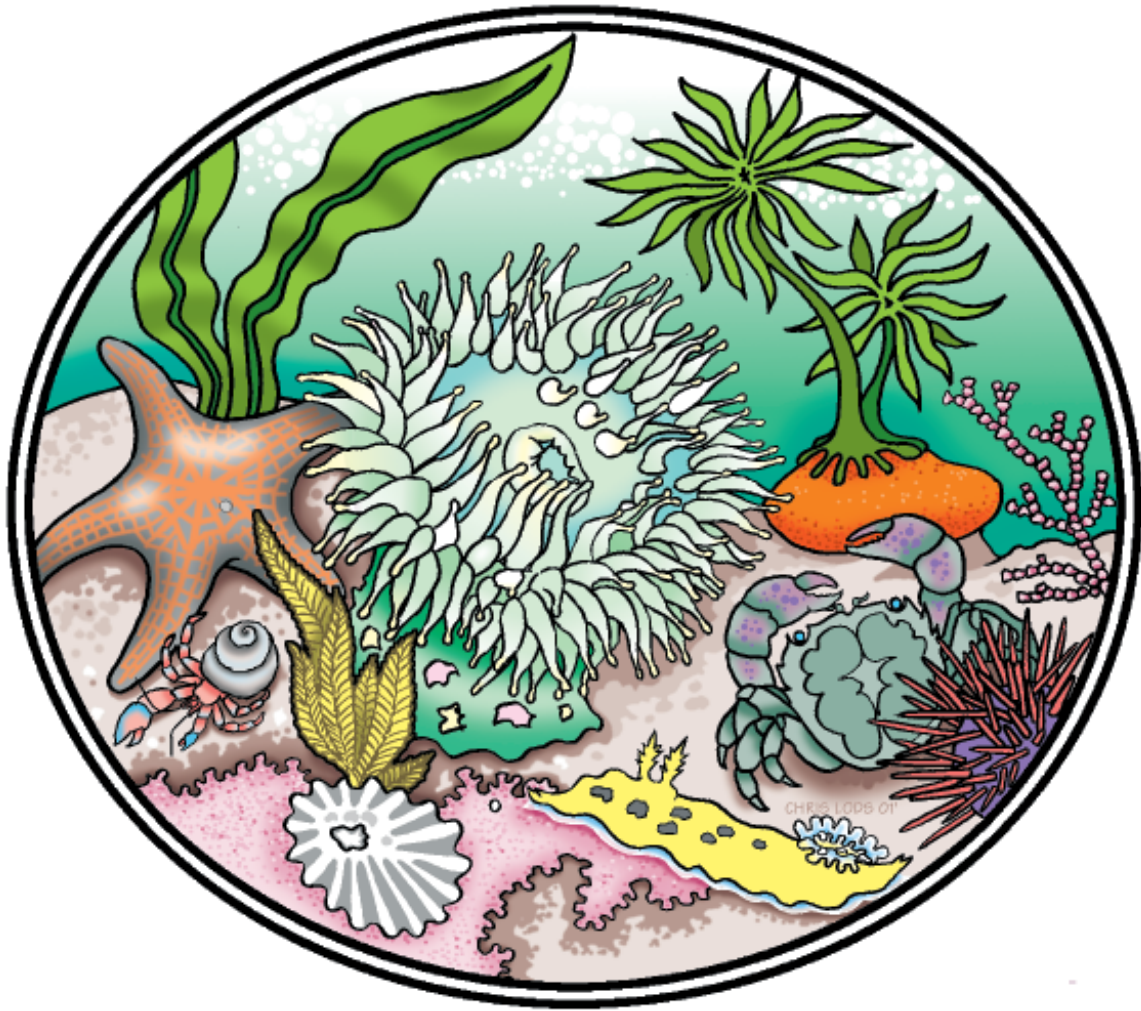


# CALIFORNIA STATE PARKS



## Tidepool Education Program Teacher's Guide

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

# Tidepool Education Program

*A curriculum- based program for Grades 3 to 8*

## California State Parks/Russian River Sector

25381 Steelhead Blvd, PO Box 123, Duncans Mills, CA 95430  
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Manual Formatting:  
Cover & Design Elements:

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# Acknowledgements

## Partnerships

This program was developed in partnership with many public and private entities.

*Stewards of the Coast and Redwoods* would like to thank all of our partners who have contributed to making this program such a great success. Working with *California State Parks* is a gratifying experience and we are proud to produce this program in partnership with them.

The original funding was received by *The Medtronic Foundation*. Additional funds were provided by *ChevronTexaco*, *the California State Parks Foundation*, and *the Fisherman's Festival Allocation Committee*.

We would like to thank *Rangers Rich Lawton, Mike Wisehart, Jeff Mecchi, Jeremy Stinson, Karen Broderick* (for the Critter Cards), and *Lifeguard Britt Horn* for working with us and contributing to the success of this program. Their expertise as state park staff has enabled us to produce a quality program.

## Acknowledgements/Credits

Special thanks to *Donna Chinlund* for her background work, *Amy Smith* for her dedication to researching and developing program materials, *Keith Nelson* for consulting as an experienced tidepool naturalist and for providing excellent references, and to *Chris Lods* for his artistic ability to design the beautiful cover and wonderful design elements.

Permission was granted to use photocopied materials in the manual. We express our thanks to the Santa Barbara Museum of Natural History.

None of the materials in this manual may be reproduced without permission except for educational purposes within the classroom.



## CALIFORNIA STATE PARKS

*In Cooperation with*  
***Stewards of the  
Coast & Redwoods***

Russian River Sector  
State Park Interpretive Association



Dear Science Educator,

Stewards of the Coast and Redwoods (*Stewards*), in cooperation with California State Parks (Russian River Sector), is very excited to extend an invitation to you to participate in our Tidepool Education program at Sonoma Coast State Beaches. In Part 1, you will find a comprehensive outline of our program and some background information on our organization.

*Stewards* is always interested in program feedback. After you have participated in our program, please use the feedback form at the end of Part 1 to let us know how we are doing, how the program has impacted your students, or just to give us ideas for improvement.

*Contact us:*

Stewards of the Coast and Redwoods (*Stewards*)  
P.O. Box 2  
Duncans Mills, CA 95430  
Phone: (707) 869-9177 Fax: (707) 869-8252  
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Website: [www.stewardsofthecoastandredwoods.org](http://www.stewardsofthecoastandredwoods.org)

Thank you and welcome to Sonoma Coast State Beaches!



## Tidepool Education Program



### Organization Description

*Stewards of the Coast and Redwoods (Stewards)*, founded in 1985, is a nonprofit environmental organization that works cooperatively with the California Department of Parks and Recreation (DPR) in the Russian River Sector. Our mission is to promote education, preservation and restoration of the natural and cultural resources of Russian River area State Parks in partnership with DPR through interpretation and stewardship.

*Stewards* is a leader in supporting volunteer interpretive activities. With modest resources, *Stewards* provides funding for recruitment, training and support to a corps of 250 regular state park volunteers who recognize the importance of educational and interpretive activities in raising awareness about environmental protection and preservation in the state parks we support. We have a proven record of attracting knowledgeable volunteers who return year after year. Annually, *Stewards*-supported volunteers give over 9,000 hours of service, valued at over \$150,000.

There is no cost to participate in the program and we just expect a commitment in preparing your students by reviewing the information in Part I of this manual. You will be provided with the following at no cost:

- Tidepool Education Teachers Guide
- Field site visit (3-3 1/2 hours)

### Additional Materials (May be purchased at our cost)

If you choose, you can purchase the following items at our cost.

- Sea Searcher's Handbook (Activities of the Monterey Bay Aquarium) - \$11 cost
- Pacific Intertidal Life (Small field guide) - \$2.50 cost
- The World between the Tides Video - \$20 cost
- Laminated Guide to California Coastal Invertebrates - \$3 cost

### Assessment

*Stewards* is very committed to evaluation and assessment, both internally and externally. Teachers and students are asked to comment on their experiences with this program by way of a written evaluation. Manuals undergo evaluation by state park staff, volunteers, and teachers. After each volunteer training program participants are asked to evaluate instructors and the material presented. The Tidepool Education Program team meets to assess the program on an ongoing basis. Program feedback is welcome as we strive to create an acclaimed program in Sonoma County.

Thank you very much for your interest.

The Sonoma Coast Tidepool Education Program helps to achieve the following State of California Academic Content Standards:

### **Seventh Grade Science**

Focus on Life Science

Structure and Function in Living Systems

- The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function.

Physical Principles in Living Systems

- Physical principles underlie biological structure and functions.

Investigation and Experimentation- Scientific progress is made by asking meaningful questions and conducting careful investigations. To understand this concept and to address the content in the other three strands, students should develop their own questions and perform investigations.

### **Seventh Grade Mathematics**

Measurement and Geometry

- Choose appropriate units of measure and use ratios to convert within and between measurement systems to solve problems.

Statistics, Data Analysis, and Probability

- Students collect, organize, and represent data sets that have one or more variables and identify relationships among variables within a data set.

### **Eight Grade Science**

Focus on Physical Science

Motion- The velocity of an object is the rate of change of its position.

Chemistry of Living Systems (Life Sciences) - Principles of chemistry underlie the functioning of biological systems.

Investigation and Experimentation- Scientific progress is made by asking meaningful questions and conducting careful investigations. To understand this concept and to address the content in the other three strands, students should develop their own questions and perform investigations.

### **Eight Grade History-Social Science**

Chronological and Spatial Thinking

- Explain how major events are related to one another in time.
- Construct various timelines of key events, people, and periods of the historical era they are studying.
- Use a variety of maps and documents to identify physical and cultural features of neighborhoods, cities, states, and countries, and to explain the historical migration of people, expansion and disintegration of empires, and growth of economic systems.

Historical Interpretation

- Explain the central issues and problems from the past, placing people and events in a matrix of time and place.
- Understand and distinguish cause, effect, sequence, and correlation in historical events, including the long- and short- term causal relations.
- Explain the sources of historical continuity and how the combination of ideas and events explains the emergence of new patterns.
- Recognize the role of chance, oversight, and error in history.

## Sonoma Coast Tidepool Education Program - Assessment Form

Please help us develop and improve our programs by taking a few minutes to complete this form and return it to: Stewards of the Coast and Redwoods, P.O. Box 2 Duncans Mills, CA 95430 or email [volparks@mcn.org](mailto:volparks@mcn.org).

Name: \_\_\_\_\_ School: \_\_\_\_\_  
School Address: \_\_\_\_\_ City/State/Zip: \_\_\_\_\_  
Phone: \_\_\_\_\_ Fax: \_\_\_\_\_ Email: \_\_\_\_\_

Grade Level: \_\_\_\_\_ Curriculum: \_\_\_\_\_

How does this program fit into California/National Standards and your personal education program?

How relevant were the contents to your curriculum?

Which lessons were the most effective and why?

Do you feel the length of the classroom visit was... (circle one) too long too short just right

Do you feel the classroom visit prepared students for the field visit?

What was most worthwhile about the field visit for your students?

Please comment on any aspect of the field experience. Include positive comments, constructive criticism, communication difficulties, and suggestions for improvement.

What are the strengths & weaknesses of the program?

What was the best part of the experience?

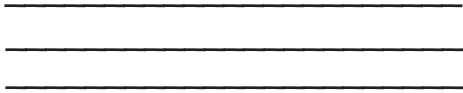
What is the level of support at your school for this program? (circle one)

Very High High Moderate Low Very Low

Overall, how would you respond if a colleague asked about this program? (circle one)

Highly recommended Recommended Recommended with some qualifications Not recommended

Other feedback or questions:



Stewards of the Coast and Redwoods  
P.O. Box 2  
Duncans Mills, CA 95430



# Tidepool Education Program Table of Contents

## **PART I**

### **SONOMA COAST STATE BEACH TIDEPOOL PROGRAM**

Intro and Welcome to the Program  
Sonoma Coast State Beach  
Sonoma Coast Beach Safety  
Tidepooling at Sonoma Coast  
Beach Summary Sheet  
Exploration Without Devastation

## **PART II**

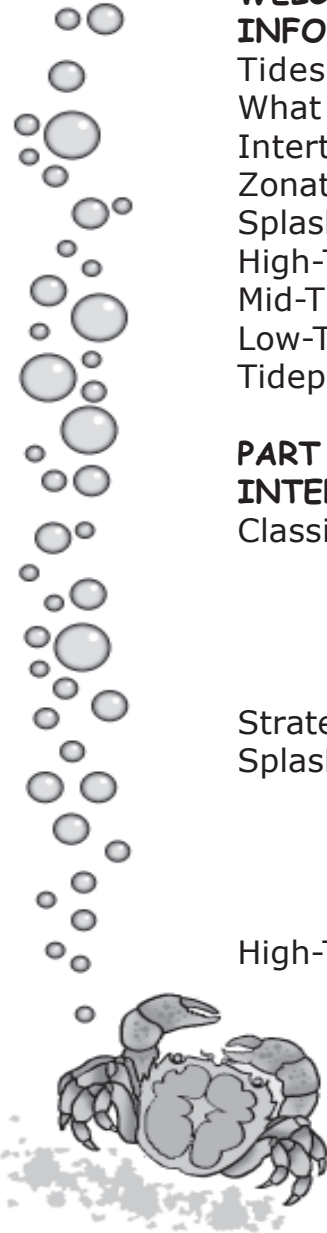
### **WELCOME TO THE INTERTIDAL ZONE - BACKGROUND INFORMATION**

Tides  
What is a Tidepool?  
Intertidal Zonation  
Zonation Diagram  
Splash Zone  
High-Tide Zone  
Mid-Tide Zone  
Low-Tide Zone  
Tidepool Zonation

## **PART III**

### **INTERTIDAL ANIMALS**

Classification of Intertidal Invertebrates  
    Phylum Arthropoda  
    Phylum Cnidaria  
    Phylum Echinodermata  
    Phylum Mollusca  
Strategies for Survival  
Splash Zone Animals  
    Periwinkle Snail  
    Rough Limpet  
    Rock Louse  
    Acorn Barnacle  
High-Tide Zone Animals  
    Black Turban Snail  
    Hermit Crab  
    Brittle Star  
    Lined Shore Crab



# Table of Contents- continued

## Mid-Tide Zone Animals

- Ochre Star
- Mossy Chiton
- California Mussels
- Bat Star
- Aggregating Anemone
- Gooseneck Barnacle

## Low-Tide Zone Animals

- Kelp Crab
- Giant Green Anemone
- Purple Sea Urchin
- Nudibranchs

## **PART IV**

### **PRE-TRIP ACTIVITIES**

- "The World Between the Tides" Video
- "The World Between the Tides" Video Questions
- Tidepool Life Coloring Project

## **PART VI**

### **TRIP ACTIVITIES**

- We are all Giants- a story
- Sea Circle – Sensory Activity
- Tidepool Scavenger Hunt
- Tidepool Critter Hunt
- Taking a Closer Look
- Intertidal Transect

## **PART V**

### **PRE OR POST-TRIP ACTIVITIES**

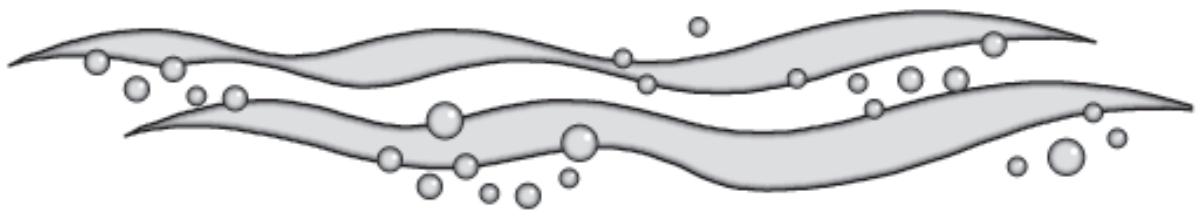
- Intertidal Zonation Diagram Project
- Intertidal Zonation Diagram Project (Cut and Paste)
- Tidepool Creature Feature Presentations
- Exploring Your School Neighborhood
- Intertidal Bingo

## **PART VII**

### **ADDITIONAL RESOURCES**

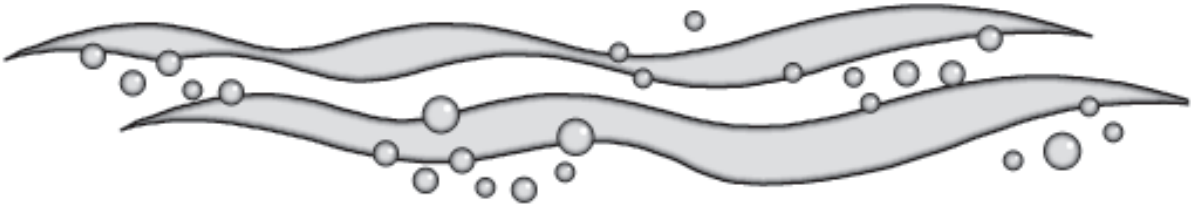
- Field Guides
- Marine Biology
- Natural and Cultural History
- Curriculum Guides
- Children's Books





**PART I**  
**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.





## SONOMA COAST BEACH SAFETY

Coastal conditions are very rough and treacherous, especially during "sleeper wave" season, from September to March. Many people have drowned along the Sonoma Coast State Beach from Bodega Head north to Russian Gulch. At Duncan's Landing, about five miles north of Bodega Dunes, more people are killed than on any other stretch of coastline in California.

