident of the lower intertidal zone.

Adaptations: The kelp crab has a long slender body and legs designed to hang on to kelp. It is quite well camouflaged there.

The kelp crab is a slender, smooth looking crab. It lives on and eats kelp, and often takes on the color of the kelp. This crab can deliver a painful pinch. Kelp crabs often have barnacles and hydroids growing on them.

Additional information can be found in Pacific Intertidal Life, page 42.



Giant Green Anemone

Cnidarian

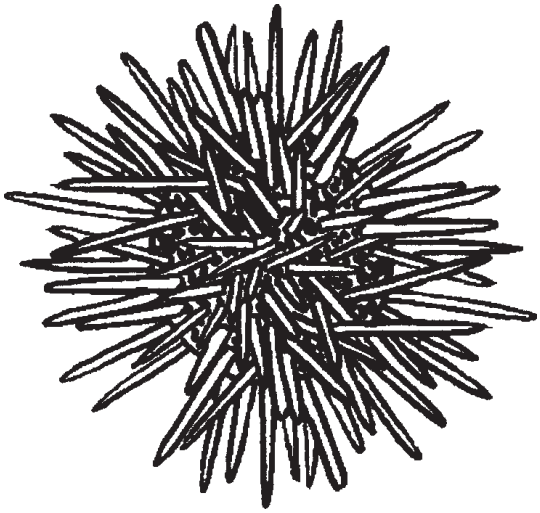
Anthopleura xanthogrammica

The giant green anemone is a common resident of the mid- to low-tide zones.

Adaptations: The giant green anemone can pull itself in to avoid drying out and to evade predators. This anemone gets its green color from an algae that lives in it and helps it to thrive. This anemone can not live in polluted water.

This anemone resembles a flower on a bumpy stalk. However, the flowery parts are actually tentacles that are covered with tiny stinging “harpoons” that help the anemone catch its prey by injecting a poison to paralyze the prey. (To humans, the anemone’s tentacles just feel a bit sticky). The anemone then moves the prey to its stomach (in the middle of its tentacles). When threatened or exposed to the air, the anemone can close itself up.

Additional information can be found in Pacific Intertidal Life, page 28.



Purple Sea Urchin

Echinoderm

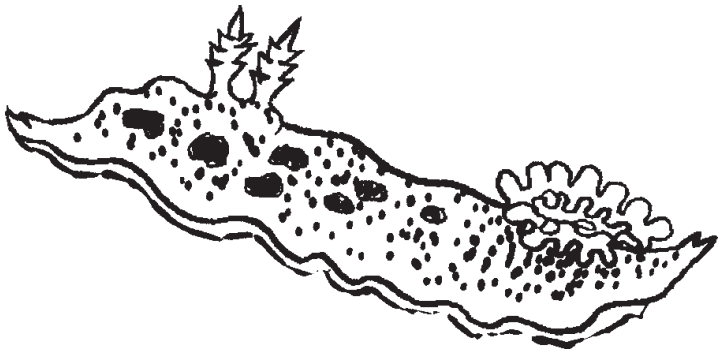
Strongylocentrotus purpuratus

The purple sea urchin is a resident of the low-tide zone.

Adaptations: The purple sea urchin uses its spines and teeth to burrow into rocks.

Sea urchins are closely related to sea stars (they have five part radial symmetry). This urchin thrives with high wave action. It can use its spines and teeth to scrape a depression out of a rock to live in. Urchins can even get stuck in these holes as they continue to grow. The purple sea urchin is an herbivore that eats kelp. It uses its spines to snag kelp and then uses tube feet and spines to pass the kelp to its mouth. The urchin's mouth has five teeth that come together in a point, known as Aristotle's Lantern. The urchin's predators include sun stars and sea otters.

Additional information can be found in Pacific Intertidal Life, page 35.



Nudibranchs

Mollusc

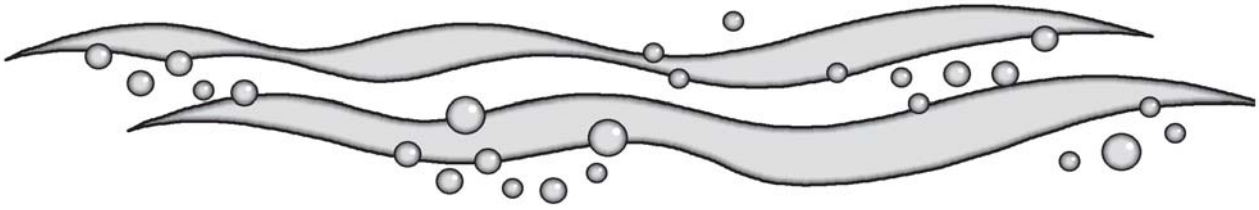
Hypselodoris californiensis

Nudibrachs can be found in the low-tide zone.

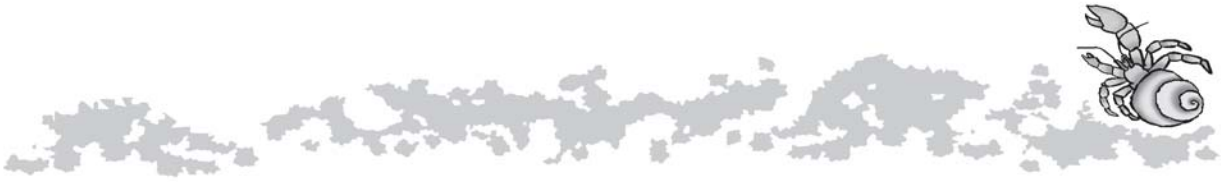
Adaptations: Certain nudibrachs can eat anemone's stingers and then store the poison in their own tentacles for their own use.

Nudibrachs are like snails without shells. They have stingers for defense and taste terrible to other animals. Nudibrach means "naked gill" in Latin. They come in a variety of bright colors (these colors may be a warning to other animals not to eat them). Nudibrachs eat all kinds of animals and will even fight each other to the death.

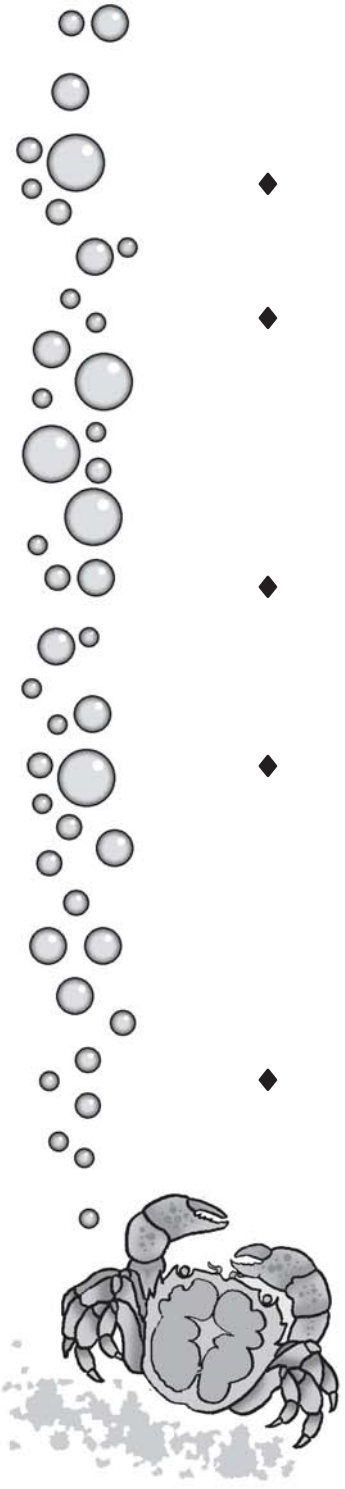
Additional information can be found in Pacific Intertidal Life, pages 24 & 25.



PART V
SCHOOL GROUP ACTIVITIES



EDUCATION VOLUNTEER TIPS FOR A SUCCESSFUL TIDEPOOL PROGRAM



- **Provide an involving program.**

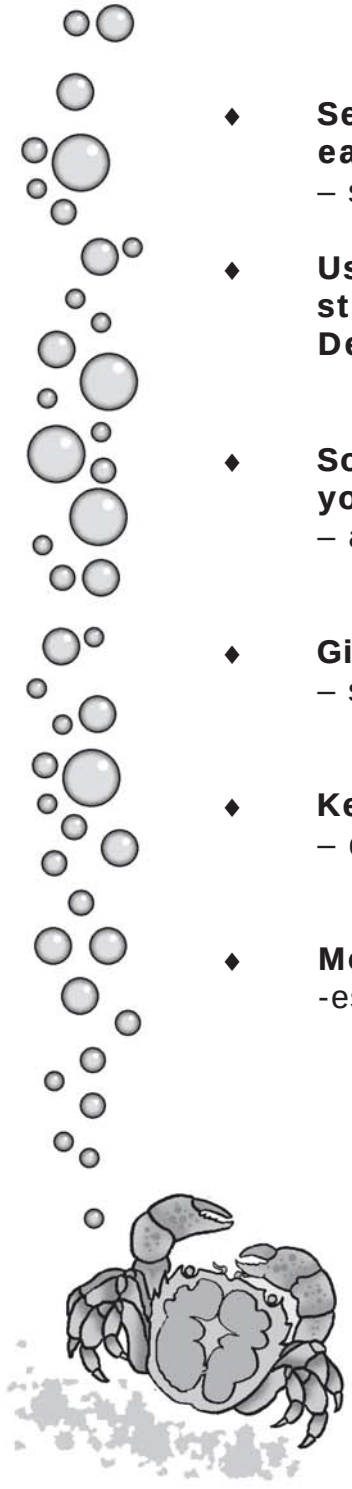
- **Organize the class into groups of five to ten if possible.**
  -or whatever size works given the number of volunteers

- **Physical and verbal involvement of each student is very important.**

- **Use grade level appropriate strategies.**
  -i.e., Intertidal Scavenger Hunt for younger students and Intertidal Transect Activity for grades 7 and 8.