There are several factors that make the water unsafe, even for strong swimmers. In the first place, it is always cold, varying from 48° to 52° F, so the hazard of hypothermia, a condition that quickly robs its victims of upper body strength, is great.

Sleeper waves are those that hit an unsuspecting individuals and pull them into the sea. "Sleeper" refers not to the wave, but to the unsuspecting visitor it snatches from the beach. These waves are giants, formed randomly by the sudden alignment of different sets of waves born of the Pacific's storms.

When the waves are out of phase, the trough of one set meets the peak of another, and they tend to cancel out one another, making the ocean appear calm. But because they are traveling at different rates of speed, at any moment they can become in phase, pitching peak atop peak, trough in trough, and a giant sleeper wave is formed.

Another factor that creates a hazard is the character of the sand itself. The Russian River spills geologically "new," large grained sand out of its mouth at Jenner, and a southerly current piles it on beaches all along the Sonoma Coast shore. This large grained sand is like popcorn and is, therefore, easily moved by the ocean. It piles up all summer long until the beaches are very steep. When individuals are awash in a wave against a steep beach, this sand erodes like a trapdoor from under their feet.

There are also dropoffs, or trenches, that run underwater parallel to the beach. They are formed by waves breaking against the beach face. If individuals are swept past a drop off where they cannot touch the ocean floor, they often panic and drown.

The following is a scenario of a typical Sonoma Coast drowning. People are walking along the beach, and suddenly a wave comes up on the beach and inundates them. As it starts to backwash, they try to climb out up the steep beach, and it erodes out from underneath them. They are taken back out with the wave. Just at the bottom of the steep beach, there is a trough where it steeply drops off. They go down into that drop off zone and then tumble along the bottom. They swallow saltwater, get saltwater in their eyes, up their nose, and lose oxygen. When they surface, they are hypothermic. If they attempt to get out again, the sand erodes out from underneath them, and they begin the cycle again. Before long they are overcome by the hypothermia and drown.

Other ocean hazards are the rip currents, which are ocean currents caused by a build up of water by the shore. They are strongest during a lull in the crashing waves. Usually a rip current will result in a channel 25 to 100 feet wide resulting in a powerful current running offshore. Rip currents are usually sandy brown in coloration and are choppy in appearance. To get out of a rip current, swim parallel to the shore until the pull stops. Then swim in or tread water until a rescuer can come to assist you.

There are a few simple safety rules that visitors should be made aware of:

- Stay back from cliff edges. Coastal rocks are extremely unstable and unsuitable for climbing.
- Never climb on cliffs or on slippery, wet rocks.
- Stay off of cliff areas that suspend you over the ocean.
- Never turn your back on the ocean.
- Look at the lines of driftwood and foam on the beach. Allow no one to go between the highest line and the ocean.
- Always have a plan of escape.
- Always watch the ocean. Sleeper waves are both large and unpredictable.
- Do not allow children to play tag with the waves.
- When fishing lines snag, do not go into the surf zone to free the line.
- **IN AN EMERGENCY, CALL 911.**



# 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 if you don't really need it.
- ◆ 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.



# TIDEPOOLING AT SONOMA COAST

The first thing needed is a low tide, preferably a minus or near minus tide. Check the Stewards tide book for this information. There are a couple of rocky beaches that are recommended for tidepooling—**Schoolhouse Beach** about 4 miles north of Bodega Dunes Campground (about 6 miles south of Jenner), **Marshall Gulch**, and **Shell Beach**, about 2 miles south of Jenner.

The tidepools, rocky pockets that retain water when the tide goes out, and the intertidal zone, that area between high and low tides, host an extremely rich and diverse marine community. Making their home here are several species of plants and animals, including seaweeds, barnacles, anemones, sponges, jellyfish, worms, snails, sea slugs, clams, oysters, scallops, chitons, squid, octopuses, abalones, periwinkles, limpets, mussels, cockles, shrimps, crabs, starfish, sand dollars, sea urchins, fish, and many others.

The ecology of the intertidal zone is very fragile and, therefore, easily disturbed. Such a simple act as turning over a rock can expose certain immobile marine animals to the fatal rays of the sun. As a result, tidal invertebrates may not be taken in any tidepool or other area between the high tide mark and 1,000 feet beyond, except as follows; Abalones, chitons, clams, cockles, crabs, lobsters, scallops, ghost shrimp, and sea urchin may be taken, always in accordance with current fishing regulations.



Insert Tidepooling Beaches handout

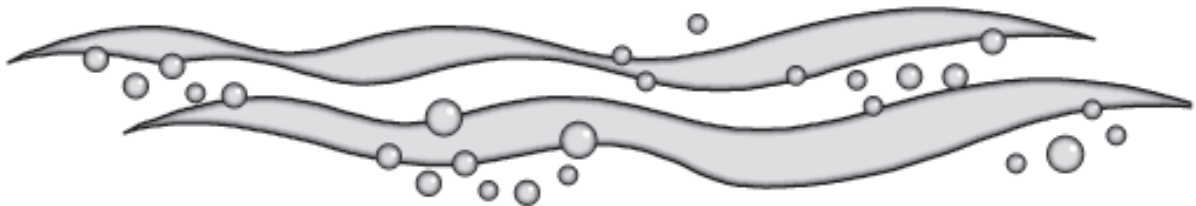
# Going Easy in the Intertidal: Exploration without Devastation

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:

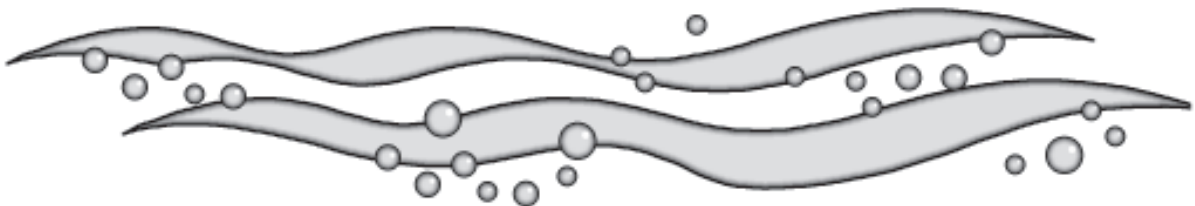
- ◆ Stay on boardwalks, posted trails or other established paths.
- ◆ Avoid stepping on fragile dune plants going to and from the shore.
- ◆ On the rocky shore, try to step on solid, bare rocks. Stepping on seaweed is not only a slippery way to travel, but also may damage creatures that take cover under 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:

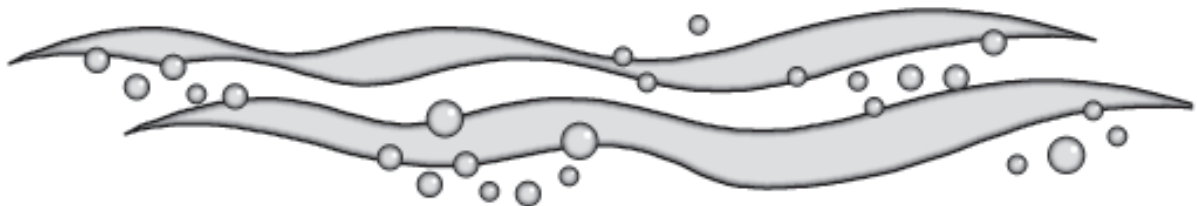
Many intertidal animals have exacting requirements for where they live, right down to a particular hole or depression in the rock that only they fit into. Many of these animals may be handled briefly to examine them, but should be treated with the following courtesies:

- ◆ **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.

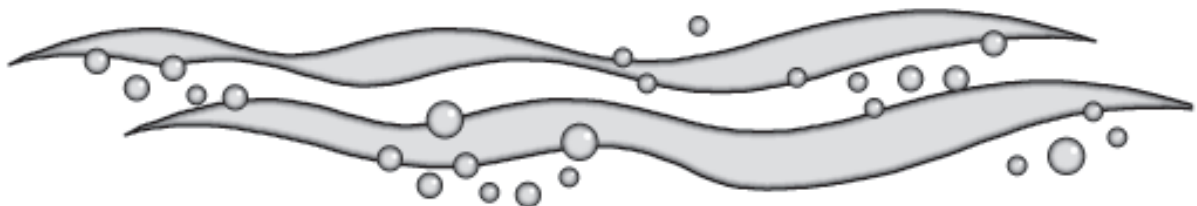


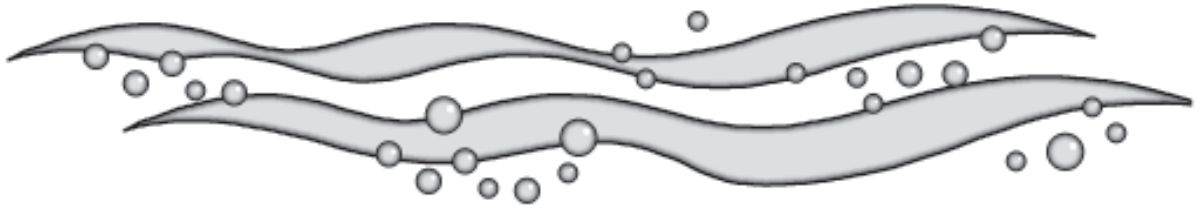
### 3. Collecting:

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.



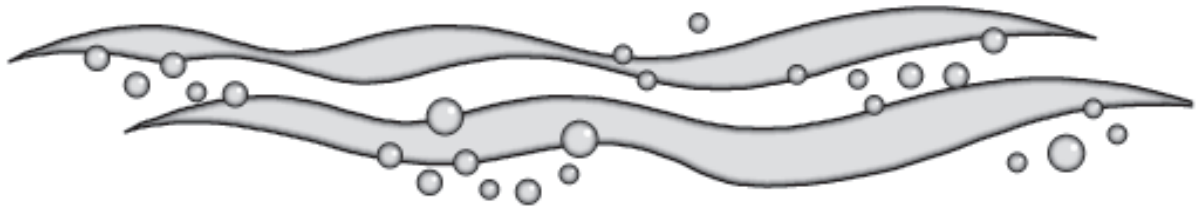


## **PART II**

# **WELCOME TO THE INTERTIDAL ZONE**

# **BACKGROUND INFORMATION**





# 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.

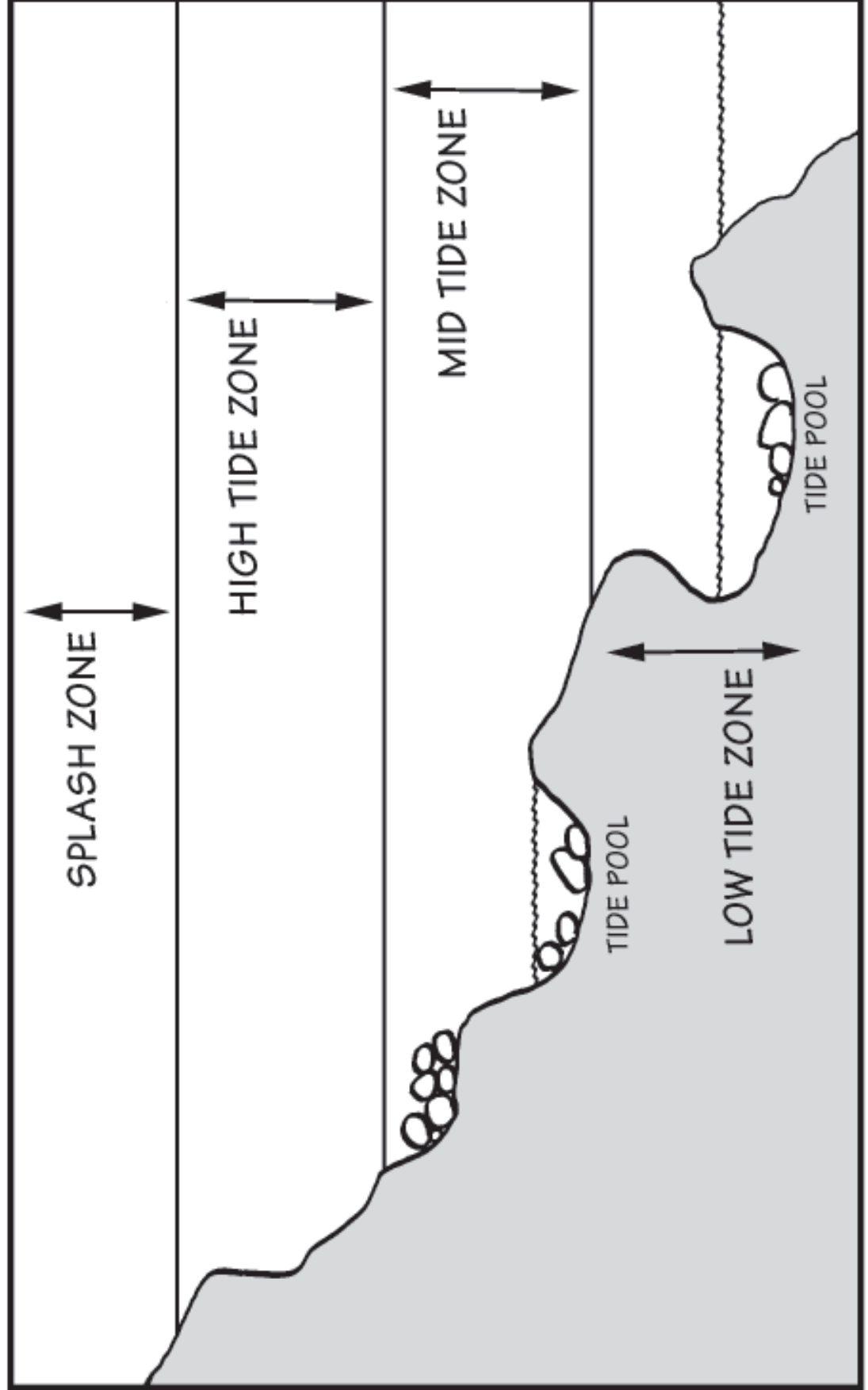
Certain plants and animals are found only in a specific zone. We call these **indicator organisms** and can use them to tell which zone we are looking at. The indicator organisms need the specific set of environmental conditions present in that zone. For example, the rock louse must keep its gills wet 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.

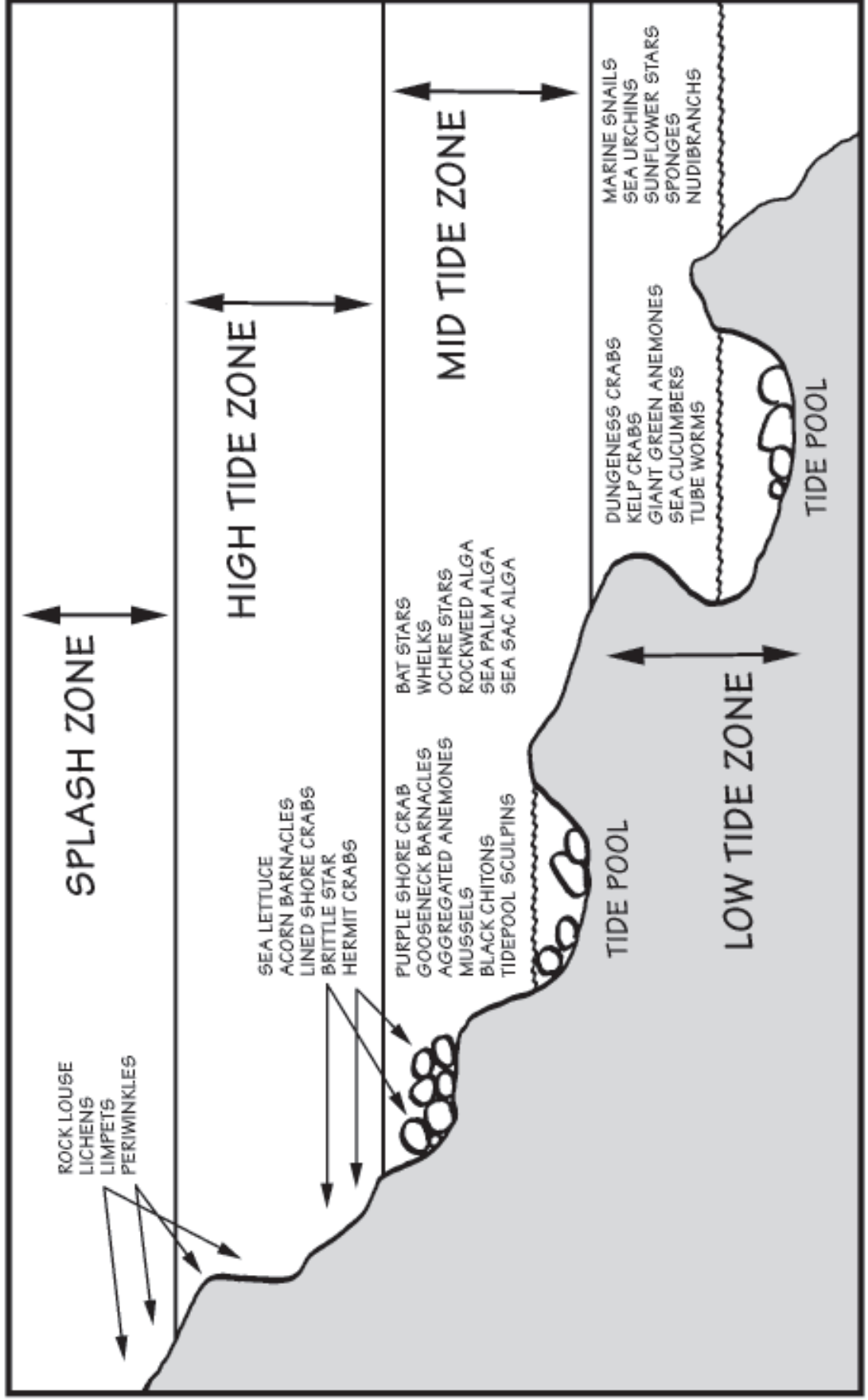




# INTERTIDAL ZONES



# 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 turban 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*).



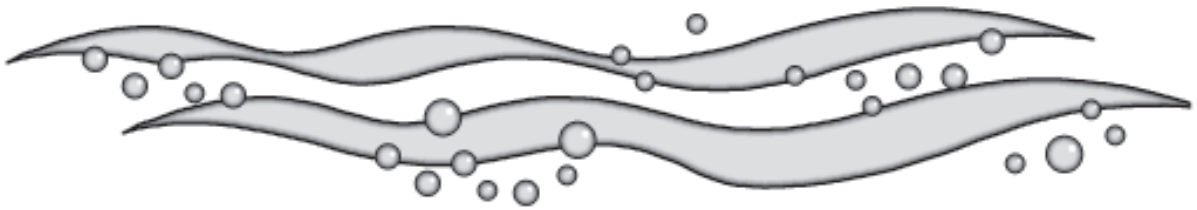
# TIDEPOOL ZONATION

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.





# PART III

## 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.

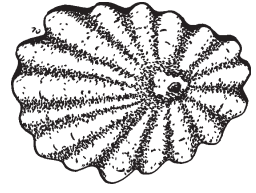
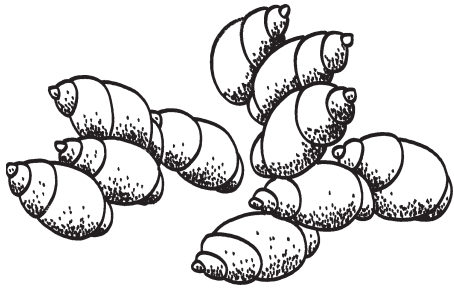
Locomotion, move between or under rocks - Lined Shore Crab, Snails

Depressions or Burrows, by mechanical or chemical means, burrow in the rocks - See Urchin and Periwinkles

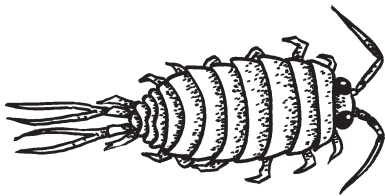
Attachment - Sea Star (tube feet), Limpet (Basal foot), Algae - hold fasts (root like)

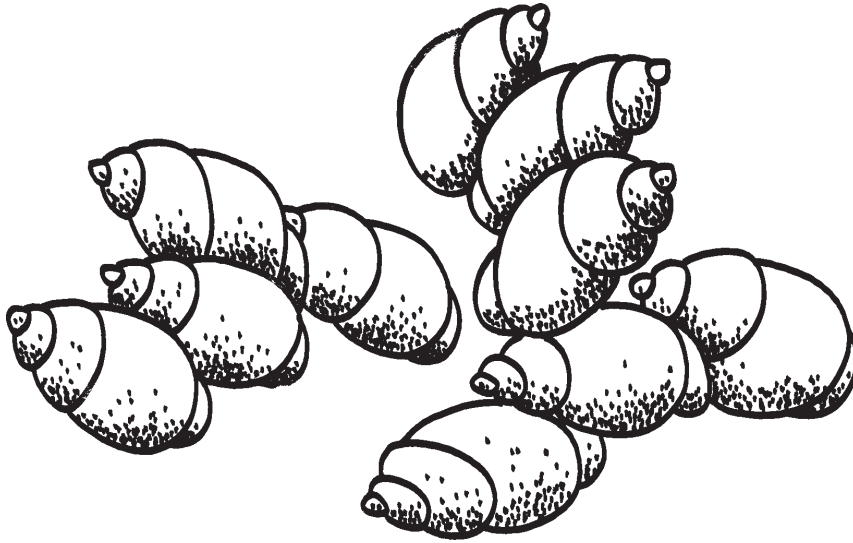
Cement - Barnacles

Guy Lines - Mussels



# Splash Zone Animals





# Periwinkle Snail

Mollusc

*Littorina sp.*

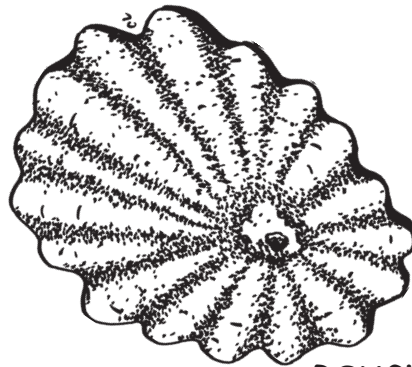
The tiny periwinkle snail is a common resident of the splash zone.

**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*

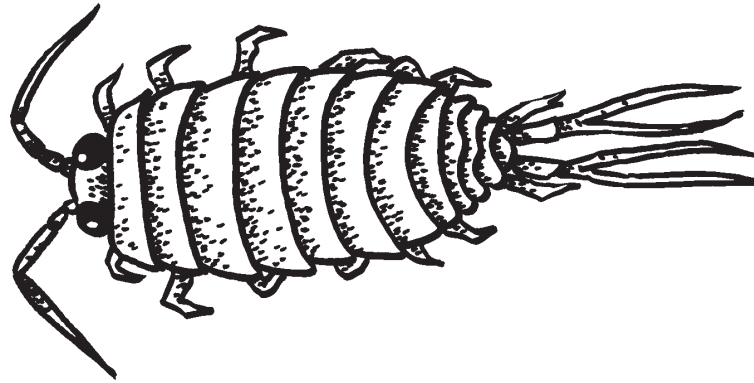
A variety of limpets are common residents in the intertidal area.

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

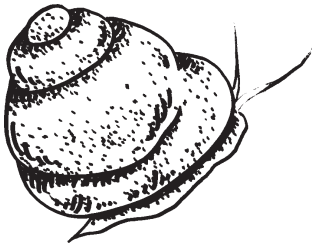
*Balanus glandula*

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

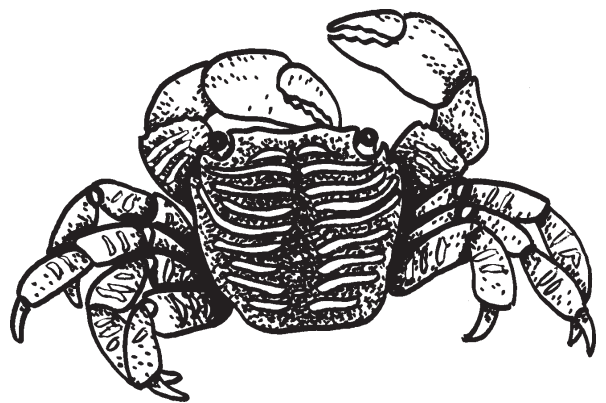
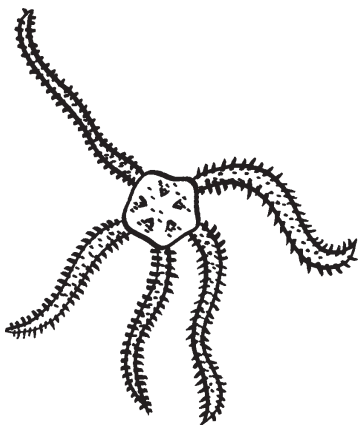
Adaptations: The acorn barnacle cements itself to a hard surface. It has a hard shell with two plates that it can pull shut to protect it from drying out.

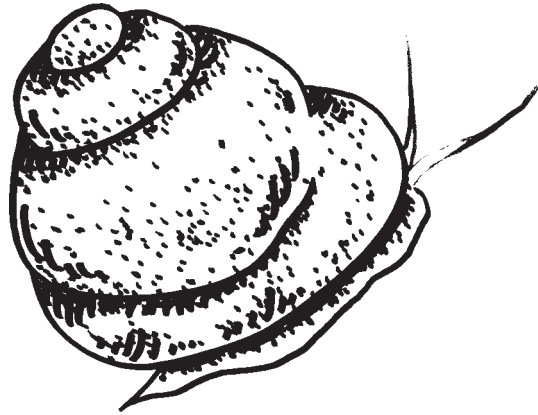
A relative of the crab, young barnacles are free floating for their first weeks of life. They can detect others of their kind (even though barnacles are blind), and when they do they settle by cementing their head to a rock or other surface they build a shell around themselves. The shell has plates that 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

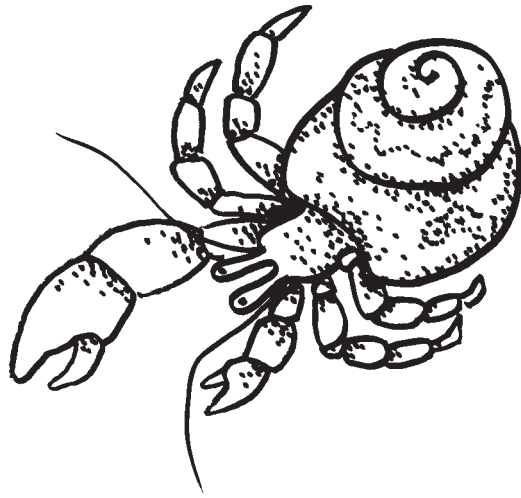
*Tegula funebris*

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

Adaptations: The black 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

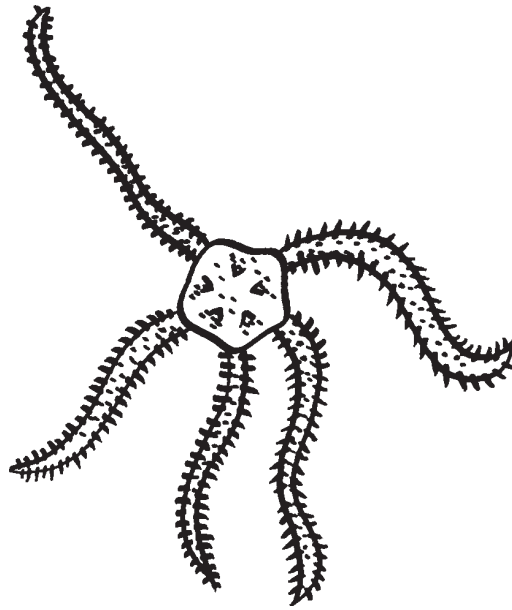
*Pagurus spp.*

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

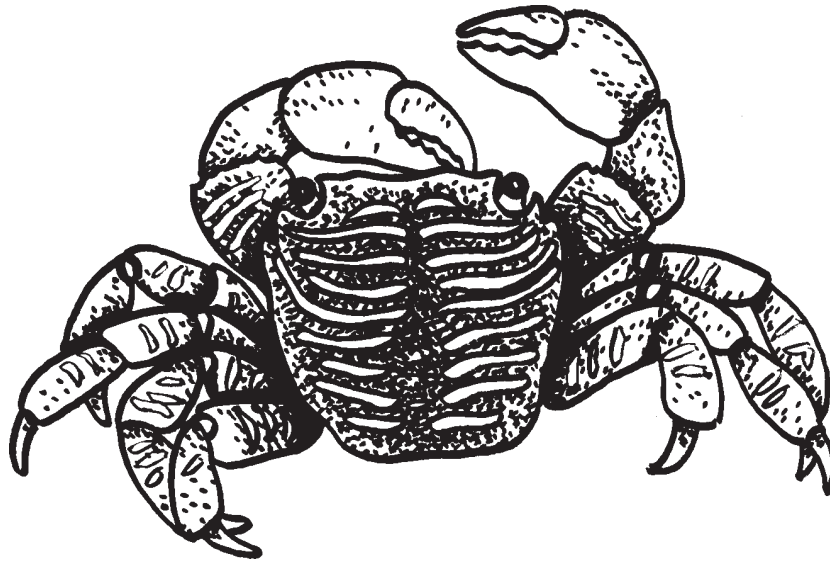
*Amphipholis pugetana*

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*

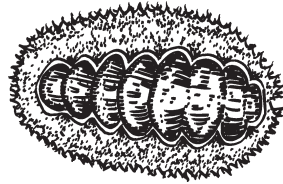
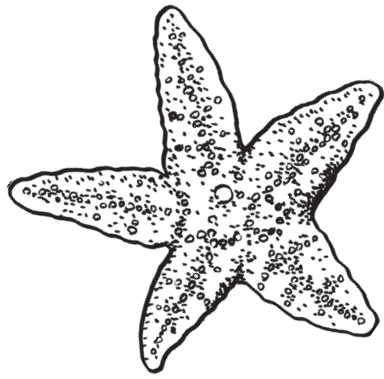
The lined shore crab is a common resident of the high-tide zone.