- **Use the resources and stories of the site.**

EDUCATION VOLUNTEER TIPS FOR MAINTAINING APPROPRIATE BEHAVIOR WITH SCHOOL GROUPS



- **Set specific behavioral boundaries and expectations early in the program**
  – see Exploration without Devastation in section 2
- **Use the "Giants in the Intertidal Zone" story at the start of your program to enforce Exploration without Devastation**
- **Solicit teacher or chaperone assistance in enforcing your boundaries and expectations**
  – as well as to help you deal with difficult students
- **Give difficult children something to do**
  – such as carrying one of the field guides
- **Keep an upbeat attitude**
  – don't yell, as this lets everyone know you have lost control
- **Model appropriate behavior**
  -especially in your handling of intertidal animals

(*Volunteers please note that it is the teacher's responsibility to maintain appropriate behavior, not yours. However, these tips can still be very useful in creating a rewarding experience for all involved*.)

STORY – WE ARE ALL GIANTS IN THE INTERTIDAL ZONE

The purpose of this story is to explain to young tidepool visitors that we need to be careful not to harm the animals.

The use of story and metaphor can be very effective as a means of communicating a point to school age children.

- Ask the students what they know about giants.
- Next, ask them what they know about a specific intertidal animal (such as a hermit crab).
- Then explain to them (i.e., tell them a story) of how each and every person (even the smallest student) is a giant in the intertidal zone. Be as creative as you would like!
- Ask the students how they would feel if a giant came and plucked their house up and held it upside down. Relate this to a student picking up a hermit crab or other intertidal animal.
- Finally ask the students how they think they can be good, kind, careful giants in the intertidal area.

SEA CIRCLE – USING YOUR SENSES

LEVELS: GRADES 3RD THROUGH 8TH

OBJECTIVES:

Students will be able to:

1. Use their senses of touch to determine if an object is naturally occurring or man-made and then identify that object

MATERIALS:

1. A variety of objects from the beach: some natural and some man-made such as:
   -crab, limpet, snail, urchin, mussel, dried seaweeds, plastic, bottle cap, newspaper
2. A safe space to have students sit with eyes closed

TIME:

Preparation: 5 minutes
Activity: 30 minutes

Directions:

1. GATHER students in a circle and have them sit down and close their eyes.

2. Have students **NAME** the five senses and talk about the sense of touch.

(SEA CIRCLE- CONTINUED)

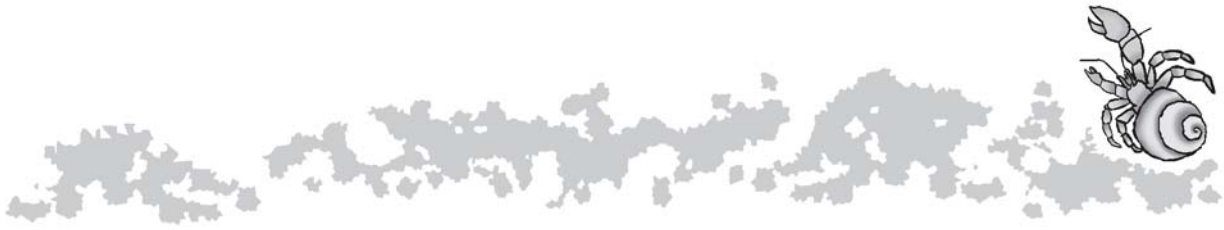
3. **EXPLAIN** your activity and how important it is for many animals to use senses other than sight.

4. **GIVE** each student an object to investigate using only touch.
   OR
   PASS one object around the circle for everyone to investigate.