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.

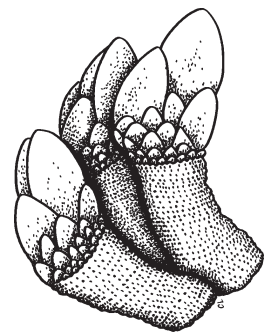
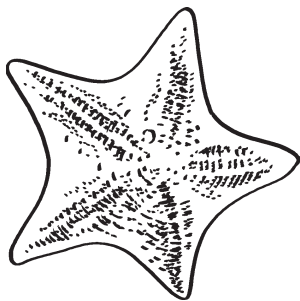
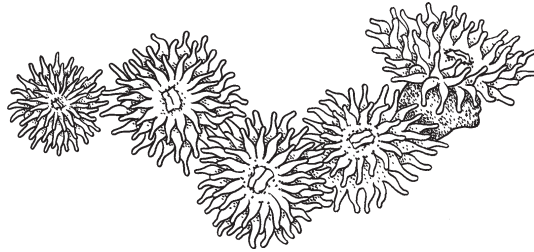
The green lined shore crab is the dominant crab of the high tide zone from Oregon to Mexico. This crab is out of the water much of the time and is able to survive in a variety of temperatures. Its flat body allows it to hide in rock crevices. It is very active (it actually runs sideways) and will run 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.

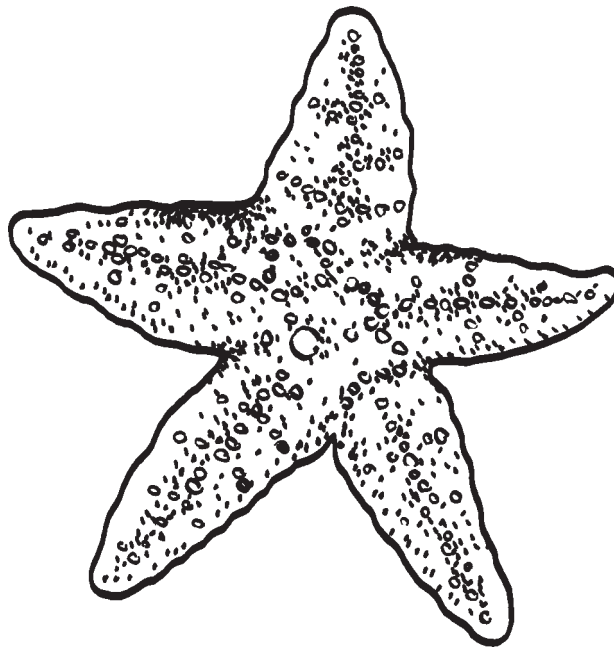
Additional information can be found in Pacific Intertidal Life, page 40.





# Mid-Tide Zone Animals





# Ochre Sea Star

Echinoderm

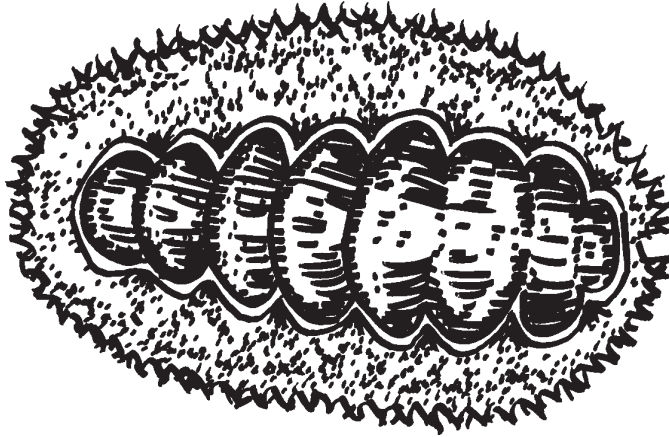
*Pisaster ochraceus*

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

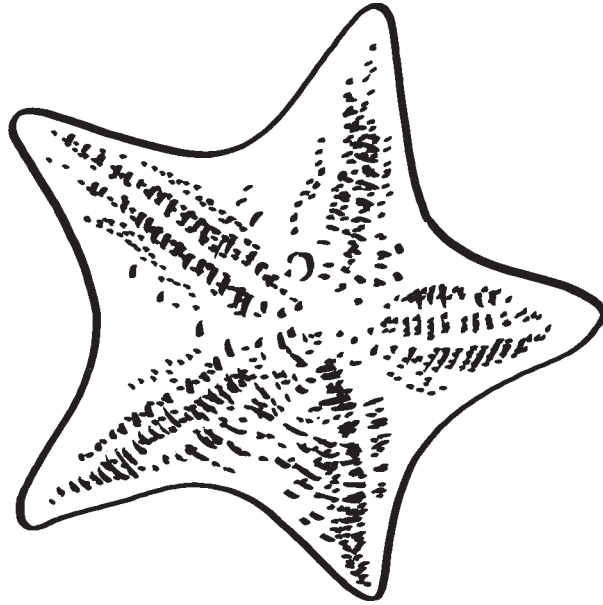
*Mytilus californianus*

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.



# Bat Star

Echinoderm

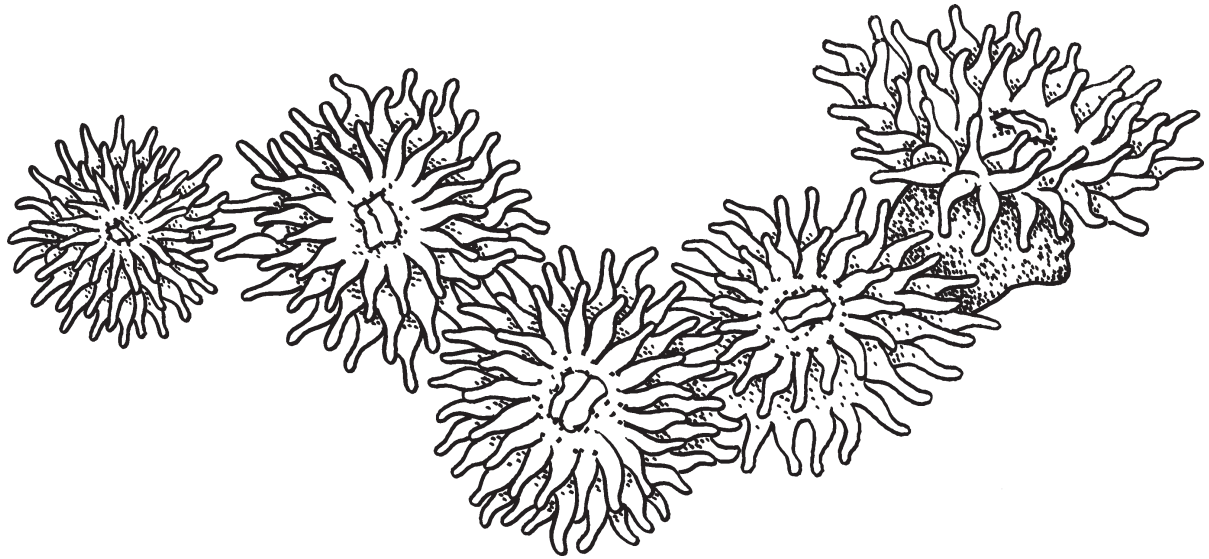
*Patiria miniata*

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

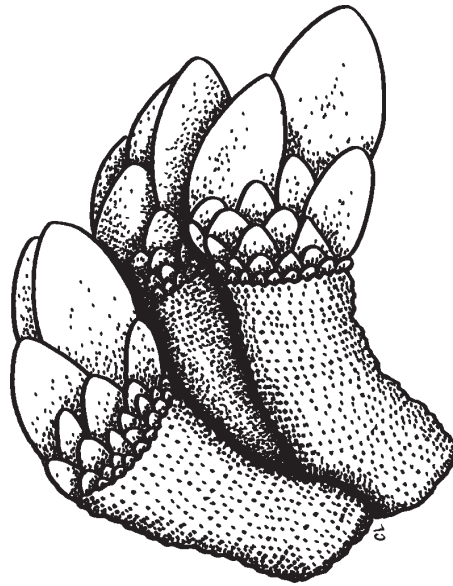
*Anthopleura elegantissima*

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 is 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

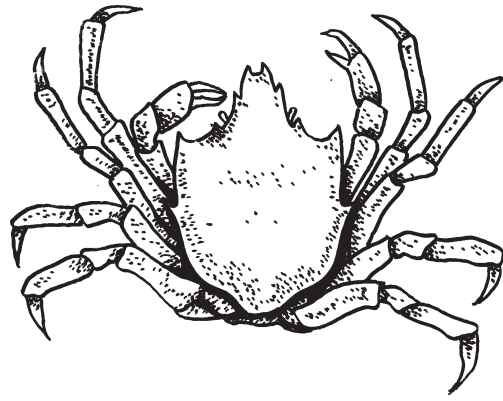
*Pollicipes polymerus*

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

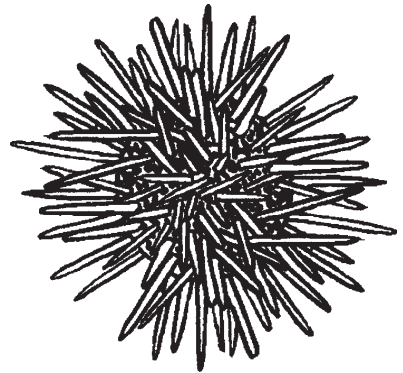
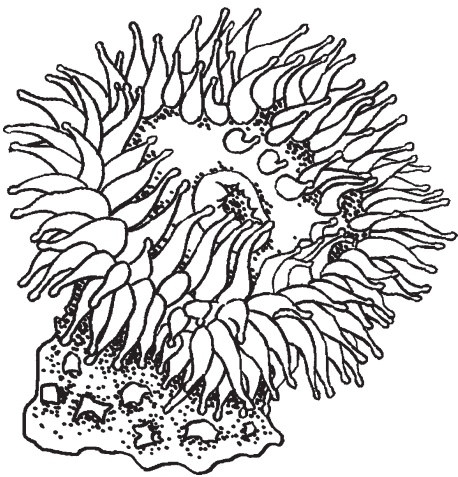
**Adaptations:** This barnacle has a flexible neck that allows it to turn to face the direction of incoming water to help it get the most food. It can also clamp its hard shells shut to keep wet when the tide is out.

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.

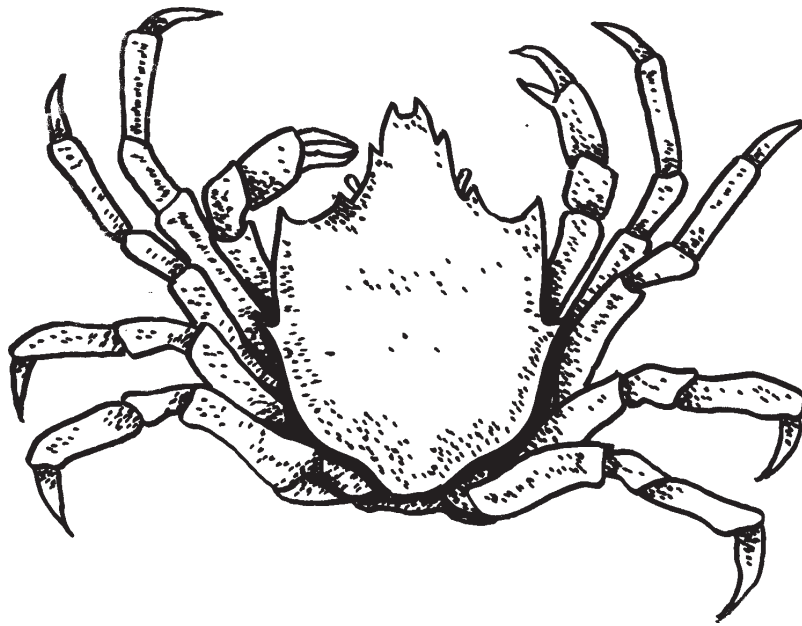
Additional information can be found in Pacific Intertidal Life, page 39.



# Low-Tide Zone Animals







# Kelp Crab

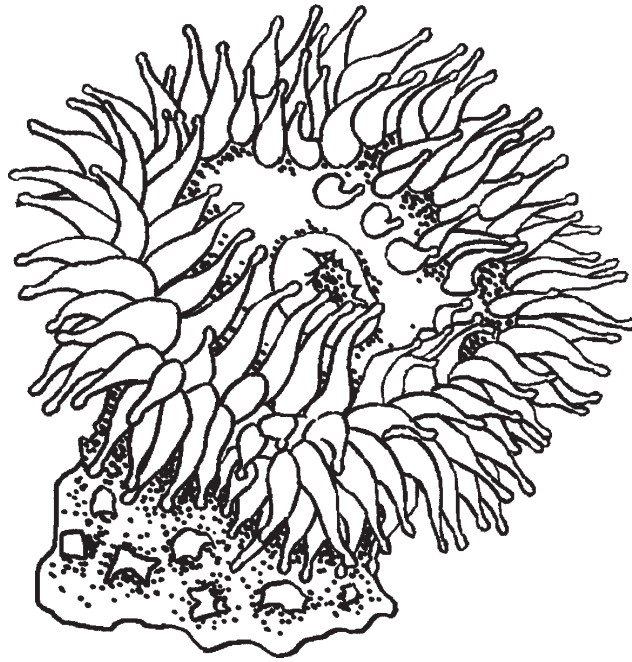
Arthropod  
*Pugettia producta*

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

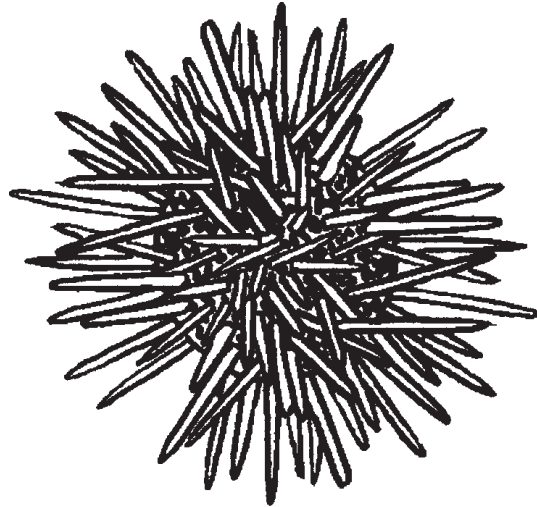
*Anthopleura xanthogrammica*

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

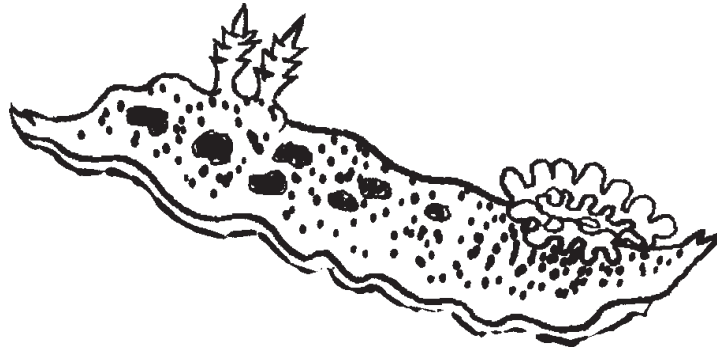
*Strongylocentrotus purpuratus*

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.