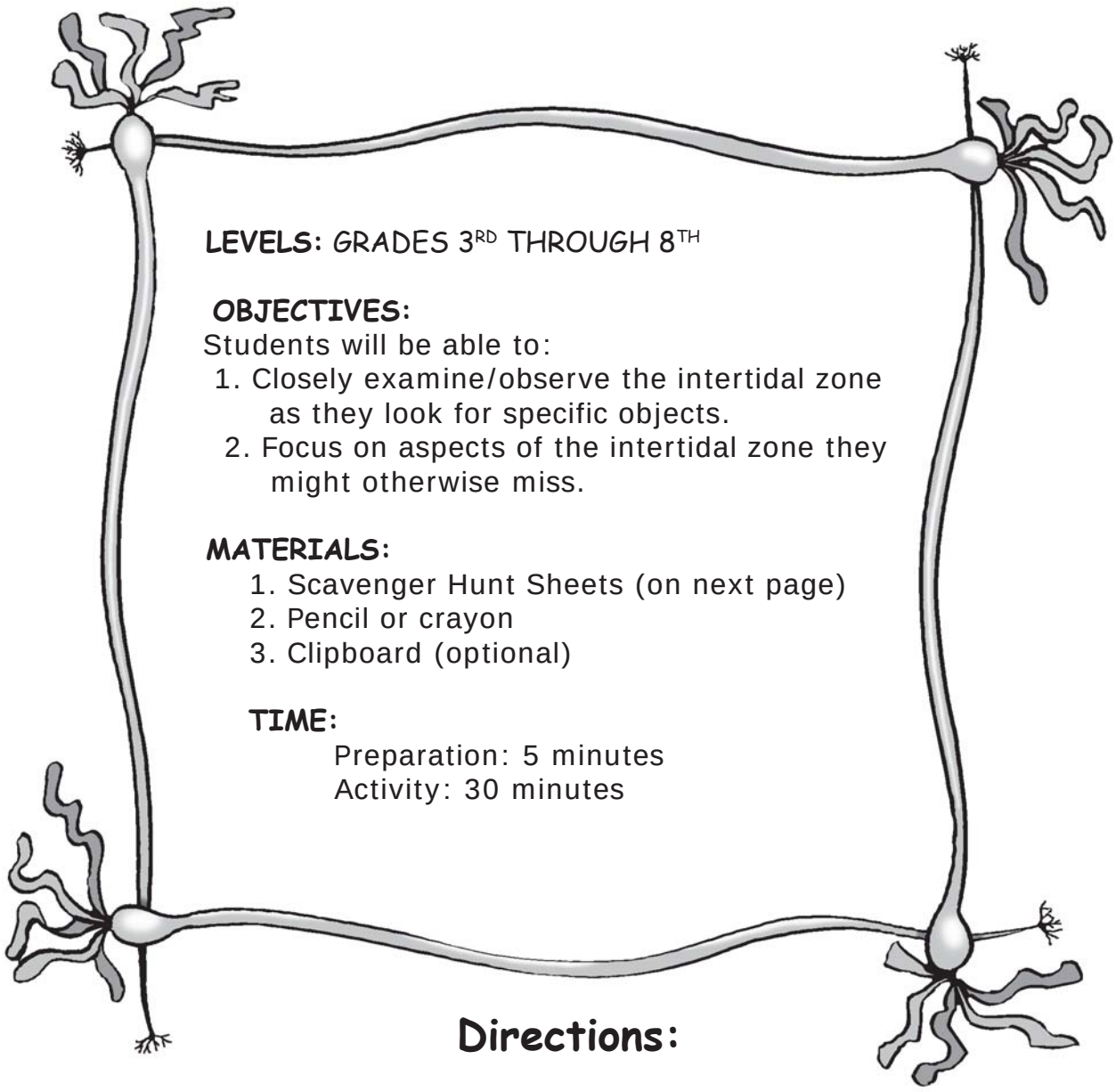
5. **HAVE** students **GUESS** three things:
   a. Is the object naturally occurring or man-made?
   b. What is the object?
   c. Should we leave it on the beach or take it away?

DISCUSSION: If we, as humans, have a hard time distinGuishing between naturally occurring and man-made items, what does this mean for animals dealing with trash in the sea?

For example: Could an animal who eats jellyfish mistake a plastic bag in the water for a jellyfish?



TIDEPOOL SCAVENGER HUNT



LEVELS: GRADES 3RD THROUGH 8TH

OBJECTIVES:

Students will be able to:

1. Closely examine/observe the intertidal zone as they look for specific objects.
2. Focus on aspects of the intertidal zone they might otherwise miss.

MATERIALS:

1. Scavenger Hunt Sheets (on next page)
2. Pencil or crayon
3. Clipboard (optional)

TIME:

Preparation: 5 minutes
Activity: 30 minutes

Directions:

1. **HAND** out a Tidepool Scavenger Hunt sheet to each student/pair

2. **EXPLAIN**: **DO NOT COLLECT THE ANIMALS**! Simply observe them where they are.

3. **EXPLAIN** that it is not a race, and give the group adequate time to locate and closely observe the items on their list.

4. **DEFINE** clear physical **boundaries** within which the group may explore.

5. **GET** the group back together and discuss the findings.

TIDEPOOL SCAVENGER HUNT

DO NOT COLLECT THE ITEMS ON THE LIST!
JUST LOOK AT THEM AND CHECK THEM OFF

1) A shell that looks like a tiny hat

_____

2) An animal that is moving _____

3) An animal with claws _____

4) An animal with two shells _____

5) An animal that looks like a flower _____

6) An ocean plant _____

7) An animal with no shell _____

8) An animal living in another animal's shell _____

9) An animal that is not moving _____

10) An animal living ON another animal _____

TIDEPOOL CRITTER HUNT

LEVELS: GRADES 3RD THROUGH 8TH

OBJECTIVES:
Students will be able to:
1. Use clues to find a certain intertidal animal and learn about it.

MATERIALS:
1. Critter Cards
   (included in Tidepool Interpreter Backpack)

-for large groups you may want to use more than one set of Critter Cards

TIME:
Preparation: 5 minutes
Activity: 30 to 45 minutes

Directions:

1. GIVE each student, or pair, or group of students one Critter Card.
2. INSTRUCT the students to **FIND** that animal in the tidepool area.
3. Have students **OBSERVE** that animal in its natural habitat.
PLEASE DO NOT PICK-UP or MOVE ANIMALS!
4. Have students **DISCOVER** at least one interesting fact about that animal.
5. Have students **ANSWER** the follow questions about their animal:
   a. Is it covered with water or exposed to the air?
   b. What special adaptations does/might it have?
   c. Can you tell what tidal zone it is in?
6. GATHER students back in a group and have them **SHARE** their findings.
7. Time permitting, students can trade cards.