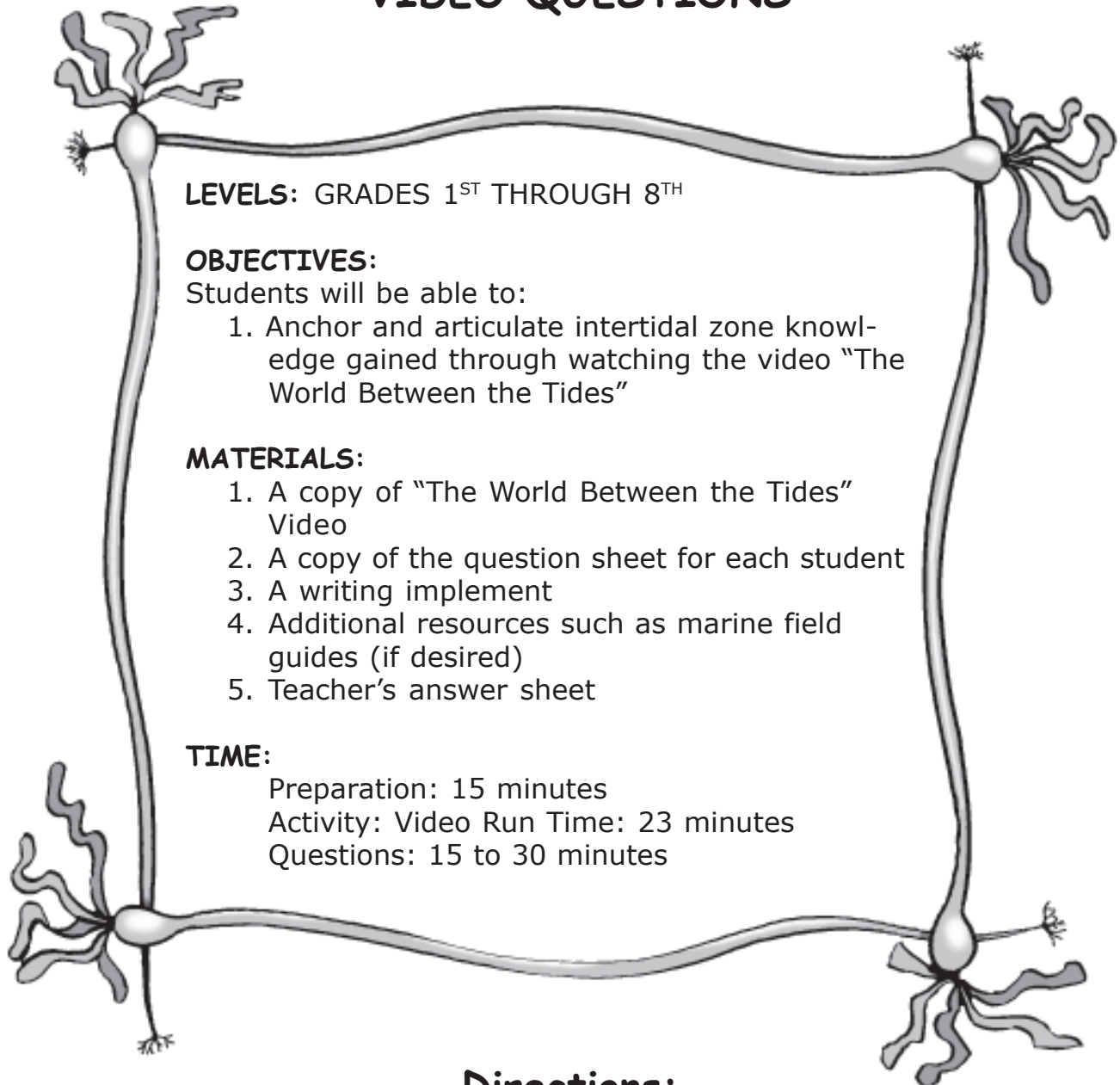
Adaptations: Certain nudibrachs can eat anemone's stingers and then store the poison in their own tentacles for their own use.

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 IV**  
**PRE-TRIP ACTIVITIES**

## "THE WORLD BETWEEN THE TIDES" VIDEO QUESTIONS



**LEVELS:** GRADES 1<sup>ST</sup> THROUGH 8<sup>TH</sup>

**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

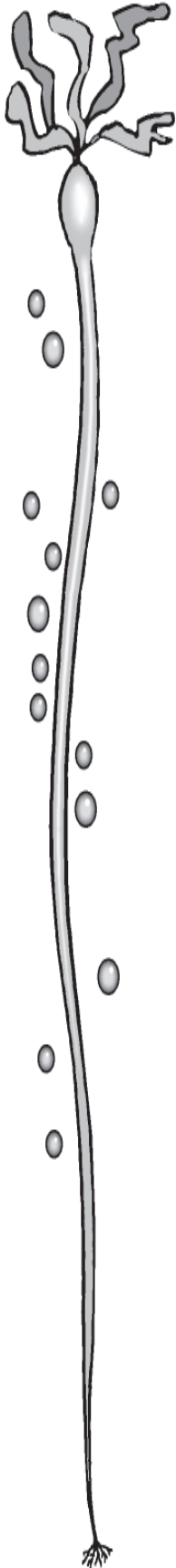
### **Directions:**

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"

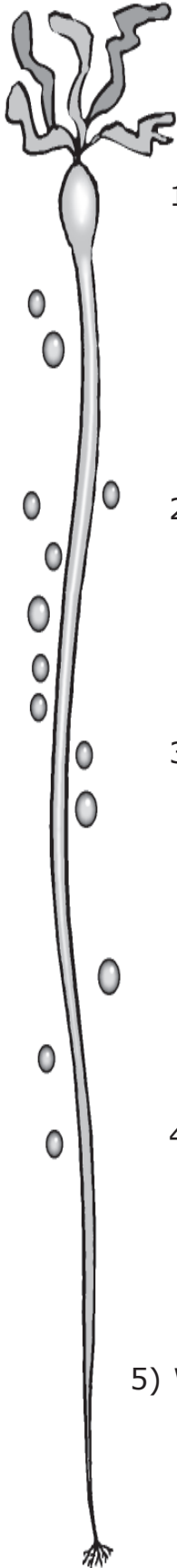
### VIDEO QUESTIONS



- 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)

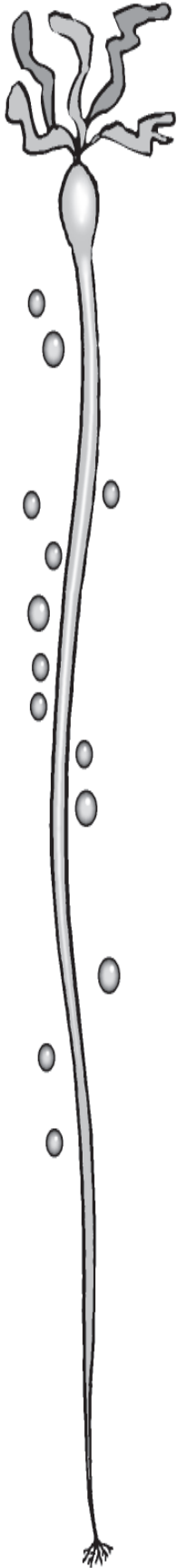
- 4) What causes the tides?

-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 chlorophyll 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

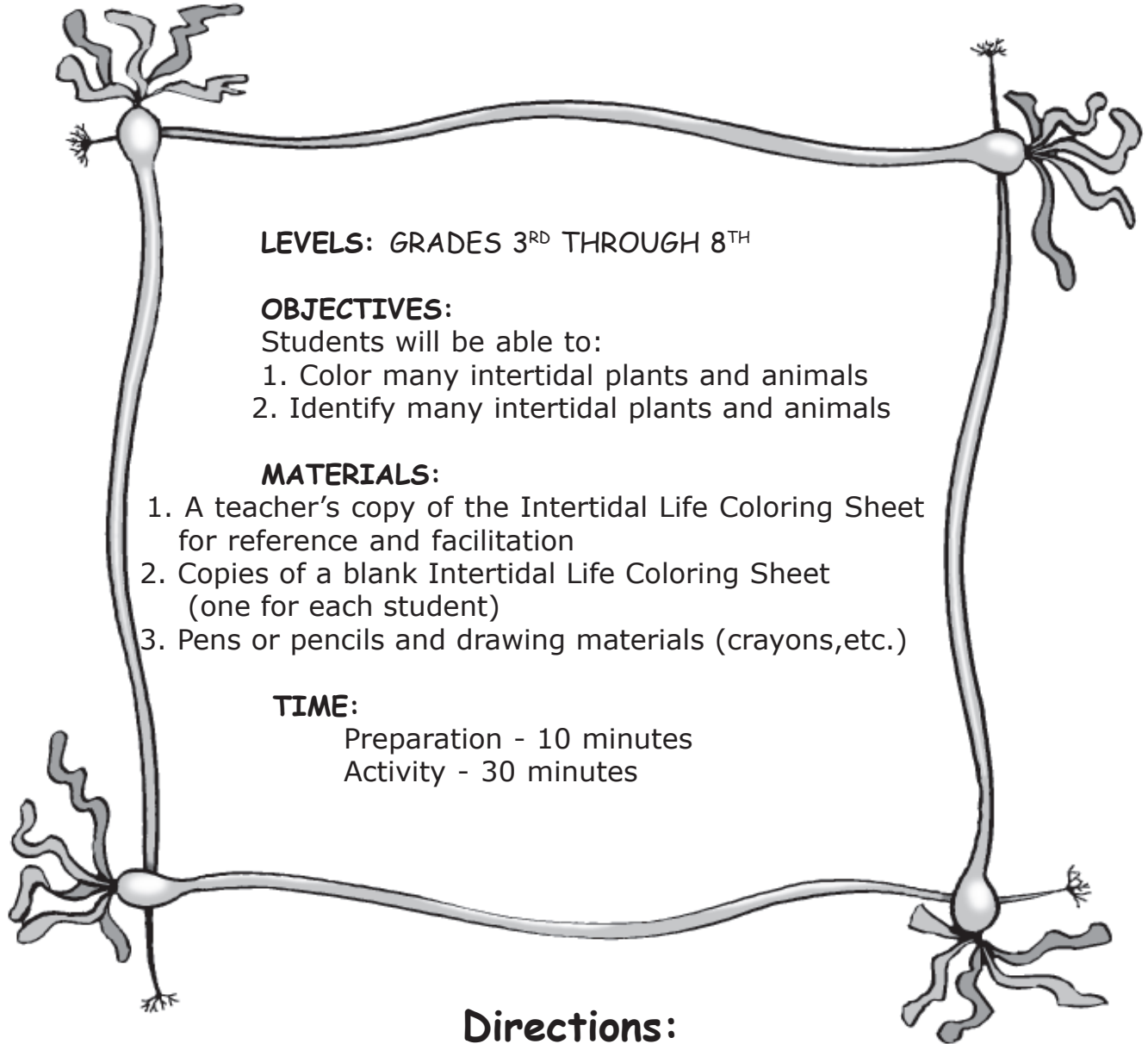
10) Name three things we can do to avoid damage to intertidal animals and plants when we visit the shore.

- 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

## TIDE-POOL PRE/POST-SITE ACTIVITY

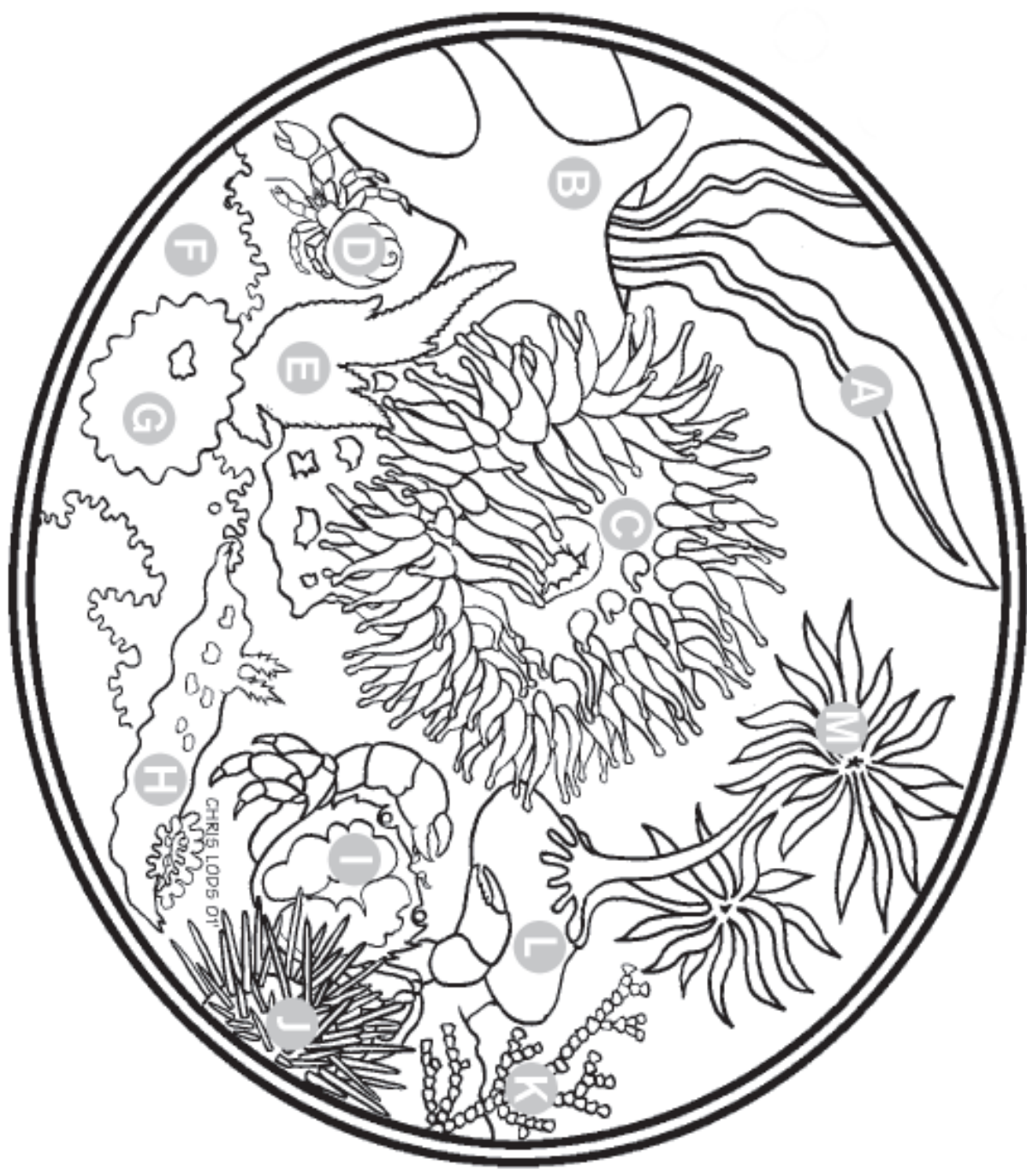
# INTERTIDAL LIFE COLORING PROJECT

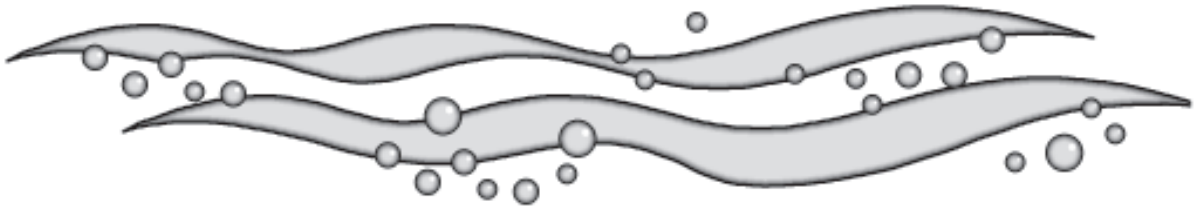
Note: this activity is appropriate either following the viewing of "The World Between the Tides Video" or following your Tidepooling Fieldtrip



1. **DISTRIBUTE** blank Intertidal Life Coloring Sheets
2. **EXPLAIN** to students that they will be expected to  
-color and identify the intertidal plants and animals in the picture
3. **REVIEW** the intertidal plants and creatures with the class  
(or have students discuss this in small groups)
4. **INSTRUCT** students to color and identify each of the animals in the diagram
5. Have each student identify and **SHARE** their favorite plant or animal in the diagram

A- Wing Kelp, B- Leather Star, C- Gaint Green Anemone, D- Hermit Crab, E- Ostrich Plume Hydroid, F- Encrusting Coralline Alga, G- Rough Limpet, H- Lemon Nudibranch, I- Purple Shore Crab, J- Purple Urchin, K- Coralline Alga, L- Encrusting Red Sponges, M- Sea Palm.





# PART V

## TRIP ACTIVITIES



## 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.

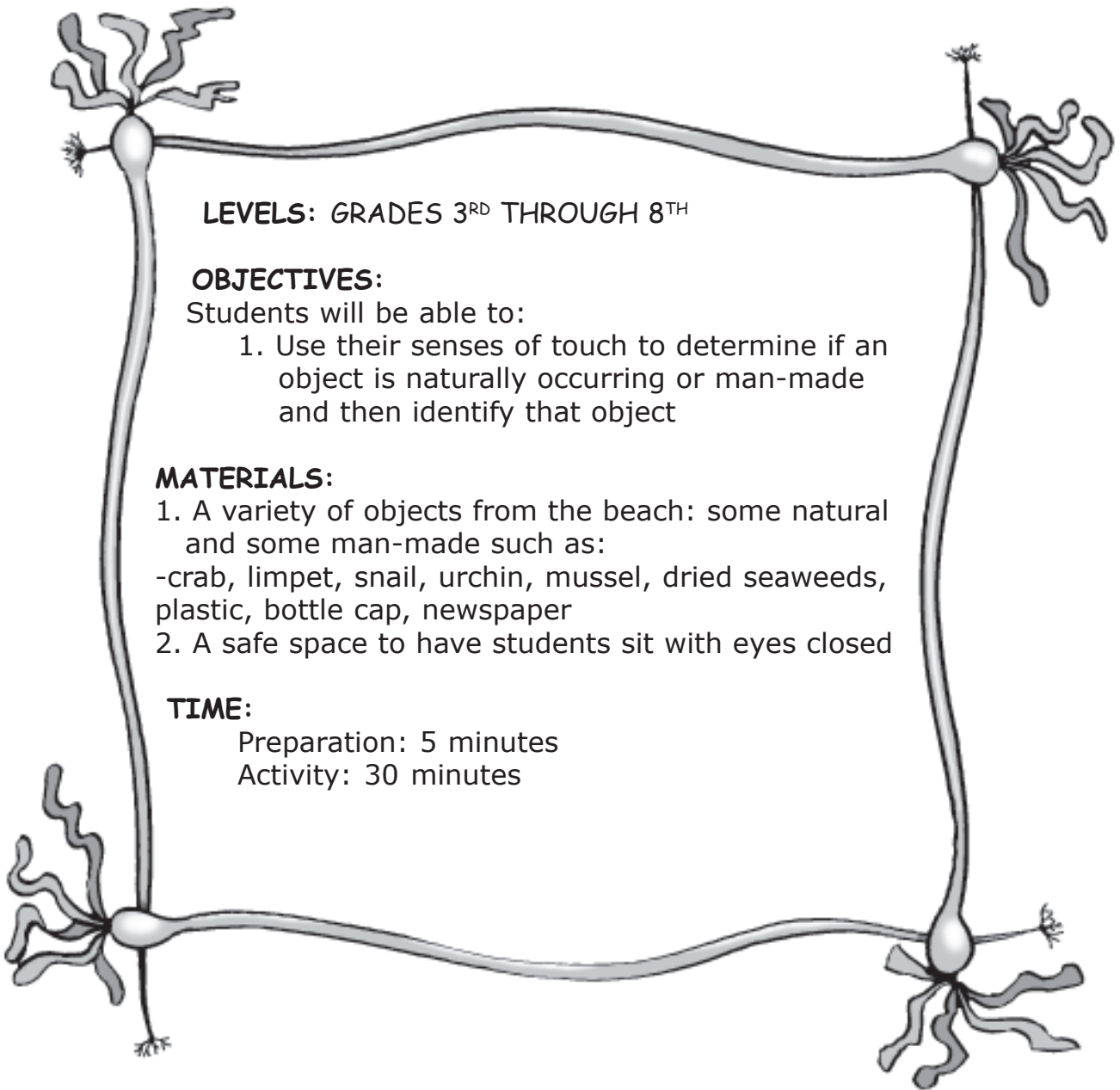
The use of story and metaphor can be very effective as a means of communicating a point to school age children.



- ◆ 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 3<sup>RD</sup> THROUGH 8<sup>TH</sup>

**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:

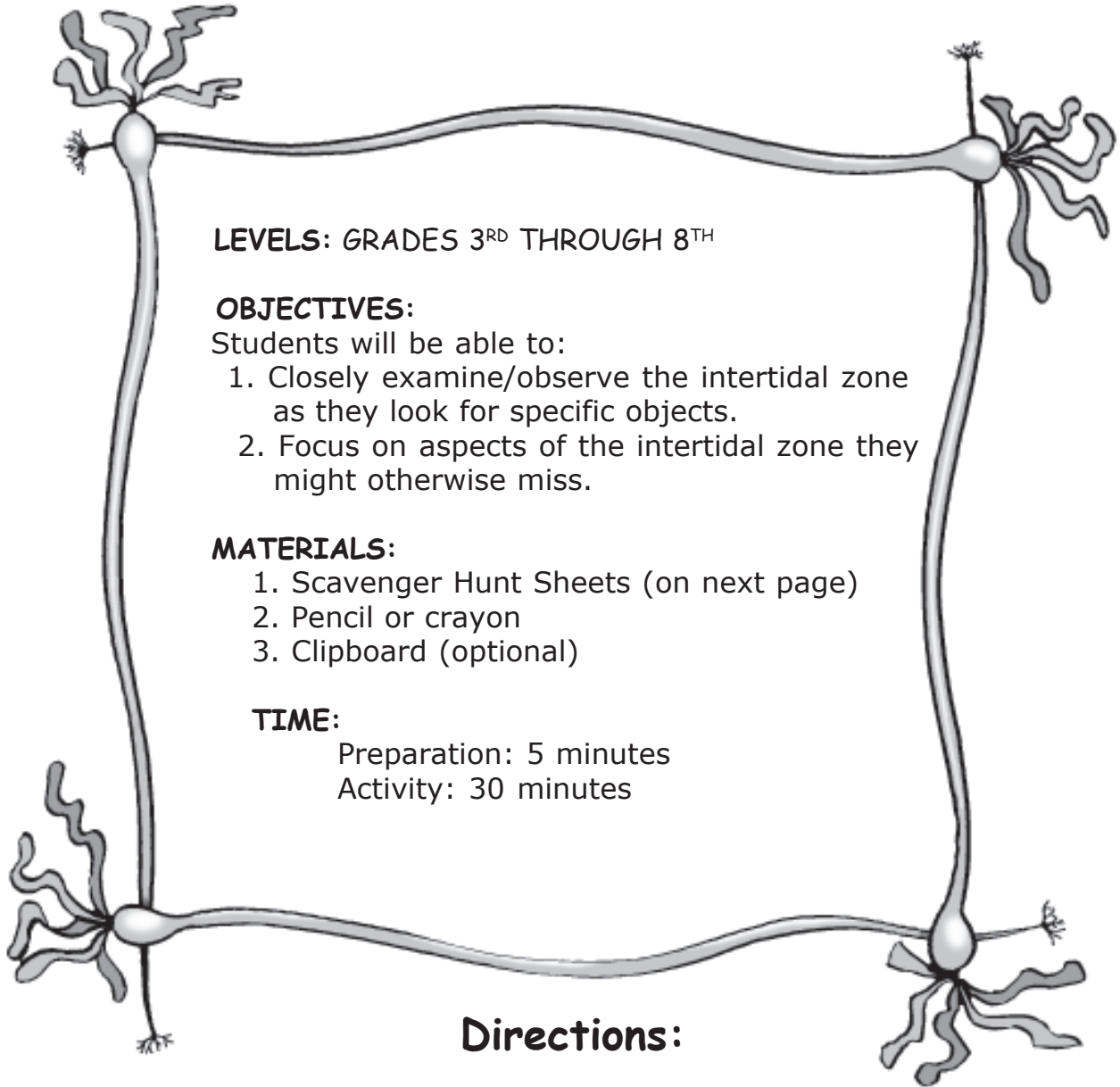
- a. Is the object naturally occurring or man-made?
- b. What is the object?
- c. Should we leave it on the beach or take it away?

**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 3<sup>RD</sup> THROUGH 8<sup>TH</sup>

**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.



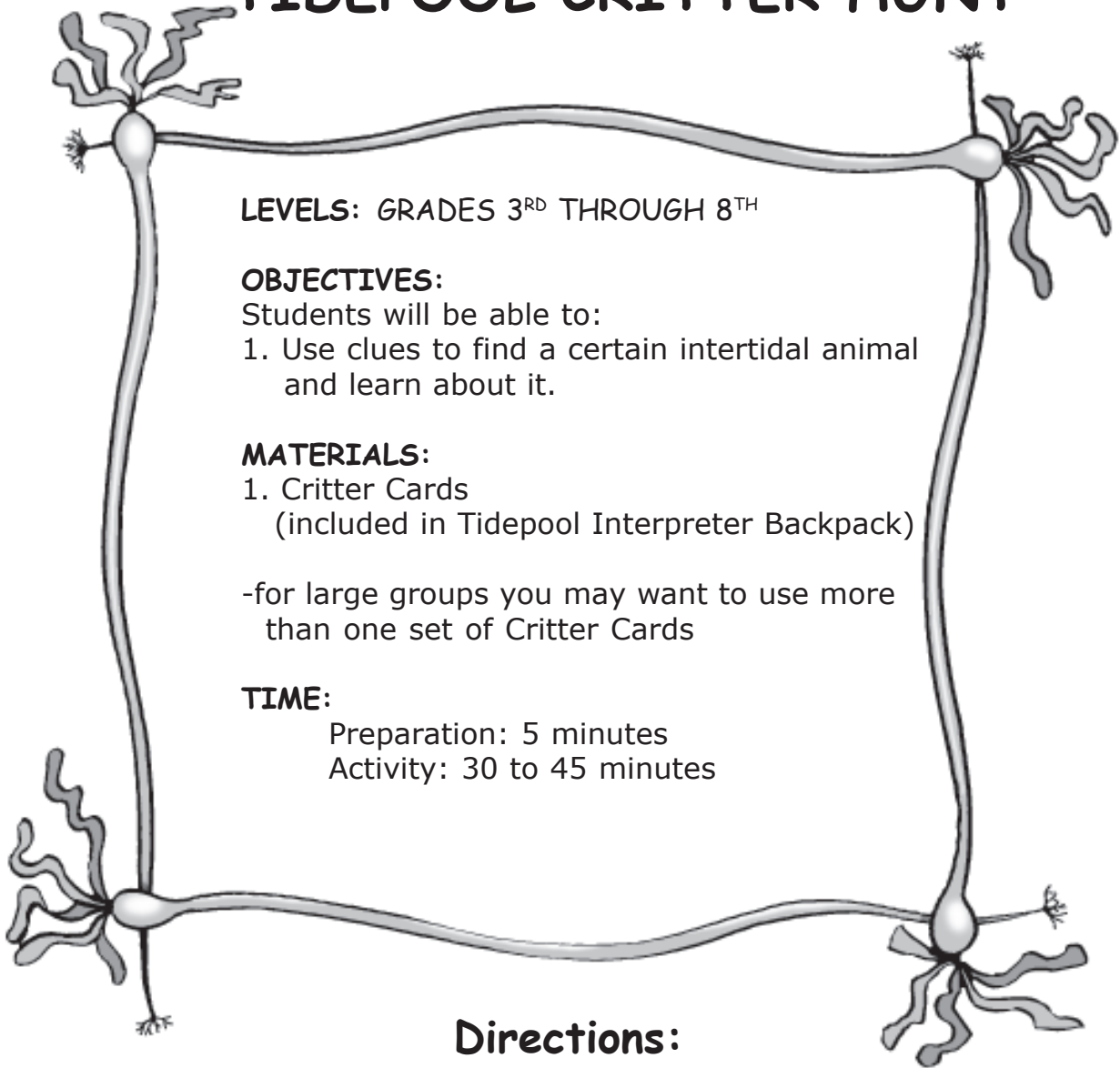
# TIDEPOOL SCAVENGER HUNT

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 3<sup>RD</sup> THROUGH 8<sup>TH</sup>