(This activity is adapted from an acitivity included in the Salt Point Adventure Pack created by Karen Broderick.)

TAKING A CLOSER LOOK

LEVELS: GRADES 3RD THROUGH 8TH

OBJECTIVES:
Students will be able to:
1. Use a hand lens to discover something about the intertidal area they did not know.
2. Draw an intertidal dweller they have observed, including small details.

MATERIALS:
1. A hand lens for each student or pair of students
2. An index card and pencil or crayon for each student

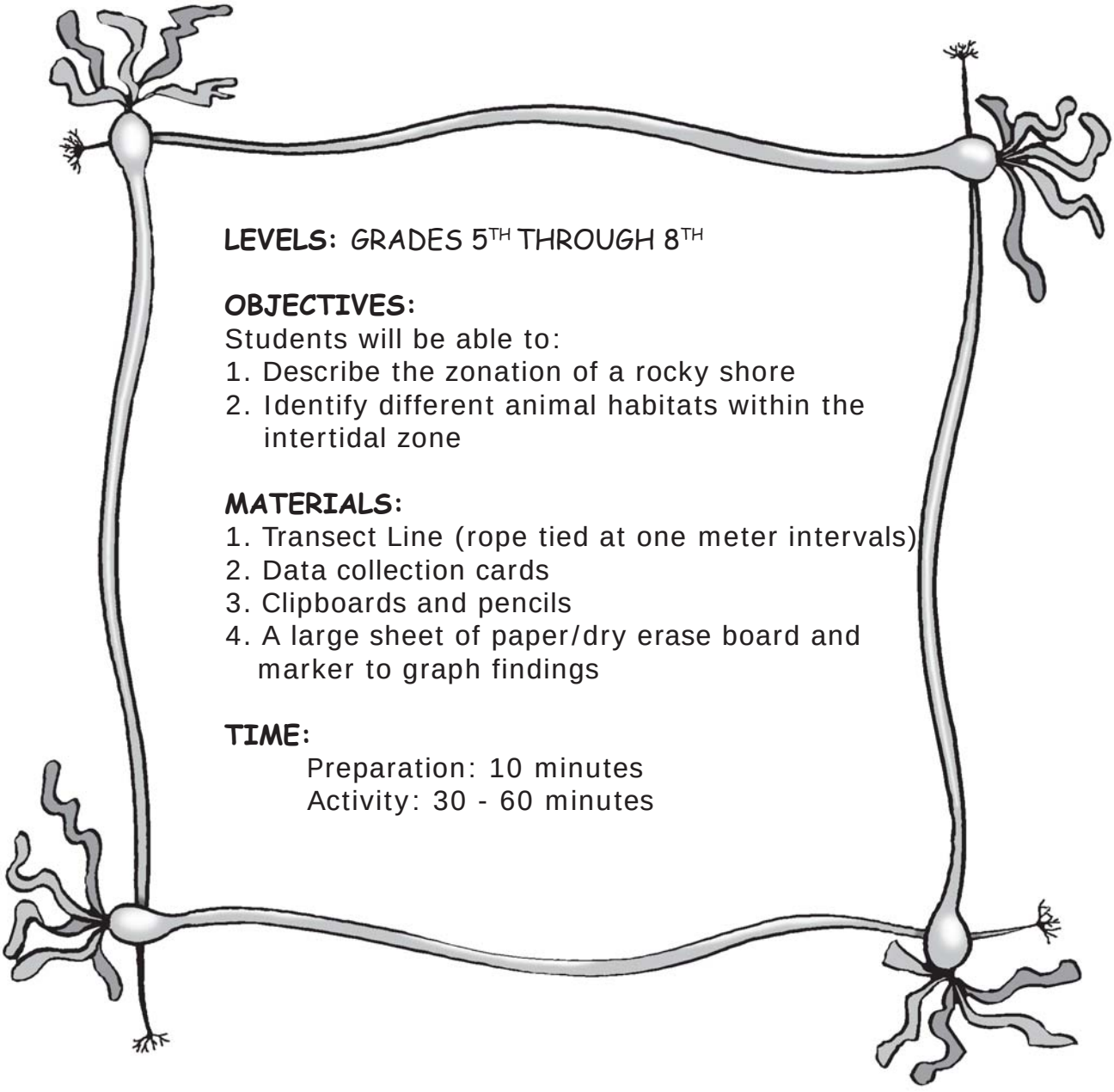
TIME:
Preparation: 5 minutes
Activity: 30 minutes

Directions:

1. **Explain** to the students that they will be asked to go quietly to observe a tidepool plant or animal up close to learn something new about it.
2. **Hand out** hand lenses and index cards.
3. Make sure students understand that they are **not to pick up or remove any animals.** They should observe the animals where they are.
4. **Define** the area in which students can explore, and let them go **observe and draw** an item for as much time as is needed by the group.
5. **Gather** the group back together and have students share their findings.

TIDEPOOL ON-SITE ACTIVITY

INTERTIDAL TRANSECT



LEVELS: GRADES 5TH THROUGH 8TH

OBJECTIVES:
Students will be able to:
1. Describe the zonation of a rocky shore
2. Identify different animal habitats within the intertidal zone

MATERIALS:
1. Transect Line (rope tied at one meter intervals)
2. Data collection cards
3. Clipboards and pencils
4. A large sheet of paper/dry erase board and marker to graph findings

TIME:
Preparation: 10 minutes
Activity: 30 - 60 minutes

Directions:

1. **LAY OUT** the transect line on a vertical or horizontal rock where different zones are present, perhaps ending in a tidepool if present.
2. **HAND OUT** an Intertidal Transect Data collection card, clipboard and pencil to each pair/group of students.

INTERTIDAL TRANSECT - CONTINUED

3. EXPLAIN the activity: the students are being marine biologists.

4. Students **WORK** in pairs and begin at the mark (knot) closest to the shore.

Students **RECORD** all animals touching the mark and any animals within a hands distance from the line. Students in the pair/group should take turns being the observer and the recorder.

(You may also opt to have each pair/group work on a separate transect. You can then combine the data later.)

5. GATHER the group back together.

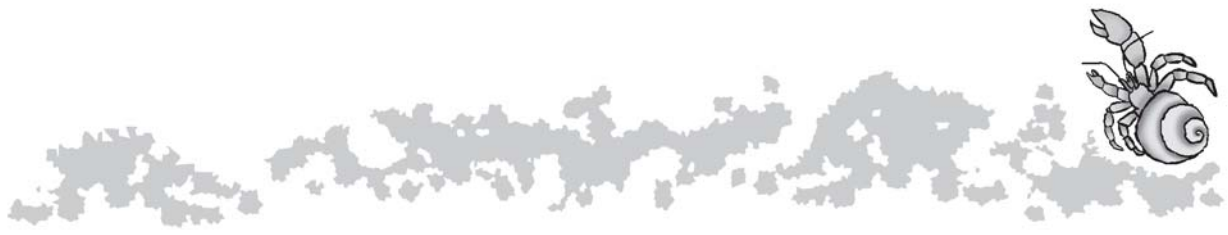
6. GRAPH several different things with the whole group:

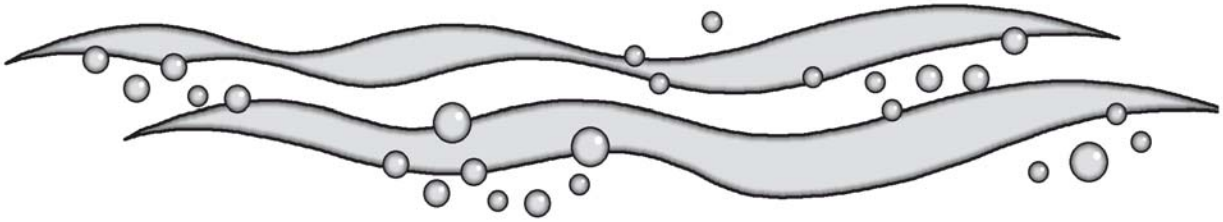
a. The total number of animals at each marker

b. The change in number of one type of animal throughout the transect

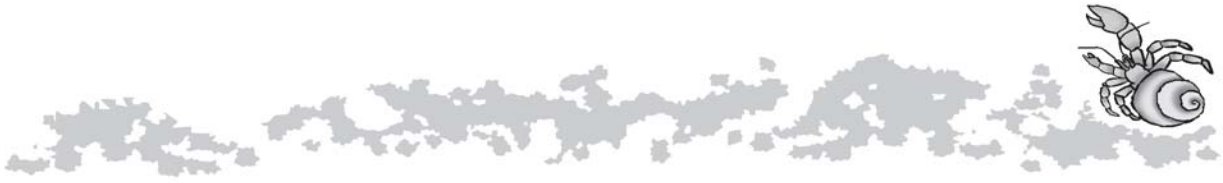
c. Determine where a particular zone is by using an indicator organism such as the periwinkle snail. See Section II page 4 for chart.

NOTE: For younger students you may want to just record data for one type of animal such as turban snails or aggregating anemones.