**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

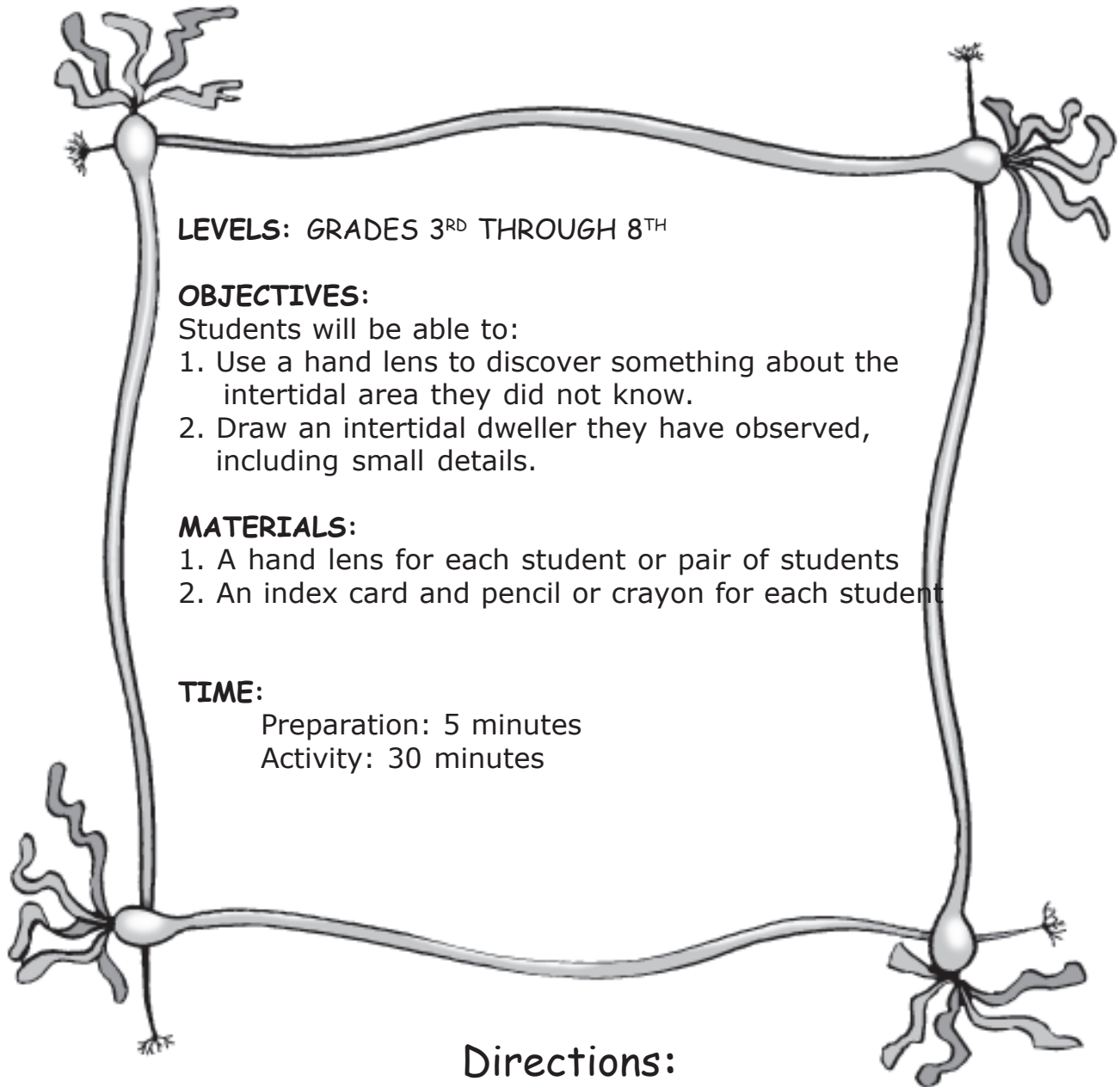
Activity: 30 to 45 minutes

## 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 3<sup>RD</sup> THROUGH 8<sup>TH</sup>

**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

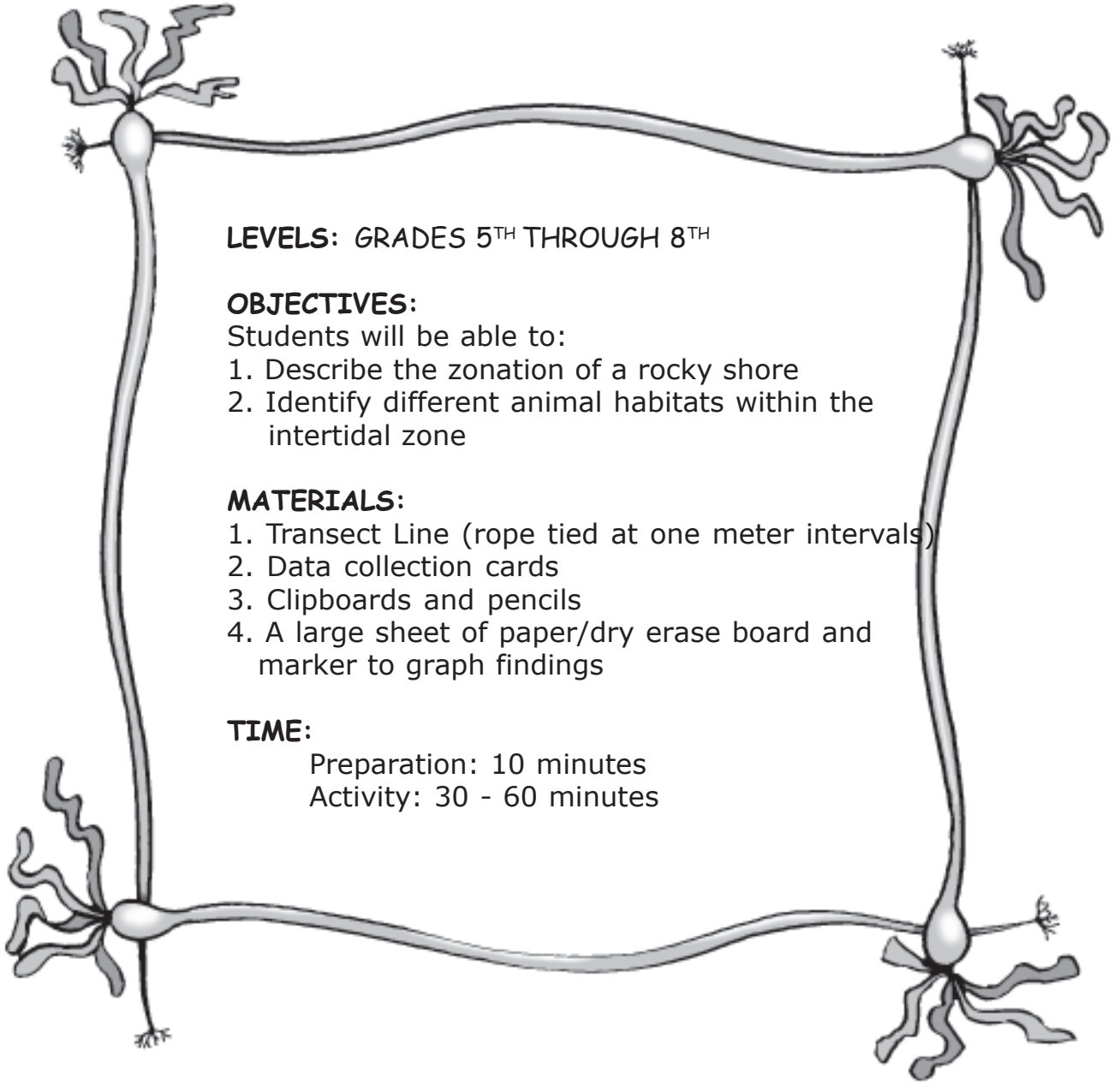
**TIME:**

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.

# INTERTIDAL TRANSECT



**LEVELS:** GRADES 5<sup>TH</sup> THROUGH 8<sup>TH</sup>

**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.)

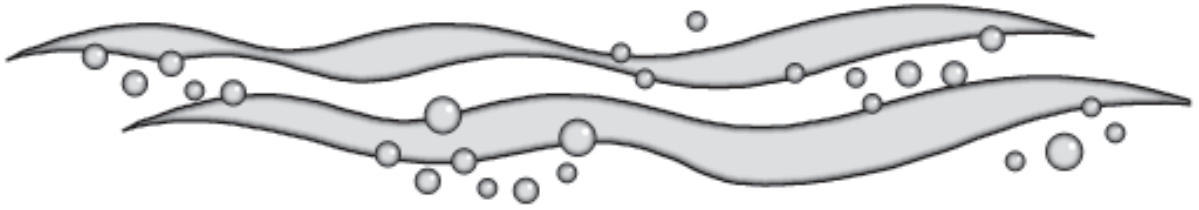
**5. GATHER** the group back together.

**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.





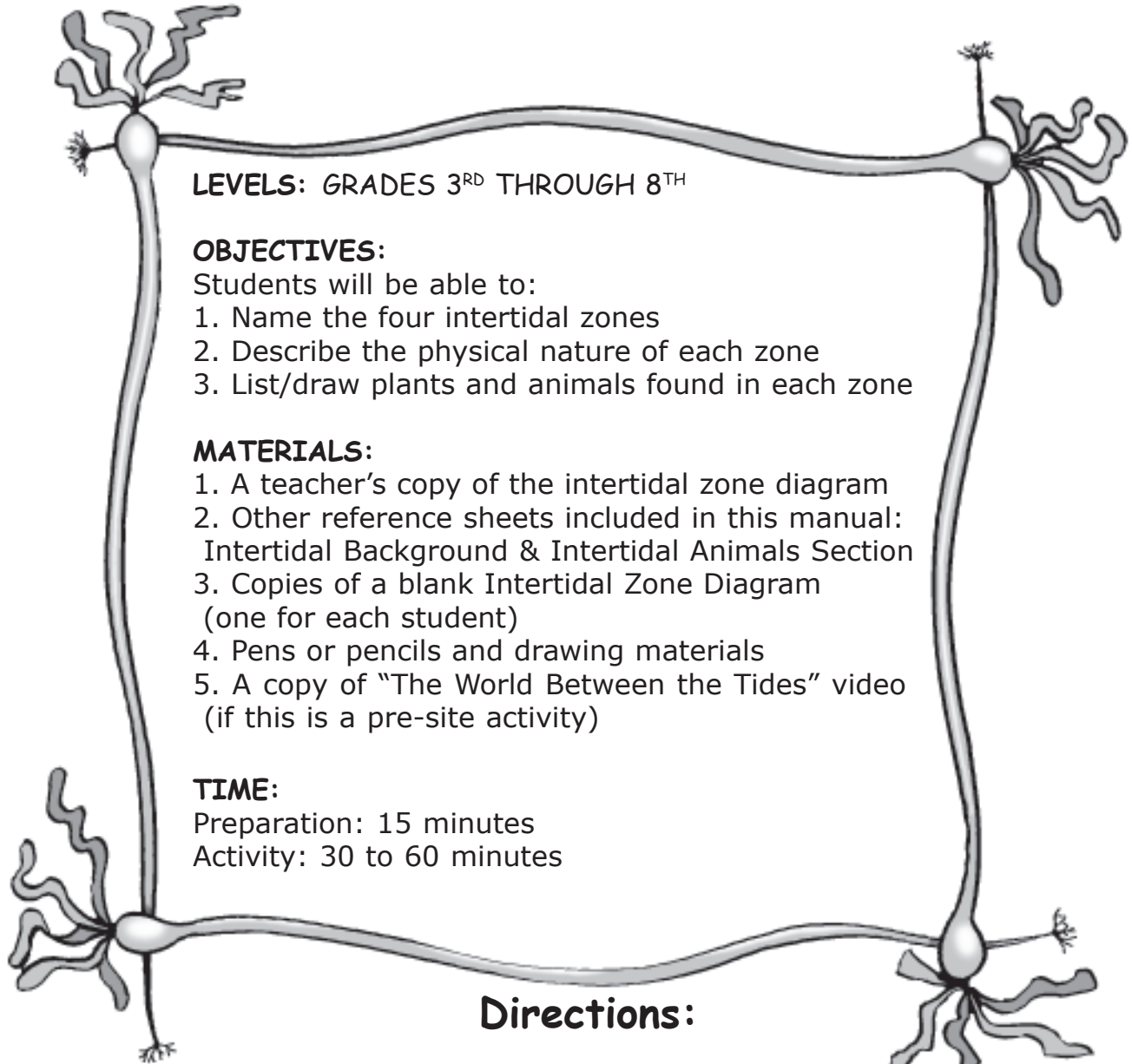
**PART V  
PRE OR POST-TRIP  
ACTIVITIES**



## TIDEPOOL PRE/POST-SITE ACTIVITY

# INTERTIDAL ZONE DIAGRAM PROJECT

Note: this activity is appropriate either following the viewing of "The World Between the Tides" video or following your Tidepooling field trip



- 1. DISTRIBUTE** blank Intertidal Zone Diagrams and writing or drawing implements to students  
(students can work on their own or in small groups)
- 2. EXPLAIN** to students that they will be expected to:
  - Name the four zones on the diagram from top to bottom
  - Describe the physical nature of each zone
  - List or draw some of the plants and animals found in each zone

## TIDEPOOL PRE/POST-SITE ACTIVITY

# INTERTIDAL ZONE DIAGRAM PROJECT - continued

**3. REVIEW** the intertidal zones, including the physical nature of each zone and animals living there with the class.  
(or have students discuss this in small groups)

**4. INSTRUCT** students to fill out their diagrams, including:

- The names of the four intertidal zones
- A description of the physical nature of each zone
- A list or drawing of plants and animals found in each zone

\*\*\*You can have students just draw plants and animals to turn this into more of an art activity, in which case they would not need to fill in the names and nature of the zones\*\*\*

**5. COLLECT** diagrams and possibly **DISPLAY** them in the classroom





## TIDEPOOL PRE/POST-SITE ACTIVITY

# INTERTIDAL ZONE DIAGRAM PROJECT VERSION 2: CUT AND PASTE

Note: this activity is appropriate either following the viewing of "The World Between the Tides Video" or following your Tidepooling field trip



**LEVELS:** GRADES 3<sup>RD</sup> THROUGH 8<sup>TH</sup>

### OBJECTIVES:

Students will be able to:

1. Name the four intertidal zones
2. Recognize and name common intertidal animals
3. Cut out -pictures of intertidal animals and place them in the proper zone

### MATERIALS:

1. A teacher's copy of the intertidal zone diagram
2. Other reference pages included in this manual - Intertidal Background (Zonation) & Intertidal Animals
3. A blank Intertidal Zone Diagram for each student
4. An Intertidal Creatures Page for each student
5. Pens, pencils, drawing materials and glue
6. A copy of "The World Between the Tides" Video. (if this is a pre-site activity)

### TIME:

Preparation: 15 minutes  
Activity: 30 to 60 minutes

## Directions:

**1. DISTRIBUTE** blank (enlarged) Intertidal Zone Diagrams and Intertidal Creatures Page to paste on diagram (students can work on their own or in small groups)