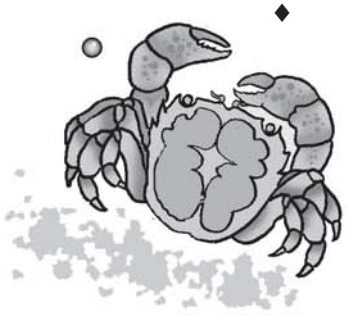


PART VI
ROVING NATURALIST ACTIVITIES AND TIPS



TIPS FOR ROVING INTERPRETERS

- **Know the site** – the beach as a whole and the intertidal area.
- **Be familiar with the subject matter** – but don't feel like you must have all the answers.
- **Know current events of interest to visitors.**
- **Ask visitors questions to gauge their level of knowledge on the subject-** adapt your presentation accordingly.
- **Wear a Volunteer vest to identify yourself.**
- **Be friendly and approachable.**
- **Carry props and tools** (included in the Tidepool Interpreter's backpack).
- **Use attractants to capitalize on visitor curiosity** (artifacts, posters, etc).



Beach Interpretation

Beaches are a dynamic environment bustling with life. However, to the average visitor they may appear to be a sterile sandlot where little regard for the environment is necessary. A little interpretation may give visitors an entirely different perspective on the subject and inspire a more caring attitude toward this habitat.

Themes for beach walks and activities:

On the beach everything is in motion**.** From the wash of waves, to littoral drift of sand, to wind-driven sand particles building dunes, few parts of a beach stand still for very long.

Life is just beneath the surface. Because of the harsh environment above the surface, most residents of the beach, sand crabs, worms, amphipods and others, live burrowed just beneath the surface. Beach wrack forms islands in this sandy, salty desert. Large piles of kelp, driftwood and other flotsam deposited on the beach form places for animals to stay moist, feed and seek shelter from predatory birds and abrasive winds.

Beaches change through the seasons. As wave patterns and energy change, and as winds shift, sand is deposited or removed from many beaches; thus beaches grow and shrink at various times. Rainfall inland of the beach may raise the water table under the surface and dramatically alter conditions for animals living in the sand. Beaches rely on imports**.** Virtually everything you see on a beach comes from elsewhere. Beach wrack, shells, trash, jellies, even the sand, is hurled up on the beach from offshore. Vascular plants, birds and people invade the beaches from inland.

Be good to beaches**.** Human impacts ranging from exotic plants, to trash, to sand mining, can have a dramatic impact on beaches. We can literally make a beach disappear in a short period of time. Humans must learn how to enjoy beaches without interfering in the natural processes that build and maintain beaches.

Interpretive Tips

1. Magnifiers bring you down to the right scale. Just like Alice through the looking glass, a whole world lies literally at your feet on a beach, you just need to look for it. Most of the life on a beach occurs in between the sand grains, under algae and driftwood, or in tiny burrows in the sand. Use magnifiers (or your binoculars in reverse) to look for animals in small samples of sand from various locations (wave wash, under the beach wrack, in the dry sand).

2. Role-play re-enacts life on the beach and gets your audience involved. Use people to create beach wrack, mimic waves and foraging birds, build food webs or follow the journey of an individual sand grain across the beach. Children in particular love to put their imagination and energy to work in these activities.

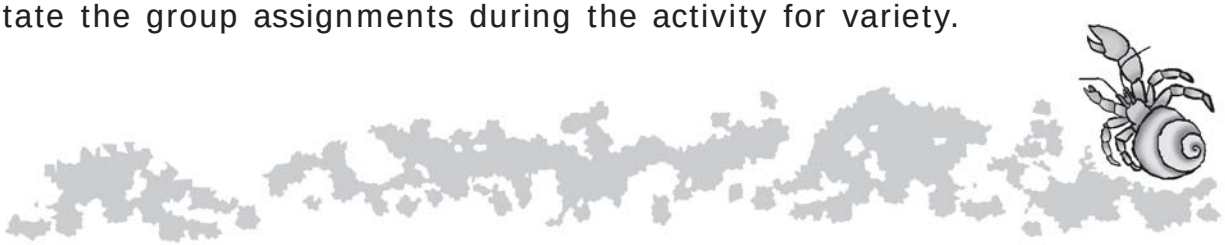
Suggested Activities

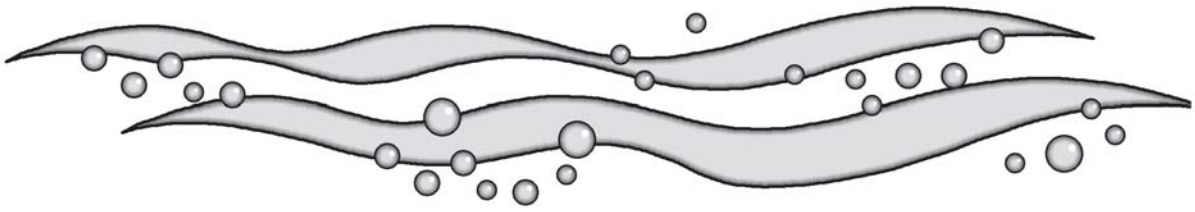
1. "Wrack'em up": Build a human wrack. Start this role-play activity by building a human kelp plant; holdfast, then stipe, blades on the stipe, and finally floats. You can be a storm surge and grab the end of the stipe and pull until the holdfast is torn loose ("snap the whip" if your audience is spunky). Turn and twist the kelp into a knot and deposit your human drift kelp on the beach. Now others play the role of amphipods digging under the wrack, isopods crawling over and through, and of course there should be some kelp flies buzzing about. A few folks can play the role of shore birds probing for various critters to eat. If you have anybody left ,they can be drifting sand grains to pile up against the wrack and start an embryonic dune.