## TIDEPOOL PRE/POST-SITE ACTIVITY

# INTERTIDAL ZONE DIAGRAM PROJECT VERSION 2: CUT AND PASTE - continued

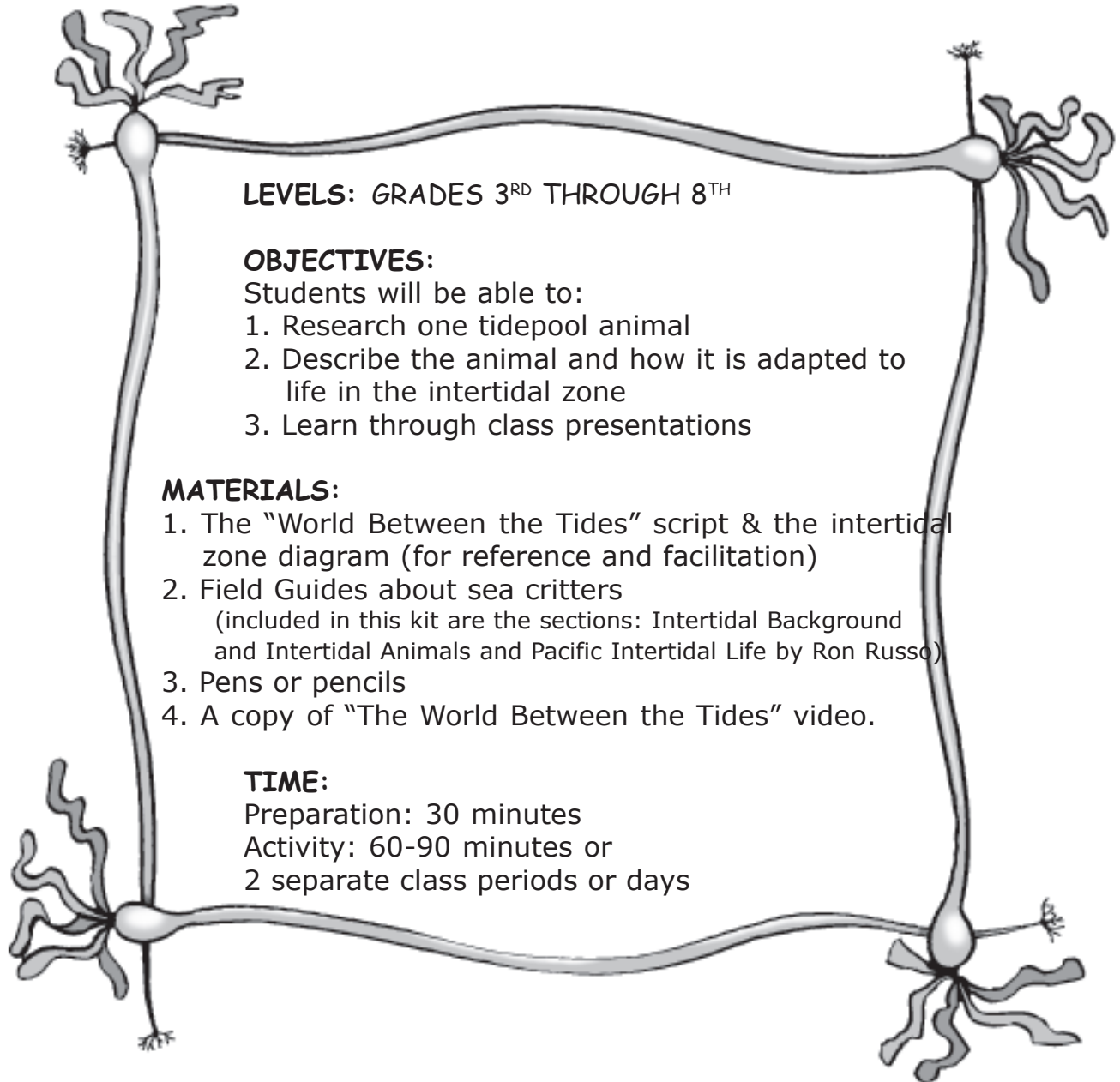
- 2. EXPLAIN** to students that they will be expected to
  - Cut out the intertidal animals
  - Glue them to the diagram in the correct zone
- 3. REVIEW** the intertidal zones, including the physical nature of each zone and plants and animals living there with the class (or have students discuss this in small groups)
- 4. INSTRUCT** students to cut and paste plants and animals to their diagrams, then HAVE students can color them
- 5.** Have each student **SHARE** where they put at least one animal and why.



## TIDEPOOL PRE-/POST-SITE ACTIVITY

# TIDEPOOL CREATURE FEATURE PRESENTATIONS

*Note: this Activity is appropriate either following the viewing of "The World Between the Tides Video" or following your Tidepooling field trip.*



**LEVELS:** GRADES 3<sup>RD</sup> THROUGH 8<sup>TH</sup>

**OBJECTIVES:**

Students will be able to:

1. Research one tidepool animal
2. Describe the animal and how it is adapted to life in the intertidal zone
3. Learn through class presentations

**MATERIALS:**

1. The "World Between the Tides" script & the intertidal zone diagram (for reference and facilitation)
2. Field Guides about sea critters  
(included in this kit are the sections: Intertidal Background and Intertidal Animals and Pacific Intertidal Life by Ron Russo)
3. Pens or pencils
4. A copy of "The World Between the Tides" video.

**TIME:**

Preparation: 30 minutes

Activity: 60-90 minutes or

2 separate class periods or days

## Directions:

- 1. REVIEW** tidepool animals and their adaptations as a class (students can brainstorm here)
- 2. BREAK** students into nine groups.

## TIDEPOOL PRE-/POST-SITE ACTIVITY

# TIDEPOOL CREATURE FEATURE PRESENTATIONS- continued

**3. RESEARCH:** have each group research one of the following tidepool creatures:

Barnacles  
Chiton  
Limpets  
Periwinkle Snails  
Sea Stars  
Sea Anemones  
Lined Shore Crabs  
Hermit Crabs  
Mussels

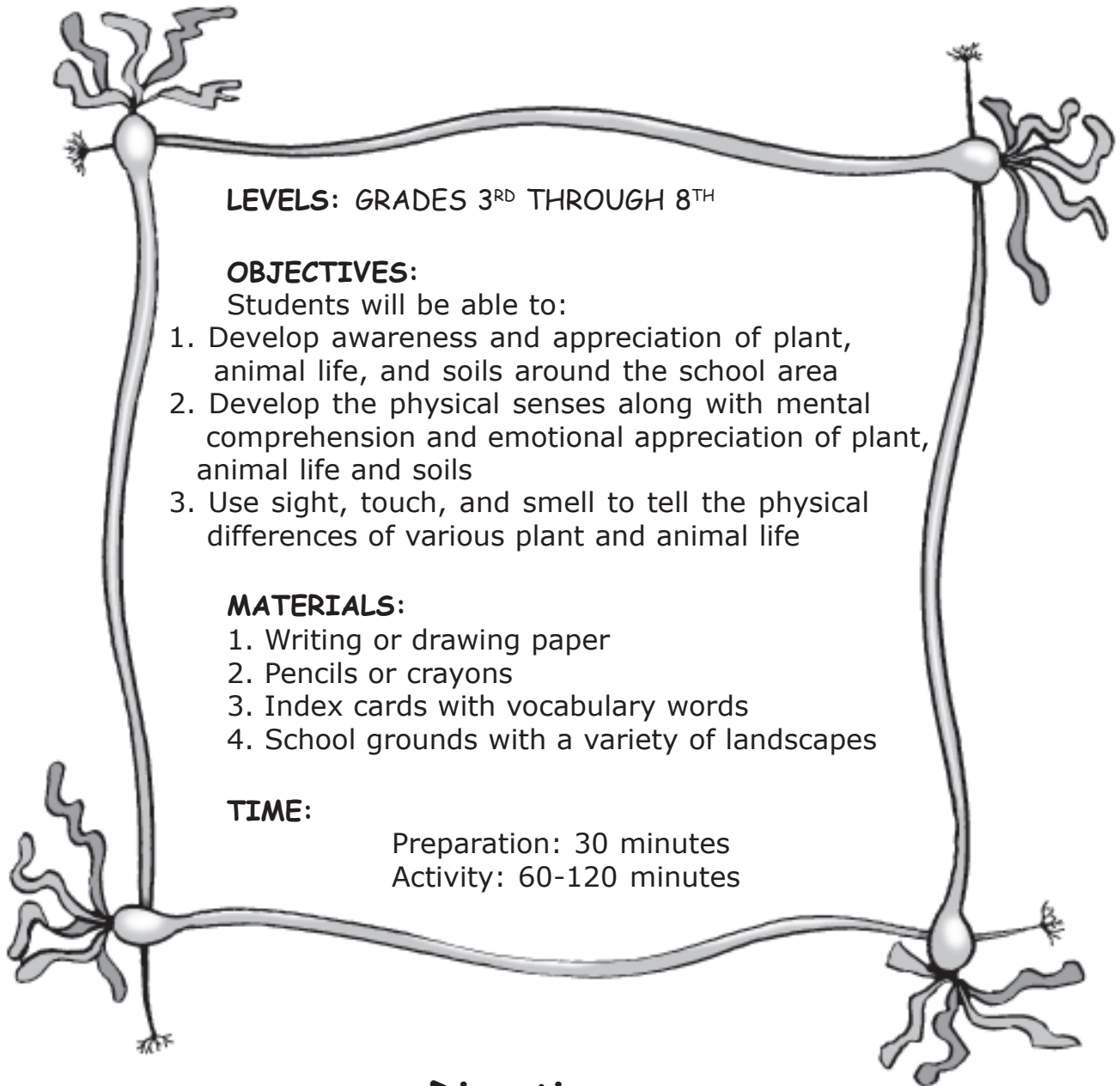
Where does your creature live?  
Does your creature move? How?  
What does your creature eat?  
What eats your creature?  
How is your creature adapted to life in the intertidal zone?

(There is a good deal of information presented about these critters in the video and each animal is covered in the Intertidal Animals section of this manual as well as in Pacific Intertidal Life by Ron Russo.)

**4. PRESENT:** have each group give a presentation about their animal



## EXPLORING YOUR SCHOOL NEIGHBORHOOD



**LEVELS:** GRADES 3<sup>RD</sup> THROUGH 8<sup>TH</sup>

**OBJECTIVES:**

Students will be able to:

1. Develop awareness and appreciation of plant, animal life, and soils around the school area
2. Develop the physical senses along with mental comprehension and emotional appreciation of plant, animal life and soils
3. Use sight, touch, and smell to tell the physical differences of various plant and animal life

**MATERIALS:**

1. Writing or drawing paper
2. Pencils or crayons
3. Index cards with vocabulary words
4. School grounds with a variety of landscapes

**TIME:**

Preparation: 30 minutes

Activity: 60-120 minutes

### Directions:

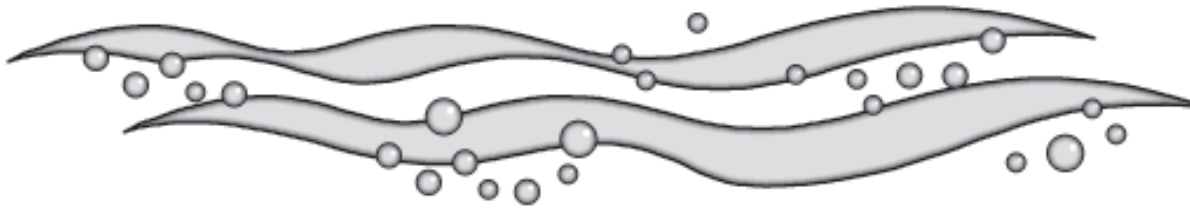
1. **EXPLAIN** that the class will explore school grounds or neighborhood to learn about various trees, flowers, animals, soil, etc. Note that this is preparation for a visit to Sonoma Coast State Beach.
2. **REVIEW** physical elements of the plants and animal life that will be seen in the area, before leaving the classroom. Depending on the knowledge level of the students, this section can be a brief synopsis. This is a tool for building vocabulary.

SONOMA COAST TIDEPOOL PRE/POST-SITE ACTIVITY

**EXPLORING YOUR SCHOOL NEIGHBORHOOD  
-continued**

- 3. TOUR A SPECIFIC SCHOOL AREA.** Ask each student to tell about what she/he sees. Point out different soils, plants, and animals and discuss how they affect each other in their neighborhood – much as humans do.
- 4. RETURN** to the classroom and have each student **DESCRIBE** his/her smelling and touching experience.
- 5.** Students **DRAW** their experience from memory.  
Students **WRITE** about their experience from memory.





## **PART VII**

# **ADDITIONAL RESOURCES**



# REFERENCES AND ADDITIONAL RESOURCES

(\*\*\*DENOTES HIGHLY RECOMMENDED REFERENCES)

## FIELD GUIDES

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*National Audubon Society Field Guide to California.*  
New York, New York: Chanticleer Press, 1998.

Amos, Stephen.  
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McConnaughey, Bayard & Evelyn McConnaughey. \*\*\*  
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*A Field Guide to Pacific Coast Shells.*  
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*Pacific Intertidal Life.*  
Rochester, NY: Nature Study Guild, 1981.

Sheldon, Ian.  
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Renton, WA: Lone Pine Publishing, 1999.

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*Mac's Field Guide to California Coastal Invertebrates.*  
Seattle, WA: The Mountaineers, 1997.



## INTERTIDAL MARINE BIOLOGY

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Berkeley, CA: University of California Press, 1973.

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*Exploring Pacific Coast Tidepools.*  
Happy Camp, CA: Naturegraph Publishers, 1996.

Connor, Judith.  
*Seashore Life on Rocky Coasts.*  
Monterey, CA: Monterey Bay Aquarium Foundation, 1993.

McLachlan, Dan & Jak Ayers.  
*Fieldbook of Pacific Northwest Sea Creatures.*  
Happy Camp, CA: Naturegraph Publishers, 1979.

Rickets, Edward & Jack Calvin, Joel Hedgepath. \*\*\*  
*Between Pacific Tides: 5<sup>th</sup> Edition.*  
Stanford, CA: Stanford University Press, 1985.

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Happy Camp, CA: Naturegraph Publishers, 1962.

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*The Intertidal Wilderness: A Photographic Journey Through Rocky-Shore Tidepools.*  
San Francisco, CA: Sierra Club Books, 1984.

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Brown, Vincent & Douglas Andrews.  
*The Pomo Indians of California and their Neighbors.*  
Happy Camp, CA: Naturegraph Publishers, 1969.

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*Memories of Sonoma Coast.*  
Santa Rosa, CA: Legacy Press, 1996.

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*The Natural World of the California Indians.*  
Berkeley, CA: University of California Press, 1980.

Grady, Rex.  
Let Ocean Seethe and Terra Slide: *A History of the Sonoma Coast and the State Park that Shares It's Name.*  
Occidental, CA: Lilburne Press, 1996.

## **CURRICULUM**

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*Marine and Coastal Educational Resources Directory.*  
NOAA, California Coastal Commission & National Marine Sanctuaries, 1996.

Cornell, Joseph.  
*Sharing Nature with Children.* \*\*\*  
Nevada City, CA: DAWN Publications, 1998.

Coulombe, Deborah.  
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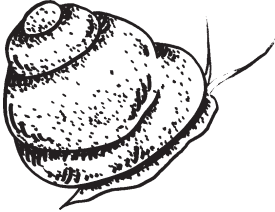
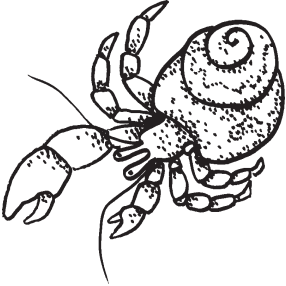
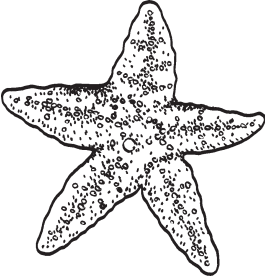
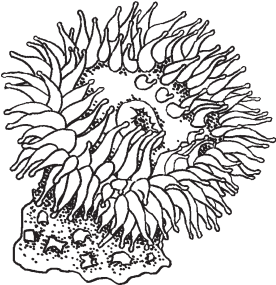
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	Location (Zone)	Habitat (Crevice, tidepool, rock)