2. "Wrack patrol": Learn about the beach and clean it at the same time. This is a great way to emphasize that nearly everything on a beach is from somewhere else—and not all of it belongs on the beach. Start by dividing the group into three teams:

¨ **Whatzit Team:** This is the identification team. Their job is to identify various objects found on the beach. They may need some resources such as field guides, local species lists, or perhaps a knowledgeable naturalist or garbage collector.
¨ **Wherefrom Team:** These are the import specialists. Their job is to work with the Whatzits to determine where objects may have come from prior to landing on the beach. Are the objects from the nearby intertidal, far offshore, or left behind by humans.
¨ **Take- it-or-leave-it Team:** As the other two teams have done their job, this crew decides if each object should be left on the beach or removed. What is the object contributing to the beach ecosystem? What will ultimately happen to the object if it is left on the beach? Is it helpful of hazardous? What do local laws say about removing various objects from protected beaches?

Take the group on a walk along the high tide line where various items are washed up and pick a few items for them to work with. See where the discussions lead the group in understanding how various items wash up on beaches. You could bring in some information from local beach clean-ups describing the volume and variety of trash found on beaches. You can also rotate the group assignments during the activity for variety.

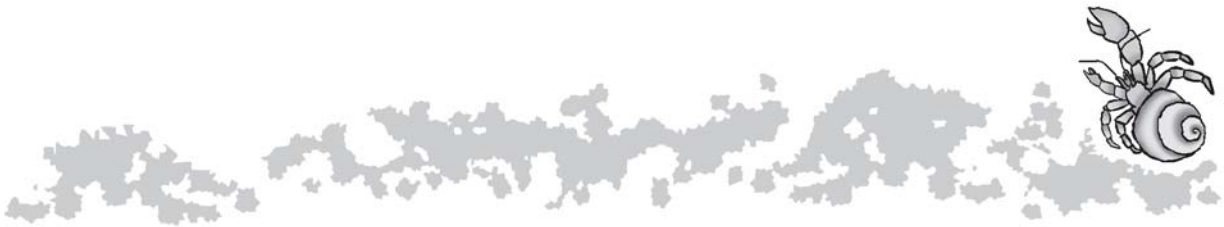




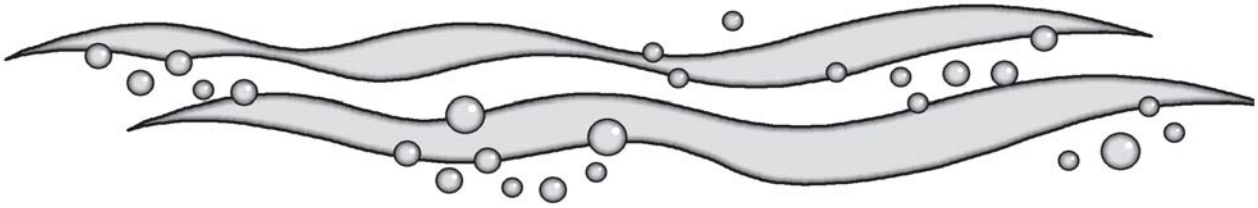
3. "Ocean Motion":

This is a simple activity to demonstrate the various forces in motion at the beach; children in particular enjoy this kind of kinesthetic learning. Have the group spread out so they all have room to move without bumping into each other. Start with copying the motion of waves running up on the beach, either with waving arms or taking steps to one side and then the other. Next add the motion for littoral drift by having the group slowly inch southward along the beach. You may create some barriers to deflect the movement of your human sand grains and pile them up; you can add wind motion to slowly drive the grains farther up the beach and pile them into a dune.

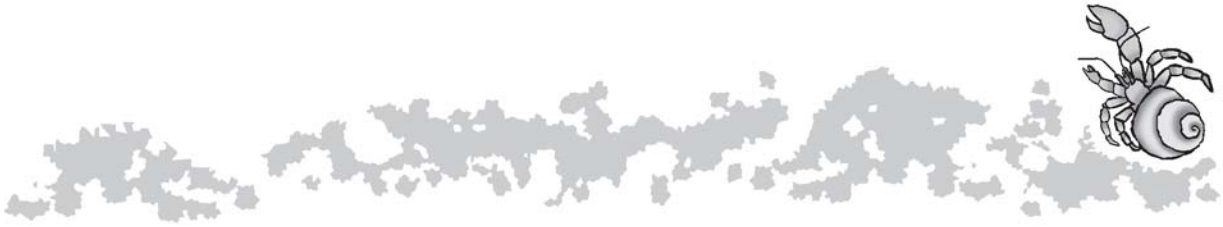
These activities were reprinted with permission from the Sonoma Coast Teacher's Ecology Guide.



Insert What to Include in Your Tidepool Talk



PART VII
ADDITIONAL RESOURCES



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